CIVIL ENGINEERING INSTITUTE
"MAKEDONIJA" J.S.

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AGENCY FOR STATE ROADS
OF THE REPUBLIC OF MACEDONIA

Final Construction of Corridor X, Highway E – 75, Section Demir Kapija – Smokvica

ENVIRONMENTAL IMPACT ASSESSMENT STUDY – Update

Skopje, July 2009

UPDATES IN THE EIA FOR DEMIR KAPIJA – SMOKVICA ROAD SECTION

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10	NON-TECHNICAL SUMMARY	Conclusion and recommendation to the Employer regarding the alternative which is to be chosen for construction. Update of the summary with the new findings from the assessment.
31	Introduction	More detailed explanation about the alternatives analyzed.
35, 36	2.1.1. Project Scope	Tables update with data for alternative 2
41	2.1.2.1.3. Demands on auxiliary structures (access roads, borrow pits etc.)	Complete update of the item with explanation of the reasons for excluding the borrow pits and access roads from the study.
48, 49	3.2.1. Tourism development	Update of the figures
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216 - 251	Chapter 8 - Assessment of the impacts	General improvement of the chapter with additional analysis of each impact to the alternatives, and conclusion for each impact regarding its impact itself to the environment.
235	Table for impacts from road construction evaluation	New table with results from the evaluation of the impacts during the road construction
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252 – 276	Chapter 9 – Mitigation measures	Complete update of the mitigation measures Chapter with an estimated costs for implementation for both alternatives
277- 281	Chapter 10 – Analysis of alternatives	Complete update of the analysis (Whole chapter)
282 - 285	Chapter 11 – Concluding remarks and recommendations	Conclusion and recommendation given.
292 -308	Chapter 13 - Environmental Management Plan and Monitoring Plan for the implementation of mitigation measures during the construction of the section Demir Kapija-Smokvica of the Highway E-75 (Corridor X	Monitoring Plan contains monitoring activities which are directly connected to the proposed MMs. It proposes responsible body, implementing body, monitoring frequency, monitoring period and residual impacts.

Foreword to the UPDATED study 2 (July, 2009)

The original EIA study of the section Demir Kapija - Smokvica of the highway E-75 (Corridor X) was prepared in April 2007. It was based upon comparison of two alternatives, named Alternative A and Alternative B. The final recommendation of that EIA study was inconclusive since both alternatives had negative impacts on the natural environment (in the case of Alternative B) or human environment and higher construction costs (Alternative A).

Since there is a justified need for construction of this section of the E-75 Natioal road, a new alignment was proposed in the **first revision** of the EIA done in **March 2008**. This new alignment or alternative was named Alternative B2 and it was a combination of both previous Alternatives A and B (furtheron named Alternative B1).

In order for better understanding of the Alternatives hereby we will give a short description of them.

Alternative A is an alternative going on the left bank of the Vardar River, along the existing road E-75. The Main Design for this Alternative is already prepared in year 2000, and it consists of widening of the existing road from Demir Kapija to Smokvica till the required width for a highway, for the first lane of the highway, and construction of completely new lane of the highway. The final product are two roads with two driving lanes and one stopping lane each, with green area in the middle. For the reasons of connection with other documents regarding this project furtheron this alternative will be called **ALTERNATIVE 1.**

Alternative B (hereon **Alternative B1**) is a new proposed corridor for highway construction going completely on the right bank of the Vardar River. This alignment does not have main Design prepared, and it was in a phase of Preliminary Study Design. The works consist of construction of entirely new highway with two roads consisted of two driving lanes and one stopping lane each, with green area in the middle.

In the revision from March 2008, a new alternative, **Alternative B2**, was elaborated due to problems with the Bela Voda Cave, and necessity of its avoidance with the alignment. Therefore the new alignment proposed was a kind of combination between the previous two alternatives, i.e. the start of the alignment to be on the left bank of the Vardar River till the exit of the tunnels of the Alternative 1, and furtheron crossing the Vardar River and continue entirely along the Alternative B1. This will avoid the sensitive area around Bela Voda cave completely, which was a recommendation in the first EIA prepared in 2007. For the reasons of connection with other documents regarding this project furtheron this alternative will be called **ALTERNATIVE 2.**

Another alternative was also assessed during the year 2007, in the early stages of the preparation of this EIA study, **ALTERNATIVE 3**. This alignment was going entirely on the right side of Vardar River (later abandoned as not environmentaly friendly with Bela Voda cave) and much closer to Vardar

River than alternative 2. The reason why this alternative was discarded from further evaluations is because it will have to pass through two areas under concession held by private domestic companies. These concessions are used for eruptive material exploitation (used for production of wearing coarse – asphalt), and those are the only quarries providing these companies with such kind of material. Passing through them will mean that they will be left without such material and high compensations asked by the concession holders for land aquisition. At the other hand, these two quarries have the most qualitative material in the whole country. Anyway the surrounding area is similar or equal to alternative 2, so the feasibiliy of existance of such alternative is questionable. This is the main reason why this alternative was discarded even from the start of the project.

The analysis of impacts of Alternative 2 in this revised study is based only on the new alignement of Alternative 2 and already analyzed Alternative 1. Analysis of old Alternative B (hereby called B1) can be found in the EIA study prepared in April 2007, where it was totally rejected due to problems with the Bela Voda cave.

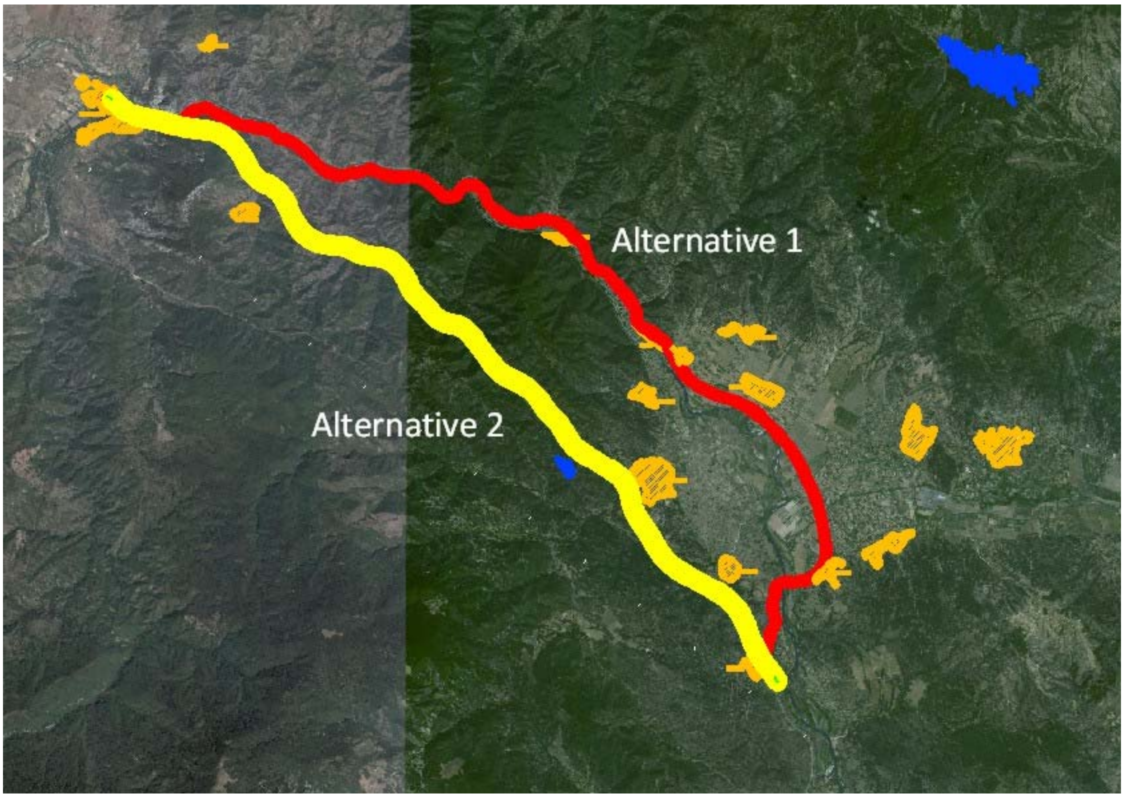
Due to its rejection as completely unacceptable alternative (regarding the problem with the vicinity of Bela Voda Cave) in the following text this alternative, (Altrenative B1) will not be elaborated since it is not feasible for construction, therefore the results achieved will not be necessary. Also alternative 3 will not be elaborated as unfeasable alternative too.

In the following text only **Alternatives 1 and 2** will be elaborated.

Consequently, there are changes in the:

- Length of Alternative 2 is 27.75 km;
- Number and length of tunnels, bridges and different crossing types (rivers, streams, existing roads) for Alternative 2;
- Corridor area of Alternative 2 and combined corridor area of both alternatives;
- Surfaces of land use types in the case of Alternative 2 and combined for both alternatives;
- Sensitivity estimation for natural environment for Alternative 2;
- Sensitivity estimation for settlements (Demir Kapija town) and archaeological sites for Alternative 2;

Besides these changes, the text was improved in the part of the impact assessment and mitigation measures, and some of the old charts were corrected and replaced (land use, sensitivity, matrices etc.).



Picture 1 - Scetch of the alternatives elaborated in this EIA Study.

Foreword to the revised study 1 (March, 2008)

The original EIA study of the section Demir Kapija - Smokvica of the highway E-75 (Corridor X) was prepared in April 2007. It was based upon comparison of two alternatives, named Alternative A and Alternative B. The final recommendation of that EIA study was inconclusive since both alternatives had very negative impacts on the natural environment (in the case of Alternative B) or human environment and higher construction costs (Alternative A).

As a result of the process of revision of the EIA study a new proposal was elaborated for Alternative B in order to overcome the most negative impacts of this alternative. The original route of Alternative B was passing through the right side of Demir Kapija canyon and over the Bela Voda cave. The new proposal contains solution that avoids the right side of the narrowest part of the Demir Kapija canyon and completely avoids Bela Voda cave. The new design of Alternative B overlaps with Alternative A from the beginning point and all the way to the exit of the tunnel in the left side of Demir Kapija canyon. After this point, routs of Alternative A and Alternative B split. The route of new Alternative B crosses Vardar River (newly proposed bridge) and joints the old route of Alternative B at point 2 km +100,

The analysis of impacts of Alternative B in this revised study is based only on the new alignment of Alternative B and already analyzed Alternative A. Hence, the term Alternative B in this study refers to the **new** alignment of Alternative B. Analysis of old Alternative B can be found in the EIA study prepared in April 2007.

Consequently, there are changes in the

- Length of Alternative A is 32.3 km;
- Length of Alternative B (new one is 32.3 km and theold one was 27.7 km);
- Number and length of tunnels, bridges and different crossing types (rivers, streams, existing roads) for Alternative B;
- Corridor area of Alternative B and combined corridor area of both alternatives;
- Surfaces of land use types in the case of Alternative B and combined for both alternatives;
- Sensitivity estimation for natural environment for Alternative B;
- Sensitivity estimation for settlements (Demir Kapija town) and archaeological sites for Alternative B;
- Estimation of impacts on natural environment (Bela Voda cave, Greek Juniper community) and human environment.

Besides these changes, the text was improved and some of the old charts were corrected and replaced (land use, sensitivity etc.).

A new Habitat map (Appendix I.4.) was produced which represents slight modification of the habitat map produced in the study of April 2007. The same is true for the Sensitivity map (Appendix I.5.).

DATA FOR THE EMPLOYER

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NON-TECHNICAL SUMMARY

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

Project: **FINALISATION OF CORRIDOR 10, HIGHWAY E-75**

Section: **DEMIR KAPIJA - SMOKVICA (32.7/27.75 km)**

Project intention

The project intention is to construct a modern highway with four lanes (two in each direction + additional lane for stopping) with predicted traffic frequency of 12000 vehicles per day as an annual average. It includes two elaborated proposals and two rejected proposals for the alignment, as well as 0-alternative:

- First alternative (hereinafter referred as Alternative 1) represents upgrade of the existing motor road from Demir Kapija to Smokvica, which runs along the river Vardar valley on its left side and mostly close to the river; for this alternative there is a final design already 10 years old.
- Second alternative (hereinafter referred as Alternative 2) is upgrade of the beginning section of the existing motor road from Demir Kapija to the end of the existing tunnel, after which the alignment turns on the right side of the river Vardar and construction of a completely new highway on the right side of the valley, far from the river; for this alternative the design is in a very early stage (preliminary design/feasibility study).
- There were also two other alternatives analysed during the preparation of this study but they are not elaborated due to the following reasons. The third alternative elaborated in the 2007 issue of this study was going entirely on the right side of Vardar River, right above the Bela Voda Cave. Since the cave was endangered by this alignment in 2008 realignment was done which gave Alternative 2 – elaborated in this study. The fourth alternative was the same as third, also analysed back in 2007, and it was going entirely on the right side of the river, but from some point closer to Vardar River than Alternative 2. It was discarded as not feasible due to alignment problems with crossing a concesion area held by private construction company, using this area to mine eruptive stone for wearing asphalt course construction all over the country and closer foreign countries. This crossing would have considerably increased the costs for construction due to a need for acquisition.

- 0-alternative, which means no action undertaken, i.e. no road construction or upgrade at all. This alternative was not taken into consideration due to the following reasons:
    - The economic growth of the area and the country in general will be lowered.
    - Traffic safety will be lower - probability of traffic accidents will be higher.
    - Application of sound mitigation measures during its future operation will be less feasible.

  0-alternative was not taken into consideration due to the above mentioned probabilities and due to the possibilities to mitigate threats from construction and operation of the highway according to other alternatives.

The Employer of the project for construction of the Highway Demir Kapija-Smokvica is the "AGENCY FOR STATE ROADS". The Highway Demir Kapija-Smokvica is part of E75 road (ETC 10) which runs through Macedonia in North-South direction along the river Vardar valley and connects the Republic of Serbia with the Republic of Greece.

For the purpose of the EIA Study two corridors of one kilometer width were set up along the two proposed alternative alignments (500 meters from both sides of the alignment axis). Both corridors are passing through the central-southern part of the country, along the valley of the river Vardar. First corridor follows the alignment along the river Vardar that overlaps with the existing motorway (32.7 km) and the other one starts at the same point with the first one and after 2 kilometers goes on the other side of the river stretching on the hills that make the right side of Demir Kapija gorge (27.75 km).

The major reason for implementation of the project under review is discontinued highway connection of the city of Skopje (capital of the Republic of Macedonia) with the town of Gevgelija at the southernmost part of the country, and Greece. The decision to complete this highway was derived from several key factors:

- Necessity for good connection with Greece as a country of EU
- Improvement of traffic to Thessaloniki - sea connection to Macedonia
- Faster and safer transportation
- Enhancement of the national and local economy
- To take advantage of available funds - grants.

The Employer provided the information concerning the raw materials, energy consumption, waste production and other basic data concerning the constructional and operational phase of the highway Demir Kapija - Smokvica. However, during the elaboration of the study, several inadequacies in knowledge and/or uncertainties were identified: elaboration of the highway design for the Alternative 2 was in the phase of preliminary design study, while final road design is still under preparation; detailed information about road construction was not yet available and present status of environmental parameters (air and climate, water and to a certain degree biodiversity) in the area under assessment was not known in details as there are no monitoring stations located there.

Applied methodology

The elaboration of the presented Environmental Impact Assessment Study was performed according to the requirements of the current national legislation and EU Directives as well as the obligations emerging from international conventions to which Macedonia is party. The respective procedure is presented in Chapter III.

During elaboration of the Study, the following methodology was applied:

- In order to assess the impacts of the project/intention on the environment, two detailed descriptions were elaborated and presented:
    - The scope of intention (size, activities, economic parameters etc.) is presented in Chapter II.
    - The detailed description of natural and anthropogenic environment (Chapters V and VI).
- Sensitivity of ecosystems, habitats, sites and localities was assessed (Chapter VII).
- Impacts arising from the construction and operation were identified and analysed (Chapter VIII).
- All negative impacts were reviewed and adequate mitigation or compensation measures were proposed in order to diminish or eliminate negative impacts (Chapter IX).
- Analysis of alternatives was done and recommendation for the best option/solution is presented.

Administrative procedure

Environmental Impact Assessment (EIA) is legal procedure stipulated by the Law on Environment by which a proponent is granted consent for the realization of the project by the Ministry of Environment and Physical Planning (MoEPP). According to the Law on Environment the EIA procedure consists of several steps:

Notification on the intention for project implementation (responsibility of Investor)

↓

Screening (responsibility of MoEPP)

↓

Scoping (responsibility of MoEPP)

↓

Preparation of the EIA Study (expert team)
↓
Review of the EIA Study (responsibility of MoEPP)
↓
Granting consent
(*or rejection of the application*) (Responsibility of MoEPP)

One of the most important parts prescribed by the legislation on EIA is **public participation** in different phases of the EIA procedure. In the first phases, the Investor can involve public in the form of direct discussion after the presentation of the key objectives of the project. Ministry of Environment and Physical Planning shall present the most important documents during the EIA procedure in daily newspapers, local TV and radio stations as well as on the web page of the Ministry.

Spatial plan

The whole area of the highway corridor is foreseen in the Spatial Plan as "Transit Corridor". Additionally, a dam on river Vardar is planned.

There are two protected areas in the highway corridor:

1. Demir Kapija which is protected as Monument of Nature.
2. Iberliska Reka as "Special Plant and Animal Species outside the Protected Areas".

Other six localities are designated for protection according to the Spatial Plan projections.

Natural characteristics of the area of interest

The current status of the basic environmental features of the project area, including the surrounding regions that may be affected by the project construction and operation is presented in the respective chapter.

The area of interest of this study is well-defined geographical unit that is encircled by mountains from west and east and opened on the north and south by the river Vardar valley and it has specific climatic characteristics. The region is one of the warmest regions in the Republic of Macedonia with characteristic Mediterranean climate.

From the geotectonic point of view, the investigated area (Demir Kapija–Gevgelija) belongs to the very unstable geotectonic unit in the Republic of Macedonia known as Vardar Zone of folding which is forming a composite valley i.e. it flows through many plain parts and gorges.

The area (projected high-way corridor) can be divided into two well-defined morphological units such as:

- Demir Kapija gorge including the River Vardar valley to village Udovo;
- Valandovo valley, hilly area between Valandovo valley and Gevgelija valley.

Geological composition is characterized by the presence of cliffs and Jurassic carbonate complex in the beginning part of the corridors. Ten caves in the carbonate complex on both sides of River Vardar can be found. Fluvio-denudation relief is prevailing from both sides of the river-valley (Demir Kapija–Udovo).

The main geologic compounds for the region are diabases (green or grey-green coloured and homogenous, massive textured rocks).

The area is characterized by rich hydrographical network represented by the flow of river Vardar and it's tributaries as well as the thermo-mineral and mineral springs, wells, etc.

Typical soils are cinnamon soils in the hilly area and modified soil types in the plain area.

Climate in the region of interest is modified sub-Mediterranean characterised by hot and dry summer and moderately cold and wet winter.

Very important characteristic of the intention of constructing the highway from Demir Kapija to Miravci is that (especially in case of Alternative 2) it will occupy almost entirely natural or semi-natural territories. The part from Miravci to Smokvica has more anthropogenic features - rural areas and more or less degraded habitats.

Ecosystems and habitats

Very thorough fieldwork along the existing and projected highway line from Demir Kapija to Smokvica resulted in establishing a long list of habitats, which were systematised in six main groups according to the type and density of the vegetation cover, type and relief characteristics of the site, natural/anthropogenic origin of the vegetation, presence or absence of human settlements or objects and water areas. According to these criteria the following habitats were identified (see also Habitat map in the appendix):

- forests and shrublands (both natural and anthropogenic);
- open terrain: grasslands, shrubby grasslands, meadows etc. (both natural and anthropogenic);
- rocky areas (including caves);
- water biotopes;
- agricultural land: orchards, fields, gardens, vineyards and cattle breeding areas;
- urban or urbanised and industrial areas;

The dominant forests in the project area are xerophytic Kermes oak forest (pseudomaquis) and thermophyllous deciduous oak forests. Pseudomaquis, as a vegetation type is represented by the Kermes oak community, an evergreen shrub-like oak. Very important pseudomaquis type is the Greek Juniper shrubland on rocky sites, especially in Demir Kapija canyon. Oak forests (forests of pubescent oak and Oriental hornbeam) develop on higher altitudes (above 300 m).

Riparian forests and shrublands develop along the riverbanks and streams everywhere in the area under consideration. The most important habitat types are the Oriental plane woodlands and belts along the rivers, dales and ravines. Willow stands and belts usually occupy the banks along river Vardar in the lower parts of the valley. Tamaris shrublands and sands are important habitats for the diversity of bird species.

Dry grasslands in the area cover small surfaces but their importance comes from the dominance of annual plant species and very rich fauna (European priority habitat type).

Rocky areas are occupied by some chasmophytic (rock-dwelling) plant communities, which are very rare, and some of them are unique for Demir Kapija canyon.

There are about 10 caves in the limestone complex of Demir Kapija and Chelevechka Reka gorge. Most of them are very short caves used by many bat species as shelter. Out of these caves, Bela Voda (955 m) is the longest and the most important. There are several cave-dwelling species that are restricted only to the underground habitat of Bela Voda (cave cricket, cave beetles etc.).

River Vardar has the dominant drainage area in Macedonia (20535 km^2) and in the area of the road corridor has about 45 km length. Boshava is the largest tributary of Vardar in the highway corridor. Chelevechka Reka and Petrushka Reka have unique geomorphologic values while Mala and Golema Javorica watersheds represent refugial regions with remains of plant assemblages from distant geologic periods.

Broadleaf and coniferous plantations in the highway corridor cover very small surfaces. Out of the anthropogenic habitats, abandoned fields and meadows differ by their greater biodiversity values. Agricultural land (fields and acres, orchards, vineyards, gardens) have smaller importance as habitats for important plant and animal species. Some of the villages in the area still hold values as habitats for several endangered bird species.

During the analysis performed on the basis of National Biodiversity Strategy and relevant international conventions, several habitats and number of species were identified as important. According to EC Habitat Directive there are several important habitats like Greek juniper community, Plane woodlands and belts, Willow woodlands and belts, dry grasslands, caves, chasmophytic vegetation of cliffs and rocks etc. About 40 plants, 30 fungi, 10 insects, 10 amphibians, 20 reptiles, 60 birds and 35 mammals are protected by several international conventions and documents (IUCN, Bern Convention, and Emerald Network Species).

Anthropogenic environment

Occupation: Agriculture is the most important economic activity in the region of interest. The intensive farming (vegetables), crop growing and production of industrial cultures as well as vineyards are characteristic ones.

The agriculture is the basic economic activity for the population of the rural settlements in the highway corridor. According the land-property 90% of the land belongs to the public sector and only 10% are private property.

The most important are fields and acres, vineyards and gardens while the orchards are represented by insignificant surfaces. The most frequent acre cultures are corn, especially the maize and wheat.

Livestock breeding is an important economic activity in the region. The goats and sheep are dominating by their importance followed by cattle. Goats are especially well adapted for foraging on shrubby species of the pseudomaquis.

Settlements: Several populated places are found along the highway corridors: Demir Kapija town and villages Klisura, Davidovo, Miravci, Miletkovo, Smokvica, Udovo, Josifovo and Marvinci. Demir Kapija is the largest populated place along the corridor, with main occupation of the population in agriculture (see also map in the appendix).

In the frame of Gevgelija–Valandovo valley as a natural opening to the south, i.e. to Thessalonica, there is a developed line infrastructure represented by roads, railways, irrigation systems etc.

Quality of environmental spheres: Air, water and soil were considered as unpolluted (in natural areas) or moderately polluted (in settlements and agricultural land). Only river Vardar has poor water quality. Also Boshava and Anska Reka show signs of pollution impact from the agriculture.

Archaeological sites: The area south of Demir Kapija is extremely rich in cultural, historical and archaeological sites. More than 20 archaeological sites were identified in the corridor area (see also map in the Appendix).

Land use: The main land use types in the highway corridor area are forest and shrublands, agricultural areas and urban/rural areas. Agricultural land occupies significant surface in the lower parts of the highway corridor: along river Vardar and in the Valandovo-Gevgelija valley. Most of the agricultural land is represented by fields and acres (see also map in the Appendix).

The highway corridor area overlaps with the territory of two forestry districts "Demir Kapija" and "Kozhuf" from Gevgelija. Forests in the corridor have low biomass and production. Pubescent oak provides most of the timber in the corridor area.

Tourism: Tourism is not well developed branch in the area of the highway corridors although there are potentials to develop this type of activity. The best known tourist places are the Demir Kapija canyon and Bela Voda cave.

Sensitive ecosystems, habitats and other sites

The most sensitive sites were pointed out, identified on the basis of 15 criteria. Separation of these key or high valuable ecosystems, habitats or sites is necessary in order to assess the possible impacts of highway construction and operation more thoroughly and to propose effective measures for their protection or future management.

Oriental plane woodlands and belts, caves and rocks and cliffs were assessed as *very high sensitive*. Pseudomaquis, willow woodlands and belts, Tamaris shrublands, dry grasslands, streams and some other habitats were assessed as *high sensitive*. The rest of the habitats were grouped into *medium sensitive* (degraded pseudomaquis, agricultural land, reed beds) or *low sensitive* (urban settlements, ravines and gullies).

Similar methodology was applied for the sites of human importance. Some of the archaeological sites that lie close to the alignment were assessed as *very high sensitive*. Some villages that will be affected the most were identified as *high sensitive* (Udovo, Marvinci).

Assessment of the impacts

Impacts of the road construction

Forests: The most affected forest ecosystems will be Kermes oak shrublands and Oak forests at number of localities by direct destruction and fragmentation effect.

The destruction of some Plane trees is recognized as the most possible impact during the road construction in the areas of streams, dales, ravines and gullies.

Water habitats: Impact on water ecosystems as a result of pollution and filling with construction material including stones, concrete waste, wood, steel, packaging plastics in the streams was assessed as significant.

Species: The construction of the highway will cause direct interruptions in the breeding cycle (clutch loss) and decrease in the breeding success of the birds breeding along the highway corridor. Bird community of the pseudomaquis, which holds significant number of species with unfavorable conservation status, will be the most affected. This is also true for the arable fields and oak forests. The passerine species (Shrikes, Thrushes, Warblers, Tits, Finches and other families) will be the most affected by fragmentation and direct habitat lost (both for breeding and foraging), but depending on the locality, highway constriction will also strongly influence the breeding behavior of some raptors. The most sensitive areas in this direction are the cliffs of Demir Kapija and their surroundings.

Impact of mining activities - in the area of Demir Kapija limestone canyon. The conflict arises from very high sensitivity of this complex locality. The complexity is a result of presence of different habitats settled by rare and endangered species, especially bird species. The risk for these species arises from the construction work. The mining is unavoidable since the tunnel has to be staved through Jurassic limestone rocks. Although the area of the canyon was assessed as very high sensitive (Chapter X), the highway line must pass through the canyon since there is no other solution (the canyon is extremely narrow and both sides of the river are valuable). The conflict becomes the most expressed during the breeding period of vultures (laying eggs, incubation period and fledging, from March to July).

Other conflict connected to this area that might arise from constriction work is damaging the protected area Chelevechka Reka. For this particular part, the conflict is not just during the construction period but also during the highway operation (due to the pollution of the stream). In this case, as it was the case with previous, the recommendation for sellecting the Alternative B1 was not possible (at the other side of the river Vardar, the Bela Voda cave is situated next to the river which may produce another conflict).

Agriculture: The most important impact on agriculture during highway construction is destruction of agricultural land. The surface of agricultural land that will be destroyed if Alternative 1 is accepted equals 56.6 ha. In the case of Alternative 2, significantly smaller agricultural land will be destroyed (approximately 9.70 ha). Fragmentation of agricultural land is also significant impact.

Archaeological sites: As presented in the baseline situation, the area is rich in cultural heritage. Monuments under special protection regime are close to construction undertaking. Unknown archaeological sites might be found during the construction of the highway. Therefore it is suggested to pay special attention to this potential impact particularly because destruction of archaeological sites or their parts is irreversible process.

Pollution: The level of emissions and duration of the construction period will not exceed the carrying capacity of the natural ecosystems. A certain increase of air pollution in the broader area of interest will certainly occur due to the increased traffic frequency. However, these emission levels will be insignificant for human health.

Waste related to construction of the highway section Demir Kapija - Smokvica will be diverse and produced in large quantities. Most of the waste will be inert waste, but also large quantities of hazardous and toxic waste are expected to be produced. One can predict sufficiently accurate that the level of impact would not be significant due to the reasonably short duration of the construction activities.

Risk assessment (oil leakage, fire, hazardous substances, personal risks etc.) was performed in order to propose adequate mitigation measures. In the course of road construction and respective infrastructure only individual risk of work injury, leak of fuel or oil from trucks or construction machines and/or risk of fire is considered.

Impacts of the road operation

The fragmentation of the **forest ecosystems and pastures** will actually be a result of the road operation. In case of Alternative 2, fragmentation of forest and shrubland habitats is particularly important, due to the cut of regular biological movement routes of large animals from Kozhuf Mt. to river Vardar (for drinking water and feeding). Many animal species depend on these migration routs, including species of European conservation concern, such are row dear, wolf, otter and wild cat. Even Brown bear was registered in this area several times (last time in March 2007). For more details see Impact on species.

Rivers and streams: The pollution of water ecosystems is caused by discharging of residues from fuel combustion (lead and hydrocarbons), lubricants and tyre parts. All of these contaminants will enter the rivers with wet deposition that washes out the surface of the road.

Usage of defrosting agents (salts and sand) will increase conductivity of river and streams' water, and sand will increase turbidity. In both cases, water quality will decrease with great impact on aquatic life. This kind of pollution is typical for strong winters with very low temperatures.

Species: In general, the impacts on the species can be divided into fragmentation effects, increased collection or hunting/poaching, changes in the reproduction and road kills (important for amphibians, reptiles, mammals).

Agriculture: Impacts on agriculture are presented by the effects of air, soil and water pollution by the increased traffic on the highway. One of the specific impacts will be fragmentation of agricultural land caused by intersection of the "agricultural" roads and new highway.

Settlements: The operation of the highway Demir Kapija - Smokvica will have both positive and negative impacts on the settlements in the area of intention. However, negative impact will be much more severe than positive ones (positive impact concerns socio-economic aspects).

Noise: The noise generated by vehicle traffic on the highway will affect the settlements located alongside the planned highway. For evaluation of noise impact and determination of suitable noise abatement measures, calculations of noise levels were carried out. The predicted noise levels were evaluated with respect to noise standard regulations of Macedonia, WHO and EC regulations. The applied noise standards for existing residential areas were 60 dB (A) at daytime and 50 dB (A) at night time. However, 55 dB (A) at daytime and 45 dB (A) at night time are recommended for the residential areas.

Soil pollution: It is well documented that the most significant pollution from gaseous substances and aerosols (emitted from exhaust pipes of vehicles) occurs in 10 meters distance due to the fast sedimentation of substances heavier than the air. The sedimentation depends on the geomorphology of the terrain, wind speed, vegetation cover etc.

Air quality: The fuel consumption on the new alignment has to be compared with the amount being emitted currently along the existing road to Gevgelija. For both situations, the number of vehicles will be the same. The speed is high with no stop-and-go characteristics.

Waste: Waste materials that will be generated during the road operation are not numerous and variable as in the case of the road construction.

Socio-economic impact: Increased traffic will improve employment possibilities to a certain extent and enlarge incomes of the local population.

Impact on human health can be considered only for the residents of the settlements close to the alignment (Demir Kapija, Udovo, Miravci and Miletkovo). Such impact can result from air pollution emission and to a limited extent to the noise generation.

Risks: in the case of traffic accidents, uncontrolled spilling of oil, oil derivates, chemical and other toxic substances might occur. Fires are also possible as a result of traffic accidents. Of the outmost importance are the risks that may occur during transport of transformer oil (PCB). The danger of possible traffic accidents is very important impact.

Mitigation measures

Mitigation measures for road construction phase

Mitigation measures concern three phases of the realization of the project: preparatory phase, construction and operation of the highway.

Extensive mitigation measures were proposed for the **preparatory phase**.

Standard **general measures** for the construction phase were identified on the basis of the best international practice and recommendations of international institutions (e.g. World Bank). Some of the proposed measures concern specific habitats, localities and sites aiming to avoid construction of access roads and setting up work camps in sensitive habitats. Measures directed toward improvement of supervision of the construction work were proposed. The construction in the area of caves and archaeological sites is prohibited.

Special measures were proposed concerning tunnel construction at Demir Kapija canyon (construction works should not be undertaken during the breeding season of vultures and other birds of prey).

Constructions of culverts for amphibians, reptiles and mammals: in the regions without natural passes and without underpasses, tunnels or bridges will be constructed.

The most adequate compensation measure in order to mitigate the impact on the forest is to fund aforestation activities in the frames of the affected forestry districts. Aforestation should be performed with native (autochthonous) tree species as stated in the Law on Nature Protection.

It is necessary to design and construct appropriate objects along highway route in order to maintain the existing local roads and important forest paths. By implementing this measure, the fragmentation of agricultural land shall be avoided as well as access to various parts/localities in the hilly region for grazing. Enabling good connection between forest lands on both sides of the highway is essential for accessibility and interventions in case of forest fires.

Extensive mitigation measures were proposed to avoid the adverse impacts on waters (storage of liquid agents, set-up of the work camps, preservation of vegetation, erosion prevention measures etc.).

It is well established practice that investor and proponent compensate the damage to the environment by setting a scheme for enhancement and improvement of environment in adjacent regions, especially in biodiversity conservation field. This is an integral part of environmental assessment process according to World Bank rules. Extensive damage to the natural and seminatural habitats (irrespective to which alternative) should be compensated by providing conditions for elaboration of management plan for Demir Kapija protected area (Monument of Nature, including Chelevechka Reka water gap) and action plan for conservation of vulture colony in the gorge. Creation of information center for Demir Kapija canyon will be expression of good will and will have positive socio-economic effect on the local population. The investment will be in the range of tens of thousands of Euros.

As a general mitigation requirement for noise reduction during the construction phase contractors will be required to use modern noise silenced equipment and to keep to usual daytime work hours (exceptions may apply for certain structures). Preferably, equipment that meets the requirements of the European Directive EC/2000/14 on noise emission by equipment for outdoor use should be used.

Borrow pits: In order to exclude the exploitation of the existing limestone mine at the entrance of the Demir Kapija Gorge and limestone marbleized masses on the section Josifovo–Valandovo–Dojran necessary quantities of carbonate material (limestone, marble) shall be provided from the reserves of the open quarry between the villages Kosturino and Memesli; the gravels and the sands from the alluvial stratum should be exploited from the existing localities at Przdevo and Gevgelija. It is necessary to prepare separate Environmental Impact Assessment for borrow pits after the design is avalialbel. Appropriate re-cultivation measures of all fields of structural stone, gravel and sand etc. should be proposed.

Mitigation measures for road operation

General measures include elaboration of emergency plans, recommendations for storage of hazardous substances, decrease dustiness (cleaning of roads etc.) and elaboration of plan for action in emergency situations.

Specific measures include:

- Landscaping and forestation of bare land in the surrounding.
- Construction of protective panels along the highway, establishment of monitoring system for bird casualties and movements of amphibians, reptiles and mammals in order to construct direction barriers towards the culverts.
- Ground waters: construction of collecting ditches and sealing of surfaces by the road to reduce the area through which surface water can infiltrate into the ground (re-vegetation of the embankments).
- Surface waters: construct road channels and side ditches; outfalls must be equipped with oil separators to prevent environmental damages to the existing ground and surface water regimes. Considering potential surface water pollution, herbicides should not be used on the road shoulders or embankments for maintenance. Mowing of the verge is highly recommended as well as to leave green cut on site (it should not be used as animal fodder, could be polluted). It will be necessary for the local highway authorities responsible for maintaining the new infrastructure, to be equipped and well trained to service the oil separators and treatment facilities in addition to other normal road maintenance requirements. Emergency plan for threats from water pollution has to be prepared. Compensation measures such as improvement and strengthening of the habitat function of the rivers and riparian vegetation should be undertaken.
- Air pollution: vegetation as a buffer along the alignment has to be planted and monitoring of the air pollution has to be established.
- Noise: *reduction of noise emissions* (reduction of the vehicle speed, construction of special noise reducing road surface which is efficient for speeds over 60 km/h and avoidance of additional noise sources of constructive origin and damages of the road surface); *Reduction of sound transmission* **(c**onstruction of noise abatement barriers like walls or embankments and construction of tunnels, housing-in-tunnels, or noise abating buildings at the road border) and *Reduction of noise impact at the impact area* **(**respecting a setback-/ noise buffer for new developments and installation of noise reducing windows in affected houses).

Analysis of the alternatives

As already mentioned, the two basic options were considered for comparison of alternatives within this Study:

- Alternative 1 (Upgrading of existing motorway from the left side of the river Vardar)
- Alternative 2 (Partly upgrading and mostly construction of a new section from the right side of the river Vardar but higher up in the hills)
- Another alternative, 0-alternative was also taken into consideration but it was rejected.

For alternative 2, the following situation will occur in the area around the highway from Demir Kapija to village Smokvica:

- There will be significant increment in terms of traffic and emission of pollutants produced by the traffic and other facilities along the whole length of the Alternative 2 route;
- Agricultural land will be less destroyed compared to Alternative 1, especially since the quality of the arable land is less class and used by the local population for agricultural activities sporadically.
- The noise created by the highway will concern less human population since there is only one settlement close to the highway.
- The disturbance of natural habitats will be more significant compared to the case of Alternative 1 scenario in case of very high sensitive habitats; the disturbances to threatened species will be restricted to the region of Demir Kapija canyon (also affected by Alternative 1).
- There will be less significant damage of high sensitive habitats and sites.
- Very high sensitive archaeological sites as non-recoverable objects of human history will be more threatened, so therefore in this study an adjustment is proposed of Alternative 2 in order to avoid this impact.
- There will be a significant change in landscape characteristics (structural and functional) in the broader area of interest by introducing completely new line object of a large scale.

For Alternative 1, the following situation will occur in the area around the alignment from Demir Kapija to village Smokvica:

- Agricultural land will be much more destroyed compared to alternative 2, especially since the quality of the arable land is first class and 100 percent used by the local population for agricultural activities.
- The noise created by the highway will concern more population since three settlements are very close to the highway (10 up to 20 meters from the highway).
- The construction work will take much longer since the operation of the existing motorway should not be interrupted.

- There will be significant increment in terms of traffic and emission of pollutants produced by the traffic and other facilities along the whole length of the Alternative 1 route;
- The disturbance of natural habitats will be less significant compared to the case of Alternative 2 scenario in case of very high sensitive habitats; the disturbances to threatened species will be restricted to the region of Demir Kapija canyon (also affected by this alternative).
- There will be certain disturbance of very high sensitive habitats, but there will be significant disturbance of high sensitive habitats and sites, particularly the valuable Oriental plane woodlands and belts, pristine streams, oak forests and pastures (destructions of oak forests and pastures were assessed as comparatively small and compensation is possible - see Chapter IX.2.3.3.).
- There will be no disturbance to the living organisms in all ecosystems (particularly threatened species) and there will be no fragmentation of important biocorridors.
- Very high sensitive archaeological sites as non-recoverable objects of human history will be less threatened.

For 0 - Alternative, the following situation will occur in the area around the highway from Demir Kapija to village Smokvica.

- There will be no disturbance on the natural environment and biodiversity components will remain unchanged or conserved.
- There will be no danger of impact on human health along the villages Marvinci and Miletkovo. There will be no significant change of human health impacts along the villages Udovo, Marvinci and Smokvica.
- The economic growth of the area and the country in general will be lowered.
- Traffic safety will be lower - probability of traffic accidents will be higher.
- Application of sound mitigation measures during its future operation will be less feasible.

0-alternative is rejected due to the above mentioned probabilities and due to the possibilities to mitigate threats from construction and operation of the highway according to other alternatives.

Although there are not enough data in the current stage of design for economic evaluation, several socio-economic considerations can be stated.

- None of the local communities will be favoured or neglected since the difference (distance between) of the alternatives is the greatest at unpopulated area.
- After implementation of proposed mitigation measures, **no significant impact** on land fragmentation and land accessibility is expected on both alternatives.

- There will be positive effect of highway construction and operation on job creation and opportunities.
- There will be large scale benefit on national scale due to the improvement of the traffic in north-south direction and accessibility of Thessalonica harbour.
- Alternative 2 is 5 km shorter and less expencive option compared to Alternative 1.

Having in mind all the aspects presented in this study, all the results from sensitivity analysis and impact assessment analysis, as well as mitigation measures necessary for remediation of the environment and their cost (for the measures that have cost) it can be concluded that both alternatives will have similar overall impacts on the environment.

From the analysis carried out for both alternatives the following conclusions can be pointed out:

- Altrenative 2 is less sensitive regarding sites of human interest. According to matrix analysis the sensitivity of Alternative 2 is 218 points compared to Alternative 1 which has 233 points.
- Alternative 2 has less impact during road construction. According matrix analysis the impact of Alternative 2 scores 28 points compared to Alternative 1 which has 29 points.
- Alternative 2 has less impact during road operation. According matrix analysis the impact of Alternative 2 scores 15 points compared to Alternative 1 which has 16 points.
- Alternative 2 is more sensitive regarding natural and anthropogenic habitats. According to matrix analysis the sensitivity of Alternative 2 is 461 points compared to Alternative 1 which has 440 points.
- Very high sensitive ecosystems and habitats are more present in Alternative 2 and high sensitive ecosystems and habitats in Alternative 1, but both together as percentage are more represented in Alternative 2. On the other hand, medium sensitive ecosystems and habitats are much more represented in Alternative 1, and low sensitive ecosystems and habitats in Alternative 2. Very high sensitive and high sensitive habitats together particapate with larger percent in Alternative 2 (43.75% in Alternative 1 and 46.88% in Alternative 2).
- The number of objects (settlement/ archeological site/ agricultural land) with low sensitivity regarding sites of human interest for Alternative 1 is 4 and for Alternative 2 is 6.
- Medium sensitivity objects regarding sites of human interest are mostly presented in corridor of alternative 2 (in ratio 6:4 with alternative 1) because of the short or long distance of most of the settlements (and two of the archaeological sites) from the future planed highway.

- Alternative 1 is critical concerning high sensitivity regarding sites of human interest due to the relatively short distance of most of the settlements (and archaeological sites) from the future planed highway.
- Maybe the most important criteria for comparison are very high sensitivity class (VHS) because of the highest impact regarding sites of human interest. Alternative 1 has 3 (three) "VHS" points and alternative 2 is critically approaching to 3 of the archaeological localities in a very short distance, and also has 3 (three) "VHS" points. In case of Alternative 2, a realignment of the future road must be considered, which will avoid these three VHS points. In case of Alternative 1 sound protection wall should be foreseen for the area of Udovo and Marvinci Villages, which will avoid one from the VHS points, and for the agricultural land – fields, acres and vineyards there are no mitigation measures, so this area will be irreversibly destroyed.
- Alternative 1 leaves the population without an alternative road, since it will be used for upgrading to a level of highway. Therefore new alternative national road will have to be constructed, parallel or at the other side of the Vardar River in accordance to EU dirctives. Alternative 2 is a completely new road, therefore an alternative road already exists (existing motorway E75, Corridor X) and there is no need for its construction.
- Alternative 1 is 32.2 km long, and Alternative 2 is 27.75 km long. Although Alternative 1 is upgrading of the existing road to a level of highway, it is more expencive for construction due to its length. On top of this higher expenses derive from the necessity of construction of an alternative road, according to EU directives.

Having in mind the abovementioned results from this study the final conclusion of the Consultant will be acceptance of Alternative 2 as final alternative for construction. Both of the alternatives are similar regarding their sensitivity and their impacts. One of them has advantages at some criteria and disadvantages at some other criteria. When taken in whole both alternatives are very similar. Alternative 2 is more favourable due to its lower costs for construction, shorter alignment, more distance from the human settlements, therefore less impact to the humans, although it is slightly more sensitive concerning the natural habitats.

Remarks and recommendations

Construction and operation of highways causes significant adverse impact on the natural areas and human environment. Besides implementation of the mitigation measures which intend to avoid significant negative impacts, some recommendations for conservation and promotion of the environment should be taken into account during the construction work and operational phase of the highway.

The destruction of the forested areas, grasslands, agricultural land can not be avoided during the construction although several mitigation measures were proposed in order to minimize this impact. About 56.60 ha of agricultural land and 96.60 ha natural land (Alternative 1) and 9.70 ha of agricultural land and 120 ha natural land (Alternative 2) will be destroyed during the construction. In order to compensate this impact, reforestation measures along the highway are strongly recommended. This will contribute towards the erosion-prevention which improves the maintenance of the highway during its operation. According to the provisions of the Law on Nature Protection, autochthonous plant species should be used during the aforestation in natural areas. The best places for reforestation are highly degraded pseudomaquis habitats on steep slopes along the highway: in the vicinity of village Udovo (in case of Alternative 1) and surrounding of the village of Miletkovo (in the case of Alternative 2).

After the completion of the construction works, agricultural roads should be repaired and adopted for their use by local population. After the completion of the construction works in forested areas, unnecessary access roads should be re-vegetated and closed for operation. This measure will prevent illegal woodcutters and poachers from reaching undisturbed natural areas.

Since there are a lot of uncertainties and unforeseeable situations due to the lack of Final Design for alternative 2, recommendations for elaboration of additional assessments (in case of access roads, borrow pits, dump sites, etc.) after producing a final design for alternative 2 have to be elaborated and duly respected.

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1. INTRODUCTION

This Revision of the Environmental Impact Assessment Study aims to assess the impacts from construction and operation of the Highway Demir Kapija-Smokvica along with all associated interventions, regardless of the alternative chosen, and to find out which of the alternatives is the most environmentally feasible.

The alternatives of the project under review have been assessed pursuant to point **7c - *Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 km or more in a continuous length*** in Annex I of the Decree determining the projects for which an environmental impact assessment shall be carried out (referred to Article 7 of the Law on Environment).

The submitted EIA Study is elaborated in compliance with Law on Environment and its Annex 3 - Ordinance regulating the procedure for carrying out the environmental impact assessment. On the other hand, Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, amended by Council Directive 97/11/EC - EIA Directive was also taken into consideration (see Chapter IV).

Additionally, the study shall serve to **screen the situation** concerning **necessity for elaboration of additional individual EIA studies** for certain constructions (investments) in the scope of the highway construction (access roads, borrow pits, landfills).

The project intents to construct a modern highway with four lanes (two in each direction + two stopping lanes) with predicted traffic frequency of about 11.000 AADT (Annual Average Daily Traffic) vehicles for 2020 (high scenario). This is the last section of the European Transport Corridor 10 (ETC 10) in the Republic of Macedonia that is not upgraded. E75 road (ETC 10) runs through Macedonia in North-South direction along the river Vardar valley and connects the Republic of Serbia and the Republic of Greece. There are four proposals for the alignment:

- First variant/alternative (hereinafter referred as Alternative 1) represents upgrade of the existing motor road from Demir Kapija to Smokvica which runs along the river Vardar valley on its left side and mostly close to the river; for this alternative there is a final design,
- Second variant/alternative (hereinafter referred as Alternative B1) is completely new motor road from Demir Kapija to Smokvica on a predominately hilly and mostly natural area on the right side of the valley, far from the river; for this alternative there was a preliminary

design. This alternative was discarded in 2008 due to its problems with the vicinity to Bela Voda Cave – marked as natural environment with high importance that shoud not be disturbed by any means.

- Third variant/alternative (hereinafter referred as Alternative 2) is upgrade of the beginning section of the existing motor road from Demir Kapija to the end of the existing tunnel, after which the alignment turns on the right side of the river Vardar, over a new brige, and construction of a completely new highway on a predominately hilly and mostly natural area on the right side of the valley, far from the river; for this alternative the design is in a very early stage (preliminary design/feasibility study).
- Forth variant/alternative (hereinafter reffered as Alternative 3) is upgrade of the beginning section of the existing motor road from Demir Kapija to the end of the existing tunnel, after which the alignment turns on the right side of the river Vardar, over a new brige, and construction of a completely new highway on a predominately hilly and mostly natural area on the right side of the valley, closer to the river than Alternative 2; for this alternative there is no design at all. This alternative was first evaluated in 2007 but due to its alignment passing through a concession area by a private construction company, used for quarrying of natural eruptive stone (used as aggregate for wearing courses of the highways and roads) it was discarded as unfeasable since it will have to be paid a significant amount of money for aquisition of the concession area.

1.1. THE SCOPE OF THE STUDY

The following EIA Report presents the summarised results of habitat types mapping, field observations and literature data on flora, fauna and fungia composition of the corridors along the existing and planned E-75 road (highway) alignment (ETC 10), starting from the town Demir Kapija down to the village Smokvica. It contains the habitat description, distribution and importance on the local and regional scale and recommendations for their preservation and protection during construction of the road. It also contains description of rare species and their status (distributional and legal), delineation of sensitive habitats, forecasting of possible conflicts during construction works and operation of the highway, socio-geographic aspects, archaeological sites, cumulative effects in relation to the development future of the whole area, water resources and water ecosystems–their quality and biological value. The aim of habitat mapping and flora, fauna and fungia composition investigation was to recognise and make the inventory of the existing habitats and to present them on the map with the scale 1:25000.

On the basis of habitat recognition and description, to evaluate the biodiversity of existing ecosystems and different sites and localities, (in the following text - habitats) along the road alignment, to recognise the sites of special importance concerning the biodiversity and natural, historical and ethnological heritage - all this in order to prevent ecosystems and species populations, as well as archaeological sites, infrastructural objects and other important locations and phenomena from disturbance, damaging or destroying during the construction works. Special attention was paid to rocky sites at Demir Kapija canyon, the forest biotopes in the rest of the Demir Kapija gorge, both on a hill slopes and along the river on the left and right side of the river Vardar, and agricultural land in the valley.

The Study also presents the anthropogenic environment and environmental spheres (air, soil pollution and water quality). In this context, description of human settlements, main economic activities (especially agriculture) and infrastructural objects was presented. Conflicts (as well as positive impacts) arising from the road construction and operation were assessed and discussed. Special attention was paid on air pollution, noise and vibration impacts of the highway construction and operation on settlements and human health. Negative effects of fragmentation of agricultural land on working activities were treated aswell.

Due to the large distance between the two feasible proposed alignments 1 and 2 (the third proposed alignment B1 was stretching at the right side of the Vardar River but was discarded due to Bela Voda Cave problems, and the fourth was the same as 2 but closer to Vardar River and also discarded due to its problems with concession areas) along the most of their length, the study encompasses two examined corridors that overlap only at the starting part of about 2 km. **Each road corridor is one kilometre wide (500 meters from both sides of the alignment axis)**.

Both corridors are passing through the central-southern part of the country, along the valley of the Vardar River. The first corridor that is following the alignment along the river Vardar (Alternative 1) is with total length of 33+800 km and the other one (Alternative B1) stretches on the hills that make the right side of Demir Kapija gorge with total length of 28+300 km. Each corridor is one kilometre wide (500 meters on both sides from the axes of the proposed alignment. The corridors partly overlap in considerable length: town Demir Kapija - km 0+000 to km 4+500 and km 25+800 to 28+100 (Smokvica). The third corridor is a combination of the previous two corridors. It starts at km 0+000 and overlaps with corridor 1 till km 2+000 where it crosses the Vardar River and continues through corridor B1. The forth corridor is a combination of the corridors 1 and 2. It starts at km 0+000 and overlaps with corridor 1 till km 2+000 where it crosses the Vardar River and continues through corridor B1. At km 5+260 it lefts corridor B1 and goes closer to Vardar River, right above the existing railroad, east from villages Davidovo, Miravci and Miletkovo and ends again in corridor B1 close to Smokvica. This study cover corridors 1 and 2, since corridor B1 and 3 are not feasible for construction, as explained before in this study.

The whole section of a newly proposed alignment can be divided in three distinctive parts (units):

- Town Demir Kapija - village Klisura region (km 0+000 - km 5+700, it stretches along the Vardar valley or is passing through a tunnel)
- Village Klisura region - village Miravci (km 5+700 - km 21+100, hilly, unpopulated area in the case of alternative B1 and 2, or in case of alternative 1 there is only one village - Udovo)
- Village Miravci - village Smokvica (km 21+100 - km 27+200, more or less lowland area, populated and with a lot of human activities.

The old design alignment runs exclusively along the river Vardar valley (See Map in Appendix I.1.).

1.2. METHODOLOGY APPLIED WITH SHORT DESCRIPTION OF THE CONTENT OF THE STUDY

The elaboration of the presented EIA Study was performed according to the requirements of the current national legislation and obligations emerging from international conventions to which Macedonia is party. The respective procedure is presented in Chapter III.

During elaboration of the Study, the following methodology was applied:

1. In order to assess the impacts of the project/intention on environment, two detailed descriptions were elaborated and presented:
    a. The scope of intention (size, activities, economic parameters etc.) was presented in Chapter II.
    b. The detailed description of natural and anthropogenic environment (environmental spheres - air, waters, soils; biodiversity - species, habitats, ecosystems etc.) was done using all existing literature data (Chapter XIII.), personal experience of the contributors to the study and targeted fieldwork; the results are presented in Chapter V and VI; detailed information used for elaboration of Chapter V is given in appendices.
2. Based on the information from Chapter V and VI and using matrix methodology with application of various criteria, the sensitivity of the ecosystems, habitats, sites and localities was assessed; the results are presented in Chapter VII.
3. Based on the sensitivity character of different sites and localities in the range of the area affected by the intention and information from Chapter VII, the main conflicts arising from construction and operation of the intention were pointed out and analysed in Chapter VIII.
4. Data from Chapter VII has served to define all possible impacts on natural environment, human health and anthropogenic objects and

sites, which are presented in Chapter VIII as impacts during highway construction and operation

5. All negative impacts were reviewed and adequate mitigation or compensation measures were proposed in order to diminish or eliminate negative impacts in Chapter IX.
6. Based on all afore mentioned concerns, the final discussion for implementation of proposed project/intention was carried out in Chapter X along with analysis of three main alternatives and proposal for preferred alternative. After that the final conclusion was brought out.
7. At the end, the recommendations for future sustainable development of the region were elaborated in Chapter XI.

2. BASIC DATA

The data presented in this chapter is related to the scope of the project, the main reasons for its development, technical and technological characteristics, materials to be used, products/outputs as well as plans for future development. All the information supplied by the Employer is included here. However, there were several constraints due to the lack of data posed to the team, such as: lack of Main Design of the Alternatives B1 and 2, only approximate figures on resources (drinking water, fuel) to be used during the construction and operation period of the highway, not well defined facilities and technologies for water treatment etc.

2.1. DATA ON THE PROJECT/INTENTION

2.1.1. PROJECT SCOPE

The **Employer** of the project for construction of Demir Kapija-Smokvica is national (public) institution Agency for State Roads. The predicted traffic frequency is 11.000 AADT.

Name:	*E75 (ETC 10) Highway - Section Demir Kapija-Smokvica*
Size (traffic frequency) of the intention:	Annual Average Daily Traffic AADT of 11.000 vehicles 2020 (high scenario)
Employer:	*Agency for state Roads*

Location: Central-south part of the Republic of Macedonia: region of Demir Kapija gorge - Miravci (Valandovo valley) - Smokvica (Gevgelija valley). Location of the area of interest can be seen from the map in Appendix I.2. This area belongs to the municipalities Demir Kapija, Valandovo and Gevgelija.

Municipality:	Demir Kapija, KO Valandovo, KO Gevgelija, KO
Cadastral units:	KO Chelevec KO Koreshnica KO Kosharka KO Klisura

KO Davidovo
KO Smokvica
KO Miravci

2.1.1.1. Character of the intention and possible cumulative impacts with other intentions

The subject of the intention (project) is to build new highway from the town Demir Kapija down to the village Smokvica. That is the last un-upgraded section of the existing motor road/highway E-75, that runs through the Republic of Macedonia and connects Republic of Serbia and the Republic of Greece. Construction of the remaining section of this highway is a joint Macedonian-Greek venture (with the assistance of EU IPA funds) that will enable faster and more safe transportation of people and goods from Central Europe to Greece, or to Turkey and Near East since it will be connected to “Via Ignatia” (West-East) highway in Greece.

The highway section is passing through the Demir Kapija canyon and the remaining gorge and through the more or less flat area from the village Miravci to the village Smokvica. The total length of the alternative 1 is 32.8 km, the total length of the alternative B1 is 27.3 km, and the total length of Aletrnative 2 is 27.75 km. The whole alignment is situated at low elevation (60 m a.s.l. to 500 m a.s.l.) with altitudinal difference of about 400 meters. The project anticipates construction of a number of bridges, tunnels, culverts, underpasses etc. (Tab. 1).

Overview of the planned structures to be built along the alignment for all alternatives

	Alternative 1	Alternative B1	Alternative 2
Bridges	12 (Ltot=2010m)	6 (Ltot = 1650m)	8 (Ltot = 1650m)
Tunnels	7 (Ltot=2855m)	2 (Ltot = 1830m)	2 (Ltot = 1830m)
Culverts	No data available	No data available	No data available
Underpasses	2 (Ltot=18m)	0	0
Overpasses	4 (Ltot=146m)	14 (Ltot-296m)	8 (Ltot-216m)
Electric power supplies	No data available	No data available	No data available
Petrol station(s)	No data available	No data available	No data available
Other objects (restaurants, etc.)	No data available	No data available	No data available
Landfills	No data available	No data available	No data available
Construction of access roads	No data available	No data available	No data available
Construction of parking places	No data available	No data available	No data available

Borrow pits	Borrow pits will be necessary in the section Udovo- Smokvica for the material of sub-layers, base layers and road layers. The position of the future borrow pits are not known at present, but they will be probably on the alluvial deposits of Vardar River, except if existing borrow pits can be used, with sufficient potential of materials for the project. The investigations of potential borrow pits will use shovel pits, drilling and core boring, or auger drill.

This intention in character is a project that will represent either highly significant environmental impact or significant impact on human health during its operation. Its operation will represent certain degradation of and threat to biodiversity and will contribute to current (negligible) air pollution and noise levels in the area. These contributions are evaluated in the respective chapters of this Study.

With respect to the character of the project, cumulative impacts of air emission and noise from transport related to the highway operation, as well as surface and underground water pollution created by the highway operation are expected. Apart from this, significant land and biodiversity deterioration will be unavoidable.

However, this project will have positive effect on the whole region in sense of enabling faster and safer transportation and connection of municipality Miravci and Valandovo to the main transportation route. It will stop migration of the rural population in the region (which is not high in this part of Macedonia anyway), construction of the local communal infrastructure etc.

2.1.1.2. Reasons for implementation of the intention and its location, including view of considered alternatives and main grounds for their selection or rejection

The major reason for implementation of the project under review is discontinued highway connection of the city of Skopje (capital of the Republic of Macedonia) with the town of Gevgelija at the southernmost part of the country and Greece (see Appendix I.1.). The decision to complete this highway was derived from several key factors:

- Necessity for good connection with Greece as a country of EU
- Improvement of traffic to Thessalonica - sea connection to Macedonia
- Faster and safer transportation
- Enhancement of the national and local economy
- To take advantage of available funds - grants.

There is no zero option (non construction) alternative solution for the proposed project. The only alternatives consider only different alignments, described above.

2.1.1.3. Concise description of technical and technology features of the project/intention

The technical design of the highway is based on the following details:

	Alternative 1	Alternative B1	Alternative 2 2c
Assumed vehicle speed (flat terrain)	100 km/h	120 km/h	120 km/h
Assumed vehicle speed (hilly terrain)	80 km/h	120 km/h	120 km/h
Maximum longitudinal inclination	-2.185 ÷ 1.342%	-4 ÷ 3.300%	-4 ÷ 3.300%
Number of traffic lanes//width	= 2x3.75m = 7.50	= 2x3.75m = 7.50	= 2x3.50m = 7.00
Stopping lanes	= 2.50m	= 2.50m	= 2.00 m
Edge lanes	= 0.5m	= 0.5m	= 0.30 m
Verge	= 1m	= 1m	= 1m
Planum	= 25.0m	= 25.0m	= 25.0m
Rigoli (drainage channel) +	= 0.75÷1.0 m	= 0.75÷1.0 m	= 0.75÷1.0 m
Berms	= 0.5m	= 0.5m	= 0.5m
On bridge			
Traffic lanes	= 3.75m	= 3.75m	= 3.50 m
Stopping lanes	= 1.0m (only for L≥ 50m)	= 1.0m (only for L≥ 50m)	= 1.0m (only for L≥ 50m)
Edge lane	= 0.5m	= 0.5m	= 0.30 m
Verge	= 0.45m (only for L≤ 50m)	= 0.45m (only for L≤ 50m)	= 0.45 m (only for L≤ 50m)
Tunnels			
Traffic lanes	= 2x3.50m =7m	= 2x3.50m =7m	= 2x3.50 m =7m
Edge lanes	= 2x0.30m = 0.60m	= 2x0.30m = 0.60m	= 2x0.30 m = 0.60 m
Verges	= 2x0.50m = 1m	= 2x0.50m = 1m	= 2x0.50m = 1m

2.1.1.4. Expected commencement date and completion date:

The expected starting date of Demir Kapija-Smokvica highway construction is 2011. Assumed date of completion is 2014. Start of the operation is supposed 2014.

2.1.1.5. List of affected territorial self-governing units

Region:	*Central-South Macedonia*
Municipality:	*Demir Kapija, Valandovo, Gevgelija*
Town/city:	*Demir Kapija*

2.1.1.6. Enlistment of the intention into the respective category and paragraph according to the Law on Environment

The intention (project) is ranked according to Ordinance determining the projects for which an environmental impact assessment shall be carried out (*Annex 1 of the Law on Environment*).

During the preparation of this Study, existing National legislation in the Republic of Macedonia and International Conventions ratified by the Republic of Macedonia were used as a legal basis and analyzed. At the other hand, Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment, amended by Council Directive 97/11/EC - EIA Directive was taken into consideration (see Chapter III).

2.1.2. PROJECT INPUTS AND OUTPUTS

2.1.2.1. Data on inputs

2.1.2.1.1. Raw materials and energy resources during construction:

Tab. 2 gives details for the quantities of earthworks, sub-grade and pavement to be used for the works for alternative 1. These quantities are detailed for a staged construction of the upgrading.

*Quantities of earthworks, sub-grade and pavement to be used for the works for alternative 1**

Section	Upgrading of existing road (Alternative 1) – Earthworks CUT m³	Upgrading – Earthworks FILL m³	Upgrading – Sub-grade Width m	Upgrading – Pavement Base Course Width m	Upgrading – Pavement Wearing Course Width m	New carriageway construction (Alternative 1) – Earthworks CUT m³	New carriageway – Earthworks FILL m³	New carriageway – Sub-grade Width m	New carriageway – Pavement Base Course Width m	New carriageway – Pavement Wearing Course Width m
Demir Kapija-Udovo	0	7000	3.00	5.00	10.00	0	28000	13.00	10.00	10.00
	5600	0	3.00	5.00	10.00	28000	0	13.00	10.00	10.00
	3000	3000	3.00	5.00	10.00	13800	12500	13.00	10.00	10.00
	9700	2000	3.00	5.00	10.00	48500	8000	13.00	10.00	10.00
	90600	4000	3.00	5.00	10.00	453000	16000	13.00	10.00	10.00
	90400	1900	3.00	5.00	10.00	452000	7600	13.00	10.00	10.00
	18600	1400	3.00	5.00	10.00	93000	5500	13.00	10.00	10.00
	5200	0	3.00	5.00	10.00	261000	0	13.00	10.00	10.00
Udovo- Smokvica	46400	0	3.00	5.00	10.00	232000	0	13.00	10.00	10.00
	76800	13900	3.00	5.00	10.00	384000	55600	13.00	10.00	10.00
	24800	2400	3.00	5.00	10.00	124000	9600	13.00	10.00	10.00
	1500	8500	3.00	5.00	10.00	7600	33000	13.00	10.00	10.00
	13000	10500	3.00	5.00	10.00	64700	42000	13.00	10.00	10.00
	43200	33500	3.00	5.00	10.00	216000	134000	13.00	10.00	10.00
	20000	1500	3.00	5.00	10.00	100000	6000	13.00	10.00	10.00
	5600	43500	3.00	5.00	11.00	28000	174000	14.00	11.00	11.00
	21000	23000	3.00	5.00	11.00	105000	577000	14.00	11.00	11.00
	17000	33500	3.00	5.00	11.00	85000	134000	14.00	11.00	11.00

TOTAL	49240 0	18960 0				2695600	1242800			

* Quantitative data of earthworks, sub-grade and pavement to be used for the works for Alternative 2 are not available since that solution is at early stage of design.

a) Land/Soil (occupation of land)

Occupation of land during highway construction, including infrastructure: The road will be aligned in cadastral area(s) in the municipalities of Demir Kapija, Valandovo and Gevgelija and cadastral units in KO Chelevec, KO Koreshnica, KO Kosharka, KO Klisura, KO Davidovo, KO Smokvica and KO Miravci. The total area occupied will be about 149.8 ha in case of Alternative 1, and 132.15 ha in case of alternative 2 (road planum, cuts and embankments). According to the field observations, soils in the area are of various qualities: I-II bonity class in Valandovo plain and on alluvial deposits along the river Vardar or V-VI category (class) on hilly region. Soils along the Alternative 1 alignment are of much higher quality compared to soils along Alternative 2 alignment.

There are no protective zones in the area of intention.

Pieces of land affected by construction of the Demir Kapija-Smokvica highway and related objects and constructions and their size according to the dominating land use type are presented in Chapter VI.8.

b) Water

There is no data concerning the quantity or sources of technical water (road construction). During the construction phase this water will be used for cleaning of machinery, as a raw material, for the road sealing etc.

There are no predictions concerning the quantity of fire fighting water although the exact amount of fire fighting water can not be predicted.

c) Raw materials

In the current phase of design of the highway it is possible to determine exact quantities only for the alternative 1 (see. Tab. 1) and it is not possible to determine sources of construction materials or their exact quantities for alternative 2. Construction materials will be supplied by commercial suppliers. However, even in case of Alternative 1 available data is not sufficient for precise assessment of impacts (generation of waste, soil and pollution).

Supply of material is expected in order of tens of thousands tons. Largest volume will constitute mineral sealing, concrete, soil into embankments. It is expected that for mineral sealing and construction of embankments autochthonous material will be used. Excavated and used earth is not well balanced in case of Alternative 1, as well as of Alternative 2. Other materials used for construction will be steel structures, aggregates, asphalt and concrete panels for construction and surface adjustment of communications.

d) Energy resources

Diesel fuel: During the construction period the diesel fuel will be used for construction machinery and heavy trucks. Refuelling of trucks will be carried out at public petrol stations outside of the construction site. Refuelling of construction machinery will be done in necessary extent on the construction site.

The fuel will be stored on the site in the barrels or tanks located in the safety retention pit provided with the oil-resistant coating. The volume of retention pit will always exceed the capacity of the largest barrel/tank located in a retention pit by at least 10 % to be able to keep all fuel in case of leakage. Barrels can also be stored in retention tubs.

Only diesel fuel for the machinery operated on the construction site (bulldozers, excavators, etc.) could be stored at the construction site.

Natural gas: No natural gas will be used during the construction period.

Electric power: During the construction period the electricity will be used especially for power supply of the construction site (for example lighting of the construction site, power supply of electric equipment, welding etc.).

For the road construction, contracted company will supply energy for construction with diesel fuel generators.

There are no exact data for predicted use of gasoline for the construction of the highway or about the number of machinery and vehicles engaged.

2.1.2.1.2. Raw materials and energy resources for operation

a) Energy resources

Electric power: Electric power will be provided from external public distribution network. The supplies of electric energy shall be connected to the distribution network of the power supply company "EVN - Makedonija". The final design and the point of the connection of the highway facilities to public will be defined in next stage of the design

There is no data about the total installed capacity of the highway electrical equipment

Natural gas: It is not foreseen to use natural gas for energy during highway operation. However, natural gas will be used in individual vehicles (personal cars mainly) as a fuel. The amount of this fuel can not be calculated at the moment. Since this fuel is used in towns and cities normally, it is not expected that it will cause any environmental deterioration ("clean" fuel) or unexpected hazards. There is no legal constrains either.

Diesel fuel: Predicted operation frequency can serve as a basis for calculation of diesel fuel consumption.

b) Raw material and auxiliary materials

Within the operation and maintenance of the Demir Kapija-Smokvica highway (including all related activities) raw and auxiliary materials will be consumed (sand, oils, cleaning agents, defrosting agents). The amount of these materials was not specified by the Employer.

Liquid materials shall be transported in bottles, cans (10 or 20 litres) and barrels with the capacity of 50 or 200 litres. Loose chemicals shall be supplied in transportation packs (barrels and bags) on palettes.

All the auxiliary materials will be stored safely in the storage area according their properties. Substances hazardous to the environment (oils, lubricants, etc.) will be stored only in amounts as necessary to ensure a continuous maintenance of the highway.

There are no detailed data about the management of future highway.

2.1.2.1.3. Demands on auxiliary structures (access roads, borrow pits etc.)

Some basic data concerning auxiliary structures are presented in Chapter II.1.1. However, these data are not sufficient for precise and correct assessment of impacts even in case of Alternative 1. There is no such data for Alternative 2 alignment except for the number and length of objects (tunnels, bridges, overpasses and underpasses).

Borrow pits and landfills are not defined yet, since their definition and need depends on the Geotechnical and Geological investigation works along the alignment. If the material which is to be excavated is suitable for the project needs, there will be no need for additional borrow pits. On the contrary, if the material along the alignment is not appropriate, then there is a need for additional borrow pits. This is going to be defined during the final design preparation period. Nevertheless, in this report there are several possible locations pointed as potential borrow pits for the Project needs (if any).

As for the Access Roads, it is Contractor’s responsibility and choise where those roads will be located. Anyway there are guidelines in this report where not to build temporary access roads, and a proposal for using the existing forest roads as much as it is possible.

2.1.2.2. Data on outputs

Data on outputs comprise data about produced degradation and produced pollutants during construction and operation of the intention/project. All these outputs were analyzed and discussed in the scope of the impacts' assessments and are presented in the respective chapters.

2.2. SPECIFICATION OF MISSING INFORMATION AND UNCERTAINTIES, WHICH APPEARED DURING ELABORATION OF THE STUDY

The following inadequacies in knowledge and/or uncertainties had to be accepted during elaboration of this study:

- Elaboration of the highway design for the Alternative 2 was in the phase of preliminary study, while the road design did not exist. That is why certain detailed information about road construction was not yet available.
- Present status of environment parameters (air and climate, water and to a certain degree biodiversity) in the area under assessment is not known in details as there are no monitoring stations located there.
- Missing information concerning some parameters (geomorphology, climate, biodiversity) was collected for the purpose of this study directly on field but not throughout the whole year (or the whole vegetational season).

This implies that "precautionary principle" has to be applied when necessary (when no reliable information exists).

However, regarding extent and type of the activity under assessment (construction and operation of the Demir Kapija-Smokvica section of the highway) it can be stated, that any principle inadequacies in knowledge and/or uncertainties, that could negatively influence the extent and content of the assessment carried out within this study, did not occur. In individual cases when available information is not sufficient, elaboration of separate environmental impact assessment study(s) will be recommended.

In general, one can conclude, that available information and background materials concerning construction and future operation of the highway were sufficient for elaboration of this EIA Study.

3. PROCEDURE FOR ELABORATION OF THE STUDY

3.1. LEGAL ASPECTS

Environmental Impact Assessment (EIA) is legal procedure prescribed by the Law on Environment[1] by which the Employer is granted consent for the realization of the project by the Ministry of Environment and Physical Planning (in the Law: organ of the state government responsible for the issues if the protection of the environment).

During the preparation of this EIA Study for the construction and operation of the proposed highway, national legislation and international documents and conventions ratified by Macedonia were taken into account

3.1.1. SHORT DESCRIPTION OF THE EIA PROCEDURE

The Law on Environment describes the EIA procedure in details. It is consisted of Screening and Scoping as well as description, evaluation and assessment of the direct and indirect impacts on the environment resulting from realization or non-realization of the project (Article 79).

3.1.1.1. Notification on the intention for project implementation

Legal entities and natural persons intending to implement a project that require EIA shall send a notification on their intention to implement the project, together with an opinion of the need of environmental impact assessment to the Ministry of Environment and Physical Planning (Article 80). The content of the Notification is described by the *Regulation for defining the procedure for EIA* (Regulation on Procedure). The Article 4 of the Regulation on Procedure states that the Notification should be published in some local newspaper in the municipality where the realization of the project shall take place. Ministry of Environment and Physical Planning shall inform the investor within 10 days from the date of the receipt of the notification on the need for supplementing the notification.

3.1.1.2. Screening

After the Notification, the Minister of Environment and Physical Planning should evaluate the need for EIA.

The proposed project for construction of the highway Demir Kapija-Smokvica is included in the projects that require procedure of Environmental Impact

[1] Law on Environment, Official Gazette of the Republic of Macedonia /05

Assessment according to point **7c - *Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 km or more in a continuous length*** in Annex I of the Decree determining the projects for which an environmental impact assessment shall be carried out (referred to Article 7 of the Law on Environment). The screening procedure should not be longer than 30 days (Article 81).

3.1.1.3. Scoping

The scope and the content of the EIA Study shall be defined by the Ministry of Environment and Physical Planning on the basis of Article 82 of the Law on Environment and Article 9 of the Regulation on Procedure. However, no time frame is envisaged by the Law on Environment. The EIA Study should at least contain the following information:

1. Description of the Project with the information on location, character and size of the project as well as land surface needed for the realization of the project;
2. Description of the environment and its components on the proposed location;
3. Description of the historical and cultural heritage and the landscape;
4. Description of the type and quantities of expected emissions and waste, especially the atmospheric emissions, solid communal waste and waste waters as well as other information needed for assessment of the significant impacts on the environment;
5. Description of the measures for prevention, reduction or elimination of the impacts on the environment as well as alternative measures in the case of environmental and landscape changes;
6. Description of the effects of the project having in mind the present knowledge and accepted methods for assessment;
7. Description of the characteristics of the technology to be used;
8. Description of alternatives for realization of the project proposed by the investor and main reasons for selecting the proposed location;
9. Short description of the EIA study without technical details
10. Assessment of the obstacles (technical defects or lack of knowledge) that the investor faced during the preparation of the study
11. Recommendations for the scope and characteristics of the changes in the project that will require amendments of the EIA study.

The presented Study elaborates all of the points presented above.

3.1.1.4. Public participation

One of the most important parts prescribed by the legislation on EIA is public participation in different phases of the EIA procedure. In the first phases, the Investor can involve public in the form of direct discussion after the presentation of the key objectives of the project (Regulation on Procedure: Article 9). The method for public participation (access to information, presenting opinions, comments on the EIA study, organization of public hearing) should be defined by the Ministry of Environment and Physical Planning on the basis of Articles 11 and 12 of the regulation on Procedure. Ministry of Environment and Physical Planning shall present the most important documents during the EIA procedure in daily newspapers, local TV and radio stations as well as on the web page of the Ministry (Law on Environment: Article 90). The Ministry of Environment and Physical Planning information shall:

- Publish the Notification in at least one daily newspaper available throughout the territory of the Republic of Macedonia and on the website of the Ministry of Environment and Physical Planning;
- Publish the decision for the need of EIA in at least one daily newspaper available throughout the territory of the Republic of Macedonia, on the web site as well as on the notice board of Ministry of Environment and Physical Planning;
- Announce that the study on the project for environmental impact assessment has been prepared and is available to the public in at least one daily newspaper available throughout the territory of the Republic of Macedonia, local radio/TV station, while non technical report of the study shall be published on the Website of the Ministry of Environment and Physical Planning;
- Publish the report on the adequacy of the study on the project environmental impact assessment in at least one daily newspaper available throughout the territory of the Republic of Macedonia and on the Website of the Ministry of Environment and Physical Planning;
- Publish the decision for granting consent to or rejecting the application for the project implementation in at least one daily newspaper available throughout the territory of the Republic of Macedonia, on the web site as well as on the notice board of the Ministry of Environment and Physical Planning;
- Announce the time and the place of the public hearing in at least one daily newspaper available throughout the territory of the Republic of Macedonia and local radio and TV station.

The public i.e. the interested persons can have access to information concerning the environmental issues in the scope of project (Law on Environment and Aarhus Convention[2]).

3.1.1.5. Review of the EIA Study

Ministry of Environment and Physical Planning is responsible for the preparation of the Report of the adequacy of the EIA Study (Law on Environment, Article 86). The term for preparation of the adequacy report should not be longer than 60 days from the date of the submission of the study. According to Article 91 of the Law on Environment, the Ministry of Environment and Physical Planning should organize public hearing regarding the EIA study. The public hearing should be organized within the 60 days for the preparation of the Report of adequacy.

