V.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.

V.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.).

V.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.).

V.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.

V.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.

V.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.).

V.5.3. AGRICULTURAL LAND

Agricultural land in the upper part of the road corridor (Demir Kapija–Udovo) in case of Alternative A 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 B 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.

V.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*, *Hypoborus ficus* on *Ficus carica*). It is important to outline that

Vertebrates

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 B).

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 A 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.

Distribution: This type of orchards 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.). Many orchards are situated next to the populated places and they are included in the biotope type defined as peripheral parts of human settlements.

V.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).

Vertebrates

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.

V.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

Invertebrates

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.

V.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 A). 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.).

V.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.

V.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.

V.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*), 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.

V.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.

V.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.

V.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

V.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, 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.).

V.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 A). 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"

V.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.).

V. 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.

V.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 B) 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 B) 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 A) 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 B) 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).

V.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. (?nov.)	new species

V.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)

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 hellespontica 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,

Species	Locality in the area of interest	Habitat
		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
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 Ushite - 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.

V.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).

Tab. 14. *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

V.6.5. INVERTEBRATES

V.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.

V.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).

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.

V.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).

Tab. 16. *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

V.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).

Tab. 17. *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 Convention	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

V.6.10. BIRDS

As Vardar valley is important migratory route, many bird species can be found in the highway corridor.

Tab. 18. *Bird species 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
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 Directive	I	27	13	2	4	14	9	6	11	17	3	3	2	6	10	0	5	2	5	4
	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).

V.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.

Tab. 19. *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	

V.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.

Tab. 20. *The most important biocorridors along both alternative alignments*

Alternative A		**Alternative B**	
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 - km 4+700 km 28+000 - km 28+700
Chelevechka Reka	km 1+600	River Boshava	km 0+900
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.

VI. 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 and Gradsko- Demir Kapija have been upgraded at the highway rank during the construction phases up to now. The section from Demir Kapija to Smokvica is in the stage of preparing the detailed study and analyses 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 counties (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). The before 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 the data that will be obtained will be quite relevant.

For that purpose, the direct observation of the area was performed and the 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 village (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.

VI. 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 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.

VI.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.

Tab. 21. *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 the village Udovo, 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.

Tab. 22. *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

VI.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.

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.

VI.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 exclusions, 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.

Tab. 24. *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

Tab. 25. *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**

VI.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.

Tab. 26. *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	Illiterate	Without school preparation or incomplete elementary school	Elementary school	Secondary school	High school	Unknown
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

Tab. 27. *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 education	Upper secondary education	Higher education	Faculty, Academy	Postgraduate 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.

VI.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 is 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 the persons with personal income is something 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.

Tab. 28. *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

Tab. 29. *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

VI. 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.

VI.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 fund and its structure by cadastre cultures and by the land-property is presented in Tab. 30.

The data presented in the Tab. 30 show 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, 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 this 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 place, by surface they cover, take vineyards because the favourable climatic conditions make viticulture very productive in the region.

Tab. 30. *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*

settlement	sector	acres (ha)	gardens (ha)	orchards (ha)	vine-yards (ha)	meadows (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
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 surfaces 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 very 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.

VI.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.

VI. 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.

Tab. 31. *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

Tab. 32. *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

Tab. 33. *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

Tab. 34. *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

Tab. 35. *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

Tab. 36. *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 occurs 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 B) 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

VI. 4. SETTLEMENTS

Several populated places are found along the highway corridors:

Alternative A: Demir Kapija, v. Klisura (in proximity to the corridor), v. Miravci (adjacent to the corridor), v. Miletkovo and v. Smokvica

Alternative B: Demir Kapija, 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.

VI. 5. INFRASTRUCTURAL OBJECTS

VI.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 plant 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 directly depends the main occupation of inhabitants i.e. agriculture production. For that aim, beside direct use of the waters of river Vardar and its tributaries, special systems for irrigation purposes are built. They are of open types and they are used for irrigation of parcel that is more distant from Vardar Riverbed. In the frame of water line infrastructure 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 supplies, 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 foresaw and established), from the subjective point of view, they will cause disturbance of the existing demographic condition.

VI.5.2. INSTITUTIONAL INFRASTRUCTURE

In the Gevgelija-Valandovo valley, differently from some other regions in the Republic of Macedonia, more precisely in the settlements through which 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, what means that in conditions of good established traffic infrastructure, opportunities for satisfying sanitary-social, cultural, educational, commercial, administrative, and other necessities. 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 are existing. 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 object has not been started yet, as it is the case with the village Udovo where the caw 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 "B" 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)

VI.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 B (near village Miravci).

The Irrigation System of Southern Vardar Valley covers surface of 7417ha. In these frames are constructed basic structures and channels with built grade of 96% (Photo 69). The necessary irrigation water quantity of these surfaces is 52.724.000m^2.

The Collector System – Dojran that collects approximately 50% of the communal waste water from the households from Star and Nov Dojran, which afterwards are conducted to physical-biological treatment into the waste water treatment plant.

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 shall be 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 it 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 distributing through 400kW transmission line from TE Dubrovo to Republic of Greece, and in regional frames in function are the transmission lines of 110kW from the same distributor, with direction Dubrovo – Valandovo, Valandovo – Miletkovo and Valandovo – Gevgelija, wherefrom through the transforming stations of 110kW are distributing to the consumers.