3.1.1.6. Granting consent

Based on the EIA Study, the Report on adequacy, public hearing and received opinions, the Ministry of Environment and Physical Planning

The Ministry of Environment and Physical Planning shall, on the basis of the EIA study, Report on adequacy, the public debate and the opinions obtained, issue a decision on whether to grant consent to or reject the application for the project implementation within 40 days from the date of submission of the Report on adequacy (Law on Environment, Article 87).

3.1.2. TRANSBOUNDARY IMPACTS

Macedonia has ratified the ESPOO Convention i.e. the Convention on Environmental Impact Assessment in Transboundary Context (Official Gazette 44/99). The main goals of the Convention are incorporated in the Law on Environment (Articles 93 and 94). According to these provisions, the Ministry of Environment and Physical Planning shall notify the neighbouring country for the proposed project that might cause serious impacts on the territory of the neighbouring country and provide for the competent authority of the foreign country equal treatment in the participation in the procedure as for the domestic public.

The highway corridor area is about 20 km from the national border with Greece. Having in mind the potential impacts of the highway construction and operation as well as the distance of the border zone it is not expected that the project will have impacts on the environment of Greece as a neighbouring country. The operation of the highway will have only insignificant indirect impacts on the socio-economic conditions. Thus, the ESPOO Convention is not applicable in the case of the highway Demir Kapija-Smokvica.

3.1.3. OTHER LAWS AND DOCUMENTS

The presented Study was prepared with account on other national laws and legal documents than the Law on Environment:

- *Spatial Plan of the Republic of Macedonia*;
- *Law on Spatial and Urban Planning* (Official Gazette of RM 4/96; 28/97; 18/99 and 53/01);
- *Law on Nature Protection* (Official Gazette of RM 67/04);
- *Law on Waters* (Official Gazette of RM 4/98 and 19/00);
- *Law on Air* (Official Gazette of RM 20/74);
- *Law on Mineral Resources* (Official Gazette of RM 18/99; 48/99 and 29/02);
- *Law on Energetic* (Official Gazette of RM 7/97; 40/99 and 98/00);
- *Law on Urban Land* (Official Gazette of RM 53/01 and 97/01)
- Decision for declaration of the species *Ilex aquifoloium* for monument of nature. Official Gazette of Gevgelija No.1, pp.2, 4.02.1997.
- Fungal species proposed for protection according to the Preliminary Red List of fungi of the Republic of Macedonia (Karadelev 2000)

3.1.4. RATIFIED CONVENTIONS

The following international conventions, ratifies by the Republic of Macedonia were taken into account during the elaboration of the Study:

- Convention on Environmental Impact Assessment in Transboundary Context -Espoo Convention (Official Gazette of RM 44/99);
- Convention on access to information, public participation in decision-making and access to justice in environmental matters - Aarhus Convention (Official Gazette of RM 40/99);
- Convention on Biological Diversity (Official Gazette of RM 54/97)
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 1979) (Official Gazette of RM 38/99)
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1972) (Official Gazette of RM 49/97)
- CORINE - Coordination of Information on the Environment
- Fungal species protected to the European Red List of Fungi (Ing 1978)
- Fungal species proposed for protection by the European Council for Conservation of Fungi (33 fungal species according to Bern Convention).

3.1.5. WORLD BANK REGULATIONS ON EIA

According to the Screening procedure prescribed by the World Bank and IBRD, proposed project “Construction of section Demir Kapija-Smokvica of E-75 highway” falls into category A: “Development activities likely to induce significant impacts upon environment and biodiversity”.

Among other activities that can significantly impact biodiversity *Transportation projects involving construction of highways, bridges, rural* *roads, railways, airports, or chanels that penetrate natural habitats and ecosystems and open them to colonization and immigration: also, canalization of rivers for navigation and dredging and coastal land reclamation for ports* are noted.

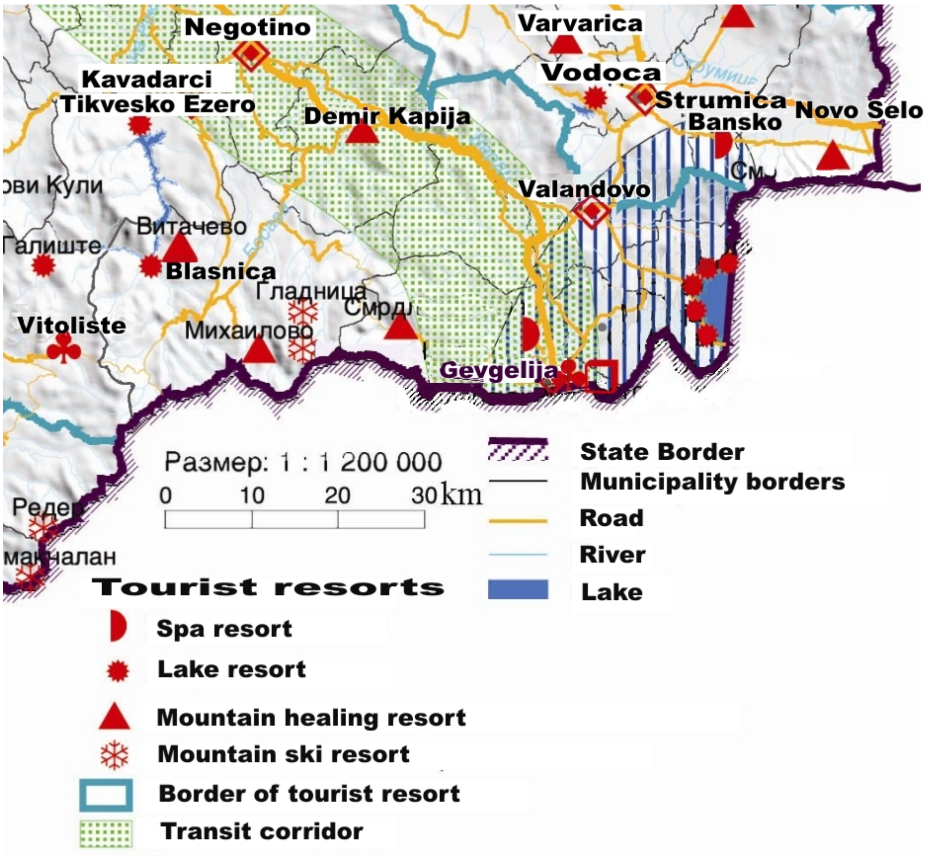
Besides national legislation some other EIA procedures were taken into consideration. In order to improve the efficiency of subsequent data collection and management, proponent and EIA team agreed on significant impacts for assessment (scoping). Three basic methods for determining impacts were: checklists, matrices and overlay mapping/GIS according to the prescriptions by the World Bank.

3.2. SPATIAL PLAN

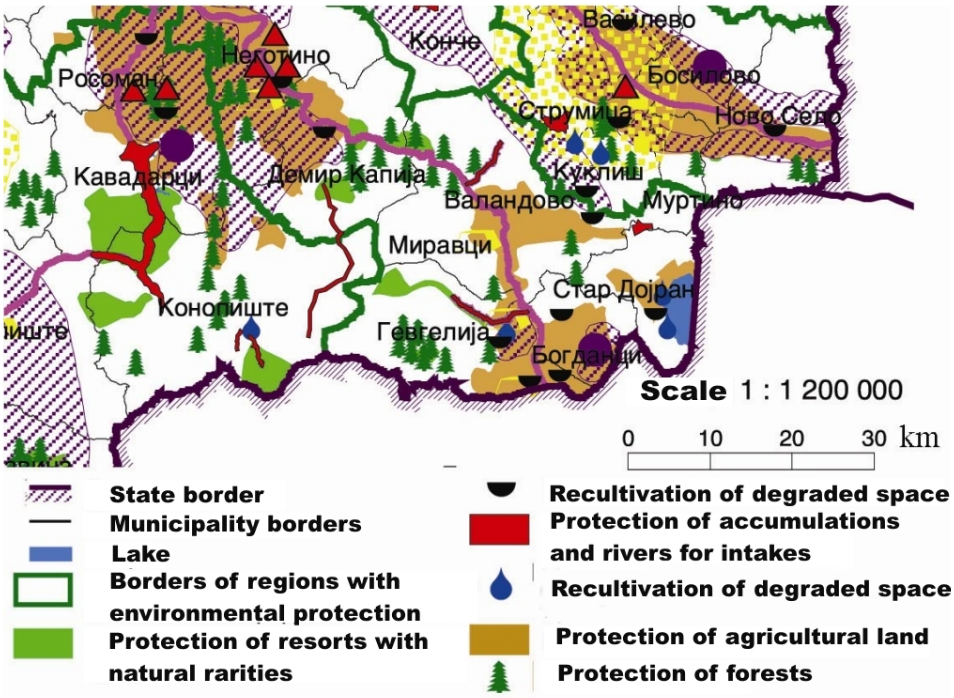
The Spatial Plan of the Republic of Macedonia is valid for the period up to 2020. It projects several activities concerning the development of tourism and expanding the network of protected areas in the region of Demir Kapija.

3.2.1. TOURISM DEVELOPMENT

There are only two foreseen activities for the development of the tourism in the region. The whole area of the highway corridor is foreseen in the Spatial Plan as "Transite Corridor". The area around town of Demir Kapija is noted as "Mountain Spa" (Fig. 1).



Extract from the Spatial Plan of the Republic of Macedonia - tourist regions and localities



Extract from the Spatial Plan of the Republic of Macedonia - protected areas

3.2.2. PROTECTED AREAS

From the aspect of the protected areas network in Macedonia, there are several activities that are noted in the Spatial Plan as well as several areas that are designated for protection. The activities refer to protection of agricultural land in the vicinity of Valandovo and reforestation of the area between Demir Kapija and Valandovo.

In the highway corridor area there are two protected areas. Other six localities are designated for protection according to the Spatial Plan projections. The categorization of the designated areas is not in concordance with the provisions of the Law on Nature Protection. For the time being, there are not elaborated analyses for the exact position, borders, surface and other features of the designated areas.

However, in the case of the Bela Voda cave it is clear that the designation refers to the whole system of the cave.

Overview of the protected areas/species and areas denoted for protection in the broader area of interest (extract from the Spatial Plan of the Republic of Macedonia)

locality/species	**category**	**status**
Iberliska Reka	IPASON	**protected**
Klisurska Reka	SINR	proposed
Studena Glava-Rid Trnika	SINR	proposed
Demir Kapija	**MN**	**protected**
Krastovec	MN	proposed
Bela Voda cave	MN	proposed
Crni Orevi	MN	proposed
Shtuder	MN	protected

IPASON - Individual Plant and Animal Species Outside of Natural Reserves; SINR - Nature Reserve for Scientific Research; MN - Monument of Nature (this classifications thus not correspond to the provisions of the Law on Nature)

3.2.2.1. Chelevechka (Iberliska) Reka

Iberliska Reka (syn. Chelevechka Reka) was proclaimed as a plane (*Platanus orientalis* L.) reserve. It is located along the river Iberliska Reka flow, between the villages Iberlija and Chelevec (Demir Kapija region). It represents a water gap cut into Demir Kapija Jurassic limestone. The reserve occupies 25 ha area. The forest is of a native origin and it is well preserved. It is distributed as a more or less narrow belt along the stream.

It was protected since 1963 as a category Individual Plant and Animal Species Outside of Natural Reserves.

3.2.2.2. Demir Kapija

Demir Kapija canyon is protected area (since 1960) in the category– Monument of Nature (III category according to IUCN). It has extraordinary importance from the biodiversity point of view (for its location, see Habitat map-Appendix I.4.).

Demir Kapija (in broad sense) is the longest gorge of the river Vardar (19 km). It is passing through limestone and eruptive rocks, which are dividing Tikvesh valley on the north-west and Gevgelija-Valandovo valley on the south-east. The entrance in the gorge is especially impressive canyon, 0,9 km in length, with different carstic shapes on its slopes–caves (9): the longest is Bela Voda cave (955 m), crevices, cuttings with steep cliffs etc.

The Demir Kapija canyon (Photo 1) is among the richest ornithological reserves in Europe considering the rare birds of pray: *Gyps fulvus*, *Neophron percnopterus*, *Aquila chrysaëtos*, *Circaëtus gallicus*, *Buteo rufinus*, different falcons–*Falco peregrinus*, *Falco naumanni* and other rare and scientifically important bird species. In the Demir Kapija gorge important mammal, reptiles and insects species are presented as well. Also, rare and endemic plant species are presented there (*Lilium heldreichii*, *Lilium martagon*, *Kitaibelia vitifolia* etc.).

In 2003 there was an initiative of the Ministry of Environment and Physical Planning to re-categorize the Demir Kapija Monument of Nature as "strictly protected reserve". An Elaborate was prepared for this purpose but the proposal was not accepted. According to the proposal from 2003, the strictly protected reserve "Demir Kapija" should cover area of 4250 ha.

Photo 1. *Demir Kapija is protected as Monument of Nature because of its ornithological and geomorphologic values. However, a number of infrastructural objects are passing through Demir Kapija canyon.*

4. CHARACTERISTICS OF THE AREA OF INTEREST

This chapter describes the current status of the basic environmental features of the project area, including the surrounding regions that could be affected by the project construction and/or operation. Both natural and anthropogenic environment are considered.

The projected highway is going to pass along the river Vardar valley. The river Vardar is running through the central part of the Republic of Macedonia, from North-Northwest to South-Southeast, thus dividing the country in two parts: western and eastern part. The lower part of the valley, where the investigated highway corridor is passing, is spread from Demir Kapija to Gevgelija (village Smokvica is situated about 10 km on the north of Gevgelija).

Foothills of Marjanska Planina (the lowest and easternmost part of Kozhuf mountains surround the valley from the right side and hilly, small mountains, from the left side: Konechka Planina, Gradeshka Planina, Plaush and many smaller hills at the southernmost part (Appendix I.2.).

Beside the main water flow (river Vardar) the valley is characterised by several rivers (Boshava from the right side and Anska Reka from the left) and small rivers and streams, among which Chelevechka Reka from the left side and Javorica and Petrushka Reka from the right side, are more important, since they have permanent water flow. Some of the streams are with temporal flow in the lower part due to the use of their water for irrigation of the fields in the valley.

Presently, the area is hardly urbanised (one urban systems is touching the project area corridor - town Demir Kapija). Several villages are distributed along the road corridor under project impact: Udovo, Josifovo, Miravci, Miletkovo, Davidovo, Marvinci and Smokvica at the end of the project area. Villages Gradec and Klisura are abandoned.

From this point forward, the terms like "project area", "the area of intention", "affected area", "affected region", "the area under project impact" or similar, shall mean the area as described in previous paragraphs.

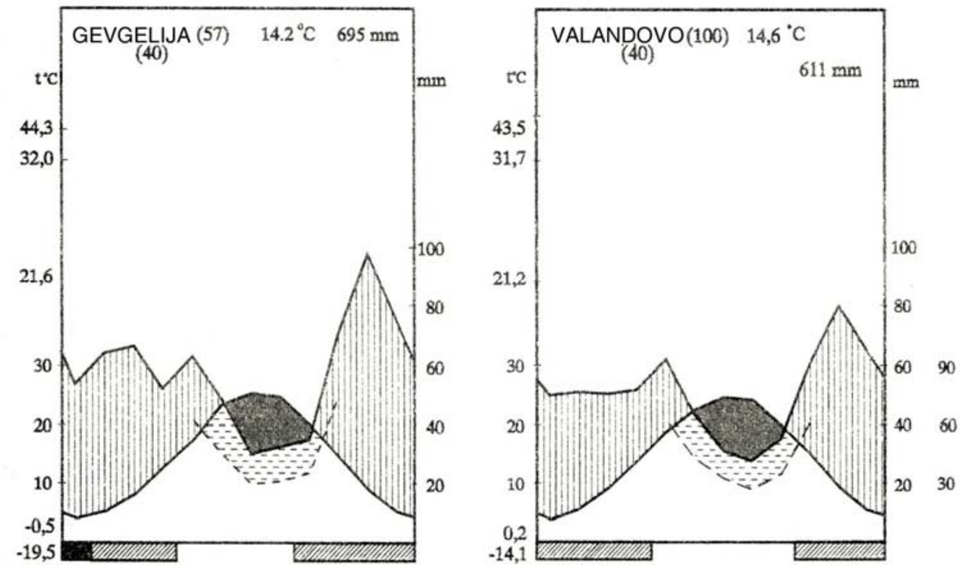
4.1. CLIMATIC CHARACTERISTICS

The area between Gevgelija, Valandovo and Demir Kapija is well defined geographical unit that is encircled by mountains from west and east, and opened on the north and south by the river Vardar valley has specific climatic characteristics. It is one of the warmest regions in the Republic of Macedonia. Gevgelija-Valandovo valley is about 60 km away from the Thessalonica gulf.

The characteristics of climate for the section of highway corridor area are presented on the bases of three meteorological stations: Demir Kapija, Valandovo and Gevgelija. The meteorological stations in Gevgelija and Valandovo are outside of the highway corridor area. However, the data of these two stations can be used to reflect the climatic conditions of the southern-most parts of the highway corridor (Miravci- Smokvica). The meteorological station in Demir Kapija represents the climatic conditions of the north part of the highway corridor as well as the gorgy and hilly parts. The measurements of the meteorological station in Valandovo present the climate in the area of Village Miravci. The climate of the area of village Smokvica is more similar to the climatic characteristics described by the data of the meteorological station in Gevgelija.

Mediterranean climate from the Thessalonica gulf penetrates into the Gevgelija-Valandovo valley and spreads along Vardar River to the north of Demir Kapija. The Mediterranean influence determines the basic characteristics of the climate of the area in whole and some climatic elements separately. Mediterranean influence in Tikvesh valley (northern of Demir Kapija) is less manifested than in Gevgelija-Valandovo valley. The Demir Kapija gorge represents natural frontier for the Mediterranean influence along the river Vardar. Because of the Mediterranean influence, the climate is characterized is modified Mediterranean climate. However, the climate of Demir Kapija shows transition to the continental climate with strong sub-Mediterranean influence.

In general, the climate is semiarid with the exception of semiarid period (July-September). The precipitation is higher during the autumn than the spring period (Fig. 3). The humid period lasts from November to March.



Walter's climate diagrams of Gevgelija and Valandovo (from: Filipovski et al. 1996).

4.1.1. AIR TEMPERATURE

The characteristics of temperature regime are presented in Tab. 4-8. Gevgelija-Valandovo valley has highest annual average air-temperature in the Republic of Macedonia of about 14.4°C (Gevgelija) to 14.8°C (Valandovo). Compared to the neighbouring valleys, the Gevgelija-Valandovo valley has 1.4°C higher temperature than Strumica valley and 1.3°C than the Tikvesh valley. Gevgelija-Valandovo valley has about 1.3°C higher temperature than the north-most valley along the river Vardar–the Polog valley (Tetovo).

The average annual temperature in Demir Kapija is 13.5 °C. It is lower than the temperature of the southern parts of the corridor area which are represented by the Gevgelija and Valandovo stations.

However, Gevgelija and its vicinity compared to Valandovo have lower temperatures because of the winds blowing in this part, although it is situated on south. Valandovo and its vicinity have higher air-temperatures because of the mountains that are surrounding the valley and protect the valley from the cold winds that are blowing from north. Average temperature in January is relatively high: 3.2°C (Gevgelija) and 3.6°C (Valandovo). Relatively high temperature is registered in the remaining winter months (December and February).

Average monthly and annual air temperatures [°C]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	1,6	4,6	8,5	13,5	18,3	22,2	24,4	23,9	20,2	14,0	8,2	3,3	13,5
Valandovo	3,6	5,5	8,8	13,5	18,3	22,3	24,8	24,3	20,4	14,7	9,3	5,2	14,2
Gevgelija	3,5	5,4	8,6	13,3	18,4	22,8	25,1	24,5	20,3	14,2	9,2	5,1	14,2

Average maximum monthly and annual air temperatures [°C]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	5,3	9,1	13,6	19,3	24,5	28,7	31,3	31,2	27,1	20,2	12,6	19,1	20,1
Valandovo	7,6	10,2	13,8	19,3	24,3	29,0	31,7	31,7	27,3	23,9	15,0	9,7	20,3
Gevgelija	8,0	10,4	14,0	19,6	24,9	28,6	32,0	31,7	27,7	21,1	14,4	9,8	20,2

Average minimum monthly and annual air temperatures [°C]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	-1,9	0,2	3,6	7,2	11,6	15,3	17,3	16,5	13,4	8,5	4,5	1,0	8,2
Valandovo	0,2	1,5	3,5	7,5	11,2	15,2	17,3	18,9	13,7	9,4	5,4	1,6	8,7
Gevgelija	-0,5	0,8	3,4	7,0	11,5	15,3	17,3	16,7	13,3	8,3	4,6	0,9	8,2

Absolute maximum monthly and annual air temperatures [°C]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	19,3	22,7	28,7	35,3	36,1	39,5	43,6	41,4	36,7	32,2	25,6	20,8	43,6

Valandovo	19,0	23,5	27,8	31,5	34,4	39,5	43,5	40,4	37,2	32,6	25,6	20,0	43,5
Gevgelija	19,5	23,0	30,0	31,0	37,0	40,0	44,3	42,5	38,6	33,6	27,0	21,6	44,3

Absolute minimal monthly and annual air temperatures [°C]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	-18,5	-18,6	-11,0	-2,5	1,4	5,7	7,8	6,1	1,1	-5,7	-8,4	-15,4	-18,5
Valandovo	-12,5	-14,1	-9,5	-0,7	1,9	7,5	10,5	8,8	3,2	-3,5	-10,5	-12,5	-14,1
Gevgelija	-19,5	-15,0	-10,7	-3,0	0,5	5,1	8,4	6,8	0,0	-5,7	-9,5	-10,1	-19,5

The average monthly temperatures during winter period in the highway corridor area are constantly above 0 °C (Tab. 4). Gevgelija-Valandovo valley and Demir Kapija have highest average January air-temperature in the Republic of Macedonia. Only during January in Demir Kapija and Gevgelija, the average minimum temperatures are lower than 0 °C (Tab. 6). The absolute minimum temperatures (Tab. 8) show that the temperatures can drop almost to -20 °C. Temperatures below freezing point were measured at all three meteorological stations during the period from October to April.

The average maximum annual temperatures are above 20 °C (Tab. 5). The absolute maximum temperatures are very high (Tab. 7). These values are highest for the Republic of Macedonia. The maximum temperature measured in Gevgelija is 44.3 °C. Demir Kapija and Valandovo have somewhat lower maximum temperatures of 43.6 and 43.5 °C.

The differences of the temperature values between warmest and coldest month in the year are varying from 22.3 °C (Valandovo) to 22.5 °C (Gevgelija). Absolute variance of the temperature has similar characteristics. The difference between absolute maximal and minimal temperature is varying between 23.0°C (Gevgelija) and 28.1°C (Valandovo). It is much bigger than the differences between absolute maximal and minimal temperatures in other valleys in Macedonia (Polog valley - 10.5 °C, Strumica valley - 16.5 °C, Tikvesh valley - 24.0 °C) etc. The varying of the temperature indicates that the temperature regime of the valley is determined by the Mediterranean influence as well as by the local orographic characteristics and sporadic penetrations of cold winds from north in the winter period. This is the reason for the disturbance of the temperature stratification that should exist according to the geographic position of the valley. The dynamics of average seasonal temperature is another important parameter for the characterisation of temperature in the area.

4.1.2. PRECIPITATION

The characteristics of precipitation regime for highway corridor area are presented on the bases of the three meteorological stations–Demir Kapija, Valandovo and Gevgelija. The average values of precipitation parameters are presented in Tab. 9 and Tab. 10.

The Gevgelija-Valandovo valley belongs to the Mediterranean pluviometric regime according to the rainfall distribution. The annual quantity of precipitation varies between 561.0 mm in the northern part (Demir Kapija) and 694.6 mm in the southern part of the valley (Gevgelija). The average annual quantity of precipitation in Gevgelija and Valandovo valley is bigger than one in the adjacent regions as well as in the other micro-regions with Mediterranean climatic modifications such as Demir Kapija area. This phenomenon is determined by the movement of the warm air that finds the high mountain frame as an obstacle in the way of its moving from north and west. The consequence of this process is cooling of the air mass and condensation of the vapour followed by the rainfalls in the valley.

Maximal precipitation is registered in November. The minimal precipitation is registered in the summer period: in July: Demir Kapija – 32.5 mm, Valandovo – 31.9 mm and Gevgelija – 32.2 mm; in August: Demir Kapija – 21.0 mm, Valandovo – 27.8 mm and Gevgelija – 32.2 mm. It is the period of highest air-temperatures. Such distribution of precipitation (monthly and seasonal) causes appearance of dry periods that are characteristic for the summer. Dry periods have tendentious to redistribute in the first months of autumn. Dry periods in the Gevgelija-Valandovo valley do not last that long as ones in the central regions of the Republic of Macedonia (northern of Demir Kapija). The precipitation in the Gevgelija-Valandovo valley consists mainly of the rainfalls. It is snowing very rare and the snow cover lasts for a short period of time. There are six days with snow cover in average in the Gevgelija plain. Number of days with snow cover is varying between 0 and 24 days in the year. The average date for the snow appearance for the first time in the year in Valandovo plain is December 22nd and on February 24th for the last time in the year. Average duration of snow cover in Demir Kapija region is 22 days per year. Maximal registered height of the snow cover is 100 cm in January 1962 and 62 cm in January 1969.

Average monthly and annual precipitation [mm]

meteorological station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	annual
Demir Kapija	48,0	46,8	49,0	44,7	58,1	41,1	32,5	21,0	31,0	50,8	63,9	71,5	561,0
Valandovo	48,7	51,3	50,8	51,7	62,3	42,9	31,9	27,8	35,5	60,0	83,8	64,0	610,8
Gevgelija	53,6	65,3	67,4	53,9	62,7	47,5	30,7	32,2	35,0	71,5	99,0	75,8	694,6

Temperature (A) and precipitation (B) by seasons

	Winter		Spring		Summer		Autumn	
meteorological station	A	B	A	B	A	B	A	B
Demir Kapija	3,1	166,3	13,4	151,8	23,5	94,6	14,1	145,8
Gevgelija	4,4	128,2	13,4	184,0	23,8	109,8	14,6	190,0

4.1.3. WINDS

Winds are important climatic factor. They are one of the most characteristic features of the area between Demir Kapija and Gevgelija. Their direction of blowing is determined by the morphoplastics of the region. Most frequent are south and north winds. South winds bring warmth in the winter period because they carry warm sea air mass. The north winds are cold and they bring continental cold air.

Winds from north-west (Vardarec) and from south-east (Jug) are prevailing in the Demir Kapija region. Vardarec is most frequent in summer (July, 237 ‰) although it blows in the whole period of the year with high frequency. Vardarec blows with much smaller speed in the Demir Kapija region. Its average month speed is 1.9 $m \cdot s^{-1}$ in October to 2.8 $m \cdot s^{-1}$ in February and March, while its maximum speed is 15.5 $m \cdot s^{-1}$. The wind called Jug is second by the frequency in the Demir Kapija region after the Vardarec. It blows along the River Vardar and it is characterised as warm wind. It blows very frequently in the whole period of the year especially in April, March and November. Average wind speed in September of Jug is pretty constant and varies from 4.5 $m \cdot s^{-1}$ to 7.1 $m \cdot s^{-1}$ in December. Winds with different directions in Demir Kapija region are not so well expressed with exception of the eastern wind (it is on the third place according its frequency). Its average monthly speed varies from 4.5 $m \cdot s^{-1}$in July to 7.0 $m \cdot s^{-1}$in January.

In the Gevgelija-Valandovo valley most expressed winds are Vardarec (blows from the north) and Jug (blows from south-east). Vardarec blows in the whole period of the year and most frequently in January (327‰), February (278 ‰) and December (275 ‰). It is no so frequent in the spring and autumn. Vardarec appears with high frequency in the summer particularly in July (238‰) and August (220‰). The duration of the period when this wind blows is 1-2 days in average, but in some years it blows continually for a whole week. Vardarec has characteristics of a gust wind: in some moments it blows with big intensity and speed. Along the River Vardar valley it blows with moderate speed and reaches the greatest speed in the Gevgelija and Valandovo valleys (23 $m \cdot s^{-1}$). Great speed of Vardarec is characteristic for winter months. Average month speed in January is 7.2 $m \cdot s^{-1}$, in February - 7.0 $m \cdot s^{-1}$ and in December - 6.2 $m \cdot s^{-1}$. Average speed of the Vardarec in summer is 6.2 $m \cdot s^{-1}$, while it is speed in autumn is very constant. Vardarec wind decreases the air temperature during the year. It is very cold wind in the winter. The wind Jug is frequent in Gevgelija-Valandovo valley. Its frequency is high in spring and autumn with maximum of 150‰ (May - 133‰ and October 122‰). Wind speed of Jug is much smaller than the Vardarec one. The average monthly speed is not bigger than 2.1 $m \cdot s^{-1}$. Jug is warm wind, particularly in the winter.

The Gevgelija-Valandovo valley is very spacious and framed with high mountains from west-north-west. This provides conditions for the appearance of local winds i.e. daily change of winds is expressed as a result of the different warming of the air in the bottom of the valley and in the mountain part. The local winds are most frequent in the warmest part of the year. Vardarec and Jug are result of atmospheric processes of bigger proportion. More important local wind are wind from north-west direction blowing from Kozhuf Mt .to the Gevgelija valley and eastern wind that blows mostly in June and July and very rare in winter. Besides these local permanent winds, there are some local whirl winds appearing as a result of the instability of the air mass with thunderstorm connective clouds. These winds are most frequent in spring and summer. Sometimes blow with great intensity and can damage the vegetation cover and crops.

4.2. GEOMORPHOLOGIC CHARACTERISTICS

In the geotectonic point of view, the investigated area (Demir Kapija – Gevgelija) belongs to the very unstable geotectonic unit in the Republic of Macedonia known as Vardar zone of folding. River Vardar that is flowing in this geotectonic unit formed a composite valley i.e. it flows through many plain parts and gorges. After the Tikvesh basin, River Vardar cuts through the blocks composed of Jurassic limestone and have created the Demir Kapija gorge –one of the most spectacular along its river basin. After the Demir Kapija gorge, River Vardar flows through the plain part of the Valandovo valley and cuts the hilly area between v. Marvinci and v. Smokvica (Smokvica pass) and runs into the Gevgelija valley.

4.2.1. RELIEF

Considering geological aspect, the explored area of Demir Kapija-Smokvica belongs to a very instable geotectonic unit in the Republic of Macedonia known as Vardar zone. The region through which the corridor of the designed motorway passes is mostly mountainous area where fluvial-erosive type of relief prevails. The major characteristics of the relief were formed by the tectonic processes. The terrain has been characterized by existing of peaks with an elevation of 150-700 m whose slopes in the East steeply plunge down towards the Vardar River or towards its tributaries. After the Tikvesh basin, the Vardar River cuts the massive Jurassic limestone, builds the Demir Kapija ravine and continues to flow through flatten parts of the Valandovo valley where fluvial type of relief is dominant.

4.2.2. IMPORTANT GEOMORPHOLOGIC STRUCTURES

4.2.2.1. Aboveground geomorphologic structures

The Demir Kapija ravine, with a length of about 20 km presents a dominant geomorphologic structure of the explored terrain. It starts eastern from Demir Kapija, about 500m after the empty of the Boshava River into the Vardar

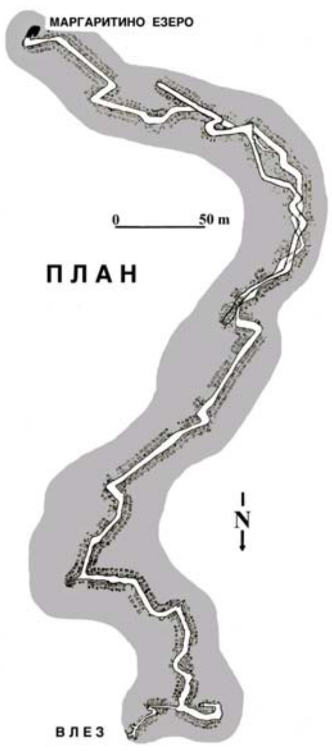
River. By out flowing of the middle Vardar Lake, towards the end of the Pliocene, the Vardar River starts building this ravine penetrating gradually across the compact Jurassic limestone. In its beginning part, the Demir Kapija ravine has a character of a canyon because the sides of the ravine are almost vertical and they fall at an angle of 70-90˚. The length of the canyon part of the ravine is 900 m. The bottom of the canyon is at an elevation of 103 m while the highest peaks reach 355 m at the left side and 230 m at the right side. In the middle part of the Jurassic carbonate complex, at the left side, the spring of the Chelevechka River has been cut which also forms a canyon with a length of 750 m.

In the remaining part, the Demir Kapija ravine has a typical ravine character which was conditioned by the change of the geological composition as to the end, at the Udovo village, the terrain has been built of spilite and diabase. The fluvial-erosive relief is dominant at both sides of the river valley (Demir Kapija-Udovo) so that the inclination at the surface of the terrain formed at the right and the left side of the valley varies between 20-50˚. The average width of the bottom of the river valley in this part is 300 m to a maximal width of 600 m on some places. The widened parts of the ravine have been filled with alluvial deposits, being to 20m thick, represented at both sides of the river flow. The river valley of the Vardar River, at the right side has been cut by tributaries that have a ravine character of valleys which have formed alluvial-proluvial fans in the lower parts. Because of the low degree of weathering of the diabase, there are no typical erosive forms such as ravines and rills in the Demir Kapija ravine. At the right side of the Vardar River, significant tributaries are the following: The stream Stara Reka, the Strkovski Dol, Golema and Mala Javorica. The alignment of the designed motorway cuts the Stara Reka stream, in the middle part at a height of about 300 m, it cuts the tributaries Mala and Golema Javorica in their spring parts and it goes on along the Kratica River flow, which is a left tributary of the Petrushka River.

The wavy hilly area which stretches from the exit of the Demir Kapija ravine, at the Udovo village, continues at the right side of the Valandovo valley and ends above the Smokvica village, can be distinguished as the second geomorphologic unit. This area has been characterized with low peaks, with a gradient of the slopes of 20-30˚ which plunge down with a less gradient towards the valley of the Petrushka River or towards the Valandovo valley and river flows that have calm character. As regards the geological structure of this part of the terrain, the spillite which is rather degraded at the surface and weathered to a depth of 2-3 m as well as liable to flushing and line erosion, are dominant. The influence of the tributaries at right side of the Vardar River along with their intensive erosive activity can be clearly noticed within the peripheral parts from the western part of the Valandovo valley, expressed through numerous and swallow ravines and rills above the following villages : Davidovo, Miravci, Miletkovo and Smokvica as well as along the Kratica Reka flow. Beneath the Miravci village, the terrain is mildly inclined in the East towards the Valandovo valley.

The third distinguished geomorphologic unit is the Valandovo Valley which stretches in the East of the Davidovo and Miravci villages. There is striking towards East-West, in the East, it is confined by southern-eastern slopes of the Belasica Mountain, in the West, by the Plaushka Mountain, and in the South, it is connected with the Gevgelija valley. The fluvial relief is characteristic for the Valandovo valley presented by alluvial fans and river valleys of large and small waterfowls. The greatest number of the alluvial fans is located at the western peripheral parts of the valleys to the following streams: Sermeninska, Kovanska, Zuica and Stara Reka, which are characteristic for the tributaries of the right side of the river Vadar. At both sides of the Vardar River, within the lower parts of the valley, there is a great area covered with terrace material.

4.2.2.2. Belowground geomorphologic structures (caves)



Apart from the insignificant occurrence of some karst forms at the surface of the terrain within the Demir Kapija gorge, in other words, within the carbonate complex both sides of the Vardar River, about ten (10) caves were registered as very important karst forms. The dimensions of the caves are inconsiderable with exception of the Bela Voda cave. The entrance of the cave (Photo 2) is located at the right side of the Vardar River (very near the railway station) and according to its dimensions it is one of the biggest caves in the Republic of Macedonia. It consists of two channels (a higher and a lower one), with different length (Photo 3). The length of the lower channel is 722 m, and to the higher one is 233 m, or 955 m total. At the end of the lower channel, there is an underground lake- sag pipe full of water (Fig.4).

Longitudinal and vertical profile of Bela Voda cave

Photo 2. Entrance of Bela Voda cave

The cave ornaments (Photo 4), stalactite and stalagmite are very unusual while it was determined that there is modern fauna in the cave. In designing the corridor of the future motorway, the cave, being a significant geomorphologic form, should be preserved as a natural phenomenon.

Photo 3. The main canal of Bela Voda cave

Photo 4. Ornaments in Bela Voda cave

4.3. GEOLOGICAL AND TECTONICAL CHARACTERISTICS

4.3.1. GEOLOGICAL STRUCTURE

In the initial part of the designed alignment of the motorway, Eocene flysch sediments were ascertained at the left side of the Vardar River. The flysch sediments have been mostly presented by fine to medium grained sandstone and thin interbeds of claystone and marl which often interchange rhythmically. The horizontal, and unusually the inclined, bedding is characteristic with a thickness of the layers of 20-200 cm.

At both sides of the Vardar River, after the emptying of the Boshava River, in other words, from 1.8 to 3 km along the designed corridor of the motorway, the Upper Jurassic limestone was developed. The limestone, in the lower parts, is marly, platy to thick-bedded and it gradually interchanges into massive one. The colour of the limestone is white, grey-white to grey. Several fractures can be noticed in it, somewhere rather wide, filled with crushed limestone material. At some places, the limestone is karstificated, so that small and great caves are noticed. Basal conglomerate occurs below the limestone, which transgressively lie above the rocks of the gabbro-diabase massif. It has a green colour and it has been built of gabbro-diabase pebble, spilite etc. with a size of 5-30 cm.

Most part of the terrain has been composed of rocks of the gabbro-diabase complex which occupy a great expanse, which occur from 3-22 km along the alignment of the designed corridor, presented by spilite and diabase. They also occur at the end of the alignment from 26-28 km where they are presented by spilite and smaller masses of quartz keratiphyre. Towards West, the diabase gradually changes into gabbroid rocks, through gabbro diabase into gabbro.

Within the gabbro diabase complex, the diabase which occurs from 3-6 and 9-19 km along the corridor are dominant. It is distinguished with green or grey-green colour, suphobite structure, homogeneous and massive texture. It is fine grained and the size of the grains doesn't exceed 1mm. It is rather hard and tenacious rock, and it is often cut by veins of calcite and epidote. The major compounds are: the basic plagioclase, augite and not often amphibole. The limonite and the magnetite are accessory minerals. SiO_2 with 56.02 %, Al_2O_3 with 14.55 % and FeO with 5.80 dominate in their chemical composition. Within these minerals, here and there, parallelepiped jointing can be noticed as well as spherical one, bit not often, and fractures with different orientation, especially along the valley of the Vardar River. The diabase represented along the Kratica river have been fairly degraded at the surface, weathered and more liable to flushing and holing (cutting) in relation to the diabase represented along the valley of the Vardar River. At the same time, ravines and drills start forming with a length to 300 m and depth of 2-3 m. The diabase is mostly fractured and altered at the surface as it has undergone a process of various transformations: uralitization, sericitization, kaolinization and mechanical deformation. These fractures are filled with weathered material and calcite veins.

Within the gabbro-diabase complex, the spillite along the alignment of the designed motorway has occurred after the Jurassic limestone in the beginning part from 6-9 km, at the end of the alignment from 19-22 and 26-28 km. The spillite has been developed along the Vardar River and in the surrounding of the Klisura village where it occurs as a great mass, but at other places as well in the diabase mass, where they occupy small areas. The spilite is submarine flows, it occurs as a type of pillow lava and has dark green colour, dark purple and pure black colour. It is characterised with a vuggy reticulate structure with numerous small and large vugs with a size from 3-8 mm, filled with secondary minerals: calcite, chlorite, epidote etc. At the surface, these minerals are often flushed, so that the rocks in these cases have porous texture. The structure of the spilite is vuggy, while the basic mass is sub ophitic. For the spilite, spherical jointing is characteristic especially expressed along the left side of the Vardar River near the tunnel at Demir Kapija, in the vicinity of villages Davidovo, Klisura etc. The size of the balls is not equal and it varies from 0.2-1 m considering the composition of the spilite, fine grained acicular plagioclase (albite) dominates and small quantities of pyroxene, which is mostly altered or totally destroyed. The chemical composition of the spilite is : SiO_2-51.80%; Al_2O_3-13.22%; Fe_2O_3-6.73%; CaO-6.35% ; FeO-6.0% ; MgO-4.17% etc. The spillite that has been represented above the villages Davidovo, Miravci, Miletkovo and Smokvica is rather degraded at the surface, weathered and more liable to flushing and holling in relation to the spilite represented along the valley of the Vardar River. At the same time, ravines and drills have been formed with a length to 200 m and a depth of 2-3 m.

Small masses of quartz- keratophyre occur towards the end part of the alignment within the spilite from 26-28 km. These masses have been represented in a form of a dike and veins. The veins have different length which varies from 10-350 m and a thickness from 1-3 m, rarely to 5 m. The contact with the spilite is sharp and clearly visible. Its colour is light green, pink and yellowish. It is fine grained, has porphyry structure and massive texture. It usually occurs along with the keratophyre from which it differs in the greater content of quartz. As regards its composition, the plagioclase is dominant and it is represented within the basic mass and as phenocryst and small quantities of quartz and rarely feldspar.

At several places in the area of the villages Davidovo, Miravci and Miletkovo, within the spilite, there are small and great masses of bedding sandstone and claystone in a form of narrow zones. Regarding the close relation with the spilite, which they interchange with, their age was determined to be Jurassic one.

The alluvial sediments have been represented in the beginning part of the designed motorway, at Demir Kapija, at the empty of the Boshava River into the Vardar River and along the flow of the Petrushka River, composed mostly of grave land sand, primarily of the gabbro-diabase composition, with a thickness of about 10 m.

The terrace sediments have been largely developed in the valley of the Vardar River, in the South of the Davidovo village and in the East of the villages Miravci and Miletkovo where they occupy a large territory. They are presented by clayey material mixed with grave land sand in the upper parts and pebbles and blocks with gravel piled without order in the deeper parts of these sediments whose thickness is about 30 m.

The diluvial deposits occur in the passing zones of the mountainous slopes towards the valley part of the Valandovo valley, in other words, at the villages Davidovo, Miravci, Miletkovo, and Smokvica and above the alluvial sediments at both sides of the Vardar River at Demir Kapija. They have been composed of slope debris mixed with sandy clay, not classified and poorly processed material.

For more information on distribution of geologic masses refer to Geologic map-Appendix I.3.

4.3.1.1. Engineering geological characteristics of the rock masses

The alluvial sediments and the terrace deposits have been mainly composed of coarse clastic sand and gravel, with heterogeneous granulometric and petrographic composition. They are distinguished by a good processing, low constraining, with no classification and medium to good compactness. The conditions for constructing in them are favourable, especially above the aquifers level. The conditions for working within the ground water zone have been complicated because of the constant ground water flowing up.

The diluvial deposits, composed of clayey sandy debris, have been distinguished by heterogeneous granulometric composition, poorly to medium compacted, not classified and poorly processed material. They are a favourable medium and stratum for constructing any kind of structures.

Because of the specific lithological composition and the great mechanical damage, the flysch sediments are liable to intensive surface weathering. In the surface parts, because of the weathering of its lithological members, thick deposits of diluvial detritus often occur, composed of sandy-clayey composition, with pieces of conglomerate, sandstone and claystone liable to sliding which is a characteristic of the flysch complexes. The conditions for constructing within the flysch sediments are not equalized in dependence of the local composition of the flysch, the degree of mechanical damage and bedding. On these terrains, the conditions for working do not refer to the difficult excavation, cutting, very much, but to the instability of their slopes.

The limestone occurring at the Demir Kapija gorge is massive but much fractured, with fractures that have different orientation and length to 50 m. The fractures are mostly open and filled with clayey debris. At certain places, it is karstificated, here and there, great caverns and caves occur. It is a good stratum and medium for building, but its advantage decreases with the increase of its fracturation, cavernosity and karstification. The stability of the slopes within the cuts, to the walls in the tunnels and other underground structures is great and is conditioned of the degree of fracturation of the limestone. The conditions for constructing civil engineering structures in the limestone are most usually suitable. Lining of the underground rooms is often unnecessary, except for the hydrotechnical tunnels, where it is most often obligatory and necessary.

The rocks of the gabbro-diabase complex (diabase and spilite) which dominate on the terrain are hard and tenacious, but at the surface they are weathered and covered with piled and not classified soil debris, with a thickness to 5m, more expressed in the second part of the alignment of the designed motorway. The terrains composed of these rocks are characterized by good bearing capacity and stable slopes. The conditions for working within these rocks are rather favourable, with an exception of the parts that ate tectonically more damaged and mylonitized Lining is necessary in the shaly and tectonically damaged zones. They are seismically most resistant rock masses; they are characterized by most favourable elastic properties and with equal reactions to seismic shocks. Earthquakes in these rocks can cause only local rock falling and crumbling under conditions of intensive fracturation and at inclinations of the slopes of 40-60˚. When the intensity of the earthquake is greater than 7 degrees, it may initiate everlasting damages to the structures with rare permanent deformations.

4.3.2. MINERAL RESOURCES

In the region where the future motorway is going to pass, actually, within the gabbro-diabase complex at both sides of the Vardar River, occurrences of copper were registered and they have been connected to the Mesozoic magmatism. The copper occurrences were ascertained in the vicinity of the Gradec village, at the left and the right side of the Vardar River valley, in the South of the Davidovo village and in the surrounding of the Negorci village. These copper occurrences are of a vein type and are related to the dislocations in the massif. Quartz veins occur with a little length and thickness, mineralized with chalcopyrite. These occurrences, because of the little reserves do not have any great economic significance.

In the immediate vicinity of the corridor to the designed motorway, there are several quarries of building stone which may be used as a material in constructing the motorway and the greatest part is located in the vicinity of Demir Kapija.

In the close surrounding of the Demir Kapija settlement, at the left side of the Vardar River, the diabase deposit is situated from where the material is used as aggregate for concrete. Very near to it, the locality Koreshnicka Krasta is found from where, kajanite-basalt was exploited, but because of the bad quality of the remaining reserves, the deposit has been abandoned.

At the left side of the entry to the Demir Kapija gorge, there is an open pit mine being under exploitation. It is a part of the big limestone massif of Upper Jurassic age with a strike North-South. It has been active for more than ten years, used by the Stock Holding Company « Granit «. Continual blasting in the quarry leads to disturbing of the general stability of the terrain within the zone of the influence of the detonations and to the geotechnical state of the rock masses in the zone of constant and future tunnel constructions through the gorge. Working in this quarry has a negative influence upon the environment; it leads to degrading and destroying certain geomorphologic phenomena, geological-paleontological localities, special landscape characteristics etc. Downstream of the gorge, at the right bank of the Vardar River, an exploitation of diabase is being performed by the same company, in the area of Javorica (Photo 5). Because of its good physical-mechanic characteristics, the material of this quarry is used as aggregate for asphalt and concrete. The concession area of the company-user is 2.5 km^2.

The borrow pits of sand and gravel along the Vardar valley and the marble borrow pit located at the Kosturino village - Strumica are potential locations for construction material (stone) which may be used in constructing the future motorway.

Along the valley of the Vardar River, in a wide area, there are two localities where alluvial detritus is being exploited and separated. The first is located 10 km upstream of Demir Kapija, in the East of the Przhdevo village, with an installed capacity of separation of 30 m^3 per hour and it is used by the company Civil Engineering Enterprise « Granit ». The second locality is found in the alluvium around the empty of the Konjska Reka into the Vardar River, 0.5 km downstream of Gevgelija. It is used by the same company and has similar capacity of separation. (Not in the area of the project interest.)

Photo 5. Quarry of the Holding Company « Granit « in the area of Golema Javorica stream

The marble quarry, located 2-3 km in the South of the Kosturino village, in other words 4-5 km in the East of Valandovo, in the vicinity of the regional road Valandovo-Strumica may be used as potential deposit of building stone in constructing the motorway. This quarry is used by the company »Ograzhden » from Strumica and the production capacity from all fractions is about 50 tons per hour. According to the analyses that were made, the material from this quarry can be used for all purposes in civil engineering.

In the designed corridor of the motorway, the Demir Kapija gabbro-diabase block and the Valandovo extended valley present a dominant structural form.

The Demir Kapija gabbro-diabase block, in other words, the complexes of gabbro-diabase rocks, and partially sediments of the Jurassic age, have been developed at both sides of the Vardar River. In the internal structure of the gabbro-diabase block, fractures were ascertained, somewhere filled with weathered material or with hard and tenacious rocks (quartz porphyry). The greatest length of the fractures is 350m. On the whole, two joint sets are noticed with a direction of striking NW-SE and SW-NE. In the northern part, above these rocks, a block of Jurassic limestone lies with monoclinal dip towards NW and a simple structure. The numerous registered fractures in this block have a different orientation and a length to 50m.

Towards the East from the Demir Kapija gabbro-diabase block, in other words, in the South of the Udovo village, the Serta Gradeshka anticline was developed whose orientation is towards NS-SE. In the North of the gabbro-diabase block, the Tikvesh ridge is stretches, located at both sides of the Vardar River. It is filled with Paleogene, Neogene and Quaternary sediments and vulcanite. In the East of the villages Miravci and Miletkovo, the Valandovo valley is located. It is filled with Quaternary sediments with E-W strike. This valley was formed between the Paleogene and the Neogene.

Photo 6. Pillow lava along the existing motor road (photo taken near village Udovo)

4.3.2.1. Field of structural materials – actual conditions

Considering the necessary quantities of structural stone for construction of the highway, besides the existing quarries we shall present **potential localities for exploitation**. There are existing resources of structural stone directly to the settlement Demir Kapija on the left side of Vardar River. It is the field of diabase wherefrom the material is using mainly as aggregate for asphalt.

Close to the same field, there is the locality Koreshnichka Krasta where from before certain time kajanite-basalt, but because of the poor quality, the rest of the reserves are unusable for this purpose and the field is leaved.

On the left side of the Demir Kapija Valley there is open pit mine in exploitation that presents part of the large limestone massive of Early Juristic Age, which comprehends surface of approximately $12km^2$ with general spreading north – south. Opening of this quarry before more than 10 years ago caused serious reactions of the institutions for environmental protection because of eventual exploitation impacts to the natural valuable resources of the region. Namely, large part of the area (200ha) of karst region has been proclaimed for natural monument under the name of Demir Kapija Gorge yet in 1960 because of the birds of prey, habitats and flora, and also presence of different geomorphologic phenomena, geological – palaeontology significant localities, particular landscape characteristics and similar. These values of the region were not respected by the authorities of that time and the same permitted exploitation of this quarry. Thereby, inherently were degraded primary ambient characteristics of the terrain, and because of the often blasting during mining, many animal species, predatory birds above all disappeared from their habitats forever. Otherwise, the question rises for the impact on the mining at this locality over the geo-technical condition of the rock masses within the zone of the existing and future tunnel structures through the gorge and over the general terrain stability in the zone of the detonations impact.

Close to the Regional Road Valandovo – Strumica on approximately 4 to 5 km east of Valandovo, i.e. 2 to 3 km south of the village Kosturino, several years ago, a quarry has been opened within the distal zone of a Palaeozoic marble mass spreading NWSE. The same uses the Mine Ograzhden from Strumica, and according to the installed Crushing Plants the production capacity is 50t/hour. According to the executed quality analysis of this rocky region has very good characteristics and it can have wider usage in the civil engineering.

Along the Vardar River Valley, at this region there are two active localities wherefrom alluvial sediment is exploiting and separating. One of these localities is situated east close to the village Przhdevo on approximately 10km upstream of Demir Kapija and the installed separation capacity is $30m^3$/hour.

The other field of gravel and sand is situated in the alluvial around the confluence of Konjska Reka in Vardar River on 0,5km downstream of Gevglija and it is with similar capacity with the previous separation.

4.3.3. TECTONICS AND SEISMIC CHARACTERISTICS

The region where the designed motorway will pass belongs to the Vardar zone, which, according to the structural characteristics, is the most unsteady tectonic unit in the Republic of Macedonia. As regards the composition, separate types of metamorphites in this area have the same characteristics as those in the Serbo-Macedonian massif, which points to the fact that these areas in the course of the Precambrian and Palaeozoic were the only ones and they presented a unit. In the geological development of the region, 4 basic phases may be distinguished: Precambrian, Paleozoic, Early Alpine and Late Alpine stadium. The gneiss as the oldest rocks in this area was formed in the course of oldest phase, when they were compressive sediments of the great geosyncline area that was clutched between the Pelagonian massif and the Serbo-Macedonian zone. But, during the Early Palaeozoic, in the beginning of the Caledonian orogeny, the Vardar zone was distinguished from the neighbouring positive structures and was formed as a special unit with a tendency of deeper rifting and deposition of the Early Paleozoic sediments. Its major plan was made most probably during the Hercynian orogeny by intensive tectonic processes, followed by intrusions of ultrabasic and basic igneous rocks, and by the Alpine orogeny, it has been processed to that level which clearly differs from the neighbouring positive structures. The intensive tectonic processes in the course of the Alpine orogeny conditioned uprising and rifting of separate parts of the Vardar zone, in other words, formation of blocks folded in linearly expanded folds with an occurrence of breaking off**,** imbrication and overthrust accompanied by intrusion and effusion of granite and gabbro-diabase rocks along the deep seated faults. Contrary to this, the concave parts (grabens) were established, for example: The Tikvesh, Valandovo and Gevgelija valleys.

As a geotectonic unit, the Vardar zone is a tectonic lineament of a great size, which in the South-South East sinks into the Aegean Sea. In the valley of the Vardar River, it has a classical development, and in the North- North West sinks below the Neogene-Quaternary sediments of the Panonian basin. Within the explored part of the Vardar lineament, it is presented by a zone of deep faults which mutually differ in genesis, age, level of activity and expressiveness in relief with a direction of striking NW-SE. Along its whole length, the East-Northeast boundary fault, in the course of the Neogene, presented a tectonically unstable zone along which the volcanic activity was taking place, while in contemporary conditions, the activity is manifested through many post-volcanic occurrences and thermal springs. The West-Southwest contour fault has been followed by diapir intrusions of serpentinites, whose contacts with the surrounding rocks are contrastly, expressed, and a great number of them are active even today.

In relation to the seismicity, the region where the designed motorway is supposed to pass as a part of the Vardar zone is an area with high seismic risk, with an occurrence of earthquakes with maximal intensity of X degrees and a magnitude of 7 Richter degrees. The greatest part of the registered earthquakes are connected to the Valandovo seismogeneous focus which is one of the most active seismogeneous sources in the Republic of Macedonia. The high seismic activity of this area is a result of the tectonic movements where the radial movements related to the deep faults have had a dominant role. The seismic activity in the Valandovo valley is connected to the deep faults with a direction NW-SE and the fault Miletkovo-Valandovo with a meridial direction. The activism of the above mentioned faults is due to the pressures of the south part of the Serbo-Macerdonian mass to the gabbro-diabase massif which have been lasting with a changeable intensity from the Jurassic period until today. The high degree of tectonic crushing of the basic intrusive rocks in that part of the Vardar zone is related to them. The highest values of the expected magnitudes of earthquakes for the Valandovo area in the future are 6.5-7 while for the Gevgelija area they are to maximal 6 Richter degrees.

4.4. HYDROLOGIC AND HYDROGEOLOGIC CHARACTERISTICS

Water of the Gevgelija –Valandovo valley is represented as underground water, springs and superficial water flows, depending on the geological composition, relief structure and climatic characteristics.

4.4.1. GROUND WATERS

Underground water lie on waterproof base and under permeable layers consisted of coarse sand and gravel. The common underground waters, freatic (well) waters, and the presence of artesian waters were registered as well. The most plentiful terrains with underground waters with 10 $l \cdot s^{-1}$ situated close by river Vardar. These underground waters are connected to the water level of the river Vardar. Starting from Udovo towards the south, the area with underground water gradually starts to expand and riches the highest proportions between Gevgelija, village Gjavato and Bogdanci

The Gevgelija-Valandovo Valley has three structure stages: Precambrian, Hercynian and Alpine stages. The rocks of the Precambrian structural stage represent compressive forms. In the Vardar zone, Bogdanci anticline and the Belasica anticay are distinguished within the Serb - Macedonian massif. The rocks of the Hercynian structural stage form the east wing of the Belasica anticline.

Within this basin, the following types of aquifers are represented: inter-granular and unconsolidated aquifer, fissured aquifer and karst aquifers. The aquifers are developed in the rocks with inter-granular porosity, i.e. the alluvial sediments, diluvial and proluvial deposits as well as the terrace, lacustrine and mud sediments. The alluvial sediments at the section of the designed alignment of the motorway are represented at Demir Kapija, at the mouth of the Boshava river into the Vardar River and long the flow of the Petrushka river, composed mainly of gravel and sand, primarily of gabbro-diabase composition with a thickness of about 10 m. Considering hydrogeological aspect, these sediments are characterized by intergranular porosity, they are water permeable and water bearing and function as a hydrogeological collector in which a confined type of aquifer was formed. The ground water level in these sediments is shallow below the surface of the terrain and it is in a hydraulic relation with the water level in the river. These sediments are composed of a mixture of sandy clay materials as well as sandy gravel debris with a total thickness of 30 m and present significant groundwater aquifers. The levels of this aquifer are various, depending on the infiltration degree and the surface water level.

The Terrace deposits at the section of the designed alignment of the motorway have been developed a lot in the valley of the Vardar River, in the South of the Davidovo village and in the East of the villages Miravci and Miletkovo where they occupy a great expanse. They have been mostly presented by grave land sand and in the upper parts by pebbles and blocks with gravel piled up without any order within the deeper parts of these sediments whose thickness is about 30 m. In the surface parts, these deposits have been covered by silty clay with fine grained composition. Considering hydrogeological aspect, these sediments are characterized by intergranular porosity, they are water permeable and water bearing as well and function as a hydrogeological collector in which a confined type of aquifer was formed. The ground water level in these sediments is shallow below the surface of the terrain.

The soil debris, at the section of the designed alignment of the motorway has been represented within the transition zones from the mountainous slopes towards the continental part and they mix with the alluvial sediments of both sides of the Vardar River at Demir Kapija. It has been composed of slope debris mixed with sandy-clay not classified and poorly processed material. As regards hydrogeological aspect, these rocks are characterized by intergranular porosity; they are water permeable and locally water bearing. They mostly function as hydrogeological conductor of ground water which gravitates towards lower elevations, while, at certain localities, they function as a hydrogeological collector depending on their composition and position.

The karst aquifer is represented in the marble and the carbonate schist, which are distributed in the Kozhuf Mountains from Vladaja, Deribash to the Belasica massif. The carbonate rocks of the Jurassic complex (limestone) have been represented in the initial part of the designed alignment of the motorway, from 1.8-3.0 km. At the surface, at several places, fractures and fissures can be noticed, and at certain places they have been affected by considerable karstification, here and there with an occurrence of greater caverns and caves. Regarding hydrogeological aspect, these rocks, at some places having been affected by karstification are characterized by karst-fracture porosity, they are water permeable and function as a hydrogeological collector in which, a karst-fracture type of aquifer was formed and a ground water level mainly at an elevation of the Vardar River. According to the type of karstification, they belong to the group of medium karstification with a density of karst occurrences to 10 per 1 km^2The circulation and the accumulating of groundwater are being done through systems of fractures and caverns, mutually well connected and 100 m in depth. The aquifer is recharged by precipitation and the drainage by many springs with a yield of over 1 1/s.

The Eocene flysch sediments were ascertained in the initial part of the designed alignment of motorway, at the left side of the Vardar River. Concerning hydrogeological aspect, these sediments are poorly water permeable to water impermeable, with slightly expressed fracture porosity shallow below the surface of the terrain. They are in practice a water impermeable medium and the terrains that were formed by these sediments are waterless. The most part of the precipitation run down at the surface, a very little part in the underground, and at the same time taking away the surface weathered material which is deposited within the lower parts of the terrain.

The rocks of the gabbro-diabase complex are dominant along the alignment of the designed motorway. Regarding hydrogeological aspect, these rocks are, here and there, characterized by fracture porosity with very poor water permeability to practical water impermeability, but in places, because of the great number of fissures and fractures, they could be poor collectors. Aquifers of ground water have been formed in the shallow parts below the surface, poor with water and the numerous springs have a small discharge. The ground water level in these rocks is in the shallow parts below the surface of the terrain. Most part of the precipitation runs down at the surface, a very little part in the underground, at the same time taking away the thin detritus that is deposited in the lower parts of the terrain.

In the Gevgelija-Valandovo valley, the average thickness and the surface area of the Quaternary sediments are estimated to be 15 m and 114 km^2. The static amount of groundwater resources in the Quaternary sediments of the Gevgelija-Valandovo valley is calculated to be 342 million m^3. The dynamic amount of groundwater resources in the Quaternary sediments of the Gevgelija-Valandovo valley is calculated to be 0.3 m^3/sec. Regarding determination of the amount of karst groundwater resources in the Lukar aquifer of the Kozhuf Mountain, the infiltration area is estimated to be 20 km^2 The amount of karst groundwater resources in the Lukar aquifer is calculated to be 0.55 m^3/s. In the case of karst groundwater resources in the Huma aquifer of the Kozhuf Mountain, the infiltration area is estimated to be 200 km^2 and the amount of karst groundwater resources in the Huma aquifer is calculated to be 0,18 m^3/s.

4.4.2. SURFACE WATERS

The hydrographic network of the terrain along the designed motorway has been well developed. There are many rivers and streams, which belong to the catchment areas of the rivers Petrushka and Vardar.

The major water artery of the terrain is the river Vardar towards which the tributaries Starata Reka, Strkovski Dol, Golema and Mala Javorica, Simenska river, the Petrushka river flow as well as other smaller watercourses located mainly at the right side of the river, while at the left side, the greater tributaries of the Vardar River are the following: Chelevechka Reka, Stojkov Dol, Arazliska Reka, Mushtenica, Kosharechka Reka, Lutkovska Reka and the Anska Reka. The Petrushka Reka, being the greatest tributary of the Vardar River, at the right side was formed by its tributaries: the stream Kalica, the Starata Reka, the Gabrovska Reka and the stream Varnica. Most of the watercourses are constant but poor with water and only a small part of them are temporary. The greatest part of the registered springs are not captured, with a low discharge and they do not have a great significance.

The constructed dams, being important water economy structures, are located at the section Miravci-Miletkovo and we consider that they are out of the possible Alternatives B1 or 2 for the alignment of the motorway. Considering the existing hydro-technical structures, an important one is the Kalica dam, built at the same called tributary of the Petrushka River, with an available volume of 640,000 m^3 with which about 150 ha are irrigated. The water economy base foresees a construction of five dams more, of which two are within the wider zone of planning the alignment of the motorway. It is the dam of the Petrushka River with an available volume of 4,000,000 m^3. It is supposed to irrigate about 100 ha, as well the dam of the Kovanska Reka with an available volume of 10,000,000 m^3.

The project for constructing the dam to the Vardar River, Gradec is a capital water economy and hydroenergetic potential, but the water of the future reservoir will not have an influence to the magistral communications, except to the railway, which in conditions of a construction will have to be dislocated above the maximal elevation of the reservoir.

The river system in Gevgelija - Valandovo valley is represented by river Vardar. River Vardar has a source on the south slopes on Shara Mt., near the village Vrutok (Gostivar) at 683 m.a.s.l. The total length, till the Aegean estuary in Greece is 388 km with 301 km belonging to Macedonia. It has the dominant 20535 km^2 drainage area in Macedonia as well. The total inclination of the riverbed is 640 m, while the average relative one is 2.1%.

The river Vardar on the section from Udovo to Gevgelija, as opposite to its part in the area between Demir Kapija- Udovo (30 km in length) has all characteristics of typical lowland river (Photo 7 and 8). The average inclination of the riverbed in the Valandovo valley is 1.0 ‰, in Smokvica isthmus is 1.19 ‰ and in Gevgelija valley- 0.72 ‰. River rapids appear only in places where the river is influenced by torrent flooding that have deposited large amounts of coarse material. Bank erosion in Gevgelija - Valandovo valley is very intensive process. As a result of it the destruction of the river banks and horizontal dislocation of Vardar Riverbed is quite often phenomenon. It is especially expressed near the railway station Miravci, where the right site bank is under strong influence of this process. The left side bank and the already existing motor road are threatened by this process in area of the village Josifovo. The destruction of the riverbanks, more intensive on the left side, continues downstream allowed to the Smokvica ishtmus. Accumulation of the sand and gravel is dominant process in these places. Also, it is stimulated by the water- flows after torrent rainfalls that inflow into river Vardar from both sides. Thus, the river flow is divided into many river arms and become wild and makes additional bends.

Photo 7. General view of Vardar valley

In the area of the road corridor for alternative 1, river Vardar has about 32 km length. It is characterised by faster flow in the upper part of the corridor (Demir Kapija–Smokvica), steep slopes rising on some places directly from the river banks, the river bank is mostly stony and gravely, and fast flow does not enable organic sediment formation. The water is characterised by high degree of turbidity almost throughout the whole year.

The water flow of river Vardar in Gevgelija-Valandovo valley during the whole year is varying. Average water current quality at the water- meter- station (Gevgelija) is 170m³/s, the maximum is 2400 m³/s and minimum is 14.4m³/s. In the same time, this water quantity is the biggest in Republic of Macedonia.
River Vardar has high water level during the spring period as a result of the snow melting and spring rains. High water level may appear during the autumn, due to the long lasting and intensive rainfalls. The low water level was registered (August) with tendency of changing in September due to the

low rainfall quantity, intensive evaporation, water sinking into earth and the use of water for irrigation.

Photo 8. River Vardar

During the periods of high water level, river Vardar floods out of its riverbed. These flooding may be of catastrophic dimensions such are floods in 1838, 1895, 1900, 1907, 1916 and 1937. During these periods the water level reached over 7m at the bridge near Gevgelija. Recent floods, as in 1962 and 1979, were registered.

Many tributaries inflow into the river Vardar in the Gevgelija–Valandovo valley such are Anska Reka (Bojmica), Luda Mara (from the left side) and Stara Reka, Zuica, Kovanska Reka, Sermeninska Reka and Konjska Reka (from the right side).

Anska Reka is left tributary of river Vardar. The spring of Anska Reka is situated in the west foothill area of Belasica Mt. It flows in the south part of Valandovo valley. Its length is 22 km with drainage area of 168 km². The total inclination of the riverbed is 492m, while the average relative is 2.2%. The river Anska Reka has similar characteristics of water flow and riverbed as Vardar in that area. The water level is varying to a great degree as a consequence of its water use in irrigation purposes. There are period during the summer when there is almost no water in the riverbed. River is divided in well-developed network of irrigation channels. There are few tributaries in the upper part of Anska Reka (Prsten Tepe, Kodzha Dere and others). Till 1958 Anska Reka was flooding in the plains of Valandovo, Pirava and Marvinci and was causing big damages. The average water current quantity is 1.08m³/s.

River Boshava, According to its basic characteristics is completely different in respect to Vardar and Anska Reka. It has characteristics of a mountain river along the largest part of river flow, i.e. very fast flow, stony bed, and mostly clean water. At the lowest part, before its mouth of the river Vardar it

becomes more similar to Vardar by all characteristics, due to the human influence from Demir Kapija town. Namely, the last 2 km of the river are passing through or next to the town.
The spring of Stara Reka stream is in the foothill area of Marjanska Mt. and all the way to Miletkovo flows in a hilly- mountainous area. In this part, Starata Reka has great number of tributaries such as: Klisura, Kriva Reka, Crnevska Reka etc. Starata Reka (Photo 9) flows in the Miletkovo Pole plain, after v. Miletkovo to mouth in the river Petrushka Reka (Photo 10). During the periods of high water level, it floods out its riverbed and deposits large amounts of coarse material on fertile soil. The length of Stara Reka is 22.3 km and the surface of its drainage area is 84 km^2. Average annual water current quantity is 0.67 m^3/s.

Photo 9. Stara Reka stream

Photo 10. Petrushka Reka stream

Photo 11. Mala Javorica stream – lower flow

Photo 12. Mala Javorica stream – upper flow

Photo 13. Golema Javorica stream - middle flow

Photo 14. Golema Javorica stream - upper flow

Photo 15. Stara Reka river – lower flow

Photo 16. Stara Reka river – middle flow

Overview of the main rivers and streams in the corridor area

Right tributaries of Vardar River	Approximate point of crossing with highway Alternative 2	Left tributaries of Vardar River	Approximate point of crossing with highway Alternative 1

River Boshava	Km 0+900	Chelevecka Reka	Km 1+600
Stara Reka (Photo 15 and 16)	Km 5+700	Kosharachka Reka	Km 6+200
Linski Dol	Km 9+100	Lutkovska Reka	Km 8+700
Golema Javorica (Photo 13 and 14)	Km 10+100	Gradeshka Reka	Km 14+000
Dragovski Dol	Km 11+800	Stream Mushtanica	Km 15+100
Mala Javorica (Photo 11 and 12)	Km 14+300	Arazliska Reka	Km 17+500
Simenska Reka	Not crossing	Anska Reka	Km 28+800
Petrushka Reka (Photo 9 and 10)	Km 22+300	-	-
Dukovec Dol	Km 25+700	-	-

In the area with the most plentiful terrains, the well water is obtained from depth of 6 to 20 m and in the lower parts nearby the river, from 1 to 2 m. In the spring, when the river Vardar has high water level, underground water is very close to the surface on some places. Such situation was noticed at the locality Gjolot and partly at the locality Dimchev Chair. In the areas poor with underground waters, it lies on the depth of about 20 m.

Water springs are characteristic and very important phenomena in the Gevgelija-Valandovo valley. Their appearance is not equal in the whole area, due to the differences in petrographic composition, elevation, climate and forestation of the terrain. The greatest number and the most plentiful springs are in the foothill area of mountain massifs, below the highest peaks, on the river terraces and on the valley slopes. The greatest number of springs was registered on the foothill area of Kozhuf Mountain and Plavush Mountain. Particularly great number of spring originates at the source area of Konjska Reka, carstic region around village Huma and in the region of Balija (on the north from Valandovo and village Pirava). The water springs in these regions are characterised by the water capacity of 4-10 $l \cdot s^{-1}$ and do not get dry during the whole year. Some of them, like "Izvorot" near Valandovo, "Fik" and "Shopot" near village Negorci, "Shupkar Cheshma" near village Huma have water capacity higher than 10 $l \cdot s^{-1}$.

Thermo-mineral and mineral springs that originate in many places connected to the fault lines are of a special importance for Gevgelija –Valandovo valley. The most famous are springs near village Negorci. Many springs are present there on a relatively small area. Such springs exist in the source area Konjska Reka, near village Konjsko and Gornichet. There is excavated well with thermal water near village Smokvica, close to the river Vardar. It is considered that an extremely rich area with thermal water is the area between villages Smokvica and Grchishte.

4.5. PEDOLOGIC CHARACTERISTICS

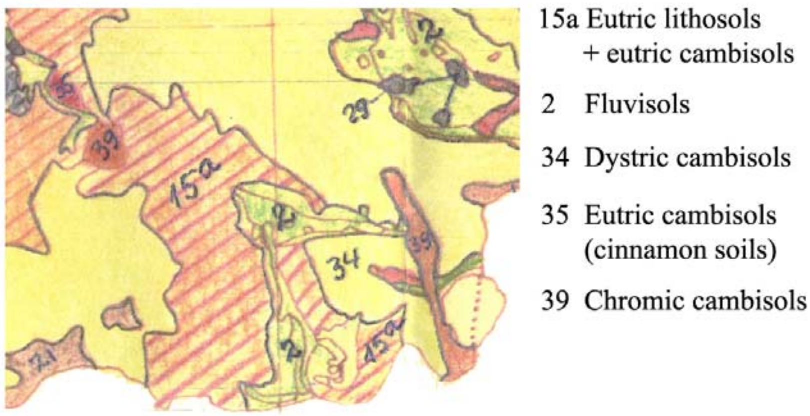
Pedological characteristics will be presented by the description of the natural and modified soil types in the highway corridor area as well as the intensity of erosion that implies the quality of the soils.

4.5.1. SOIL TYPES IN THE ROAD CORRIDOR AREA

The presence and distribution of the soil types in the highway corridor area are given according to the monographs "Soils of the Republic of Macedonia" (Filipovski 1997-2004).

Pedological composition is diverse in the river Vardar valley (from Demir Kapija to village Smokvica). There are atypical (non-developed) soils and typical (developed) soils that were formed due to different influence of pedogenetic factors (bedrock, relief, climatic and hydrographic characteristics). Alluvial, delluvial, silicate syrozem and skeletal soils (lithosols) are the most abundant of the atypical soils. Typical soils are represented by cinnamon soils (Fig. 5: 15a+35) and very rare and insignificantly by vertisols. Cinnamon soils are the dominant soil type in the area, especially under natural vegetation.

Cinnamon soils are the climazonal soil type in the highway corridor area. They have richer clay horizon (B) that lies between horizon A and C. These soils appear on the localities where the influence of Mediterranean climate (climazonal soils) is well expressed. Cinnamon soils in the investigated area occur up to 500 m a.s.l. and mainly in the xerophilous and thermophilous oak vegetation (forest communities of *Quercus coccifera* and communities of *Quercus pubescens* and *Carpinus orientalis*) as well as under pastures. Cinnamon soils in the agricultural land have changed characteristics due to the anthropogenic influence. Although the climatic-vegetational factors are dominant, some other ones (relief, parent material, time and human influence) have great importance for their genesis, evolution and features. They appear in the parts of with wavy-hilly (fluvio-denudation) relief and on the lake terraces. Cinnamon soils are formed on the different types of parent material. The bedrock determines their characteristics and their subtypes (e.g. in the foothill area of Kozhuf Mt. they are formed on the parent material; on the delluvial soils appear young, undeveloped cinnamon soils).



Distribution of the main soil types in the wider area of interest

Cambisols (brown forest soils) in the highway corridor area are present in the well developed oak forests. These soils are the next stadium of development of the cinnamon soils. Cambisols in the highway corridor area are distributed in the area of Demir Kapija and probably in the upper parts of the highway corridor area – Kalica river valley (Fig 5).

Alluvial soils may be found in the middle part of the valley that extends up to 100 m a.s.l. They are widely distributed along the river Vardar. The layers of these soils are well sorted. They are water permeable i.e. have well expressed capillary ability for the water ascending. Alluvial soils are poor with humus (under 1 %). There are many varieties of alluvial soils in dependence of some specific features. Such varieties are alluvial fine sorted carbonates, alluvial shallow soils on gravel materials, alluvial covered soils etc. The most distributed is the alluvial fine-sorted soil.

The formation of **lithosols** depends on parent material and on the conditions of the locality (relief, climate, and vegetation). Lithosols in the investigated area are formed on different compact rocks. The most of the lithosols are formed of the bedrocks that produce stony (skeletal) detritus without grus and small particles. They appear only on higher parts of the mountain relief with steep inclinations (over 30 ^{0}).

Lithosols are not used as agricultural land because these are shallow soils and they have unfavourable skeletal characteristics. Another reason is that they appear on very steep slopes. Some of them are covered by poor pastures, and another part is afforested (mostly with degraded forests).

Syrozems (regosols) represent undeveloped substrate and poorly developed soils. They appear after erosion of previously existing soils on the remained material. Lithosols are shallow (20 cm), they have lithic contact and they are formed above massive rocks. Regosols are deeper, they do not have lithic contact and they are formed over mealy substrate. Regosols are conquered quicker by the higher flora and so, the pedogenesis is more intensive. Regosols in the investigated area appear on wavy hilly terrain (up to 800 m a.s.l.) where the erosion is intensive as a result of the destruction of the Oak complex. The characteristics of regosols depend on the parent material in the greatest part. These are rocks that easily disintegrate into grus or minute detritus. The profile of regosols is morphologically weakly differentiated.

Delluvial (coluvial) soils are formed by the erosion and transportation of the parent material and soils and sedimentation of the material in the foothills of these parts. These processes are caused by the torrent water-streams from the higher mountain and hilly regions. Important factors of their pedogenesis are the climatic conditions (torrent rainfalls and aridity of the climate i.e. poor natural vegetation and hard revival of the destroyed vegetation. The conditions of their formation are changing through the time, from one place to another and consequently they are very heterogenic. Delluvial soils may turn into different soil as a result of the influence of shallow underground waters or by the influence of the pedogenesis' processes in a longer period of time. In the investigated area the delluvial soils, in the most part, develop into rendzinas and cinnamon forest soils with appearance of cinnamon–red-brown horizon (B) that is more compact, more rigid and more clayey than the rest horizons of the profile. Compared to the alluvial soils (that usually border with), the delluvial soils have less productive features i.e. they are less sorted and they appear on terrain that is not so flat (as in the case of alluvial soils). They are poorer with water i.e. the underground water in these soils is on bigger depth. These soils are not used as agricultural land and represent very poor pastures in the greatest number of cases.

Anthropogenic soils are distributed in the agricultural area of the highway corridor area since their genesis is connected exclusively with the anthropogenic activities. **Rigosols** are the soils that are formed by human intervention in the vineyards and orchards; **hortisols** can be found in the gardens which are fertilized for longer periods of times, probably in the vicinity of Demir Kapija, Miravci and Smokvica; **anthropogenized soils** can be found in the previously mentioned natural soil types which are modified by erosion stimulated by human activities.