The supplying pipeline for thermo-mineral water starts from the geo-thermal field Smokvica wells near Vardar River, wherefrom warm water to the greenhouses of Vinojug at village Negorci is distributing.

The oil pipeline alignment is located approximately 500m western of the wider border of the location.

There is older Irrigation System from Anska Reka, starting from Udovo up to Marvinci and new Irrigation System of Southern Vardar Valley that currently is in 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 Kozhuf, Gradeshka 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 a 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 that are out of the Alternative "A" but close to the Alternative "B" as possible variant of the highway alignments. More significant is the accumulation Kalica with capacity of 640.000m^3, wherefrom through PVC pipeline with diameter Ø400mm irrigates 150ha. Nevertheless, it is of significance to note that with water economy bases foreseen are constructions of five more dams of which two are located in the wider zone for Alternative "A" and close zone for Alternative "B" of the highway alignment planning. That is the dam at Petrushka River with capacity of 4.000.000m^3 that will irrigate 100ha as also the dam at Kovanska River with capacity of 10.000.000m^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 on to the main communications besides on to the railway that in conditions of construction shall be dislocated above the maximal level of the accumulation.

VI. 6. AIR QUALITY, WATER AND SOIL

VI.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 Republican 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.

Tab. 37. *Presentation of mid-daily concentrations of the environmental parameters, for month January 2006*

KAVADARCI	SO2 µg/ m^3	NO2 µg /m^3	CO mg/m^3	O3 µg/m^3	PM 10 µg/m^3
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 subject region of Alternative A and Alternative B, 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 this the mobile automatic air measuring station identifies pollutions substances concentrations that are product of the industry, traffic and the heating during the winter period. The station, besides the concentrations of the usual parameter, 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.

VI.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.

VI.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 B- on the right site of river Vardar, no important air pollution sources of this kind are noticed.

VI.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) exist only for river Vardar. Also, many investigations performed by different institutions (Faculty of Natural Sciences, Institute of Animal Sciences, etc) give 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. Beside 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.

VI.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 orientated 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 arose 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 increasing of the all measured parameters in the region of Skopje-Veles with categorisation of the waters in V class of bonity. Detected increasing 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) show 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.

VI.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.

VI.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*).

VI.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.

VI.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.

VI.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.

VI.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 site of the Vardar valley, which is broadly on both sides of the river Vardar.

Alternative A- Design of a new carriageway on the left bank of the Vardar River, as close as possible of 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 into 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. So main sources of noise are the daily activities of the people on the settlements, traffic on 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 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 B- The project route is on the right site of the Vardar River, with a design speed of 120 km/h
This 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 Klisura, Miravci, Miletkovo and Smokvica).
The characteristic 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). 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.

VI. 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 climatic 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, neolith, and antic and middle-age period.

As a result of this, many remains 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 "B". 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 remains 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.

VI.7.1. ALTERNATIVE "A"

VI.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.

VI.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

The locality is situated around the crossroad at the village Udovo. The remains (tympanums) of a small pre-Roman temple and silver dinars have been found there.

VI.7.1.3. The area around the village Davidovo

Varijanta

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.

VI.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), **Grobishta-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), **Selishte** (Late Antic settlement situated 1 km on the west of the village. Remaining of the ceramics may be found on the surrounding fields).

VI.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.

Krchanovo

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.

Chaushevec

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.

VI.7.1.6. The area around the village Miletkovo

Gradishor-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.

Grobishta-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.

VI.7.1.7. The area around the village Smokvica

Agova cheshma

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 cheshma-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.

Bishev 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.

Gradishte-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.

Mushnica

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.

Crkvishte

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.

VI.7.2. ALTERNATIVE "B"

Manastir

Afore the entrance in the River Vardar canyon, on the right side, the Manastir locality is situated close to the chainage km 2+000 of the road corridor "B", and it is identified as settlement from ancient historical to Late Antic period and necropolis from Ancient Christian and Mediaeval period.

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.

Finding 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 "B".

VI. 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 Alternative A and B 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.

Tab. 38. *Overview of land use types and their surfaces (ha) in the corridor area.**

Land use types	Alternative A	Alternative B	Alternative A+B
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 A and Alternative B is equal or higher that the value for the total corridor area (Alternatives A+B) 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.

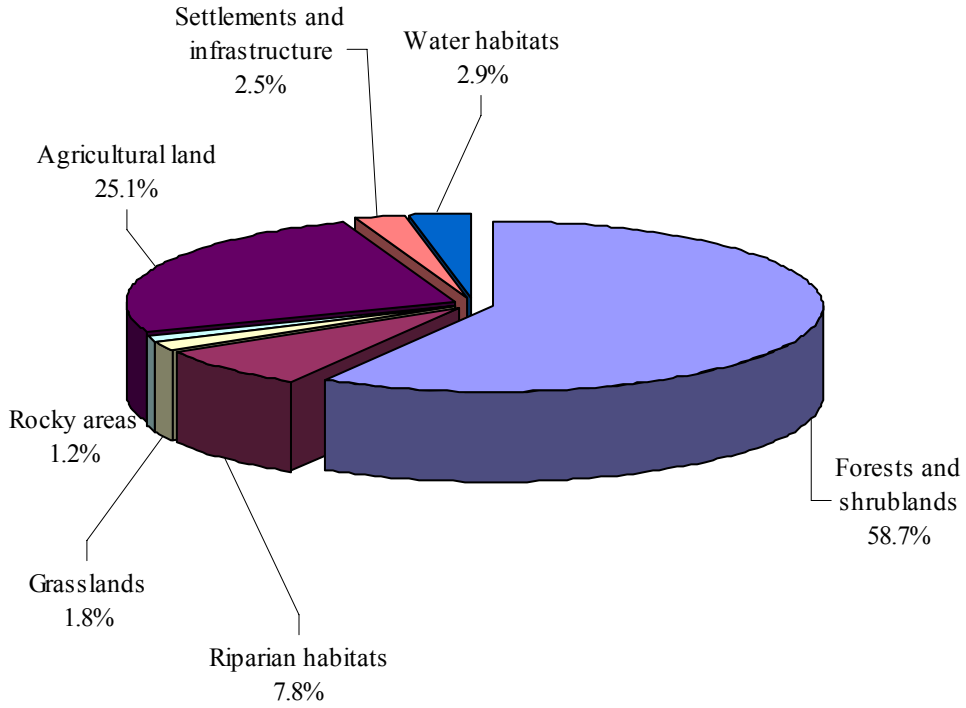

Fig. 7. Percentage of the land use types in the corridor of the whole highway corridor area (Alternatives A+B)

It should be mentioned that the water biotopes (as presented in this chapter) refer only to the surfaces of rivers and larger streams (Vardar, Boshava and Petrushka 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 occupies 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.).

VI.8.1. ALTERNATIVE A

Kermes oak shrublands and agricultural land cover almost identical percentages of the surface in the corridor area of Alternative A – 39.7 and 39.1 %, respectively (Fig. 8). This is the main difference with Alternative B 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 A. The economic value of these forests is low since they are not suitable for forestry practices. The pseudomaquis of the Alternative A 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 A 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 A (compared to Alternative B) and they cover surface of 48.7 ha.

The surface of settlements and infrastructure in the corridor of Alternative A covers almost twice the size of this land use type in Alternative B. 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 B (59.3 ha).

Grasslands occupy 2.3 % which is similar to the percentage of this land use type for the whole corridor area (Alternative A+B) and Alternative B corridor. The total surface of dry grasslands is 59.4 ha. If the area of abandoned fields is added than the pastureland of Alternative A corridor is more than 75 ha.

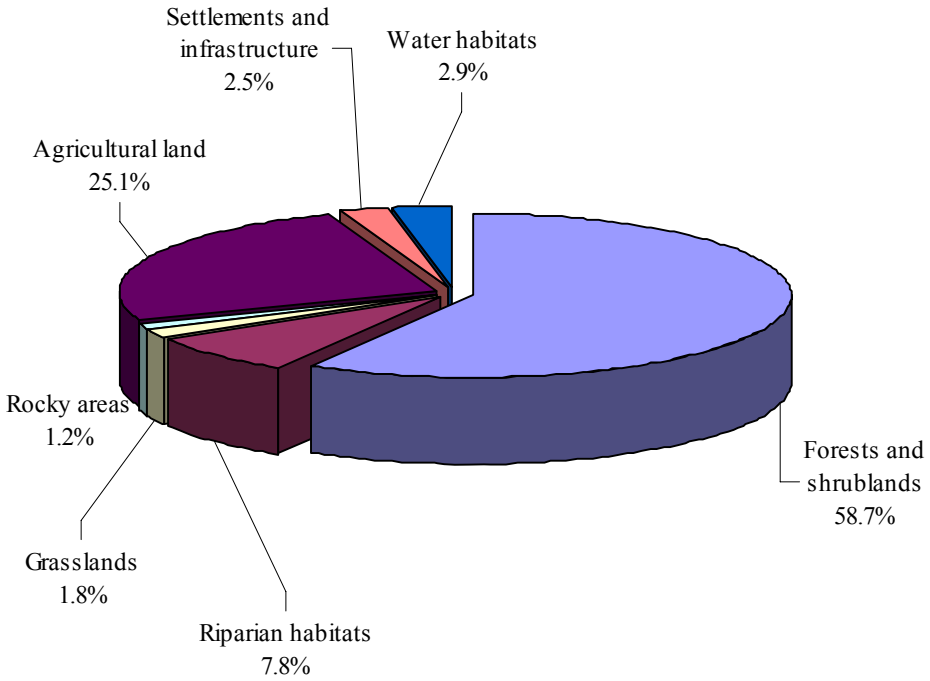

Fig. 8. Percentage of the land use types in the corridor of Alternative A

VI.8.2. ALTERNATIVE B

The surface of corridor of Alternative B 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 A 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 B 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 B 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).