4.5.2. SOIL EROSION (EGZOGEODINAMIC PROCESSES AND PHENOMENA)

The terrains along the alignment for highway are characterized with complex geology structure, matured relief and relatively low representation and extensive of contemporary egzodynamic processes and phenomenon. On the processes intensity and representation affect different factors: lithology structure, region position and appearance of lithology components, rocks resistances and physiognomy, degree of decay, hydrogeology and geology characteristics of rocks, morphological conditions and terrain surface conditions. On the research terrain are developed next recent engineer geology processes: washing processes and inline erosion, rocks boulder, alluvial fan, and karstifications. As results of these processes are formed gulch, presence of different kind of karst forms, rocks slide and high sediments of alluvium and proluvial debris disposed in the periphery parts of the Vardar Valley.

The processes of surface washing and gulch forming are most significant in rock masses from gabbros diabase complex (spilites and diabases) in the riverflow of river Kalica and river Petrushka and also over the villages Davidovo, Miravci, Miletkovo, and Smokvica. The processes of surface washing are in direct connection with surface rocks destruction which rapidly influenced on relief forming. As result of the processes of line erosion were formed numerous water gullies and gulches statement on researched terrain. During construction of the highway it is necessary to take measures for effectively drainage and safety disposal of rainfalls, especially on the places with riverflows, dales, and streams, using different methods and construction of channels, gutters, manholes, to protect the road surface and the future highway construction.

The processes of landslide are poorly developed on the research terrain. The most frequent are terrains constructed from good rocks, on the aslope parts of the terrain (vertical and sub vertical) represented with mechanical separation, falling, and surface rock destruction under exogenic factors. The separated materials (different granulations and blocks) under gravitation fall and disposed in the base of the slope thereat making alluvial fans, rockfalls, which have to be taken into consideration during designing and highway construction.

Karstifications processes are developed on terrains composed from carbonate rock masses and have big influence in forming of the relief. The results of carstification processes, which mean chemical resolution of carbonate rock masses under influence of surface and underground water flows, form geomorphologic and speleological forms – caves.

During detail design elaboration for highway the technical planner have to provide temporary and permanently safety disposal of soil and rock materials during highway construction. Thereat the soil landfill have to be designed with adequate safety slopes, surface protection from atmospheric influences, and drainage, all in accordance with positive actual standards and best engineering practices to mitigate negative environmental impact assessment.

4.6. LANDSCAPE AND BIOGEOGRAPHIC CHARACTERISTICS

4.6.1. BIOGEOGRAPHY

The region of Demir Kapija is the warmest and almost the driest part of Macedonia. It is under the strongest Mediterranean influence, which is the main factor for its floristic, fungal and faunal composition.

The origin and the genesis of the biological diversity in the project area are closely related with the regional geological history, the climatic change in the past and the recent conditions. All these characteristics, accompanied with the migrations that had been presented during the Pleistocene glaciations, as well as in the postglacial period resulted in the recent composition of the local faunal and floral diversity. Consequently, the most striking features of the Demir Kapija gorge region biodiversity today are its richness and heterogeneity, especially Mediterranean faunal and floral elements.

4.6.1.1. Basic features of faunal biogeography

From zoo-geographical point of view, two main faunal complexes of Species - Eremial and Arboreal are present in the area of intention.

I. The Eremial complex of faunal elements includes species that originate from the Aral-Caspian Region adapted to survive in dry steppe-like and semi-desert conditions. In the project area these species are mostly present within the belt of *Sub-Mediterranean Region* (up to 600 m) in open habitats, mainly grasslands.
II. The Arboreal complex of faunal elements in the area of project interest is represented with its Mediterranean sub-complex. It encompasses species that are predominantly connected with broadleaved woodlands. It is further split on Holo-Mediterranean and Ponto-Mediterranean (East-Mediterranean) faunal elements. Within the Demir Kapija gorge and Miravci region the species that belongs to this sub-complex inhabit the belts of the Sub-Mediterranean (up to 600 m).

4.6.1.2. Basic features of floral biogeography

There is no common and widely accepted phytogeographical division of the territory of the Republic of Macedonia, although there are many attempts as a result of extensive botanical investigations in the region (there is no common biogeographical division either). The difficulties and different approach of different authors result from specific transitional position of Macedonia in Europe and Balkan Peninsula and from its specific geological history. The most important fact in this respect is lack of glaciations on the most of its territory (except for the highest mountains) which contributed for maintaining very rich biodiversity (floral and faunal). Lower Vardar valley was one of the most important refugial zones in Macedonia during Pleistocene glaciations.

For the purpose of this study, the most convenient division is the following (???):

Macedonian territory belongs to the Euro-Siberian sub-zone of the Holarctic floristic region. The following two floristic provinces are characteristic for the area of the highway corridor (compiled on the basis of different authors - Kostadinovski, not published):

1. Mediterranean biogeographical region, represented by its
    1.1. European-submediterranean sub-region, with its
        1.1.1. Macedonian-Thrace province

This is the area of Kermes oak (*Quercus coccifera*) shrublands, which occupies the lowest elevations of the slopes that create Demir Kapija gorge. It is much degraded on the left side of the river and more preserved (it has appearance of a real forest) on the right side of the river.

2. Middle-European biogeographical region, represented by its
    2.1. Sub-Middle-European-Balkan sub-region, with its
        2.1.1. Scardo-Pindic province

This is the area of pubescent oak and Oriental hornbeam forests and woodlands. In the region of Demir Kapija gorge it grows above the previous vegetation type (biome) or on the northern faced slopes. In the region of interest (highway corridor as defined in Chapter II.1.) is distributed only on the slopes on the right side of the river Vardar.

The landscape division (section bellow) for the project area can be used as biogeographical division as well since the approach of Matvejev (biome division) and Filipovski at al. (vegetational-climate-soil division) is biogeographically based.

4.6.2. LANDSCAPES

Very important characteristic of the intention of constructing the highway from Demir Kapija to Miravci is that (especially in case of Alternative 2) it will occupy almost entirely natural or seminatural territories. That is why the landscapes in the area of intention have natural appearance. The part from Miravci to Smokvica has more anthropogenic features - rural areas and more or less degraded habitats.

One principal landscape can be distinguished in the project area - **Sub-Mediterranean (hilly) forested landscape**. This principal landscape can be sub-divided into several functionally and spatially distinctive units. These are:

- limestone canyon part of Demir Kapija gorge
- Demir Kapija gorge from the canyon down to village Udovo
- hilly more or less natural area from village Klisura to village Udovo and
- broad valley from Udovo to Smokvica (Valandovo valley).

However, precise definition of landscape type(s) in the affected region is not possible due to the absence of landscape division of the country's territory (Republic of Macedonia) based on the contemporary perception of the landscape and its scientific concept.

To exceed this situation, one can use the existing biome (Matvejev 1995) or climate-vegetation-soil zones (Filipovski et al.) division. Especially biome division of Matvejev is appropriate since the author has landscape approach and formerly he used terms biome and landscape as synonyms.

According to Matvejev (1995) there are two types of forest biomes in the area of project interest: (a) Sub-Mediterranean-Balkan forests, and (b) Balkan-Middle European forests.

The second biome is not typical since the altitude in the whole project area is lower than typical altitudinal zone for this biome. There are only fragments of Balkan-Middle European forests on higher elevations of the project area (above 300 meters) only in deep valleys perpendicular to the main Vardar valley, from its right (western) side. Shady and moist conditions in these valleys have offered suitable sites for existence and survival of these atypical and azonal forest communities and have served as refugial sites for such mesophyllic forests. Actually, these forests are the most interesting and the most valuable biodiversity components in the area of intention. Due to the fragmentary character and small area that these communities cover, they are not prominent feature of the region as a whole. They are rather mixed and "lost" in the surrounding Sub-Mediterranean-Balkan forests and do not contribute for distinguishing separate landscape type. However, they give the landscape specific structural diversity.

Due to the above mentioned, only one landscape type in the area of the project interest can be distinguished - Sub-Mediterranean hilly forested landscape.

4.6.2.1. Sub-Mediterranean (hilly) forested landscape

Basic feature of this landscape is domination of dark Jurassic diabase bedrock mostly covered with shrubby vegetation of Kermes oak as characteristic species. Main geomorphologic feature is the long Vardar valley surrounded by small or high hills that are cut by deep dales or valleys perpendicular to the main valley direction. Dense, forest vegetation covers these dales mainly composed of Oriental plane community. Anthropogenic character of the landscape in the area of the project intention is not expressed as in the Gevgelija region (on the south of the project area), but it is present all over the area. Main anthropogenic features are: line infrastructure (power lines, roads and railway), small fields and gardens along the valleys, individual houses in the valleys and few villages.

As mentioned before, four separate units of this landscape can be distinguished along the area of intention based on geological and geomorphologic features and degradation stage of the natural vegetation.

- limestone canyon part of Demir Kapija gorge
- Demir Kapija gorge from the canyon down to village Udovo (bottom of the valley)
- hilly more or less natural area from village Klisura to village Udovo and
- broad valley from Udovo to Smokvica (Valandovo valley).

4.6.2.1.1. Natural features of Sub-Mediterranean hilly forest landscape

The most striking features are the rich biodiversity of the landscape and particular geological features.

There are at least two very special biodiversity features that should be mentioned - domination of Kermes oak community (association Coccifero-Carpinetum orientalis) and frequent occurrence of Oriental plane communities (Juglando-Platanetum orientalis), shrublands and woodlands. For details see sub-chapters of V.1. This landscape (in accordance with Filipovski at all) occupies the southernmost part of Macedonia with total participation of about 2% in country's territory. Since the road corridor is entirely in this territory, the destruction of the habitats in this landscape has significant impact on overall national biodiversity.

Due to Mediterranean character of the flora, fungia and fauna, this region is extremely rich in biodiversity (for details, see Appendix II). The level of biodiversity significance is pronounced with its refugial character, i.e. presence of many relict communities that give special aspect to the landscape - beech forest that grow on the lowest elevation in whole Macedonia (or probably the whole Balkan Peninsula), as well as rich Oriental plane community. Very important vegetation type for the landscape appearance is development of Greek juniper on many places as a tree stands of sporadic individuals everywhere.

Specific units of this landscape are described bellow.

1. Limestone canyon part of Demir Kapija gorge is the northernmost part of the project area and northernmost part of Kermes oak distribution. It is the narrowest part of the whole Vardar valley from the source to the mouth and it is about 1 km long. It distinguishes from the rest of the landscape because of the vertical cliffs, more than 200 m high, dominating white colour, and diverse plant communities (but all sub-Mediterranean with Kermes oak). Development of Phillyreo-Carpinetum orientalis, Pruno webbii-Juniperetum excelsae and Centaureo-Ramondietum nathaliae and other communities is the unique character for these cliffs. Vulture colony is the most striking feature of the canyon - large Griffons and Egyptian vultures are often flying above the rocks.
2. Demir Kapija gorge from the canyon down to village Udovo (bottom of the valley) is the dominant landscape unit along the alternative 1. It is a continuation of the canyon. The valley is broadening and it has a feature of a gorge with different width along the valley. But, this is not the only difference to the previous landscape unit. The main characteristic is the river Vardar flow with its narrow alluvial plain and dark bedrock with degraded Kermes oak shrublands on the slopes.
3. Hilly more or less natural area from village Klisura to village Udovo is the landscape unit with the most preserved natural characteristics in the whole landscape. Dense and more or less high shrubland and woodland stands are common in the area. Oriental plane stands along the dales are the most specific feature.

4. Broad valley from Udovo to Smokvica (Valandovo valley) differs from previous landscape units according to its geomorphology (it is more or less flat) and the most degraded natural Kermes oak vegetation. The most of it is actually the wide Vardar valley plain.

Geomorphologic and biodiversity characteristics of the region were described in more details in sub-chapters of Chapter IV.2.

4.6.2.1.2. Anthropogenic features of Sub-Mediterranean hilly forest landscape

Human aspect of the whole landscape can be assessed as an important feature of the whole area. However, the natural features were low to moderately change throughout the rich history of the region (an important transport route since antiquity - Roman period). Archaeological sites are very abundant, especially in the wide valley plain from Udovo to Smokvica although they are not giving particular physiognomic appearance to the landscape. The reason for this low human intervention is inaccessible slopes of the gorge inadequate for agriculture and non-valuable timber produced in Kermes oak plant community. That is why the southern part of the project area in the wide Vardar valley was the most altered part of the landscape.

Different landscape units as defined above in the area of project interest are characterised by different degree of human interventions.

1. Limestone canyon part of Demir Kapija gorge is unsuitable for human use due to its steep slopes and sparse vegetation. However, the lowest parts of the canyon, next to the river, are heavily used since the available space for the main transport corridor (ETC 10) is only a few tenths of meters. Existing motor road E-75 is passing the canyon through a tunnel and it is not spoiling the landscape, but transmission lines and railway are giving the landscape human dimension.
2. Demir Kapija gorge from the canyon down to village Udovo (bottom of the valley) is a continuation of the canyon and continuation of the line infrastructural object - motor road from the left side of the river and railway from the right side. Very sparse individual houses (non-residential) can be seen from the right side. There are a lot of small fields and acres in alluvial plain along the river Vardar, especially on the sharp bends. The rest of the landscape is more or less natural, except for the ugly recent intervention - the quarry for diabase rocks from the right side of the river at km. 8+700
3. Hilly more or less natural area from village Klisura to village Udovo is the landscape unit characteristic for the large part of the area where alignment according to the alternative B is going to be constructed. There are almost no human interventions in this area.
4. Broad valley from Udovo to Smokvica (Valandovo valley) landscape unit is under the strongest anthropogenic influence. It is flat and fertile area where intensive agricultural activities are practiced (from the left side of

Vardar (Udovo-Josifovo-Marvinci) and area with gentle slopes with extensive agriculture practices (right side of the river - Davidovo-Miravci-Miletkovo-Smokvica. The most important feature of this landscape unit is presence of human settlements. All villages are active and dense populated. Main occupation of the population is agriculture. Line infrastructural objects are much more developed compared to the previous landscape units. (For details see Chapter VI.5.1.)

5. DESCRIPTION OF ECOSYSTEMS AND HABITATS

During the field mapping and analysis of the aerial photographs of the area of highway corridors a high diversity of habitats were registered. This was expected concerning the diversity of geological substrates, relief, climate, hydrological characteristics, historical and cultural development of the area under consideration.

Historically, the investigated area was populated permanently for millennia. The strong and long lasting human impact on the environment, especially forests, resulted in different kinds of changes in the sense of degradation of natural ecosystems and producing new, managed ecosystems. The degradation of forests and shrublands led to appearance of hill pasture communities which are characterized by anthropogenic features. There are very diverse, mainly small fields and acres, vineyards, orchards, meadows and others. Most of them are managed using traditional practices and still hold a number of species of surrounding natural habitats.

The habitats in both highway corridors are divided in two main categories according to their origin: natural and anthropogenic habitats. Natural habitats include forests and shrublands, grasslands, rocky sites and water habitats. The division inside these categories followed criteria such as presence of different plant communities, distribution, degradation level and geomorphologic features, but the main criterion was the division proposed by Palaearctic Habitat Classification (European Commission, DG Environment).

Description of the habitats follows this pattern: description of the plant association, dominant and most common plant species and characteristic fungi species. Fauna of the habitats is presented by vertebrates (amphibians, reptiles, birds and mammals) and selected groups of invertebrates (dragonflies, ground beetles and daily butterflies). Fish species and some other groups of invertebrates (caddis flies, mayflies) are analysed in the description of wetlands. At the end of the description of habitats, their general distribution range and distribution in the highway corridor is presented.

The complete lists of species by habitats are presented in appendices: Appendix I.1 - Plant species; Appendix II.2 – Fungi; Appendix II.3 – Fauna (Appendix II.3 – Vertebrates (Appendix II.3.1 – amphibians; Appendix II.3.2 – Reptiles; Appendix II.3.3 – Birds; Appendix II.3.4 - Mammals); Appendix II.4 – Invertebrates (Appendix II.4.1 – Dragonflies; Appendix II.4.2 – Ground beetles; Appendix II.4.3 – Daily butterflies)).

5.1. NATURAL FORESTS AND SHRUBLANDS

Forests and shrublands are divided into four habitat types: pseudomaquis, oak forests (forests of *Quercus pubescens* and *Carpinus orientalis*), refugial beech forests and riparian habitats.

Almost the whole area (from Demir Kapija to Smokvica) is situated in the belt of thermophyllous mixed evergreen and deciduous forests or shrublands belonging to the European-submediterranean sub-region – Macedonian - Thrace Province. It is dominant type of vegetation that determines the features of the Submediterranean hilly forested landscape.

The forests of *Quercus pubescens* and *Carpinus orientalis* represent the upper vegetation belt in the highway corridor area. They belong to the Sub-Middle-European-Balkan sub-region and its Scardo-Pindic province. In the frames of this zone, refugial beech forests can be found in the gorges of streams, penetrating outside of their main altitudinal zone (above 1000 m).

Plane woodlands and belts are developing in the gorges of streams as well as dales and ravines in the area of thermophyllous kermes oak shrubland. These habitats penetrate from the lowest parts of the highway corridor area up to 400-500 m a.s.l.

All of the four habitat types have been under strong anthropogenic pressure for many centuries. Almost all of them are in different stages of degradation. The degradation level was second criterion for division of forests and shrublands, especially the kermes oak shrubland (preserved, sparse and degraded).

5.1.1. PSEUDOMAQUIS

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 32.71 Helleno-Balcanic pseudomaquis

The community of Kermes oak *Quercus coccifera* (Photo 17), an evergreen shrub-like oak (which is forming the typical plant association for this area - **Coccifero-Carpinetum orientalis** Oberd. 1948 emend. Ht. 1954) represents the habitat. This climazonal community in the Republic of Macedonia is spread up to Demir Kapija that is the north border of its areal. The community is occupying all steep and rocky terrains from the plain (57 m a.s.l.) up to around 400 m altitude.

There are other plant associations in the zone of the pseudomaquis. These associations are connected to different degradation stages or the development of the soil. Thus, association **Paliuretum submediterraneum (Riz., prov.)** is characteristic for highly degraded habitats, **Phillyreo-Carpinetum orientalis** develops on rocky sites etc. Rocky sites are very diverse according to the species composition and many other plant communities can be distinguished: Rhus coriaria shrubland (**Rhuetum coriariae** Tomašević 1959), Greek juniper shrubland (**Pruno webbii-Juniperetum excelsae** Em**)** and some other grass communities.

General qualitative composition of plant, fungal and animal species is very similar throughout the pseudomaquis. Thus, it is described in general context bellow. However, one should have in mind that the dominant species are different in the parts of the pseudomaquis which makes possible to distinguish two principal habitat types: kermes oak shrubland and shrubland on rocky sites. Specific properties for each habitat type are presented separately.

Fungi: The fungia of this biotope is characterised by thermophyllous, Mediterranean species. Lignicolous fungi are more characteristic since the dry climate is not favourable for development of terricolous species. The most specific thermophyllous species for this habitat are *Peniophora meridionalis*, *Pulcheritium caeruleum*, *Meruliopsis hirtellus*, *and Vuilleminia megalospora*. The presence of thermophyllous trees and shrubs with limited distribution within the region, as a host to different substrate specific fungal species, caused presence of rare fungal species as well. Particularly for this biotope, 23 lignicolous species are noted for Kermes oak, 10 for *Phillyrea media*, 8 for *Juniperus oxycedrus* and 15 for Greek Juniper (evergreen trees and shrubs) and 43 fungal species on *Carpinus orientalis*, 23 on *Fraxinus ornus* etc. (deciduous trees). The most characteristic species for this habitat are *Peniophora quercina* and *Vuilleminia megalospora* (on *Quercus coccifera*), *Antrodia albida* (on *Phillyrea media*), *Peniophora jinipericola*, *Hyphodontia juniperi*, (on *Juniperus oxicedrus*), *Antrodia juniperina* and *Pyrofomes demidoffii* (on *Juniperus excelsa*) etc.

Among terricolous fungal species *Astraeus hygrometricus*, *Tulostoma brumale*, *Stropharia coronilla* are characteristic for this biotope. A comprehensive list of fungal species is presented in the Appendix II.2.

Since the fauna of the pseudomaquis is very similar in all of its types (well preserved, degraded etc.), the description of the common species is presented hereafter. The differences and specifics of the pseudomaquis types will be presented in respective sections.

Photo 17. Kermes oak (Quercus coccifera)

Most of the animal species living in the pseudomaquis are characteristic for dry and warm regions i.e. Mediterranean and mostly subterranean. Animals of the dense evergreen oak shrublands prefer much more the open terrain in the community. For animal species compositions see Appendix II.3 and II.4.

Vertebrates

Mammals - characteristic and common species are Brown Hare (*Lepus europeus*), Red Fox (*Vulpes vulpes*), Wolf (*Canis lupus*), Golden Jackal (*Canis aureus*), Wild Boar (*Sus scrofa*) etc.

Birds - large number of species can be found here, owing to high number of breeding species (ca 50), but also large number of foraging species, especially birds of prey. Characteristic species for this habitat type are two Mediterranean passerine species, the rare Rufous Bushchat (*Cercotrichas galactotes*) and Sardinian Warbler (*Sylvia melanocephala*). One rare bird of prey is the Short-toed Eagle (*Circaetus gallicus*), with few pairs in the region of interest. Common species are Cirl Bunting (*Emberiza cirlus*), Sombre Tit (*Parus lugubris*), Blackbird (*Turdus merula*), Jay (*Garrulus glandarius*), Subalpine Warbler (*Sylvia cantillans*) etc.

Reptiles - characteristic and rare species are the Turkish Boa (*Eryx jaculus turcicus*) and European Legless Lizard (*Ophisaurus apodus*), while common species are Balkan Green Lizard (*Lacerta trilineata*), Greek Tortoise (*Testudo graeca*), Erhard's Wall Lizard (*Podarcis erhardii riveti*), Nose-horned Viper (*Vipera ammodytes*), Western Four-lined Snake (*Elaphe quatuorlineata*), Dahl's Whip Snake (*Coluber najadum*) etc.

Amphibians - due to generally dry conditions in the habitat, the overall number of amphibians is low, and there are no characteristic species. Commonly found species is the European Green Toad (*Bufo viridis*).

Invertebrates

Pseudomaquis is unique habitat type in Macedonia from the aspect of the composition of the invertebrate fauna. Many of the characteristic species of the area are spread in the southern parts of Macedonia, along Vardar River and its tributaries. The most common and characteristic species are centipedes *Scolopendra cingulata* and *Lithobius* spp., scorpion *Mesobuthus gibbosus*, spiders of the family Lycosidae (*Hogna radiata*, *Lycosa vultuosa*).

Regarding daily butterflies (Rhopalocera), the most characteristic species of this habitat are: *Iphiclides podalirius*, (Papilionidae), some satyrid species (*Hipparchia fagi*, *Maniola jurtina*, *Neohipparchia statilinus*) and pierid species (*Pontia edusa*, *Pieris mannii*, *Aporia crataeg*, *Euchloe ausonia*). *Colias crocea*, *Gonepteryx rhamni*, *Polyommatus icarus* and *Maniola jurtina* can be found in many different habitats including pseudomaquis.

Family Carabidae is represented by many thermophyllous species: *Zabrus brevicollis*, *Pachycarous atrocoerules*, *Carterus dama*, *Harpalus spp.*, *Ophonus spp.*, *Carabus graecus morio*, *Carabus preslii jonicus*, *Carabus coriaceus emgei*.

In the open places of the shrubby forests there are many orthopteroid species such as *Ancistrura nigrovittata*, *Poecilimon macedonicus*, *Saga natoliae*, *Acrida sp.*, *Dociostaurus marrocanus, etc.*

5.1.1.1. Kermes oak shrubland

The characteristic plant association is Coccifero-Carpinetum orientalis which implies the dominance of Oriental hornbeam (*Carpinus orientalis*). However, in the degraded stands the Kermes oak is dominant species and gives the appearance of the pseudomaquis. The dominance of kermes oak over the Oriental hornbeam in the present time is secondary feature produced through the anthropogenic influence in past periods. Humans exploited deciduous species (such as Oriental hornbeam, ash, white oak) and thus increased the abundance of evergreen species, especially the Kermes oak, juniper species and *Phillyrea media*.

Three separate types of the kermes oak shrubland were recognized on the basis of their degradation level.

Photo 18. Well preserved pseudomaquis

Photo 19. Sparse pseudomaquis

5.1.1.1.1. Well preserved kermes oak shrubland

Carpinus orientalis has edificatory role in the preserved sites, but *Quercus coccifera* and *Quercus pubescens* are also very abundant (Photo 18). Among evergreen species *Quercus coccifera* and *Phillyrea media* dominate, but also *Juniperus oxycedrus* and *Juniperus excelsa* are common. Other important tree species are *Fraxinus ornus* and *Pistacia terebinthus* and shrub species: *Colutea arborescens*, *Coronilla emeroides*, *Jasminum fruticans*, *Cistus incanus* etc., than liana species: *Ephedra campylopoda*, *Clematis flammula*, *Lonicera etrusca* and others. Characteristic species in herb layer are: *Anemone pavonina* var. *purpureoviolacea*, *Crocus chrysanthus*, *Romulea bulbocodium* and others. The extended list of plant species growing in this habitat type is given in the Appendix II.1.

Distribution: This biotope is distributed exclusively in the southernmost part of Macedonia up to 600 m a.s.l on south expositions. Its northernmost distribution is up to Demir Kapija, thus occupying the whole highway corridor as well as Gevgelija, Valandovo, Dojran and Strumica valleys.

Distribution in the area of the road corridor: the best areas representing this biotope are on the right side of the river Vardar, from Demir Kapija to village Davidovo. Only small areas on the left side are covered by dense pseudomaquis community (see Habitat map-Appendix I.4.).

5.1.1.1.2. Sparse kermes oak shrublands

The same plant community characterises this habitat as well. The difference results from the lower percentage of deciduous species (*Carpinus orientalis*, *Quercus pubescens*, *Fraxinus ornus*, *Pistacia terebinthus* and others) due to their overexploitation in the past, but also at present, so the physiognomy of the community has been changed (Photo 19). *Quercus coccifera* and other evergreen elements mark out the present appearance of the community such as *Phillyrea media*, *Juniperus oxycedrus* and *Juniperus excelsa*.

Other characteristics that separate this biotope from previous are: much better developed herb layer, due to the presence of open spots and clearings between the evergreen shrubs, than shallow, eroded soil, dense ravine system, smaller or bigger bare rocks etc. During the winter period green colour dominates as opposite to previous biotope, where brown colour with green spots is more characteristic.

The fungal composition is very similar to the previous biotope since it represents the same habitat and same host tree and shrub species. The difference is that here lignicolous macromycetes developing on evergreen tree species are predominating.

Distribution: The same remarks as for the previous biotope are true for this one too.

Distribution in the area of the road corridor: Almost all slopes from the left side of the Vardar valley, from Demir Kapija to Smokvica are occupied by this biotope. It is also presented sporadically on the small hills in the lower part of the road corridor (area of the village Smokvica). (See Habitat map-Appendix I.4.).

5.1.1.1.3. Highly degraded kermes oak shrubland

This biotope type differs greatly from previous two, since both evergreen and deciduous tree and shrub species are very sparse (Photo 20). Degraded natural pseudomaquis stands representing this biotope are usually invaded by *Paliurus spina-christi*, *Pyrus amygdaliformis*, *Prunus spinosa*, *Juniperus oxycedrus* etc. (Photo 21). The plant association that represents this habitat is **Paliuretum submediterraneum Rizovski prov**. It differs from the other associations with domination of *Paliurus spina-christi* in different succession stages: in other areas it develops into Querco-Carpinetum orientalis, while in the area south of Demir Kapija it develops into Coccifero-Carpinetum orientalis.

The most important plant species in the tree layer of this association are *Paliurus spina-christi*, *Quercus coccifera*, *Phillyrea media*, *Juniperus oxycedrus*, *Juniperus excelsa*, *and Pistacia terebinthus.* The herb layer is composed of *Minuartia glomerata*, *Euphorbia myrsinites*, *Ajuga laxmanii*, *Asphodeline lutea*, *Knautia orientalis*, *Tunica illyrica*, *Althea cannabina* etc.

Smaller or larger grassland areas discontinue the stands. Among other grass species, tall grasses like *Chrysopogon gryllus*, *Andropogon ischaemum* etc. are characteristic. This plant community is formed as a result of high anthropogenic pressure; thus characteristic elements of natural vegetation are rare and occasional. The natural vegetation has been cut in order to enlarge the agricultural areas or pastures. The typical biotope of highly degraded pseudomaquis has usually secondary origin, since the above mentioned elements invade abandoned fields and pastures afterwards. Consequently, this kind of biotope is usually distributed close to the settlements and next to the arable fields.

Photo 20. Highly degraded Kermes oak shrubland on rocky sites (left side of Vardar valley)

Photo 21. Highly degraded pseudomaquis – Paliuretum submediterraneum

The characteristic lignicolous fungal species for the biocoenosis defining this biotope more or less lack here, due to the absence of adequate hosts, but new tree species as *Paliurus spina-christi* with 9 lignicolous fungal species growing on it and *Pyrus amygdaliformis* with 15 species are enabling development of other fungal species such are *Peniophora incarnata* for *Paliurus spina-christi* and *Lopharia spadicea*, *Corticium polygonioides*, *Phlebia rufa* etc. for *Pyrus amygdaliformis*. Nevertheless, terricolous fungi have greater diversity in this biotope. Among others, *Pisolithus arrizus*, *Amanita vitadinii*, *Myriostoma coliforme* etc. are specific for this habitat.

Composition of the fauna is very similar to the overall fauna of pseudomaquis. A main specificity is that species of open terrains in the community are dominating over the species typical for well-preserved pseudomaquis. This especially refers to the invertebrate fauna such as daily butterflies *Hipparchia fagi*, *Neohipparchia statilinus*, *Pontia edusa*, *Artogeia mannii*, *Aporia crataegi* and ground beetles (*Harpalus dimidiatus*, *Harpalus rufipes*, *Ophonus azureus*, *Ophonus cribricollis*, *Cymindis coadunate*, *Amara aenea*). On the open places in the shrublands there are many orthopteroid species.

Distribution: This biotope is also connected to the pseudomaquis type, and so the remarks for general distribution are the same.

In the area of the road corridor it does not have regular distribution, but it is connected to the village surroundings, close to the agricultural land and usually close to the existing roads and railway (see Habitat map-Appendix I.4.).

5.1.1.2. Shrubland on rocky sites

This habitat type is represented by two main communities: sparse *Phillyrea media* shrubland and Greek Junipers community accompanied by the *Rhus coriaria* shrublands (the latter is presented by association **Rhuetum coriariae** Tomašević 1959 characterised by domination of *Rhus coriaria*).

5.1.1.2.1. Sparse *Phillyrea media* shrubland on rocky sites

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: No specific reference

Very sparse *Phillyrea media* shrubland occurs on rocky sites, but more often on the cliffs and bare rocks of the Demir Kapija canyon. Thus, it is described in Chapter V.3.1.1. Sparse *Phillyrea shrubland* on rocky sites is not presented separately on the Habitat Map (Appendix I.4.), but in the scope of *Phillyrea media* habitat on cliffs and rocks.

5.1.1.2.2. Greek Juniper community

Reference to Habitat Directive: 9560 *Endemic forests with *Juniperus* spp.
Reference to Palaearctic Habitats: 42.A3 - Grecian juniper woods (*Juniperetum excelsae*) - forest formations dominated by *Juniperus excelsa*, of the *Ostryo-Carpinion* zone of the mountains of northern Greece (up to 900-1000m, around lake Prespa);

Plant associations **Pruno webbii-Juniperetum excelsae** occupies the rocky sites in the Demir Kapija gorge on both sides of the river Vardar (Photo 22). Dominant species is *Juniperus excelsa*. This species grows in the crevices of the limestone rocks, as well. Other important species of this community are *Prunus webbii*, *Phillyrea media*, *Prunus mahaleb*, *Pistacia terebinthus*, *Fraxinus ornus*, *Paliurus spina-christi*, *Ephedra campylopoda*, *Asyneuma limonifolium*, *Cerinthe retorta*, *Asphodeline lutea* etc.

The extended list of probable plant species growing in this biotope is given in the Appendix II.1 concerning the rocky area.

Photo 22. Greek Juniper shrubland on rocky sites (Shtuder locality)

The qualitative composition of fungi is very similar to that of biotopes 1.1.1 and 1.1.2, because of presence of the same dendroflora species.

Composition of the fauna is very similar to the previous habitats, but it is much poorer. The greatest deal of the species in the shrublands on bare rocks and rocky places are rare, even the species that are more frequent in the dense or sparse pseudomaquis forests.

Butterflies *Pyrgus sidae* and *Coenonympha pamphilus* are probably more frequent in this biotope than in other types of pseudomaquis. Characteristic butterflies for open rocky habitats with shrubs are: *Erynnis marloyi*, *Antocharis grunei*, *Carcharodus alceae*, *Lampides boeticus*, *Neohipparchia fatua*, *Polygonia egea*, *Leptidea duponcheli* and *Tarucus balkanicus.*

Distribution: This habitat is sporadically distributed on the slopes of Vardar valley and lower flows of its larger tributaries. It is strictly connected to the rocky and stony areas.

Distribution in the area of the road corridor: In the highway corridor this kind of biotope is distributed only on the rocks of Demir Kapija gorge covering relatively small area. The *Rhus coriaria* community is distributed as patches on the right side of the Demir Kapija gorge (not presented on Habitat map-Appendix I.4.).

5.1.2. FORESTS OF PUBESCENT OAK AND ORIENTAL HORNBEAM (OAK FORESTS)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 41.82 Oriental hornbeam woods

It is characterised by the forest community **Querco-Carpinetum orientalis macedonicum** Rud. 39 apud Ht. 1946 (Photo 23). This thermophyllous and xerophyllous community is developing under regional climatic influence on the skeletal soils. The edifier species is Oriental hornbeam (*Carpinus orientalis*), and very abundant and frequent is Pubescent oak (*Quercus pubescens)* – Photo 24. Beside these tree species *Fraxinus ornus, Colutea arborescens, Coronilla emeroides, Acer monspessulanum, Rhamnus rhodopaea* are coming in the tree and shrub layers and *Cyclamen neapolitanum, Carex halleriana* are characteristic for the herb layer. The extended list of plant species growing in this biotope is given in the Appendix II.1.

The fungal characterisation of this biotope is presence of fungal species developing on deciduous trees such are *Radulomyces molaris, Vuilleminia comedens, Stereum hirsutum, Daedalea quercina, Dichomitus campestris, Hapalopilus rutilans* etc. (on *Quercus pubescens*) and *Hyphodontia crustosa, Steccherinum ochraceum, Phellinus punctatus* etc. (on *Carpinus orientalis*). The terricolous fungi are characterised by thermophyllous species like *Leccinum griseum, Amanita Caesarea, Boletus fechtneri* etc. A comprehensive list of fungal species is presented in the Appendix II.2.

The characteristics of fauna representing this biotope are more or less the same as pseudomaquis type, at least in the area of the road corridor.

Photo 23. Forest of Pubescent oak and Oriental hornbeam

Photo 24. Pubescent oak (without leaves) and Oriental hornbeam (foliated)

Vertebrates

Mammals - Mammal fauna is similar with the one in Pseudomaquis. Nevertheless, some Rodent species (*Apodemus sylvaticus, Mus macedonicus, and Dryomys nitedula*) can be found. Wild cat (*Felis silvestris*) is a typical forest species. Brown bear is common visitor in the area of this forests (frequently coming from Kozhuf-Nidze mountain range for feeding).

Birds - this is another habitat rich wit bird species (more than 60 species), two thirds of which are breeding. Common birds for the oak forests are Blackbird (*Turdus merula*), Jay (*Garrulus glandarius*), Chaffinch (*Fringilla coelebs*), Great Tit (*Parus major*), Robin (*Erithacus rubecula*) etc. There are two species with very small populations in Macedonia breeding in the oak forests around Demir Kapija, the Booted Eagle (*Hieraaetus pennatus*) and Black Kite (*Milvus migrans*).

Reptiles - Composition of reptiles is similar to that from the pseudomaquis. There are Erhard's wall lizard (*Lacerta erhardii riveti*), Green lizard (*Lacerta viridis*), Balkan green lizard (*Lacerta trilineata*), Aesculapian snake (*Elaphe longissima*), Dahl's Whip Snake (*Coluber najadum*) etc.

Amphibians - due to the more humid environmental conditions, more amphibian species are found here than in the pseudomaquis. The most characteristic species are Fire Salamander (*Salamandra salamandra*), Common Toad (*Bufo bufo*), Green Toad (*Bufo viridis*), European Tree Frog (*Hyla arborea*) etc.

<u>Invertebrates</u>

Ground beetle fauna is similar to the one of the pseudomaquis. Its composition is presented in Appendix II.4.2. The most interesting species are *Laemostenus cimmerius, Carabus coriaceus emgei* and *Carabus preslii jonicus*.

Distribution: This association is widespread in Adriatic and Aegean submediterranean region. In Vardar and its tributaries it is climazonally distributed up to about 600 m a.s.l. and on southern slopes it is climbing up to 1000 m altitude.

In the area of the road corridor this habitat is represented by small areas, only touching the corridor of Alternative 2 - on the right side of the river Vardar.

In some of the localities in the dales on the right side of Vardar valley, a special species complex with Box (*Buxus sempervirens*) is developing. Similar "habitat type" is mentioned under Habitat Directive as **5110 Stable xerothermophilous formations with *Buxus sempervirens* on rock slopes (*Berberidion* p.p.)** which corresponds to **31.82 Box thickets** of the Palaearctic classification. The stands are characterized usually by large boulders and deep soil. The tree layer in this habitat is consisted of tall tree species (*Quercus* spp., *Carpinus betulus, and Fraxinus ornus*) but the most prominent feature is the evergreen shrub layer of Box. At some of the localities, Box can be found in the tree layer, as well. This unique species combination has the best stands at Golema Javorica gorge. Since the presence of Kermes oak is common in these stands, it is difficult to distinguish separate habitat out of dense pseudomaquis. That is the reason why this "habitat type" is not presented on the Habitat map, although the value of the site was stressed in many occasions.

In the upper parts of the Oak forest belt (Alternative 2: Usite, Stefan, Miravsko Ushche and Golata Chuka) there are stands of Italian oak (*Quercus frainetto*). This stands represent small patches of the forest belt **Quercetum frainetto-cerris macedonicum**, which is normaly above the lower Oriental hornbeam-Pubescent oak belt. In the area of project interest (Alternative 2) it only touches the highway corridor and does not have particular significance for further analyses of impacts. Thus, it was not considered (and mapped) in details.

5.1.3. BEECH FORESTS

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 41.17 Southern medio-European beech forests (41.175 Sub-Mediterranean calcicolous beech forests)

The beech forests that develop at lower altitudes belong to the piedmont beech belt. The beech forests in the area of Demir Kapija (Marjanska Planina Mt.) are peculiar having in mind the altitude they are developing on. These beech forests can be found in the sheltered localities of the gorges of streams and dales or ravines at altitudes of 500 m and lower. These types of beech forests are typical for the refugial regions.

The refugial beech forest on Marjanska Planina (Javorica region) is represented by the submediterranean beech community (ass. **Aristolochio-Fagetum** Em 1965 prov. = as. Fagetum submediterraneum). The dominant substrate is diabase. Only at the locality Linski Dol the substrate is consisted of basalt rocks. The soil is deep and fertile, and most probably cambisol.

The composition of the flora can not be presented in details due to the lack of data. It is characteristic that the species of oak forests prevail in this beech community. The following plant species were registered during field observations: *Quercus petraea*, *Carpinus betulus*, *Tilia tomentosa*, *Ostrya carpinifolia*, *Carpinus orientalis*, *Buxus sempervirens*, *Ilex aquifolium*, *Hedera helix*, *Corylus avellana*, *Aristolochia rotunda* etc.

There are probably some stands with Box (*Buxus sempervirens*) that gives distinctive features of the shrub layer. Such habitats may be included in habitat type 41.1751 Box beech forests of the Palaearctic Classification of habitats.

In the area of the highway corridor it is distributed in the catchment areas of streams Javorica and Klisurska Reka (Krastavec hill). The beech forest on Davidovski Rid in the catchment of stream Mala Javorica (locality Usite) was destroyed in the period after World War II. Other stands in the area of interest are also heavily degraded and beech can only be found sporadically. Typical stands of this forest type are not present within the road corridor.

Refugial beech forests are distributed in several regions in Macedonia, especially western parts. The submediterranean beech community is recorded only for Marjanska Planina (area of Alternative 2), Plavush Mt. and Serta Mt.

Vertebrates

Mammals - Mammal fauna is similar with the one in Pseudomaquis. Nevertheless, some Rodent species (*Apodemus sylvaticus*, *Mus macedonicus*, *and Dryomys nitedula*) can be found. Wild at (*Felis silvestris*) and Brown Bear (*Ursus arctos*) are a typical forest species.

Birds - As the surface of this habitat is very small and on low altitude, there are no bird species that are typically found in the montane beech forests, but species moainly coming from the neighbouring habitats. Common are Robin (*Erithacus rubecula*), Blackbird (*Turdus merula*) and Chaffinch (*Fringilla coelebs*).

Reptiles - There is relatively small number of typical species, with Aesculapian Snace (*Elaphe longissima*) being most characteristic.

Amphibians - The composition of amphibians is very similar to that of the oak forests.

5.1.4. RIPARIAN FORESTS, WOODLANDS AND SHRUBLANDS

These forests and shrublands are developing along the riverbanks and streams everywhere in the area under consideration (Photo 25). Well-preserved forests of this type are very rare presently. People were clearing these stands for providing fertile alluvial soil for agriculture. The advantage of Oriental plane wood biomass over oaks and hornbeams was also important in this sense.

In this area, the forest communities belong to **Platanion orientalis** I. et V. Kárpáti 1961, **Salicion albae** Soó (30) 1940 alliance and shrublands to **Tamaricion parviflorae** I. et V. Kárpáti 1961 alliance.

5.1.4.1. Well developed *Platanus orientalis* forests and woodlands

Reference to Habitat Directive: 92C0 *Platanus orientalis* and *Liquidambar orientalis* woods (*Plantanion orientalis*)

Reference to Palaearctic Habitats: 44.711 - Helleno-Balkanic riparian plane forests

This biotope is azonal distributed since the plant community that defines the biotope (**Ass. Juglando-Platanetum orientalis** Em et Đekov 1961) is developing along the rivers and streams up to 500 m a.s.l. on sandy, gravely or stony soils. The stands are usually temporarily flooded during the rainy period.

The forests of this type in the investigated road corridor are at different stages of degradation and typical mature communities are very rare.

The Oriental plane (*Platanus orientalis*) occupies the dominant position in the community and by its appearance and dimensions it determinates the physiognomy of the forest and thus the whole habitat. Beside Plane, *Juglans regia* has optimal growing conditions there. In some stands close to the river Vardar, *Salix Alba*, *Populus Alba*, *Populus nigra* and other hygrophilous tree species are present as well.

The special characteristic of this biotope is the presence of different liana species such are: *Hedera helix*, *Humulus lupulus*, *Periploca graeca*, *Vitis silvestris*, *Clematis vitalba*, and beneath them: *Solanum dulcamara*, *Clematis flammula*, *Marsdenia erecta*, *Rubus caesius* etc.

Photo 25. Willow woodland and Plane belts along river Vardar

In the herb layer *Ficaria grandiflora*, *Cynanchum acutum*, *Thalictrum angustifolium*, *Rumex tuberosus*, *Plumbago europaea*, *Dracunculus vulgaris* are common (Appendix II.1.).

Platanus orientalis in this particular habitat represent a host to 17 lignicolous fungal species among which *Panus tigrinus*, *Auricularia mesenterica*, *Stereum* *hirsutum*, *Laetiporus sulphureus*, *Schizopora paradoxa* are more important, and *Juglans regia* only to 6 (*Fomes fomentarius*, *Polyporus squamosus*, *Polyporus varius*, *Schizophyllum commune* etc.) Some of them, like *Fomes fomentarius* and *Ganoderma adspersum*, are dangerous parasites on old stems. The terricolous fungi are represented by species of *Russula*, *Agaricus* and *Lepiota* genera. (Appendix II.2.)

The fauna of the Plane community is very similar to the fauna of willow woodlands (V.1.4.1.) and shrublands of *Tamarix* and *Salix amplexicaulis* (V.1.4.5.) i.e. most of the animal species are common for these biotopes. Similarity is determined by the presence of the water ecosystems near these biotopes. Thus, the fauna of the biotope near river Vardar and its tributaries is very similar to the fauna of the biotopes near the ponds and channels filled with water. The main difference is the frequency of the species. Generally, animals in the Plane forests are less abundant than in the willow woodlands.

Vertebrates

Mammals - Vicinity to the rivers and broadleaved trees offer mammals' a good shelter, variety of food and water. Thus, the diversity of mammal species is bigger in this habitat. Most characteristic ones are: *Erinaceus concolor*, *Talpa europea*, *Lepus europeus*, *Canis aureus*, *Vulpes vulpes*, *and Felis sylvestris*. Some bat species (*Pipisterllus pipistrellus*, *P. nathusii*, *Nyctalus noctula*, *and Myotis mystacinus*) can be found in the hollow trees as well.

Birds - Bird composition of these narrow habitats depends on the bird assemblages in the neighbouring habitat. This habitat offers good conditions for foraging and breeding, and bird species are abundant. Characteristic species is the Levant Sparrowhawk (*Accipiter brevipes*) which rarely breeds on the larger plane trees. Common species are some finches (Goldfinch *Carduelis carduelis*, Greenfinch *Carduelis chloris*), Tits (Great Tit *Parus* major, Blue Tit *Parus caeruleus*), Blackbird (*Turdus merula*), Jay (*Garrulus glandarius*) etc.

Reptiles - similar to birds, reptiles usually find in the neighbouring habitats are found in this habitat as well. Some other whip-snakes (Aesculapian Snake *Elaphe longissima*, Leopard Snake *Elaphe situla*) are more common here than in the pseudomaquis.

Amphibians - due to more humid conditions in this habitat, amphibians are more numerous and diverse. Among the common species are Balkan Stream Frog (*Rana graeca*), European Tree Frog (*Hyla arborea*), Common Toad (*Bubo bufo*), Fire Salamander (*Salamandra salamandra*), etc.

Invertebrates

The Fresh-water Crab (*Potamon fluviatilis*) is very interesting inhabitant of the Plane community. It was registered near the Chelevechka Reka stream.

The group of Dragonflies (Odonata) is very diverse and represented by many species. The most common and distributed in the whole investigated area are *Orthetrum brunneum*, *Sympetrum sanguineum*, *Epallage fatime* and *Calopteryx splendens*.

Coleoptera is represented mainly by the ground beetles (Carabidae) such as *Chlaenius festivus*, *Tachyura diabrachys*, *Pterostichus nigrita*, *Bembidion* spp. as the most abundant species. Most common species of butterflies are *Limenitis reducta*, *Lasiommata maera*, *Thymelicus sylvestris*, *Polygonia c-album*, *Celastrina argiolus*, *Apatura ilia*, *Vanessa Atalanta* etc.

In the projected road corridor the *Platanus orientalis* woodlands are more common than forests. They are spread throughout the whole corridor, along almost all streams and rivers. Well preserved forests are presented along Chelevechka Reka, the area along Petrushka Reka, Javorica river etc. (see Habitat map-Appendix I.4.).

The community that defines this biotope is distributed along the river Vardar valley up to river Pchinja inflow into Vardar on the north and in Strumica and Dojran region.

5.1.4.2. Belts of *Platanus orientalis* along the rivers or in the dales and ravines

Reference to Habitat Directive: 92C0 *Platanus orientalis* and *Liquidambar orientalis* woods (*Plantanion orientalis*)
Reference to Palaearctic Habitats: 44.711 - Helleno-Balkanic riparian plane forests

Stands of the community that characterise the previous biotope are preserved as narrow belts along the streams and rivers, but also along the dales and ravines (Photo 26). These belts are more common than well-developed forests or woodlands. They are characterised by poorer floral composition and often lack of some characteristic elements.

These belts are regularly distributed along almost all ravines and dales in the investigated road corridor. The plane belts can be found along river Vardar and all of its tributaries from their inflow to the source areas in the highway corridor (see Habitat map-Appendix I.4.).

Photo 26. Plane belt along Kalica stream

5.1.4.3. Well developed willow woodlands

Reference to Habitat Directive: *Salix Alba* and *Populus Alba* galleries
Reference to Palaearctic Habitats: 44.1412 Eu-Mediterranean white and crack willow galleries

The willow woodlands in the investigated area are developing on alluvial sandy soils on the river bank terraces. The ground is flooded regularly during the wet period. The biotope is characterised by permanent humidity, light structure and texture of the soil. On the wider areas along the rivers, often, open terrain and small meadows are present.

This woodland type belongs to the **Salicetum albae-fragilis Soó (1930, 1934) 1958** association. The most characteristic tree species are *Salix Alba*, or mixed *Salix Alba* and *Salix fragilis*. *Populus nigra*, *Salix triandra*, *Sambucus nigra*, *Viburnum opulus*, *Cornus sanguinea*, *Rhamnus frangula*, *Amorpha fruticosa* etc. are coming in small groups or individually. On some stands poplar trees (*Populus nigra*, *Populus tremula* and *Populus Alba*) are dominating and the stand reminds the typical poplar community.

In the herb layer the most characteristic species are: *Poa trivialis*, *Poa palustris*, *Carex vulpina*, *Polygonum lapatifolium*, *Polygonum hidropiper*, *Rumex sanguineum*, *Veronica anagalis-aquatica*, *Scirpus lacustris* etc.

The willow woodland biotope is very rich with fungi, especially lignicolous, due to the high humidity and the diversity of host trees. Some species, like *Phellinus* *igniarius*, *Trametes gibbosa* and *Fomes fomentarius* are dangerous parazites on *Salix* spp. and *Populus nigra*. Some others, like *Perenniporia fraxinea*, *Funalia trogii*, *Ganoderma adspersum*, *Ganoderma resinaceum*, *Pleurotus ostreatus*, *Laetiporus sulphureus* etc. are saprophytes (Appendix II.2.).

Vertebrates

Mammals – the fauna of mammals is very similar fauna to the previous habitat.

Birds - characteristic species for this habitat are Cetti's Warbler (*Cettia cetti*) and Penduline Tit (*Remiz pendulinus*). Many other species use willow trees for breeding and protection, and commonest are Nightingale (*Luscinia megarhynchos*), Robin (*Erithacus rubecula*), Blackcap (*Sylvia atricapilla*) and few others. Many migratory species, especially herons (Ardeidae) use willows as roosting places.

Reptiles - the most common species are Grass Snake (*Natrix natrix*) and Dice Snake (*Natrix tesselata*).

Amphibians - species composition is similar to that of the Plane belts, but some species, especially Lake Frog (*Rana ridibunda*) and Southern Crested Newt (*Triturus carnifex*) are more common.

Invertebrates

Daily butterflies are well represented in this habitat. Most common species are: *Plebejus argyrognomon*, *Lycaena tityrus* and *Leptots pirithous*.

Distribution: This biotope is common for almost all lowland rivers in Macedonia.

In the area of the road corridor well preserved willow forest are presented at the lower flow of river Vardar, especially the district of village Marvinci, Prdejci, Grchishte etc. (see Habitat map-Appendix I.4.).

5.1.4.4. Belts of willows along the rivers and streams

Reference to Habitat Directive: *Salix Alba* and *Populus alba* galleries
Reference to Palaearctic Habitats: 44.1412 Eu-Mediterranean white and crack willow galleries

Stands of the community that characterise the previous biotope are preserved as narrow belts along the streams and rivers. These belts are more common than well-developed woodlands. Poorer floral composition and often lack of some characteristic elements characterises them.

In the area of the road corridor it is distributed almost along the whole river Vardar flow and some channels as well. It is usually altering with *Platanus* belts or woodlands and *Tamarix* shrublands (see Habitat map-Appendix I.4.).

5.1.4.5. Shrublands of Tamaris and *Salix amplexicaulis*

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24.32 Vegetated river sand banks

This biotope represents mostly the heliophylous shrubland dominated by *Tamarix parviflora* and *Salix amplexicaulis*. These shrub species are forming the specific plant community named as **Tamarici-Salicetum amplexicaulis** (Kárpáti 1962) Em 1967. It is developing on the sandy and gravely river drifts in the range of *Platanus orientalis* community. The stands are flooded during the spring period.

In the herb layer *Lycopus europaeus*, *Equisetum arvense*, *Juncus articulatus*, *Mentha longifolia*, *Agrostis Alba* etc. are common. Numerous annual species from the neighbouring grassland areas are can be often meet.

Lignicolous fungi are represented by very specific species growing on Tamarix spp. such are: the saproparasitic species *Inonotus tamaricis*, than *Peniophora tamaricicola* etc.

Animal composition of the shrublands of *Tamarix* and *Salix amplexicaulis* is mixture of the different types of fauna of the neighbouring communities and it is very similar with the fauna of the Plane communities and willow woodlands, but much poorer. It is due to the small surface that the community is distributed on. Disjunctive distribution is another reason for the present situation.

<u>Vertebrates</u>

Mammals – the fauna of mammals is very similar to the previous habitat.

Birds - there are no characteristic bird species in the Tamarisk growths, although there is one rare (Masked Shrike, *Lanius nubicus*). Among the common species are Blackbird (*Turdus merula*) and Whitethroat (*Sylvia communis*). Also, there are no permanently present rare bird species on the sandbanks, but occasionally Glossy Ibis (*Plegadis falcinelus*) and other species might appear. Among the commonest here are Ringed Plover (*Charadrius dubius*) and Common Sandpiper (*Actitis hypoleucos*), while on migration and during wintering Grey Herron (*Ardea cinerea*) and Little Egret (*Egretta garzetta*) are also common.

Reptiles - there are no characteristic reptiles for this habitat type. The commonest species is Grass Snake (*Natrix natrix*).

Amphibians - again, there are no characteristic species. Number of frogs (Lake Frog *Rana ridibunda*, Balkan Stream Frog *Rana graeca*) can be found on the river banks, while European Tree Frog (*Hyla arborea*) in the Tamarisk growths.

Invertebrates

Following species of Odonata are characteristic and more abundant: *Onychogomphus forcipatus*, *Orthetrum cancellatum* and *Libelulla depressa*. The composition of the ground beetle fauna is consisted of riparian species such as *Bembidion* spp., *Asaphidion caraboides balcanicum*, *Tachyura diabrachys*, *Chlaenius* spp. as well as species of open sandy habitats: *Cicindela campestris*, *Amara aenea* etc.

Daily butterflies *Lysandra coridon*, *Lycaena vigaureae*, *Pontai chloridicae*, *Lcaena thersamon* and *Iolana iolas* are the most frequent in this habitat.

Distribution: Tamaris shrubland biotope is regularly distributed in the lower and middle Vardar valley together with valleys of main Vardar tributaries: Crna Reka, Bregalnica, Pchinja etc.

The best preserved Tamaris shrublands along the E5 highway corridor are distributed on frequently flooded large Vardar drifts in the vicinity of the villages Davidovo and, Miravci (see Habitat map-Appendix I.4.).

5.1.4.6. Sandy areas with different density of herb plant cover and small bushes of *Tamarix spp*.

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24.32 Vegetated river sand banks

This biotope is representing very specific type of grassland that is developing on the river Vardar banks or smaller permanent river islands. The ground is represented by sandy or gravely soil or the soil is in the process of formation. These areas are flooded from time to time and the wetland shrubland or forest vegetation can not be established.

The vegetation is not covering the whole ground, it is sparse and represented by herb species, mainly Gramineae, than many pioneer plant species adapted to sandy ground from Polygonaceae, Chenopodiaceae and other families. The presence of small, young Tamarix spp. sprouts is also giving the physiognomy of this biotope.

Insects are represented mainly by the Carabidae species that are adapted to the living conditions in such biotopes. *Dyschiriodes sp.*, *Tachyura diabrachys*, *Siagona europaea* and *Cicindela campestris olivieria* are typical and very characteristic inhabitans of this biotope. Odonata and butterfly species are the same ones as those mentioned in the description of shrublands of *Tamarix* and *Salix amplexicaulis* (Chapter V.1.4.5.).

The most characteristic birds of this biotope are *Phalacrocorax carbo*, *Motacilla flava*, *M. Alba*, *Chradrius dubius*, *Ciconia ciconia*, *Ardea cinerea*, *Tringa ochropus* etc. The above-mentioned species are very common on the sandy riverbanks.

Distribution: This kind of biotope is characteristic for the river Vardar valley and lower flow of its tributaries. It is more or less common biotope, although restricted at the territories already mentioned.

The investigated highway corridor, passes through the lower flow of river Vardar which is the part of the river where conditions (slow water flow, wide flat river terraces etc.) for establishing of this kind of biotope are the most abundant (see Habitat map-Appendix I.4.).

5.1.4.7. River banks represented by sandstone cliffs

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: No specific reference

Most of the riverbanks in the area of the road corridor are either glacis or rarely firm limestone cliffs. On some places loose sandstone cliffs, cut by the action of the river, are presented. They are not very high (usually several metres), distributed mostly along the sharp bends of the river.

Usually these places are not covered by vegetation, since they can undergo frequent changes due to the water erosion. They are very suitable as nesting places for some birds such are Crag Martin *Riparia riparia* and Bee Eater *Merops apiaster*.

Distribution: This kind of biotop is very rare in Macedonia. It is present on some places along upper part of Vardar valley, river Pchinja and Kriva Reka valleys and some other places.

In the area of the road corridor it is also rare habitat. It is distributed along the left bank of the river Vardar –the section between villages Josifovo and Marvinci. In that area, there are some banks of sandstone cliffs several hundred metres long (see Habitat map-Appendix I.4.).

5.2. OPEN TERRAIN - GRASSLANDS OF NATURAL ORIGIN

The grasslands in the area of highway corridor are not characteristic vegetation type. This region is either covered by zonal *Quercus coccifera* shrubland or it is turned into arable fields after clearing of shrubland. Thus, very small area in the road corridor is represented by grassland, and only small parts of it have natural origin. Most of the grasslands are formed after temporal abandonment of the fields.

More or less natural type of grasslands in the area along the road corridor is developing either close to the river Vardar (the possibility of frequent flooding does not allow development of final vegetational stage) or close to the settlements and roads.

5.2.1. DRY GRASSLANDS

Reference to Habitat Directive: 6220 * Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*

Reference to Palaearctic Habitats: 32.D22 East Mediterranean – pre-desert scrub
34.5 Mediterranean xeric grasslands
34.532 Helleno-Balcanic short grass and therophyte communities

This grassland type has been formed by devastating larger areas of natural vegetation (pseudomaquis), mainly close to the populated places or along main traffic lines. It is represented by areas covered by herb vegetation surrounded by kermes oak shrubland of different degradation stages. The dominant plant association of dry pastures in the pseudomaquis is **Tunico-Trisetetum myrianthi** Mic. 1972. These pastures are consisted of therophyte plant species which dry-out in the beginning of the summer.

Helianthemo-Euphorbietum thessalae K. Micevski develops in the clearings of Coccifero-Carpinetum orientalis on rocky sites. Only a small number of plant species can be found: *Euphorbia thessala*, *Alyssum minimum*, *Alyssum murale*, *Tunica saxifrage*, *Moenchia graeca*, *Aethionema graeca*, *Trifolium stellatum* etc.

The floral composition of the typical grassland which marks the physiognomy of this biotope in pseudomaquis shrubland is very similar to that from the surrounding sparse shrubland. Thermophyllous species are dominating. The presence of some small shrubs (either degraded *Quercus coccifera* or other species like *Cistus villosus* etc) is common. Many tall herb species with thorny habitus (*Eryngium campestre*, *Cirsium spp*., *Echinops spp*. etc.) are also characteristic.

The vegetation of the grasslands developing close to the roads is usually represented by floral elements of the neighbouring biotopes (mostly pseudomaquis type), but the important characteristic is that ruderal plants are commonly found there.

The fungal composition is very similar to open terrains in shrubland. The mycorhizal species are very rare, and grassland species are dominating. *Pleurotus eringii*, *Agaricus spp*., *Lepiota spp*., *Stropharia spp*. etc. are more representative.

Vertebrates

Mammals - This habitat is characterized by large mammal diversity. Most common species are: Wolf, Brown Hare, Red Fox, Golden Jackal, European Ground Squirrel, Red Fox etc.

Birds - As this habitat is with only small surface, there are not many characteristical bid species. Commonest are Crested Lark (*Galerida cristata*) and corn Bunting (*Miliaria calandra*), but many other species are coming from the neighbouring habitats for foraging. Some raptor species, such as Buzzards and Kestrels, should be also mentioned.

Reptiles - this habitat is very rich with species (15 in total), and with some very important ones. Common are some lizards and many snake species (*Coluber caspius*, *Elaphe quatourlineata* etc.)

Amphibians - there are only two species regularly found in this habitat, but several others probably can be found coming from neighbouring habitats. Commonest is the Green Toad (Bufo viridis).

The representatives of fauna are the same as for pseudomaquis forests of different types of development and degradation. It should be outlined that the orthopterans and hemipteran species are much more abundant. Daily butterflies species are very frequent in this habitat.

Distribution: these habitats are not very common in the Republic of Macedonia, as they are connected to pseudomaquis. They are distributed in the lowlands in the lower sections of river Vardar (the other sections of the river Vardar and its tributaries' valleys are characterized by specific hill pastures' biotope in the zone of *Carpinus orientalis* and *Quercus pubescens* forests).

Some of the areas representing this habitat type in the projected highway corridor are distributed along the existing roads and especially railroad line, but they are usually very small and not typical. More typical biotopes of this type are distributed in the area close to village Smokvica and Miletkovo (see Habitat map-Appendix I.4.).

5.3. ROCKY AREAS

5.3.1. OVERGROUND HABITATS

Rocky and stony areas are characterised by extremely low biological production, but are very important for biodiversity of certain area. The mineral composition of the rocks and extreme ecological conditions offer unfavourable habitat, and present plant and animal communities are adapted to this habitat.

Rocky and stony sites are common biotope in the upper part of the road corridor, especially the canyon part of Demir Kapija gorge. Typical rocky sites are presented in the beginning of the gorge, while smaller rocky and stony habitats are frequent through the entire road corridor, both alternatives.

5.3.1.1. Sparse *Phillyrea media* shrubland

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: No specific reference

Phillyrea (*Phillyrea media*) shrublands on smaller rocky and stony sites are quite regular through the whole Demir Kapija gorge. They are especially frequent on the left (eastern) slopes of the gorge. Usually they are of very small dimensions and mostly they are not marked on the Habitat map-Appendix I.4. The most extensive sites representing this biotope are distributed at the beginning of the gorge. Specific characteristic for this biotope is regular existence of unstable ground represented by moving stones (scree).

Cliffs and rocks of Demir Kapija canyon are sparsely vegetated by several shrub species. *Phillyrea media* is dominant species in the ravines of the canyon. However, Greek Juniper shrubs (*Juniperus excelsa*) are typical on the bare rocks of the canyon, together with shrubs of *Rhamnus* sp., *Prunus webbii*, *Ficus carica* and some other species. However, only *Phillyrea media* forms distinct shrubby communities on the rocks and cliffs of the Demir Kapija canyon. Other sites of this biotope are surrounded or sparsely covered by **Coccifero-Carpinetum orientalis** Oberd. 1948 emend Ht 1954 association, which was described under sparse pseudomaquis habitat type (Chapter V.1.1.1.2.).

Very sparse *Phillyrea media* shrubland, together with pubescent oak and Oriental hornbeam forms separate plant association - **Phillyreo-Carpinetum orientalis** Em 57. This community in the Republic of Macedonia is developing only on the rocky places and bare rocks. It represents climax vegetational stage conditioned by the high inclination and stony ground. Bedrock is usually represented by limestone and serpentinete. *Quercus pubescens* is dominating in the tree layer, but *Carpinus orientalis* is also frequent. In the shrub layer the most common are: *Phillyrea media*, *Pistacia terebinthus*, *Coronilla emeroides*, *Jasminum fruticans*, *Prunus webbii*, *Quercus coccifera* etc. The herb layer is characterized by Mediterranean species: *Asparagus verticillatus*, *Carex distachya*, *Anemone blanda*, *Oryzopsis virescens*, *Arrhenatherum palaestinum* etc.

The latest community in the area of the project interest is only distributed in the limestone canyon Demir kapija. It is very rare community in Macedonia as well.

5.3.1.2. Chasmophytic vegetation on cliffs and rocks

Reference to Habitat Directive: Eastern Mediterranean screes (not relevant habitat for Macedonia)

Reference to Palaearctic Habitats: 61.4 Eastern Mediterranean screes (not relevant habitat for Macedonia)
62.4 Limestone bare inland cliffs
62.1A131 Balkan range *Ramonda* cliffs

The beginning of the Demir Kapija gorge (0.9 km in length, see Habitat map-Appendix I.4.) is represented by very high cliffs and steep rocks, which are vertical on some places, and it has typical canyon-like shape with different karst formations. There are nine caves and many crevices, ledges etc.

Several plant associations develop on the rocks in the highway corridor area:

a) **Centaureo-Ramondietum Nathaliae Rizovski prov.** – it develops in the shadowed crevices of the limestone rocks. It can be found on the both sides of Vardar River in Demir Kapija canyon as well as the higher parts of Krastovec. The most important plant species are *Ramonda nathaliae*, *Centaurea campylacme*, *Arenaria filicaulis*, *Saxifraga hederacea*, *Poa bivonae*, *Cachrys alpine*, *Vesicaria utriculata* etc.

b) **Stachyo-Inuletum aschersonianae Rizovski prov.** – the physiognomy of the association is determined by *Inula aschersoniana*. It develops on the west slopes of Krastavec, in the areas covered by Paliuretum submediterraneum. The list of plant species contains *Stachys horvaticii*, *Ceterach officinarum*, *Dianthus armerioides*, *Sedum ochroleucum*, *Sedum dasyphyllum*, *Melica transsilvanica*, *Allium pulchelum*, *Galium purpureum*, *Alyssum orientale*, *Minuartia glomerata*, *Draba elongata* and *Achillea ageratifolia*.

The physiognomy of the habitat is defined by the shape and appearance of the rocks, while plant cover has only sporadic role, as it was mentioned above (Photo 27). The main characteristic for plant composition is not their biomass, but presence of rare and endemic species, like *Lilium heldreichii*, *Kitaibelia vitifolia*, *Dianthus cruentus ssp. turcicus*, *Allyssum desertorum*, *Alyssum minutum* etc. It gives this habitat very high biodiversity importance in national and international scale.

For more detailed description of flora and fungi see Appendix II.1 and II.2.
Appart from important plant species that grow in the two habitats mentioned above, there are many important animal species as well.

Vertebrates

Mammals - several bat species (*Barbastella barbastellus*, *Pipistrellus savii*, *P. pipistrellus*, *and Myotis mystacinus. M. myotis*, *Tadarida teniotis*) found their shelter in the crevices of the cliffs and rocky areas along the investigated area. Wolf, Brown Hare, Red Fox, Golden Jackal, European Ground Squirrel etc, are commonly found in this habitat.
Birds - there are many important bird species found in this habitat, especially on the cliffs of Demir Kapija Gorge. The list includes many birds of prey, among which globally threatened Lesser Kestrel (*Falco naumanni*) might still breed here, then Egyptian and Griffon Vultures (*Neophron percnopterus*, *Gyps fulvus*), Golden Eagle (*Aquila chrysaetos*), Long-legged Buzzard (*Buteo rufinus*), Peregrine (*Falco peregrinus*), Lanner (*Falco biarmicus*) and other species with limited distribution, like Rock Nuthatch (*Sitta neumayer*), Blue Rock Thrush (*Monticola solitarius*), Alpine Swift (*Apus melba*), etc. the cliffs has formerly hosted the most important Griffon Vulture colony in the country, which has now almost completely disappeared.
Reptiles - the most characteristic species are Erhard's Stone Lizard (*Podarcis erhardii riveti*) and Kotschy’s gecko (*Cyrtopodion kotschyi*), but Nose-horned Viper (*Vipera ammodytes*) and Leopard Snake (*Elaphe situla*) are also common.

Amphibians - European Green Toad (*Bufo viridis*) finds shelter under the rocks and in crevices during the daytime period. There are no other abundant species, but Balkan Stream Frog (*Rana graeca*) can be also found.

Photo 27. Chasmophytic vegetation on cliffs of Demir Kapija canyon

Invertebrates

Invertebrates are represented by orthopteroids, beetles and butterflies that inhabit the neighbouring shrub communities. The following species can be mentioned as characteristic ones: *Acrida hungarica*, *Oryctes nasicornis*, *Megopis scabricornis*, *Gnaptor spinimanus*, *Cyphogenia lucifuga*, *Iphiclides podalirius*, *Aglais urticae*, *Vanessa cardui*, *Artogeia manni*, *Myrmeleon formicaris* and some other species.

For more detailed description of animal composition see Appendix II.3. and II.4.).

In the area of the road corridor it occupies only the cliffs at the beginning of the Demir Kapija gorge (see Habitat map-Appendix I.4.).

5.3.2. UNDERGROUND HABITATS

Natural underground habitats can be found in the limestone area of the Demir Kapija canyon and Krastavec hill. This habitat type is represented by the caverns in the limestone and several (known) caves.

5.3.2.1. Endogean habitat (caverns)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: No specific reference

Caverns in the limestone are important for the existence of the endogean species while the caves are important for cave-dwelling species. However, the fauna species of caverns and caves is mixed and thus it can not be presented separately.

So far, we are aware of the presence of two endogean species (*Syro* sp.- Opiliones and *Cyphoniscus markoi*) which occurs in the soil caverns around Markova Cheshma locality (Photo 28). Since no other data are available for the caverns habitat in the highway corridor area, it can not be described properly.

Photo 28. Markova Cheshma – in the vicinity of the fountain is the locality of two endogean species (Cyphoniscus markoi and Syro sp.)

5.3.2.2. Caves (Bela Voda cave)

Reference to Habitat Directive: 8310 Caves not open to the public
Reference to Palaearctic Habitats: 65.41 Troglobiont invertebrate temperate caves

There are about 10 caves in the limestone complex of Demir Kapija and Chelevechka Reka gorge. Most of them are very short caves used by bats as their shelter. Out of these caves, Bela Voda (955 m) is the longest and the most important.

The cave Bela Voda is inhabited by a number of invertebrate species as well as extraordinary high number of bat species. Sometimes, some reptile and amphibian species may be found at the entrance of the cave (*Elaphe situla*, *Rana graeca*). The animal species of Bela Voda cave can be divided in three groups (troglobionts – exclusive cave dwellers; troglophylls – species that inhabit caves and other cold and wet places and trogloxens – species that feed outside of the cave and hide in the caves, tunnels, mines etc. such as bats and butterflies).

Photo 29. Cave cricket Dolichopoda remyi

Photo 30. Snail of the family Zonitidae in Bela Voda cave

Photo 31. Isopod species in Bela Voda cave

Photo 32. Nesticus sp. – troglophilous spider in Bela Voda cave

Alpioniscus vardarensis and *Mladenoniscus belavodae* (*in litt.*) are endemic species of Isopoda known from the Bela Voda cave only and represent troglobiontic species. Another strict endemic species from Bela Voda cave is troglobiont *Choleva macedonica* (Cholevidae, Coleoptera).

The cave cricket *Dolychopoda remyi* (Photo 29) is troglophyllous species known from some caves in northern Greece and south Macedonia. There are other troglophylls such as *Scutigera sp*. (Myriapoda), *Nesticus* sp. (Araneae, Photo 32), terrestrial snails (Photo 30) and some isopods (Photo 31).

Insects of family Staphylinidae and Diptera (Limoniidae, flies and mosquitoes and other insects which are not real cave dwelling insects - they are mostly feeding on the guano of the bats) are trogloxenic species.

There are 18 bat species that are registered in Bela Voda cave (Nastov A. & Petkovski S., 2004). Most frequent ones are: *Rhinolophus ferrumequinum*, *R. hipposideros*, *Miniopterus schreibersi*, *Pipistrellus pipistrellus*, *Myotis myotis*, *M.*

blithii etc. Greatest number of individuals is using this cave as a summer roost, however two species found shelter in this cave in the winter period: *Miniopterus schreibersi* and *Myotis myotis*. Following bat species are restricted to the Bela Voda cave: *Eptesicus seroticus*, *Myotis emarginatus*, *Pipistrellus nathusii*, *Rhinolophus blasii*, *R. mehellyi*, *Barbastella barbastellus*, *Plecotus austriacus* and *Tadarida teniotis.*

Beside these already known species of animals, very probably there are other animal species, such as representatives of Leptodirinae-Cholevidae and endogean Carabidae.

The fact that Bela Voda cave is third longest cave in the Republic of Macedonia along with its rich fauna makes its protection necessary. Every disturbance of the stabile conditions in the cave could have negative consequences on the cave fauna.

5.4. WETLANDS/WATER HABITATS

5.4.1. RIVERS AND STREAMS

There are several types of water bodies in the area of interest. The proper typology according to Water Framework Directive (WFD) is ongoing process in Macedonia. Preliminary results from these investigations will be used for the purposes of this study.

5.4.1.1. Rivers (approximately wider than 5 m)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24. Rivers and streams
Reference to Water Framework Directive (EEC 60/2000): lowland medium/small river type

Water flows that can fulfil the aforementioned criteria for "river" in the area of the road corridor are Vardar and Boshava rivers. Vertebrate fauna that is present in this habitat is more or less the same in large rivers and streams. Thus, it is presented in the following text.

Vertebrates

Mammals - Typical mammal species that inhabit bigger rivers are: Southern water shrew (*Neomys anomalus*), Muskrat (*Ondatra zibethicus*), European water vole (*Arvicola terrestris*), Southern vole (*Microtus rossiaemeridionalis*) and Coypu (*Myocastor coypus*).

Birds - there are no characteristic breeding bird species along Vardar and Boshavica Rivers. Several species can be found during migration and wintering, of which commonest are Cormorant (*Phalacrocorax carbo*) and Mallard (*Anas plathyrhynchos*), while Teal (*Anas crecca*), Pintail (*Anas acuta*) and Garganey (*Anas querquedula*) can be occasionally found on migration. Kingfisher (*Alcedo atthis*) and Dipper (*Cinclus cinclus*) are common species found in the winter period.

Reptiles - two water turtles, European Pond Terrapin (*Emys orbicularis*) and Caspian Turtle (*Mauremys caspica*) are the most important reptilian species in the rivers, the second one being with restricted distribution in Macedonia (found only south of Demir Kapija and around Dojran Lake).

Amphibians - Different species and especially their larvae (tadpoles) can be found in the rivers. This includes frogs (*Rana ridibunda*, *Rana graeca*), toads (*Bufo bufo*, *Bufo viridis*, and Yellow-bellied Toad *Bombina variegata*), newts (*Triturus vulgaris*, *Triturus cristatus*), etc.

5.4.1.1.1. River Vardar

River Vardar springs out in the area of Shar Planina Mt. near the village Vrutok and mouths into the Aegean Sea in Greece. The total length of the river Vardar from spring to the mouth is 388 km of which the length of the river in Macedonian territory is 300,7 km. Vardar River is the main river in Macedonia. The catchment of the river Vardar is the biggest in Macedonia and drains 80% of the territory (approximately 20.500 km^2). Total surface of Macedonia is 25 713 km^2, with the highest point 2764 m.a.s.l. on Korab Mountain, the highest point in the Vardar catchment is Titov Vrv with the altitude 2748 m.a.s.l., the lowest point, 44 m.a.s.l., in Macedonia and hereby the lowest point in the Vardar catchment is near Gevgelija. Land use in the watershed is approximately 16% of arable land, 26% is covered by pastures and 37% is covered by forests. Data about land use are very important mostly for hydrological assessment, where this data are used for calculation of specific runoff.

In the area of the road corridor, river Vardar has about 45 km length. It is characterised by faster flow in the upper part of the corridor (Demir Kapija–Udovo). There are steep slopes rising on some places directly from the river banks. In the region of Demir Kapija, actual wetted width in the water level is 75 m, it is a large river type. The cross section profile is natural, and variation in depth is high. The river channel is single braided channel with sinuous curving. The river valley for this part of river is wide U-shape valley. Migration barriers are not present here. The vegetation in riparian zone and floodplain zone is natural. In this survey unit there are presented lateral and middle bars and riffles. The bed substrates are: boulders, cobbles, gravel, sand and mud. The variation in width is high. The presence of flow types is various: broken standing waves, unbroken standing waves, rippled, smooth and no perceptible flow. The mean annual long-term discharge is 126 $m^3 \cdot s^{-1}$ calculated for reference period 1951-2000.

Vascular vegetation that gives the physiognomy of the river banks and of the water close to the banks is not well-developed, due to the fast flow and pollution coming downstream from Skopje and Veles region. Anyway, there is some plant species related to the water ecosystem especially from the right side of the river. These are *Myriophyllum spicatum*, *Polygonum hydropiper*, *Ranunculus trichophyllus*, *Myosotis scorpioides* etc. Stony bad enables development of populations of *Cladophora spp*, during summer, and rich epilithic diatoms communities and cyanophytes, during winter and spring. In addition eutrophic diatom species *Cyclotella menghiniana*, *Navicula capitatoradiata*, *Nitzschia palea* etc. have greatest abundance, indicating the high level of saprobity.

Fish community in this part is dominated by *Alburnoides bipunctatus*, *Barbus peloponnesius* and *Leuciscus cephalus*. The total number of species recorded for this area is 11.

At the lower part of the river, near village Smokvica, actual wetted width in the water level was 90 m. The bankfull width was 110 m. The river is of large river type, the survey length is 1000 m and survey sub-unit lengths are 200 m. The variation in depth is high. The river channel is single and braided. The river Vardar flows in this part through imperceptible river valley. Migrations barriers are not presented here. Many bars and islands are presented there. Bed substrates characteristic for this place are: cobbles, gravel and mud. Variation in width is very high. Types of flow are: broken standing waves, smooth and no perceptible flow. The natural hydrological regime is influenced by wastewater discharging and by surface water abstraction. The mean annual long-term discharge is 135 $m^3 \cdot s^{-1}$.

The vegetation in riparian zone is natural. The form of the floodplain area is not changed and it is natural or semi-natural open land. This part of the river is characterised by intensive agricultural area around the river. Among other vascular plant species associated with water *Veronica anagalis-aquatica*, *Veronica beccabunga*, *Stelaria aquatica*, *Lycopus europaeus*, *Myosotis scorpioides*, *Alisma plantago-aquatica*, *Phragmites communis*, *Rumex cristatus*, *Polygonum hydropiper*, *Ranunculus repens* etc.

The composition of algal communities in the lower part of the river Vardar in the investigated corridor has the same characteristic species as the upper part, although characterised by a much slow flow and muddy bad. The composition of the fauna of river Vardar and its tributaries is very characteristic due to the occurrence of species with southern distribution.

Mayflies are represented by many species, many of them endemic and very rare. Very interesting, but unfortunately, unreliable information is about the occurrence of *Lethroceris patruelis* in the River Vardar and its tributaries.

Batrachofauna is represented by *Rana ridibunda* and *Rana graeca*, which were quite common along the projected highway corridor. Ornithofauna of the banks of river Vardar is presented in Chapter V.4.1.1.

Fish fauna is dominated by *Rhodeus amarus*, *Alburnoides bipunctatus*, *Barbus peloponnesius* and *Pseudorasbora parva*. The last was for the first time recorded in river Vardar in period 1996-1998 as an introduced species. It was supposed that its population will decrease, but the last investigation show that it is still present in the river Vardar. Additionally, another introduced species was recorded *Ameiurus nebulosus* during 1998. In that period the population of *A. nebulosus* was low and was supposed that it has no chances for increase of its populations. During the last investigation, this species was not recorded.

5.4.1.1.2. River Boshava

According to its basic characteristics, river Boshava is completely different in respect to Vardar and Anska Reka. It has characteristics of a mountain river along the largest part of its flow, i.e. very fast flow, stony bed, and mostly clean water (oligosaprobic). At the lowest part, before its mouth in the river Vardar it becomes more similar to Vardar by all characteristics, due to the human influence from Demir Kapija town. Namely, the last 2 km of the river are passing through or next to the town. In this region channel plan form is sinuous and the channel is single. Variation in depth is high for the whole survey unit.

In this part of river these bed elements are dominant: bars and riffles and lateral bars as teh most significant. Characteristic bed substrates are: cobbles, gravel, sand and mud, but the presences of waste material (building waste, PET flasks etc.) are significant, which negatively influences the score. The variation in width is significant; ratio of the maximum and minimum width is 3, what reflects the significant changes in flow dynamics, what is reflected in flow types. The flow types are: unbroken standing waves, rippled, smooth, no perceptible flow, broken standing waves. Artificial bed elements in this survey unit were mostly created by parts of building waste (concrete panel). The riparian vegetation is also influenced by the solid waste, although natural plant communities are present on the right side of the river bank. The bank stabilization is not willful, but there is the artificial material on the bank, which practically serves as stabilization. The profile of the cross section is also changed. The form of floodplain area is not changed and floodplain is used for agriculture.

Cladophora glomerata is dominant macrophyte species in the river, which is covered by epiphytic diatom communities. Diatom epiphytic assemblages are composed by cosmopolitan diatom taxa as *Navicula tripunctata*, *Diatoma vulgaris*, *Gomphonema olivaceum*, although some not very common taxa like *Mastogloia smithii var. lacustris*, *Stauroneis agrestis* and *Navicula lesmonesis* are recorded in Boshava diatom community.

5.4.1.1.3. River Anska (channel in the area of the highway corridor)

River Anska Reka is located in the southern part of Macedonia. It is a left tributary of river Vardar with total length of 22 km. The catchment area is 18 km^2. In the lower part of the river several sublacustrine springs are recorded. The river channel is single and sinuous. For this river unit the presence of bed elements is not characteristic. It is presented here only by small lateral bars and in one survey sub-unit also by riffles. Bed substrates are: cobbles, gravel, sand and mud. In two surveyed sub-units boulders are also present. The variation in width is high; ratio of the maximum and minimum width is 2,2. Types of flow are: broken standing waves, unbroken standing waves, rippled, smooth. The riparian vegetation is modified.

The water is turbid during wet season, as a result of erosion from surrounding agricultural land. The river is highly impacted by eutrophication from agriculture that enables massive development of macrophytes. Macrophytes are present during the whole year. The most dominant species during summer period are *Potamogeton fluitans*, while in part with very slow flow *Lemna minor* is covering the water surface. During spring time, the most dominant macrophyte species is green alga *Cladophora glomerata*. Such composition of macrophytes enables intensive development of epiphytic diatom communities. Diatoms composition is represented by eutrophic diatom species as *Cymbella tumida*, *Ulnaria ulna*, *Cocconeis pediculus*, *Hippodonta capitata*, *Gomphonema capitatum* etc.

5.4.1.2. Streams (approximately narrower than 5 m)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24.14 Epipotamal streams
24.15 Metapotamal and hypopotamal streams
Reference to Water Framework Directive (EEC 60/2000): lowland calcareous streams

The area of road corridor is not characterised by well-developed hydrographical network.

The most of the dales that slopes down to Vardar valley are dry throughout the larger part of the year, especially those from the upper part of the projected highway road corridor (Demir Kapija–Udovo). The most of the streams flowing into river Vardar in the lower section of road corridor (Udovo–Gevgelija) do not enter the flat part of the valley, since they are captured and transported by network of channels to the fields.

The following streams with permanent flow can be registered in the highway corridor area:

- **Left tributaries of Vardar**: Chelevechka Reka, Vodosir, Gradeshka Reka, Mushtenica and Arazliska Reka
- **Right tributaries of Vardar**: Stara (Klisurska) Reka, Golema Javorica, Mala Javorica, Simonska Reka, Selishte Potok, Petrushka Reka and its tributaries (Kalica, Gabreshka Reka and Varnica) and Dukovec.

However, the most important permanent and larger waterflows (streams) are Chelevechka Reka, Petruska Reka, Golema Javorica and Mala Javorica.

Vertebrates

Mammals - the composition of species is identical as in the rivers.

Birds - there is one characteristic and common species dependent on the streams, Grey Wagtail (*Motacilla cinerea*), breeding in small numbers along streams in the region.

Reptiles - there are no important species, but some snakes (*Natrix natrix*, *Natrix tesselata*) and probably turtles (*Emys orbicularis*, *Mauremys caspica*) can be found.

Amphibians - the composition of species is identical as in the rivers.

5.4.1.2.1. Chelevechka (Iberliska) Reka

This stream is left tributary of river Vardar, with mouth in the region of Demir Kapija canyon (the beginning of Demir Kapija gorge). At the lowest flow Chelevechka Reka is passing through the water gap, cut in Jurassic limestone cliffs and thus separating two tunnels of existing motor road (Photo 33).

Along the Chelevechka Reka dale very well preserved plane (*Platanus orientalis*) forests (proclaimed as protected area–Monument of Nature) is developed. Although the brook looks like pure natural clean rivulet, it is highly eutrophicated in its lower flow. The eutrophication comes as a result of strong farming and other anthropogenic influences from village Chelevec. The lowest part, directly before confluence, the stream is polluted by solid waste from passengers that stopped on parking place between two tunnels.

The diatom composition is mainly consisted of eutrophication tolerant species as taxa from genera *Nitzschia* (*N. hungarica*, *N. dissipata*, *N. sigmoidea* etc.) and *Navicula* (N. tripunctata and N. trivialis). The bottom of the stream is mainly covered with *Cladophora glomerata* and *Spirogyra* spp. what enables good substratum for epiphytic growth of diatom species.

The fauna of Chelevechka Reka is not so diverse due to the pollution of its water. *Anodonta cygnaea* is common in the Chelevechka Reka. *Potamon fluviatilis* (Crustacea) was registered on the banks of Chelevechka Reka. Odonata species composition near the water stream is similar to one of other water flows. The most common species are: *Sympetrum sanguineum*, *Sympetrum flaveolum* and *Orthetrum brunneum*.

During the spawning period different fish species, enters the rivulet in large numbers and, spawn there.

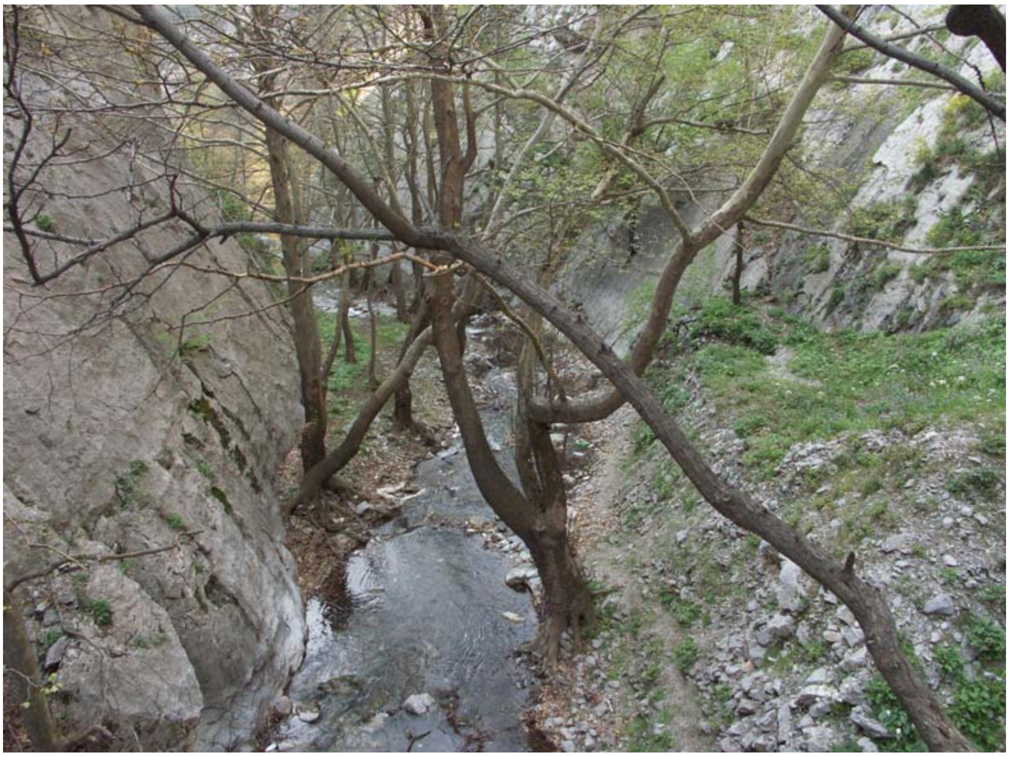


Photo 33. Chelevechka Reka gorge

5.4.1.2.2. Petrushka Reka

This stream is right tributary of river Vardar with mouth in the region between villages Miletkovo and Miravci. According to its hydrobiological characteristics this stream is typical oligosaprobic rivulet, with stony bed, fast flowing waters, and rich epilithic algal communities (Photo34. 35 and 36). It is characterized by high conductivity (over 600 µS/cm). Along the rivulet very well developed sites of Oriental plane are presented (See Habitat map- Appendix I.4.). Before entering the plane, the water from Petrushka Reka is dammed, and during the driest period almost no water is reaching Vardar.

The diatom composition is quite different from all other investigated water flows, and characterised by typical oligotrophic species like: *Amphipelura pelucida*, *Encyonema caespitosum*, *Cymbella neocistula*, *Cymbella Lange-bertalotii* and many others. Among recorded diatom species in Petrushka Reka, several species are rare in the flora of Macedonia: *Diploneis margenstriata*, *Gomphoneis ohridana*, *Gomphonema sp*.

Photo 34. Confluence of Petrushka and Stara Reka *Photo 35. Petrushka Reka near village Miletkovo* *Photo 36. Algal community in Petrushka Reka*

5.4.1.2.3. Golema Javorica and Mala Javorica

These streams are right tributaries of the river Vardar. According to their hydrobiological characteristics these stream are typical oligosaprobic rivulets, with stony bed, slow flowing waters, and rich epilithic algal communities (Photo 37 and 38). Along the both streams very well preserved plane (*Platanus orientalis*) forests are presented. The cannopy cover is about 50%. In the lower part of the streams, several characteristic species were recorded *Campylodiscus hybernicus, Diploneis krammeri, and Gomphonema sp.*, previously recorded in few streams on Mountain Kozuf. The diatom composition in upper part is dominated by typical oligotrophic species like *Gomphonema amoenum*, *Meridion circulare*, *Diploneis fontanella*, *Amphipleura pelucida* etc.

Photo 37. Mala Javorica stream

Photo 38. Golema Javorica stream

5.4.1.3. Streams which are usually dried up during the summer (ravines)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24.16 intermittent streams

These streams characterise numerous ravines in the road corridor region on the left and right slopes of river Vardar valley. The water flow exists only during the humid period of the year (See Habitat map-Appendix I.4.). They have high water level after snow melting in early spring, and a half of the year (more or less) these streams are characterised by dry bed. That is the reason these streams do not have great importance as water ecosystems. But, the ravines through which they flow are regularly covered by denser or sparser plane forests or belts, thus strongly differing from surrounding pseudomaquis or agricultural habitats.

5.4.1.4. Streams with water flow only during the rainy period (gullies)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 24.16 intermittent streams

The most important characteristic for this biotope is shallow, stony, eroded diches cut by running waters during heavy rains. They are distributed mostly on the left slopes of the river Vardar valley in the region of sparse pseudomaquis biotope (Section Demir Kapija –Udovo; see Habitat map-Appendix I.4.).

They are characterised by poor, very sparse plant cover, mainly pioneer species due to the permanent erosive processes. Numerous animal species are coming from neighbouring biotopes (pseudomaquis).

5.4.1.4.1. Thermal waters/springs

Thermal water is spatially connected with the neo-tectonic fissure structures in the Vardar zone or with the transversal fissure marginally located in the depressions. The main hydrothermal systems are located in the east and northeast of the country in the crystalline rocks of Macedonian-Serbian massive and are characterized by low TDS (total dissolved solids) and low corrosion activity. A number of geothermal areas composed by separate fields were discovered as a result of investigations from more than 50 prospecting and operating wells with a depth from 40 to 2100 m.
The following geothermal zones are exploited in the area of interest:

1. Geothermal zone Gevgelija:
   - Twenty two wells with depth of 30-850 at the Smokvica field. The most productive stratum was found in the range of 350-500 m. The total discharge of four wells was 180 l/s, the average wellhead temperature (WHT) was 65 °C.
   - The field Negorska Banja was investigated by means of a few wells. The total discharge of thermal water of 80 l/s at 51°C was obtained by pumping from two wells from a depth of 600 m.

There is one geothermal project in this area consisted by two parts. The first part is the system of geothermal heating for 22.5 hectare of stationary greenhouses from the Smokvica field (15 MWh). The second part is a system of geothermal heat supply of a hotel complex that includes the heating of rooms, hot water supply and balneology. The thermal water is transmitted from the field Negorci (10 km from Smokvica).

The diatom composition is highly specific to this type of waters: *Denticula elegans*, *Nitzschia thermalis*, *Achnanthidium thermale*, *Nitzschia vitrea*, *Mastogloia smithii*.

5.4.1.5. Channels

Reference to Habitat Directive:
Reference to Palaearctic Habitats:

According to the WFD *Article 2(8)*: *"Artificial water body means a body of surface water created by human activity".* A key question in order to differentiate between AWB and HMWB is the meaning of the word "created" as used in Article 2(8). More specifically, the question is whether "created" refers to creating a new water body from previously dry land (e.g. a canal), or whether it could also denote a water body that has changed in category (e.g. river into a lake as a consequence of damming, or coastal water into a freshwater lake due to reclaiming).

The Guidance for identification of water bodies interprets an AWB "as a surface water body which has been created in a location where no water body existed before and which has not been created by the direct physical alteration or movement or realignment of an existing water body". Note, this does not mean that there was only dry land present before. There may have been minor ponds, tributaries or ditches which were not regarded as discrete and significant elements of surface water. Where an existing water body is modified and moved to a new location (i.e. where previously there was dry land) it should still be regarded as a HMWB and not an AWB. The same applies to water bodies that have changed category as a result of physical modifications; such water bodies (e.g. a reservoir created by damming a river) are to be regarded as HMWB and not as AWB.

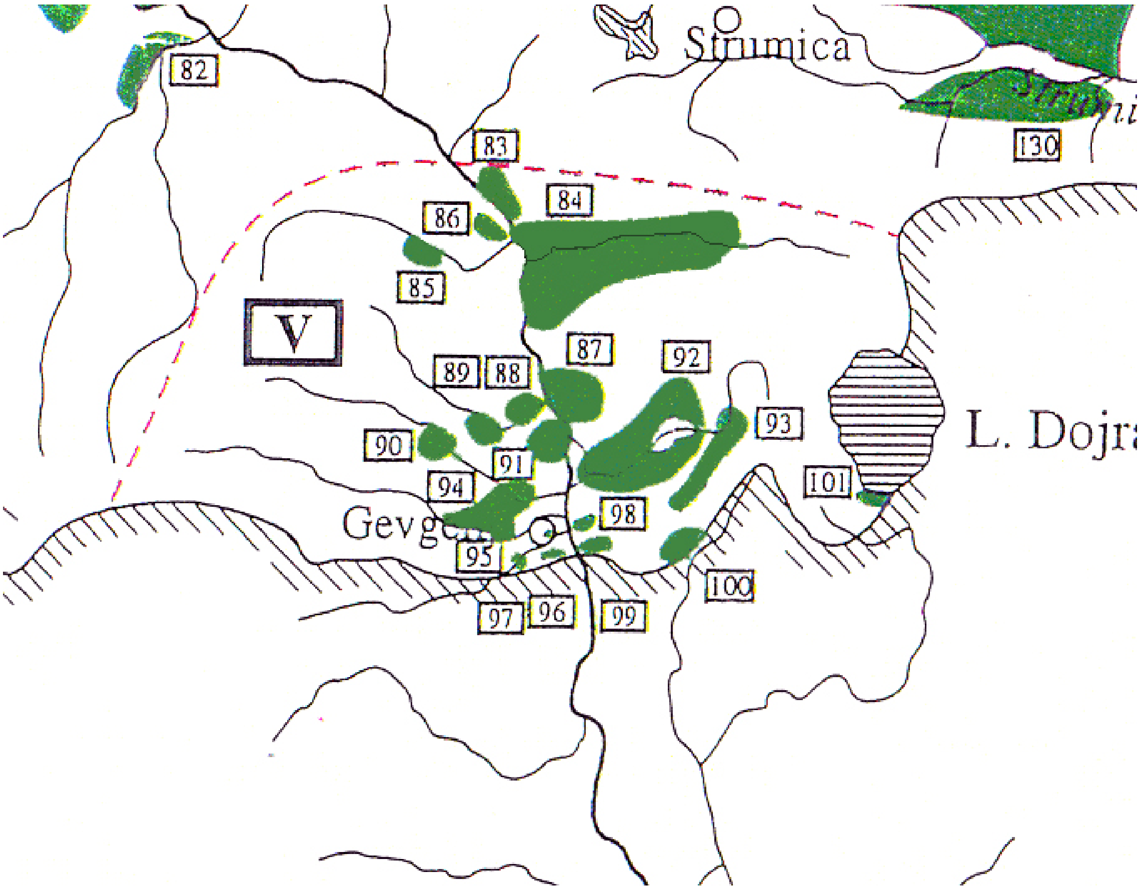
The irrigation schemes are complex engineering systems consisting of numerous facilities widely dispersed in space. They consist of basic structures (dams, intakes, pumping stations, main and group canals), secondary and tertiary network and irrigation equipment. The main conveyers are usually the open concrete canals, or pressurized pipelines. The secondary and tertiary network usually consists of pipelines, made of different material, while the network of the older schemes, or there where specific crops are grown (rise), consist of concrete or earth made open canals.

In the area of interest there are 20 Irrigation Systems (IS) with the area of 12.277 ha (Table 12). The largest IS are Udovo-Valandovo with area of 3.624 ha and Boshavica 1.935 ha (Fig. 6).

List of Irrigation Systems in area of interest

No.	**Code**	**Irrigation system**	**Irrigation area (ha)**	**River of water source**		
				0	**1**	**2**
80	III.0b-1	Boshavica	1.935	Vardar		
81	III-1	Pepelisho Pole	1.600		Boshava	
82	III.1a-1	Demir Kapija	300	Vardar		
83	III-2	Gradec	264	Vardar		
84	III-3	Udovo-Valandovo	3.624		(Stara)	Petruska
85	III.3a.0a-1	Petrushka Reka	100		Stara	
86	III.3a-1	Miravci	100		Vardar	
87	III-4	Grchishte I	423		Vardar	

No.	Code	Irrigation system	Irrigation area (ha)	River of water source		
				0	1	2
		and II				
88	III-5	Smokvica I and 2	110		Vardar	
89	III-6	Prdejci	200			
90	III.6a-1	Kovanska, Sermeninska Reka	200		Vardar (wells)	
91	III-7	Vinojug	150		Vardar	
92	III-8	Gjavato	1.340			
93	III.8a-1	Paljurci	800			
94	III8b-1	Konska Reka	571		Vardar	
95	III-9	Sehovo	200		Vardar	
96	III-10	Granica	120			
97	III10a-1	Pod anot	120		Vardar (wells)	
98	III-11	Avlakjot	40			
99	III-12	Keramidnica	80		Vardar	
SUM			12.277			



In the area of interest, higher impact is expected on open channels from Anska Reka. The water quality of this irrigation system is under great influence of agricultural land. Massive development of aquatic macrophytes is noticeable during summer period, where *Cladophora glomerata* is the most dominant. Several diatoms as typical eutrophic indicators are present in epiphytic communities (see description of Anska Reka).

Water fauna of the channels is very similar to one of the stagnant water biotopes. The most representative inhabitant of channels is *Mauremys caspica rivulata*, a reptile with south range of distribution. Ornithofauna and enthomofauna is almost identical with the fauna mentioned in the description of stagnant water biotopes.

Vertebrate fauna for rivers (excluding fish)

Mammals - Typical mammal species that inhabit larger rivers are: Southern water shrew (*Neomys anomalus*), Muskrat (*Ondatra zibethicus*), European water vole (*Arvicola terrestris*), Southern vole (*Microtus rossiaemeridionalis*) and Coypu (*Myocastor coypus*).

Birds - there are no characteristic breeding bird species along Vardar and Boshavica Rivers. Several species can be found during migration and wintering, of which commonest are Cormorant (*Phalacrocorax carbo*) and Mallard (*Anas plathyrhynchos*), while Teal (*Anas crecca*), Pintail (*Anas acuta*) and Garganey (*Anas querquedula*) can be occasionally found on migration. Kingfisher (*Alcedo atthis*) and Dipper (*Cinclus cinclus*) are common species found in the winter period.

Reptiles - two water turtles, European pond terrapin (*Emys orbicularis*) and Caspian Turtle (*Mauremys caspica*) are the most important reptilian species in the rivers, the second one being with restricted distribution in Macedonia (found only south of Demir Kapija and around Dojran Lake).

Amphibians - different species and especially their larvae (tadpoles) can be found in the rivers. This includes frogs (*Rana ridibunda*, *Rana graeca*), toads (*Bufo bufo*, *Bufo viridis*, and Yellow-bellied Toad *Bombina variegata*), newts (*Triturus vulgaris*, *Triturus karelini*), etc.

Vertebrate fauna for streams (excluding fish)

Mammals - the composition of species is identical as for the rivers.

Birds - there is one characteristic and common species dependent on the streams, Grey Wagtail (*Motacilla cinerea*), breeding in small numbers along streams in the region.

Reptiles - there are no important species, but some snakes (Natrix natrix, Natrix tesselata) and probably turtles (*Emys orbicularis*, *Mauremys caspica*) can be found.

Amphibians - the composition of species is identical as in the rivers.

5.4.2. STAGNANT WATER BIOTOPES

The biotopes representing the area along or around the slow moving water are not very frequent in the area of the road corridor. Usually they are represented with swampy areas in the scope of the river arms and reed belts along the rivers or channels.

5.4.2.1. Swampy reed biotope in sparse willow stands

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: No specific reference

This kind of biotope in the investigated road corridor is occupying areas covered by sparse willow grows, usually old and tall stems, continuing into Tamaris shrubland. Such places are almost exclusively in the frame of the river Vardar arms, where the water flow is very slow or the water is almost stagnant. Usually, they are not dried up during the summer period.

The physiognomy of the habitat is marked mainly by the well developed and dense reed (*Phragmites australis*) grows mixed with *Typha latifolia* and *Typha angustifolia*, *Scirpus lacustris* etc. (Photo 39). The willow (*Salix Alba*, *Salix fragilis*), poplar (*Populus nigra*, *Populus tremula*) and often plane (*Platanus orientalis*) trees are also sparsely present. Early summer period is characterized by presence of different colours owing to intensive blossoming of *Butomus umbelatus*, *Iris pseudoacorus*, *Alisma plantago-aquatica* etc. The lower stratum is built of different swamp species from genera *Juncus*, *Carex*, *Mentha*, *Lycopus*, *Polygonum* and others. The water surface is completely covered by *Lemna* spp.

The constant humidity in this biotope provides very suitable conditions for permanent growing of diverse plant species offering rich and divers habitat, food and shelter niches for vast number of animal species from all groups.

Dominant animal groups inhabiting this biotope are the semiaquatic and subaquatic groups of insects and waterfowels. Odonata, Plecoptera and Ephemeroptera are the representatives of the semiaquatic insects. The most abundant species of Dragonflies (Odonata) are *Crocothemis erythraea*, *Lestes dryas*, *Calopteryx splendens*, *Libelulla depressa* and *Sympetrum sanguineum*.

Species of the beetles (Coleoptera) that were registered as characteristic ones are *Potamonectes griseostriatus*, *Rhantus sp.* and *Gyrinus caspius*. Order Hemiptera is represented by *Corixa spp.*, *Sigara spp.*, *Gerris lacustris*, *Gerris sp.*, *Notonecta glauca*, most of them very common and widely distributed in other parts of Macedonia. All of the mentioned insect species are living in the ponds and small rivers in the investigated area.

Photo 39. Swampy reed biotope in sparse willow stands

Rana ridibunda, *Rana graeca*, *Bombina variegata* and *Natrix natrix* can be mentioned as common species of these ecosystems - representatives of batrachofauna and herpetofauna.

As it could be expected, the waterfowels are the most characteristic and important animal groups for these biotopes. *Nycticorax nycticorax*, *Ixobrychus minutus*, *Fulica atra*, *Acrocephalus arundinaceus* inhabit exclusively the reed communities. Some other bird species looking for their prey such as *Ardea cinerea* and *Ciconia ciconia* may be found in the shallow waters of the biotope. *Phalacrocorax carbo* and some other common species (*Remiz pendulinus*, *Parus major*, *Parus caeruleus*, *Luscinia megarrhynchos*, *Picus viridis*, *Oriolus oriolus*, *Columba palumbus* etc.) are using the tree canopies as resting, feeding or nestling place (See Appendix II.3.3.).

It is comparatively rare habitat in Macedonia due to the melioration activities after the World War II due to which it is endangered habitat type in Macedonia (NBSAP).

Swampy reed beds are rare in the area of the project interest as well, it covers insignificant surface in the road corridor so it is not very important for overall assessment of highway construction impacts.

5.4.2.2. Reed belts (Phragmites australis)

Reference to Habitat Directive:
Reference to Palaearctic Habitats:

The reed stands in the projected road corridor does not represent the typical reed biotope in the most cases. They are developing as narrow belts along the slow flowing water in channels and some river Vardar arms. Such reed stands usually represent the fragments of the **Scirpo-Phragmitetum** W. Koch 1926 swamp plant association (as in the previous habitat). This kind of biotope is much poorer from the floral and faunal point of view, compared to the previous one.

5.4.2.3. Reservoirs

According to the Water Framework Directive (WFD), the overall goal for surface waters is that a Member States should achieve "good ecological and chemical status" in all bodies of surface water by 2015. Some water bodies may not achieve this objective for different reasons. Under certain conditions the WFD permits to identify and designate artificial water bodies (AWB) and heavily modified water bodies (HMWB) according to Article 4(3) WFD. HMWB are bodies of water which, as a result of physical alterations by human activity, are substantially changed in character and cannot, therefore, meet "good ecological status" (GES).

Specified uses of water bodies generally result in pressures that might impact the status of the water body. In the context of HMWB and AWB identification and designation process, changes to hydromorphology resulting from "physical alterations" are relevant [Art. 2(9)]. Physical alterations include alterations in the morphology and hydrology of the water regime (compare glossary and step 6). For example, the most common physical alterations include dams and weirs, which disrupt the river continuum and cause alterations of the hydrologic and hydraulic regime. The dams, according to their importance, size, complexity of problems to be resolved during their design and construction, their impact on the environment etc., are included among the most important water management facilities.

In the area of interest there is one HMWB – Kalica Reservoir (Fig. 40) which is used for irrigation purposes. The dam is build as rock fill, made of local material. During field investigations the water level was decreased and the water remains only in the deepest parts of the reservoir. The bottom is covered with large amount of organic sediment. On this substrate large-celled diatoms are predominant in the epipelic community and represent the most important primary producers. Most dominant diatom species are *Pinnularia rupestris*, *Surirella biffrons*, *Caloneis amphisbaena*, *Cymbopleura amphycephalla*, *and Cymbella affinis*. Such diatom composition indicates oligo-mesotrophic conditions of the water with moderate to high electrolyte content. This finding is in concordance with measurements of the basic chemical parameters.

Due to high variation of the water level, aquatic macrophytes and riparian vegetation are completely absent. This situation is characteristic for reservoirs with high variability of the water level.

Photo 40. Reservoir Kalica – used for irrigation purposes and fishing

5.4.3. SPRINGS AND WELLS

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 54.11 Soft-water springs

Springs and wells are not numerous in the area of the road corridor but their significance as water resources is great (Photo 41 and 42). They are marked on the Habitat map (See Appendix I.4.).

Photo 41. Fountain near *Photo 42. Spring on* *Photo 43. Vegetation of the spring habitat (fountain*

Mala Javorica stream *Golema Javorica stream* *Ilinden)*

Apart from the socio-economic value they have biological value as well. Permanent ecological conditions in springs enable establishing of specific biocoenoses with restricted distribution only to the small springs area (Photo 43). The algal and animal species in springs are oligosaprobic organisms. Very often rare or endemic species are presented and thus, springs are worth for conservation from biodiversity point of view as well (not only as a water resource).

The situation with wells is very similar.

5.5. ANTHROPOGENIC HABITATS

This chapter deals with the anthropogenic habitats such as urban and rural settlements as well as plantations of conifers and deciduous trees and agricultural land (fields, orchards, vineyards, fallow fields).

5.5.1. WOODLANDS AND PLANTATIONS

Plantations in the highway corridor area cover small surfaces. Most of them can be found near the settlements and along the existing motor way and railway.

5.5.1.1. Broadleaf plantations

Black locust (*Robinia pseudoacacia*), Canadian poplar (*Populus X canadensis*) and high-stemmed *Populus nigra* cultivars represent the broadleaf plantations in the highway corridor. Along the railway some small stands of *Ailanthus glandulosa* can be found. However, the latter can be included in the ruderal sites.

<u>Vertebrates</u>

Mammals - Mammal fauna in this habitat consists of species typical for forest: wild cat (*Felis sylvestris*), Yellow -necked mouse (*Apodemus flavicolis*), wood mouse (*Apodemus sylvaticus*). However, highly flexible species can be found in this habitat also: Red Fox, Wolf, Badger, Wild Boar etc.

Birds - Only small number of bird species breed in this habitat, although many more visit it from the neighbouring habitats. Typical species are Warblers (Sylviidae) and Tits (Paridae).

Reptiles - also, all species found here are coming from the neighbouring habitats..

Amphibians - There are no characteristic species of Amphibians in this habitat type, although some species are more abundant here than in the surrounding habitats (Toad *Bufo bufo*, Fire Salamander *Salamandra salamandra*).

5.5.1.1.1. Pure stands of Black locust's (*Robinia pseudoacacia*)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.324 Locust tree plantations

The Black locust's stands are planted on small areas. They are very open and ground vegetation is well developed and it is similar to that of the neighbouring grasslands. Many ruderal elements are present in the Black locust's stands because of their proximity to the roads and settlements.

The forest-like stands of this biotope are rare in the investigated road corridor, but belts of Black locust along the roads and especially the railway line are more common, since the Black locust was planted for erosion prevention.

Black locust's biotope is characterised by the presence of some lignicolous fungi, which are not common in other biotopes that were already mentioned, such are *Phellinus robiniae*, *Phellinus torulosus*, *Ganoderma resinaceum* etc. Quite common terricolous fungal species in this biotope are edible mushrooms of *Macrolepiota procera* and several *Agaricus* species.

Fauna of Black locust's stands is not specific and represents a mixture of the thermophyllous species inhabiting neighbouring localities.

Distribution: Black locust's forests and woodlands are widespread in the Republic of Macedonia due to the fast growing characteristics of the species and great resistance to unfavourable conditions. Many areas were afforested in order to prevent eolian and alluvial erosion processes.

In the investigated road corridor the best Black locust's stands are distributed in the beginning of the road corridor (before Demir Kapija canyon), than on several localities next to the river Vardar in the area of Demir Kapija gorge. Localities in the lower part of the valley are smaller and less significant (see Habitat map-Appendix I.4.). The best stands of Black locust's belts are distributed along the railway line from Miravci to Miletkovo (see Habitat map-Appendix I.4.).

5.5.1.1.2. Stands with *Populus spp*.

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.3212 other poplar plantations

Individual poplar trees growing along the rivers and channels are not included in this biotope, since they are integral part of the willow habitats. Planted poplar stands are distributed on very small areas in the area of project interest, usually not creating forest type of vegetation, except for the very few plantations of Canadian poplar (*Populus* X *canadensis*). Very often individual Lombardian poplar trees (*Populus* CV *italica* - pyramidal form of *Populus nigra*) are planted on the field or acre boundaries.

The stands are usually open and ground vegetation is well developed. It is very similar to that from neighbouring grasslands or other communities.

The poplar forest biotope is characterised by the presence of some lignicolous fungi which are common for planted Old Italian poplar trees, such are: *Ganoderma adspersum*, *Pleurotus ostreatus*, *Agrocybe aegerita* etc.

Generally, the fauna of these stands does not have some specific features and it is not rich in species. Mammal fauna is very similar to the one in the oak forest.

The following species of daily butterflies are characteristic and more abundant: *Everes decoloratus*, *Inachis io* and *Pontia edusa.*

Distribution: Poplar plantations are widespread in the Republic of Macedonia. They are intensively planted due to their high and fast biomass production. Many field and garden edges in Macedonia were planted with Italian poplar in order to prevent wind blowing and to produce shade for farmers.

In the investigated highway corridor the largest stands of Canadian poplar are distributed close to the river Vardar in the district of Davidovo. The small stands of Canadian poplar and Lombardian (Italian) poplar, as well as tree belts, are evenly distributed throughout the whole corridor.

5.5.1.2. Coniferous plantations

Some coniferous species (*Pinus halepensis*, *Cupressus arizonica* and *Cupressus sempervirens*) are very well adapted to the climatic conditions in Gevgelija and Valandovo valleys. However, in the investigated road corridor only small stands of coniferous plantations are present.

Vertebrates

Mammals - the composition of species is identical as in the broodleaf plantations.

Birds - As these stands have very small surface, there are no typical bird species. But, many species use these habitats for foraging. Typical are Jay (garrulus glandarius), Goldfinch (Carduelis chloris) and some Tits and Finches..

Reptiles - lizzards (*Lacerta* sp.) are commonest representatives of the reptile fauna, and sometimes snakes (Colubridae) also use this habitat.

Amphibians - this habitat is very pood with amphibians, due to the unfavourable hygrografic conditions and soil layer.

5.5.1.2.1. Aleppo pine (*Pinus halepensis*) stands

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.3123 other exotic conifer plantations

This pine tree is very well acclimatised on the soil and climate conditions in the region under consideration and it is very often used in plantations. Aleppo pine stands are not very frequent in the highway corridor area. The existing stands are open with sparse trees, thus they do not represent typical coniferous habitat. The shrub and herb layer of pine stands is consisted of native plant species which are characteristic for neighbouring habitat types (Photo 44).

Photo 44. Aleppo pine "stand" near village Miravci

Photo 45. Ailanthus glandulosa stand along railway near village Davidovo

The Aleppo pine plantations are characterised by the presence of some lignicolous fungi that are specific for different pine species, such are *Meruliopsis taxicola*, *Peniophora pini*, *Phellinus pini* etc. This biotope is characterised by the presence of mycorhizal terricolous fungal species, connected to the pine root systems. The most characteristic are *Suilus granulatus*, *Suilus luteus*, *Lactarius deliciosus* etc.

The fauna of the Aleppo pine stands is not analysed separately because of their small surface. Consequently their fauna is composed of animal species of neighbouring biotopes and most of them sporadically visit the Aleppo pine stands.

Distribution: The plantations of this type are not very common in the Republic of Macedonia, except for the submediterranean region. The whole projected highway corridor is passing through that region.

The best stands of these plantations in the road corridor are situated on the right side of the existing motor road between the villages Miravci and Smokvica (see Habitat map-Appendix I.4.).

5.5.1.2.2. Mixed stands of *Cupressus* spp. and *Pinus halepensis*

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.3123 other exotic conifer plantations

As it was the case with the previous habitat, the mixed stands of *Cupressus arizonica* and *Cupressus sempervirens* with *Pinus halepensis*, are also rare in the highway corridor area. According to the stand density, these plantations are somewhat less sparse. The presence of Mediterranean floral elements, characteristic for the area as a whole is common. The *Cupressus* spp. thin and high tree crowns mark the physiognomy of the biotope.

The notes for ground flora composition in previous habitat can be applied for this habitat, as well.

Due to the *Cupressus* resistance to fungal parasites and saprophytes, the fungal species are rare. Similar situation concerns terricolous fungi, except for those connected to Pine trees.

The most common species of butterflies are *Artogeia rapae*, *Polyommatus icarus*, *Gonepteryx rhamni* i.e. the species that are common in most of the habitat types.

Distribution: The notes for distribution of the previous biotope type are valid for this biotope as well (see Habitat map-Appendix I.4.).

5.5.1.2.3. Tree lines along the roads (*Ulmus* spp., *Ficus carica*, *Prunus cerasifera*, *Robinia pseudoacacia* etc.)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 84.1 Tree lines

Tree lines along the roads may not create a specific plant community or separate habitat. The importance of such vegetation, together with the tree lines on the edges of fields, acres and gardens is great because they may serve as corridors for spreading of many species.

Tree and shrub species composing this biotope have both natural and anthropogenic origin. Some of the tree species are reminders of the natural vegetation (*Ulmus spp.*, *Celtis australis*, *Pyrus amygdalyformis*, *Prunus spinosa*, *Crataegus monogyna*, *Rosa canina*, *Rubus spp*. etc.) and some of the species were introduced by people (*Populus* cv *italica*, *Prunus cerasifera*, *Robinia pseudoacacia*, *Ailanthus altissima* – Photo 45, etc.).

The herb species are represented by the elements from neighbouring ruderal or agricultural communities.

Tree lines are scattered irregularly throughout the whole area of interest. The most characteristic ones can be found in the plain area between villages Udovo, Josifovo and Marvinci.

5.5.2. GRASSLANDS OF ANTHROPOGENIC ORIGIN

The most of the grasslands in the area in the highway corridor are of anthropogenic origin. Similar to the grasslands with natural origin, they occupy small areas, since the most of the agricultural land is usually permanently arable.

5.5.2.1. Abandoned fields (Fallow fields)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 87.1 Fallow fields

The most important characteristic for this biotope, concerning the floral composition, is the domination of weedy and ruderal plant species over herb species characteristic for grassland communities (Photo 46). The vegetation cover is more or less closed, in that way indicating that the fields were abandoned for many years.

Grass species like *Cynodon dactilon*, *Lolium spp.*, *Bromus spp.*, *Hordeum vulgare* etc. form the herb cover. *Andropogon ishemum* is often pentetrating from natural grassland areas. Other herb species (mainly weeds) characteristic for warm and dry climate like *Tribulus terrestris* are characteristic for this habitat, too. Tall herbs like *Arctium lappa*, *Hyosciamus niger*, *Datura stramonium*, *Cichorium intybus*, *Xantium spinosum*, *Onopordon sp.*, *Cirsium spp*. and many others are quite common.

The presence of grassland fungi is the main characteristic of this habitat from mycological aspect.

Photo 46. Abandoned field on the alluvial deposits along river Vardar

Photo 47. Abandoned fields with tree hedges

Vertebrates

Mammals - Most common mammal species in this habitat are: Eastern European hedgehog (*Erinaceus concolor*), Badger (Meles meles), European mole (*Talpa europea*), European ground squirrel (*Spermophilus citellus*), Wolf (*Canis lupus*), Least weasel (*Mustela nivalis*), Wild Boar (Sus scrofa) etc.

Birds - This habitat type is very similar to the dry pastures, and similar bird species can be found.

Reptiles - Again, almost the same species foun in the dry pastures can be found here.

Amphibians - are also very rare in this type of habitat, only Toad (*Bufo bufo*) is more common. Other species probably also come from the neighbouring habitats.

Invertebrates

Ground beetles are represented by species that are characteristic for agricultural land and hill pastures. The most common are *Amara aenea*, *Harpalus distinguendus*, *Harpalus serripes*, *Harpalus triseriatus* and *Zabrus incrassatus*.

Distribution: Abandoning the arable land is quite common process in Macedonia in the last several decades. For that reason abandoned fields and meadows habitat is common in Macedonia. It is very similar throughout the whole area of its distribution, but it differes in many specific characteristics concerning species composition, arising from the different grassland communities neighbouring this biotope in different areas.

Abandoned fields and meadows in the area of the road corridor are represented by small surfaces, distributed in a patchy pattern in the scope of agricultural land (see Habitat map-Appendix I.4.).

Abandoned fields and meadows with sparse shrubs is only a variant of previous habitat. This variant originates from the abandoned fields, with development of several tree and bush species as a consequence of natural succession (Photo 47).

Although very similar to the previous habitat, it was considered as different one, since the presence of shrubs offers niches for many animal species, especially for food and shelter.

Beside the characteristic herb plants defining this habitat mentioned for previous biotope type, the shrub species growing here (*Paliurus spina Christi*, *Rosa spp.*, *Prunus spinosa* etc.) are defining its physiognomy.

Ther fauna is almost identical with the fauna of the previous habitat, with more favourable conditions for the presence of orthopterans and more bird species. Butterflies species that are most comonly found here are: *Pieris brassicae*, *Pyrgus malvae* and *Artogeia balcana.*

Distribution: The remarks for the previous habitat are also true for this one.

This habitat has the same pattern of distribution in the area of the highway corridor as the previous one (see Habitat map-Appendix I.4.).

5.5.3. AGRICULTURAL LAND

Agricultural land in the upper part of the road corridor (Demir Kapija–Udovo) in case of Alternative 1 is occupying only the narrow area next to the river

Vardar. Usually small acres and gardens are grown on the alluvial deposits from both sides of the river. These deposits are creating small or medium size accumulative river terraces that are forming the characteristic bends of the river in that area. In the lower part of the road corridor (Udovo–Smokvica) the valley is much broader and much wider area was turned into agricultural land. The relief and land use practices along the road corridor is defining two completely different landscape sub-units.

Agricultural land in the area of the road corridor in case of Alternative 2 is negligible

Agricultural habitats in the area of the road corridor are represented mostly by individual parcels of different types of fields, acres, gardens and meadows. Although most of the parcels are of small size, the presence of hedges is not common.

Large monoculture plantations of both wheat and corn or grape are also represented, but only in the southern part of the road corridor (from Udovo down to Smokvica). Anyway, they are not occupying the large percentage of the total agricultural land.

5.5.3.1. Orchards

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.15 Fruit orchards

Orchards in the area of the road corridor are not characteristic type of agricultural activity. Fruit trees are usually planted in the villages and in their close proximity. The production is intended only for individual use. Therefore, orchards are only sporadically presented in the investigated road corridor, and with very small dimensions. They are more or less extensively managed, trees are of different sizes and ages and very often diverse fruit species are mixed.

The most abundant fruit trees are peaches, pears, plums and apricots. The presence of understorey herb vegetation is a specific characteristic for these particular orchards.

The animal composition of orchards is identical to one that inhabits all types of agricultural land. The main differences are species connected to some cultivated host plants. The most representative are Scolytidae species that are living in the wood and bark of the cultivated trees in orchards (*Scolytus Mali* on apple-tree, *S. amygdali* on *Amygdalus communis, and Hypoborus ficus* on *Ficus carica*). It is important to outline that.

<u>Vertebrates</u>

Mammals - Brown Bear (Ursus arctos) is usualy visiting this habitat and can cause damage to the crops and fruit trees in the area of Marjanska Planian (Alternative 2).

Birds - There are no characteristic species, but Jay (*Garrulus glandarius*), Goldfinch (*Carduelis carduelis*), Golden Oriole (*Oriolus oriolus*), Starling (*Sturnus vulgaris*) etc. are among the commonest ones.

Reptiles - reptiles in this habitat mostly arive from the neighbouting, and tortoises, some lizards and snakes can be found.

Amphibians - There are no characteristic amphibians, but the Tree frog (*Hyla arborea*) could be mentioned as more common.

Distribution: This type of orchards (habitat) is widespread in the rural flat and hilly regions in Macedonia.

As it was mentioned before, orchards in the investigated road corridor cover very small surface (see Habitat map-Appendix I.4.), mainly along the Alternative 1 alignment. Many orchards are situated next to the populated places and they are included in the biotope type defined as peripheral parts of human settlements.

5.5.3.2. Fields and acres

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 82. Crops

Fields, acres and plantations in the area of the projected highway corridor are represented mostly by wheat and corn culture (Photo 48). Industrial plants are very seldom cultivated except for some fields and acres of tobacco.

Photo 48. Agricultural land in the plain near village Miravci

The important characteristic of the area under consideration is that the climate enables growing of two cultures per year. The most frequent alteration of cultures is between wheat fields and vegetable gardens. The alteration of two, although similar, biotopes on same place, dos not have very important role in biodiversity value of the biotopes, but it has a great economic value.

There are some characteristic fungal species for different types of agricultural land such as: *Agaricus hortensis*, *Coprinus* spp., *Anelaria semiovata*, *Volvariella speciosa* etc. The species composition is identical in all types of agricultural land.

The fauna of the agricultural habitats is represented by species that are common for these biotopes in many other regions of Macedonia (See Appendix II.3 and II.4).

<u>Vertebrates</u>

Mammals - the composition of species is identical as in the abandoned agricultural land.

Birds - some bird species (Great Lark *Melanocorypha calandra*, Crested Lark *Galerida cristata*, Wheather *Oenanthe oenanthe*) can be found commonly breeding in this habitat. Many other species use it for foraging.

Reptiles - This habitat is also rich with reptile species, among and the species composition is very similar to that of the dry pastures and abandoned fields.

Amphibians - toads (*Bufo bufo*, *Bufo viridis*) are commonest amphibian species in this habitat.

5.5.3.2.1. Wheat acres and plantations

Beside wheat, barley, corn and rye are the most common crops in the area of the road corridor. The parcels covered with wheat are of a different size, usually acres and smaller fields are predominating (Photo 49). The separate wheat fields are close to each other or altering with gardens, vineyards and cornfields.

Plantations of monocultures have less biodiversity value than individual fields. The monotypic structure of the community, ecological conditions controlled by man, using a large amount of pesticides and fertilisers, are dictating development of biocoenosis with low species diversity.

Some fields are delineated by hedges, and most common trees or shrubs are usually fruit trees, among which *Ficus carica*, *Morus spp.*, *Punica granatum*, *Cydonia oblonga*, *Pyrus spp.* and *Juglans regia* are the most abundant.

Photo 49. Fields and acres in the alluvial deposits along river Vardar

Photo 50. Gardens with cabbage near village Miletkovo

<u>Invertebrates</u>

As characteric invertebrate species of wheat acres are some Ground-beetle species. Most common ground-beetles are: *Harpalus rufipes*, *H. anxius*, *H. autumnalis*, *H. serrpies*, *Dixus obscurus* and *Dixus eremita*.

Distribution: Fields and acres are widely distributed throughout the country.

5.5.3.3. Gardens

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 82.12 Market gardens and horticulture

Due to the favourable climatic conditions, vegetable growing is very important agricultural occupation in the highway corridor (especially Alternative 1). The gardens are usually individually owned and they are mostly of a medium and small size (Photo 50).

Main cultures are different kinds of vegetable (watermelon, cabbage, pepper, tomato, potato etc.). Very often, wheat fields are used for planting second culture. Mostly, cabbage and potato are planted after wheat harvesting. This implies that gardens are very often temporal biotopes and alter with wheat fields in the same year.
Tobacco fields are quite frequent in the highway corridor. Intensively managed meadows can be mentioned, with alfalfa as the most common plant.

Vertebrates

Mammals - Most of the species that are conected to this habitat are typical for the urban and rural areas. Some of them are following: Eastern European hedgehog (*Erinaceus concolor*), European mole (*Talpa europea*), Least weasel (*Mustela nivalis*), Beech marten (*Martes foina*), Wild Boar (*Sus scrofa*), House mouse (*Mus domesticus*), House rat (*Rattus rattus*) etc.

Birds - There are no characteristic species, and Crested Lark, some Warblers and some foraging species (crows, pigeons) are most common.

Reptiles - A number of species can be found here thanks to the rich food base (rodents, insects).

Amphibians - the Tree Frog (Hyla arborea), Toads and Balkan Stream Frog are the most common species.

Distribution: The distribution pattern for gardens is quite the same as that of wheat and cornfields. (See Habitat map-Appendix I.4.).

5.5.3.4. Vineyards (Small parcels and plantations)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 83.211 Traditional vineyards

Vineyards are characteristic for the area of the road corridor and are represented with a high portion of the total agricultural land (Photo 51 and 53).
Small parcels of vineyards are characteristic for the wider part of the river Vardar valley on the section from Udovo to village Smokvica. (see Habitat map-Appendix I.4.).
The most characteristic grape sorts grown in this vineyard area are Kardinal, Kratoshija, Drenak, Kilibar, Afus-Ali and many others.
As far as biodiversity is concerned, vineyards have higher significance than fields and gardens.

Photo 51. Vineyard and wheat acre near village Miletkovo

Photo 52. Green houses near village Miletkovo

Vertebrates

Mammals - Few species can be registered in this habitat: Beech marten (*Martes foina*), Red Fox (*Vulpes vulpes*) and Eastern European hedgehog (*Erinaceus concolor*).

Birds - There are only few species breeding in this habitat (Blackbird *Turdus merula*, House and Tree Sparrow *Passer domesticus*, *Passer montanus*), but this habitat provides good feeding conditions for many other bird species, among which the Starling (*Sturnus vulgaris*) is the most abundant.

Reptiles - there are no characteristic reptiles, and species composition is similar to that of orchards.

Amphibians - again, there are no characteristic species of amphibians in this habitat.

Photo 53. Vineyard near village Miletkovo

Invertebrates

Many species of butterflies can be found in this biotope. The most characteristic ones are *Leptotes pirithous*, *Celastrina argiolus*, *Polyommatus icarus*, *Artogia rapae*, *Pieris brassicae*, *Colias alfacariensis*, *Polyommatus icarus*, *Artogeia napi* etc.

5.5.3.5. Greenhouses for vegetable growing

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats:

Besides vegetable growing in open gardens, early vegetable growing in greenhouses is also an important characteristic for the area of the road corridor (Photo 52). Main vegetable cultures cultivated in the greenhouses are cucumbers and tomatoes. The green houses are constructed of nylon cover and thus they represent temporal agicultural objects. They are not important as habitats.

5.5.4. URBAN OR URBANISED AREAS AS HABITATS

There is one settlement with higher degree of urbanisation - Demir Kapija in both corridors, and several smaller or larger villages along the Vardar valley. The influence of the highway on the population is elaborated in another section (Chapter VIII) of the study. In this case, the populated areas are discussed as a special habitat type.

In the area of the road corridor there are no large industrial objects. Some smaller capacities for industrial production are situated in the settlements (Demir Kapija, Miravci and Gevgelija), but they are not specifically marked on the biotope maps, since they were included in the urban area.

There are some mining objects (quarries), pumping stations for irrigation and thermal water, and railway stations apart from the settlements.

Vertebrates

Mammals - Almost all the species living in urbanized areas are connected to the human presence: House mouse (*Mus domesticus*), House rat (*Rattus rattus*), and Brown rat (*Rattus norvegicus*). However, bat species are also present in this habitat: Pipistrellus pipistrellus, P. nathusii, P. kuhli, P. salvi and Barbastella barbastella.

Birds - Many sinantropic bir species can be found here, and in some of the villages in the lower section of the highway corridor the Lesser Kestrel Falco naumanni might still breed. Common are corvids, pigeons, sparrows etc.

Reptiles - Several snak species enter human species due to the abundance of rodents, but the Kotchi's Gekko Cyrtodactylus kotschyi is the most typical species.

Amphibians - Again, Toads (bifo bufo, bufo viridis) are the commonest amphibians, although some other (Tree Frog, Lake Frog etc) can be found in the small irrigation ditches in many villages.

5.5.4.1. Populated areas and settlements

The basic characteristic for populated areas as a biotope type is presence of allochtonous plant species, mainly decorative trees and shrubs, but also fruit trees and vegetable plants. It is also significant that many plant and animal species are strictly adapted to urban conditions like ruderal and weed plants (see Appendix II.1.), specific bird and mammal species etc.

Taking into consideration the significance of settlements as biotopes for many plants (especially) and animal species, we have grouped them in several biotope types.

5.5.4.1.1. Abandoned settlements (with fruit trees, abandoned gardens, small meadows etc.)

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 86.2 Villages
87.2 Ruderal communities

This kind of biotope refers to few settlements (like Gradec and Klisura) fully or partly abandoned. They are characterised by dense vegetation around the houses or house remains. Many wild plants and animals invading the area, together with abandoned fruit trees, vines and other plants provides conditions for establishing of biotope rich with species and biomass, close to the natural biotopes by many characteristics.

Insects of these biotopes are representing mixture of species inhabiting highly urbanised settlements and species of agricultural land. Qualitative composition is poorer that the one of agricultural land and richer than one in highly urbanised settlements. Many common butterfly species can be registered in this habitat such as: *Pieris brassicae*, *Colias crocea*, *Cynthia cardui*, *Polyommatus Icarus*, *Iphiclides podalirius*, *meleageria Daphnis*, *Inachis io*, *Polygonia c-album*, *Argynnis pandora*, *Argynnis niobe*, *Maniola jurtina* etc. Some bird species may be mentioned as characteristic for these biotopes: *Carduelis carduelis*, *Chloris chloris*, *Sylvia atricapilla*, *Passer hispanioliensis*, *Erithacus rubecula* etc.

5.5.4.1.2. Rural settlements - villages

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 84.4 Rural mosaics
87.2 Ruderal communities

Village settlements along the road corridor are characterized by rural features (Photo 54). As a rule, the houses in these villages are surrounded by small gardens and fruit trees even in their central part. In such condition many wild animal species are adapted for living close to human presence.

Peripheral parts of the villages in the area of the road corridor are characterized by sparsely distributed houses with small meadows, grasslands and sparse trees around. The participation of natural vegetation is high. Beside cultural and decorative plant species, vegetation is mainly represented by elements from neighbouring biotopes and ruderal and weed species (see Appendix II.1.).

Some of the villages or parts of villages are more urbanised (Miravci, some parts of Udovo etc.) and are less important from biodiversity point of view.

Photo 54. Rural area – village Davidovo

5.5.4.1.3. Urban settlements - Demir Kapija town

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 86.1 Towns

The fauna of urbanised settlements along the projected high-way corridor is consisted mostly of common species, both invertebrates and vertebrates. Thus, there are not many species that require higher attention.

Vertebrates

The most characteristic bird species of urbanised settlements are *Corvus cornix*, *Coloeus monedula*, *Streptopelia decaocto*, *Pica pica*, *and Passer domesticus*. Even though these species are very common for all of the biotopes in the area, they use urban biotopes as main nestling place.

Mammal fauna in this habitat is consisting of species that are connected to the human presence as well as species with wide ecological valence. Most common species are: House mouse (*Mus domesticus*), House rat (*Rattus rattus*), Brown rat (*Rattus norvegicus*), Least weasel (*Mustela nivalis*), Beech marten (*Martes foina*), Eastern European hedgehog (*Erinaceus concolor*), Badger (*Meles meles*), European mole (*Talpa europea*) etc.

Invertebrates

Ground beetles are represented by *Harpalus rufipes*, *H. distinguendus*, *Chlaenius vestitus*, *Amara aenea*, all of them widely distributed species and very abundant in the whole areal of their distribution. Similar situation was established for butterfly species (*Pieris rapae*, *P. brassicae*, *Colias crocea* etc.).

5.5.4.2. Urbanized areas: roads, railway and railway stations

The railway line stretches along the river Vardar, on the right side of the valley, through the whole area of the projected highway corridor (mainly Alternative 1). Through the gorge part of the corridor it is situated on the opposite side of river Vardar than existing motor road, whereas after village Marvinci it is on the same side with the road. The railway line was constructed more than a century ago and it is passing close to the river.

Beside the main motor road, many other local roads are functioning in the projected road corridor. These are mainly roads without asphalt, except for the local road connecting some villages: Udovo–Davidovo–Miravci–Miletkovo–Smokvica, Udovo–Josifovo and Marvinci–Grchishte.

The distinctive characteristic of this biotope is common presence of special type of natural vegetation dictated by anthropogenic influence. Presence of some neophytes, together with native plants is also common (Photo 56). Sides of road and railway line are very often planted with belts of trees, which was described in Chapter V.5.1.2.3.

Some of ruderal plant communities are strictly adapted for development along the roads (Photo 55), railways and railway stations (Photo 57). Such communities for the area of the road corridor are **Hordeo-Sisymbrietum orientalis** Oberd 1954 and **Onopordo-Marrubietum peregrini** Matvejeva 1982 (characteristic for the area around the railway stations), **Geranio-Silybetum mariani** Oberd 1954 (characteristic for the edges of roads and railways) **Lolio-Plantaginetum commutatae** H-ic (1934)1963 **and Sclerochloetum durae** Br.-Bl 1931 (characteristic for stouter soils along the roads and streets). For species composition, see Appendix II.1.

Composition of the fauna in this biotope is very diverse and not very specific except for the animals connected to the host plants.

Distribution: The habitats of this type are spread along all roads and railway mentioned above, but they were not included in biotope mapping, since they occupy very narrow area along the roads and it is impossible to present them on the 1:25000 scale maps. Since they are not specific for the area, they do not have high importance for overal biodiversity of the region.

Photo 55. Ruderal vegetation near restaurant "113"

Photo 56. *Opuntia* sp. – adventive species

Photo 57. Ruderal site along railway (railway station "Miravci"

5.5.4.3. Quarries

Reference to Habitat Directive: No specific reference
Reference to Palaearctic Habitats: 86.413 hard stone quarries

There are three quarries in the area of the investigated corridor. The natural biotopes on the area around these places are totally destroyed and conditions are produced for development of anthropogenic habitats. One of the major quarries is situated in the lower parts of river Golema Javorica and covers surface of 247 ha. (See Habitat map-Appendix I.4.).

5.6. IMPORTANT HABITATS AND SPECIES

There is not any special publication in Macedonia that determines the threatened, rare and other important habitats and species of plants, animals and fungi. The only source of information is NEAP (1996) which (with exclusion of bird fauna) is insufficient for application in EIA study. Other sources that might be used are the Decree of rare forest tree species and Hunting Law of Macedonia. Both of them have lists that are incomplete and they do not correspond to the actual situation in Macedonia, and thus, in the investigated area. The most recent and reliable document that contains lists of threatened species and habitats is Country Study for Biodiversity (2003) and National Biodiversity Strategy and Action Plan (NBSAP).

This is the main reason that the lists of threatened and rare species were compiled on the basis of international publications that may be applied for Macedonian conditions (e.g. IUCN), or European legislation (EU Birds and Habitats Directives), or international conventions (Bern, Ramsar etc.). In some cases judgement or personal knowledge on the current situation of experts elaborating this study was applied.

5.6.1. HABITATS

According to NBSAP there are several important habitats which are of interest for the highway corridor area:

1. Periploco-Alnetum glutinosae is plant community characteristic for wetland habitat type in Monospitovo swamp (Strumica). It is not represented in the area of the project interest, but it is mentioned here since *Periploca graeca* as rare plant in Macedonia is distributed along the river Vardar on many places. Habitats with this plant species can be considered as threatened in the area of project interest as well. In the area of the road corridor it is distributed at Petrushka Reka in the Oriental plane habitat (km 22+300) and along the river Vardar in Oriental plane woodlands and belts as well as with willows and poplars in many places.
2. Oak forest habitat with community Querco-Carpinetum orientalis macedonicum - is considered threatened by fires. Not much well developed stands of these forests have remain in Macedonia..
3. Pseudomaquis - Greek juniper community (quoted in NBSAP as: Phillyreo-Juniperetum excelsae) - Demir Kapija is threatened by fire (large part already burnt - see Photo. 58). It is also European priority habitat type.

Photo 58. Pseudomaquis that was partially burnt during a forest fire

Habitat Directive:

1. Pseudomaquis - Greek juniper community is of high conservation importance in Europe (it is priority habitat type (*) according to the Habitat Directive - Annex I: 9560 * Endemic forests with *Juniperus spp.*).
2. Well developed *Platanus orientalis* forests and woodlands and Belts of *Platanus orientalis* along the rivers or in dales and ravines are habitats dominated by the same plant community. It is a habitat type which is

need of conservation in Europe and Special Areas of Conservation (SACs) on its site should be designated (Habitat Directive, Annex I: 92CO *Platanus orientalis* and *Liquidambar orientalis* woods). They are characterized by high species richness (154 vascular plants, 35 fungi, 46 birds etc.).

3. Well developed willow woodlands and Belts of willows along the rivers and streams is habitat with equal importance as previous (Habitat Directive, Annex I: 92AO *Salix Alba* and *Populus Alba* galleries).
4. Dry grasslands. This habitat type is of high conservation importance in Europe (it is priority habitat type (*) according to the Habitat Directive - Annex I: 6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea). It is characterised by extraordinary species richness (317 vascular plants, 27 fungi, 30 birds, 38 ground beetles) in the area of the highway corridor although represented only by smaller areas usually in the clearings in pseudomaquis or on a long time ago abandoned fields and meadows. Since it is wide distributed habitat in Macedonia (it has secondary origin on the formally forestland area) it should be considered as not very important on national scale.
5. Chasmophytic vegetation on cliffs and rocks. Similar habitat type (Habitat Directive, Annex I: 8140 Eastern Mediterranean screes) is considered as threatened habitat in Europe. However, the species composition of the scree habitat referred to in Habitat Directive annexes does not correspond to the communities that develop on limestone and diabase rocks in the area of the road corridor. Despite this fact, one can consider chasmophytic communities in the area of project interest as threatened due to the high anthropogenic pressure (excavation of minerals - quarries).
6. Caves (Bela Voda cave, km 2+300) are considered as threatened habitat type in Europe (Habitat Directive, Annex I: 8310 Caves not open to the public). Bela Voda cave is also of very high national importance: it is one of the longest caves (955 m), it is a habitat of endemic species (see Chapter V.6.) and 18 bat species (Chapter VII.1.3.15.).

Expert judgement:

1. Rivers
   - Boshava. The highway (Alternative 2) crosses Boshava at km 0+900. According to WFD all water bodies must receive at least good ecological status until 2015. River Boshava in the area of the corridor is lowland medium/small river type that is not so frequent type of rivers in Macedonia. Several vascular plants are connected with the river (see Appendix II.2.). Additionally, several rare species in diatom flora of Macedonia were recorded (e.g. *Stauroneis agrestis*, *Navicula*

lesmonesis). During the spawning period different fish species, enters the river in large number.

- Petrushka Reka. The road (Alternative 2) crosses Petrushka Reka at km 23+300. Petrushka Reka is typical oligotrophic water body with high conductivity, enabling development of several rare species in the flora of Macedonia (*Diploneis margenstriata*, *Gomphoneis ohridana*, *Gomphonema* spec. nov.). According to all parameters it receives high ecological status and can be used as reference site for lowland calcareous streams, so it is imperative to protect it from any additional human impacts.

2. Streams
   - Chelevechka Reka. The road (Alternative 1) crosses this stream at km 1+600. During the spawning period different fish species from river Vardar enter the strream in large number. It is one of the most important spawning areas in the river Vardar watershed. Along the Chelevechka Reka dale very well preserved plane forests are developed. Although it is polluted by solid waste (close to the tunnels) in the lower part (close to the mouth), this river in the upper part is typical oligotrophic clean water, supporting development of several rare species.
   - Golema and Mala Javorica. The road (Alternative 2) crosses Golema and Mala Javorica at their upper flow (it crosses small streams that create Javorica streams). The streams are characterized by high conductivity and low nutrient content. This type of stream is characteristic only for the southern part of Macedonia. Due to the low anthropogenic influence this water bodies can be used as reference sites for this river type where almost undisturbed conditions can be observed. In that sense, it is imperative to protect it from any additional human impacts.
3. Channels - see Chapter V.4.1.5.). From biological point of view, irrigation channels do not support specific communities. Nevertheless, the good water quality is essential for good irrigation practices. The erosion and input of solid material from the road construction can influence the water quality and the flow regime in the channels.
4. Reservoirs - Kalica. This reservoir is used for irrigation purposes and possesses higher economic value than biodiversity value. Maintaining of the good water quality is essential. Fish populations are introduced and have small economic importance. Additionally, it is important water body for amphibians (spawning place) and for some birds.
5. Springs and wells. They have social and economic value, especially for the local population.

Anthropogenic habitats (planted broadleaf and conifer stands, fields, orchards, vineyards, rural settlements, urban areas, queries etc.) are more important from the socio-economic aspect than as habitats. Their value and sensitivity is presented in other chapters (Chapter VII).

5.6.2. IMPORTANT DIATOM SPECIES

There are several diatom species that can be considered as important. Three of them are regarded as extremely rare, five are rare, three are endangered and one species is threatened. The overview of the important diatom species is presented by rivers/streams in the following list:

I. Boshava

Stauroneis agrestis Petersen	extremely rare
Navicula lesmonensis Hustedt	rare
Hantzschia virgata var.capitellata Hustedt	extremely rare

II. River Vardar

1. *Navicula Americana Ehrenberg*	extremely rare

III. Anska Reka

1. *Pinnularia lundii Hustedt*	rare

IV. Petrushka Reka

Fragilaria alpestris Krasske	decreasing
Achnanthes minutissima v.graciilima (Meister)	decreasing
Achnanthes Montana Krasske	endangered
Nitzschia angustatula Lange-Bertalot	rare
Neidium binodeiforme Krammer	endangered
Amphora Montana Krasske	rare
Diploneis margenistriata Hustedt	threatened
Diploneis oblongella (Naegeli) Cleve-Euler	decreasing

V. Golema and Mala Javorica

Gomphoneis ohridana Levkov	endemic/rare
Gomphonema spec.	new species

5.6.3. VASCULAR PLANTS

There are many plant species that are considered as important. These species are presented in the following text.

IUCN: *Heptaptera macedonica* (category ***i*** - indeterminate) - Krasta-Demir Kapija (km 0-500), *Ramondia nathaliae* (category ***r*** - rare) - Demir Kapija canyon - limestone (km 1+500).

Bern Convention: *Salvinia natans* - Boshava River.

Habitat Directive: *Ruscus aculeatus* (Annex V - Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures).

Strict endemics: *Hedysarum macedonicum* (Important Plant Areas - IPA species) - Demir Kapija town region on hill pastures - dry grasslands.

Rare plants (1-5 localities in Macedonia) (Tab. 13)

Important plant species: rare and endemic

Species	Locality in the area of interest	Habitat
Alyssum foliosum	Klisura - railway station and Udovo	Kermes oak, Dry pastures, Cliffs and rocky areas
Alyssum murale	Krasta - Demir Kapija canyon	Oak forests, Cliffs and rocky areas
Amaranthus crispus	Along Demir Kapija gorge	Rivers, Urban settlements
Astragalus contortuplicatus	Gevgelija, village Miravci and village Petrovo	Tamaris growths and sandbanks
Athyrium filix-femina var. *dentatum*	Along Demir Kapija gorge, upper flows of Vardar tributaries	Beech forests, Plane stands and belts
Bilderdykia dumetorum.	Along Demir Kapija gorge	Abandoned agricultural land
Bunias orientalis	Village Miravci	Abandoned agricultural land, Fields and acres, Urban settlements
Centaurea formanekii f. *vardarensis*	**Endemic - Demir Kapija canyon**	Cliffs and rocky areas
Chelianthes maranthae	Bozhikovec (Javorica)	Greek juniper, cliffs and rocky areas
Chenopodium hybridum	Village Marvinci	Abandoned agricultural land, Fields and acres, Urban and Rural settlements
Clematis viticella	Krasta	Kermes oak, Oak forests
Consolida hellespon-tica subsp. *macedonica*	Along Demir Kapija gorge	Dry pastures, Cliffs and rocky areas
Consolida orientalis subsp. *phrygia*	Along Demir Kapija gorge	Dry pastures, Fields and acres
Corrigiola litoralis	Demir Kapija gorge	Cliffs and rocky areas
Euphorbia oblongata	Krasta - Demir Kapija canyon	Kermes oak
Glaucium flavum	Demir Kapija	Cliffs and rocky areas
Heptaptera macedonica	**Endemic - Krasta - Demir Kapija canyon**	Cliffs and rocky areas, Abandoned agricultural land, Vineyards
Herniaria cinerea	Along Demir Kapija gorge	Cliffs and rocky areas
Lagoecia cuminoides	Along Demir Kapija gorge	Dry pastures, Cliffs and rocky areas, Abandoned agricultural land
Marsdenia erecta	Along Demir Kapija gorge	Dry pastures, Abandoned agricultural land, Rocky places
Onobrychis lasiostachya. f. *thessala*	Along Demir Kapija gorge	Dry pastures, Cliffs and rocky areas

Species	Locality in the area of interest	Habitat
Paeonia mascula	Krasta	Oak forests
Parietaria lusitanica	Golema and Mala Javorica, Garvan	Plane stands and belts, Cliffs and rocky areas
Periploca graeca	Along Demir Kapija gorge, Petrushka Reka	Willow stands, Oriental plane stands
Polycarpon tetraphyllum	Abandoned village Gradec	Dry pastures, Cliffs and rocky areas, Rural settlements
Rhamnus intermedia	Demir Kapija canyon	Cliffs and rocky areas
Rumex cristatus	River Boshava	Willow belts, Rivers
Rumex hydrolapathum	Along Demir Kapija gorge and river Boshava	Plane stands and belts, Tamaris growths and sandbanks
Saxifraga hederacea	Bela Voda - Demir Kapija canyon	Cliffs and rocky areas
Sedum dasyphyllum var. *glabrum*	Bela Voda - Demir Kapija canyon	Cliffs and rocky areas
Silene linifolia	Stream Javorica watershed	Dry pastures, Cliffs and rocky areas
Stachys horvaticii var. *macedonica*	**Endemic-Demir Kapija gorge**	Cliffs and rocky areas
Taxus baccata	Golema and Mala Javorica, Garvan	Plane stands and belts
Torilis ucranica	Village Udovo	Kermes oak, Dry pastures
Trifolium cinctum	Village Marvinci	Tamaris growths and sandbanks
Viola hirta (Photo 59)	Stream Javorica watershed and Usite - stream Kalica watershed	Kermes oak, Oak forests, Plane stands and belts

Act for denoting of rare tree species in forests (Official Gazette of RM, 23:1350):

Juglans regia, Ulmus Montana, Platanus orientalis, Quercus robur, Amygdalus webbii.

Relict species (Tertiary relicts):

Acer campestre, *Acer tataricum*, *Alnus glutinosa*, *Carpinus orientalis*, *Clematis vitalba*, *Coryllus avellana*, *Fraxinus ornus*, *Hedera helix*, *Lonicera etrusca*, *Phillyrea media*, *Quercus cerris* and *Salix alba*. Although these species are important as Tertiary relicts, they are not rare in Macedonia or in the area of project interest.

5.6.4. FUNGI

The criteria for selecting species were mostly empirical, as no critical amount of data required for setting strictly objective conditions existed. The choice of species was contingent upon either of the following two broad principles:

small frequency of records of a species and a obvious threat to the habitat type where the species occurs. According to the IUCN categorisation (IUCN 1994), all the species included belong to the DD category (Data Deficient) because of the lack of information on their distribution and population status for making direct or indirect assessment as to the risk of their extinction. In selecting the species to be entered in the list, preference was given to those which might be used as qualitative and quantitative indicators of pristine areas demanding protection. Special attention was also given to the species included in the European Red List (ERL)(Ing 1993).

Proposed fungal species from E5 highway corridor for different status of protection

Species	MK	IUCN	ERL
1. *Agaricus macrosporus (Moll. & J.Schaef.) Pil.*	EN		
2. *Amanita caesarea (Scop.: Fr.) Pers.*	EN	LR	
3. *Amanita vitadinii (Moretti) Vittad*	LR	LR	
4. *Antrodia juniperina (Murril) Niemelä et Ryv.*	VU		
5. *Astraeus hugrometricus (Pers.: Pers.) Morgan*	LR	VU	C
6. *Battarea phalloides (Dicks.) : Pers.*	LR	EN	D
7. *Boletus fechtneri Velen.*	EN		D
8. *Boletus satanas Lenz*	EN	VU	A
9. *Clathrus ruber Mich.: Pers*	LR		
10. *Dichomitus albidofuscus (Domanski) Domanski*	LR		
11. *Gloeoporus dichrous (Fr.) Bres.*	LR		
12. *Hygrophorus marzuolus (Fr.) Bres.*	EN		D
13. *Hyphoderma pallidum (Bres.) Donk*	LR		
14. *Inonotus tamaricis (Pat.) Maire*	VU		
15. *Langermania gigantea (Batsch.) Rostk*	LR		
16. *Lindtneria leucobryophila (P.Henn.) Jülich*	LR		
17. *Macrolepiota procera (Scop.: Fr.) Sing.*	EN		
18. *Mycoaciella bispora (Stalp.) Erikss.et Ryv.*	LR		
19. *Myriostoma coliforme (With.: Pers.) Corda*	LR	VU	B
20. *Peniophora junipericola J.Erikss.*	VU		
21. *Peniophora tamaricicola Boidin*	VU		
22. *Phellinus rimosus (Berk.) Pilat*	LR		
23. *Phellinus robustus (P.Karst.) Bourd.et Galz.*	VU		
24. *Poronia punctata Fr.*	LR		B
25. *Porostereum spadiceum (Boidin) Ryv.*	LR		B
26. *Pyrofomes demidoffii (Lev.) Kotl.et Pouz.*	VU		
27. *Steccherinum litschaueri Berk.& Kurt.*	LR		
28. *Tulostoma brumale Pers.: Pers.*	LR	LR	C
29. *Volvariella bombycina (Sch.: Fr.) Singer*	LR	LR	C
30. *Vuilleminia macrospora (Bres.) Hjortst.*	LR		

According to IUCN:

LR - Lower Risk (rare, tending to be endangered in the future);
VU - Vulnerable;
EN - Endangered

For the species included in the ERL (European red list) are used the following categories:

A - Species that need maximum intensity protection

B - Endangered species on large area, permanent number decreasing is evident, the species need intensive protection
C - Medium level of protection
D - Locally endangered species

5.6.5. INVERTEBRATES

5.6.6. NON-INSECTS

Among the invertebrates the following species should be outlined as rare and with southern range of distribution: *Scolopendra cingulata* and *Mesobuthus gibbosus*. These species were registered in the pseudomaquis.