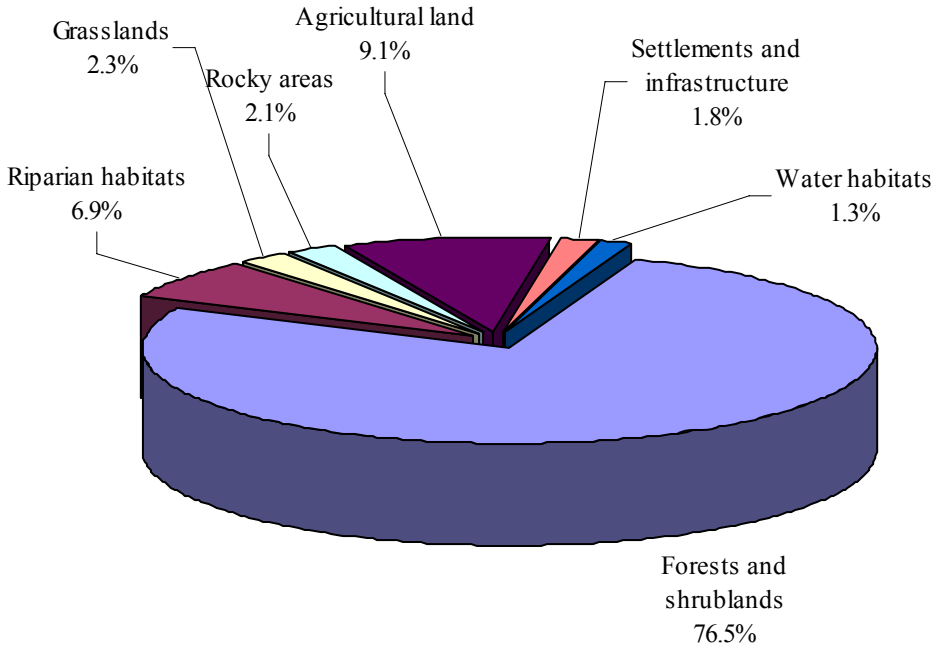

Fig. 9. Percentage of the land use types in the corridor of Alternative B

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 A) or 6.9 % (higher than Alternative A). Besides the surface, riparian land use type of Alternative B differs from Alternative A 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 B 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 A, the settlements and infrastructure cover small area of about 51 ha or 1.8 %.

Both alternatives are similar by the small area of dry grasslands. In the case of Alternative B 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 B (1.5 ha).

VI. 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 B will pass next to the western 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 A and almost whole Alternative B, 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 A). 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.).

VI.9.1. FORESTRY

Timber exploitation is the main for of utilization of forests in the area of highway corridor. However, by its extent, 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 Kozhuf 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 “Kozhuf”-Gevgelija) which are part of the Public enterprise “Makedonski Shumi” (Macedonian Forests).

Highway corridor of Alternative A 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 B (Tab. 39).

Tab. 39. *Standing volume and forestry units of "Kozhuf" forestry district which overlap with the highway corridor of Alternative B.*

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	121 a	Carpino orientalis-Quercetum conferttae	22
36a	Coccifero-Carpinetum orientalis	1 000	72 a	Carpino orientalis-Quercetum conferttae	40
34a	Dry grasslands	500	76 b	Carpino orientalis-Quercetum conferttae	32
33a	Querco-Carpinetum orientalis	1375	77 b	Carpino orientalis-Quercetum conferttae	23
32	Querco-Carpinetum orientalis	250	78 a	Carpino orientalis-Quercetum conferttae	/
26a	Juniperetum excelsae		79 a	Coccifero-Carpinetum orientalis	/
27a	Juniperetum excelsae	1 000	81 a	Coccifero-Carpinetum orientalis	/
9a	Juniperetum excelsae	1375	81 b	Coccifero-Carpinetum orientalis	11
8a	Juniperetum excelsae	625	82	Coccifero-Carpinetum orientalis	
TOTAL		**10 220**	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.

VI.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 "Chestovo" (Valandovo managed by Public Enterprise "Makedonski Shumi (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 Koreshnica, 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, Bozhikovec 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.

VI.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 A, and livestock breeding is the most important activity for the area of the highway corridor in case of Alternative B (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.

VI.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).

VI.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)

VI.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"

VII. 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) was 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.

VII. 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.

VII.1.1. CREATION OF MATRIX

Ecosystems/sites (presented in rows) were evaluated against the criteria (presented in columns of the matrix table).

VII.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.

VII.1.1.2. Description of criteria

VII.1.1.2.1. Criteria for sensitivity assessment of natural, seminatural and anthropogenic habitats

Seventeen 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 - **G**eological 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.

VII.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.

VII.1.1.3. Scoring and rating

VII.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.

VII.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.

VII.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.

Tab. 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
Kermes oak shrublands - preserved	1	2	3	1	3	2	1	2	2	1	2	0	0	3	1	*24*	hs
Kermes oak shrublands - sparse	1	1	2	1	2	3	1	2	1	0	2	0	0	2	1	*19*	hs
Kermes oak shrublands - degraded	1	1	1	1	2	3	1	2	0	0	2	0	0	1	0	*15*	ms
Phillyrea media shrubland on rocky sites	2	2	3	0	1	3	0	2	2	0	1	1	2	1	0	*20*	hs
Greek juniper on rocky sites	3	2	2	0	1	3	0	2	3	1	1	2	2	1	1	*24*	hs
Oak forests	2	1	1	1	2	3	1	1	1	2	2	0	0	3	1	*21*	hs
Beech forests	3	3	1	0	2	1	1	1	2	2	1	0	0	3	1	*21*	hs
Oriental plane woodlands	3	3	3	0	3	1	1	2	3	1	2	0	0	3	2	*27*	vhs
Oriental plane belts along streams	3	3	3	0	2	1	1	2	3	1	2	0	1	3	2	*27*	vhs
Oriental plane belts along ravines and gullies	3	3	1	0	1	0	0	1	1	1	1	0	1	1	1	*15*	hs
Willow and poplar belts	3	1	3	0	2	2	0	1	2	0	1	0	1	3	1	*20*	hs
Tamaris shrublands	1	1	3	0	2	2	0	2	2	0	1	0	1	2	1	*18*	hs
Sand banks with sparse Tamaris	1	1	2	0	2	2	0	2	1	1	1	0	1	1	1	*16*	ms
Sandstone cliffs	1	2	2	0	0	1	0	0	0	0	0	0	1	0	0	*7*	ls
Hill pastures - dry	2	1	1	2	2	3	1	2	1	2	3	0	0	1	0	*21*	hs
Chasmophytic bare rock habitats	3	2	3	2	1	3	2	3	3	0	2	3	3	0	0	*30*	vhs
Caves	3	3	3	3	3	0	3	2	1	0	0	3	2	0	0	*26*	vhs
Rivers - Vardar	1	1	1	2	1	2	2	1	2	2	2	2	0	0	2	*21*	hs
Rivers - Boshava	2	2	2	2	2	2	2	1	2	2	2	1	0	0	2	*24*	hs
Stream - Chelevechka Reka	3	2	2	2	2	1	2	2	3	1	1	3	0	0	0	*24*	hs
Stream - Petrushka Reka	3	2	2	2	2	1	2	2	3	2	1	3	0	0	0	*25*	hs
Stream - Golema Javorica	3	3	3	2	2	1	2	1	3	1	1	1	0	0	0	*23*	hs
Stream - Mala Javorica	3	3	3	2	2	1	2	1	3	1	1	1	0	0	0	*23*	hs
Streams - all others	2	2	2	2	2	1	2	1	2	1	1	1	0	0	0	*19*	hs
Intermittent streams (ravines)	1	1	2	0	0	0	1	0	1	0	0	0	0	0	0	*6*	ls
Gullies (dry flows)	1	1	2	0	0	0	0	0	1	0	0	0	0	0	0	*5*	ls
Channels	1	1	1	2	1	1	1	1	1	1	1	0	0	0	1	*13*	ms
Swampy reed beds and belts	1	1	1	0	1	1	0	0	0	0	1	0	0	2	1	*9*	ms
Springs and wells	2	2	2	0	1	0	1	1	1	1	1	0	0	0	0	*12*	ms
Anthropogenic forest stands	1	0	0	0	0	1	0	0	0	0	1	0	0	1	0	*4*	ls
Abandoned fields	1	1	1	1	2	3	1	1	1	2	2	0	0	0	0	*16*	ms
Fields and acres	1	0	0	0	1	3	0	0	2	3	1	0	0	0	0	*11*	ms
Vineyards	1	0	0	0	1	1	0	0	2	3	1	0	0	1	0	*10*	ms
Orchards	1	1	0	0	1	1	0	0	1	2	0	0	0	1	0	*8*	ms
Gardens	1	0	0	0	1	1	0	0	2	3	1	0	0	1	0	*10*	ms
Rural settlements with sparse houses	1	1	1	1	1	3	0	2	3	3	1	0	0	0	0	*17*	hs
Urban settlements	0	1	0	0	0	1	0	0	1	3	1	0	0	0	0	*7*	ls
Roads, railways - ruderal communities	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	*4*	ls
Quarries	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	*2*	ls

VII.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.

VII.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 B, on the slopes on the right side of the river Vardar gorge.

VII.1.3.2. Kermes oak shrublands - sparse (pseudomaquis) (Chapter V.1.1.1.2.)

The pseudomaquis has 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.

VII.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**.

VII.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 A and canyon Demir Kapija (1+400 km) of Alternative B. Due to its natural values it was assessed as **hs**.

VII.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).

VII.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 B) is presently under high anthropogenic pressure anyway - it was cut recently. The last remains are at km 9+900.

VII.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 - Ushite (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 A, 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).

VII.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 is greater along streams compared to the narrower belts that develop along ravines and gullies.

VII.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.

VII.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

VII.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 A construction only by activities indirectly connected with the road construction.

VII.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.

VII.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.

VII.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 A. Most of the other criteria had low scores and thus, the sandstone cliffs were assessed as low sensitive (ls).

VII.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 A), near village Gradec (Alternative B) 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.

VII.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, Long-legged Buzzard etc.

VII.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 B) 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.).

VII.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 A the bridge should be built near village Smokvica (km 29+650 of Alternative A)

Besides its values as habitat (although polluted), river Vardar has great value for the local population since it is used for irrigation purposes.

VII.1.3.17. River Boshava (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**).

VII.1.3.18. Chelevechka 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 A 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.

VII.1.3.19. Petrushka 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 B 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.