5.6.7. INSECTS

A total number of eight insect species present in the highway corridor are listed in the European conventions and directives for protection of species and ecological networks (Bern Convention, Habitat Directive and Emerald Network). These species belong to three groups of insects: butterflies (Lepidoptera), beetles (Coleoptera) and dragonflies (Odonata). All insects are listed in the Habitat Directive. Only *Lucanus cervus* is included in all three conventions/networks for protection (Tab. 15).

Overview of insect species included in international conventions

Species	Bern	Habitats directive	Emerald
Maculinea arion (butterflies)	II	IV	
Parnassius mnemosyne (butterflies)	II	IV	
Zerynthia polyxena (butterflies)	II	IV	
Lucanus cervus (beetles)	II III	II	II
Cerambyx cerdo (beetles)	II	II	
Morimus funereus (beetles)		II	
Cordulegaster heros (dragonflies)		II IV	
Lindenia tetraphylla (dragonflies)	II	II IV	

Besides the species that are internationally important, there are species with particular national importance. Some of these species are rare or represent endemics.

Insects are one of the least-studied groups in Macedonia so the discussion of the important species is based only on terrain investigations.

Reticulitermes lucifugus (Photo 62) is one of the two known species of termites on the Balkan Peninsula. Colonies of this species were found in the locality "Markova Cheshma" and the Plane belt along Petrushka River. Although it was recorded in two localities it can be presumed that it is common species in the lower parts (Vardar gorge) of the highway corridor.

There are several subendemic subspecies of ground beetles (Photo 61): *Carabus preslii jonicus*, *Carabus graecus thessalonicensis* and *Carabus coriaceus emgei*. These species are common in the pseudomaquis, oak forests and other secondary habitats.

Photo 59. Viola hirta – rare species

Photo 60. Iris reichenbacii – subendemic species

Photo 61. Ground beetle Carabus convexus dilatatus

Photo 62. Termite – Reticulitermes lucifugus

Daily butterflies *Artogeia balcana* and *Lycaena candens* are Balkan endemics. *Polygonia egea*, *Pseudochazara anthelea*, *Gonepteryx farinosa* are very sporadic and rare. In Macedonia *Pontia chloridice* is registered only in Demir Kapija and Gevgelija region.

Poecilimon macedonicus is endemic orthopteroid species with similar distribution as previous species. *Ancistrura nigrovittata* is an endemic species inhabiting the wide region of Balkan Peninsula. *Saga natoliae* as attractive species can be noticed, too.

Endemic species of butterflies is *Octogyna parasita*.

There are many species of Plecoptera of bigger importance for biodiversity protection. The following species are endemic: *Brachyptera graeca*, *Taeniopteryx stankovici*, *Capnioneus balcanica macedonica*, *Isoperla oxylepis balcanica*, *I. submontana*, *Brachyptera macedonica*. Rare species of Plecoptera are: *Nemoura marginata* and *Perlodes dispar*. Most of them are living in the tributaries of the river Vardar.

5.6.8. AMPHIBIANS

There are two Emerald species (*Bombina variegata* and *Titurus carnifex*) found in the highway corridor (Tab. 16). Seven species are included on the Annex IV of the Directive 92/43/EEC of the European Council (species in need of strict protection). Additionally, the Balkan Stream Frog *Rana graeca* has limited distribution on the Balkan Peninsula (Balkan endemite).

Amphibians in the highway corridor according to evaluation criteria

		Pseudomaquis	Oak forests	Beech forest	Plane stands and belts	Willow belts	Tamarisk growths and sandbanks	Dry pastures	Cliffs and rocky areas	Rivers	Streams	Broadleaved stands	Conifer stands	Abandoned agricultural land	Fields and acres	Gardens	Orchards	Vineyards	Urban settlements	Rural settlements
Bern Convention	annex II	1	2	2	4	4	2	1	1	4	3	1	0	1	2	2	2	2	1	3
	annex III	2	3	3	5	5	4	1	2	5	5	1	0	0	1	3	1	2	3	4
Habitats directive	annex II	0	0	0	1	1	0	0	0	2	1	0	0	0	0	0	0	0	0	1
	annex IV	1	3	3	5	5	3	2	2	5	4	1	0	1	2	3	2	3	2	4
	annex V	0	0	0	2	1	1	0	0	1	1	0	0	0	0	0	0	0	1	1
Emerald Network	included	0	0	0	1	1	0	0	0	2	1	0	0	0	0	0	0	0	0	1

5.6.9. REPTILES

In the highway corridor there are three species (Tab. 17) considered as globally threatened - The Greek Tortoise *Testudo graeca* is classified as vulnerable, and two more (*Testudo hermanni*, *Emys orbicularis*, categorised as "Lower risk/near threatened" (according to the 1994 IUCN criteria). Six species are included in the Emerald Network, and as much as 21 (from total number of 25) are listed in the Annex IV of the Directive 92/43/EEC of the European Council (species in need of strict protection).

Reptiles in the highway corridor according to evaluation criteria

		Pseudomaquis	Oak forests	Beech forest	Plane stands and belts	Willow belts	Tamarisk growths and sandbanks	Dry pastures	Cliffs and rocky areas	Rivers	Streams	Broadleaved stands	Conifer stands	Abandoned agricultural land	Fields and acres	Gardens	Orchards	Vineyards	Urban settlements	Rural settlements
Bern Conven-tion	annex II	14	11	7	8	6	9	13	10	3	3	11	4	12	10	10	5	9	5	8
	annex III	4	3	1	4	2	3	2	2	1	1	3	1	2	3	4	3	2	2	3
Habitats directive	annex II	4	4	2	2	2	3	4	2	2	2	4	1	4	3	3	2	3	0	1
	annex IV	16	12	7	9	6	11	14	11	3	3	12	5	13	11	11	6	10	5	9
2006 Global IUCN Red List Category	LR/nt	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0
	VU	1	1	1	0	0	1	1	0	0	0	1	0	1	1	1	1	1	0	0
Emerald Network	included	4	4	2	2	2	3	4	2	2	2	4	1	4	3	3	2	3	0	1

5.6.10. BIRDS

As Vardar valley is important migratory route, many bird species can be found in the highway corridor.

Bird species in the highway corridor according to evaluation criteria

		Pseudomaquis	Oak forests	Beech forest	Plane stands and belts	Willow belts	sandbanks	Dry pastures	Cliffs and rocky areas	Rivers	Streams	Broadleaved stands	Conifer stands	agricultural land	Fields and acres	Gardens	Orchards	Vineyards	Urban settlements	Rural settlements
BiE2 SPEC category	1	2	0	0	0	0	0	2	1	0	0	0	0	2	2	0	0	0	0	1
	2	15	13	3	5	3	9	2	4	2	2	3	2	3	3	3	4	3	4	3
	3	27	7	1	8	12	18	18	13	14	0	3	5	19	22	11	9	10	14	11
	non-SPEC^E	25	24	10	16	17	18	5	2	3	0	16	16	5	5	5	14	16	16	12
	non-SPEC^{E}W	2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	non-SPEC	25	20	14	17	27	29	7	10	17	5	16	17	10	12	8	13	15	20	19
BiE2 European Threat Status	EN	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	VU	2	0	0	0	0	2	1	1	0	0	0	0	1	1	0	0	0	0	0
	(VU)	4	1	0	1	2	1	0	1	0	0	0	0	1	1	0	0	0	0	0
	D	7	5	2	5	5	6	4	3	0	0	3	3	5	5	4	5	6	4	3
	(D)	10	5	0	3	2	6	8	3	6	0	0	1	6	8	6	4	3	6	4
	R	2	0	0	0	0	0	1	2	1	1	0	0	1	1	0	0	0	0	0
	(R)	2	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
	H	4	1	0	1	3	4	2	2	6	1	1	1	2	3	2	1	1	4	3
	(H)	11	7	2	3	3	8	5	4	3	0	2	2	7	7	2	3	3	5	4
	(S)	16	12	1	7	10	14	4	7	5	0	7	6	6	7	3	5	7	10	7
	S	36	34	23	26	34	33	8	5	16	5	25	27	9	10	10	22	24	26	24
Birds	I	27	13	2	4	14	9	6	11	17	3	3	2	6	10	0	5	2	5	4

Directive	II/1	2	0	1	2	1	1	2	1	9	0	0	1	3	3	1	1	2	1	1
	II/2	9	7	3	7	7	11	8	1	4	0	4	6	9	9	7	7	10	8	8
	III/1	1	0	1	1	1	1	2	0	1	0	0	1	2	2	0	1	1	0	0
	III/2	0	0	0	1	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0
Bern Convention	II	77	54	22	32	46	54	20	25	22	6	31	30	21	26	14	27	25	40	30
	III	14	11	4	9	9	16	9	3	15	1	6	6	12	12	8	8	12	9	9
Emerald Network	Incl.	26	12	2	4	14	10	7	11	18	3	3	2	7	11	0	5	2	5	4
Bonn Convention	I	2	0	0	0	0	0	2	1	0	0	0	0	2	2	0	0	0	1	0
	II	54	28	10	18	32	32	12	15	24	2	16	19	12	16	9	14	16	15	12
AEWA	Incl.	0	0	0	0	4	8	0	1	21	2	0	0	0	0	0	0	0	1	1
European IUCN Red List Category	EN	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	VU	6	1	0	1	2	3	1	2	0	0	0	0	2	2	0	0	0	0	0
2006 Global IUCN Red List Category	VU	2	0	0	0	0	0	2	1	0	0	0	0	2	2	0	0	0	0	1

There is presence of two globally threatened species (*Falco naumanni*, *Aquila heliaca*, IUCN, the same species are included in the Annex I (Species threatened by extinction) of the convention on Migratory species), and many species (up to 24) with population concentrated in Europe and with unfavourable conservation status. In total, 52 species are listed in the Annex I of the Council Directive 79/409/EEC ("Birds Directive") - species of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution (Tab. 18). There is also very high number of bird species (54) included in the Emerald Network. In addition, there are several species that are very rare in Macedonia (e.g., *Neophron percnopterus*, expecting uplifting to "endangered" according to IUCN criteria (Globally threatened species), *Plegadis falcinellus*, *Hieraaetus pennatus*, *Milvus migrans*, *Gyps fulvus*, *Falco biarmicus*, *Cerchotrichas galactotes* and few other).

5.6.11. MAMMALS

There are 53 mammal species that can be found in the highway corridor area. Thirty four of them are included in European conventions and directives for protection of species and ecological networks.

Photo 63. Bat colony (Myotis sp.) in Bela Voda cave

For the purposes of the project, we applied the following conventions and directives: Convention on Migratory Species - Bonn Convention (Annex II); Convention on the Conservation of European Wildlife and Natural Habitats - Bern Convention (Annexes II and III); Habitats Directive (Annexes II, IV and V) and Emerald Network (Annex II). The mammal species presented in Tab. 19 belong to five orders: Insectivora, Lagomorpha, Rodentia, Carnivora and Chiroptera. Most of the species are representatives of the order Chiroptera (20) from which 11 species are included in all of the categories for protection (Photo 63). It is important to mention that Bonn Convention comprises only bat species. This is because bats are migratory animals and are protected with the Convention on Migratory Species.

European ground squirrel (*Spermophilus citellus*), wolf (*Canis lupus*) and brown bear (*Ursus arcots*) belong to the three of the conventions above. Brown bear is a prioity species listed in the Habitat Directive.

Mammal species in the highway corridor according to different status of protection

Species	Bonn	Bern	Habitat Directive	Emerald
1. *Neomys anomalus*		III		
2. *Crocidura suaveolens*		III		
3. *Crocidura leucodon*		III		
4. *Lepus europeus*		III		

5. *Sciurus vulgaris*		III		
6. *Spermophilus citellus*		II	II IV	Yes
7. *Canis aureus*			V	
8. *Canis lupus*		II	II IV	Yes
9. *Ursus arctos*		II	*II IV	Yes
10. *Mustela nivalis*		III		
11. *Mustela putorius*			V	
12. *Martes foina*		III		
13. *Meles meles*		III		
14. *Felis sylvestris*		II	IV	
15. *Eptesicus seroticus*	II	II	IV	
16. *Myotis myotis*	II	II	II IV	Yes
17. *Myotis blythi*	II	II	II IV	Yes
18. *Myotis capaccinii*	II	II	II IV	Yes
19. *Myotis emarginatus*	II	II	II IV	Yes
20. *Myotis mystacinus*	II	II	IV	
21. *Pipistrellus pipistrellus*	II	III	IV	
22. *Pipistrellus nathusii*	II	II	IV	
23. *Pipistrellus kuhli*	II	II	IV	
24. *Pipistrellus savii*	II	II	IV	
25. *Rhinolophus ferrumequinum*	II	II	II IV	Yes
26. *Rhinolophus hipposideros*	II	II	II IV	Yes
27. *Rhinolophus euryale*	II	II	II IV	Yes
28. *Rhinolophus blasii*	II	II	II IV	Yes
29. *Rhinolophus mehellyi*	II	II	II IV	Yes
30. *Barbastella barbastellus*	II	II	II IV	Yes
31. *Plecotus austriacus*	II	II	IV	
32. *Nyctalus noctula*	II	II	IV	
33. *Miniopterus schreibersi*	II	II	II IV	Yes
34. *Tadarida teniotis*	II	II	IV	

5.6.12. BIOCORRIDORS

Apart from intrinsic value of particular habitats described above in this chapter, many natural and seminatural habitats (including some parts of habitats not mentioned above) have additional importance due to their function as biocorridors. Their function as biocorridors results from the fact that they enable various daily, periodical or seasonal movements and migrations of different animals or dispersal of plants. The most important roles of biocorridors in the area of project interest are:

- connection of Kozhuf Mt. higher parts to Vardar valley (drinking water, food availability) and to a lesser degree connection of Serta Mt. with Vardar
- bird migrating route along the river Vardar.

The most important biocorridors along both alternative alignments

Alternative 1	Alternative 2

Biocorridors	Position along the alignments	Biocorridors	Position along the alignments
The whole length of the river Vardar with its Plane and Willow belts	km 0+800 - km 32+800	Small parts of river Vardar	km 0+800
Chelevechka Reka	km 1+600	Chelevechka Reka	km 1+600
Ravine at Kavakba	km 3+100	Starata Reka	km 5+700
Kosharachka Reka	km 6+200	Strkovski Dol	km 6+900
Lutkova Reka	km 8+700	Kofilski Dol (Golema Javorica)	km 9+700
Ravine at Ilovski Chukar	km 10+800	Lipovski Dol (Golema Javorica)	km 9+500
Vodosir	km 12+100	Linski Dol (Golema Javorica)	km 9+200
Gradeshka Reka	km 14+000	Garvanski Dol (Mala Javorica)	km 11+800
Mushtenica	km 15+100	Dragovski Dol (Mala Javorica)	km 11+500
Arazliska Reka	km 17+500	Left tributaries of Kalica stream	km 19+000 km 19+300, km19+700
		Ravine at Golemo Brdo	km 20+800

Biocorridors are especially important for normal life cycle for many animals:

- Amphibians - migrations during reproduction to spawning areas (Common toad, Green toad)
- Brown bear - movements for searching food from Kozhuf to Vardar valley; Brown bear is extremely rare in this area (see Chapters V.1.2. and V.1.3.) and these corridors are very important for maintaining its small population (connected to Greek population); bear is not present on the left side of Vardar.
- Gray wolf - movements for searching pray
- Ungulates, particularly Roe dear - movements and seasonal migration for grazing
- Small mammals - periodical and seasonal movements.

The most important parts of the highway corridor that can play the role as biocorridors are presented in Tab. 20.

6. ANTHROPOGENIC ENVIRONMENT

The need for further upgrading of traffic direction Skopje–Gevgelija on the highway level is in correlation with physical planning documentation for the territory of the Republic of Macedonia and the European integration development courses.

In that sense, the motor road passing through the river Vardar valley, as special development axis, has to acquire technical characteristics of a highway. The sections from Kumanovo to Skopje, Skopje – Veles, Veles – Gradsko, Gradsko - Demir Kapija, and Smokvica – Greek Border have been upgraded at the highway rank during the construction phases up to now. The section Serbian Border – Kumanovo is under construction at this moment. The section from Demir Kapija to Smokvica is in the stage of preparing of the detailed study and analysis of the area in order to establish the most suitable route of the future road.

In this chapter the socio-geographic and the economic-geographic characteristics along the existing motor road line and on the new proposed alternative have been considered.

The basic geographic data about the area where the existing motor road is passing are given in Chapter II. From the administrative point of view, the road corridor is spread through several municipalities (Demir Kapija, Valandovo and Gevgelija). It is passing through territories of 11 settlements (Demir Kapija, Chelevec, Klisura, Gradec, Udovo, Josifovo, Marvinci, Miletkovo and Smokvica, and it concerns directly the villages Davidovo and Miravci). All the mentioned settlements are situated on a different distance from the road, which is anyway not bigger than 5 km. It means that this distance is quite suitable for socio-geographic and economic-geographic characteristics of the future highway corridor to be foreseen. Thus, the results and data that will be obtained will be quite relevant.

For that purpose, direct observation of the area was performed and relevant statistical and questionnaire data were collected for all above mentioned populated places along the projected highway. The presentation of the data on the level of settlement (i.e. populated place) district is a special quality in the process of analysis and synthesis of the socio-geographic and economic-geographic condition in the area.

6.1. BASIC CHARACTERISTICS OF THE POPULATION

The study of particular elements of the human population is essential in order to characterise the basic functions of the given area. In order to analyse the socio-geographic and economic-geographic aspects of the area along the alternatives route of the projected highway direction Demir Kapija–Smokvica, the state of the population number, population and households dynamics, sex and age structure, and the population by its activity were considered as a basic parameters. The study was performed on the basis of settlements (populated places).

The area is characterized by relatively low population density; the population is generating revenues mainly in the primary (production) sector, using own agricultural parcels. The fragmentation of the agricultural parcels prevents use of the agricultural machinery and therefore increase of the soil productivity is limited whatever melioration techniques are applied.

The qualification structure is inappropriate, while the compulsory education is most common level obtained; the age and gender structure is stable. Migrations are low, but daily travelling from home to the working place and migrations between local villages is frequent, due to jobs of local population living in villages created in section Demir Kapija - Smokvica.

6.1.1. THE NUMBER AND DYNAMICS OF THE POPULATION AND THE HOUSEHOLDS

It is well known that natural and social conditions are the basic factors that influence the dynamics of the population and households in general, and in that sense in the settlements along the highway corridor Demir Kapija–Smokvica. As it was mentioned, the road corridor passes through the territory of 11 (or 13) populated places. These settlements are of a dense type. Concerning their functions, 10 are village settlements; one is town- Demir Kapija. Similarly to the rest of the Macedonian territory, a certain demographic peculiarities, as well as changes and the population and households' dynamics are characteristic for the area of the road corridor under study.

The review of the population and households in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventories in 1961, 1994 and 2002, population density and family number

Settlement	Area (ha)	Population			Population density			Households			Family number		
		1961	1994	2002	1961	1994	2002	1961	1994	2002	1961	1994	2002
Demir Kapija	3.780	1907	3249	3275	504	859	866	427	897	992	4.5	3.8	No data available
Chelevec	12.077	44	49	52	4	4	4	6	12	9	7.3	4.1	
Klisura	46.216	384	-	3	8	-	6490	72	-	1	5.3	-	
Gradec	with Udovo	558	-	-	5	-	-	127	-	-	4.4	-	
Udovo	112.230	287	886	851	-	-	44	58	227	260	4.9	3.9	
Josifovo	18.983	951	1721	1730	50	91	91	200	435	483	4.7	3.9	
Marvinci	7.638	379	519	504	50	68	66	79	137	151	4.8	3.8	
Davidovo	25.266	378	364	373	15	14	15	75	108	112	5.0	3.4	
Miravci	28.852	1438	1667	1647	50	58	57	317	484	528	4.5	3.4	

Miletkovo	6.470	128	122	117	20	19	18	23	41	44	5.6	3.0	
Smokvica	24.385	523	326	263	21	13	10	117	94	85	7.0	3.5	
TOTAL	**285.897**	**6977**	**8903**	**8815**	**727**	**1126**	**7661**	**1501**	**2435**	**2665**	**58**	**32.8**	

The total territory of the populated places along the road corridor is 285.8 km^2. 6,977 inhabitants were living in this area in 1961, in 1994 the population number increased to 8,903, what equals to 27.6% (note: villages Gradec and Klisura have had phenomenon demographic havoc - without their population, the population increase is 47.5% in 1994). In 2002 the number of inhabitants is 8,815. If settlements are analysed separately, than the settlements in the hilly region, i.e. at the gorge part of the road corridor, are characterised by considerably much smaller in number, which is in correlation to the general trend in the Republic of Macedonia. Unlike to this, the villages to the south of Udovo village, i.e. the settlements in the flat region, are characterised by an increase of the population. Consequently, further demographic strengthening in that area may be expected in the future.

The population density in the road corridor as a whole (which in 1994 and 2002 is almost the same as the population density on the level of the Republic of Macedonia) confirms the former statements.

Something more specific is an increasing trend of the households' number (an increase of 62.2% in 1994). The reason for this is the breakdown of former more numerous, traditional (patriarchal) families. This is a characteristic for all populated places, what can be seen from the data for the number of household members. This number decreases on average for one member during the period from 1961 to 1994. Never the less, the number of members in households, as working units, does not have a special reflection, from the economic point of view, due to the presence of contemporary mechanisation.

Total population, households and dwellings in the settlements along the highway corridor Demir Kapija–Smokvica, according to the population inventory in 2002

Settlement	Total population	Number of households	Number of dwellings (all types of living quarters)
Demir Kapija	3275	992	1139
Chelevec	52	9	9
Klisura	3	1	19
Gradec	-	-	5
Udovo	851	260	352
Josifovo	1730	483	509
Marvinci	504	151	140
Davidovo	373	112	147
Miravci	1647	528	609
Miletkovo	117	44	39

Smokvica	263	85	113
TOTAL	8815	2665	3081

6.1.2. THE POPULATION ACCORDING SEX IN THE POPULATION INVENTORIES 1961, 1994 AND 2002

The sex structure of the population represents a special demographic structure that is very important for studying other demographic characteristics and particularly for estimation of the vitality of population in a certain area. These data, from the population inventories in 1961, 1994 and 2002, are presented on the basis of populated places in Tab. 23.

The population according sex in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventories in 1961, 1994 and 2002

Settlements	Population (sex) in 1961			Population (sex) in 1994			Population (sex) in 2002		
	total	male	female	total	male	female	total	male	female
Demir Kapija	1907	971	936	3249	1654	1595	3275	1671	1604
Chelevec	44	24	20	49	25	24	52	25	27
Klisura	384	192	192	-	-	-	3	2	1
Gradec	558	267	291	-	-	-	-	-	-
Udovo	287	142	145	886	475	411	851	457	394
Josifovo	951	498	453	1721	900	821	1730	902	828
Marvinci	379	206	173	519	278	241	504	262	242
Davidovo	378	191	187	364	190	174	373	189	184
Miravci	1438	747	691	1667	842	825	1647	837	810
Miletkovo	128	68	60	122	66	56	117	60	57
Smokvica	523	264	259	326	163	163	263	137	126
TOTAL	6977	3570	3407	8903	4593	4310	8815	4542	4273

Analysis of the data shows that the male population is dominating in almost all population inventories. In 1961 the male and female population is more equal, probably due to the World War Two, compared to 1994 and 2002. The higher number of the male population is due to the traditional reasons.

Anyway, it can be said that sex structure of the population corresponds to the rest of the demographic characteristics, excluding settlements Chelevec, Klisura and Gradec, where so called demographic havoc is present.

6.1.3. THE AGE STRUCTURE OF THE POPULATION

Age structure of the population is another demographic component, which characterises the vitality of the population, the proportion of the working part of the population and the process of sustaining the settlements as functional centres for living. Thus, the description of the population age structure on a settlement basis is presented in the following text.

According to the presented data, similarly to the other demographic characteristics previously described, one can conclude that the population from the 15-64 years age class is predominating (about 70%), than the age class 0-14 years is following (about 20%) and the rest is on the age above 65 (10%). This proportion, with some exclusion, is also present if one analyse the populated places separately. According to that, one can conclude that this proportion among the age classes is relatively good. This implies that the populated places in the projected highway corridor are demographically vital and with good possibilities for further existence and development.

The population according age structure in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventory in 1994 and 2002

Settlement	Total (1994)	Age classes (years)			Total (2002)	Age classes (years)		
		0-14	15-64	over 65		0-14	15-64	over 65
Demir Kapija	3249	667	2275	307	3275	529	2338	408
Chelevec	49	23	24	2	52	18	33	1
Klisura	-	-	-	-	3	-	1	2
Gradec	-	-	-	-	-	-	-	-
Udovo	886	202	618	66	851	127	599	125
Josifovo	1721	420	1166	135	1730	326	1222	182
Marvinci	519	131	337	51	504	111	348	45
Davidovo	364	66	256	42	373	57	250	66
Miravci	1667	358	1128	181	1647	281	1134	232
Miletkovo	122	20	87	15	117	26	73	18
Smokvica	326	64	194	68	263	36	140	87
TOTAL	8903	1951	6085	867	8815	1511	6138	1166

The population according age structure in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventory in 2002

Settlement	**Total population**	**Age classes (years)-Male**			**Age classes (years)-Female**		
		0-14	**15-64**	**over 65**	**0-14**	**15-64**	**over 65**
Demir Kapija	3275	277	1212	182	252	1126	226
Chelevec	52	7	18	-	11	15	1
Klisura	3	-	1	1	-	-	1
Gradec	-	-	-	-	-	-	-
Udovo	851	74	318	65	53	281	60
Josifovo	1730	187	637	78	139	585	104
Marvinci	504	52	190	20	59	158	25
Davidovo	373	29	128	32	28	122	34

Miravci	1647	135	594	108	146	540	124
Miletkovo	117	11	40	9	15	33	9
Smokvica	263	17	76	44	19	64	43
TOTAL	8815	789	3214	539	722	2924	627

6.1.4. THE LITERACY AND EDUCATION OF THE POPULATION

The educational structure of the population along the projected E5 road corridor Demir Kapija–Smokvica is another demographic component through which the promoting of social, cultural and economic aspects of the populated places development can be assessed.

The population according literacy and education in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventory in 1994

Settlements	Population above 10 years of age	Illite-rate	Without school preparation or incomplete elementary school	Elemen-tary school	Secon-dary school	High schoo l	Un-know n
Demir Kapija	2815	466	938	671	824	126	23
Chelevec	32	12	25	1	-	-	-
Klisura	-	-	-	-	-	-	-
Gradec	-	-	-	-	-	-	-
Udovo	765	17	195	258	211	18	2
Josifovo	1446	82	527	418	313	37	6
Marvinci	433	20	199	133	47	8	1
Davidovo	317	7	118	106	59	11	4
Miravci	1435	32	408	524	343	34	-
Miletkovo	107	4	47	34	20	1	-
Smokvica	278	4	110	99	40	12	1
TOTAL	7628	644	2567	2244	1857	247	37

Total population at 5 years of age and over, according to the age and educational attainment in the municipalities along the highway corridor Demir Kapija–Smokvica, according to the population inventory in 2002

Municipality	Total population at 5 years of age and more	Visiting					Without education
		Primary educatio n	Upper seconda ry educatio n	Higher educatio n	Faculty, Academ y	Postgrad uate studies	
Demir Kapija	4322	430	212	5	109	3	3563

Valandovo	11298	1321	661	16	364	17	8919
Miravci (former municipality)	2517	262	128	2	37	-	2088
TOTAL	18137	2013	1001	23	510	20	14570

Note: Municipality Demir Kapija, besides other settlements, comprehends city of Demir Kapija and villages Klisura, Chelevec and Gradec.
Municipality Valandovo, besides other settlements, comprehends villages Udovo, Josifovo and Marvinci.
Municipality Miravci comprehends, besides other settlements, villages Miravci, Miletkovo, Davidovo and Smokvica

Educational structure of the population in 1994 is presented in the Tab. 26 and the educational structure of the population in the road corridor spread through several counties (municipalities) in 2002 is presented in Tab. 26.

It can be seen from the presented data in the Tab. 27 that in all settlements along the road corridor 7,628 inhabitants are on the age above 10, which represent 86.5% of the total population. In this number, about 644 persons are totally unlettered, what represent a relatively high percentage – about 8%. The main reason for this situation is because of about 500 persons from Demir Kapija settlement where mental hospital is situated. The number of the illiterate persons in the other settlements is in the frame of the situation in educational process through which the population was transitioning, i.e. these are older persons who were not able to undergo the education in their youth. In this context the persons without school education or with incomplete education can be mentioned. But, the data in the Tab. 27 (both total and on the settlement basis) show that the number of people with elementary education make 29%, persons with secondary education are represented with about 24%, and persons with high education are 3,2% from the total population above 10 years of age. This implies that the number of the people who are educating is relatively high. Of course, persons with high education and graduates are mainly from the town, but, in correlation with the total population in the settlements, their number is relatively high. This means that the educational component of the population is quite good what enables future socio-economic, cultural and functional prosperity of the population and the settlements along the highway corridor.

6.1.5. SOCIO-ECONOMIC STRUCTURE OF THE POPULATION

The analysis of the population according to the activity is an important component in demographic studies, because through the number of the active, subsisted and the persons with personal income the socio-economic structure of the particular population can be estimated. In that context, the data for this demographic element in the settlements along the Demir Kapija–Smokvica highway corridor have been elaborated (Tab. 28 and 29).

It can be seen in the Tab. 28 that the subsisted persons are the most numerous (48%), than active population (about 40%) and people with personal income make 12%. It means that, from the demographic point of view, favourable conditions for engaging of the working population in different economy branches are presented, and especially in agriculture, which in this area has very high economic values.

The situation in the separate settlements is similar, excluding Demir Kapija and village Chelevec. The number of persons with personal income is somewhat higher in Demir Kapija due to the presence of the mental hospital in Demir Kapija, since many of the patients in the hospital have personal income (state social participation).

There is a column in the Tab. 28 representing the agricultural population as well. It can be seen there that the population in the village settlements is mainly occupied by agricultural activity. But, according to the statistical data, a part of the population is occupied in other activities, which means that there are people who are earning their incomes from other economy branches.

The population according activity in the populated places along the highway corridor Demir Kapija–Gevgelija according to the population inventory in 1994

Settlements	Active persons	Persons with income	Subsisted persons	Total	Agricultural population
Demir Kapija	1274	402	1572	3248	173
Chelevec	14	1	34	49	11
Klisura	-	-	-	-	-
Gradec	-	-	-	-	-
Udovo	387	113	382	882	160
Josifovo	874	174	672	1720	713
Marvinci	227	66	226	519	257
Davidovo	142	58	164	364	8
Miravci	674	277	715	1667	105
Miletkovo	52	18	52	122	37
Smokvica	82	95	149	326	20
TOTAL	3726	1204	3966	8897	1484

Total population at 15 years of age and over, according to the activity; persons that are performing an activity, according to the occupation in the populated places along the highway corridor Demir Kapija–Smokvica according to the population inventory in 2002

Settlement	Total	Economically active			Economically non active	Skilled agricultural and fishery workers
		All	Persons that are performing an activity	Persons that are not performing an activity		

Demir Kapija	2745	1398	875	523	1347	15
Chelevec	34	10	3	3	24	1
Klisura	3	2	2	2	1	2
Gradec	-	-	-	-	-	-
Udovo	724	353	213	140	371	4
Josifovo	1394	728	419	309	666	27
Marvinci	393	247	90	157	146	33
Davidovo	316	182	144	38	134	27
Miravci	1363	695	522	173	668	40
Miletkovo	91	39	26	13	52	-
Smokvica	227	90	73	17	137	16
TOTAL	7290	3744	2367	1375	3546	165,00

6.2. BASIC ECONOMIC-GEOGRAPHIC CHARACTERISTICS

Due to the favourable climatic conditions (modified Mediterranean climate), favourable pedological and hydrographical conditions, the agriculture with all of its branches, is the most important in the economical development in the area along the projected road corridor E-5 from Demir Kapija to Smokvica. The truck farming, crop growing and production of industrial cultures as well as viticulture should be emphasised as the most characteristic ones.

6.2.1. BASIC CHARACTERISTICS OF AGRICULTURE

Taking into consideration the development of economy in the area along the projected road corridor E-5 from Demir Kapija to Smokvica, the agriculture may be noticed as the basic economic activity for the population of the rural settlements. The land funds and its structure by cadastre cultures and by the land-property are presented in Tab. 30.

The data presented in the Tab. 30 shows many important compounds in the scope of the agricultural organisation.

According the land-property 90% belong to the public sector and only 10% are private property from the total surface of 305.6 km^2. The comparison of the arable land shows different relation: 64.1% of this land is private property. This characteristic is valid for the cultivated cultures: 67.8% of the acres are private property, 72% of the gardens, 70% of the orchards, and 86.7% of the meadows. The private sector has about 48% of the vineyards, which means less than the public sector.

The same conclusions may be applied by different settlements with the exception of some settlements where the public sector is represented by plantations for green-house production as in the example of the vineyards of the villages Josifovo, Miletkovo, etc.

The public sector owns about 96% of the pastures, meadows and non-fertile land. The same situation is observed in the different settlements. It is very characteristic that the non-fertile land covers very large surfaces in the surroundings of some villages. The most typical example is the case of village Chelevec. The consequence of the unfavourable relief structure of the area and climatic conditions is that the large part of the village area is covered by Kermes oak (*Quercus coccifera*). The future highway should be constructed in areas like this and the fertile land will be protected in the most proper way.

Taking into consideration the land use by cadastre cultures, the most important are the fields and acres, vineyards and gardens while the orchards are represented by insignificant surfaces.

As acre cultures the most frequent are the corns, especially the maize and wheat. Besides these two main cultures there are some other corn and industrial cultures. Pedological characteristics of the land, the hydrography and climate provide conditions for second culture growing in one vegetation period such as the combinations of barley, wheat and similar cultures with cabbage, potato etc.

As it was mentioned previously, the second places, by surface they cover, take vineyards because the favourable climatic conditions make viticulture very productive in the region.

Survey of the agricultural land by the cadastre cultures in the village areas along the projected road corridor E-5 from Demir Kapija to Smokvica

Settle-ment	**sector**	**acres (ha)**	**Gar-dens (ha)**	**orchards (ha)**	**vine-yards (ha)**	**Mea-dows (ha)**	**total arable land**	**pastures (ha)**	**forests (ha)**	**non-fertile land**	**total (ha)**
1	2	3	4	5	6	7	3+4+5+6+7	9	10	11	8+9+10+11
Demir Kapija	Private	70,7	1,0	1,0	14,3	0,0	87,0	1,2	0,9	14,9	104,0
	Public	29,4	1,5	0,0	0,0	0,0	30,0	75,1	24,7	143,3	273,1
	Total	100,1	2,5	1,0	14,3	0,0	117,9	76,3	25,6	158,2	378,0
Chelevec	Private	5,5	0,0	0,0	0,0	0,0	5,5	0,0	0,0	0,3	5,8
	Public	26,6	0,0	0,0	0,6	0,0	27,2	46,3	3,6	1124,8	1201,9
	Total	32,1	0,0	0,0	0,6	0,0	32,7	46,3	3,6	1125,1	1207,7
Klisura	Private	245,5	0,0	0,4	23,8	1,0	270,7	4,0	4,1	20,8	299,6
	Public	160,2	0,0	0,4	5,0	0,0	165,6	33,4	3900,6	222,4	4322,0
	Total	405,7	0,0	0,8	28,8	1,0	436,3	37,4	3904,7	243,2	4621,6
Gradec Udovo	Private	205,2	14,0	0,2	31,7	51,7	302,8	6,1	2,0	11,1	322,0
	Public	88,4	0,0	0,1	6,0	6,6	101,1	1014,7	9538,7	247,4	10901,9
	Total	293,6	14,0	0,3	37,7	58,3	403,9	1020,8	9540,7	258,5	11223,9
Josifovo	Private	214,1	27,0	5,7	81,9	0,0	328,7	2,8	0,8	14,8	347,1
	Public	181,9	0,0	2,6	296,2	0,0	480,7	388,0	475,7	206,8	1551,2
	Total	396,0	27,0	8,3	378,1	0,0	809,4	390,8	476,5	221,6	1898,3
Marvinci	Private	152,1	13,0	1,7	28,4	1,7	196,9	6,8	0,6	4,7	209,0
	Public	88,7	0,0	0,9	24,8	0,5	114,9	130,3	226,4	83,2	554,8
	Total	240,8	13,0	2,6	53,2	2,2	311,8	137,1	270,0	87,9	806,8

Settle-ment	sector	acres (ha)	Gar-dens (ha)	orchards (ha)	vine-yards (ha)	Mea-dows (ha)	total arable land	pastures (ha)	forests (ha)	non-fertile land	total (ha)
1	2	3	4	5	6	7	3+4+5+6+7	9	10	11	8+9+10+11
Pirava	Private	451,6	27,0	1,0	185,7	4,3	669,6	18,1	0,3	18,0	706,0
	Public	160,5	55,0	0,3	115,3	1,8	332,9	531,9	313,0	152,1	1329,9
	Total	612,1	82,0	1,3	301,0	6,1	1002,5	550,0	313,3	170,1	2035,9
Davidovo	Private	147,7	10,0	0,0	22,6	0,0	180,3	0,7	0,2	5,4	186,6
	Public	47,1	0,0	0,0	1,4	0,0	48,5	152,8	1956,3	182,4	2340,0
	Total	194,8	10,0	0,0	24,0	0,0	228,8	153,5	1956,5	187,8	2526,6
Miravci	Private	440,2	37,2	0,9	0,0	0,0	478,3	20,5	1,5	18,0	518,3
	Public	184,8	0,0	0,5	0,0	0,0	185,3	243,1	1706,4	166,0	2300,8
	Total	625,0	37,2	1,4	0,0	0,0	663,6	263,6	1707,9	184,0	2819,1
Miletkovo	Private	111,8	5,2	0,0	11,4	0,0	128,4	15,5	0,7	2,0	146,6
	Public	40,8	0,0	0,0	25,0	0,2	66,0	68,5	312,6	54,0	501,1
	Total	152,6	5,2	0,0	36,4	0,2	194,4	84,0	313,3	56,0	647,7
Smokvica	Private	134,7	10,5	0,7	37,3	1,2	184,4	11,9	1,2	5,6	203,1
	Public	26,6	0,0	0,0	4,6	0,1	31,3	281,4	1715,1	207,6	2235,4
	Total	161,3	10,5	0,7	41,9	1,3	215,7	293,3	1716,3	213,2	2438,5
TOTAL	Private	2179,1	144,9	11,6	437,1	59,9	2832,6	87,6	12,3	115,6	3048,1
	Public	1035,0	56,5	4,8	478,9	9,2	1583,5	2965,5	20173,1	2790,0	27512,1
	Total	3214,1	201,4	16,4	916,0	69,1	4416,1	3053,1	20185,4	2905,6	30560,2
	Private %	67,8	71,9	70,7	47,7	86,7	64,1	2,9	0,1	4,0	10,0
	Public %	32,2	28,1	29,3	52,3	13,3	35,9	97,1	99,9	96,0	90,0

There are big areas with gardens due to the climatic conditions, which is not the case in the most of the territory of the Republic of Macedonia. They have great importance in the production and effects of truck farming although they are represented on much smaller surfaces than the acres and vineyards. It is a word about the production of early vegetables in the whole period of the year. This production is much specialised with big economical effects that make it very convenient. This region (in the Gevgelija-Valandovo valley) including the area of the projected highway corridor together with the region of Strumica is the most important for the market supply in the Republic of Macedonia. Significant quantities are exported on the markets of foreign countries, as well.

The truck farming in the public sector is organised in modern green-houses, with heat systems while the individual truck farming is carried out on much smaller allotments protected by plastic cover.

Meadows are represented on 69.1 ha, and gardens 201,4 ha. That is lesser than in the other parts of the Republic of Macedonia. They are used for the production of grass cultures for the raising of cattle (mostly cows) in stables of individuals.

The presented conclusions about the agricultural land by cadastre cultures have fundamental importance in the process of planning of the new lane of the highway Demir Kapija - Smokvica. Most important suggestion is that the highway should pass through pastures, forests and sterile land, which is public property.

Special characteristic of the land is that it is fractured in allotments. The allotments are relatively small; smaller than 1 ha in the private sector which means great variety of the fertile land. The allotments in the property of the public sector are large and cover few to more than 10 ha.

Observation of the pastures and meadows revealed that the region provides favourable conditions for the development of stock breeding, especially for raising of sheep and goats in the mountain area in the surroundings of the plane agricultural regions and cattle in the plane. However, the present data (literature and questionnaires) show that the stockbreeding is decreasing as a result of:

- The mechanisation that substitutes the animals used for work
- Low market prices for the stock products
- The fact that agriculture is much productive in this region.

These conclusions are entirely valid for all of the settlements along the road corridor. The consequence is that the cattle's farming is used for satisfaction of individual needs for the stock products. It is illustrated by the questionnaires conducted in the village Udovo that has about 900 citizens. There are only two sheep flocks with 100 animals each, a half of the village possesses 1-2 goats or one cow and eventually one sumpter.

The forestry is not so important as a economy branch although there are large forested areas because the forests along the highway are characterised with wood of low quality, or, to be more precise, the most frequent tree species along the highway is the Kermes oak.

6.2.2. OTHER ECONOMIC ACTIVITIES AND BRANCHES

Agriculture is the main working occupation of the population in the section between villages Udovo and Smokvica i.e. Gevgelija-Valandovo valley, as a result of the fertile land, the existing irrigation systems and high production effects of the appropriate plant cultures. The consequence is the restriction of the industrialisation in the district i.e. town centres Gevgelija and Valandovo. So, when speaking about industry as a economical branch (in the case of the settlements along the road corridor) we mean the industrial capacities situated in the town of Gevgelija, which is not a subject of this study.

The questionnaires’ results revealed that in city of Demir Kapija are several hotel or restaurant keepers and several craftsmen in the sphere of production. The most represented crafts are related with the car, agricultural mechanisation and electrical devices repair. These crafts are well developed due to the relatively good economic standard of the population in this region. Besides these, there are hairdresser saloons, hotels and restaurants, taxi services in the bigger settlements such as Udovo, Josifovo and Miravci. There are several drugstores and some specialised stores for electric devices and house equipment, stock food, car parts etc.

The natural potential of the area provides conditions for the development of tourism as a separate economical branch. In this context, there are two archaeological sites (from III and IV century AD) important for the tourism that are situated along the highway corridor. Some of them are situated village Smokvica, and others are on the left side of the highway next to the village Marvinci in the locality Isar.

6.3. LIVESTOCK BREEDING

Data on livestock breeding were available from the last census of households (2002) for private-owned heads, and for state-owned heads from 2001. This makes assessment of the present situation more difficult. Even more, data from these years are available only for the territories of the municipalities (according to the territorial division valid in 2001 and 2002) and not for each village separately.
Tables 31 to 36 show that sheep breeding is dominant, especially among the private households. Overall, most livestock heads are in private property. They are followed by Goats (Photo 64), Cattle (Photo 65) and Pigs.

Horses in the private and state holdings in the municipalities of the highway corridor

No	**Horses**	Private (2002)	State (2001)	Total
1	Valandovo	359		359
2	Gevgelija	148		148
3	Demir Kapija	274		274
4	Miravci	155		155
TOTAL		**936**	**0**	**936**

Donkeys in the private holdings in the municipalities of the highway corridor

No	**Donkeys**	Private (2002)
1	Valandovo	615
2	Gevgelija	149
3	Demir Kapija	129
4	Miravci	209
TOTAL		**1102**

Cattle in the private and state holdings in the municipalities of the highway corridor

No	**Cattle**	Private (2002)	State (2001)	Total
1	Valandovo	1132		1132
2	Gevgelija	598		598
3	Demir Kapija	415		415
4	Miravci	209		209
TOTAL		**2354**	**0**	**2354**

Sheep in the private and state holdings in the municipalities of the highway corridor

No	**Sheep**	Private (2002)	State (2001)	Total
1	Valandovo	3497		3497
2	Gevgelija	3724	1063	4787
3	Demir Kapija	859		859
4	Miravci	1239		1239
TOTAL		**9319**	**1063**	**10382**

Goats in the private and state holdings in the municipalities of the highway corridor

No	**Goats**	Private (2002)	State (2001)	Total
1	Valandovo	1010		1010
2	Gevgelija	622		622
3	Demir Kapija	759		759
4	Miravci	327		327
TOTAL		**2718**	**0**	**2718**

Pigs in the private and state holdings in the municipalities of the highway corridor

No	**Pigs**	Private (2002)	State (2001)	Total
1	Valandovo	862	443	1305
2	Gevgelija	662	487	1149
3	Demir Kapija	232		232
4	Miravci	345		345
TOTAL		**2101**	**930**	**3031**

From the above analysis it is obvious that livestock breeding is an important economic activity in the region of the highway corridors. In many cases it is an important source of additional income for the families (there is a trend of increase of poverty in Macedonia). The goats and sheep are dominating due to the cheep food for this kind of animals (mild climate allows grazing throughout the whole year). For goats shrublands (even Juniper and Kermes oak) are important for feeding. This implies that a lot of daily migrations occur in the area around the villages (especially toward the hills). Thus, existing local roads and paths from villages toward neighbouring shrablands (especially in case of Alternative 2) have high socio-economic value (see Tab. 52 and 53).

Photo 64. Flock of goats at Petkova Niva (village Miravci)

Photo 65. Small cattle farm in the area of Golema Javorica watershed

6.4. SETTLEMENTS

Several populated places are found along the highway corridors:

Alternative 1: Demir Kapija, v. Klisura (in proximity to the corridor), v. Miravci (adjacent to the corridor), v. Miletkovo and v. Smokvica

Alternative 2: Demir Kapija, v. Klisura, v. Gradec, v. Udovo, v. Josifovo (adjacent to the corridor), v. Marvinci, v. Smokvica

Infrastructural characteristics of these settlements are described in the appropriate Chapter VI.5. In the Chapter V.5.4 they are also treated as separate habitat types. Impacts and appropriate mitigation measures are described in Chapters VIII and IX)

Demir Kapija is largest populated place along the corridor, with main preoccupation of the population in agriculture. The few people from the two almost abandoned villages, Klisura and Gradec, are preoccupied mainly with livestock breeding and agriculture accordingly, and agriculture is main preoccupation of the inhabitants of the rest of the villages.

6.5. INFRASTRUCTURAL OBJECTS

6.5.1. LINE INFRASTRUCTURE

Functional organisation of the area along the highway corridor Demir Kapija–Smokvica in great deal depends of line infrastructure. In this sense, in the frame of Gevgelija–Valandovo valley as a natural opening to south, i.e. to Thessaloniki flatland there is a developed line infrastructure represented by roads, railways, irrigation systems, power transmission systems etc.

Road line infrastructure is consisted mainly of existing motor road Demir Kapija–Gevgelija, regional road Udovo–Valandovo–Dojran with branch to Strumica and Gevgelija–Bogdanci–Dojran, as well as numerous local roads. More precisely, in settlements along the designed road corridor the most important are local roads that connect them with the highway and with the urban centres Gevgelija, Valandovo and wider with rest of the country. It was realized from the field investigations that all settlements, with exemption of villages Chelevec and Klisura, are connected with asphalt roads what enables fast and easy communications with area around them. This means that in circumstances of construction of the highway, maintaining of existing functionality of the traffic system has to be an important objective in order to preserve the effectiveness and functioning of the highway. For that purpose some gate/exit roads and numerous objects on the road for common use of local populations and travellers, are to be built.

The next important traffic object is railway which in explored corridor has almost parallel direction in the section Demir Kapija–Smokvica, nevertheless from Demir Kapija to village Miletkovo it is going from right side of river Vardar. In its way, almost a half of the explored settlements are directly associated with railway stations.

Particular importance in the line infrastructure has the Irrigation systems from which the main occupation of inhabitants i.e. agriculture production directly depends. For that aim, besides direct use of the river Vardar water and its tributaries, special systems for irrigation purposes are built. They are of open channel types and they are used for irrigation of parcels that are most distant from Vardar Riverbed. In the frame of water line infrastructure there is the system for transfer of hydrothermal energy which is used for heating of the green-houses in the village Negorci. This system is transferring thermal water from village Smokvica close to Vardar, to the green-houses near village Negorci. Water infrastructure is consisted of objects for water supply, as well. They are different, depending of the topographic location of settlements. In villages located lower in the plane and closer to river Vardar, main source of water supply are wells, while in the settlements located in the border between the plane and mountain slopes, taps built on natural water springs can be found.

Nevertheless enormous importance of natural and anthropogenic hydro-graphic infrastructure, in process of designing and construction of a highway, planning and designing must be carefully done in order to prevent any perturbation of this system. In opposite, effects of highway will be counter-productive with catastrophic consequences, (although the effects can not be foreseen and established), from the subjective point of view, they will cause disturbance of the existing demographic condition.

6.5.2. INSTITUTIONAL INFRASTRUCTURE

In the Gevgelija-Valandovo valley, differently from some other regions in the Republic of Macedonia, more precisely in the settlements where the road is passing, electrification was established significantly earlier. Cultural, educational, sanitary-social, financial-telecommunication, religious, commercial, administrative and other objects are particularly important.

In the length of about 50 km there are three main administration centres: Demir Kapija, Valandovo and Gevgelija, which means that in conditions of good established traffic infrastructure, opportunities for satisfying sanitary-social, cultural, educational, commercial, administrative, and other necessities exist. This refers mainly to the settlements located in plane, more exactly in the part from Udovo to Smokvica. The settlements located in region around Demir Kapija gorge were considerably early depopulated or exist in the same form as 30 and more years before. Typical example is village Chelevec. However in settlements in the plane, separate infrastructure has been built. That means that in all of them exist four-year primary schools in this period, and in larger such as Josifovo, and Miravci, eight-year primary schools exist. It means that educational process is realised in the place of living or in its neighbourhood.

Sanitary-health-social necessities are satisfied mainly in the health institutions in the region of the highway corridor. In some of the larger settlements, for example Josifovo, and Miravci, ambulance with permanently employed or temporally present staff during one week is working. Beside that, in Demir Kapija two mental hospitals exist, and medical staff is working, as well.

In the scope of the telecommunication system, fairly good infrastructure is established, because 1/3 of the analysed settlements have modern post-office objects with possibilities for accepting and distribution of the post shipments, financial working, and possibilities for telecommunication. In this sense, the activity for establishing telephone line to every family in all of the settlements is undertaken. This activity should be realised till the end of this year.

In administrative and managing sense besides management and public organs in the community centres in Demir Kapija, every settlement has regional office which co-ordinates and realises different activities on behalf of the settlement, and in that sense of co-ordination with the rest of the villages, especially neighbouring ones.

In function of satisfying of different commercial necessities, today in all of the settlements, shops exist. In some of them, for example Demir Kapija, Udovo, Josifovo, Miravci and others, several (about eight) shops can be found. Beside them, there are several inns where parties and other social events for the young population are organised.

There are churches in order to satisfy the religious needs in every settlement because inhabitants are orthodox (Photo 66 and 67). There are recreational and sport amenities, as well (Photo 68)

Photo 66. Chapel in village Udovo

Photo 67. Church St. Ilija (village Davidovo)

Characteristic for this village milieu, process of opening small private producing facilities has not been started yet, as it is the case with the village Udovo where the cow farm and dairy are functioning. In this kind of objects, people with finished secondary or high school, who are numerous in all of the settlements, as we can see, would be employed.

The residential area located close to the highway alternatives “A” and “2” is not connected to municipal sewage water treatment systems. Houses are usually equipped with septic tanks, beside the village Miravci where sewage system with waste water treatment plant exists.

Household waste is collected on a regular basis. However, uncontrolled waste dumping and littering is still a problem in the country.

Photo 68. Football ground of the football club “Miravci” (village Udovo in the background)

6.5.3. EXISTING INFRASTRUCTURE

Infrastructure facilities of regional significance that are located at the analysed region are as follows:

- Irrigation System of Valandovo and Gevgelija Valley, i.e. water economy area of Southern Vardar
- Irrigation System for Southern Vardar Valley
- Collector System – Dojran
- Railway
- Main road M1 (international highway E-75)
- Regional roads 103, 111, 112 and 604
- Coaxial cable
- Transmission line 400kW, transmission lines 110kW
- Transformer stations 110kW
- Oil pipeline Miladinovci - Thessaloniki

Photo 69. Newly constructed irrigation system which intersects with the route of highway alignment 2 (near village Miravci).

The Irrigation System of Southern Vardar Valley covers surface of 7417 ha. In these frames basic structures and channels are constructed, with built grade of 96% (Photo 69). The necessary irrigation water quantity of these surfaces is 52.724.000 m^3.

The railway is of international character and connects the country with Republic of Greece to south and with the countries of foreign Yugoslavia, Western and Eastern Europe.

The Main road M1, presents highway in construction with constructed section from Gevgelija up to the border with Republic of Greece. The rest part but the Section Demir Kapija – Smokvica is already constructed, which means that the connection with the finished sections shall be achieved.

The Regional road directions are connecting more significant municipal centres and settlements in the region on the relation Gevgelija – Bogdanci – Dojran – Valandovo – Miravci – Gevgelija and up to Banjsko – tourist complex Smrdliva Voda.

The coaxial PTT cable, which is placed in two directions from Gevgelija to Negotino and from Gevgelija to Valandovo and is component of the so called ISDN network that is organized on international, national and local level

The electric power from the main producers is distributed through 400 kW transmission line from TE Dubrovo to Republic of Greece, and in regional frames in function are the transmission lines of 110 kW from the same distributor, with direction Dubrovo – Valandovo, Valandovo – Miletkovo and Valandovo – Gevgelija, where from through the transforming stations of 110 kW is being distributed to the consumers.

The supplying pipeline for thermo-mineral water starts from the geo-thermal field of Smokvica wells near Vardar River; where from warm water is distributed to the greenhouses of Vinojug at village Negorci.

The oil pipeline alignment is located approximately 500 m western of the wider border of the location.

There is an older Irrigation System from Anska Reka, starting from Udovo up to Marvinci and new Irrigation System of Southern Vardar Valley that currently is under construction. Negorci - Prdejci irrigation region is located on the right side of the Vardar River in the district of the Negorci and Prdejci villages. From the west and north side, the region is protected by the mountains of Kozuf, Gradeska and Belasica. From the south and southeast side, the region is opened up to the river Vardar valley. River Vardar absorbs water from approximately 80% from Macedonian areas. The covered area of South Vardar Valley is around 1.015 km^2. Regarding the water quality of Vardar River in the South Valley, it is classified as class II and it is suitable for irrigation.

The present irrigation system consists of water coming from the river Kovanska and Sermeninska (supplied by gravity open earth channels) and from Vardar River (supplied by pumping with pump stations Prdejci and Keramidnica).

The constructed dams as particularly significant water economy are located on the section Miravci – Miletkovo and we consider them out of the Alternative 1 but close to the Alternative "2" as possible variant of the highway alignments. More significant is the accumulation Kalica with capacity of 640.000 m^3, where from through PVC pipeline with diameter Ø400 mm, 150 ha are irrigated. Nevertheless, it is of significance to note that with water economy bases constructions of five more dams are foreseen two of which are located in the wider zone for Alternative 1 and close zone for Alternative "2" of the highway alignment planning. That is the dam at Petrushka River with capacity of 4.000.000 m^3 that will irrigate 100 ha and the dam at Kovanska River with capacity of 10.000.000 m^3, as part of the Detail Reviewed Design for construction.

Capital water economy and hydro-energetic potential of this area represents the design for construction of the Gradec Dam on Vardar River, but the water of the future accumulation shall not influence the main communications besides the railway that in conditions of construction shall be dislocated above the maximal level of the accumulation.

6.6. AIR QUALITY, WATER AND SOIL

6.6.1. AIR QUALITY

The quality of air in urban centres has been monitored for more than 20 years. This monitoring is carried out by the Republic Hydro-Meteorological Institute on the basis of separate Programme, adopted and financed by the Government. This Programme specifies the manner of monitoring and examination of the air quality, by monitoring the concentrations of polluting substances in the air in the lower atmosphere layer and their distribution in terms of time and space.

Presentation of mid-daily concentrations of the environmental parameters, for month January 2006

KAVADARCI	SO2 µg/m³	NO2 µg/m³	CO mg/m³	O3 µg/m³	PM 10 µg/m³
01.01.2006	48,321	29,189	2,461	18,11	157,911
02.01.2006	42,373	24,925	1,867	13,462	120,836
03.01.2006	39,154	20,949	1,811	15,688	93,903
04.01.2006	37,325	16,675	1,219	13,161	39,451
05.01.2006	37,517	23,328	1,811	8,042	73,275
06.01.2006	37,699	15,869	1,174	10,872	36,345
07.01.2006	38,981	9,949	1,239	20,923	37,219
08.01.2006	41,878	11,924	0,984	40,097	43,982
09.01.2006	42,762	25,48	1,702	46,679	121,249
10.01.2006	45,453	27,651	1,339	38,278	143,081
11.01.2006	52,286	-	1,032	37,224	122,607
12.01.2006	44,377	-	0,407	52,842	49,401
13.01.2006	53,879	-	0,5	53,485	62,595
14.01.2006	53,972	-	1,085	49,392	97,867
15.01.2006	45,694	-	1,953	30,74	158,287
16.01.2006	49,203	-	2,357	28,7	217,109
17.01.2006	51,822	-	2,715	23,669	291,45
18.01.2006	55,758	-	2,757	13,537	325,574
19.01.2006	46,66	-	0,812	25,373	67,769
20.01.2006	46,851	-	1,557	36,412	134,225
21.01.2006	46,96	-	2,314	26,507	216,715
22.01.2006	50,917	-	1,269	37,718	117,71
23.01.2006	38,863	-	0,82	28,473	50,051
24.01.2006	43,544	-	0,806	54,716	51,863
25.01.2006	48,298	-	1,513	57,807	95,557
26.01.2006	46,045	-	2,65	47,242	180,111
27.01.2006	44,929	-	2,132	39,786	175,305
28.01.2006	51,133	-	2,843	32,816	219,935
29.01.2006	52,923	-	2,744	31,929	228,643
30.01.2006	49,374	-	2,779	27,6	222,451
31.01.2006	49,355	-	2,552	32,97	169,417
MDK	**150**	**85**	**1**	**110**	**120**
Middle value	46,27	20,59	1,72	32,07	132,96
Minimum	37,325	9,949	0,407	8,042	36,345
Maximum	55,758	29,189	2,843	57,807	325,574

Number of days with mid-daily concentrations above MDK	0	0	25	0	17

It is assumed that the concentrations in the area of the new alignment are those found typically in areas of rural character.
For the subjected region of Alternative 1 and Alternative 2, input data for the existing condition of the air quality have been taken from the mobile automatic air measuring station that started with experimental regime on 06.04.2005.
Based on the operative working program of the Governmental automatic monitoring system for air quality the mobile automatic air measuring station identifies pollution substances concentrations that are product of the industry, traffic and the heating during the winter period. The station, besides the concentrations of the usual parameters, also measures concentrations of petrol, toluene, ethil petrol, othoxilen and paraxilen in the ambient air. Coordinates of the automatic monitoring station for air quality and values for parameters on which depends air quality, in the city nearest to the investigated corridor - city of Kavadarci (E 22°00'26''; N 41°26'26''; 269 m a.s.l.) are presented in Tab. 37.

6.6.1.1. Diffuse pollution sources

No significant diffuse sources of air pollution are present in the investigated corridor for both alternatives, since the whole area hasn't industrial activities or similar pollution producing branches.

6.6.1.2. Linear pollution sources

Currently, only the existing road passing on the left site of river Vardar, local roads connecting the settlements and railway are main linear air pollution sources in the future road corridor.

It should be mentioned that by alternative 2 - on the right site of river Vardar, no important air pollution sources of this kind are noticed.

6.6.2. WATER QUALITY

State water monitoring system by Hydro-meteorological Institute (HMI) doesn't cover smaller rivers and streams. Nevertheless, new monitoring program proposed by Water Quality Expert Group (WQEG) includes some of the tributaries of river Vardar (Boshava, Anska and Petrushka). The proposed monitoring is based on requirements of WFD for all types of water bodies in Macedonia. Until now, data for water quality (chemical and biological) exists only for river Vardar. Also, many investigations performed by different institutions (Faculty of Natural Sciences, Institute of Animal Sciences, etc) gives

some data on the water quality of the river Vardar or its tributaries. These data are also taken in consideration in evaluation of the water quality.
However, one can say that the water quality of all streams is high, since there are no significant sources of pollution. Besides this approximation, the water quality can be judged indirectly on the basis of bioindicators. This approach is the base of the WFD that includes phytobenthos as one of the important groups for evaluation of the water quality.

6.6.2.1. River Vardar

The hydrobiological investigations on river Vardar, as a central water ecosystem in Macedonia, have been introduced since the beginning of 60-ties through the postulated projects of Petrovska (1965) and Ikonomov (1969) which were mainly oriented to examinations from a taxonomic standpoint, thus confirming moderately to diverse phyto and zoocenosis in the river. An increased anthropogenic influence and pressure during the 70-ties have arosen the problem of determination of the physico-chemical as well as sanitary investigations that were dominantly performed by specialised institutions and the results published in a very limited numbers. Nevertheless, even those early investigations have pointed to increasment of all measured parameters in the region of Skopje-Veles with categorisation of the waters in V class of bonity. Detected increasment in concentrations of heavy and toxic metals and worsening of the epidemic situation were declared as most critical findings by that point of time.

The last investigation of river Vardar and its tributaries (Levkov unpubl. data) shows that according to chemical parameters river Vardar in the area of the corridor has poor water quality.

Part of the river around Demir Kapija, is characterized by evident self-purification processes, although many of organic pollutants form industry and communal waste waters are still present in significant quantities in the water and sediment. High values of nutrients (NH4 and P) as well as heavy metals and BOD were recorded. More critical situation was observed in content of priority substances (PS) - The high values of DEHP (Diethylhexyl phthalate) and DDT (Dichlorodiphenyltrichloroethane) were recorded in river Vardar. Estimated concentrations of many phthalates were extremely high (Dibutylphthalate, 36.89 μg/l and DEHP, 26.44 μg/l). Dissolved fraction of the contained Cr (0.2 μg/l), Ni (1.1 μg/l), As (2.11 μg/l) and Al (0.112 mg/l). AA-EQS for DEHP in surface water according to DSD was exceeded more than 20 times and for Pentachlorobenzene almost 10 times. A presence of PAHs (Polycyclic Aromatic Hydrocarbons), alkanes, phthalates, siloxane derivative and fecal sterols was detected. Additionally, 4.4’ - DDT and four out of eight target. Industrial pollutants (DEHP, Nonylphenol tech. mix.) were detected.

River Vardar around Gevgelija is very similar in chemical composition with upper part, although higher as concentration was detected. The highest values were observed also in PS. Estimated concentrations of many phthalates were extremely high (Dibutylphthalate, **95.77** µg/l and DEHP, 23.99 µg/l). Dissolved fraction of the water contained Cr (0.5 µg/l), Cu (0.5 µg/l), Ni (1.5 µg/l), Pb (2.0 µg/l), As (2.50 µg/l) and Al (0.120 mg/l). AA-EQS for DEHP, hexachlorobenzene, octylphenols, and nonylphenol tech. mix in surface water according to DSD were exceeded several times!

Biological analyses on this part of the river generally support of the findings of the chemical investigations. Vardar River after Gevgelija has strange benthic macroinvertebrate communities (only young specimen) indicated a restoration of benthic communities after serious incidental/accidental pollution. Diatom composition shows dominance of several indicators of high eutrophication (*Nitzschia palea*, *Cyclotella meneghiniana* etc) indicating poor water quality.

6.6.2.2. River Boshava

Chemical analyses of river Boshava exist only for early 90-es. These results suggest high impact of eutrophication from agricultural land as well as impact of untreated waste waters. Additional influence of solid waste water (biodegradable and non-biodegradable) was also observed. High nutrient content resulted with high abundance of eutrophication tolerant macrophyte *Cladophora glomerata*. Diatom composition in epiphytic communities is consisted mainly by moderately tolerant diatom taxa. Such composition indicates moderate water quality compared to reference site.

6.6.2.3. River Anska

Anska river diatom microflora is also very similar to that of river Vardar, but with marked presence of specific and very valuable forms that are unique for this river and suggest possible better water quality (II - III class). Nevertheless, dominance of eutrophic diatom species is recorded in this part of the river (*Cymbella tumida*, *Ulnaria ulna*, *Cocconeis pediculus*, *Hippodonta capitata*, *Gomphonema capitatum*).

6.6.2.4. Chelevechka (Iberliska) Reka

Diatom microflora composition of Petrushka Reka is quite different in relation to rest of investigated sites. The community is consisted mainly by typical oligosaprobic indicators, which can be found as rare in this investigated area. Beside this species, some taxa were found as very rare in flora of Macedonia as *Nitzschia angustata*, *N. angustatula*, *Fragilaria alpestris* and *Achnanthes montana* which are known only for high mountain lakes and streams on Shara Mountain.

6.6.2.5. Other rivers (streams)

Estimated water quality of the streams in the area of the corridor (based on bioindicators) is good to high. Some of the streams (Golema Javorica and

Mala Javorica) can be used for reference sites for lowland streams. It is therefore an imperative to protect this water ecosystem from any additional human impacts.

6.6.3. SOIL QUALITY

According to the soil fertility and soil quality, the area of the highway corridor can be divided in two general categories:

- Soils under natural types of vegetation (pseudomaquis, dry grasslands, rocky sites etc.). These soils are generally characterized by low fertility and high soil quality in terms of pollution levels. As previously described (Chapter IV.5.) the main soil type are cinnamon soils.
- Soils of the anthropogenic habitats (agricultural land) are strongly modified by the agricultural activities especially fertilization. These soils can be named as antroposols which.

Soils of seminatural habitats (abandoned fields, tree plantations) represent transition between natural soils and antroposols.

6.6.4. NOISE

Generally, the whole area from Demir Kapija to Smokvica is characterized with low level of noise sources and noise pollution, irrespective which alternative of the future road is analyzed. The topography of the whole area is mostly mountainous, except lower side of the Vardar valley, which is broadly on both sides of the river Vardar.

Alternative 1 - Design of a new carriageway on the left bank of the Vardar River, as close as possible to the existing road, with a design speed of 80÷ 100 km/h. Presently, the area is hardly urbanized (only one urban system is touching the investigate corridor- town Demir Kapija), but it is more or less regularly populated (villages Udovo, Josifovo, Marvinci, and Smokvica). In general, the area of the future infrastructure can be divided in two main separate landscapes according to the following criteria: topography, land use, vegetation cover etc., on which criteria depends the dispersion of sound.

- Demir Kapija / Udovo section

The specifics of this section is its mountainous topography, beginning with the Demir Kapija gorge and narrow valley with more or less steep slopes, covered by more or less degraded natural vegetation on each side of the valley. This kind of topography is potentially shielding the terrain of dispersion of sound.
There is only one urban system - city of Demir Kapija and villages Gradec (abandoned) and Udovo. Main sources of noise are the daily activities of the people at the settlements, traffic at existing roads and railway, and activities in the rural areas.

- Udovo / Smokvica section

This section, located at the east of the "Vardar Zone" (major tectonic structure in Macedonia), is completely different in its morphology: it is a flat land, with some gentle hills. It is an open and plain territory where dispersion of sound is not shielded significantly by terrain, vegetation or other barriers.
Along the projected road, in this area there are villages Josifovo, Marvinci and Smokvica. Currently, main sources of noise are also daily activities of the people on the settlements, traffic on the existing roads and railway and activities in the rural areas.

Alternative 2- The project route is part on the left (at the beginning of the alignment) and major part on the right side of the Vardar River, with a design speed of 120 km/h.
This area is hardly urbanized (only one urban system is hardly touching the investigated corridor- town Demir Kapija), but it is more or less regularly populated (villages Klisura, Miravci, Miletkovo and Smokvica).

The characteristical topography of this area is presented by complicate morphology conditions, as mentioned in the above text.

The Demir Kapija gorge has very steep, even vertical slopes covered by different plant community than the rest of the region (sparse and sporadic vegetation).

City of Demir Kapija, existing primary road and railway are the only noise producing objects.

The route from the end of Demir Kapija gorge to village Miravci is typically mountainous, characterized with narrow valley with more or less steep slope. The slopes are covered by more or less degraded natural vegetation composed of forest communities.

This area is almost unpopulated (there is only one small village- Klisura with several inhabitants). No significant roads of any kind are passing through it. Therefore, no specific noise sources are noticed.

Section between village Miravci and village Smokvica is different from the previous one: the valley is becoming broader from both sides of the river Vardar, with almost no natural vegetation but the region is characterized by intensive agricultural production. No significant objects like terrain, vegetation or other barriers can serve as natural noise shield.

Sources of noise are local roads and railway, different field activities and daily activities of the people in the settlements.

6.7. CULTURAL, HISTORICAL AND ARCHEOLOGICAL SITES

Objects of cultural heritage represent the historical development of mankind.

The *Institute for Protection of the Cultural Monuments of the City of Skopje, IPCM* provided the following information to the technical planner (letter dated 14 June 2000 printed in Granitproekt 2001). For the complete region several archaeological locations dating from prehistoric, antique or middle age period can be expected. IPCM requested that an archaeological reconnaissance survey of the terrain should be carried out.

Due to the very favourable climate conditions, fertile alluvial soil along the river Vardar valley, the permanent water-flow and other geographic characteristics were, and are, providing good opportunities for living in the area of present and projected highway corridor. Due to these conditions, this area was permanently densely populated since very long time ago–paleolite, neolite, and antique and middle-age period.

As a result of this, many remainings with high archaeological value have been found along the road corridor. They have an extraordinary historical and cultural value for the Republic of Macedonia and due to this they have been determined as high sensitive sites or localities (see Chapter VII.1.4).

The provisional historical and archaeological sites and localities have been represented for both alignments of the highway Demir Kapija – Smokvica, road corridor “A” and road corridor “2”. The marks in the maps are mainly provisional and the marked area is maybe broader than the real one, due to the next phase of archaeological explorations with the method of recognising that implies detection of surface remainings of ancient cultures and identification of the locations type.

The historical and archaeological sites and localities are especially distributed along the lower part of the road corridor, i.e. Udovo – Smokvica (see map in Appendix I.3.). The data about exact position of the smaller localities are very obscure and often not precisely pointed out in the archaeological literature.

6.7.1. ALTERNATIVE 1

6.7.1.1. The area of Demir Kapija gorge

Village Gradec

The important historical object in this village is the church, situated on the hill above the village, close to the existing motor road, from its left side, just above the existing bridge. According to the architecture it is from more recent time.

6.7.1.2. The area around the village Udovo

The chapel next to the village

The chapel is situated on the left side of the existing motor road on a small hill next to the village Udovo. It is originating from the period of Balkan wars. The remains of the solders are placed in the basement of the chapel.

Turski grobishta (Turkish cemetery)

The locality is situated around the crossroad at the village Udovo. The remainings (tympanums) of a small pre-Roman temple and silver dinars have been found there.

6.7.1.3. The area around the village Davidovo

Settlement and necropolis from Late Antic period that is situated 2.5 km north of the village. Pieces of ceramics, pythos and construction material have been found on the surrounding fields.

Sveti Ilija

Middle-age church and necropolis that is situated 200 m north-eastern from the village.

6.7.1.4. Other important localities

These are close to the road corridor, but not in its area:

Brest (settlement from Late Antic period, situated 2 km north-west from the village, near the tab and covers surface of 100 x 80 m. Pieces of ceramics, pythos and construction material have been found), **Granitite** (this Roman settlement is situated 2.5 km north-west from the village, on a hill that dominates above the Vardar Riverbed. Pieces of ceramics, pythos and construction materials have been found), **Grobista-Reka** (it is a necropolis from the late antic period. Stony plates of the graves may be found on the locality on 1 km north-west from the village), **Seliste** (Late Antic settlement situated 1 km on the west of the village. Remaining of the ceramics may be found on the surrounding fields).

6.7.1.5. The area around the village Miravci

Dolna Crkva

There is sacral object from Roman period. It is situated on the southeast edge of the village at the right side of the local road Miravci–Gevgelija, on the smooth hill. The visible remains of fundaments, orientated in the east-west direction can be found, than marble columns, the fragments of roman ceramic etc. It is concerned as a Roman temple.

Krcanovo

These are settlement and necropolis from Roman period. It is situated about 1 km north from the village. Fragments of ceramics, construction materials and grave constructions are found.

Megdan

It is late Antic settlement. It is situated on the south periphery of the village. Pieces of ceramic dishes, pythoses and construction material is found on the fields and acres.

Causevec

It is late Antic settlement. It is situated 1 km south of the village. Fragments of ceramics and construction material are found on the fields.

6.7.1.6. The area around the village Miletkovo

Gradisor-Mramor

These are settlement and necropolis from early Antic and Roman period. It is situated 1.5 km south of the village, on the right side of the river Vardar, opposite to the Isar Kale, on a flat fluvial plateau with surface of 2.5 ha.

Grobista-Manastir

It is late Antic settlement from Roman period. It is situated 1.5 km on the south-east of the village, on the village cemetery that previously existed there.

Lozjata-Dukovec

It is Aqueduct from the Roman period. There are two aqueduct terraces 1 km on the south-east of the village that was supplying the Gradishor-Mramor settlement with water.

Smrekov Rid

It is settlement from Hellenic and Roman period. It is situated 2 km on the west of the village, on a small hill with flat plateau on its top. Fragments of ceramics, pythoses and construction material are found.

6.7.1.7. The area around the village Smokvica

Agova cesma

It is settlement from Neolithic period. It is situated 1km southern of the village, next to the locality Goli Rid. Fragments of ceramics on the surrounding fields may be found.

Agova cesma-Vetka Crkva

It is sacral object from the Roman period. It is situated 150 m southern of the village on the right side of the road Skopje—Gevgelija. Fragments of architectonic plastics and construction material are present.

Aerot

These are Citadel and necropolis from the Roman period. It is situated 4.5 km western of the village, on high hill with flat plateau. Bases of the citadel 0.7 m high are present.

Bisev Javor

It represents the necropolis from the Late Iron period. It is situated 800 m north-east of the village, immediately next to the railway. The graves have been discovered in the acres.

Goli Rid

It is settlement from the Late Antic period. It is situated 1 km southern of the village. Fragments of ceramics and construction materials are present on the fields.

Gradiste-Brest

It is settlement from Hellenic period. It is situated about 3 km south-western of the village. Fragments of ceramics and construction material are present on the fields.

Leskite

These are Citadel from Hellenic and Roman period. It is situated 3 km western of the village, next to the old road to Gabrovo, on the spacious terrace. Fragments of ceramics, pitoses and construction material are found.

Mramorot-Manastir

These are settlement and necropolis from Late Antic period. It is situated about 2.5 km north-eastern of the village, next to the bridge on river Vardar, in between the highway and the railroad. Fragments of ceramics and construction material are found.

Musnica

It is settlement from Late Antic period. It is situated about 500 m northern of the village. Fragments of ceramics, pythoses and construction material are found

Padarnica

It is settlement from Late Antic period. It is situated about 1.5 km from of the village, on the left side of Nedin Dol dale. Fragments of ceramics, pythoses and construction material are found

Sveti Ilija

It is medieval church. It is situated next to the northern of the village. Massive pieces of construction rocks and ceramics are present.

Tufka

These are settlement from the Bronze and Hellenic period. It is situated 200 m eastern of the village, between the railroad and the highway, on the hill with flat plateau. Fragments of ceramics and construction material are found.

Kjeramidnica

It is Hellenic necropolis. It is situated about 1.5 km from the village, between the river Vardar and the railroad. Remains of graves are present there.

Crkviste

It is settlement from the Late Antic period. It is situated 4.5 km western from the village, in the area of the localities Padarnica and Goli Rid. There are fragments of ceramics, pythoses and construction material.

6.7.2. ALTERNATIVE "2"

Javorka

This archaeological locality is situated close to the chainage km 7+000 of the road corridor "B" identified as settlement of Early Antic period.

Kalica

The archaeological locality Kalica is situated close to the chainage km 21+000 of the road corridor "B" identified as settlement from Iron Age and Early Antic period.

Gudlanica

Close to the chainage km 25+000 of the road corridor "B", there is archaeological locality identified as settlement of Neolith period.

Trskata

This archaeological locality is situated close to the chainage km 26+000 of the road corridor "B" identified as necropolis of Roman period.

Findings with incomplete data

Possible location of one more locality with un-complete data situated close to the chainage km 20+000 of the road corridor "2".

6.8. LAND USE

Total surface of the whole corridor area is 5725.03 ha. The main land use types are forests, riparian habitats, shrublands, agricultural areas and urban/rural areas. The structure of the land use types and their surfaces are presented on Tab. 38. The percentage of land use types in the whole corridor area as well as separately for Alternatives 1 and 2 are presented in Fig. 7, 8 and 9 which are the basis for the description and discussion of the land use.