VII.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 that its undisturbed and unique natural values.

The most important conflict will arise in the case of Alternative B 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.).

VII.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 B at km 14+300 that represents the most significant conflict of the road construction and operation.

VII.1.3.22. Other streams (Chapter V.4.1.2.)

All of the other streams (Vodosir, Arazliska Reka, Lutkovska Reka, Gradeshka Reka, Kalica, 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).

VII.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 A) and at km 7+000 (Alternative B). 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).

VII.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.

VII.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.

VII.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).

VII.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 A with spring at Chirkov Chukar at km 9+000 and Odov Chukar at km 12+200. Alignment of Alternative B 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.

VII.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 B passes near the reservoir, but significant conflicts are not expected.

VII.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.

VII.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.

VII.1.3.31. Fields and acres (Chapter V.5.3.2.)

This habitat type was assessed as medium sensitive (ls) 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).

VII.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 A (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 B 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.

VII.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.

VII.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.

VII.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.

VII.1.3.36. Urban settlements (Chapter V.5.4.1.3.)

Demir Kapija and larger villages (Miravci, Udovo, Josifovo, Miletkovo, Marvinci, Smokvica) have low sensitivity as habitats. Their importance is mainly economic (See Chapter VII.1.).

VII.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.

VII.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 B passes close to the existing quarry at Golema Javorica.

VII.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).

Tab. 41. *Sensitivity estimation matrix for sites of human interest*

	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 - positive		SUM		Sensitivity	
Settlements/archeological sites/agricultural land	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	**A**	**B**	A	B
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	3	0	3	0	3	0	1	0	2	0	2	0	1	2	1	***2***	***18***	**ls**	**hs**
Village Davidovo	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2	***2***	***2***	**ls**	**ls**
Village Miletkovo	0	2	0	1	0	1	0	1	0	2	0	2	0	3	0	3	0	1	***0***	***16***	**ls**	**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	2	0	2	0	1	0	2	0	***20***	***0***	**hs**	**ls**
Village Josifovo	2	0	1	0	1	0	1	0	2	0	2	0	3	0	0	0	0	2	***12***	***2***	**ms**	**ls**
Village Marvinci	2	0	1	0	1	0	1	0	1	0	2	0	2	0	0	0	0	2	***10***	***2***	**ms**	**ls**
Abandoned village Klisura	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	2	0	***2***	***4***	**ls**	**ls**
Abandoned village Gradec	3	0	3	0	2	0	1	0	3	0	3	0	1	0	0	0	0	2	***16***	***2***	**hs**	**ls**
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***	**ls**	**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**	**ls**
Archeological site "Turski grobishta" #7	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	2	0	***8***	***0***	**ms**	**ls**
Archeological site "The Chappel - Udovo" #8	2	0	2	0	2	0	2	0	2	0	2	0	0	0	0	0	1	0	***13***	***0***	**ms**	**ls**
Archeological site "Kalica" #12	0	2	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	1	***0***	***7***	**ls**	**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**	**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***	**ls**	**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***	**ls**	**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***	**ls**	**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***	**ls**	**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	1	3	1	3	1	3	1	3	1	3	1	0	0	0	0			***18***	***6***	**hs**	**ls**
Agricultural land - vineyards	2	1	2	1	2	1	2	1	2	1	2	1	0	0	0	0			***12***	***6***	**ms**	**ls**
Agricultural land - orchards	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0			***6***	***0***	**ls**	**ls**

VII. 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 A

- Demir Kapija canyon - limestone cliffs - nesting site for vultures (protected area)
- Chelevechka Reka (protected area)

Alternative B

- Demir Kapija canyon - limestone cliffs- protected area
- Chelevechka Reka (protected area)
- Bela Voda cave
- Dolni Krastavec - nesting site of vultures
- Golema and Mala Javorica watersheds
- Shtuder - Greek juniper habitat
- Kalica watershed
- Petrushka Reka gorge
- Trskata - archaeological site
- Gudlanica - archaeological site
- Mushnica - archaeological site

VIII. ASSESSMENT OF THE IMPACTS

The possible impacts of the intention (project) will be assessed on the basis of the planed activities (Chapter II.1.) and sensitivity of the ecosystems, habitats, sites and localities (Chapter VII.). The precise and concrete assessment of impacts was enabled by taking into consideration all aspects, characteristics, peculiarities of living and non-living environment in the area of the project interest (Chapter V. and VI.). The emphasis will be put on characteristics of potential impacts and estimation of their size, complexity and significance (concerning probability, duration, frequency and reversibility).

The following chapters deal with assessment of impact of the highway construction and operation.

VIII. 1. General aspects of impacts from road construction and operation

Current design of the Alternative A foresees modern two lane highway with projected speed limit of 80 km and 100 km/h. Alternative B alignment was pre-designed for 120 km speed limit. Looking from the standpoint of the road design one can see that all efforts were made in order to satisfy the technical elements of the road, sometimes neglecting the natural areas that are being impacted. The greatest attention was paid to the road service for transport, while the landscape values and other natural values are sometimes neglected and severely affected.

Although this is due to the complexity of the project that involves several aspects, starting from the road construction to the supervision, 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, landfalls, 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 B). 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.

VIII. 2. IMPACT OF THE ROAD CONSTRUCTION

Generally, the road construction will affect the environment in numerous and various ways. The alternative B will also negatively affect the aesthetic characteristics and functional values of the landscape by introducing a new object. 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.

VIII.2.1. IMPACT ON THE FOREST ECOSYSTEMS AND PASTURES

Large part of the alignment, especially in case of Alternative B, will pass through forested and hill pasture area:

- 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.

VIII.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.

Tab. 42. *Estimation of the forested surface that will be destroyed during the construction of the highway (Alternatives A and B)*

Forests, shrublands and plantations	Alternative A		Alternative B	
	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 A. 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 A 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 B. Larger surface of forested area will be destroyed during the construction of Alternative B - 119.3 ha.

Tab. 43. *Timber volume (m^3) that will be cut during the construction of the highway of Alternative B and its market value.*

Forestry Unit	Length of the overlap with the highway	Timber to be cut (m^3)	Market value denars (and €)	Comment
Forestry unit "Klisura"				
52	1270	/	/	Tunnel
51	750	45	90000 (1463 €)	
50a	750	93.7	187400 (3047 €)	
49a	625	77.5	155000 (2520 €)	
48a	700	122.5	245000 (3983 €)	
36a	1000	34.1	68200 (1108 €)	Grassland - 375m
34a	500	/	/ (/ €)	Grassland with Greek juniper trees and Plane trees in the ravines and dales
33a	1375	66.5	133000 (2162 €)	
32	250	/	/ (/ €)	Tunnel
26a			(0 €)	Tunnel
27a	1000	30	60000 (975 €)	
9a	1375	27.5	55000 (894 €)	
8a	625	33	66000 (1073 €)	
Subtotal	**10220**	**529.8**	**1059600 (17229 €)**	
Forestry unit "Javorica-Samovilska Reka"				
126 б	450	24	48000 (780 €)	Forest in length of 400m
125 б	1300	66	132000 (2146 €)	Forest in length of 1100 m
123 a	875	150	300000 (4878 €)	
122 б	800	136	272000 (4422 €)	
121 a	800	88	176000 (2861 €)	
72 a	1000	160	320000 (5203 €)	Forest in length of 800m
76 б	625	99	198000 (3219 €)	
77 б	625	71	142000 (2308 €)	
78 a	1500	/	/ (/ €)	Burnt by forest fire
79 a	1000	/	/ (/ €)	Burnt by forest fire
81 a	250	/	/ (/ €)	Burnt by forest fire 10 years ago
81 б	1250	68.7	13700 (222 €)	
82	250		(0 €)	Burnt by forest fire 13 years ago
56	1000	52.5	105000 (1707 €)	Pod {uma -700 m
55 a	1100	/	/ (/ €)	Burnt by forest fire 10 years ago.
52	1200	/	/ (/ €)	Burnt by forest fire 10 years ago and afforested with cypress 2 years ago
51	500	/	/ (/ €)	Burnt by forest fire 10 years ago and afforested with cypress 2 years ago
50	250	/	/ (/ €)	Burnt by forest fire 10 years ago and afforested with cypress 2 years ago
47 a	850	/	/ (/ €)	Burnt by forest fire and afforested with cypress 4 years ago
Subtotal	**15625**	**615.2**	**1830400 (29762 €)**	
TOTAL	**25845**	**1445**	**2890000 (46991 €)**	

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. In terms of volume (Alternative B), about 1450 m^3 will be cut with market values of 2,890,000 denars = approximately 47,000 € (Tab. 43).

Alternative A was not assessed since the alignment is next to the existing road and occupies mainly highly degraded pseudomaquis with low economical value.

VIII.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. The most important sites are in the valley of teh stream Kalica (Alternative B), near village Gradec (Alternative A) 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.

VIII.2.2. IMPACT ON THE RIVERS AND STREAMS

The proposed highway crosses an area with many hills and valleys except the last few km which is almost flat plain. In this region many surface water (rivers, streams) are present close to the proposed motorway alignment. The groundwater surface is typically 15 m below the ground surface. 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. There unsaturated zone above the groundwater table is very shallow and the sandy soil can be very permeable. It is thus considered to be a sensitive receptors.

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 150 workers would be deployed on various works. However, on an average the number of workers would be around 100 in the construction works. Contamination of water ecosystem with solid (plastics, metal, 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, laying 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 block up 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 shall be selected in such a way that it leads to minimal impacts on forest cover, water ecosystems, wildlife etc.

VIII.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 (especially in case of Alternative B) 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. The entry point of the tunnel on the route at the right bank of river Vardar will be in close proximity to the nest of the Egyptian Vulture *Neophron percnopterus*, species threatened at European level and expecting uplisting to Globally threatened

species under IUCN criteria. On the same location there is a nest of long-legged Buzzard *Buteo rufinus*, another threatened species in Europe. Both species have small populations in Macedonia, the first one with strong declining trend and in need of special conservation measures. On the other hand, very close to the exit point of the tunnel a pair of Booted Eagle *Hieraaetus pennatus* breeds, another rare species in Europe with Macedonian population less than 15 breeding pairs. This species is highly sensitive to fragmentation and disturbance. Another rare species breeding in this section is the Black Kite *Milvus migrans*, and the same things told for the Booted Eagle hold true for the Black Kite. Furthermore, close to the exit point is the locality Dolni Krastavec, where Griffon Vultures used to breed in the recent past and now only a pair of Egyptian Vulture is breeding.