The area under different types of forests and shrublands occupies almost 60 % of the total corridor area. Oak forests which are the most important for the forestry activities in the area cover total surface of only 215.2 ha. The largest area of 3130 ha is covered by forests and shrublands.

The second most important land use type in the highway corridor area is agricultural land which occupies significant surface (1434.8 ha; 25.1 %) in the lower parts of the highway corridor: along river Vardar and in the Valandovo and Gevgelija valleys. Most of the agricultural land is represented by fields and acres of wheat, corn and barley.

All other land use types (grasslands, rocky areas, agricultural land, settlements and infrastructure and water biotopes) participate with less than 3 % of the total corridor area.

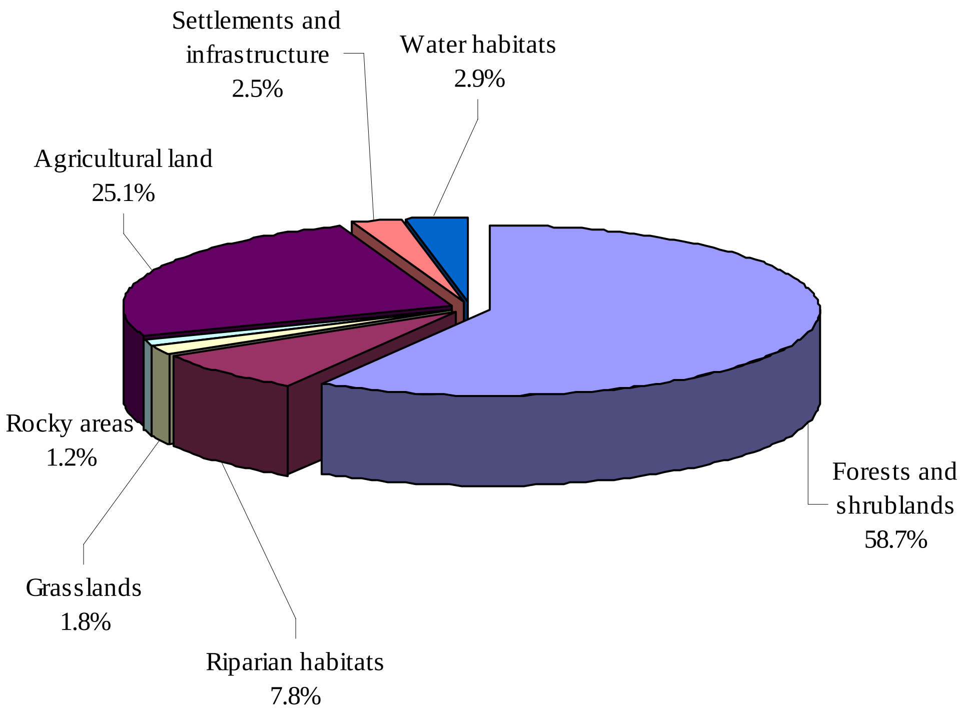
Overview of land use types and their surfaces (ha) in the corridor area.

Land use types	Alternative 1	Alternative 2	Alternative 1+2
Forests and shrublands	**1361.01**	**2172.04**	**3361.47**
Shrublands (Pseudomaquis)	**1345.05**	**1955.22**	**3130.34**
Well preserved pseudomaquis	778.35	1093.65	1801.38
Sparse pseudomaquis	290.60	548.19	796.98
Highly degraded pseudomaquis	247.07	268.03	485.73
Greek juniper on rocky sites	29.03	45.35	46.25
Forests	**0.00**	**215.17**	**215.17**
Oak forest	0.00	215.17	215.17
Plantations	**15.96**	**1.65**	**15.96**
Conifer stands	0.96	0.00	0.96
Tree lines	11.24	0.00	11.24
Poplar stand	3.76	1.65	3.76
Riparian habitats	**301.39**	**196.83**	**444.14**
Woodlands and tree belts	**247.98**	**188.11**	**390.13**
Willow stands and belts	148.01	28.47	148.01
Plane stands	3.12	2.71	3.12
Plane belts	96.85	156.93	239.00
Riparian shrublands and reed beds	**53.41**	**8.72**	**54.01**
Tamaris shrubland and sand banks	48.70	8.72	49.30
Reed belts	2.88	0.00	2.88
Swampy reed habitats	1.83	0.00	1.83
Grasslands	**59.36**	**65.29**	**102.29**
Dry grasslands	59.36	65.29	102.29
Rocky areas	**67.99**	**59.32**	**67.99**
Rocky area	67.99	59.32	67.99
Agricultural land	**1340.06**	**258.95**	**1434.79**
Fallow field	15.61	1.48	16.12
Fields and acres	1127.10	188.66	1195.95
Vineyards	168.80	64.41	192.17
Orchards	28.55	4.40	30.55
Settlements and infrastructure	**136.90**	**50.93**	**145.57**
Urban or urbanized area	26.83	26.83	26.83
Rural area	98.01	15.33	100.62
Park	2.51	1.63	2.51
Quarry	9.55	7.14	15.61
Water habitats	**162.51**	**37.18**	**168.78**
Rivers (Vardar, Boshava and Petrushka Reka)	162.51	33.41	165.01
Reservoir Kalica	0.00	3.77	3.77

TOTAL	3429.22	2840.54	5725.03

*The sum of the surfaces in Alternative 1 and Alternative 2 is equal or higher that the value for the total corridor area (Alternatives 1+2) due to the overlapping of the corridors of the alternatives.

Riparian habitats are presented as separate land use type although they include different types of habitats and human activities. All of these habitats have erosion and flood prevention values; they are not used for timber exploitation (although Plane trees are occasionally cut). Riparian habitats cover surface of 444.1 ha or 7.76 %. The largest surfaces of riparian habitats are distributed along river Vardar. Narrow belts of Plane and Willow can be found along all the streams and intermittent stream in the corridor area.



Percentage of the land use types in the corridor of the whole highway corridor area (Alternatives 1+2)

It should be mentioned that the water biotopes (as presented in this chapter) refer only to the surfaces of rivers and larger streams (Vardar, Bosava and Petruska Reka). Smaller streams as well as intermittent streams and gullies were neglected in the land use analysis since they cover very small surfaces which are impossible to measure in appropriate way.

Grasslands cover small surface of 102.3 ha or 1.8 %. But, as it was mentioned in the description of dry grasslands as habitats (Chapter V.2.1), significant areas in the highly degraded pseudomaquis are occupied by smaller parts of grasslands.

Abandoned fields play similar role as dry grasslands – they serve as pastures for the livestock that is bred in the region (sheep, goats and cows). They have some natural characteristics, as well. However, they were formed by abandoning the agricultural land and they are often re-used for agricultural production which groups them in the agricultural land.

All the settlements and infrastructure objects cover surface of 145.6 ha or 2.5 %. Most of this land use type regards parts of Demir Kapija town as well as parts of the rural settlements of Udovo, Josifovo, Marvinci, Miletkovo and Smokvica. The abandoned quarry at the beginning of Demir Kapija was included in the land use type of Settlements and infrastructure. Few significant surface of land near villages Udovo and Josifovo were included, as well (see Habitat map-Appendix I.4.).

6.8.1. ALTERNATIVE 1

Kermes oak shrublands and agricultural land cover almost identical percentages of the surface in the corridor area of Alternative 1 – 39.7 and 39.1 %, respectively (Fig. 8). This is the main difference with Alternative 2 which is characterized by dominance of forested area (77.4 %).

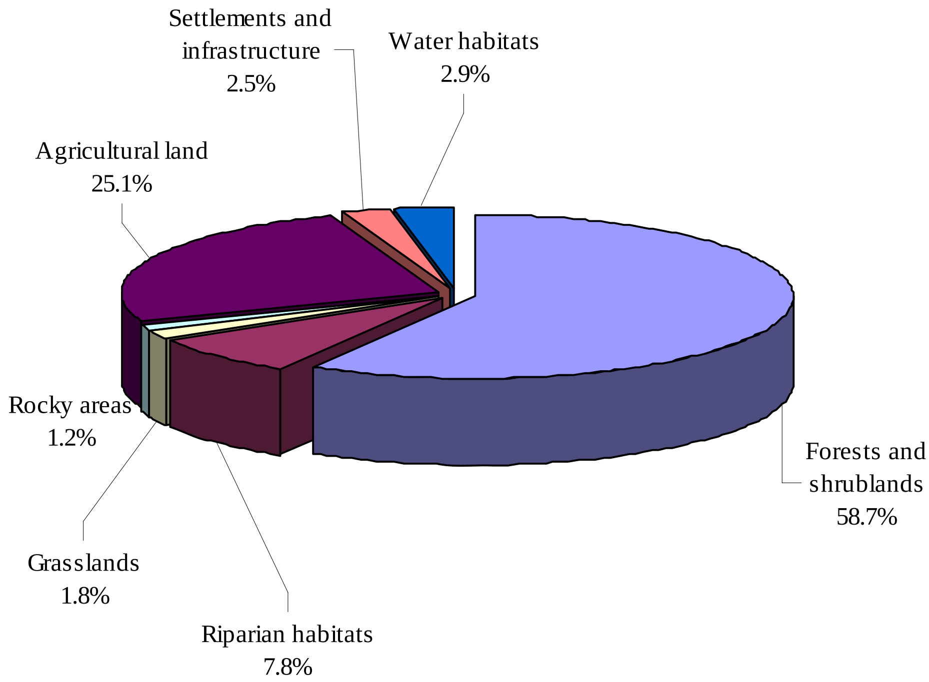
Low-stemmed shrublands of Kermes oak cover large surfaces (1345 ha) in the corridor of Alternative 1. The economic value of these forests is low since they are not suitable for forestry practices. The pseudomaquis of the Alternative 1 is dominated by Kermes oak, while the Pubescent oak is less frequent. There are no typical forests or stands of pubescent oak or Italian oak.

Riparian habitats in Alternative 1 corridor cover significant surface of 245 ha or 6.9 %. Most of them represent willow and Plane belts and stands that develop along river Vardar. Tamaris shrublands and sand banks are characteristic for Alternative 1 (compared to Alternative 2) and they cover surface of 48.7 ha.

The surface of settlements and infrastructure in the corridor of Alternative 1 covers almost twice the size of this land use type in Alternative 2. There are 136.9 ha of settlements and infrastructure land use type. The largest portion of this area is represented by rural settlements and their accompanying infrastructural objects (Udovo, Josifovo, Marvinci and Smokvica).

Rocky areas cover surface of 68 ha which is larger, but similar to the surface of rocky area of Alternative 2 (59.3 ha).

Grasslands occupy 2.3 % which is similar to the percentage of this land use type for the whole corridor area (Alternative 1+2) and Alternative 2 corridor. The total surface of dry grasslands is 59.4 ha. If the area of abandoned fields is added than the pastureland of Alternative 1 corridor is more than 75 ha.



Percentage of the land use types in the corridor of Alternative 1

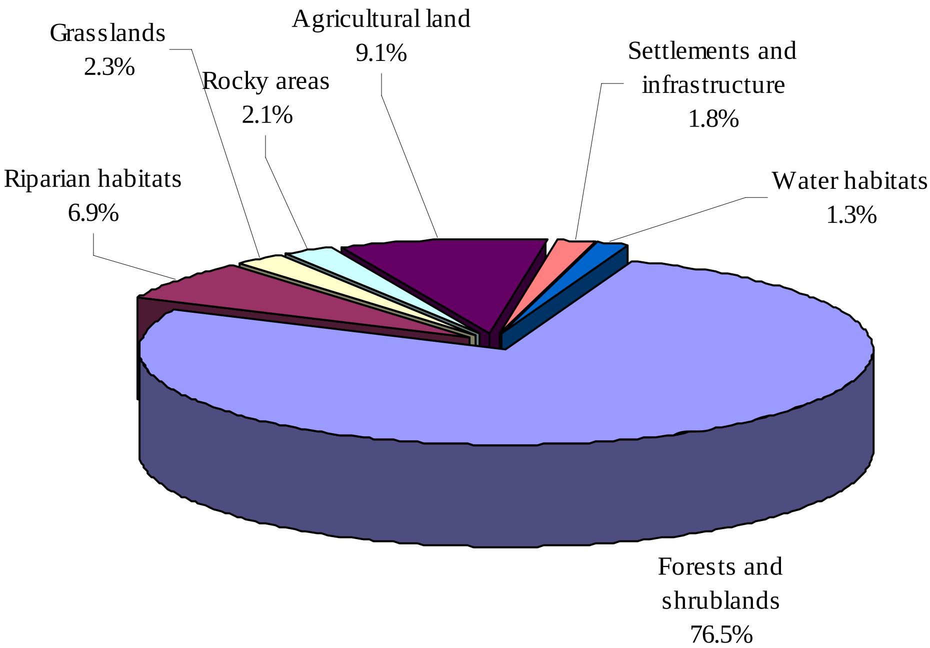
6.8.2. ALTERNATIVE 2

The surface of corridor of Alternative 2 is 2840.5 ha. The land use structure and surface is presented in Tab. 38 and Fig. 9.

Forested area (forests and shrublands) in the corridor area of Alternative 1 covers surface of 2172 ha or 76.5 % (Fig. 9). The most significant part of the forested area is represented by low-stemmed shrublands (degraded pseudomaquis) of Oriental hornbeam and Kermes Oak. However, the most important forests from the aspect of forestry are Pubescent oak forests. These forests are used by the foresters and local population for timber of the Pubescent oak. In the upper parts of the highway corridor Italian oak (*Quercus frainetto*) is cut for wood. The Pubescent oak forest in the corridor of Alternative 2 covers area of more than 200 ha.

Agricultural land is represented by 9.1 %. It is consisted mainly of fields and acres (259 ha) and vineyards. Abandoned fields and orchards are less frequent and occupy smaller surfaces.

Significant surface of the corridor of Alternative 2 is presented by rocky areas (2.1 %). This area refers to parts of Demir Kapija canyon (on the right side of river Vardar) and rocky sites in the watershed of Golema Javorica (locality Shtuder).



Percentage of the land use types in the corridor of Alternative 2

Another important land use type is represented by the riparian forests, shrublands and sandbanks. These cover area of 196.8 ha (smaller than in the case of Alternative 1) or 6.9 % (higher than Alternative 1). Besides the surface, riparian land use type of Alternative 2 differs from Alternative 1 by its structure. The areas of Tamaris shrublands and sand banks are almost insignificant since these habitats are developing along river Vardar which is generally remote to the Alternative 2 corridor. The main area of this land use type is covered by Plane belts along the streams and in the ravines and gullies of the hilly area between Demir Kapija and Miravci.

Unlike the Alternative 1, the settlements and infrastructure cover smaller area of about 51 ha or 1.8 %.

Both alternatives are similar by the small area of dry grasslands. In the case of Alternative 2 it is 65.3 ha or 2.3 %. In the sense of pastureland it can be noted that abandoned fields are rarer and smaller in Alternative 2 (1.5 ha).

6.9. SOCIO-ECONOMIC ASPECTS

Both designed alignments pass near some villages and residential areas; housing areas in Udovo and Miletkovo villages will be touched by the alignment. The alignment in case of Alternative 2 will pass not so close to the eastern end of Demir Kapija town. All other villages and residential areas in the corridor are at least at about 200 m distance from the alignment.

The route crosses mainly hilly area in the upper part of Alternative 1 and almost whole Alternative 2, and intensively used agricultural areas (partly with high structural diversity), vineyards and dry pastures in the lower part of the alignment, as an open and plain territory (mostly Alternative 1). Because of the intensive use of land for agricultural purposes, industry is not characteristic for the region and industrial zones are not designated for development in the alignment corridor.

It is certain that construction of new highway will have certain impact on socio-economic conditions in the region.

For details concerning population structure and social aspects see respective chapters (VI.1.).

6.9.1. FORESTRY

Timber exploitation is the main form of utilization of forests in the area of highway corridor. However, by its extents, it does not represent significant economic income. Forest communities in the highway corridor area are characterized by low biomass and low production (Tab. 39). The oak forest of Pubecent oak and Oriental hornbeam is under largest pressure from forestry activities. Kermes oak shrublands and other pseudomaquis forests are not used as a major wood source. Only occasionally local population uses this forest as a timber resource. Activities for timber exploitation depend on forests on higher altitudes of Kozuf Mt. (outside of the highway corridor) which include oak forests (forest of Italian oak - *Quercus frainetto* and forest of Sessile oak - *Quercus petraea*) and beech forests.

The highway corridor area overlaps with the territory of two forestry districts "Demir Kapija" (part of forestry region "Demir Kapija"-Demir Kapija) and "Javorica-Samovilska Reka" (part of forestry region "Kozuf"-Gevgelija) which are part of the Public enterprise "Makedonski Sumi" (Macedonian Forests).

Highway corridor of Alternative 1 passes through 13 forestry units of Demir Kapija forestry district. There are 19 forestry units of "Kozhuf" forestry district, which overlap with the highway corridor of Alternative 2 (Tab. 39).

Standing volume and forestry units of "Kozhuf" forestry district which overlap with the highway corridor of Alternative 2.

Forestry unit	Forest association	Standing volume ($m^3 \cdot ha^{-1}$)	Forestry unit	Forest association	Standing volume ($m^3 \cdot ha^{-1}$)
Forestry district "Demir Kapija"					
52	Coccifero-Carpinetum orientalis	1 270	126 b	Coccifero-Carpinetum orientalis	12
51	Coccifero-Carpinetum orientalis	750	125 b	Carpino orientalis-Quercetum conferttae	12
50a	Coccifero-Carpinetum orientalis	750	123 a	Carpino orientalis-Quercetum conferttae	34
49a	Querco-Carpinetum orientalis	625	122 b	Carpino orientalis-Quercetum conferttae	34

48a	Querco-Carpinetum orientalis	700
36a	Coccifero-Carpinetum orientalis	1 000
34a	Dry grasslands	500
33a	Querco-Carpinetum orientalis	1375
32	Querco-Carpinetum orientalis	250
26a	Juniperetum excelsae	
27a	Juniperetum excelsae	1 000
9a	Juniperetum excelsae	1375
8a	Juniperetum excelsae	625
TOTAL		**10 220**

121 a	Carpino orientalis-Quercetum conferttae	22
72 a	Carpino orientalis-Quercetum conferttae	40
76 b	Carpino orientalis-Quercetum conferttae	32
77 b	Carpino orientalis-Quercetum conferttae	23
78 a	Carpino orientalis-Quercetum conferttae	/
79 a	Coccifero-Carpinetum orientalis	/
81 a	Coccifero-Carpinetum orientalis	/
81 b	Coccifero-Carpinetum orientalis	11
82	Coccifero-Carpinetum orientalis	
56	Coccifero-Carpinetum orientalis	15
55 a	Coccifero-Carpinetum orientalis	/
52	Coccifero-Carpinetum orientalis	/
51	Coccifero-Carpinetum orientalis	/
50	Coccifero-Carpinetum orientalis	/
47 a	Coccifero-Carpinetum orientalis	/
TOTAL		**/**

Non-timber forest resources in the highway corridor area are used by local population. These include:

- Grass is used for grazing by the animals that are raised by the local people. They mow the abandoned fields and meadows in order to assure food for the animals in the winter period. This type of activity is very important since sparse and degraded Kermes oak shrubland is open habitat with patches of dry grasslands.
- Medicinal and industrial plants such as: *Matricaria chammomila*, *Rosa canina*, *Mentha spp.*, fruits of *Crataegus monogyna* and *Juniperus oxycedrus* etc. are collected by individuals for commercial purposes, but it is not that significant with the exception of *Juniperus oxycedrus* and *Rosa canina* exploitation.
- The most frequently collected mushrooms are: *Boletus edulis s.l.*, *Cantharellus cibarius*, *Macrolepiota procera*, *Lactarius deliciousus*, *Agaricus spp.*, *Amanita Caesarea* etc. Mushrooms are collected very intensively in short periods appropriate for mushroom

exploitation. There are some ransom stations that buy up mushrooms.

6.9.2. HUNTING AND FISHING

Hunting is not important economic activity in the region of the roads' corridors. However, in rising poverty conditions in Macedonia hunting is additional source of meat for limited number of households. It has more social significance (sport).

There are several hunting grounds like Hunting ground "Cestovo" (Valandovo managed by Public Enterprise "Makedonski Sumi (Macedonian Forests) which occupies 7000 ha of predominantly shrubland area at an elevation from 58 m a.s.l. to 322 m a.s.l.), Hunting ground Koresnica, Hunting ground Besvica etc.

During the field inspection for the purpose of this study, lot of shells or cartridges of army or hunting weapons were found (above the village Miravci, Bozikovec and other places).

There are 3 hunting societies registered in the area: Orel from Gevgelija, Orel from Valandovo and Krastavac from Demir Kapija. The most important game species in the area of interest are: Wild boar, Hare, Gray partridge (*Perdix perdix*), Rock partridge (*Alectoris graeca*) and Pheasant (*Phasianus colchicus*). Hike hunt is organized on an irregular basis for extermination of Gray wolf and Red fox.

6.9.3. AGRICULTURE AND CATTLE BREEDING

Agriculture and cattle breeding represents the main activity in the region of interest and they generate the highest share of income of the population in the area of the highway corridor. Crop growing is the most important activity for the area in the corridor in case of Alternative 1, and livestock breeding is the most important activity for the area of the highway corridor in case of Alternative 2 (see Chapter VI.2.).

Most of the people in the villages rely on agriculture (See Chapter VI.1.). The alluvial plain along river Vardar is used for rising of wheat, barley, corn, cabbage, tomatoes etc. Vineyards are usually grown on the hilly terrain in the vicinity of the villages and Demir Kapija town.

Cattle breeding seem to decrease its significance and probably the most significant decline appeared during the 60s and 70s (as in the whole of Macedonia). There are about 10000 sheep in the area and almost 3000 goats.

The dominance of agricultural activity implies that existence of developed local road network is important.

6.9.4. INDUSTRY

It is not very important economic activity in the region of highway corridors. The most important aspects of the industrial objects are presented in Chapter VI.5 (Infrastructure).

6.9.5. TOURISM

Tourism is not well developed branch in the area of the highway corridors although there are potentials to develop this type of activity. The development of tourism is planned in the Spatial Plan of the Republic of Macedonia (Chapter III.2.1.).

Most of the "tourists" visit the Demir Kapija canyon. There are occasional bird-watchers in the canyon looking for birds of prey. Few people visit the Bela Voda cave.

Some domestic tourists visit the churches in the area during religious holidays.

The most important tourism is the "transit tourism". People travelling by the existing motor road are visiting the few restaurants in the area (Photo 70). Their final destinations are usually resorts in the southern parts of Macedonia (Dojran, Strumica region, Gevgelija and Negorci spa) or Greece.

Photo 70. Restaurant "113" situated in the Vardar valley (between Demir Kapija and Udovo)

6.9.6. MOUNTAINEERING AND ALPINISM

Demir Kapija is famous for rock climbing among Macedonian alpinist (Photo 71). This activity is noted on Wikipedia (www.wikipedia.org): "*Demir Kapija is an outdoors haven for sports and recreational activities. Mountaineers often enjoy hiking the area for their favorite tea plants. Formerly, the national and regional Kayak competitions were held here because of the natural rapids formed by the river into the canyon. Alpinists climb the rock towers to see the most impressive view of the canyon beyond. Trails are also made to hike to these points, as well as to the remains of the forementioned ruins of the fortress Prosek. Possibly the most interesting hike, noted in The Brandt Guide to Macedonia, is the stopping point between the 2 tunnels on the highway. Parking exists, and it is very interesting walking along the small river in between 2 rock faces, like an open-ended cave to some unique Turkish Villages. You may even be invited for tea.*"

Mountaineering is not well developed sport activity in the highway corridor area. There are some mountain paths that lead to higher parts of Kozhuf Mt. These paths start at the foothills near village Smokvica, Miletkovo and Miravci.

Photo 71. Information table for the climbing locality "Demir Kapija"

7. DETERMINATION OF THE SENSITIVE ECOSYSTEMS, HABITATS AND OTHER SITES

Based on the description of current situation of environmental spheres in Chapter V and VI, and using the nationally and internationally recognized criteria, the sensitivity of ecosystems, habitats and other sites (archaeological and historical sites, human settlements) were assessed. The most sensitive sites were pointed out and their natural or human induced values were stressed. The most particular localities from sensitive habitats were separately treated. Separation of these key or high valuable ecosystems, habitats or sites is necessary in order to assess the possible impacts of highway construction and operation more thoroughly and to propose effective measures for their protection or future management.

7.1. METHODOLOGY

Sensitivity was assessed using **matrix** that was specifically designed for this purpose. The matrix was used to evaluate the sensitivity of natural ecosystems and habitats exclusively.

Special matrix was applied to assess the sensitivity of human settlements, archaeological sites and infrastructural objects.

7.1.1. CREATION OF MATRIX

Ecosystems/sites (presented in rows) were evaluated against the criteria (presented in columns of the matrix table).

7.1.1.1. List of evaluated ecosystems/sites

The following ecosystems (described in Chapter V.1.) were evaluated: pseudomaquis (separately preserved, sparse and degraded), *Phillyrea media* shrubland on rocky sites, Greek juniper on rocky sites, Oak forests, Beech forests, Oriental plane woodlands, Oriental plane belts, Willow and poplar belts, Tamaris shrublands, sand banks with sparse Tamaris, sandstone cliffs, Dry grassland (hill pastures), Chasmophytic bare rock habitats, Caves, Rivers (separately Vardar and Boshava), Streams (separately Chelevechka Reka, Petrushka Reka, Golema Javorica, Mala Javorica and all the other streams with permanent flow), Intermittent streams, Gullies, Channels, Swampy reed beds and belts, Springs and wells, Anthropogenic forest stands, Abandoned fields, Fields and Acres, Vineyards, Orchards, Gardens, Rural settlements with sparse houses, Urban settlements, Ruderal communities and Quarries.

Some of these ecosystems include several plant associations that were not assessed separately.

7.1.1.2. Description of criteria

7.1.1.2.1. Criteria for sensitivity assessment of natural, seminatural and anthropogenic habitats

Fifteen different criteria were applied in order to evaluate sensitivity of the above mentioned ecosystems/habitats and sites:

1. **Habitat Directive (habitats)**
2. **Rare communities in Macedonia**
3. **Well preserved natural communities**
4. **Presence of species from IUCN Global Red List**
5. **Presence of species important for Europe (Habitat Directive)**
6. **Presence of threatened birds**
7. **Presence of Endemic species**
8. **Presence of rare species**
9. **Landscape value**
10. **Economic value**
11. **Species richness**
12. **Geomorphologic value**
13. **Geological value**
14. **Erosion prevention**
15. **Pollution prevention value**

The criteria were selected in order to demonstrate national and international (European and global) importance of the ecosystems/habitats and their species composition that can be met in the area of project interest. The more valuable (the more criteria apply) the habitat the more sensitive it is.

Criterion 1 - Habitats Directive (Council Directives 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). The list of important habitats is given in:

- Annex I - Natural habitat types of community interest whose conservation requires the designation of special areas of conservation.

Criterion 2 - Rare communities in Macedonia. Rareness of the community was estimated on the basis of experts' experience and current knowledge about distribution of the community.

Criterion 3 - Well preserved natural communities. The degree of naturalness i.e. the extent of human intervention and land use pattern was evaluated on the basis of expert judgement.

Criterion 4 - Presence of species listed in IUCN Global Red List. The number of species listed on IUCN Global Red List in the habitat determines the value. The categories of the IUCN Red List are described below:

- **EXTINCT (EX).** A taxon is Extinct when there is no reasonable doubt that the last individual has died. A taxon is presumed extinct when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), and throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
- **EXTINCT IN THE WILD (EW).** A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. A taxon is presumed Extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual) throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
- **CRITICALLY ENDANGERED (CR).** A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.
- **ENDANGERED (EN).** A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered (criteria A to E are not presented in this Study), and it is therefore considered to be facing a very high risk of extinction in the wild.
- **VULNERABLE (VU).** A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (criteria A to E are not presented in this Study), and it is therefore considered to be facing a high risk of extinction in the wild.

  Species from the three categories listed above are considered as **threatened.**
- **NEAR THREATENED (NT).** A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
- **LEAST CONCERN (LC).** A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
- **DATA DEFICIENT (DD).** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known,

but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and a threatened status. If the range of a taxon is suspected to be relatively circumscribed, and a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

- **NOT EVALUATED (NE).** A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Criterion 5 - Presence of species important for Europe. This criterion takes into account Habitats Directive and European IUCN Red List. The important species in Habitats Directive are listed in:

- **Annex II** - Animal and plant species of community interest whose conservation requires the designation of special areas of conservation
- **Annex IV** - Animal and plant species of community interest in need of strict protection

Criterion 6 - Presence of threatened birds. This criterion is based on several conventions. Birds were evaluated separately because of their good elaboration in the international conventions. The following conventions were taken into account:

A. Bird Directive - Council Directive 79/409/EEC on the conservation of wild birds

- **Annex I** - Species of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution. In this connection, account shall be taken of:

  (a) Species in danger of extinction;

  (b) Species vulnerable to specific changes in their habitat;

  (c) Species considered rare because of small populations or restricted local distribution;

  (d) Other species requiring particular attention for reasons of the specific nature of their habitat.

- **Annex II -** Owing to their population level, geographical distribution and reproductive rate throughout the community, the species listed in annex II may be hunted under national legislation. Member states shall ensure that the hunting of these species does not jeopardize conservation efforts in their distribution area.

  Annex II/1 - The species referred to in Annex II/1 may be hunted in the geographical sea and land area where this directive applies.

Annex II/2 - The species referred to in Annex II/2 may be hunted only in the member states in respect of which they are indicated.

- **Annex III** - Member states shall prohibit, for all of naturally occurring birds in the wild state in the European territory of the member states, the sale, transport for sale, keeping for sale and the offering for sale of live or dead birds and of any readily recognizable parts or derivatives of such birds

B. Bonn Convention

- Appendix I - Species threatened by extinction
- Appendix II - Migratory species conserved through Agreements

Migratory species that have an unfavourable conservation status or would benefit significantly from international co-operation organized by tailored agreements are listed in Appendix II to the Convention. For this reason, the Convention encourages the Range States to conclude global or regional Agreements for the conservation and management of individual species or, more often, of a group of species listed on.

31. C. SPEC - Species of European Conservation Concern (for birds only)

SPEC 1	European species of global conservation concern
SPEC 2	Unfavourable conservation status in Europe, concentrated in Europe
SPEC 3	Unfavourable conservation status in Europe, not concentrated in Europe
Non-SPEC^{E}	Favourable conservation status in Europe, concentrated in Europe
Non-SPEC	Favourable conservation status in Europe, not concentrated in Europe

D. European Threat Status (ETS)

- CR - Critically endangered - if the European population meets any of the IUCN Red List Criteria for Critically Endangered.
- EN - Endangered - if the European population meets any of the IUCN Red List Criteria for Endangered
- VU - Vulnerable - if the European population meets any of the IUCN Red List Criteria for Vulnerable
- D - Declining - if the European population does not meet any of the IUCN Red List Criteria, but declined by more than 10% over 10 years or three generations, whichever is longer

- R - Rare - if the European population does not meet any of the IUCN Red List Criteria and is not Declining, but numbers fewer than 10000 breeding pairs (or 20000 breeding individuals or 40000 wintering individuals) and is not marginal to a larger non-European population.
- H - Depleted - if the European population does not meet any of the IUCN Red List Criteria and is not Rare or Declining, but has not yet recovered from a moderate or large decline suffered during 1970-1990.
- L - Localised - if the European population does not meet any of the IUCN Red List Criteria and is not Declining, Rare or Depleted, but is heavily concentrated, with more than 90% of the European population occurring at 10 or fewer sites.
- S - Secure - if the European population does not meet any of the criteria listed above.
- DD - Data Deficient - if there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status.
- NE - Not evaluated - if its European population has not yet been evaluated against the criteria.

Criterion 7 - Presence of endemic species. This criterion evaluates the number of endemic species present in the habitat. The score presented in Tab. 40 is average of the scores for endemic species of flora and fauna.

Criterion 8 - Presence of rare species. This criterion evaluates the number of rare species present in the habitat. The score presented in Tab. 40 is average of the scores for rare species of flora, fauna and fungia.

Criterion 9 - Landscape value. The landscape value was estimated based on several characteristics: structural and functional importance of certain landscape, aesthetic value, rarity in Macedonia etc.

Criterion 10 - Economic value. The importance for human economy determined this criterion. The most important economic values in the project area concern forestry, water potential and livestock breeding.

Criterion 11 - Species richness. The overall biodiversity value i.e. species richness was assessed on the basis of expert judgement and current knowledge of species composition of different habitats (List of known species - known from the literature data and field observations - is given in Appendix II). In cases when comparison of species richness was not possible due to the incomparable area, incomparable substrate or incomparable state-of-the-art of knowledge, expert judgement for specific value of the habitat was decisive.

Criterion 12 - Geomorphologic value. The presence of important geomorphologic characteristics was the basis of this criterion. It should be pointed out that the score in the matrix regards only certain localities in the range of the evaluated habitat (they will be mention individually in the explanation that follows the matrix table.

Criterion 13 - Geological value. The presence of important geologic characteristics was the basis of this criterion.

Criterion 14 - Erosion prevention. One of the important features for preservation of the natural conditions is the erosion prevention potential of the habitat.

Criterion 15 - Pollution prevention value. The absorption capacity for pollutants is very important feature of the ecosystems. The evaluation was based on expert judgement.

7.1.1.2.2. Criteria for sensitivity assessment of objects of human importance

Nine different criteria were applied in order to evaluate sensitivity of the objects, sites and localities of an anthropogenic origin:

Criterion 1 - Proximity to the alignment. This criterion is one of the most important preconditions for applying other criteria.
Criterion 2 - Level of destruction. It concerns only approximate assessment of possible destruction of objects of human importance (houses, industrial objects, agricultural areas, farms, infrastructural objects etc.
Criterion 3 – Recoverability; If the destruction of objects from previous criterion is recoverable than evaluated object, village or site receives the lowest score.
Criterion 4 - Costs for reconstruction. The higher the costs for reconstruction of the damaged object or site, the higher the score is.
Criterion 5 - Noise impact. It is evaluated on the basis of assessed noise impact for particular site in the respective chapter.
Criterion 6 - Air pollution impact. Same as previous
Criterion 7 - Fragmentation of agricultural roads. The more agricultural roads or paths are cut by the alignment, the higher the score is.
Criterion 8 - Fragmentation of local roads. Same as previous
Criterion 9 - Socio-economic impact. Overall positive or negative impact of road construction on particular villages or sites is assessed. The more positive the impact is, the lower the score is.

7.1.1.3. Scoring and rating

7.1.1.3.1. Natural and seminatural habitats

The scoring was from 0 to 3. The meaning of these scores is the following:

0 - No occurrence/importance
1 - Low occurrence/importance
2 - Medium occurrence/importance
3 - High occurrence/importance

The sum of scores for a habitat determined its sensitivity. The highest possible score is 51. The rating of sensitivity was performed on the basis of the following table:

0 - 7	**- low sensitivity (ls)**
8-16	**- medium sensitivity (ms)**
17-25	**- high sensitivity (hs)**
26-45	**- very high sensitivity (vhs)**

The sum of scores for a habitat determined its sensitivity. The highest possible score is 45. The rating of sensitivity was performed on the basis of the following table:

The meaning of each degree of sensitivity is described as follows:

- **ls** – There are no special obstacles for construction works; however, the aesthetic value of the landscape should be protected and redundant destruction and excessive perturbation should be avoided; the impacts on these habitats will have lower significance.
- **ms** – The construction works are permitted but the work should be done with precaution measures; the destruction of these habitats or their parts should be avoided; if the destruction is inevitable than the recultivation measures should be undertaken; the impacts on these habitats will have medium significance.
- **hs** – such sites, biotopes or localities have great importance concerning natural, or economic value; any kind of construction work should be avoided; if no other solution is possible, maximum measures for protection of the site or locality should be undertaken; when natural sites are concerned, special construction regime should be applied (e.g. seasonal restrictions, strict territorial recommendations etc.); the damage done to these kinds of ecosystems should be revitalized and compensated in compliance with the Law on Nature Protection. Permanent monitoring during the construction work has to be organized by the Investor.
- **vhs** – any kind of construction work is forbidden; any kind of construction work close to such sites or localities should be restricted and measures should be undertaken as in the case with **hs** habitats/localities. Very high adverse impacts will cause irreversible changes in these habitats/localities i.e. they will be permanently lost. Permanent monitoring during the construction work has to be organized by the Investor as in the case of hs habitats/localities.

7.1.1.3.2. Objects of human importance

Each criterion was scored according to the same principle as for the habitats (scores from 0 to 3). However, the sum of the score is different. The highest possible score is 27. The rating of sensitivity was performed on the basis of the following table:

0 - 6	**- low sensitivity (ls)**
7-13	**- medium sensitivity (ms)**
14-20	**- high sensitivity (hs)**
21-27	**- very high sensitivity (vhs)**

The meaning of each degree of sensitivity is similar as for the habitats.

7.1.2. SENSITIVITY ESTIMATION MATRIX

Sensitivity of natural, seminatural and anthropogenic habitats was assessed according to the described methodology. The results are presented on Tab. 40 at the end of this section.

7.1.3. RATIONALE FOR SENSITIVE ECOSYSTEMS AND SITES

In the following subchapters the separate localities in the frame of evaluated ecosystems/habitats (Tab. 40) will be distinguished based on the conflict situations emerging from the construction works and operation of the Demir Kapija Smokvica Highway section. Next to the title in the following sections, the reference for the description of the habitat is given in brackets.

7.1.3.1. Kermes oak shrublands - preserved (pseudomaquis) (Chapter V.1.1.1.1)

Well preserve pseudomaquis was assessed as hs (score 25), mainly because of the presence of endangered and rare species of plants and animals. The community itself is important for Macedonia since its distribution is limited to the area south of Demir Kapija (Gevgelija and Valandovo valleys).

This habitat type has low economic value particularly for the local population. It is important because it represents the real appearance of this type of shrubland community. Many rare species have found suitable habitat in this ecosystem (see Chapter V.6). It has anyway been under strong anthropogenic influence throughout the centuries and large portion of it is already highly degraded. Best stands are distributed in the corridor of the Alternative 2, on the slopes on the right side of the river Vardar gorge.

7.1.3.2. Kermes oak shrublands - sparse (pseudomaquis) (Chapter V.1.1.1.2)

The pseudomaquis have been changed due to the pronounced anthropogenic influence. It has even less (if any) economic value than the preceding biotope, but rare species (like *Canis aureus*, *Ophiosaurus apodus* and many bird species) are present. It was assessed as high sensitive (**hs**) habitat with smaller score than well preserved pseudomaquis.

7.1.3.3. Kermes oak shrublands - degraded (pseudomaquis) (Chapter V.1.1.1.3)

All of the values arising from the presence of rare and endangered species are very similar (in some cases even higher) than the preceding two pseudomaquis habitats. However, the low economic, landscape and erosion-prevention values are lower and thus this habitat was assessed as **ms**.

7.1.3.4. Greek juniper community on rocky sites (Chapter V.1.1.2.2)

The Greek Juniper community is European priority habitat type. The best stands are at Bozhikovec (km 8+900), Shtuder (km 9+600 to 11+700), Dolni Krastovec (km 3+000), canyon Demir Kapija (km 2+300) of Alternative 1 and canyon Demir Kapija (1+400 km) of Alternative 2. Due to its natural values it was assessed as **hs**.

7.1.3.5. Oak forests (Chapter V.1.2)

The sensitivity of oak forest was estimated to be high (**hs**) due to the presence of many important species, its economic and erosion prevention value, the species richness, geomorphologic and other values (Tab. 40). Not much well developed stands of these forests have remain in Macedonia. The best stands of this community in the highway corridor are distributed at upper flow of Golema Javorica, Mala Javorica and Kalica (km 9-16).

7.1.3.6. Beech forests (Chapter V.1.3)

The sensitivity of this forest comes from the fact that it is of a great importance for Macedonia since it is specific forest community distributed at the lowest elevation in its whole range on Balkans. Beech forest in the area of the road corridor (Alternative 2) is presently under high anthropogenic pressure anyway - it was cut recently. The last remains are at km 9+900.

7.1.3.7. Oriental plane woodlands (Chapter V.1.4.1)

The sensitivity is very high sensitive (vhs) because of the uniqueness of the plant community which is rare in Macedonia; it is included as important habitat in the Habitat Directive; presence of important species and especially its landscape value.

Best stands in the area of the highway corridor (alternative B) are at Golema Javorica (km 10+100 - this is the most diverse stand), Golema Javorica - Dragovski Dol (km 11+500 - the best preserved stand), Mala Javorica left armlet - Miravsko Ushce (km 13+200), Mala Javorica right armlet - Usite (km 15+000), Kalica - Trskata (km 17+200), Petrushka Reka - Tuperichkova Muchara (km 23+300 - particular stand, also with high geomorphologic value). In case of alternative 1, best stands are at Chelevechka Reka (km 1+600 - the most particular site in geomorphologic sense), Kosharachka reka (km 6+200), Lutkova Reka (km 8+700), Vodosir (km 12+100), Gradeshka Reka (km 14+000), Mushtenica (km 15+10) and Arazliska Reka (km 17+500).

7.1.3.8. Oriental plane belts (Chapter V.1.4.2)

Oriental plane belts form long and continuous belts along streams, ravines and gullies. It is obvious that the value and the sensitivity of the Plane belts are greater along streams compared to the narrower belts that develop along ravines and gullies.

7.1.3.8.1. Oriental plane belts along streams

Oriental Plane Belts along streams were assessed as **vhs**, the same score as for the Plane woodlands. They are characteristic for almost all dales and ravines on both slopes along the river Vardar (see Habitat map, Appendix I.4. and Biotope description–Chapter III.1.2.2.). They form continuous belts along all streams from their inflow in river Vardar to their source areas.

7.1.3.8.2. Oriental plane belts along ravines and gullies

Oriental plane belts along ravines and gullies form narrow belts and they lack some of the features of the plane belts along streams. Thus, this habitat subtype was assessed

7.1.3.9. Willow and poplar belts (Chapter V.1.4.3 and V.1.4.4)

Well developed willow woodlands and Belts of willows along the rivers and streams is habitat with almost equal importance as previous (Habitat Directive, Annex I: 92AO *Salix alba* and *Populus alba* galleries). However, they were assessed as medium sensitive (**ms**) due to their wider distribution in Macedonia and smaller economic and landscape value.

The best stands develop along the river Vardar, but those at the river Boshava (km 0+900) will be the most impacted by the intention. Stands along Vardar could be damaged in the case of alternative 1 construction only by activities indirectly connected with the road construction.

7.1.3.10. Tamaris shrublands (Chapter V.1.4.5)

There are many well-preserved communities of Tamaris along the lower part of the road corridor, especially along the river Vardar. They were assessed as high sensitive because of the presence of rare and endangered species, erosion-prevention value (stabilization of sand against floods). Although they are important habitat type for Macedonia, the Tamaris shrublands are not included in the Habitat Directive.

7.1.3.11. Sand banks with sparse Tamaris (Chapter V.1.4.6)

This habitat type was assessed as medium sensitive (**ms**), lower score than the previous habitat due to their lower erosion-prevention value. The most important feature of this habitat is the presence of rare and endangered species. It is rare habitat type in Macedonia since it is distributed almost exclusively along river Vardar.

7.1.3.12. Sandstone Cliffs (Chapter V.1.4.7)

Sandstone cliffs are very interesting phenomenon from geomorphologic point of view, but they are even more important as nesting places for numerous *Merops apiaster* populations (see Habitat map, Appendix I.4., Biotope description–Chapter III.5.1.3.). They cover very small surface in the highway corridor area – Alternative 1. Most of the other criteria had low scores and thus, the sandstone cliffs were assessed as low sensitive (ls).

7.1.3.13. Dry grasslands (Hill pastures) (Chapter V.2.1)

This habitat type is of high conservation importance in Europe (it is priority habitat type (*) according to the Habitat Directive - Annex I: 6220 * Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea). It is characterised by extraordinary species richness (at least 317 vascular plants, 34 bird species, 15 species of reptiles, 81 species of daily butterflies) in the area of the highway corridor although represented only by smaller areas usually in the clearings in pseudomaquis or on a long time ago abandoned fields and meadows. Since it is wide distributed habitat in Macedonia (it has secondary origin on the formerly forestland area) it should be considered as not very important on national scale.

The most important sites in the area of the project corridor are in the valley of Kalica river (Alternative 1), near village Gradec (Alternative 2) and near village Smokvica (both alternatives). However, dry grasslands can be found in the scope of pseudomaquis, especially degraded Kermes oak shrublands.

According to the sensitivity matrix, dry grasslands habitat was assessed as high sensitive with score of 21.

7.1.3.14. Chasmophytic bare rock habitats (Chapter V.3.1.2)

Similar habitat type (Habitat Directive, Annex I: 8140 Eastern Mediterranean screes) is considered as threatened habitat in Europe. However, the species composition of the screes referred to in Habitat Directive annexes does not correspond to the communities that develop on limestone and diabase rocks in the area of the road corridor. Despite this fact, one can consider chasmophytic communities in the area of project interest as threatened due to the high anthropogenic pressure (excavation of minerals - quarries). Their value is increased by the presence of two very specific plant associations: Centaureo-Ramondietum nathaliae Rizovski prov. and Stachyo-Inuletum aschersonianae Rizovski prov. (See Chapter V.3.1.2.). The best sites are at Demir Kapija limestone canyon (km 1+800 of both alternatives).

The bare rock habitat is included in the Demir Kapija Monument of Nature. It has extraordinary importance from the biodiversity point of view and consequently it was assessed as very high sensitive (vhs) with highest score of 30. Besides the rare associations and rare plant species there are very important birds such as Lesser Kestrel, Egyptian Vulture, and Long-legged Buzzard etc.

7.1.3.15. Caves (Chapter IV.2.2.2. and V.3.2.2)

Caves are considered as threatened habitat type in Europe (Habitat Directive, Annex I: 8310 Caves not open to the public). The most important cave in the highway corridor (Alternative 2) is **Bela Voda cave**. It has extraordinary value due to its length (it is among the longest caves in the Republic of Macedonia - 955 m; see Habitat map, Appendix I.4. and Biotope description–Chapter III.5.1.1.1.) and it is a habitat of endemic species of invertebrates (see Chapter V.3.2.2.) and endangered bat species (Chapters V.3.2.2. and V.6).

According to the sensitivity estimation matrix it was assessed as very high sensitive (**vhs**) although it lacks some of the values according to some of the applied criteria (landscape, economic, erosion-prevention values etc.).

7.1.3.16. River Vardar (Chapter V.4.1.1.1)

River Vardar was assessed to be high sensitive (**hs**). Its high score (21) is due to the presence of important species (especially fish), its economic and geomorphologic value. River Vardar gives special value to the landscape of the highway corridor area, as well.

Both Alternatives predict bridges that will cross river Vardar. In the case of alternative 1 the bridge should be built near village Smokvica (km 29+650 of Alternative 1)

Besides its values as habitat (although polluted), river Vardar has great value for the local population since it is used for irrigation purposes.

7.1.3.17. River Bosava (Chapter V.4.1.1.2)

River Boshava is important because of specific algal (especially diatom) community which differentiate this river from the other rivers in the road corridor (see Habitat map-Appendix I.4. and Biotope description–Chapter III.7.1.1.3). Irrigation value of the lower flow of the river for Demir Kapija is very high, thus any kind of pollution or destruction due to the highway construction or functioning should be avoided. It was assessed as high sensitive (**hs**).

7.1.3.18. Celevecka Reka (Chapter V.4.1.2.1)

Chelevechka Reka stream was assessed as high sensitive (**hs**). Its gorge is protected in the category of *Individual Plant and Animal Species Outside of Natural Reserves* i.e. Plane reserve. The geomorphologic and landscape value as well as the presence of important species are the main characteristics of this stream which increase its value. Chelevechka Reka holds its great importance although the existing motor road cuts is gorge next to the inflow into river Vardar.

Alternative 1 assumes that Chelevechka Reka will be cut (km 1+600) by another tunnel that will be built parallel to the existing one. This activity will represent additional disturbance of the geomorphologic and landscape values of the stream as well as its water quality.

7.1.3.19. Petruska Reka (Chapter V.4.1.2.2)

Petrushka Reka is very important for the area around villages Miravci and Miletkovo. It is divided into numerous channels in the lower flow. Beside the economic value, it has biodiversity importance, since the best plane (*Platanus orientalis*) community is developing on a broad area of the lower flow of the river (see Habitat map-Appendix I.4. and Biotope description– Chapter III.1.2.1. and Chapter III.7.1.2.2.). The algal community and presence of rare species is also evident (see Chapter V.6.).

The road alignment of Alternative 2 is designed in a way to cross the Petrushka Reka at km 22+300. According to the sensitivity estimation matrix it was assessed as high sensitive and intersection with the highway can be considered as significant conflict.

7.1.3.20. Golema Javorica stream (Chapter V.4.1.2.3)

Golema Javorica has great biodiversity value which was the main reason to assess this stream as high sensitive (**hs**). However, it has smaller economic value than Petrushka Reka due to its smaller water capacity and distance from the populated areas. The preservation of the Golema Javorica stream should be of high priority having in mind its undisturbed and unique natural values.

The most important conflict will arise in the case of Alternative 2 at the point of intersection with the highway alignment (km 10+100). It should be stressed out that part of the lower flow of Golema Javorica stream is included in the area granted for concession to the existing quarry (See Habitat Map-Appendix II.4.).

7.1.3.21. Mala Javorica stream (Chapter V.4.1.2.3)

Mala Javorica stream holds the same natural values as Golema Javorica and it has almost identical score (23, high sensitive).

This stream will be crossed by the highway alignment of Alternative 2 at km 14+300 that represents the most significant conflict of the road construction and operation.

7.1.3.22. Other streams (Chapter V.4.1.2)

All of the other streams (Vodosir, Arazliska Reka, Lutkovska Reka, Gradeshka Reka, Kalica, and Starata Reka) with permanent flow have similar characteristics as Mala and Golema Javorica. The values of these streams are lower (19). Nevertheless, they were assessed as high sensitive and conflict situations can be expected at the intersections with the highway alignment (in both alternatives).

7.1.3.23. Intermittent streams - ravines (Chapter V.4.1.3)

The most important streams which are usually dried up during the summer (ravines) (on the basis of representative habitat or geomorphology) are at km 6+200, km 8+700, km 15+000 (Alternative 1) and at km 7+000 (Alternative 2). The sensitivity of intermittent streams was assessed as low sensitive (**ls**) according to their values as natural habitats. However, intermittent streams have importance as biocorridors (together with their riparian Plane vegetation, see Chapter V.6.12).

7.1.3.24. Dry flows - gullies (Chapter V.4.1.4)

Gullies were estimated as low sensitive with smaller score (5) than the Intermittent streams.

7.1.3.25. Channels (Chapter V.4.1.5)

Channels in the highway road corridor can be found in the Valandovo plain (between villages Udovo, Josifovo and Marvinci). They were assessed as medium sensitive with score of 13 due to their reed beds. However, they have economic importance since they are used for irrigation purposes.

7.1.3.26. Swampy reed beds (belts) (Chapter V.4.2.1. and V.4.2.2)

Swampy reed biotope in sparse willow stands and reed belts along the rivers and channels are important for enhancing biodiversity value of water habitats, especially anthropogenic - channels. Outside of the channel areas, they cover small surfaces which decrease their sensitivity (they were assessed as medium sensitive with score of 9).

7.1.3.27. Springs (Chapter V.4.3)

Springs and wells are important as natural habitats. Thus, they were assessed as medium sensitive (ms) according to the sensitivity matrix. However, they have high social and economic value, especially for the local population which underlines the need for their preservation in the corridor area. The area of the road corridor is characterised by the long dry period and quantity and quality of drinking water is not sufficient (see Habitat map-Appendix I.4.).

Conflict situations may arise in the case of Alternative 1 with spring at Chirkov Chukar at km 9+000 and Odov Chukar at km 12+200. Alignment of Alternative 2 passes near the spring at Krstova Proseka at km 7+700, Raskol at km 9+200, Petkov Rid at km 16+600 and Petkova Niva at km 17+100.

7.1.3.28. Reservoir - Kalica (Chapter V.4.2.3)

The reservoir Kalica (km 19+000) was not assessed by the sensitivity matrix. It is obvious that it has low biodiversity value but high economic value. The alignment of Alternative 2 passes near the reservoir, but significant conflicts are not expected.

7.1.3.29. Anthropogenic forest stands (Chapter V.5.1)

Anthropogenic habitats (planted broadleaf and conifer stands) have low biodiversity values. The value for erosion-prevention and timber exploitation is low since there are no well developed stands in the highway corridor area. Consequently, they were assessed as low sensitive.

7.1.3.30. Abandoned fields (Chapter V.5.2)

Abandoned fields (fallow fields) have greater biodiversity value, but much lower economic value than the agricultural land in the area. Their characteristics from the aspect of species diversity are similar to the dry grassland with fewer important species. Abandoned fields cover small surfaces in the corridor area and no major conflicts are expected.

7.1.3.31. Fields and acres (Chapter V.5.3.2)

This habitat type was assessed as medium sensitive (Is) with score of 11. The biodiversity value of fields and acres is low. However, conflict situations may appear due to their economic importance for local population. The destruction of such sites should be compensated according to the Law on Expropriation (Official Gazette of RM 35/95, 20/98 and 40/99).

7.1.3.32. Vineyards (Chapter V.5.3.4)

Vineyard plantations are very important part of the local population occupation. They are very characteristic for the area of the road corridor especially in the case of Alternative 1 (see Habitat map-Appendix I.4. and Biotope description–Chapter III.4.4. and Development plans–Chapter IX). Direct destruction of the vineyards during the construction is not expected, but the impacts during the operational phase should be taken into account (especially air and soil pollution impact).

Although vineyards along the alignment of Alternative 2 are smaller by size, conflict situation during the road construction may be expected in the region of Miravci where the route crosses or passes near some small vineyards.

7.1.3.33. Orchards (Chapter V.5.3.1)

Orchards in the area have small economic importance because they occupy small surfaces. Their biodiversity importance is low as well. They were assessed as medium sensitive but significant conflicts are not expected.

7.1.3.34. Gardens (Chapter V.5.3.3)

Gardens have medium sensitivity which is the case for all types of agricultural land. The destruction of gardens should be compensated according to the Law on Expropriation (Official Gazette of RM 35/95, 20/98 and 40/99) just as in the case of fields and acres, vineyards and orchards.

7.1.3.35. Rural settlements with sparse houses (Chapter V.5.4.1.1 and V.5.4.1.2)

Rural settlements with sparse houses represent habitat with a mixture of anthropogenic and some natural features. The presence of some important species and their socio-economic value raises their importance and sensitivity as habitats. However, the alignments of both alternatives do not represent serious threat to this kind of rural settlements.

7.1.3.36. Urban settlements (Chapter V.5.4.1.3)

Demir Kapija and larger villages (Miravci, Udovo, Josifovo, Miletkovo, Marvinci, and Smokvica) have low sensitivity as habitats. Their importance is mainly economic (See Chapter VII.1.).

7.1.3.37. Roads, railways - ruderal communities (Chapter V.5.4.2)

Ruderal communities are developing along the existing road and the railway as well as on some dump sites in the vicinity of the villages. Their biodiversity and economic values is very low and thus, they were assessed as low sensitive. Conflicts situations are not expected in the case of both alternatives.

7.1.3.38. Quarries (Chapter V.5.4.3)

Quarries as habitats have very low value. In the sensitivity estimation matrix they have lowest score (2). They have economic importance which should be taken into account. The alignments of both alternatives do not represent any threat to the functioning of the quarries, although the alignment of Alternative 2 passes close to the existing quarry at Golema Javorica.

Table 40. Sensitivity estimation matrix for natural and anthropogenic habitats

HABITATS	Habitat Directive		Rare communities in Macedonia		Well preserved natural communities		Presence of species on IUCN Red List		Presence of species important for Europe		Presence of threatened birds		Presence of endemic species		Presence of rare species in Macedonia		Landscape value		Economic value		Species richness		Geomorphologic value		Geologic value		Erosion prevention		Pollution prevention value		SUM		Sensitivity	
ALTERNATIVE	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Kermes oak shrub lands - preserved	1	3	1	2	1	3	0	1	2	3	1	2	1	1	1	2	1	2	1	2	1	2	0	0	0	0	1	3	2	3	***14***	***29***	**ms**	**vhs**
Kermes oak shrub lands - sparse	1	0	1	0	2	0	1	0	2	0	3	0	1	0	2	0	1	0	0	0	2	0	0	0	0	0	2	0	1	0	***19***	***0***	**hs**	**-**
Kermes oak shrub lands - degraded	1	1	1	1	1	1	1	1	2	2	3	3	1	1	2	2	0	0	0	0	2	2	0	0	0	0	1	1	0	0	***15***	***15***	**ms**	**ms**
Phillyrea media shrub lands on rocky sites	2	2	2	2	3	3	0	0	1	1	3	3	0	0	2	2	2	2	0	0	1	1	1	1	2	2	1	1	0	0	***20***	***20***	**hs**	**hs**
Greek juniper on rocky sites	1	1	1	1	1	1	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	***13***	***13***	**ms**	**ms**
Oak forests	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	1	0	1	***0***	***13***	**-**	**ms**
Beech forests	0	3	0	3	0	1	0	0	0	2	0	1	0	1	0	1	0	2	0	2	0	1	0	0	0	0	0	3	0	1	***0***	***21***	**-**	**vhs**
Oriental plane woodlands	3	3	3	3	3	3	0	0	3	3	1	1	1	1	2	2	3	3	1	1	2	2	0	0	0	0	3	3	2	2	***27***	***27***	**vhs**	**vhs**
Oriental plane belts along streams	3	3	3	3	3	3	0	0	2	2	1	1	1	1	2	2	3	3	1	1	2	2	0	0	1	1	3	3	2	2	***27***	***27***	**vhs**	**vhs**
Oriental plane belts along ravines and gullies	3	3	3	3	1	1	0	0	1	1	0	0	0	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	***15***	***15***	**hs**	**hs**
Willow and poplar belts	3	1	1	0	3	1	0	0	2	0	2	0	0	0	1	0	2	0	0	0	1	0	0	0	1	0	3	0	1	0	***20***	***2***	**hs**	**ls**
Tamaris shrub lands	1	1	1	1	3	1	0	0	2	1	2	1	0	0	2	1	2	1	0	0	1	0	0	0	1	0	2	1	1	0	***18***	***8***	**hs**	**ms**
Sand banks with sparse	1	0	1	0	2	0	0	0	2	0	2	0	0	0	2	0	1	0	1	0	1	0	0	0	1	0	1	0	1	0	***16***	***0***	**hs**	**-**

HABITATS	Habitat Directive		Rare communities in Macedonia		Well preserved natural communities		Presence of species on IUCN Red List		Presence of species important for Europe		Presence of threatened birds		Presence of endemic species		Presence of rare species in Macedonia		Landscape value		Economic value		Species richness		Geomorphologic value		Geologic value		Erosion prevention		Pollution prevention value		SUM		Sensitivity	
Tamaris																																		
Sandstone cliffs	1	0	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	***7***	***0***	**ls**	**-**
Hill pastures - dry	1	2	1	1	1	1	1	2	1	2	2	3	1	1	1	2	1	1	1	2	2	3	0	0	0	0	1	1	0	0	***14***	***21***	**hs**	**vhs**
Chasmophytic bare rock habitats	3	3	2	2	3	3	2	2	1	1	3	3	2	2	3	3	3	3	0	0	2	2	3	3	3	3	0	0	0	0	***30***	***30***	**vhs**	**vhs**
Caves	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***	***0***	**-**	**-**
Rivers - Vardar	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	2	1	2	1	2	1	2	1	0	0	0	0	2	1	***21***	***13***	**vhs**	**ms**
Rivers - Bosava	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***	***0***	**-**	**-**
Stream - Celevecka Reka	3	3	2	2	2	2	2	2	2	2	1	1	2	2	2	2	3	3	1	1	1	1	3	3	0	0	0	0	0	0	***24***	***24***	**vhs**	**vhs**
Stream - Petruska Reka	0	3	0	2	0	2	0	2	0	2	0	1	0	2	0	2	0	3	0	2	0	1	0	3	0	0	0	0	0	0	***0***	***25***	**-**	**vhs**
Stream - Golema Javorica	0	3	0	3	0	3	0	2	0	2	0	1	0	2	0	1	0	3	0	1	0	1	0	1	0	0	0	0	0	0	***0***	***23***	**-**	**vhs**
Stream - Mala Javorica	0	3	0	3	0	3	0	2	0	2	0	1	0	2	0	1	0	3	0	1	0	1	0	1	0	0	0	0	0	0	***0***	***23***	**-**	**vhs**
Streams - all others	2	2	2	2	2	2	2	2	2	2	1	1	2	2	1	1	2	2	1	1	1	1	1	1	0	0	0	0	0	0	***19***	***19***	**hs**	**hs**
Intermittent streams (ravines)	1	1	1	1	2	2	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	***6***	***6***	**ls**	**ls**
Gullies (dry flows)	1	1	1	1	2	2	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	***5***	***5***	**ls**	**ls**
Channels	1	1	1	0	1	0	2	2	1	0	1	0	1	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	1	***13***	***5***	**ms**	**ls**
Swampy reed beds and belts	1	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	1	0	***9***	***0***	**ms**	**-**
Springs and wells	2	1	2	1	2	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	***12***	***8***	**ms**	**ms**
Anthropogenic forest stands	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	***4***	***4***	**ls**	**ls**
Abandoned	1	1	0	1	0	1	0	1	1	2	1	3	0	1	0	1	1	1	1	2	1	2	0	0	0	0	0	0	0	0	***6***	***16***	**ls**	**hs**

HABITATS	**Habitat Directive**		**Rare communities in Macedonia**		**Well preserved natural communities**		**Presence of species on IUCN Red List**		**Presence of species important for Europe**		**Presence of threatened birds**		**Presence of endemic species**		**Presence of rare species in Macedonia**		**Landscape value**		**Economic value**		**Species richness**		**Geomorphologic value**		**Geologic value**		**Erosion prevention**		**Pollution prevention value**		**SUM**		**Sensitivity**	
fields																																		
Fields and acres	1	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	2	1	3	1	1	0	0	0	0	0	0	0	0	0	***11***	***2***	**ms**	**ls**
Vineyards	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	2	1	3	1	1	0	0	0	0	1	1	0	0	***7***	***10***	**ms**	**ms**
Orchards	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0	1	0	0	0	***8***	***1***	**ms**	**ls**
Gardens	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	2	1	3	1	1	1	0	0	0	0	1	1	0	0	***10***	***6***	**ms**	**ls**
Rural settlements with sparse houses	1	1	1	1	1	1	1	1	1	1	3	3	0	0	2	2	3	3	3	3	1	1	0	0	0	0	0	0	0	0	***17***	***17***	**hs**	**hs**
Urban settlements	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	3	3	1	1	0	0	0	0	0	0	0	0	***7***	***7***	**ms**	**ms**
Roads, railways - ruderal communities	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	***4***	***4***	**ls**	**ls**
Quarries	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***2***	***2***	**ls**	**ls**
																															440	**461**		

7.1.4. SITES OF HUMAN IMPORTANCE

As already mentioned, there are some sites that do not have high value from the aspect of their importance as habitats. However, they are of great importance for the human well-being and health (Tab. 41). In the table when all the values for both alternatives are summarised it is visible that Alternative 1 is more sensitive than Alternative 2.

Table 41. Sensitivity estimation matrix for sites of human interest

Settlements/archeological sites/agricultural land	**Proximity to the alignment**		**Level of destruction**		**Recoverability**		**Costs for reconstruction**		**Noise impact**		**Air pollution impact**		**Fragmentation of agricultural roads**		**Fragmentation of local roads**		**Socio-econimic impact**		**SUM**		**Sensitivity**	
ALTERNATIVES	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
Demir Kapija town	2	2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	***7***	***7***	**ms**	**ms**
Village Miravci	0	2	0	2	0	3	0	3	0	1	0	2	0	2	0	1	2	0	***2***	***16***	**ls**	**hs**
Village Davidovo	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	***3***	***1***	**ls**	**ls**
Village Miletkovo	0	2	0	1	0	1	0	1	0	2	0	2	0	2	0	2	0	1	***0***	***14***	**-**	**hs**
Village Smokvica	3	3	1	1	1	1	1	1	2	2	2	2	1	1	0	0	0	0	***11***	***11***	**ms**	**ms**
Village Udovo	3	0	3	0	2	0	2	0	3	0	3	0	2	0	1	0	2	0	***21***	***0***	**vhs**	**-**
Village Josifovo	2	0	1	0	1	0	1	0	2	0	2	0	3	0	1	0	0	2	***13***	***2***	**ms**	**ls**
Village Marvinci	2	0	1	0	1	0	1	0	2	0	2	0	2	0	0	0	0	2	***11***	***2***	**ms**	**ls**
Abandoned village Klisura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***	***0***	**-**	**-**
Abandoned village Gradec	3	0	3	0	2	0	1	0	3	0	3	0	1	0	0	0	0	0	***16***	***0***	**hs**	**-**
Archeological site "Bandera" #1	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	0	2	2	***20***	***20***	**hs**	**hs**
Archeological site "Manastir" #2	0	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	2	***0***	***20***	**-**	**hs**
Archeological site "Church near Gradec" #4	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	2	0	***20***	***0***	**hs**	**-**
Archeological site "Turski grobishta" #7	2	0	2	0	2	0	2	0	2	0	2	0	0	0	0	0	3	0	***15***	***0***	**hs**	**-**
Archeological site "The Chappel - Udovo" #8	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	2	0	***20***	***0***	**hs**	**-**
Archeological site "Kalica" #12	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	1	***0***	***7***	**-**	**ms**
Archeological site "Megdan" #13	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	***0***	***4***	**-**	**ls**
Archeological site "Chaushevec" #15	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	1	***0***	***7***	**-**	**ms**
Archeological site "Gudlanica" #16	0	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	3	***0***	***21***	**-**	**vhs**
Archeological site "Trskata" #17	0	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	3	***0***	***21***	**-**	**vhs**
Archeological site "Mushnica" #20	0	3	0	3	0	3	0	3	0	3	0	3	0	0	0	0	0	3	***0***	***21***	**-**	**vhs**
Archeological site "Agova Cheshma" #22	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	***1***	***4***	**ls**	**ls**
Archeological site "Tufka" #23	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	***1***	***4***	**ls**	**ls**
Agricultural land - fields and acres	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	3	2	***27***	***18***	**vhs**	**hs**

Settlements/archeological sites/agricultural land	Proximity to the alignment		Level of destruction		Recoverability		Costs for reconstruction		Noise impact		Air pollution impact		Fragmentation of agricultural roads		Fragmentation of local roads		Socio-econimic impact		SUM		Sensitivity	
ALTERNATIVES	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Agricultural land - vineyards	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	3	1	***27***	***9***	**vhs**	**ms**
Agricultural land - orchards	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	***18***	***9***	**hs**	**ms**
SUM																			***233***	***218***		

7.2. IDENTIFICATION OF CHARACTERISTIC REGIONS AND OBJECT ALONG HIGHWAY DEMIR KAPIJA - GEVGELIJA

Several sites along the highway corridors were identified as characteristic and extremely sensitive.

Alternative 1

- Demir Kapija canyon - limestone cliffs - nesting site for vultures (protected area)
- Chelevechka Reka (protected area)

Alternative 2

- Demir Kapija canyon - limestone cliffs - nesting site for vultures (protected area)
- Chelevechka Reka (protected area)
- Golema and Mala Javorica watersheds
- Shtuder - Greek juniper habitat
- Kalica watershed
- Petrushka Reka gorge
- Trskata - archaeological site
- Gudlanica - archaeological site
- Mushnica - archaeological site

8. ASSESSMENT OF THE IMPACTS

The impact of a highway on the environment may be split into impacts during construction and during operation.
The construction phase is limited and will cause several impacts as noise and vibrations. These effects are temporary. During operation e.g. noise and immission of pollutants have to be assessed.
The impacts on the environment are described in the following chapters.

8.1. GENERAL ASPECTS OF IMPACTS FROM ROAD CONSTRUCTION AND OPERATION

Current design of the Alternative 1 foresees modern two lane highway with projected speed limit of 80 km and 100 km/h. Alternative 2 alignment is pre-designed for 110 km speed limit.

The project involves several aspects, starting from road construction to supervision, so it has to be stressed that incorporating the road in the existing ambient is a difficult and very responsible task. The document regarding the natural environment, put forward by the World Bank, is one of the most demanding with respect to satisfying all given requirements, thus the studies of impact assessment must follow the investment/technical documentation for each investment object.

The experience and practice in road construction in Macedonia, as well as the impact over the natural environment are generally reflected in the following:

- Establishing a proper alignment/route is definitely a difficult challenge if the road designers tend to satisfy the technical aspects of the road and conserve the natural environment. Large scale deforestation, degradation of vegetation, destruction of valuable habitats and sites, fragmentation of habitats and cut of important biocorridors often accompany road construction.
- In the beginning of the road construction, small local or agricultural roads and water courses are being neglected, and every usage of materials other than previously defined in the design can result with misbalance of the conditions in the natural environment, and can affect the morphological and aesthetic characteristics.
- The greatest number of weaknesses are manifested in the designing of the body of the road (cuts, channels, embankments), because these surfaces are incorrectly or insufficiently processed. Forestation, or other ways of cultivating the degraded soil are frequently omitted or are inadequately performed.

- Designed temporary landfills often remain waste locations after the road construction. In the process determining of these localities the final decision is often reached by the designers/constructors, while previously arranged localities are not used for these purposes.
- In the evaluation of soil categories, often wrong estimates for the soil quality and extent of exploitation are given, while re-cultivation of degraded localities is almost never performed.
- Ecologically misplaced quarries that continue to operate after the road is constructed have to be pointed out as serious threats to the natural environment.
- Road construction further impacts the environment by noise from mining, construction machines, dust production, soil and forest degradation, filling of river beds, or lakes, etc.
- The geo-technical risk is predominant during road construction and estimating its contribution to the general risk for the environment is a key issue in order to assess its acceptable levels. During road construction, the most frequent geo-technical hazards in mountain/hilly ecosystems are the following:
    - changes in morphological characteristics
    - processes of surface degradation, landslides, and intensified erosion
    - possible changes in underground or surface water regime
    - possibilities of large pollution of the geological environment due to accidents in waste transport and permanent micro-pollution
    - Indirect changes of the geological environment due to changes in the biodiversity, microclimate changes, etc.

The most important and the most devastating (the largest scale) impact of the road construction and operation is when it is constructed in natural areas, previously under low human impact (in the case of the area of project intention it is especially the alternative 2). In general, the living communities of certain area are closely related with the ecological characteristics of the same area. The disturbance of single or more ecological parameters is directly manifested on the community, firstly by reduced abundance of the populations from the most sensitive species (primary bio-indicators for the ecological changes), than they are disappearing and are displaced by other species that are possessing wider ecological valence and appear as competitive superior species. These processes develop successively and in the starting phases they are practically unnoticeable, because they first appear within the organisms of lower level of organization and complexity.

However, certain species of birds and mammals, as well as, certain amphibians, reptiles and invertebrates will be expanding. This concerns the species that are less sensitive, with higher adaptive potential that will enlarge the abundance of their populations as a result of the new sources of food. Other possibility is that intruder species from lower altitudes or from surrounding will penetrate (species that adapt easily in human environment),

and a strong competition will appear between the indigenous species for and the intruders.
The following direct effects of road construction and operation on the terrestrial and aquatic ecosystems and communities are the most important (Trombulak and Frissell 2000):

- Mortality from road construction,
- Mortality from collision with vehicles (road operation),
- Modification of animal behaviour,
- Fragmentation and isolation of populations
- Disruption of the physical (non-living) environment,
- Alteration of the chemical characteristics of the environment (pollution),
- Spread of the alien (allochtonous - invasive or exotic) species,
- Changes in human use of land and water.

Indirect effects are possible as well:

- Better access of humans into the wilderness areas,

Cumulative effects (complex interaction of different factors), etc. are possible as well.

8.2. IMPACTS FROM THE ROAD CONSTRUCTION

Generally, the road construction will affect the environment in numerous and various ways. Some of these impacts (for both Alternatives) are listed bellow:

- Permanent change of the landscape by introducing a new man maid object
- Deposition of rocky and sandy materials in the rivers and streams water courses
- Degradation of certain plant communities and vegetation
- Degradation of some animal communities by affecting the communication between habitats (fragmentation of habitats)
- Wildlife migration caused by noise, and the presence of humans and mechanization
- Local contamination of soil from explosives, gasses, motor oils, etc.
- Creating conditions for development of new geo-exodynamic processes
- Destabilization of unstable terrain and inflicting landfalls resulting with degradation of vegetation and deposition of materials in the valleys
- Intensive soil pollution caused by mechanization accidents and spilling of fuels and motor oils
- Possible fires provoked by human carelessness, which can result with total destruction of vegetation and profound changes in the biodiversity. This is especially important during the period July - September, a period of high temperatures and droughts.

Genrally both alternatives will have the same amount of impacts during the road construction since it is limited only on noise and vibrations.

8.2.1. IMPACT ON THE FOREST ECOSYSTEMS AND PASTURES

Large part of the alignment, especially in case of Alternative 2, will pass through forested and hill pastures areas:

- Kermes oak woodlands and shrublands (see Chapter V.1.1.1. and VII.1.3.1.-VII.1.3.4.)
- Thermophyllous oak forests (see Chapter V.1.2. and VII.1.3.5.)
- Beech forests (see Chapter V.1.3. and VII.1.3.6.)
- Oriental plane forests (see Chapter V.1.4.2. and VII.1.3.7.) and
- Zone of dry grasslands (see Chapter V.2.1. and VII.1.3.13.).

Thus, the construction of the road will have significant impacts expressed by the direct destruction of some habitats' parts, plants and some animals.

8.2.1.1. Forest ecosystems

The most affected forest ecosystems will be Kermes oak shrublands and Oak forests at number of localities, which, as it has already been mentioned, are included in the list of high sensitive habitat types (See Chapter VII.1.3.). Some parts of the Plane belts and Willow belts will be severely disturbed, as well.

The impacts on forest will result in the following disturbances:

- **Fragmentation** - this is especially important for the riparian (Plane and Willow) woodlands and belts. Fragmentation includes biodiversity aspects and socio-economic aspects. At the present moment there are number of forest roads that will intersect with both of the alternatives (Tab. 52 and 53). This impact is assessed as significant.
- **Direct destruction** – road construction will inevitably cause direct destruction of forested areas. In order to estimate the significance of this impact an analysis of the surface of destruction was performed (Tab. 42). The length of the highway that passes through different habitat types was multiplied by 50 m - width of the destruction of habitats in order to obtain the surface of the area to be destroyed. The destruction caused by the construction of access roads, work camps and parking lots was not estimated separately.

Estimation of the forested surface that will be destroyed during the construction of the highway (Alternatives 1 and 2)

Forests, shrublands and plantations	Alternative 1		Alternative 2	
	l (m)	s (ha)	l (m)	s (ha)
Well preserved pseudomaquis	10171	50.9	11778	58,9
Sparse pseudomaquis	4440	22.2	5635	28,2
Highly degraded pseudomaquis	3868	19.3	3490	17,4

Greek juniper on rocky sites	0	0	534	2,7
Oak forest	0	0	727	3,6
Conifer stands	0	0	0	0
Poplar stand	0	0	0	0
Willow stands and belts	164	0.8	131	0,7
Plane stands	0	0	70	0,4
Plane belts	690	3.5	1498	7,5
Total	**19333**	**96.7**	**23863**	**119.3**

l – Length of the intersection with the respective alternative; s – surface of the forest that will be destroyed during the construction.

Alternative 1 - Considerable surface of well preserved pseudomaquis (50.9 ha) will be cut during the construction works. Sparse and degraded pseudomaquis will be destroyed on surfaces of 22.2 and 19.3 ha, respectively. Highway route of Alternative 1 will cross more than 40 streams, rivulets and gullies, thus the potentially destroyed surface of Plane belts will be approximately 3.5 ha. The total area of destroyed forests will equal 96.7 ha.

Alternative 2 - Larger surface of forested area will be destroyed during the construction of Alternative 2 - 119.3 ha.
The most affected habitat type will be well preserved pseudomaquis (53.2 ha). Oak forest (forest of Pubescent oak and Oriental hornbeam) which provides the best-quality wood will be destroyed on a surface of about 4 ha. Considerable surface of Plane belts (4.6 ha) will be affected during the intersection of the construction works with more than 60 streams, small rivers, rivulets and gullies.

It is visible that the impacts considering the forest destruction will be more rendered at Alternative 2, since the area is larger and the wasted trees will be more then Alternative 1.

8.2.1.2. Dry grasslands (hill pastures)

Dry grasslands are high sensitive habitat type. However, they cover small surfaces, mostly in the area of highly degraded pseudomaquis. There are only a few proportionaly larger areas of dry grassland.

Alternative 1 - The most important sites are near village Gradec and near village Smokvica (both alternatives)

Alternative 2 - The most important sites are in the valley of the stream Kalica, and near village Smokvica (both alternatives).

Direct destruction of dry grasslands during the road construction is the most probable impact that can be mentioned. Although dry grasslands are important habitat type according to the Habitat Directive, the impacts on dry grasslands in the corridor area can be considered as not significant. Anyway Alternative 2 will have larger impact then Alternative 1, since it passes in more areas with dry pastures (grasslands).

8.2.2. IMPACT ON THE RIVERS AND STREAMS

The proposed highway (both alternatives) crosses an area with many hills and valleys except the last few km which is almost flat plain. In this region many surface waters (rivers, streams) are present close to the proposed motorway alignments. The groundwater surface is typically 15 m below the ground surface in the areas close to Vardar River and deeper in the hilly areas. At the time of the inspection standing waters were identified at several locations close to the river Vardar level. Aquatic receptors comprise the groundwater and the surface water channels. The unsaturated zone above the groundwater table is very shallow and the sandy soil can be very permeable. It is thus considered to be sensitive receptor.

Based on the project details and the baseline environmental status, potential impacts as a result of the construction of the proposed motorway have been identified.

During the construction phase about 100 to 250 workers would be deployed on various works. However, on an average the number of workers would be around 150 in the construction works. Contamination of water ecosystem with solid (plastics, metal, and glass) and communal waste etc. can be significant. Inadequate provision of portable restrooms and garbage dumpsters at the construction site could lead to unsanitary conditions. Resulting impacts could vary from unsightly littering of the site, fly and vermin infestations to increased nutrient levels in the stream leading into the rivers and streams. Reliable sewage treatment systems and portable restrooms must be provided in the first stage of the construction works.

The topography of the area is not adverse to road construction and threat of erosion due to road construction is very high. The runoff from the construction sites will have a natural tendency to flow towards river Vardar or its tributaries. Removal of vegetative cover and the subsequent excavation activities required for infrastructure installation (paving of roads, lying of water/sewage pipes, electrical cables, etc.) will impact the existing drainage patterns in the area. The removal of trees and shrubs would reduce the existing forest cover, resulting in irreversible loss of natural habitat for flora and fauna particular to the area.

Loss of topsoil due to soil erosion as well as excessive runoff into the river, are causes for concern which must be addressed prior to the clearing phase. Soil erosion will remain a problem during the clearing as well as during the construction phases of the project. Lack of proper drainage ways could result in localized pooling and flooding. Excessive runoff, especially during heavy rains, could also lead to elevated nutrient loading into the rivers. Due to erosion and possible sewage waters increased levels of nutrients and salinity in receiving waters is possible. This can result in the overgrowth of algae (eutrophic conditions). Eventual die off of these algae result in increased oxygen demand associated with their decay. For some distance downstream of major construction sites, there is a possibility of increased sediment levels which will lead to reduction in light penetration and increase in turbidity.

Additional impact on water ecosystems is changes of the water flow in streams as result of filling with construction materials including stones, concrete waste, wood, steel and packaging plastics could be dispersed and could end up blocking the stream flow.
This will cause temporarily alterations of the local flow regime that will have great impact on hydrobionts due to the habitat loss and changes in water quality (nutrients, pH and conductivity).
Projected impacts of the construction works are associated with the need to dispose of sewage water and storm water run off. Where the disposal of these is carried out without taking into consideration environmental imperatives the following can result in increased oxygen demand in receiving waters resulting in lowering of dissolved oxygen possibly to critical levels particularly during the night. Deterioration in water quality caused by pollutants, either through spillages of liquids or runoff contaminated with liquids or particulate matter, or interception, disturbance and mobilisation of pollutants in existing areas of contaminated ground. Increased contamination of ground water due to drainage of sewage into the aquifers can be also significant. Area of construction is characterized by large quantities of ground waters used for different purposes. Decreasing of water quality of these waters will have great environmental impact in the area, because all ground waters are interconnected among each other and also with surface waters (rivers Vardar, Anska etc).

The project construction would entail significant vehicular movement for transportation of large construction material, heavy construction equipment. During construction phase, various types of equipment will be brought to the site. (Batching plant, drillers, earthmovers, rock bolters, etc) The storing and working space requirement of these construction equipments would be significant. In addition, land will also be temporarily acquired, i.e. for the duration of project construction for storage of the quarried material. A storage area should be selected in such a way that it leads to minimal impacts on forest cover, water ecosystems, wildlife etc.

It can be concluded that both variants will have the same impact on the surrounding environment.

8.2.3. IMPACT ON FLORA AND FAUNA

There are populations of some sensitive plant species in proximity to the road route which are characterized by limited distribution. The destruction of some Plane trees is recognized as the most possible impact during the road construction in the areas of streams, dales, ravines and gullies. According to the field research results there are some old trees of Oriental Plane that deserve special attention during the construction (Photo 72). The destruction of Plane trees, especially old ones, will alter the functional properties of Plane belts and disturb the appearance of the areas along running waters. It has cumulative effect on landscape characteristics as well. Several other rare plant species will be damaged but significant destruction of their populations is not expected.

Photo 72. An old tree of Oriental plan (Platanus orientalis) along Mala Javorica stream

Permanent destruction of important plant species quoted in Chapter V.6.3 is not expected in both alternatives if proposed mitigation measures are respected.

Impacts on the invertebrate fauna during the road construction are not expected to be significant.

The construction of the highway will cause direct interruptions in the breeding cycle (clutch loss) and decrease in the breeding success of the birds breeding along the highway corridor. Most affected will be the bird community of the pseudomaquis, which holds significant number of species with unfavorable conservation status. This is also true for the arable fields and oak forests. The passerine species (Shrikes, Thrushes, Warblers, Tits, Finches and other families), will be most affected by fragmentation and direct habitat lost (both for breeding and foraging), but depending on the locality, highway constriction will also strongly influence the breeding behavior of some raptors. The most sensitive areas in this direction are the cliffs of Demir Kapija and their nearest surrounding.

As far as the alternative 1 along the left bank of Vardar River is concerned (Alternative 1 and Alternative 2 – beginning section), close to the exit point of the first tunnel in Chelevechka River an old nest of Egyptian Vulture exist, that might be re-occupied during 2007, as a non-breeding pair was observed in 2006 on this location. On the cliffs of exit point of the second tunnel the old nests of Griffon Vultures are located, and one of them was active in 2006. With expected growth of the Demir Kapija colony these sites will be re-occupied, and the Employer should take care that minimal damage is done to the cliff (see also "mitigation measures").

Mining activities in the area of Demir Kapija limestone canyon

The conflict arises from very high sensitivity of this complex locality. The complexity is a result of presence of different biotopes settled by rare and endangered species, especially bird species. The risk for these species arises from the construction work. The mining is inescapable since the tunnel has to be staved through Jurassic limestone rocks. Although the area of the canyon was assessed as very high sensitive (see Chapter VII), the highway line must pass through the canyon since there is no other solution (the canyon is extremely narrow and both sides of the river are valuable). The conflict becomes the most expressed during the breeding period of vultures (laying eggs, incubation period and fledging, from January to July).

Other conflict connected to this area that may arise from constriction work is damaging or destroying the protected area Chelevechka Reka (see Chapter III.2.2.1.). For this particular part, the conflict is not just during the construction period but also during the highway operation (due to the pollution of the stream). In this case, as it was the case with previous, the recommendation for changing the route is not possible (at the other side of the river Vardar, the Bela Voda cave is situated next to the river which may produce another conflict).

The most important influence of the construction work is mining. It has negative effects on both plant and animal species and communities, especially birds (vultures). Its effects can be mechanical (destruction of habitat and covering), sound, vibration and pollution (dust etc.).

Since the proposed alignements for both alternatives have the same route the impacts on the environment will be the same regardless of alternative chosen.

Flora and fauna are part of the forest ecosystems and they always go together as a nonbrakeable union. Therefore in the table for impacts during road construction those two impacts are presented as one under impact on forested ecosystems.

8.2.4. IMPACT ON AGRICULTURE

As noted in Chapter VI.2.1., agriculture is the most important economic activity in the broader area of highway corridor. The most important impact on agricultural land during road construction is destruction of agricultural land. The surface of agricultural land that will be destroyed if Alternative 1 is accepted equals 56.6 ha. In the case of Alternative 2, significantly smaller agricultural land will be destroyed (approximately 10 ha).

Estimation of the agricultural land surface that will be destroyed during the construction of the highway (Alternatives 1 and 2)

Land use types	Alternative 1		Alternative 2	
	l (m)	s (ha)	l (m)	s (ha)
Fields and acres	10480	52.4	1718	8.6
Vineyards	812	4.1	182	0.9
Orchards	20	0.1	49	0.2
Total	**11314**	**56.6**	**1949**	**9.7**

The fragmentation effect on agricultural land caused by the construction works and access road will have only temporal effects and thus it is not considered as significant.

It is visible that Alternative 1 will have much more negative impacts than Alternative 2 due to several times larger area destroyed by the construction works, and unrecoverable loss of arable land used by the population.

8.2.5. IMPACT ON THE SETTLEMENTS (NOISE, AIR POLLUTION)

Construction of the highway will have negative impact on the settlements in the road corridor (town Demir Kapija and villages: Udovo, Josifovo, Marvinci, Miravci, Davidovo, Miletkovo and Smokvica) on a short term air pollution and human health (see Chapter VIII.2.8. and VIII.2.13.), short term noise nuisance (see Chapter VIII.2.10.1.), visual effects, landscape destruction, waste generation (see Chapter VIII.2.17., Chapter VIII.2.9.) and others. Villages Udovo and Marvinci (if Alternative 1 is to be accepted) and Marvinci and Miletkovo (in case of Alternative 2) will be more affected due to the proximity of the alignment.

All these impacts, along with the mitigation measures implemented, can be considered not significant compared to the benefit that modern road connection gives to the region or compared to the long term operation effects.

Anyway both alteratives are starting and ending at the same point where two settlements are affected (Demir Kapija and Smokvica). At the other hand both alternatives are passing near settlements, Udovo and Marvinci for Alternative 1 (several meters from the houses) and Miravci and Miletkovo for Alternative 2 (several hundred meters from the houses). The alignment of Alternative 1 is much closer to the settlements then the alignment of

Alternative 2, so it can be considered that **noise and pollution impacts are more severe for the Alternative 1**.

8.2.6. IMPACTS ON ARCHAEOLOGICAL SITES

Besides the archaeological localities already mentioned (Chapter VI.7.), many other sites of cultural and historical importance are distributed along the existing road corridor.

Some of these localities have great historical importance. Some of them are very close to the existing motor road, and some are simply cut by the road. Due to this, the area of Demir Kapija, as also from village Marvinci up to village Smokvica is mostly very high sensitive and consequently many conflicts may arise during the construction works. Another very sensitive area is the one between villages Marvinci and Smokvica. Destruction of archaeological sites or their parts is irreversible which represents high concern.

As presented in the baseline situation, the area is rich in cultural heritage. Monuments under special protection regime are close to construction undertaking. Unknown archaeological sites might be found during the construction of the highway. Therefore it is suggested to pay special attention to this potential impact.

From the investigation works carried out during the preparation of this study it is clear that Alternative 2 has more potential archaeological sites that can be found than Alternative 1, so it can be considered as an alternative with more impacts.

8.2.7. RAW MATERIALS AND ENERGY RESOURCES FOR CONSTRUCTION

The quantities of raw materials and energy resources used for construction were discussed in Chapter II.1.2. The impact of these materials is discussed in respective chapters (air, soil, water, waste etc.).

For both variants there will be the same need for raw materials and energy resources, maybe a little bit more for Altrenative A since it is 4.5 km longer than the other thus requiring more materials and resources.

8.2.8. IMPACT ON AIR QUALITY

Human health is considered as the most significant aspect of the air pollution impact. Thus, the human residential areas would be the most affected. The level of emissions and duration of the construction period will not exceed the carrying capacity of the natural ecosystems.

A certain increase of air pollution in the broader area of interest will certainly occur due to the increased traffic frequency (trucks carrying raw materials for construction). However, these emission levels will be insignificant for human health since the number of trucks per day will be mostly bellow 100.

Individual sources of air pollution related to construction of the road can be classified into different categories, like point-sources, linear sources or non-point air pollution sources.

During the construction period the major air emission sources will be represented by the construction machinery and heavy-duty trucks. The emitted substances will be, first of all, carbon dioxide, nitrogen oxides and aromatic hydrocarbons. With respect to expected extent of the construction it will be only short-term to medium-term emissions in the area of construction site and along transport routes for building materials.

Air emissions during the construction period cannot be estimated reliably, as either supplier of construction works or construction machinery and heavy duty truck to be used are not specified yet.

Emission of pollutants from the linear sources of pollution was not calculated due to low traffic intensities of heavy duty trucks related to the construction of the road. It is generally accepted that dispersion modelling for changes in traffic intensities lower than 100 cars per day is inaccurate and it is not necessary to carry out it due to negligible impact of traffic on the ambient air quality.

This applies for both alternatives equally since the construction works will be carried out in mostly nonpopulated areas.

8.2.9. IMPACT OF THE SOLID WASTE

Waste related to construction of the highway section Demir Kapija - Smokvica will be diverse and produced in large quantities (see Tab. 45). Most of the waste will be inert waste, but also large quantities of hazardous and toxic waste are expected to be generated.

The impact of toxic waste is dangerous for the environment (soil, ground water, surface waters, but also air - volatile compounds from the waste) and it causes pollution. Biodegradable waste (organic materials) can cause eutrophication of streams and rivers. Inert waste (soil, concrete etc.) can occupy large land surfaces and can disturb the landscape appearance.

Composition of waste and their quantities should be determined, where possible and purposeful, based on experience of the designer.

Excavated soil is waste type, which will be produced in largest quantities during the construction of the road. Another waste, which is expected to be produced in relatively large amounts, is waste of wood, bricks, concrete, or mixtures of these construction materials.

It can be expected that hazardous waste will comprise different types like waste oils and possibly residues of organic solvents and thinners, remainders of colours, packings contaminated with hazardous substances, cleaning fabrics, remains of insulation and construction materials containing hazardous

substances (e.g. tar), etc. These materials should be collected separately, in adequate containers, which comply with requirements of relevant legislation in force.
Also hazardous wastes shall be in preference re-used and/or re-cycled (for example recycling of waste oils) or disposing of in the landfill for hazardous waste (Drisla). Basic principle related to hazardous waste is, that hazardous waste must not enter into municipal waste.
Types of waste that would originate during construction period are presented in Tab. 45. The list is not final, because during construction activities creation of another type of waste cannot be excluded.
The largest volume of waste produced during the road construction will consist of excavated soil and rocks. This quantity can be calculated on the basis of the road design, but it does not exist for the time being (at least for the Alternative 2). Any way it is visible that this kind of waste will be larger for Alternative 2 due to hilly terrain it passes by. Major part of excavated soils will be utilized for road lining and field-engineering or deposited on temporary deposits for subsequent use. Quantities of other wastes, which will originate during construction of the road, cannot be specified precisely. Specific category of waste will be communal waste produced in work camps.
If properly managed and due to the short duration of the construction works, the impact of waste generated from the construction works on the environment can be considered insignificant.

Wastes originating during road construction period

Catalogue number	Kind of waste	Category
08 01 11	Waste colours, varnish containing organic solvents or other hazardous substances	Hazardous
08 01 12	Other waste colours and varnish not listed under the number 08 01 11	Hazardous
12 01 13	Waste from welding	Other
14 06 02	Others halogenated solvent and mixtures of solvent	Hazardous
14 06 03	Others solvent and mixtures of solvents	Hazardous
15 01 01	Paper and fibre packing	Other
15 01 02	Plastic packing	Other
15 01 03	Wooden packing	Other
15 01 04	Metal packing	Other
15 01 06	Mixed packing	Other
15 01 10	Packing containing remains of hazardous substances or polluted with those substances	Hazardous
17 01 01	Concrete	Other
17 01 02	Bricks	Other
17 01 03	Tiling and ceramic products	Other
17 01 06	Mixtures or separated fractions of concrete, bricks, tiling and ceramic products containing hazardous substances	Hazardous
17 01 07	Mixtures or separated fractions of concrete, bricks, tiling and ceramic products containing hazardous substances not listed under the number 17 01 06	Other

17 02 01	Wood	Other
17 02 02	Glass	Other
17 02 03	Plastics	Other
17 02 04	Glass, plastics, wood containing hazardous substances or polluted with hazardous substances	Hazardous
17 03 02	Asphalt mixtures not listed under number 17 03 01	Other
17 04 05	Iron and steel	Other
17 04 07	Mixed metals	Other
17 04 08	Cables	Other
17 04 11	Cables not listed under numbers 17 04 10	Other
17 05 01	Soil and stones (clean)	Other
17 05 03	Soil and stones containing hazardous substances	Hazardous
17 09 03	Other mixed construction and demolition waste containing hazardous substances	Hazardous
17 09 04	Mixed construction and demolition waste not listed under numbers 17 09 01, 17 09 02 and 17 09 03	Other
20 02 01	Biodegradable waste	Other
20 02 03	Other biodegradable waste	Other
20 03 01	Mixed municipal waste	Other

In terms of waste both Alternatives will have the same impact due to the equality of works carried out for construction. Slightly larger waste materials from excavation works are expected for Altrenative 2 because the earth masses and their balance is larger then Alternative 1.

8.2.10. IMPACT OF THE NOISE AND VIBRATIONS

8.2.10.1. Noise

8.2.10.1.1. Basic introduction and legislation

Noise is typically measured in units called decibels (dB), which are ten times the logarithm of the ratio of the sound pressure squared to a standard reference pressure squared. Because loudness is important in the assessment of the effects of noise on people, the dependence of loudness on frequency must be taken into account in the noise scale used in environmental assessments.

Common noise levels

Sound Source	dB(A)
Military jet, air raid siren	130
Amplified rock music	110

Jet takeoff at 500 meters Freight train at 30 meters Train horn at 30 meters	100 95 90
Heavy truck at 15 meters Busy city street, loud shout Busy traffic intersection	80
Highway traffic at 15 meters, train	70
Predominantly industrial area	60
Light car traffic at 15 meters, city or commercial areas or residential areas close to industry	50
Background noise in an office Suburban areas with medium density Transportation Public library	40
Soft whisper at 5 meters	30
Threshold of hearing	0

Source: Cowan, James P. Handbook of Environmental Acoustics. Van Nostrand Reinhold, New York, 1994. Egan, M. David, Architectural Acoustics. McGraw-Hill Book Company, 1988.

Frequency is the rate at which sound pressure fluctuate in a cycle over a given quantity of time, and is measured in Hertz (Hz), where 1 Hz equals 1 cycle per second. Frequency defines sound in terms of pitch components. In the measurement system, one of the simplified scales that accounts for the dependence of perceived loudness on frequency is the use of a weighting network—known as A-weighting—that simulate response of the human ear. For most noise assessments the A-weighted sound pressure level in units of dBA is used in view of its widespread recognition and its close correlation with perception.

In this analysis, all measured noise levels are reported in dB(A) or A-weighted decibels. Common noise levels in dB(A) are shown in Tab. 46.

Generally, changes in noise levels lower than 3 dBA are barely perceptible to most listeners, whereas 10 dBA changes are normally perceived as doublings (or halvings) of noise levels. These guidelines permit direct estimation of an individual's probable perception of changes in noise levels:

Average Ability to Perceive Changes in Noise Levels

Change dB(A)	Human Perception of Sound
2-3	Barely perceptible
5	Readily noticeable
10	A doubling or halving of the loudness of sound
20	A dramatic change
40	Difference between a faintly audible sound and a very loud sound

Source: Bolt Beranek and Neuman, Inc., *Fundamentals and Abatement of Highway Traffic Noise*, Report No. PB-222-703. Prepared for Federal Highway

Administration, June 1973.

Limits for noise levels used in this study are adapted from regulations of Macedonia, the WHO, and Countries of the European Community. The used limits are as follows:

Existing residential area	day	60 dB(A)
School	day	57 dB(A)
Planned, future residential area	day	55 dB(A)
Existing residential area	night	50 dB(A)
Planned, future residential area	night	45 dB(A)

The Republic of Macedonia addresses the issue of noise in the Law on Prevention of Harmful Noise Impact (The Official Gazette of SRM No. 21/84). The maximum allowed noise levels, classified for area structure type and area use category, is based on the decision to specify cases and conditions under which the peace of citizens is considered to be disturbed by noise (The Official Gazette of SRM No. 64/93). Based on this very precautious background, the maximum equivalent indoor noise levels for residential as well as mixed business/residential area buildings are 40 dB(A) for daytime and 35 dB(A) for night time. Outdoor limits for residential and leisure areas are 55 dB(A) at daytime and 45 dB(A) at night time.

The World Health Organisation (WHO) 1996 suggests guideline values for average outdoor noise levels in residential areas of 55 dB(A) at daytime and 45 dB(A) at night time, however, commenting that lower noise levels may disturb sleep depending on the individual sensitivity, the type of noise source and the overall noise situation.

The Member States of the European Community practice basic limits from 58 to 62 dB(A) at daytime and from 48 to 55 dB(A) at night time measured as equivalent noise level (LAeq) at the outside walls of buildings in residential areas adjacent to new roads.

In this study we recommend to limit average exposure to 60 dB(A) at daytime and 50 dB(A) at night time in already existing residential areas. For the planning of future residential areas it is recommended to consider the WHO-guideline values of 55 dB(A) at daytime and 45 dB(A) at night time.

8.2.10.1.2. Noise impact

One of the most significant impacts caused by traffic is noise impact in human settlements and recreational sites. Generally, great part of the population feels annoyed from noise caused by road traffic.

Noise impact can cause a variety of diseases in human beings, like e.g. circulatory troubles, hardness of hearing or nervous system troubles. New medical investigations even show correlation of noise impact with cardiac infarction.

Although, the highway crosses less populated areas, the noise impact from traffic will affect several residential areas, due to the close distance to the planned alignment.

The equivalent noise level at night time in residential areas is the essential criterion for evaluation of the noise impact, due to the higher share of very noisy vehicles (busses, heavy and long vehicles) and the lower applicable noise standards for the night.

Noise generating activities during construction comprise operation on work sites by heavy machinery and noise from construction related traffic. Their appearance is not equal in the whole area due to the differences in petrographic composition, elevation, climate and forestation of the terrain.

Construction machinery and trucks used for the transport of construction materials usually generate noise with an intensity of 85-90 dB(A) at the source, while the noise propagation will depend on the climate (wind speed, moisture, air pressure etc.), morphology, absorption capacity of vegetation and other factors whose differences may impede projections of the noise intensity at various distances from the source.

Sound pressure levels dB[A] at 10 m distance produced by different types of construction machinery and trucks

Typical representative of technology group of construction machinery	Sound pressure level dB[A] at distance of 10 m from source
Large universal loader	76
Bulldozer	69
Vibratory roller	78
Excavator on caterpillar chassis	69
Truck-mounted crane (only motor of the crane)	71
Heavy duty truck	80 – 85

The alignment of Alternative 1 is much closer to the settlements then the alignment of Alternative 2, so it can be considered that noise impacts will be more severe for the Alternative 1.

8.2.10.2. Vibrations

Impact by vibration generated by construction activities and future vehicle traffic might become relevant for buildings and especially for objects at archaeological localities, which are located close to the alignment.

Ground vibrations are caused by blasting operations, rock bursts and bumps. Blasting operations damage buildings and regular vibrations cause annoyance. Ground movement due to vibration can be controlled by avoiding overcharging, use of delays and improve blasting technology. Tectonics (geological formations) and seismics (terrain stability) should be kept at minimum. Buildings likely to be affected may be protected by trenching.

The potential for resonance of these buildings shall be investigated to identify potentially sensitive structures.

Vibration is caused during construction of the alignment by soil moving machines (e.g. bulldozers, trucks) and from soil compaction measures. Since vibration decreases very fast with the distance, potentially adverse effects could be possible only for very short distances up to 30 m. Therefore, nearby buildings might be a resonator for the vibrations generated during construction. At larger distances of 50 m to 100 m, vibrations might cause annoyance. Provided daytime construction, no vibrations might affect night's rest.

The alignment of Alternative 1 is much closer to the settlements then the alignment of Alternative 2, so it can be considered that vibration impacts are more severe for the Alternative 1.

8.2.11. IMPACT ON THE SOCIAL ASPECTS

Construction works bring certain positive socio-economic impacts. For the implementation of the complete construction works there will be a need to recruit about 50 unqualified persons or more (periodically much more), which will be present at the construction site during one shift only, so additional buildings for accommodation of workers will not be required. Local population could be considered to respond these employment needs, however some qualified staff will be required for the engineering and supervision works, which should be recruited from Demir Kapija and other more densely populated areas.

There are several houses along the road alignment in the Alternative 2 (along the stream Kalica, village Miravci area). These houses (not inhabited permanently) are marked on the Habitat map (Appendix I.4.). At least two of them are almost directly on the alignment and will be destroyed.

Anyway the impacts are more positive than negative for both alignments.

8.2.12. TRANSPORT

The size of transport (traffic) for road construction needs was discussed in Chapter II.1. Transport as an economic sector will have positive effect on the inhabited areas (settlements and villages) in the area of project interest and in the broader affected area (intensified trade activities in the villages). Negative impacts of transport on the environment are discussed in the respective chapters (soil, air, water etc.).

8.2.13. IMPACT ON HUMAN HEALTH

Impact of the highway construction on the human health can be considered only for the settlements close to the alignment (town Demir Kapija and village Smokvica (both alternatives), villages Udovo, Josifovo and Marvinci (alternative 1), Miravci and Miletkovo (Alternative 2). Such impact can result from air pollution emission (see Chapter VIII.2.8.) and to a limited extent to the noise generation (see Chapter VIII.2.10.1.2.). The exact extent of impact on human health can only be assessed after establishment of definite road alignment in the road design (for Alternative 2).

However, one can predict sufficiently accurate that the level of impact would not be significant due to the reasonably short duration of the construction activities.

8.2.14. OTHER IMPACTS

Other impacts that can occur during construction of the highway and should be assessed are radiation and odour (smell).

8.2.14.1. Radiation

Radioactive radiation

Within the road construction site there will be no sources of ionizing radiation (pursuant to the provisions of the Decree No. 59/1972 Coll. on the Protection of Health against Ionizing Radiation by the Ministry of Health). No materials that could be a source of radioactivity will be used within construction site - road corridor. All used materials will comply with the limit activity values pursuant to the Decree of the Ministry of Health No. 76P/1991 Coll. and should be supplied with a certificate proving their adherence to such limits.

Electromagnetic radiation

Present levels of electromagnetic radiation within the area of interest were not monitored. However, no significant levels of radiation are expected with respect to the construction site into the un-built (residential) area.

With the exception of common telecommunication appliances such as mobile phones there will be no other systems that would generate electromagnetic radiation within the construction site. Under standard operation there will be no source of electromagnetic radiation.

The impacts of high-frequency (HF), infra-red (IR), visible, ultraviolet (UV) and ionizing radiation may have short-term effects in the course of construction activities and/or maintenance works as a consequence of e.g. welding.

8.2.14.2. Odour

Significant sources of bad smell are not expected along the highway corridor.

8.2.15. RISK ASSESSMENT (OIL LEAKAGE, FIRE, HAZARDOUS SUBSTANCES, PERSONAL RISKS ETC.)

In the course of road construction and respective infrastructure only individual risk of work injury, leak of fuel or oil from truck or construction machines and/or risk of fire is considered.

Possible leak of fuel/oil (oil hydrocarbons) from trucks or construction machines would be immediately removed using standard means for remediation of accidents of such type. Contaminated soils would be excavated, loaded into leak-proof container(s) and handed over to the specialized company for biodegradation, deposition at the landfill for hazardous waste and/or incineration in the incineration plant for hazardous waste.

In case of fire on the construction site its propagation will be prevented first and the fire will be extinguished using fire-extinguishers located on the site. In the event of larger fire the nearest fire brigade will be sent for.

Site management will enforce execution of the road construction in compliance with all the respective regulations and standards and will introduce adequate measures to minimize probability of emergency during the construction period.

The impacts will be the same for both alternatives.

8.2.16. IMPACT ON SOILS AND GEOLOGY

Impacts of the road construction on soils can be classified in two categories: soils as representing a certain area of land (change of land use and land degradation) and soil pollution and degradation. Impacts on geological structures, erosion and changes in geomorphologic characteristics are also assessed in this chapter.

8.2.16.1. Impact on certain soil types

Most of the soils in the road corridor are common for Sub-Mediterranean part of Macedonia. There are no particular rare types of soils in the area of intention, thus no particular impact in sense of soil type loss is **not expected**.

8.2.16.2. Impact on extent and way of use of land, soil and other material (gravel)

The position of the road body, including its associated banks is defined according to excerpt from the real estate cadastre. It occupies pieces of land from cadastral unites presented in Chapter II.1.2.1.

The plots for the construction of the road are situated mostly in forest and forest land, pasture land and to a lesser degree agricultural land (Alternativie 2) or considerable portion of agricultural land (Alternative 1). Predominating soil types in the road alignment are cinnamon soils and rankers (see Chapter

IV.5.1.). Soil quality is comparably high in case of Alternative 1. However, for the most of the soils, which are not agricultural soils, no precise categorisation exists.
Excavation of gravel and other material for sealing of the alignment was not specified yet. It will have great impact on land degradation and erosion and should be assessed precisely after elaboration of the final design.
Excavation of soil for embankments was not specified yet. It is important to assess this impact on environment, so the road design is necessary.
Impact of soil excavation is not expected to be high since more soil will be produced from cuts than used for embankments (Alternative 1). There are no data for balance of soil masses for Alternative 2, but it can be expected that the surplus material will be higher.
Construction of the road, access road(s) and the related infrastructure can temporarily affect also pieces of adjacent land, which do not belong to the road body itself. This should be avoided to the maximum extent possible from the point of size and time. Anyhow the Designer of the Alternative 2 will have to provide EIA studies for any access roads determined with the design, as well as the Contractor will have to prepare EIA studies for the access roads he is proposing to use.
The Design for Alternative 1 does not have particular designs for access roads, so it will again be Contractor's duty to provide EIA for the access roads he is intending to use, since they are not known at this moment.

8.2.16.3. Protective zones

There are **no protective zones** that can be adversely impacted by the road construction, i.e. land occupation, in sense of water protection zones (Law on Waters, Official Gazette of RM, No. 4/98 and 19/00, 254/2001, as amended, or Law on mineral water resources (and spas), Official Gazette of RM, No. 164/2001 - it means protective zones of mineral waters, or any other kind of protection. As protective zones, protection linear constructions (rail road and/or roads etc.) and engineering infrastructure (water supply, power supply, gas supply networks, etc.), which are located or are passing through the pieces of land intended for construction shall also be considered. The purpose of protective zones of linear constructions and/or engineering infrastructure is on one hand to protect them from damage during the construction, and on the other hand to protect them from degradation as a consequence of mutual interference and consequent deterioration of service characteristics.

Within any protective zone it is possible to carry out building activity only with the agreement of operator, or if needed be manager of the protected equipment and/or object. All future protective zones will be observed in compliance with valid regulations and standards during design works. Any potential protective zone of existing equipment and/or object will be respected in design and will be lay out on the site and respected on the construction site.

8.2.16.4. Impact on local topography, soil stability and soil erosion

It is **not expected** any significant change in local topography and soil stability. Erosion could be increased due to some inevitable forest cut and destruction of pasture vegetation during the construction works. Basic data concerning erosion are presented in Chapter IV.5.2.

However, the quantification of these effects is not possible due to the lack of the road design (alternative 2).

8.2.16.5. Impacts on rock and mineral resources

Any adverse impact on rocks and mineral resources is **not expected**.

8.2.16.6. Soil pollution

Significant soil pollution may only appear in accidental situations (oil spills, traffic accident of transport tracks and other toxic materials). Regular and appropriate maintenance of the machinery and trucks will contribute to avoid such situations (discussed in Chapter VIII.2.15.).

8.2.17. IMPACTS ON THE LANDSCAPE

The construction activities that would give rise to landscape and visual impacts over and above those experienced during operation would include the following activities:

- Creation of borrow pits.
- Work camps - temporary settlements that can affect landscape long after ending of construction works (in some cases).
- Presence of construction compounds, storage and stockpile areas and activities within them.
- Movement of construction machinery, plant and delivery vehicles on the existing road network and temporary haul roads from the borrow pit areas.
- Presence of any large earth moving equipment.
- Potential closure of access to any existing farm roads, if required

The most important impact on landscape will be fragmentation of habitats (already dicussed in the section on biocorridors).

So, in any way both of the alternatives will have the same impact on the landscape since it will be constructed by the same types of plant and equipment, with a slight higher impact of Alternative 2 due to larger fragmentation of habitats.

All the impacts addressed in the above text are classified by their evaluated impact at the environment with the following points:

0 - No impact/importance
1 - Low impact/importance

2 - Medium impact/importance
3 - High impact/importance

And the results are presented in the following table:

Impact of the road construction			
		Alternative 1	Alternative 2
1	Impact on the forest ecosystems and pastures		
i	Forest ecosystems	2	3
ii	Dry grasslands (hill pastures)	1	3
2	Impact on the rivers and streams	2	2
3	Impact on agriculture	3	1
4	Impact on the settlements (noise, air pollution)	2	1
5	Impacts on archaeological sites	1	2
6	Raw materials and energy resources for construction	2	1
7	Impact on air quality	2	2
8	Impact of the solid waste	1	2
9	Impact of the noise and vibrations		
i	Noise	2	1
ii	Vibrations	2	1
10	Impact on the social aspects		
11	Transport	1	1
12	Impact on human health	1	1
13	Other impacts		
i	Radiation	0	0
ii	Odour	0	0
14	Risk assessment (oil leakage, fire, hazardous substances, personal risks etc)	3	3
15	Impact on soils and geology		
i	Impact on certain soil types	0	0
ii	Impact on extent and way of use of land, soil and other material (gravel)	2	1
iii	Protective zones	0	0
iv	Impact on local topography, soil stability and soil erosion	0	0
v	Impacts on rock and mineral resources	0	0

Impact of the road construction			
		Alternative 1	**Alternative 2**
vi	Soil pollution	1	1
16	Impacts on the landscape	1	2
	Sum of values of impacts	**29**	**28**

the above assessment of the impacts coming from the road construction, it is visible that they are practically the same for both alternatives with a slight advantage of the Alternative 2 towards Alternative 1.

8.3. IMPACT OF THE ROAD OPERATION

The impacts of the road operation (regular traffic) are less destructive and damaging compared to the road construction. However, the impacts of the road operation will be expressed on the long term basis. There are numerous negative impacts that could seriously damage the environment if no effective mitigation measures are implemented. Positive impact is only if it enables connectivity for the movement of people and goods. In case of this project, connectivity is mostly on national and international level. It has only minor importance for regional railway - connection between towns in the south region of Macedonia.

8.3.1. IMPACT ON THE FOREST ECOSYSTEMS AND PASTURES

The fragmentation of the forest ecosystems and pastures will actually be a result of the road operation. In case of Alternative 2, fragmentation of forest and shrubland habitats is particularly important, due to the cut of regular biological movement routes of large animals from Kozhuf Mt. to river Vardar (for drinking water). Many animal species depend on these migration routs, including species of European conservation concern, such are Row dear, wolf, otter and wild cat. Even Brown bear was registered in this area several times (last time in March 2007). For more details see Impact on species.

The possibility of indirect threat to forest resources created by the improved transportation communication will be certain. These threats include illegal wood exploitation; mushroom and medicinal plant collection etc.

Nevertheless, the greatest threat to the forest ecosystems will be accidental forest fires. The frequency of forest fires can be increased proportionally to the traffic intensity.

Another impact of the road operation will be the pollution by the exhaust gasses due to the increased number of vehicles. The disturbance to the ecosystem functions caused by the presence of people in the forests and pastures can be considered as insignificant. Impacts should be expected on separate species of flora, fauna and fungi.

There are other impacts with very low significance when the functioning of forests and pastures are considered: solid waste disposal, oil spills, car crash incidents (these impacts are elaborated in the following chapters).

According to the Second National Report to Climate Change Convention (unpublished data), large movement of this vegetation type in north direction and along the vertical gradient is expected during next 50-100 years. In this respect, fragmentation of habitats is very important issue. Keeping free corridors will enable species to move in correspondence to the changing climate. Since Kermes oak shrublands were not assessed as threatened by the climate change, negative impact on relict communities (Oriental plane) will be the most serious.

The impacts are expected to be more severe for Alternative 2, since it is a new road, thus the fragmentation of the habitats will be higher. Alternative 1 has already constructed road which in a way is a natural barrier for the living creatures for years, i.e. the fragmentation already happened in the past, and it can be assumed that they have already established their own new ways to cross the road. As for Alternative 2, the fragmentation will be new and the impacts will be more severe.

As for the forestry, Alternative 2 will have higher impact because it is completely new road, and it can be assumed that people will start using this road for some illegal wood cutting or accessing areas which were not accessible in the past, which is also not a case with Alternative 1. The same applies for forest fires too.

8.3.2. IMPACT ON THE RIVERS AND STREAMS

The pollution of water ecosystems is caused by discharging of residues from fuel combustion (lead and hydrocarbons), lubricants and tire parts. All of these contaminants will enter the rivers with wet deposition that washes out of the surface of the road. This type of pollution has great intensity in early autumn, after dry season during summer period. In this period, the river flow is on the lowest level, and the impact of the road will be the highest. The second type of pollution is connected with usage of defrosting agents such as salts and sand. The salts will increase conductivity of river water, and sand will increase turbidity. In both cases, water quality will decrease with great impact on aquatic life. This kind of pollution is typical for strong winters with very low temperatures.

The rarest type, but maybe the most dangerous one, is incidents connected with traffic accidents that might release toxic substances as fuels and motor oils. In the event of a road traffic accident any spilled material should be contained and recovered immediately rather than allowing them to enter the drainage system. During road operation, toxic substances are frequently deposited on the road lane and the surrounding area. During melting of snow in the spring period, toxic substances accumulate in the water and reach high concentrations.

One of the measures that will be applied during construction is a drainage system for the complete alignment, providing oil separators at every and each outlet towards the natural streams and rivers. These will alow some cleaning of the water before discharge, thus reducing the impacts at some degree, but generally the impact will remain. As far as the alternatives are concerned since the traffic will be the same, the impacts will also be the same.

8.3.3. IMPACT ON FLORA, FUNGIA AND FAUNA

In general, the impacts on the species can be divided into fragmentation effects, increased collection or hunting/poaching, changes in the reproduction and road kills (important for amphibians, reptiles, mammals).

The increased accessibility of some localities (Demir Kapija canyon, Krastavec, Shtuder, sources areas of Mala and Golema Javorica) will cause impacts on the plant species. The illegal and uncontrolled collection of rare, endemic and relict plants and medicinal plants could cause impact on the wild flora. However, the increased accessibility of these localities can have positive effects due to the possibilities for economic benefits if sustainable use is implemented.

Similar notes can be made for fungi. The collection of edible fungi (*Boletus* spp., *Cantharellus cibarius*) will increase due to the accessibility of the forests on higher altitudes.

Impacts on the invertebrate fauna during the road operation may arise from the accessibility of the localities next to the highway lanes as in the case of flora and fungi. Demir Kapija is popular site for collection of various groups of invertebrates, especially daily butterflies, beetles (ground beetles, golden beetles, longhorn beetles), spiders etc.

The enlarged frequency of vehicles on the road will cause negative impact on certain amphibians, reptiles and mammals, by cutting their migratory corridors. More precisely, if one takes into consideration the long movement distances within the large mammals (Otter, Badger, Hare, Red Fox, Wolf, Roe Deer, Wild Boar, Chamois), that range among 10 to 80 km per day, than it is clear that these animals will be exposed on a potential danger to become victims from the enlarged frequency on the road.

However, the mammals, especially those species that are included in the list of game species, will be even more endangered by the intensified poaching and uncontrolled hunting in the broader area of the Kozhuf Mt., than will be a traffic itself.

Finally, the most significant negative impact caused by the enlarged frequency of vehicles on the road will appear within the amphibian and reptile species, especially in the spring months, i.e. within the period of spawning and breeding season of these animals. The amphibians and reptiles will continue to use the already established migratory corridors across the road notwithstanding the new barriers.

Furthermore, because the asphalt of the road is warming much faster than the surrounding ground, during cold days, especially in the mornings, the lizards and snakes will use the road to accumulate heat from the warmed road, and could easily become victims of the traffic on the road. The most threatened amphibian species in will be the following: Fire Salamander (*Salamandra salamandra*), Green Toad (*Bufo viridis*) and Stream Frog (*Rana graeca*). From the reptiles, most threatened species will be Glass Lizard (*Ophisarus apodus*), Wall Lizard (*Podarcis erhardii rivetii*), Leopard Snake (*Elaphe situla*) and Four-lined Snake (*Elaphe quatourlineata*). The following mammal species will be also threatened: Hedgehog (*Erinaceus concolor*), *Mustela putorius*, *Mustela nivalis* etc.

It has been found (Matthysen et al. 1995) that the bird population density decreases with the increase of the fragmentation of the habitat, but not necessarily followed by decrease in the species richness. Changes in the predation level, increases in number of edge species and disappearance of species with high area requirements have all been documented as results of forest fragmentation. In addition, it has been shown (Peris & Pescador, 2004) that traffic noise might constitute serious problem for part of the breeding bird community, and that different species differently react to the noise level.

Construction of the highway is definitely going to have all these effects, but the decrease in population densities caused by direct habitat loss can not be predicted.

Many bird species and bats will be victims of collision with vehicles ("road kills"), and this will mostly affect small passerine birds (Finches, Tits, Larks, Shrikes etc) and some non-passerines (Owls, Nightjars, Bee Eaters etc.), and possibly all cave dwelling bats in Demir Kapija section of the highway.

Road operation might have great impact on the aquatic life. Discharges of various toxic substances, salts, sand from road surface will force development of tolerant species to pollution, with permanent decrease of population of sensitive species. Many algal species are sensitive to toxic substances and increased salinity (conductivity). Also, fish population will decrease due to the bad water quality for reproduction (spawning). Increased turbidity will result in lower light penetration and photosynthesis intensity.

The conclusion is that during operation Alternative 1 will have less impacts since it is already constructed road (one half of it) providing the living creatures to already have their new moving paths, and Alternative 2 will have more severe impacts because it is completely new road which cuts the habitats directly, and there will be a certain time until the living creatures will establish new moving paths, during which accidental killings and accidents are going to be more frequent (although there will be a protective fence at the road edges). As for the flora and fungi, the same applies because of the sme reasons – new road and existing road.

8.3.4. IMPACT ON AGRICULTURE

Impacts on agriculture will be presented by the effects of air, soil and water pollution by the increased traffic on the highway. These impacts are elaborated in Chapters VII.3.8., VII.3.7 and VII.3.2. One of the specific impacts will be fragmentation of agricultural land caused by intersection of the "agricultural" roads and new highway. Points of intersection of the highway (for Alternative 1 and Alternative 2) are presented on Tab. 52 and 53. Fragmentation of agricultural land will have negative impacts on the agriculture in the area due do the decreased accessibility of some fields, vineyards or orchards.

Since the agricultural activities are more developed along the Alternative 1, it will have higher impacts on the agriculture, compared with the other alternative. The agricultural area that is going to be devastated is 5 times bigger than the one in Alternative 2. The surrounding fields are also arable and under permanent activities by the population. The new road will cut all the established local agricultural roads, thus preventing the population to access their land or to travel longer using new constructed access roads which on the other hand have their own impacts. It can be considered that Alternative 1 has high impacts on agriculture, and Alternative 2 low impacts on agriculture.

8.3.5. IMPACT ON THE SETTLEMENTS

The operation of the highway Demir Kapija - Smokvica will have both positive and negative impacts on the settlements in the area of intention. However, negative impact will be much more severe than positive (positive impact concerns socio-economic aspects). Actually, positive impact can be mostly attributed on the national level and only to a smaller degree to a regional level (see Chapter VIII.2.11 - Socio-economic impacts).

Negative impacts will be stronger, but generally it is not considered as very significant due to the large distance of the settlements from the road alignment in case of the most of them (the closest settlement to the alignment are Udovo, Josifovo, Marvinci (alternative 1); Miravci and Miletkovo (alternative 2); Demir Kapija and Smokvica (both alternatives). Special impacts of highway operation on population in settlements and human health is described in the following chapters (air pollution, noise, waste generation etc.).

Anyhow since Alternative 1 passes through more settlements then Alternative 2, and much closer to them, it can be considered that it has more impacts then the other Alternative.

8.3.6. IMPACT OF NOISE AND VIBRATIONS

8.3.6.1. Noise

The noise generated by vehicle traffic on the highway will affect the settlements located alongside the planned highway. For evaluation of noise impact and determination of suitable noise abatement measures, calculations of noise levels were carried out. The predicted noise levels were evaluated with respect to noise standard regulations of Macedonia, WHO and EC regulations. The applied noise standards for existing residential areas were 60 dB(A) at daytime and 50 dB(A) at night time. However, 55 dB(A) at daytime and 45 dB(A) at night time should be kept in future residential areas.

Although, the highway crosses less populated areas, the noise impact from traffic will affect several residential areas, due to the close distance to the planned alignment.

Generally, no systematic tests of noise levels have been conducted to indicate the general noise condition and threat to the inhabitants because of noise. The source of sound emissions to be considered in this study is the traffic expected on the projected highway. The noise levels, predicted in this study, are based on the expected traffic loads for the year 2024 and all the road design data (road characteristics, detailed traffic study and forecast) (Feasibility Study- Final Report, Section Demir Kapija- Gevgelija, Scetaroute, 1999).

Bearing in mind the configuration of the terrain and distribution of populated areas which are distanced from the alignment, noise should not represent a major impact. However, the alignment at some points of it is passing through the city of Demir Kapija and villages Udovo, Josifovo and Marvinci for Alternative 1, Demir Kapija, Miravci and Miletkovo for Alternative 2 and both alternatives are critically approaching Smokvica and its individual houses and weekend houses. Also the junction of the highway with the local road towards these villages could create problems with noise, due to the vicinity of the nearby houses. In other words, the highway section is passing a flat area, from village Udovo to village Smokvica (for both alternatives), allowing for noise distribution, due to the lack of barriers and absorbers, which could be otherwise created by hilly terrain, vegetation etc. However, the originally high noise intensity in non urbanized areas may abate in inhabited areas due to the lower speed of vehicles.

During an early stage of a planning, there is the opportunity to locate the alignment in appropriate distance to settlement borders and archaeological sites. In addition, existing noise prevention barriers like slope cuts and present vegetation can be used to hide the road. This is especially important because, either by alternative 1 or alternative B, the planed route is passing close to villages Gradec, Udovo, Marvinci and Smokvica, which contain many valuable archaeological sites existing in this part, and especially concentrated around village Smokvica. Some of these localities are extremely sensitive on noise impact and vibrations due to their antiquity. By Macedonian legislation for protection of cultural heritages, any activities of this kind in archaeological areas are strictly forbidden (Law for Protection of Cultural Heritages, Chapter 4, Sector 1, titles: General Prohibitions; Archaeological Researches and Occasionally Discoveries).

Alternative 1 - Design of a new carriageway on the left bank of the Vardar River, as close as possible to the existing road, with a design speed of 80÷ 100 km/h

In the corridor of about 500 meters on both sides of the highway, the city of Demir Kapija and village Smokvica (from the right site) and villages Udovo and Marvinci (from left site) are located, as well as several small hamlets and separate houses.

Residential areas in Udovo, Marvinci and Smokvica will be affected by noise levels exceeding 45 dB(A) at night time which reveals the possible need for implementation of noise abatement measures. Effects of various mitigation measures alternatives should be calculated. Installation of noise prevention walls may be the most efficient mitigation measure, especially in village Udovo which is directly affected from the noise impact from the future highway.

The distance from the residential areas in the north part of city of Demir Kapija to the alignment is approximately 250 m by both alternatives.

Village Udovo is one of the critical points of alternative 1. The projected highway passes the northeastern residential areas of Udovo in a distance of few meters. Some of the houses will be passed in a very short distance; for example at km 1131+200. Possible construction of noise protection walls along the length of the highway passing through village Udovo must be investigated.

Alternative 2 - The project route is on the left and than right site of the Vardar River, with a design speed of 120 km/h

In the corridor of about 500 meters on both sides of the highway the city of Demir Kapija and villages Smokvica and Klisura (from the right site) and villages Miravci and Miletkovo (from left site) are located, as well as several small hamlets and separate houses. Most of the houses have 1 ½ or 2 storeys.

Only residential areas in city of Demir Kapija and village Smokvica will be affected by noise levels exceeding 45 dB(A) at night time, due to their distance from the future highway. That reveals the possible need for future exploration for implementation of noise abatement measures.

It is clear that Alternative 1 has more severe impacts during the road operation then Alternative 2. It passes through more settlements which are also closer to the alignment, thus requiring mitigation measures for sound absorbtion, which at the end of the day are not solving the problem, just reducing it to a comfortable level.

8.3.6.2. Vibrations

Like most vibration problems, traffic vibrations can be characterized by a source-path-receiver scenario. Vehicle contact with irregularities in the road surface (e.g., potholes, cracks and uneven manhole covers) induces dynamic loads on the pavement. These loads generate stress waves, which propagate in the soil, eventually reaching the foundations of adjacent buildings and causing them to vibrate. Traffic vibrations are mainly caused by heavy vehicles such as buses and trucks. Passenger cars and light trucks rarely induce vibrations that are perceptible in buildings and houses.
Heavy vehicle traffic on the highway might cause vibrations. This will strongly correspond with the road surface in regard of ripples, bumps and damages. The distance of effects is considered shorter than for the construction period. However, buildings situated very close to the road might be affected.
As mentioned for the noise item, Alternative 1 is closer to the settlements and also there are more settlements along the alignement, which makes this alternative more severe from vibrations impact then the other one.

8.3.7. IMPACT ON SOILS AND SOIL POLLUTION

Road operation can only have impact on pollution of the soil next to the road surface.

8.3.7.1. Soil pollution

It is well documented in the extensive world literature that the most significant pollution from gaseous substances and aerosols (emitted from exhaust pipes of vehicles) occurs in 10 meters distance due to the fast sedimentation of substances heavier than the air. The sedimentation depends of the geomorphology of the terrain, wind speed, vegetation cover etc.

Other soil pollution source is the road surface itself. Oils, gasoline and other polluting agencies leaked from the vehicles (due to the accidents and to a lesser extent regularly, when vehicles function properly) are rinsed with the rainfall water from the road surface and transported to the neighbouring soil.

In the case of the mountain/hill roads, pollution from defrosting agencies (salt and others) is very common.

Similarly as in the case with water pollution, soils can be contaminated during road operation by toxic substances that are frequently deposited on the road lane and the surrounding area. During melting of the snow in the spring period and during the heavy rainfalls, toxic substances could be rinsed and accumulate in the soil next to the road. They can be than transferred downwards with the seepage water, eventually reaching the groundwater or streams. Main pollutants and their concentrations are presented in Tab. 49.

Main pollutants and their concentrations according to the detailed investigations conducted by the Institute of Roads in Belgrade

Type of pollutant	Amount ($kg \cdot ha^{-1} \cdot yr^{-1}$)
Solid materials	1500
Heavy metals	10
Salts	2000
Hydrocarbons	100

Winter management of the road that includes usage of sand and salts to keep the road operational continuous, will produce a certain amount of pollutants with more or less permanent intensity. The extend of the impact posed by the winter maintenance of the road is not considered as high due to the mild winters in Sub-Mediterranean region where the whole highway section is situated.

Regarding soil pollution both alternatives will have the same impacts, since the pollution occurs in the vicinity of the alignment. But, Alternative 1 passes through an arable land a lot more then Alternative 2. Therefore the area of surrounding agricultural parcels which will be affected with the soil pollution for Alternative 1 is much higher than Alternative 2, when arable land is concerned. It is correct to say that Alternative 1 in generall has more impacts then Alternative 2 regrding soil pollution.

8.3.7.2. Protective zones

The remarks in Chapter VIII.2.16.3 are the same as for the road operation.

8.3.7.3. Transport

The most important impact of transport on soil concerns soil pollution and emergency situation, which were discussed in respective chapters.

8.3.8. IMPACT ON THE AIR QUALITY

The legal provision for air pollution monitoring is contained in the Law on Air Protection and recommendations of the European Community Directive (80/779/EEC). The Law is accompanied by several regulations, defining the organization of this activity in more details. According to this Law, maximum permissible concentrations of polluting substances in urban centers are determined with regard to 13 compounds. However, only those compounds that are most frequently present in urban areas are monitored on regular basis. These are as following:

- sulphur dioxide (SO_2);
- smoke (suspended substances);

- nitrogen oxides (NOx);
- total oxidants with low layer ozone (O_3);
- chemise of precipitation; and
- air radioactivity.

The state of the air pollution has been monitored since 1973, and measuring network comprises 20 measuring stations. All of these measuring stations monitor the concentrations of sulphur dioxide and smoke, and the concentration of nitrogen oxides and total oxidants is monitored only at one measuring station in Skopje. At the measuring station in Lazaropole, which is connected to the EMEP and BAPMON measuring networks, parameters specified in the programmes are being monitored (sulphur dioxide, smoke, nitrogen oxides, total oxidants with low layer ozone, chemise of precipitation, and air radioactivity). In addition, this measuring station and the measuring station in Berovo monitor radioactivity of the air, precipitation and soil.

8.3.8.1. Measuring methodology

Sulphur dioxide is measured by West-Gek method, the smoke by the standard British reflection-measuring method, nitrogen oxides by spectra-photometric sulphur-anilamide method, and total oxidants by potassium-iodine method.

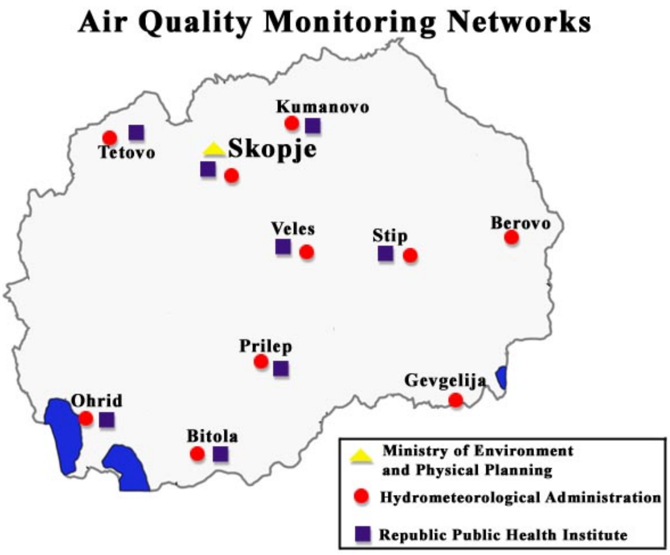
8.3.8.2. Maximum permissible concentrations (MPC)

According to the positive legal regulations, the standards applied for individual pollutants are:

- MPC - SO2 = 150 mg/m3
- MPC - smoke = 50 mg/m3
- MPC - NOx = 85 mg/m3
- MPC - total oxidants = 125 mg/m3

Results are presented as average 24-hours concentrations of polluting substances.

Emissions of motor cars (in tons)						
Location:	CO_2	Organic Carbon	SO	NO_2	Rb	Total suspended particles
Republic of Macedonia	457	16.732	48.148	11.348	83	1.830



Map of automatic monitoring stations for ambient air in Republic of Macedonia.

There are 20 monitoring stations for measuring of air quality

8.3.8.3. Analysis of results

The results from measuring carried out in 2006 show that there are no high concentrations of polluting substances that have been registered in Kavadarci closest city to the subject region. Compared with the European Community Directive (80/779/EEC), the values of 24-hours concentrations of sulfur dioxide have not exceeded the maximum permissible values at no place in the Republic. Concentrations of smoke are not high in Kavadarci closest city to the subject region. Compared with the standards of the European Union, the concentrations have been registered in the limits of permitted values. Concentrations of NOx have been lower than maximum permissible ones, according to the national standards, with both measuring stations in which they are monitored. The same conclusion can be made with reference to total oxidants.

The analysis of the results obtained from the measuring of concentrations of polluting substances shows that the air pollution in the Republic of Macedonia is of seasonal nature and highest concentrations have been registered only with the smoke, due to the intensive use of fossil fuels in this period of the year.

For the purposes of monitoring air quality in the Republic of Macedonia, a study is now being developed on the monitoring system; Skopje, the capital of Macedonia, has been chosen to be the pilot city to the study as it is the largest industrial centre in the country. This project implementation is financed by the Japanese Government.

Measurements are performed on 4 various measurement points where special stations have been located with installed measurement instruments which monitor 12 various parameters (CO_2, CO, NO, NO_2, NO_x, SPM, Wdir, Temp., Wspeed, O_3, Solar, Humidity).

From there, data arrives through radio connection to the Information Centre of Environment Protection, where this data is processed and is automatically sent to a public display through which citizens are able to get informed on air quality within the city.

Standards for air quality

Harmful substances		Maximal allowed concentrations in mg/m^3	
		Maximal absolute	Maximal mean daily
1	Sulphur dioxide	0.5	0.15
2	Sulphuric acid per mol. of H_2SO_4 per hydro ion	0.3 0.006	0.1 0.002
3	Fume	0.15	0.05
4	Lead and its compounds (except tetra ethyl lead)	0.5	0.15
5	Lead sulphide	/	0.0007
6	Arsine (inorganic compounds), except arsine hydrogen estimated as arsine	/	0.003
7	Carbon disulfide	0.03	0.01
8	Carbon monoxide	3.0	1.0
9	Nitrogen dioxide NO_2	0.085	0.085
10	Fluorine compounds (estimated as fluorine) in gas condition (H_2S_4)	0.02	0.005
11	Oxidants	0.125	/
12	Hydrocarbons (corrected for methane)	0.125	/
13	Ashes and inert dust up to 300 mg/m^3 daily		

Source: National Environment Action Plan

The monitoring system also includes a mobile vehicle that is equipped with the same apparatus as are the (monitoring) measurement stations. This vehicle helps carry out measurements of emissions at industry facilities that are potential polluters of the environment.

Effects of the new highway on climate and air quality can result from:

- Influence on local wind streams
- Influence on local micro climate
- Carbon dioxide emission (CO2).

Local wind systems can be affected by barriers for local wind streams and change of surface characteristics, like i.e. by the concrete surface of the highway. Given the design of the alignment, no significant barrier is planned. Valleys are crossed by bridges and not by walls. Therefore, wind streams are not expected to be influenced significantly. However, some minor changes of local micro climate may result where (i) new cuts for the alignment are

required, (ii) noise prevention walls maybe will be installed, and (iii) possible construction of embankment. With respect to the absence of highly sensitive ecosystems (see Chapter VII) a significant effect on the environment is not considered likely.
The CO_2 emissions of the traffic depend on the amount of fuel consumed. This depends on the type and performance of the vehicles' engines, the extent of inclines along the road, and traffic flow characteristics. In general, the fuel consumption by vehicles will be reduced in the future by improvement of vehicle technologies (i.e. efficiency).
The amount being emitted on the new alignment compared with the amount being emitted by alternatively using the existing road to Gevgelija is practically the same. For both situations, the number of vehicles will be the same. The speed is high with no stop-and-go characteristics. Fuel consumption per kilometre under these conditions is approximately 2 – 3 times lower than in a city. So, the impacts on the air quality are the same for both alternatives, having in mind that both alternatives have settlements in their vicinity (even Alternative 1 is closer to the settlements, the air pollution is spreading in wider areas due to wind).

8.3.9. IMPACT OF THE SOLID WASTE

The waste materials that will be generated during the road operation are not numerous and variable as in the case of the road construction. The distance of about 30 kilometres is quite short and there will be not too many stops. However, some toxic waste will be generated accidentally (especially oils). Since there are no data about the designed parking places or "refreshment areas" along the projected highway section, the quantity and quality of generated waste can not be estimated sufficiently accurate. However, the waste quantities in normal situations will be insignificant and so the impact on the environment will be **insignificant** and same for both alternatives.

8.3.10. SOCIO- ECONOMIC IMPACT

Increased traffic and creation of conditions for other working activities and services (local motels, hotels, restaurants, season road maintenance) will contribute to the generation of new (permanent) employments and improvement of the local population lifestyle (on local level). Economic impact of the highway operation will be much higher on national level.

8.3.11. IMPACT OF VARIOUS TYPES OF DISTURBANCES

Other impacts that can occur during operation of the highway section Demir Kapija - Smokvica and should be assessed are radiation and odour (smell).

8.3.11.1. Radiation

Radioactive radiation

During the road operation there will be **no sources** of ionizing radiation (pursuant to the provisions of the Decree No. 59/1972 Coll. on the Protection of Health against Ionizing Radiation by the Ministry of Health).

Electromagnetic radiation

Present levels of electromagnetic radiation within the area of interest were not monitored. However, no significant levels of radiation are expected with respect to the operation of the road into the un-built (residential) area.

With the exception of common telecommunication appliances such as mobile phones there will be no other systems that would generate electromagnetic radiation within the construction site. Under standard operation there will be **no source** of electromagnetic radiation.

8.3.11.2. Odour

Sources of bad smell are **not expected** along the road corridor.

8.3.12. IMPACT ON HUMAN HEALTH

Impact of the highway operation on the human health can be considered only for the residents of the settlements close to the alignment (Demir Kapija, Udovo, Miravci, Miletkovo, and Marvinci). Such impact can result from air pollution emission (see Chapter VIII.3.8.) and to a limited extent to the noise generation (see Chapter VIII.3.6.). Even if the emission and immission levels will not exceed maximum allowable concentrations after implementation of mitigation measures, intermittent and even permanent degradation of the air quality in the region of intention could be expected. The extent of this impact will not be very high due to several reasons: (i) the settlements are mostly far enough from the alignment except for the village Udovo (Alternative 1) where special mitigation measures are necessary); (ii) some villages are separated from the alignment with densely forested area and (ii) the diminishing effect of mixture with current clean air. Slightly more severe impacts are expected for Alternative 1 than Alternative 2.

8.3.13. RISK ASSESSMENT (TRAFFIC ACCIDENTS, OIL LEAKAGE, HAZARDOUS SUBSTANCES ETC.)

In the case of traffic accidents, uncontrolled spilling of oil, oil derivates, chemical and other toxic substances might occur. Fires are also possible as a result of traffic accidents.

Of the outmost importance are the risks that may occur during transport of transformer oil (PCB).

The danger of possible traffic accidents remains, as well as their results, which were already commented under the section of road construction.

Emergency hazards related to use of substances and technologies

Emergency situations that could appear because of substances and/or processes used or transported along the road will be described in the operating instructions and/or emergency plan including description of preventive, corrective and mitigation measures.

Overview of possible undesirable situations

Type of possible emergency situation	Type of risk[2]
Fire	Community risk, environmental risk
Leak of hazardous substance	Individual risk, (environmental risk)
Leak of fuel or oil from truck/machinery	Environmental risk
Gas-escape, gas explosion and a fire	Community risk, environmental risk

The types of possible emergency situations, which could appear due to the types and extent of activities carried out and situations that can occur along the road are presented in Tab. 51. The types of risk, which could represent such emergency situation, are also presented.

8.3.13.1. Probability of emergency situations

Probability of occurrence of emergency situations listed in Tab. 21 is discussed bellow.

Fire

The major causes of fire could be as follows:

- Failure of human factor – incorrect manipulation with fire of flammable substance
- Short-circuit in electric device or cable (if there are such facilities)
- Leak and ignition of flammable substance as a consequence of failure of machinery (e.g. fuel from the tank of diesel generator or truck)
- Gas-escape and explosion (from transportation of gas)
- Purposeful ignition.

The operator of the road should comply with relevant legislation related to fire prevention, including plan for action in such situation. The plan will be elaborated in close co-operation and collaboration with forest management enterprise responsible for managing forests from Demir Kapija and Gevgelija.

Leak of hazardous substance

[2] Individual risk represents risk for individual person in the closeness to the source of risk; Community risk is the risk for group of persons, which could be impacted by the source of risk; Probability of risks presented in brackets is low.

It is not expected that any substances and preparations, like disinfection and cleaning agents, materials for maintenance (oils, lubricants, solvents, paints, etc.), fuels etc., will be stored on the road or its vicinity. Thus, the leak of hazardous substances could be expected only from traffic accidents. The procedure for reaction in these situations and mitigation of such probabilities is regulated along with regulations for traffic safety.

Leak of fuel or oil from truck/machinery

Possible leak of fuel or oil from the truck or maintenance machinery on the ground would be immediately removed. Contaminated soil will be excavated, loaded into leak proof container and handed over to the specialized company for biodegradation, deposition at the landfill for hazardous waste and/or incineration in the incineration plant for hazardous waste depending on level of contamination.

With respect to limited amount of fuel/oil in trucks and machinery and technical parameters of modern engines no significant risk of leakage of fuel/oil is assumed. As a consequence no significant impacts on environment (soil, groundwater) are expected.

Gas-escape, gas explosion and fire

The same remarks as for the leak of hazardous substances are valid for gas escape.

8.3.14. THE LANDSCAPE CHARACTERISTICS

The overall effect within the area of the Alternative 2 alignment would be the introducing of a major structure, which will be a prominent feature and landmark within the current natural and rural landscape. There will be a direct loss of large surfaces of forestry land and forests, as well as some habitats due to the construction of the highway. The highway will also form a linear feature in the landscape.

Concerning the section of the road passing through the oak forest some impacts resulting from the deforestation of the forest belt along the road can be expected. However, from landscape point of view this impact is not very significant and it is elaborated in chapters dealing with impacts on forests, flora and fauna etc. (Chapter VIII.3.1. and Chapter VIII.3.3.).

The most significant impact on the landscape characteristics will be observed in the area of dales of Golema Javorica and area between upper armlets of Mala Javorica and Kalica stream (areas with high and long bridges). The greatest changes will occur in the structural aspects of the landscape - its aesthetic value. However, the function of this landscape type will not be altered significantly if proper mitigation measures will be implemented. Degradation of landscape functional characteristics considers especially fragmentation of individual habitats and agricultural land (Chapter VIII.3.1. and VIII.3.4.).

Alternative 1 is already passing through a formed alignment from the old road so the changes in the landscape will not be as significant as the other alternative.

Impacts from the road operation			
		Alternative 1	**Alternative 2**
1	Impact on the forest ecosystems and pastures	1	3
2	Impact on the rivers and streams	2	2
3	Impact on agriculture	3	1
4	Impact on the settlements	2	1
5	Impact of noise and vibrations		
I	Noise	2	1
Ii	Vibrations	2	1
6	Impact on soils and soil pollution		
I	Soil pollution	2	1
Ii	Protective zones	0	0
Iii	Transport	1	1
7	Impact on the air quality		
Iii	Analysis of results	1	1
8	Impact of the solid waste	1	1
9	Socio- economic impact	0	0
10	Impact of various types of disturbances		
I	Radiation	0	0
Ii	Odor	0	0
11	Impact on human health	1	0
12	Risk assessment (traffic accidents, oil leakage, hazardous substances etc)		
I	Probability of emergency situations	0	0
13	The landscape characteristics	0	2
Sum of values of impacts		**18**	**15**

According the above assessment of the impacts coming from the road operation, it is visible that they are practically the same for both alternatives with a slight advantage of the Alternative 2 towards Alternative 1.

Having the results from the impacts assesment, both for road construction and road operation, it can be concluded that both alternatives are similar regarding various impacts analysis.
The difference is negligible but for the needs of this Study it has to be stressed that anyhow Alternative 2 has less impacts on the environment then

Alternative 1. Therefore, having in mind the impacts and mitigation measures that are going to be explained in the following chapter it is recommended to proceed with construction of Alternative 2, not only because it will have less impacts, but because it will give the local population one more **BIG** benefit, that is an alternative road to the highway, which will not exist if Alternative 1 is to be constructed.

9. MITIGATION MEASURES

Construction of the projected highway section (both alternatives), as well as its future operation, necessary generates diverse conflicts resulting in specific negative impacts, concerning damaging and destruction of natural and anthropogenic ecosystems, particular sites or habitats, archaeological and historic localities etc.

On the basis of assessed impacts (Chapter VIII) and the degree of sensitivity of ecosystems, sites or localities (Chapter VII), possible solutions for avoiding of damages will be proposed in this chapter.

The measures for mitigation of adverse impacts of the highway construction and operation can not be elaborated in details due to the lack of final design for the alternative 2 alignment. However, even in cases when the data is insufficient, some recommendations can be pointed out in order to provide useful background for the designer. The measures listed in the Chapters IX.2 and IX.3 should be taken into consideration by the designer during the design process for alternative 2 if it is accepted. They can serve particularly for bringing the final decision on the adjustment of the proposed alignment.

9.1. MEASURES FOR THE PREPARATORY PHASE

The following prevention, elimination, mitigation and/or compensation measures are proposed for the preparatory phase of the Alternative 2. Alternative 1 already has a Final Design. Therefore prevention, elimination and mitigation/compensation measures can not be applied, since the design is finished long time ago. Since the phase for final design of Alternative 2 is going to happen soon, it wil have an advantage over Alternative 1 regarding all the prevention, elimination, mitigation and/or compensation measures that are going to be applied:

- Carry out the design for the highway and all access roads, objects and facilities (work camps etc.) in compliance with valid legislation in the area of environmental protection, pertinent technical standards and Best Available Techniques (BAT).
- Take into account all strategic and development documents concerning nature conservation, environmental protection and use of natural resources.
- Design adequate monitoring system for surface water quality monitoring.
- Apply for exemption of pieces of land from agricultural and forestry land resources at the respective body of the state administration.
- Elaborate a waste management system for the construction period focused first of all on separate collection of waste and their consequent re-use and re-cycling.
- Work out an emergency plan. The emergency plan should contain at least all of the provisions that are mentioned in the Chapters VIII.2.15. and

VIII.3.13 for the case of leakage of substances hazardous to waters during the construction period(s). The emergency plans have to be elaborated for cases of construction of the highway and its operation.
- Work out detailed Environmental Management Plan (EMP). It will include recommendations for monitoring program proposed in this study, but elaborated in more details and for exact sites and localities, than indicators, timeframe and frequency, responsibilities, budget etc.

9.1.1. GENERAL MEASURES FOR ALTERNATIVES 1 AND 2

General measures refer to the measures that should be implemented on the whole construction site (the whole length of the highway corridors) and during the whole construction period. These measures are applicable no matter if final road design does exist or not.

The following prevention, elimination, mitigation and/or compensation measures are proposed for the implementation phase:

- Keep care about technical conditions of heavy-duty trucks and construction machinery and minimize their noisiness, emission into the atmosphere and potential leaks of oils and/or lubricants. (The machinery and vehicles should be checked periodically for emission concentrations in the exhaust gases).
- Minimize pollution of the existing roads with dirt from the construction site and resulting dustiness by cleaning of trucks before leaving the construction site.
- Minimize dustiness during long dry periods by watering of excavated and/or deposited soils on the construction site.
- Minimize storage of substances harmful to waters (e.g. fuels for construction machinery) on the construction site.
- Store the necessary fuels in proper manner (for example barrels in retention tanks).
- Pursue filling of vehicles and machinery with fuel on the construction site only in inevitable case, when filling out of premises would be too complicated or technically infeasible.
- Do not carry out maintenance and/or repairs of trucks or construction machinery on the construction site with the exception of common daily maintenance.
- Carry out collection of waste from the construction site and ensure its proper liquidation with preference of re-use and recycling. Store collected waste in adequate containers depending on volume of waste, properties of waste and way of waste handling. Final waste disposal should be organized in the nearest landfill (e.g. Gevgelija, Valandovo).
- Collect hazardous waste (cleaning fabric polluted with oils or lubricants, waste colors and thinner, etc.) in particularly labeled special vessels. Waste oils and other hazardous waste should be disposed on Drisla Landfill (Skopje) since it is the only landfill in Macedonia for such kind of waste.
- Replaced motor lubricants that will occur in significant quantities are to be stored in separate barrels and transported up to the locations where they shall be safely disposed or recycled.

- Avoid temporal occupation and destruction of adjacent land. Each use of land that is not included in the project design must have prior consent of the owner or other type of permit.
- Detailed erosion prevention plan has to be elaborated after final design is prepared.
- Recultivation of all destructed and disturbed sites along the road after construction using local autochthonous species.
- Provide permanent presence of fire-brigade vehicle in case fires and damages occur.
- Set up gate and security service that will control the vehicles and locate eventual defects that might cause uncontrolled spills of oil, oil derivates and other chemicals. Movements on the access road(s) should be allowed only to the employees of the Construction Company and official representatives and institutions.
- If the Constructors concept of the highway section Demir Kapija – Smokvica foresees construction of accommodation capacities for the workers, than garaging of the vehicles and the machines, opening of services for their maintenance and construction of necessary infrastructure, the following issues should be considered:
    - Setting up camps on alluvial terrains has to be avoided because of the high levels of underground water and possibilities of their pollution.
    - Construction of underground structures on agricultural land of higher class is not recommended.
    - For the selected location Design is to be elaborated wherein well dimensioned objects for receiving and treatment of waste water shall be provided; alternative solution is to use removable toilets.
    - Containers for collecting of solid communal waste are to be provided that shall be regularly removed up to the closest communal landfill (in hitherto practise the waste are scattered uncontrolled directly to the site).
    - After finishing of the highway construction works, if there is no necessity of usage of the organized site, after it's dismantling, the terrain is to be re-integrated with the environment wherein certain bio-technical activities are to be necessary.

9.1.2. GENERAL MEASURES CONCERNING SPECIFIC HABITATS, LOCALITIES AND SITES

Besides the general mitigation measures that apply on the whole length of the highway construction (previous chapter), separate measures are proposed for some important habitats, localities and sites:

- **No access roads should pass through these habitats:**
    - Tamaris communities

- Alluvial deposits with willow stands
- Demir Kapija canyon
- Plane stands and belts
- Greek juniper stands

- **Permanent or irregular expert supervision (agricultural engineer, ecologist or biologist) is recommended for these habitats:**
  - Agricultural land
  - Tamaris communities
  - Plane stands and belts
  - Demir Kapija canyon
  - Greek juniper
  - All other habitats on a irregular basis

- **The waste material (concrete, iron, rocks etc.) accidentally deposited, should be immediately removed from**
  - Plane stands and belts
  - Rivers Bosava and Vardar
  - Demir Kapija canyon
  - All streams in the highway corridors

- **All sites that should serve as temporary deposits for topsoil and raw materials have to be proposed by the designer and constructor in advance in order to be assessed for possible adverse impacts on the environment. These habitats should not serve as temporary deposits for row material:**
  - Tamaris communities
  - Demir Kapija canyon
  - Plane stands and belts

- **No construction works should be done in the following habitats/locations:**
  - Archaeological localities
  - Limestone rocks in Demir Kpaija canyon (except inside - tunnels)

- **Setting up of work camps and mechanization parks should be avoided in:**
  - River Anska Reka and channels
  - Alluvial deposits
  - Demir Kapija canyon
  - Plane stands and belts

- **Borrow pits for mineral sealing or other raw materials have to be identified in advance in order to be assessed for possible impacts on the environments. It is not allowed to use raw materials from the following habitats:**

- Tamaris communities (sand)
- Alluvial deposits with willow stands (sand and gravel)
- Demir Kapija canyon (limestone mineral sealing)
- Plane stands and belts (wood or soil)
- Greek juniper habitats (diabase mineral sealing)

9.1.3. MITIGATION MEASURES FOR THE FOREST ECOSYSTEMS AND PASTURES

General measures

Direct destruction of forests (Chapter VIII.2.1.1.) during the construction of Alternative 2 will lead to loss of about 1445 m^3 of timber or 47000 €. Impacted forests belong to the forestry districts "Demir Kapija" and "Kozhuf". Thus, the most adequate compensation measure is to fund forestation activities by respective amount of money in the frames of the aforementioned forestry districts. Forestation should be performed with native (autochthonous) tree species as stated in the Law on Nature Protection. Forestation costs per one hectare at present conditions about 2000 €. It means that about 23.5 ha should be afforested (47000 € divided by 2000 € per ha).

In the case of Alternative 1 similar compensation measures should be applied. Forestation should be done on a scale that corresponds to the value of cut timber in the adjacent forestry units (approximately half amount).

9.1.4. MITIGATION MEASURES FOR THE RIVERS AND STREAMS

Specific measures

The thermal springs in Smokvica are used for heating of 6 ha of greenhouses. Maximal measures for their protection must be undertaken in order to prevent the destruction of the existing natural and already built system on hydrothermal sources during the processes of investigation of the geological, hydro-geological and hydro-technical activities

General measures

R1: Any disturbance must be avoided, no damping in the near vicinity and no discharge of polluted water into the rivers and streams should be allowed. Due to this, the recommendation would be to foresee presence of experts (environmental engineer, hydrogeologist or hydrotechnical engineer) on site, during the whole construction period.

R2: Storage and handling of petrol, diesel, lubricants and paints should take place as far as possible outside the construction site. Waste materials especially oils arising from machine maintenance must be properly disposed, according to the Macedonian legislation.

R3: When working close to the groundwater table extra care should be taken to avoid spillage of water endangering substances such as oils and lubricants, and immediate clean-up action is to be taken in the event of an accidental spill.

The potential for impacts to occur should be minimized by adoption of the following measures:

- In order to prevent water pollution resulting from worker-generated sewage effluents, portable toilets should be provided or alternatively existing toilet facilities located on the site would be identified for construction worker use;
- Storage compounds (for the storage of construction materials or temporary stockpiling of excavated soils) should be located away from surface watercourses and drains;
- Where water would need to be removed from excavations, it should be transferred the minimum practical distance to discharge.
- Drums and barrel should be stored in a designated bundled safe area within the site compound;
- All drums and barrels should be fitted with flow control taps and should be properly labeled;
- The placing of any wet concrete in or close to any watercourse should be controlled to minimize the risk of leakage of wet cement into the watercourse;
- The washing of any concrete mixing plant or ready mix lorries should be carried out so as to prevent effluent from cleaning from being allowed to flow into any watercourse or drain;
- Roads on the site and the approaches to the watercourse should be regularly cleaned to prevent the build up of mud;
- All roads and hard standings should be kept clean and tidy to prevent the build up of oil and dirt that may be washed into a watercourse or drain during heavy rainfall;
- Concreting at watercourse culvert sites should be closely supervised to prevent concrete contamination of the watercourses;
- Where practicable, drainage from storage compounds would be passed through oil interceptors prior to discharge;
- Protection of natural rivers or streams and their riparian vegetation in the whole study area; no regulations and removal of vegetation to develop the self-purification power of the rivers and streams.

9.1.5. MITIGATION MEASURES FOR FLORA AND FAUNA

Specific measures

Having in mind the identified impacts of the road construction on fauna (Chapter VIII), the following measures are proposed:

1. **Tunnel construction at Demir Kapija Gorge**

Due to very high sensitivity of this region and habitats, special mitigation measures are proposed to minimize the negative effect on birds (especially vultures and birds of pray).

- Construction works on the tunnel should not be undertaken in the breeding season, from beginning of March until end of August. This especially refers for the entry and exit point of the tunnels, where dynamite use should be avoided in the mentioned period. This measure should above all provide conditions for successful breeding of the birds of prey known to breed in this region, but also many other passerine species will benefit from this measure.
- For both Alternative 1 and Alternative 2, the new tunnel should pass as close as possible to the existing one, in order to minimize the damage on the cliff on its exit point.

General measures

F1: To avoid unnecessary additional loss of biotopes, the construction site should be limited to the minimum area that is needed for the road works, especially in sections with a high value for plants and animals. The dumping or storage of soils and excess material should be limited within the construction site. Sections which are assigned a high ecological value have to be protected by fencing during the construction phase. Construction vehicles should only operate on the construction site and not leave the site boundaries. Removed biotope structures at the construction sites should be restored after completion of the road works.
Excess soil dump sites should not be placed in areas with high importance for flora and fauna.

F2: After exploitation of gravel from the potential borrow pits (if needed), no rubbish or waste should be dumped in the borrow areas. A concept for re-naturalization under consideration of the ecological needs of the river plain ecosystem is necessary.

F3: The removal of shrubs and trees should be carried out in winter, outside the bird's breeding period which is from 1st of March - 30th of September, especially in the hilly areas and in the Vardar plain. Upon completion of the road works, impacted biotopes should to be restored.

F4: Constructions of culverts for amphibians, reptiles and mammals: in the regions without natural passes and without underpasses, tunnels or bridges will be constructed, culverts should be constructed on every ditch that is intersected by the highway, and where there are no natural ravines, and culverts should be constructed on every 200 m. On intersects with streams, culverts should be constructed on every 100 m, in 500 m length from both sides of the streams (including intermittent streams).

9.1.6. MITIGATION MEASURES FOR AGRICULTURE

General measures

The highway route (in both alternatives) intersects with number of local (unpaved) roads (Tab. 53). At some intersections solution was proposed by the designer. However, in number of cases there is no proposed solution (overpasses, underpasses etc.).

A1: It is necessary to design and construct appropriate objects along highway route in order to maintain the existing local roads and important forest paths. By implementing this measure, the fragmentation of agricultural land shall be avoided as well as access to various parts/localities in the hilly region for grazing. Enabling good connection between forest lands on both sides of the highway is essential for accessibility and interventions in case of forest fires.

*Overview of the intersection of the highway route of **Alternative 1** with different types of existing local (unpaved) roads*

Existing measure in the highway design	Kilometer	Local road
existing	6+270	path
not existing	13	forest road
existing	14+930	forest road
existing	14+980	forest road
not existing	15+330	forest road
existing	16+140	forest road
existing	18+570	forest road
not existing	20	forest road
not existing	20+120	road
not existing	21+70	road
not existing	21+200	road
not existing	21+560	road
not existing	22+90	road
not existing	22+280	road
not existing	22+480	road
not existing	22+880	road
not existing	23+130	road
not existing	23+640	road
not existing	24+150	road

not existing	24+680	road
not existing	25+240	road
not existing	25+690	road
not existing	26+176	road
not existing	26+710	road
not existing	27+540	road
not existing	27+860	road
not existing	28+130	road
existing	28+240	road
existing	29+340	road
existing	29+940	road
not existing	30+280	road
not existing	30+650	road
existing	32+660	road

Overview of the intersection of the highway route of ***Alternative 2*** *with different types of existing local (unpaved) roads*

Kilometer	Local road
5+620	village road (bridge)
6+700	forest road
7+300	forest road
7+700	path
10+130	road (bridge)
13+100	forest road
13+530	forest road
15+200-15+500	path
16+900	path
17+100	forest road (overpass)
17+600	path
19+100	path
19+200	forest road
20+600	path
21+100	PTT optical cable
21+850	path
22	path
22+250	pipeline (bridge)
22+650	village road
22+950	village road
23+050	forest road (overpass)
24+600	path
25+750	path
26+700	path
27+300	village road
27+520	road (overpass)

9.1.7. MITIGATION MEASURES FOR ARCHAEOLOGICAL SITES

General Measures

If the highway passes along the existing motor road (Alternative 1), than extreme measures of precaution during the construction should be undertaken, and continuous presence of archaeologist during the preliminary and excavation works of the road corridor is advised.

Anyway, there is no solution that can solve all conflicts since other important archaeological localities in the region of village Marvinci are present (see Chapter VIII.2.6.). The fact that the main road in Balkan Peninsula from Roman period, Via Ignatia, was passing exactly through this proposed route, implies that other archaeological localities might be discovered during construction work on this part. This can produce additional conflicts that can arise directly during the work (Alternative 2).

In any case, precaution measures are to be undertaken by means that during the preliminary construction works at site, presence of professionals from the field for cultural heritage are to be present in case some of the archaeological localities are detected and adequate measures are to be undertaken.

The Republic of Macedonia cultural heritage reflects the ancient tendency to maintain spiritual continuity without which no human action may be conceived. Its variety, starting from pre-history, ancient Greece, the period of the Roman Empire rule, the Middle Age, the Ottoman Empire oppression and the reformation of peoples in this region - has left numerous proofs of its essence.

Natural heritage conservation and protection are covered by the Law on the Conservation of Monuments of Nature and the Law on Monuments and Memorials. This issue is also addressed in the Criminal Code, the Law on Spatial and Urban Planning and the Law on Investment Structure Construction. Several relevant conventions have been ratified and applied: the Convention on Cultural Heritage Protection in Times of Armed Conflicts (the Hague Convention); the Convention on Measures to Prohibit and Prevent Cultural heritage Illegal Imports, Exports and Ownership Transfer; the Convention on the Protection of the World's Natural and Cultural Heritage; and the Convention on the Protection of Architectural Heritage in Europe. As natural heritage conservation issues are a must that goes beyond the professional circles of conservators, architecture monuments are treated not only as an integral part of each nation's cultural tradition, but also as an essential component of the world's contemporary culture. The parallel existence in towns of the old and the new, the past and the presence, are a dimension that is increasingly missing in modern towns and cities.

It is also recommended that the earth works should be accompanied by an archaeologist. Furthermore the constructor should be committed to notify immediately any other findings to the relevant authority.

9.1.8. RAW MATERIALS AND ENERGY RESOURCES FOR CONSTRUCTION

9.1.8.1. Borrow pits

Specific measures

Based on the above mentioned conditions, and assessing the necessity of establishing professional attitude in usage of the natural resources and consistent with the natural potentials of the analyzed region, recommendations are as follows:

B1: To exclude the exploitation of the existing limestone mine at the entrance of the Demir Kapija Gorge because of the extreme sensitivity of the existing ecosystems and geo-localities and to stop further extermination of this natural monument.

2: It is very risky eventual exploitation of limestone marbleized masses on the section Josifovo – Valandovo – Dojran because of the significance of these formations as main hydro-geological collector and their potentiality for water supplying of the population of this region. This is already evidenced through performed well's water intakes in the karst aquifer with yield above 50l/sec (Pirava, Valandovo, Dojran etc.).

B3: Necessary quantities of carbonate material (limestone, marble) shall be provided from the reserves of the open quarry between the villages Kosturino and Memesli that has been mentioned before, and the same have large quantities of balanced reserves that because of the good communications and the vicinity of the larger part of the analyzed alternatives will be easily accessible.

B4: The gravels and the sands from the alluvial stratum should be exploited from the existing localities at Przhdevo and Gevgelija.

General measures

It is necessary to prepare Environmental Impact Assessment and Design for re-cultivation of all fields of structural stone, gravel and sand, and especially for the alluvial findings it is necessary to perform detailed hydro-geological analysis (level of underground water, regime of feeding etc.). The whole documentation is to be submitted for insight and evaluation to the Agency for environment and nature protection, and the exploitation conditions of these resources are to be determined.

It is really significant to determine an adequate location for disposal of the materials from the excavation that are not going to be used for the highway construction and conditions of their disposal, both from the aesthetic environmental aspect and from the aspect of the landfill stability.

9.1.9. MITIGATION MEASURES FOR AIR QUALITY

Exhaust gasses which will be emitted from the traffic will cause concentrations of polluters in the ambient air. Due to the lack of any polluters in the area the air is relatively clean. Therefore it can not be considered that there will be any significant worsening with the traffic. The terrain is open, natural ventilation is suitable for easy dispersion of air pollution, therefore this impact is not considered as very significant. Considering the temporary character of this impact there are no measures foreseen. Dust control as usual procedure at construction sites is recommended.
Since no adverse impact of air pollutants could be identified. No mitigation measures are required to protect the environment with respect to ambient air quality.

9.1.10. MITIGATION MEASURES FOR THE SOLID WASTE

General measures

The waste generated during construction should be gathered every day and dumped on a special area designated for this purpose. Regularly, with a Contract that the Contractor will make with the local communal enterprises, the waste will be taken from this area and dumped into a legal landfill owned by the communal enterprise.

The Contractor should introduce waste generation and gathering plan, and follow it by the complete time of construction.

9.1.11. MITIGATION MEASURES FOR THE NOISE AND VIBRATIONS

i. Mitigation measures for Noise

General measures

As a general mitigation requirement for noise reduction during the construction phase contractors will be required to use modern noise silenced equipment and to keep to usual daytime work hours (exceptions may apply e.g. for certain structures). Preferably, equipment should be used which meets the requirements of the European Directive EC/2000/14 on noise emission by equipment for outdoor use; e.g. especially in the vicinity of residential objects operation of noise equipment should be limited as far as possible and/ or noise shielding provided, e.g. by placement of equipment apart of residential buildings and/ or behind natural sound barriers, piles, containers which can serve as shielding.
No matter which alternative is considered, the regions near archaeological localities, concentrated in the section between villages Udovo, Marvinci and Smokvica, are mostly very high sensitive and consequently many conflicts may happen during the construction works. So, extreme measures of precaution during the construction should be undertaken and all measures

proposed in other parts (concerning the part for the archaeological sites) are necessary for this part as well and set by Macedonian Law for Cultural Heritage Protection. Therefore, the recommendation would be to foresee presence of archaeological experts during the whole construction period for those critical areas.
Open cast mining operations cause noise pollution for the workers on site, in the neighboring communities and damage to the nearby structures. Main sources of noise pollution are blasting, drilling, ventilation fans, instruments used for underground mining, heavy earth moving machinery, dumpers, crushers, material handling and cleaning equipments etc.
During active mining operations the highest priorities are generally given to health and safety issues during operation. All of the requirements have to be met. However, to nurture a sustainable growth and development with minimal environmental impact to the community, the following is generally recommended during active mining operations: use noise control methodologies during active mining operations by providing temporary noise barriers/ fences utilizing the brushes removed during site cleaning and by limiting operations of machinery generating high noise levels during the daylight hours. In addition to the safety requirements of blasting, similar practices to minimize disturbance to the community are recommended.

Noise can be abated by choosing right machinery and equipments. Noise can also be prevented at source by proper maintenance of compressors, ventilation fans by oiling and greasing and installing noise insulating enclosures.

ii. Mitigation measures for Vibrations

No mitigation measures are proposed since the impact of vibrations during road construction will be insignificant.

Note: Mining in areas of cultural, historical, religious and scenic importance should be undertaken only after taking sufficient safeguards to protect these sites since these sites can not be restored once perished.

9.1.12. MITIGATION MEASURES FOR SOILS AND GEOLOGY

General measures

The technical planner intends or will intend to construct the embankments with materials from the neighboring cuts. It is an engineering goal to achieve as far as possible a neutral cut and fill balance, meaning that there is neither a surplus of excavated materials nor a deficit of raw materials. This target meets also the environmental considerations by minimizing the need for raw material extraction as well as for depots. Furthermore transport distances will be minimized resulting in fewer pollutants.
Each area for depot of excess soils which is to be planned should follow the below mentioned rules:

- Separate the top soil
- Flatten the surface
- Compact the material in the underground.

Surplus of excess material should be re-used as far as possible.

SG1: The Consultant recommends that the construction of concrete retention walls should be considered for those sections where geological layers dipping parallel with the slope and where clay layers are inter-bedded or where natural springs are occurring. For the foundation and the design of those walls additional testing is required.

SG2: For those parts of the slopes developing loose surface after the cut, the Consultant would recommend protection by nets against stone fall.

SG3: Permanent seepage of water along cut areas can severely change the water content of the slope material and can decrease cohesion and increase load resulting in land sliding. Therefore, as mentioned previously, the Consultant recommends taking care for the construction of drains and drainage systems.

It should be planned to re-use the top soils as far as possible, therefore some principles for handling of soils at construction sites will be given in this chapter. The most appropriate way assuring soil quality is the placement of the soils without any intermediate storage. If required, the layers should be stored at appropriate sites in an appropriate manner. Soils are in general sensible to compaction (increase in bulk density due to mechanical forces such as wheels) which will lead to negative effects, mostly none reversible, with respect to their later use. Negative impacts are caused by anaerobic conditions damaging the soil quality.
Therefore wet soils (which have a consistence like “soft” or “pappy”) should not be removed and the optimum season for excavation as well as placement are the summer/autumn months for these earth works. Driving over the top soils with heavy equipment should be avoided, as the wheels of trucks and the chains of dredgers are the most important source for compaction at road work sites. The top soil should be excavated in one single working step to avoid driving over. The ideal excavation takes place with the equipment driving only on the subsoil.
At the storing site water logging of the soils must be strictly avoided. Therefore areas where groundwater level is close to the surface are not suitable for the temporary storing of excess soils. The temporary soil depots should be planted with deep rooting plants. Even an intermediate agricultural use of the temporary depot can be reasonable.
After finalization of construction works the fertile soil will be placed on the slopes of the newly constructed dikes and cut areas. On the one hand this reinstatement is a reasonable re-use of the soils on the other hand it facilitates a fast restoration of vegetation and by this it is an efficient tool to protect

against soil erosion and will reduce potential costs for road maintenance.
After finalization of the earth work protection measures against soil erosion are needed. This can be done by different protection means.
On the slopes of the cuts and slopes of the high and low embankments the Consultant recommends top-soiling and hydro-seeding with a mixture of autochthon seeds. Additionally the slopes of the high embankments can be strengthened with yuta net, and slopes of the cuts with mat net, made of polyester material.

9.1.13. MITIGATION MEASURES FOR THE LANDSCAPE

Every possible measure should be undertaken in order to avoid unnecessary destruction of habitats. Using of latest achievements of "good construction practice" in the field of motor way construction is imperative.

Attention should be paid to all habitats and parts of the landscape along the road corridor mentioned in previous chapter (Chapter IX.2.2.) in order to avoid excessive destruction.

The following mitigation measures are possible to minimize the impact of road and traffic on the landscape and its recreational potential:

L1: If feasible, the vertical road gradient should be attached more to the relief of the terrain to reduce the impacts on the scenery due to land cuts, embankments and bridges.
As for the construction sites, especially in sensitive areas, land exploitation should be limited to the minimum extent possible
There are no reasonable mitigation measures outside of the housing areas to prevent impacts of traffic noise on the recreational potential of the landscape.
At particular places near the housing areas sound walls are proposed (see Noise Study in Appendix B). These sound walls also have a locally limited mitigating effect in the above mentioned areas of specific importance for the recreational potential.

9.1.14. BIODIVERSITY COMPENSATION MEASURE

It is well established practice that Employer and Contractor compensate the damage to the environment by setting a scheme for enhancement and improvement of environment in adjacent regions, especially in biodiversity conservation field. This is an integral part of Environmental Assessment process according to World Bank rules. Extensive damage to the natural and semi natural habitats (irrespective to which alternative) should be compensated by providing conditions for elaboration of management plan for Demir Kapija protected area (Monument of Nature, including Celevecka River water gap) and action plan for conservation of vulture colony in the gorge. Creation of information center for Demir Kapija canyon will be expression of good will and will have positive socio-economic effect on the local population. The investment will be in the range of tenths of thousands of Euros.

9.2. MITIGATION MEASURES FOR THE ROAD OPERATION

The same remarks noted in IX.1 are valid in this case as well. However, operation of the highway creates more general impacts applicable to variety of situations. That means that measures proposed bellow are applicable, although one should keep in mind that specific measures may become necessary after elaboration of the final design for Alternative 2 (if accepted) due to the specific relief and other environmental characteristics.

9.2.1. GENERAL MEASURES

The following prevention, elimination, mitigation and/or compensation measures are proposed for the operation phase:

- Elaborate emergency plans. Pursue regular emergency training.
- Store the substances hazardous to water in proper manner (for example defrosting agents) in compliance with corresponding regulation and technical standards in force.
- Carry out measures to decrease dustiness (cleaning of roads etc.).
- Elaborate plan for action in emergency situations.

9.2.2. SPECIFIC MEASURES

9.2.2.1. Landscape

Following measures should be applied in order to reduce the impacts on the landscape:

- Planting of tress, shrubs and grasses for landscaping purposes adjacent to the motorway by using pyrophobic tree species
- Forestation of bare forestry land in the surrounding - only native species of plants are to be used for planting purposes in particular adjacent natural and near-natural habitats.

9.2.2.2. Fauna

Construction of protective panels along the highway: monitoring system for bird casualties form the traffic is proposed along the highway section, and construction of plastic protective panels along highway sides on the most critical places. Panels should be partially transparent, with clear marking on them (usually, it is a silhouette of bird of prey), Photo 73 and 74.

It is assumed that highest number of mortalities will be in the agricultural habitats (i.e., when the surrounding habitat is approximately on the same level with the highway).

Photo 73. Protective panels for prevention of bird kills during highway operation

Photo 74. Detail of the protective panels for prevention of bird kills

Monitoring on the movements of amphibians, reptiles and mammals - if strong movements are found on sections of the highway far from culverts, direction barriers should be constructed that should not allow animals to pass above them but will divert them to the culverts.

9.2.2.3. Waters

9.2.2.3.1. Ground waters

Under normal circumstances – meaning that the groundwater is protected by an effective soil layer of several meters – groundwater pollution caused by normal operation of road is not a concern if a proper environmental management is applied.

The sealing of surfaces by the road reduces the area through which groundwater can infiltrate into the ground. Embankments will after re-vegetation regain their function to take up water. Also structures (overpasses, bridges) do not reduce groundwater recharge significantly. The total area, which will sealed permanently by the new surfaces is linear in extent considering the scale of the project area. Therefore, no impacts of significance are anticipated by the effects of surface sealing.

The pollution threat of groundwater is similar to that of surface water. However, the potential of groundwater pollution also depends on the surface layers. No dumping of waste or excavated material on the banks of the rivers and streams is allowed and removal of solid waster from the riverbeds is needed (if such kind of pollution exists). Additionally, waste dumping of gravel pits after the construction phase must be excluded.

9.2.2.3.2. Surface waters

The surface water drainage system of the road is to be piped. Collection is to be via road gullies and side ditches, and outfalls must be equipped with oil separators to prevent environmental damages to the existing ground and surface water regimes.

Considering potential surface water pollution, herbicides should not be used on the road shoulders or embankments for maintenance. Mowing of the verge is highly recommended as well as to leave green cut on site (it should not be used as animal fodder).

It will be necessary for the local highway authorities responsible for the maintaining the new infrastructure, to be equipped and well trained to service the oil separators and treatment facilities in addition to other normal road maintenance requirement. For cases of accidents on road an emergency plan should be established to respond and quickly deal with threats from water pollution.

A surface water drain discharging into basin of the river Kalica and in the vicinity of the intended accumulation Petrushka for irrigation on the same river close to the highway was deemed to be too risky for the accumulation, which might have become polluted (e.g. de-icing agents during winter, accidental spills).

The Technical planer of highway and drainage system with oil separators must propose appropriate additional measures to prevent any water pollution in the future. Furthermore, maintenance and clean up of the drainage, channels is recommended in order to avoid blocking by driftwood, waste and other bulky materials, which can lead to overflow and flooding at another place..

A total mitigation of the impacts on the surface water is not possible; therefore, compensation measures are necessary.

- Improvement and strengthening of the habitat function of the rivers, a protected biotope according to the European FFH-Directive.

- The development of riparian vegetation within a buffer of at least 10 meters of the riverbanks can be supported by planting additional shrubs and trees.

- Within this buffer zone no land use or other impacts (gravel pits, dumping of waste, roads) should take place. According to the EIA-Directive 97/11 Appendix II, No. 2.c an EIA is needed for gravel pits in fluvial plains especially if biotopes according to the European directives (FFH, EWB) are likely to be endangered.

If proper management is applied it is assumed that construction and operation of the road will not have any significant effect on surface water quality.

9.2.2.4. Air

9.2.2.4.1. Air pollution

It is proposed to revitalize vegetation as a buffer along the alignment, at sections surrounded by high quality agricultural land. Considering the temporary character of this impact there are no measures foreseen. Dust control as usual procedure at construction sites is recommended.

9.2.2.4.2. Ambient air

The Alternative 1 and “2” are passing through unpopulated areas, without industrial plants being known as sources of emissions of polluting matters in the atmosphere; in addition, the natural aeration of the open and flat area (constant wind blows) contribute to the fact that the ambient air is considered as relatively clear.

The impact of toxic gases may cause consequences upon the human health, especially upon these people who are long-term exposed to this impact, by direct or indirect exposures (inhalation, or by consummation of polluted agricultural products). Fume affects the respiratory organs and skin, while the hydrocarbon oxides act as toxics and anti-oxidants. The lead which is added in the petrol as tetraethyl lead is particularly harmful for the respiratory and digesting organs, as well as for nerves; even at the allowed concentrations the lead may cause adverse affects upon the blood tissues.

Nitrogen oxides cause asthma, allergies and cancer of the respiratory organs. Some compounds from the group of poly-cyclic hydrocarbons (benzene, as a product of the burning out of diesel, while on tone of diesel produces 50 mg of benzene) are leading in the list of compounds responsible for the appearance of cancer (it is also the most distributed compound in the air polluted by the traffic) Fume is also containing cancerous substances (similar to the effects of tobacco smoke), but extremely cancerous features are attached to various particles originating from the process of the burning out of diesel.

A permanent emission of such polluting substances will be present during the operation of the highway. Vulnerable sections are those approaching to the inhabited areas; moreover, such sections are constructed by embankments, allowing for free distribution of the polluting substances. Some parts of the alignment where the highway is approaching to high quality agricultural land may be considered as vulnerable as well. Maximum allowed concentrations of harmful substances in the ambient airs should be in the following ranges:

Due to the lack of any polluters in the area the air is relatively clean. Therefore it is not considered any significant worsening with the traffic. Terrain is open, natural ventilation is appropriate therefore the dispersion of air pollution is expected. However, monitoring (especially in winter season) should take place. If any indications on pollution would be found, the project developer will be responsible to apply appropriate measures.

9.2.2.5. Noise and vibrations

9.2.2.5.1. Noise

A major scope of the noise assessment was to investigate on mitigation measures to avoid adverse noise impacts on residential areas.

Noise reduction can be achieved by different approaches:

(i) reduction of emissions,

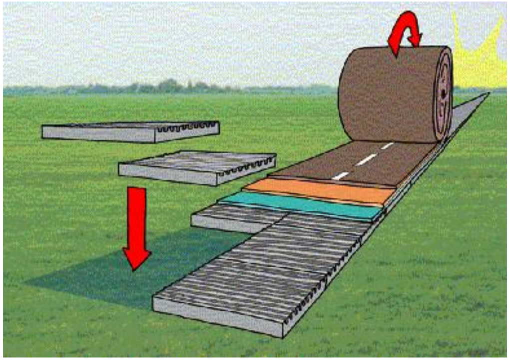
(ii) reduction of transmission, and

(iii) reduction of noise at the impact area.

The most important mitigation measures are:

Reduction of noise emissions:

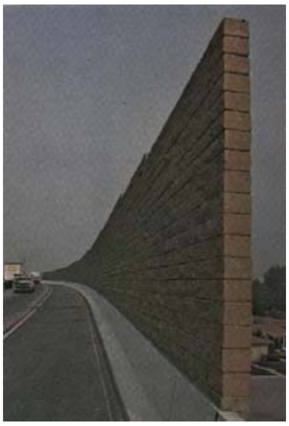
- reduction of the vehicle speed;
- construction of special noise reducing road surface which is efficient for speeds over 60 km/h;
- avoidance of additional noise sources of constructive origin and damages of the road surface.



Example of a prefabricated modular road surface (Pictures courtesy of DWW)

Reduction of sound transmission:

- construction of noise abatement barriers like walls or embankments (note: the latter have significant reduction effects only if installed close to the road);
- construction of tunnels, housing-in-tunnels, or noise abating buildings (houses) at the road border.



Abrupt endings on wall

Plywood panel

Reduction of noise impact at the impact area:

- respecting a setback-/ noise buffer for new developments;
- installation of noise reducing windows in affected houses.

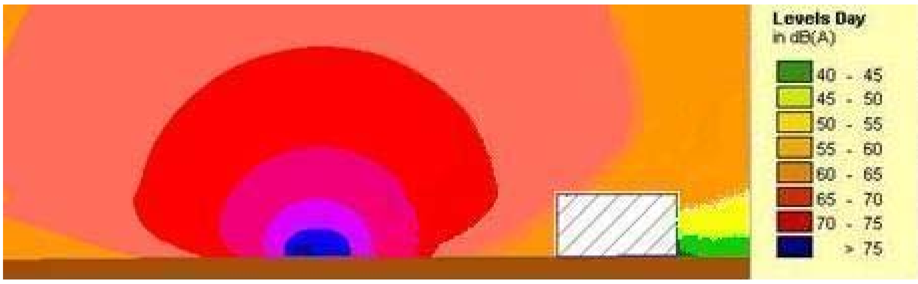
Two alternative 1lignments of the future road are investigated during this early stage of the planning. Since the road design for the section Demir Kapija-Smokvica hasn't already been finished, all possibilities for mitigation measures can be used. Of course, the most important measure to be taken into consideration, is constructing an alignment that will have no noise impact (or it will be minimized) by setting the route as far as possible from the settlements or/ and avoiding them. If that is not possible, the construction of noise reduction barriers and the use of noise reducing windows should be taken into consideration and should be investigated in details.

Thermo mineral and mineral springs that originate in many places connected to the fault lines are of a special importance for Gevgelija- Valandovo valley. Many springs are present there on a relatively small area. There is excavated well with thermal water near village Smokvica, close to river Vardar. It is considered that an extremely rich area with thermal water is on the area between villages Smokvica, which fact must be taken into consideration due to possible future potential of this area for recreation and tourism activities and impact of noise pollution by the future highway.

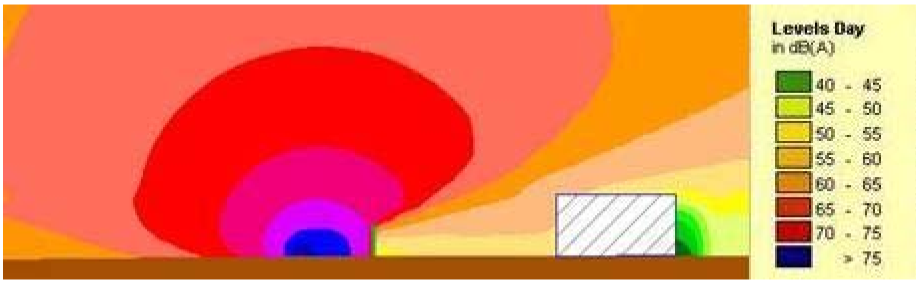
Without any noise prevention measures reveal high impacts with outdoor levels exceeding 65 dB(A) at night time for few buildings (houses) located close to the highway.

Restrictive car speed limits on sections near settlements for example can reduce noise emissions; e.g. by about 2 dB(A), if passenger car speed is limited to 80 km/h instead of 100– 120 km/h and large and heavy vehicles to 60 km/h instead of 80 km/h.

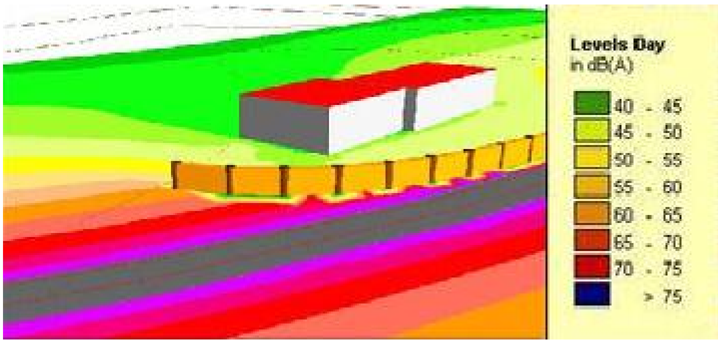
To mitigate impacts concerning noise in the area of the projected highway, retention walls in the area of previous mentioned villages must be foreseen. Their precise position, height and design should be determined with the detailed design.



Noise contours without noise protection barrier



Noise contours with noise protection barrier



3D view on effect of noise protection barrier

Noise transmission at the source should be intercepted by planting trees around the source of noise generation. Boundary walls and green belts between the township (settlements) and highway site should be developed which work as an effective acoustic barrier. The noise barriers (acoustic walls) and the hedges (trees) should be planted along the final alignment where needed. Since the risk of forest fires in the area is high, tree hedges should consist of autochthonous pyrophobic (fire resistant) tree species.

If the proposed measures will be applied, there should not be any significant noise impact originating from the construction and exploitation phases of the highway.

It should be proposed to the client and to the national and local organs in charge, as well as to the concerned public, to undertake the preparatory works for the implementation of the project.

Noise pollution prevention management plan

	Mitigation Measures	**Implementatio n Schedule**	**Responsibility for Implementation**	**Responsibility for Supervision**	**Monitoring indicators**	**Type and Frequency of Monitoring and Reporting**
Construction	Use modern noise silenced equipment; keep usual daytime work hours	During construction work	Fund for National and Regional Roads (FNRR)	Ministry of Environment and Physical Planning (MEPP)	Noise thresholds in the Law and subsequent legislation	Annual report to MEPP
Operation	Retention walls where needed	During construction work	Fund for National and Regional Roads (FNRR)	Ministry of Environment and Physical Planning (MEPP)	Noise thresholds in the Law and subsequent legislation	n/ a

Some possible solutions of noise prevention walls are presented on Photos 75-80.

Photo 75. A wall which varies in plan view, to reduce the straight line effect, and provide visual interest

Photo 76. A gabion noise wall

Photo 77. Gabions are essentially wire baskets filled with stone

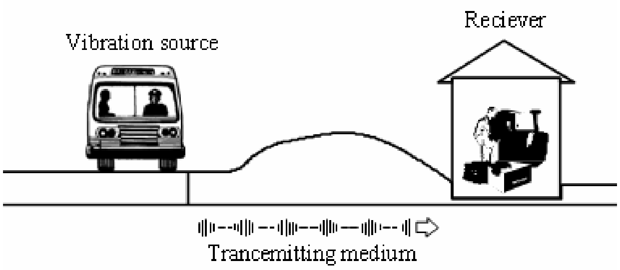
Photo 78. Gabions may be stacked in a variety of ways to construct a wall

Photo 79. Excessive contrast. A darker colour would blend this barrier into the background trees

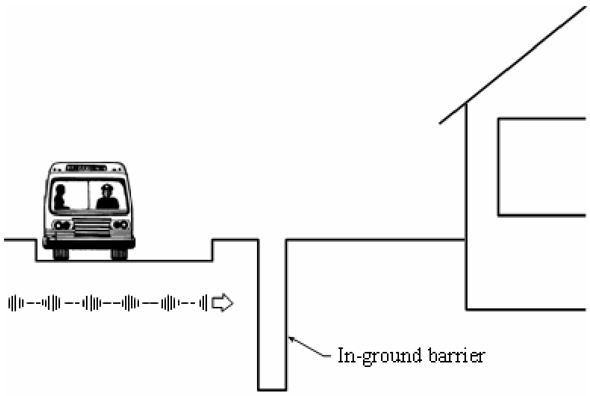
Photo 80. Noise prevention wall- a combination with vegetation

9.2.2.5.2. Vibrations

Given potentially adverse effects caused by construction activities, nearby buildings should be inspected before and during construction work to identify building damages, e.g. walls, roofs (Fig. 17 and 18). Where buildings remain after commencement of the highway, regular inspections of these buildings should be performed, if identified as potentially sensitive in a first investigation (e.g. building structures have resonant frequency comparable to the traffic generated vibration).



Traffic vibrations can be characterized by a source-path-receiver scenario



Schematic illustration of an in-ground vibration barrier

9.3. ESTIMATED COST OF THE MITIGATION MEASURES

The mitigation measures proposed can be divided in measures without cost (measures giving path to the Designer or Contractor how to proceed with the Design or with the works) and measures with cost (measures that will cost additional investment in order to be implemented).
For the needs of evaluation of the Alternatives, the Consultant has roughly calculated the quantities required for implementation of the measures with cost, and the following table gives the results of this analysis for both alternatives.

Costs in Macedonian denars

Measure	Quantity		Unit price (MKD)	Cost for mitigation	
	Alternative 1	Alternative 2		Alternative 1	Alternative 2
1	4	5	6	7	8
Forestation (Ha)	14.00	23.50	123,000.00	1,722,000.00	2,890,500.00
Construction of additional culverts for animals passages (pcs)	10.00	30.00	820,000.00	8,200,000.00	24,600,000.00

Measure	Quantity		Unit price (MKD)	Cost for mitigation	
	Alternative 1	Alternative 2		Alternative 1	Alternative 2
1	4	5	6	7	8
Protection of slopes of the cuts from erosion with topsoiling (m2)	45,670.00	64,238.00	95.00	4,338,650.00	6,102,610.00
Protection of slopes of the cuts from erosion with mat (m2)	45,670.00	64,238.00	615.00	28,087,050.00	39,506,370.00
Protection of slopes of the cuts from erosion with hydro seeding (m2)	45,670.00	64,238.00	78.00	3,562,260.00	5,010,564.00
Protection of slopes of embankments with topsoiling (m2)	26,750.00	32,800.00	95.00	2,541,250.00	3,116,000.00
Protection of slopes of embankments with yuta (m2)	26,750.00	32,800.00	143.00	3,825,250.00	4,690,400.00
Protection of slopes of embankments with hydro seeding (m2)	26,750.00	32,800.00	78.00	2,086,500.00	2,558,400.00
Alluminium sound walls, height 2.9 m, placed on concrete foundations and wall 1.0 m high (m2)	7,200.00	1,800.00	12,000.00	86,400,000.00	21,600,000.00
Gabions for slopes of the cuts protection (m')	2,100.00	4,400.00	1,200.00	2,520,000.00	5,280,000.00
information center for Demir Kapija canyon	1.00	1.00	1,537,500.00	1,537,500.00	1,537,500.00

TOTAL COSTS	**144,820,460.00**	**116,892,344.00**

Costs in Euros

Measure	Quantity	Unit price	Cost for mitigation

	Alternative 1	Alternative 2		Alternative 1	Alternative 2
1	4	5	6	7	8
Forestation (Ha)	14,00	23,50	2.000,00	28.000,00	47.000,00
Construction of additional culverts for animals passages (pcs)	10,00	30,00	13.333,33	133.333,33	400.000,00
Protection of slopes of the cuts from erosion with topsoiling (m2)	45.670,00	64.238,00	1,54	70.547,15	99.229,43
Protection of slopes of the cuts from erosion with mat (m2)	45.670,00	64.238,00	10,00	456.700,00	642.380,00
Protection of slopes of the cuts from erosion with hydro seeding (m2)	45.670,00	64.238,00	1,27	57.922,93	81.472,59
Protection of slopes of embankments with topsoiling (m2)	26.750,00	32.800,00	1,54	41.321,14	50.666,67
Protection of slopes of embankments with yuta (m2)	26.750,00	32.800,00	2,33	62.199,19	76.266,67
Protection of slopes of embankments with hydro seeding (m2)	26.750,00	32.800,00	1,27	33.926,83	41.600,00
Alluminium sound walls, height 2.9 m, placed on concrete foundations and wall 1.0 m high (m2)	7.200,00	1.800,00	195,12	1.404.878,05	351.219,51
Gabions for slopes of the cuts protection (m')	2.100,00	4.400,00	19,51	40.975,61	85.853,66
information center for Demir Kapija canyon	1,00	1,00	25.000,00	25.000,00	25.000,00

TOTAL COSTS	**2.354.804,23**	**1.900.688,52**

10.ANALYSIS OF ALTERNATIVES

Three basic Alternatives were considered for comparison within this Study:

- Alternative 1 (Upgrading of existing motorway from the left side of the river Vardar)
- Alternative 2 (Upgrade of the first 2 kilometers and construction of a new section from the right side of the river Vardar but higher up in the hills)
- 0-alternative, which means no action undertaken, i.e. no road construction or upgrade at all.

In case of Alternative 1 - construction works will comprise of widening of existing road for its use as two lanes road in one direction (plus one stopping lane) and construction of another two lanes in opposite direction next to the existing road (plus one stopping lane). Both carriageways will be divided by a central green belt width of 3 meters.

In case of Alternative 2 construction works will comprise a construction of a completely new highway on the most of its length.

In case of 0 - alternative no construction works will be undertaken and the situation will remain the same - old one-lane in each direction motor road from the left side of the river Vardar will be the only mean of transportation.

For technical details of alternatives 1 and 2 see Chapter II.

In this Chapter, advantages and disadvantages of each alternative will be presented and analyzed through comparison of the participation of sensitive or low sensitive habitats and ecosystems, sites, localities, infrastructure and economic activities along both alternative alignments.

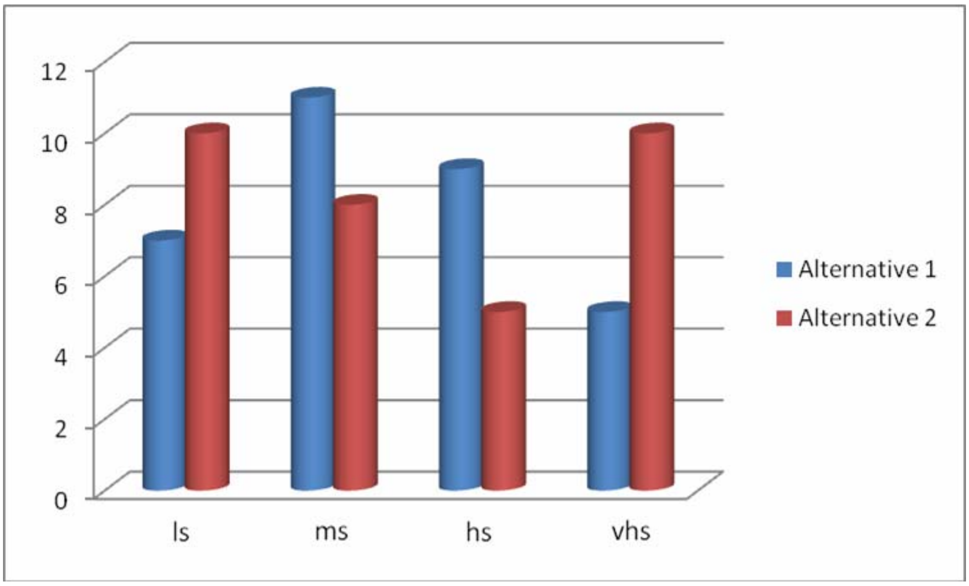
General analysis of the participation of sensitive habitats was performed on the basis of habitats in broad sense as described in the study (Chapter VII). However, if deemed necessary particular sites and localities or particularly sensitive parts of ecosystems to be pointed out (For detailed description of particular sites and sensitive habitat parts, see Chapter VII - Sensitivity).

Socio-economic context in local and national scale is considered as well. Social aspects are treated through comparison of sensitivity of different man made structures (settlements, infrastructure and agricultural amenities and archaeological sites). The meaning of sensitivity level is the same as in case of natural and seminatural ecosystems and habitats. In addition, basic economic activities (agriculture and forestry) are discussed as well.

Sensitivity of natural habitats

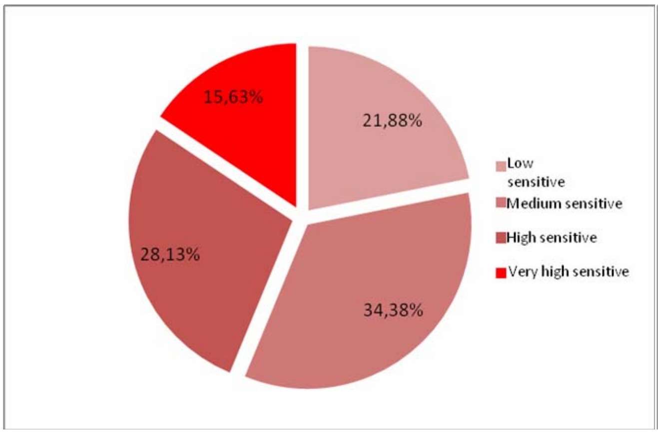
Analysis of participation of sensitive habitats in each alternative highway corridors is presented in Fig. 19 and 20. It is presented separately for each level of sensitivity (vhs, hs, ms, and ls).

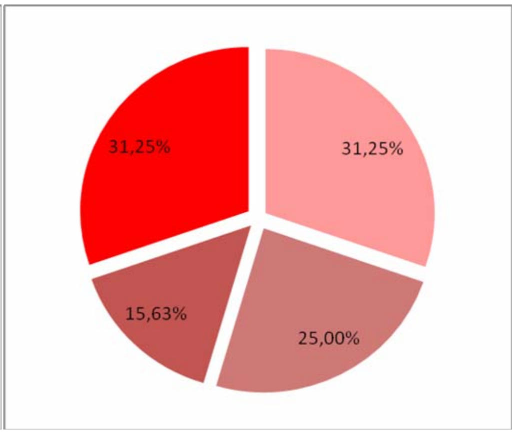
It is noticeable that very high sensitive ecosystems and habitats are more present in Alternative 2 and high sensitive ecosystems and habitats in Alternative 1 (for meaning of the level of sensitivity in sense of construction activities, see Chapter VII.1.). On the other hand, medium sensitive ecosystems and habitats are much more represented in Alternative 1 (see also Sensitivity map-Appendix), and low sensitive ecosystems and habitats in Alternative 2. Fig. 19 presents the area of different sensitivity classes in both alternatives, while Fig. 20 presents percent contribution of different sensitivity classes in both alternatives.



Comparison of the sensitivity levels in Alternative 1 and Alternative 2.

It is obvious (Fig. 20) that high sensitive participate with larger percent in



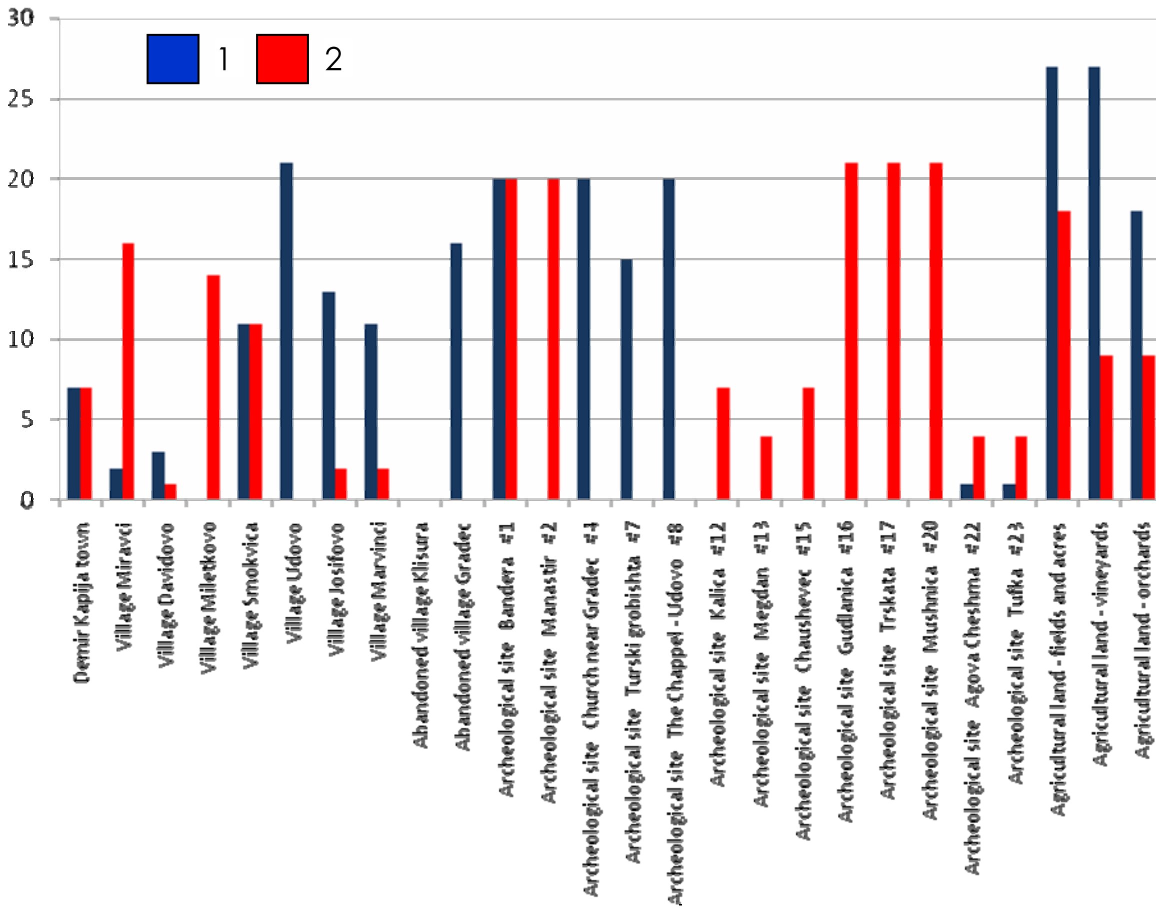


Alternative 2.

Alternative 1 ***Alternative 2***

Sensitivity of sites of human interest

The comparison between the objects of human interest along the alternative 1 and 2 is presented on Fig. 21. The comparison was based on sensitivity scores from sensitivity matrix on Tab. 41 (Chapter 7.4.1.).
Medium sensitivity objects are mostly presented in corridor of Alternative 2 (in ratio 6:4 to alternative 1) because of the distance of most of the settlements (and two of the archaeological sites) from the future planed highway.
Maybe the most important criteria for comparison are very high sensitivity class (VHS) because of the highest impact on the environment taken as a whole. Alternative 1 has 3 (three) "VHS" points and alternative 2 is critically approaching to 3 of the archaeological localities in a very short distance, and also has 3 (three) "VHS" points.



Comparison of sensitivity of sites of human interest in alternatives 1 and 2.

For alternative 2, the following situation will occur in the area around the highway from Demir Kapija to village Smokvica:

- There will be significant increment in terms of traffic and emission of pollutants produced by the traffic and other facilities along the whole length of the Alternative 2 route;
- Agricultural land will be less destroyed compared to Alternative 1, especially since the quality of the arable land is less class and used by the local population for agricultural activities sporadically.
- The noise created by the highway will concern less human population since there is only one settlement close to the highway.
- The disturbance of natural habitats will be more significant compared to the case of Alternative 1 scenario in case of very high sensitive habitats; the disturbances to threatened species will be restricted to the region of Demir Kapija canyon (also affected by Alternative 1).
- There will be less significant damage of high sensitive habitats and sites.
- Very high sensitive archaeological sites as non-recoverable objects of human history will be more threatened, so therefore in this study an adjustment is proposed of Alternative 2 in order to avoid this impact.
- There will be a significant change in landscape characteristics (structural and functional) in the broader area of interest by introducing completely new line object of a large scale.

For Alternative 1, the following situation will occur in the area around the alignment from Demir Kapija to village Smokvica:

- Agricultural land will be much more destroyed compared to alternative 2, especially since the quality of the arable land is first class and 100 percent used by the local population for agricultural activities.
- The noise created by the highway will concern more population since three settlements are very close to the highway (10 up to 20 meters from the highway).
- The construction work will take much longer since the operation of the existing motorway should not be interrupted.
- There will be significant increment in terms of traffic and emission of pollutants produced by the traffic and other facilities along the whole length of the Alternative 1 route;
- The disturbance of natural habitats will be less significant compared to the case of Alternative 2 scenario in case of very high sensitive

habitats; the disturbances to threatened species will be restricted to the region of Demir Kapija canyon (also affected by this alternative).

- There will be certain disturbance of very high sensitive habitats, but there will be significant disturbance of high sensitive habitats and sites, particularly the valuable Oriental plane woodlands and belts, pristine streams, oak forests and pastures (destructions of oak forests and pastures were assessed as comparatively small and compensation is possible - see Chapter IX.2.3.3.).
- There will be no disturbance to the living organisms in all ecosystems (particularly threatened species) and there will be no fragmentation of important biocorridors.
- Very high sensitive archaeological sites as non-recoverable objects of human history will be less threatened.

For 0 - Alternative, the following situation will occur in the area around the highway from Demir Kapija to village Smokvica.

- There will be no disturbance on the natural environment and biodiversity components will remain unchanged or conserved.
- There will be no danger of impact on human health along the villages Marvinci and Miletkovo. There will be no significant change of human health impacts along the villages Udovo, Marvinci and Smokvica.
- The economic growth of the area and the country in general will be lowered.
- Traffic safety will be lower - probability of traffic accidents will be higher.
- Application of sound mitigation measures during its future operation will be less feasible.

0-alternative is rejected due to the above mentioned probabilities and due to the possibilities to mitigate threats from construction and operation of the highway according to other alternatives.

Comparison of sensitivity (and impacts) (Tab. 40 and 41 Chapter VII) has shown that both active alternatives have disadvantages and advantages. Alternative 2 is less favorable in regard to the natural environment and Alternative 1 is less favorable due to the impacts on human environment.

The final choice for the most preferable alternative was made putting human health, wellbeing and human environment into central position.

It was considered that sound mitigation measures along Alternative 2 will decrease the disturbance to acceptable level (if no financial constrains will be foreseen) while disturbance to human health and the basic source of the local people income (agricultural land) will be irreversible.

Thus, Alternative 2 is recommended for highway construction followed with series of mitigation measures and recommendations for compensation and other measures. All these actions are systematized in all-embracing and full-scale Environmental Management Plan. EMP includes detailed review of mitigation measures and responsibilities for their implementation and detailed monitoring plan with responsible entities for its execution. Additionally, estimate of residual impacts is given in a separate column.

11. CONCLUDING REMARKS AND RECOMMENDATIONS

Construction and operation of highways causes significant adverse impact on the natural areas and human environment. Beside implementation of the mitigation measures which intend to avoid significant negative impacts, some recommendations for conservation and promotion of the environment should be taken into account during the construction work and operational phase of the highway.

The destruction of the forested areas, grasslands, agricultural land can not be avoided during the construction although several mitigation measures were proposed in order to minimize this impact. About 56.60 ha of agricultural land and 96.60 ha natural land (Alternative 1) and 9.70 ha of agricultural land and 120 ha natural land (Alternative 2) will be destroyed during the construction. In order to compensate this impact, reforestation measures along the highway are strongly recommended. This will contribute towards the erosion-prevention which improves the maintenance of the highway during its operation. According to the provisions of the Law on Nature Protection, autochthonous plant species should be used during the aforestation in natural areas. The best places for reforestation are highly degraded pseudomaquis habitats on steep slopes along the highway: in the vicinity of village Udovo (in case of Alternative 1) and surrounding of the village of Miletkovo (in the case of Alternative 2).

One of the mitigation measures was to minimize the alteration with the "agricultural" roads. During the construction of the highway these roads should be used as access roads. After the completion of the construction works, agricultural roads should be repaired and adopted for their use by local population.

During the construction in the forested areas, existing forest roads should be used. In case of Alternative 2, the best access road is the one that passes by Kalica reservoir and runs along the valley of Kalica stream. These measures were already noted. The construction of new access roads should be done in coordination with the forestry enterprise in Demir Kapija or Gevgelija depending on the affected forestry units. After completion of the construction works, unnecessary access roads should be re-vegetated and closed for operation. This measure will prevent illegal woodcutters and poachers from reaching undisturbed natural areas.

Since there are a lot of uncertainties and unforeseeable situations, recommendations for elaboration of additional assessments (in case of access roads, borrow pits etc.) after making a final decision for the preferred alternative have to be respected.

Having in mind all the aspects touched by this study, all the results from sensitivity analysis and impact assessment analysis, as well as mitigation measures necessary for remediation of the environment and their cost (for the measures that have cost) it can be concluded that both alternatives will have similar overall impacts on the environment.

From the analysis carried out for both alternatives the following conclusions can be pointed out:

- Altrenative 2 is less sensitive regarding sites of human interest. According to matrix analysis the sensitivity of Alternative 2 is 218 points compared to Alternative 1 which has 233 points.
- Alternative 2 has less impact during road construction. According matrix analysis the impact of Alternative 2 scores 28 points compared to Alternative 1 which has 29 points.
- Alternative 2 has less impact during road operation. According matrix analysis the impact of Alternative 2 scores 15 points compared to Alternative 1 which has 16 points.
- Alternative 2 is more sensitive regarding natural and anthropogenic habitats. According to matrix analysis the sensitivity of Alternative 2 is 461 points compared to Alternative 1 which has 440 points.
- Very high sensitive ecosystems and habitats are more present in Alternative 2 and high sensitive ecosystems and habitats in Alternative 1, but both together as percentage are more represented in Alternative 2. On the other hand, medium sensitive ecosystems and habitats are much more represented in Alternative 1, and low sensitive ecosystems and habitats in Alternative 2. Very high sensitive and high sensitive habitats together particapate with larger percent in Alternative 2 (43.75% in Alternative 1 and 46.88% in Alternative 2).
- The number of objects (settlement/ archeological site/ agricultural land) with low sensitivity regarding sites of human interest for Alternative 1 is 4 and for Alternative 2 is 6.
- Medium sensitivity objects regarding sites of human interest are mostly presented in corridor of alternative 2 (in ratio 6:4 with alternative 1) because of the short or long distance of most of the settlements (and two of the archaeological sites) from the future planed highway.
- Alternative 1 is critical concerning high sensitivity regarding sites of human interest due to the relatively short distance of most of the settlements (and archaeological sites) from the future planed highway.
- Maybe the most important criteria for comparison are very high sensitivity class (VHS) because of the highest impact regarding sites of human interest. Alternative 1 has 3 (three) “VHS" points and alternative 2 is critically approaching to 3 of the archaeological localities in a very short distance, and also has 3 (three) “VHS" points. In case of Alternative 2, a realignment of the future road must be considered, which will avoid these three VHS points. In case of Alternative 1 sound protection wall should be foreseen for the area of Udovo and Marvinci

Villages, which will avoid one from the VHS points, and for the agricultural land – fields, acres and vineyards there are no mitigation measures, so this area will be irreversibly destroyed.

- Alternative 1 leaves the population without an alternative road, since it will be used for upgrading to a level of highway. Therefore new alternative national road will have to be constructed, parallel or at the other side of the Vardar River in accordance to EU dirctives. Alternative 2 is a completely new road, therefore an alternative road already exists (existing motorway E75, Corridor X) and there is no need for its construction.
- Alternative 1 is 32.2 km long, and Alternative 2 is 27.75 km long. Although Alternative 1 is upgrading of the existing road to a level of highway, it is more expencive for construction due to its length. On top of this higher expense derive from the necessity of construction of an alternative road, according to EU diractives.

Having in mind the abovementioned results from this study the final conclusion of the Consultant will be acceptance of Alternative 2 as final alternative for construction. Both of the alternatives are similar regarding their sensitivity and their impacts. One of them has advantages at some criteria and disadvantages at some other criteria. When taken in whole both alternatives are very similar. Alternative 2 is more favourable due to its less cost for construction, shorter alignment, more distance from the human settlements, therefore less impact to the humans, although it is slightly more sensitive concerning the natural and anthropogenic habitats.

Elaboration of detailed monitoring and supervision plan (EMP) for construction and operation period of the highway is also measure that have to be considered further since it was not possible to elaborate it in this stage. Some very general aspects of monitoring plan are presented bellow.

Monitoring

It is not possible to elaborate detailed monitoring scheme at this stage of project design. The proposals bellow have to be understood as general directions that can serve the designer to calculate possible expenses for future construction and operation of the highway.

The following aspects have to be monitored during the construction of the highway:

Level of destruction of the following habitats on particular localities along the alignments and access roads:

- Alluvial sites with willow stands

- Plane woodlands and belts
- Greek juniper stands
- Tamaris communities

Indicators: surface of the range of particular habitat damaged, population of rare species, especially plants, destruction of individual plane stems

Level of destruction of agricultural land:

- Alluvial deposits along the river Vardar
- Valandovo plain (Udovo, Josifovo and Smokvica)

Indicators: area of damaged land not used directly for the road planum.

Level of destruction of forests

Archaeological sites

Concrete sites that have to be monitored have to be stated in the EMP after acceptance of preferred alternative for construction.

Supervision of implementation of mitigation measures (according to the timeframe for construction)

The following aspects have to be monitored during the operation of the highway:

- Air quality on selected points
- Water quality at selected watercourses (depending on the selected alternative)
- Noise generated close to the most affected settlements
- Bird populations in Demir Kapija canyon
- Amphibian crossings at selected points

Selected mammal species at underpasses and culverts

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13.ENVIRONMENTAL MANAGEMENT PLAN AND MONITORING PLAN FOR THE IMPLEMENTATION OF MITIGATION MEASURES DURING THE CONSTRUCTION OF THE SECTION DEMIR KAPIJA-SMOKVICA OF THE HIGHWAY E-75 (CORRIDOR X)

The proposal for Environmental Management Plan (EMP) was prepared on the bases of the proposed mitigation measures for Alternative 2 proposed by the EIA study for the section Demir Kapija-Smokvica of the Highway E-75 (Corridor X). The most challenging obstacle is the absence of final road design, thus the time period, duration, location, costs, etc. could not be accurately defined. Update(s) of the EMP after completion of the design stage(s) will be necessary.

All of the mitigation measures within the EIA study were identified and aligned in groups according to their primary importance (*noise reduction*, *soil pollution prevention*, *habitat protection*, etc.), although the implementation of most of them will be beneficial for several environmental spheres and different aspects of nature.

The geographic position for the implementation of the MMs is presented. However, most of the MMs could not be associated with exact locality and they refer to the entire alignment of the highway. Majority of the MMs for noise reduction focus on Smokvica village area. MMs associated with tunneling and mining activities are positioned in Demir Kapija canyon.

Implementation time for the MMs was estimated in connection to the envisaged construction phases. Most of the MMs should be implemented during whole period of construction.

The responsibility for the implementation of the MMs was located; Constructor was identified as responsible entity for MMs during the highway construction; aforestation activities are proposed to be implemented by Macedonian Forests public enterprise, etc.

The most difficult point of the EMP was the estimation of costs for the implementation of MMs which disabled the estimation of the total costs for implementation for EMP. However, *good practice* in highways construction should be the most effective measure to implement the greatest deal of MMs.

Monitoring Plan contains monitoring activities which are directly connected to the proposed MMs. It proposes responsible body, implementing body, monitoring frequency, monitoring period and residual impacts.

The Monitoring Plan foresees contract with independent agencies/experts as *responsible* and *implementing bodies* for the monitoring of implementation of MMS. Main responsibilities of the implementing bodies for the monitoring will be to supervise implementation of the EMP, and reporting to the financing authorities.

Several methods for monitoring are proposed, mostly direct regular visits of the construction site, but it also proposes development of specific protocols for some of the most sensitive groups, i.e., vertebrates, regular checks of air pollution, noise levels etc.

It is understandable that regardless of the type and extension of the mitigation measures applied, some irreversible damage will be done during construction, or will be occurring during the operation of the highway. It extent was approximately described, in absence of detailed survey and monitoring. It will be possible to quantify the residual impact of the project in more details once more technical aspects are known, and active monitoring is regularly implemented. At this stage, it can be estimated that most of this residual impact after the mitigation will be without significant impact on the environment.

Having in mind this residual impact, but also damage to the environment during the construction and operational stages, few compensatory measures were also proposed, that should compensate the effects of the highway at regional level. Monitoring period, responsible bodies and locations are proposed, as well.

Construction phase

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
General measures									
• Carry out the design for the highway and all access roads, objects and facilities (work camps etc.) in compliance with valid legislation in the area of environmental protection, pertinent technical standards and Best Available Techniques (BAT)	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Elaborate study for camps for workers and machinery	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Limit the construction site to the minimum area that is needed for the road works	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Minimal land destruction along the alignment
• Avoid temporal occupation and destruction of adjacent land	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Minimal land destruction along the alignment
• Limit unauthorized use of access roads	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Uncontrolled use of access roads
Archaeological sites protection									

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Damaging and destruction of archaeological sites has to be avoided	Whole alignment	Entire construction period	Constructor	Depending on the change of the alignment	Regular checks on site	Archeological museum Gevgelija,/Archeological Museum in Skopje	Archaeologist	Entire construction period	none
Existing infrastructure preservation									
• Prevent destruction of the existing line infrastructure (power lines, channels, etc.)	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Repairable damages to the line infrastructure, temporal system failure
• Prevent destruction of the existing natural and existing pipeline for thermomineral water during the processes of investigation of the geological, hydro-geological and hydro-technical activities	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
• Design and construct passages (underpasses, bridges) along highway route in order to maintain the existing local roads and important forest paths	Whole alignment	Entire construction period	Constructor	Included in the construction costs (about 26 crossings)	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Impaired movement of farmers, foresters, etc.; temporal blocking of local roads and daily routines
Landscape protection									
• Restore natural vegetation on the construction sites	Whole alignment	Entire construction period	Constructor	~2500€ per hectare	Regular checks on site	Environmental consultancy	Forestry or Agricultural engineer	Entire construction period	Slow regeneration of natural vegetation and possible soil eroding

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Restore the natural vegetation in the borrow pits	Whole alignment	Earthworks before asphalting of the road	Constructor	~2500€ per hectare	Regular checks on site	Environmental consultancy	Biologist	Entire construction period	Slow regeneration of natural vegetation and erosion
• Limestone quarries at Demir Kapija canyons should not be used	Whole alignment	Entire construction period	Constructor	Good practice		Environmental consultancy	Independent supervising consultant	Entire construction period	none
Habitat protection									
• Elaborate special management plans for each very high sensitive habitat	Whole alignment	During the design preparation	External consultant	15000€	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• No access roads should pass through these habitats: Tamaris communities, alluvial deposits with willow stands, plane stands and belts; Greek juniper stands	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
• Prevention of unjustified degradation of these habitats: Agricultural land, Tamaris communities, Plane stands and belts, Demir Kapija canyon, Greek juniper stands	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Biologist	Entire construction period	Minimal linear destruction of the mentioned habitats
• Accidentally deposited waste material (concrete, iron, rocks etc.), should be immediately removed from Plane stands and belts, Rivers Bosava and Vardar, Demir Kapija canyon,	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Degradation of riparian vegetation, destruction of river beds

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
and all streams in the highway corridors									
• The following habitats should not serve as temporary deposits for row material: Tamaris communities, Demir Kapija canyon, Plane stands and belts	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
• Setting up of work camps and mechanization parks should be avoided in: River Anska Reka and channels, Alluvial deposits, Demir Kapija canyon, Plane stands and belts	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
• It is not allowed to use raw materials from the following habitats: Tamaris communities (sand), Alluvial deposits (sand and gravel), Demir Kapija canyon (limestone mineral sealing), Plane stands and belts (wood or soil) and Greek juniper habitats (diabase mineral sealing)	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Construct the new tunnel as close as possible to the existing one, in order to minimize the damage on the cliff on the entry points	Whole alignment	September-January	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	Disturbance of animal species, decrease of breeding success, possible damage to caves, underground water courses
• No construction works should be done in the following habitats/locations: limestone rocks in Demir Kapija canyon (except in the case of tunnel construction)	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
Flora and fauna conservation									
• Construction of the tunnel at Demir Kapija gorge should not be undertaken in the breeding season	Demir Kapija	No construction in the period February-August	Constructor	Good practice		Environmental consultancy	Independent supervising consultant	February-August	Decreased breeding success
• Construct culverts and underpasses on every ditch that is intersected by the highway; at 200 m distance at areas without natural underpasses; at 100 m distance in the vicinity (500 m from both sides) of streams.	Whole alignment	Earthworks before asphalting of the road	Constructor	13300€ per culvert (Total costs to be estimated after final road design)	Regular checks on site	Environmental consultancy	Biologist	Entire construction period	
• Maintenance of feeding place for vultures	Demir Kapija	Entire construction period	Local NGO	5000€ per year	Monthly checks; amount of food; breeding success of vultures	Ministry of Environment and Physical Planning	Biologist		

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
Geodiversity and Ground water protection									
• Avoid exploitation of limestone marbleized masses on the section Josifovo – Valandovo – Dojran	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	Entire construction period	none
• Exploit gravels and the sands from the alluvial stratum of the existing localities at Przhdevo and Gevgelija	In the vicinity of village Smokvica	Earthworks before asphalting of the road	Constructor						
• Use carbonate material (limestone, marble) from open quarries between the villages Kosturino and Memesli	Whole alignment	Earthworks before asphalting of the road	Constructor						
Soil protection									
• Elaborate study for borrow pits	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Elaborate detailed erosion prevention plan after final design is prepared	Whole alignment	After final road design adoption	Constructor	~10000€	Review of the final erosion prevention plan	Consultancy	Environmental consultant	After completion	n/a
• Avoid construction of underground structures on agricultural land	Whole alignment, especially in the lower (rural, third) section	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Civil engineer	periodical checks	none
• Limit the dumping or storage of soils and excess material within the construction site	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Localized soil pollution

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Surplus of excess material during construction of the embankments should be re-used as far as possible	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil degradation
• Placement of excavated top soils for re-use without any intermediate storage, store the top soil at appropriate sites in an appropriate manner	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil degradation
• Avoid maintenance and/or repairs of trucks or construction machinery on the construction site	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Localized soil pollution
• The top soil should be excavated in one single working step to avoid driving over	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil degradation
• Water logging of the excess soils must be strictly avoided	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	
• Placing of the fertile soil will on the slopes of the newly constructed dikes and cut areas after finalization of construction works	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil degradation and erosion
• Slopes along the road should be hydro-seeded with a mixture of seeds of autochthonous plants. Additionally the slopes of the high embankments can be strengthened with yuta net, and slopes of the	Whole alignment	Entire construction period	Constructor	~1.5 milion €	Regular checks on site	Environmental consultancy	Civil engineer	periodical checks	Minor soil degradation and erosion

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
cuts with mat net, made of polyester material									
• The temporary soil depots should be planted with deep rooting plants	Whole alignment	Earthworks before asphalting of the road	Constructor	Good practice should mean that this mitigation measure is unnecessary (otherwise~ 1000€ per hectare)	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil degradation and erosion
Water quality prevention				3000 € per month					
• Provide treatment of waste water and use of removable toilets	Whole alignment	Entire construction period	Constructor		Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor water pollution
• Construction of drains and drainage systems	Whole alignment	Entire construction period	Constructor	Included in the construction costs	Regular checks on site	Environmental consultancy	Civil engineer	periodical checks	Certain degree of water pollution
• Avoid leakage of wet concrete into the water courses	Whole alignment, in the vicinity of water courses	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor water pollution, certain degradation of the river beds
Air quality protection: Reduction of dust pollution									

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Minimize dustiness by watering of excavated and/or deposited soils on the construction site	Whole alignment	Entire construction period, especially during dry periods	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	continuous, especially during dry periods	Negligible dust pollution in narrow belt along the alignment
• Reduce speed limit of the construction machinery	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	continuous, especially during dry periods	Negligible dust pollution in narrow belt along the alignment
Noise reduction									
• Use equipment which meets the requirements of the European Directive EC/2000/14 on noise emission by equipment for outdoor use	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Independent supervising consultant	periodical checks	Acceptable noise levels
• Minimize the noisiness of construction machinery	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks of the emission concentrations in the exhaust gases	Environmental consultancy	Air and noise expert	periodical checks	Acceptable noise levels
• Keep to usual daytime work hours	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Air and noise expert	periodical checks	Acceptable noise daily levels
• Minimize noise in the vicinity of settlements	In the vicinity of village Smokvica	Entire construction period	Constructor	Good practice	Measurement of noise levels on monthly bases	Environmental consultancy	Air and noise expert	periodical checks	Acceptable noise levels
• Use noise control methodologies during active mining operations	Whole alignment, especially Demir Kapija canyon	Entire construction period	Constructor	Good practice	Checks during mining operations	Environmental consultancy	Air and noise expert	periodical checks	Animal disturbance, decrease of the breeding success
• Construction of sound walls at particular	Village Smokvica	Entire construction	Constructor		Check on site	Environmental consultancy	Air and noise expert	Inspection after completion	Acceptable noise levels

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
places near the housing areas		period							
• Provide permanent presence of fire-fighting brigade vehicle to prevent fires	Whole alignment	Entire construction period	Fire-fighting brigade	To be negotiated	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	
Waste management									
• Elaborate study for temporary waste disposal sites (locations, maintenance, management, etc.)	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Collect waste from the construction site and ensure re-use and recycling	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil pollution
• Waste disposal should be organized in the nearest landfill (e.g. Gevgelija, Valandovo) on daily basis	Whole alignment	Entire construction period	Constructor	Included in the construction costs	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	n/a
• Collect hazardous waste (oils, lubricants, waste colors and thinner, etc.) in particularly labeled special vessels and dispose od Drisla landfill	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minimal hazards, minor soil pollution
• Provide properly labelled and tapped containers for collection of solid and liquid communal waste, away from water courses	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minimal hazards, minor pollution

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Avoid cleaning of oils, lubricants, concrete from machinery on the construction sites	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Localized soil pollution
• Minimize storage of substances harmful to waters	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor water pollution
• Store the necessary fuels in proper manner	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minimal hazards
• Avoid filling of vehicles and machinery with fuel on the construction site	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minimal hazards, minor soil pollution
Hazards									
• Work out an emergency plan	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Minimize leaks of oils and lubricants	Whole alignment	Entire construction period	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minor soil pollution

Operation phase

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
Air quaility protection									
• Revitalize vegetation as a buffer along the alignment	at sections surrounded by high quality agricultural land	Landscaping phase	Constructor	~2500€ per hectare	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Negligible dust pollution in narrow belt along the alignment
Flora and fauna conservation									
• Construction of protective panels for birds along the highway	Whole alignment	Entire construction period	Constructor	500 €/m	Regular checks on site	Environmental consultancy	Environmental consultant	After completion	Cca 50% mortality is still expected
• Construction of direction barriers in sections of the highway with intensive animal movement and absence of culverts	Whole alignment	Entire construction period	Constructor	200 €/m	Regular checks on site	Environmental consultancy	Biologist	periodical checks	Cca 10% mortality is still expected
• Prepare monitoring system for animal casualties	Whole alignment	Finalization of the road construction	External contract	~5000€	Review of the final monitoring plan	Environmental consultancy	Biologist	After completion	
Agriculture									
• Mowing of the verge is highly recommended as well as to leave green cut on site (it should not be used as animal fodder)	Whole alignment	Spring/summer period during the road operation	Makedonija Pat	Good practice	Monthly checks	FNRR	Environmental consultant	periodical checks	Soil pollution along the alignment

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
Habitat protection									
• Forestation of bare forestry land in the surrounding - only native species of plants are to be used for planting purposes in particular adjacent natural and near-natural habitats	Whole alignment	Entire construction period	Macedonian forests	~2500€ per hectare	Regular checks on site	Environmental consultancy	Forestry engineer	periodical checks	Slow vegetation regeneration; soil erosion
Landscape protection									
• Planting of trees, shrubs and grasses for landscaping purposes adjacent to the motorway by using pyrophobic tree species	Whole alignment	Landscaping phase	Constructor	~2500€ per hectare	Regular checks on site	Environmental consultancy	Forestry engineer	periodical checks	
Noise reduction									
• Construction of special noise reducing road surface which is efficient for speeds over 60 km/h	Whole alignment	Finalization of the construction works	Constructor	Included in the construction costs	Regular checks on site	Environmental consultancy	Civil engineer	periodical checks	Acceptable noise levels
• Avoidance of additional noise sources of constructive origin and damages of the road surface	Whole alignment	Finalization of the construction works	Constructor	Good practice	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels
• Construction of noise abatement barriers like walls or embankments	Smokvica village area	Finalization of the construction works	Constructor	500 €/m (polycarbonate) 300 €/m (aluminium) 100 €/m (soil embankements)	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
• Construction of tunnels, housing-in-tunnels, or noise abating buildings (houses) at the road border	Smokvica village area	Finalization of the construction works	Constructor	Probably not necessary	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels
• Installation of noise reducing windows in affected houses	Smokvica village area	Finalization of the construction works	Constructor	Probably not necessary	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels
• Restrictive car speed limits on sections near settlements	Smokvica village area	Finalization of the construction works	Constructor	Good practice	Regular checks on site	Ministry of Interior	Traffic police	periodical checks	Acceptable noise levels
• Noise transmission at the source should be intercepted by planting trees around the source of noise generation	Smokvica village area	Finalization of the construction works	Constructor		Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels
• Boundary walls and green belts between the settlements and highway site should be developed which work as an effective acoustic barrier	Smokvica village area	Finalization of the construction works	Constructor		Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Acceptable noise levels
Water quality prevention									
• Elaborate water quality monitoring plan in accordance to the Water Framework Directive (pH, salinity, phosphates, nitrites, nitrates, nitrogen, TOC, TSS, oxygen demand, PAH)	Whole alignment	Entire construction period	Consultancy	15000€	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.
• Store the substances hazardous to water in proper manner (for example defrosting agents) in compliance with corresponding regulation and technical standards in force	Whole alignment	During road operation	Waste management compyan	Included in the construction costs	Regular checks on site	Environmental consultancy	Environmental consultant	periodical checks	Minimal hazards
• Collection of runoff water by road gullies and side ditches,	Whole alignment	During road operation	Makedonija Pat	Included in the	Regular checks on site	FNRR	Environmental consultant	periodical checks	Minor water pollution

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
and purifaction by oil separators				maintenance costs					
• Avoid use of herbicides on on the road shoulders or embankments	Whole alignment	During road operation	Makedonija Pat	Good practice	Regular checks on site	FNRR	Environmental consultant	periodical checks	none
• Maintain and clean up the drainage channels	Whole alignment	During road operation	Makedonija Pat	Good practice	Regular checks on site	FNRR	Environmental consultant	periodical checks	
Hazards									
• Work out an emergency plan	Whole alignment	Entire construction period	Designer	Included in the design costs	Review after completion	Environmental consultancy	Environmental consultant	After completion	n.a.

Compensation measures

Implementation of mitigation measures					Monitoring of the implementation of mitigation measures				
Activity (MM)	**Location**	**Implementation time**	**Implementing body**	**Costs**	**Monitoring frequency/parameters/criteria/protocols**	**Responsible body**	**Monitoring body**	**Duration**	**Residual impacts**
Aforestation of 23.5 ha in Demir Kapija and Kozhuf forestry units	Forested areas (between Demir Kapija and Smokvica village)	During road construction	Macedonian forests (Demir Kapija and Kozhuf forestry districts)	60000. €			Environmental consultant	After completion	
Elaboration of management plan for Demir Kapija protected area	n/a	2011-2012		80000. €			Environmental consultant	After completion	
Creation of information center for Demir Kapija canyon	Demir Kapija	2011		75000. €			Environmental consultant	After completion	