As far the alternative along the left bank of Vardar River is concerned, 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 investor should take care that minimal damage is done to the cliff (see also "mitigation measures").

The cave Bela Voda is sensitive habitat because of its stable conditions and specific fauna. Changes of the water regime and other disturbances can have severe impact on all animal species in the cave. Bats and other trogloxens of the cave are susceptible to any type of disturbance and there is danger that they will abandon the cave habitat. Similar consequences can be expected for the troglophyllous species (*Dolichopoda remyi*, *Scutigera* sp., *Nesticus* sp.). However, the troglobiontic species which are adapted for this particular biotope can be considered as the most threatened group. The destruction or severe disturbances of the cave system can lead to their extinction. At the present moment, the complete list of the troglobionts of Bela Voda cave is not known. It means that the disturbance of the cave will have impact on species that are not yet discovered or registered.

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 on both sites 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.).

VIII.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 A is accepted equals 56.6 ha. In the case of Alternative B, significantly smaller agricultural land will be destroyed (approximately 10 ha).

Tab. 44. *Estimation of the agricultural land surface that will be destroyed during the construction of the highway (Alternatives A and B)*

Land use types	**Alternative A**		**Alternative B**	
	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. Other impacts that should be taken into account are elaborated in respective chapters on air pollution, waters, solid waste, soil quality, erosion etc.

VIII.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 (in case Alternative A will be accepted) and Marvinci and Miletkovo (in case of Alternative B) 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.

VIII.2.6. IMPACTS ON ARCHAEOLOGICAL SITES

Beside 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.

VIII.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.).

VIII.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 (Precise number of trucks was not specified by the designer - Chapter II.1.2.1.).

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.

VIII.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 B). 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.

Tab. 45. *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

VIII.2.10. IMPACT OF THE NOISE AND VIBRATIONS

VIII.2.10.1. Noise

VIII.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.

Tab. 46. *Common noise levels*

Sound Source	dB(A)
Military jet, air raid siren	130
Amplified rock music	110
Jet takeoff at 500 meters	100
Freight train at 30 meters	95
Train horn at 30 meters	90
Heavy truck at 15 meters	80
Busy city street, loud shout	
Busy traffic intersection	
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	40
Public library	
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 pressures 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:

Tab. 47. *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. These values have also been applied in the EIA Study for the Skopje Bypass (ERM Lahmeyer 2000). 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.

VIII.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.

Tab. 48. *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

VIII.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.

VIII.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 the shift only, so additional buildings for accommodation of workers will not be required. Local population could be considered to respond to 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 B (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.

VIII.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.).

VIII.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 A), Miravci and Miletkovo (Alternative B). 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 B).

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.

VIII.2.14. OTHER IMPACTS

Other impacts that can occur during construction of the highway and should be assessed are radiation and odour (smell).

VIII.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.

VIII.2.14.2. Odour

Significant sources of bad smell are not expected along the highway corridor.

VIII.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.

VIII.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.

VIII.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.

VIII.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 B) or considerable portion of agricultural land (Alternative A). 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 A. 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 A). There are no data for balance of soil masses for Alternative B.
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.

VIII.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 need 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.

VIII.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 B).

VIII.2.16.5. Impacts on rock and mineral resources

Any adverse impact on rocks and mineral resources is not expected.

VIII.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.).

VIII.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 fragmentatin of habitats (already dicussed in the section on biocorridors).

VIII. 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.

VIII.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 B, 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.

VIII.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.

VIII.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.

VIII.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 VIII.3.8., VIII.3.7. and VIII.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 A and Alternative B) is 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. This effect will be more pronounced in hilly areas where a limited number or no alternative "agricultural" roads are available.

VIII.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 A); Miravci and Miletkovo (alternative B); 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.).

VIII.3.6. IMPACT OF NOISE AND VIBRATIONS

VIII.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 its passing through the city of Demir Kapija and villages Udovo, Josifovo, Marvinci, (Miravci, Miletkovo) and Smokvica is critically approaching to 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 A 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 A- Design of a new carriageway on the left bank of the Vardar River, as close as possible of 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 measure alternatives should be calculated. Installation of noise prevention walls may be the most efficient mitigation measures, 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 B- The project route is on the 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.

VIII.3.6.1.1. 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.

VIII.3.7. IMPACT ON SOILS AND SOIL POLLUTION

Road operation can only have impact on pollution of the soil next to the road surface.

VIII.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.

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 continuously, 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.

The extent of road operation on soil pollution can only be assessed properly and quantified after elaboration of the detailed road design (which is not the case for Alternative B).

VIII.3.7.2. Protective zones

The remarks in Chapter VIII.2.16.3. are the same as for the road operation.

VIII.3.7.3. Transport

The most important impact of transport on soil concerns soil pollution and emergency situation, which were discussed in respective chapters.

VIII.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.

VIII.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.

VIII.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 particles	suspended
Republic of Macedonia	457	16.732	48.148	11.348	83	1.830	

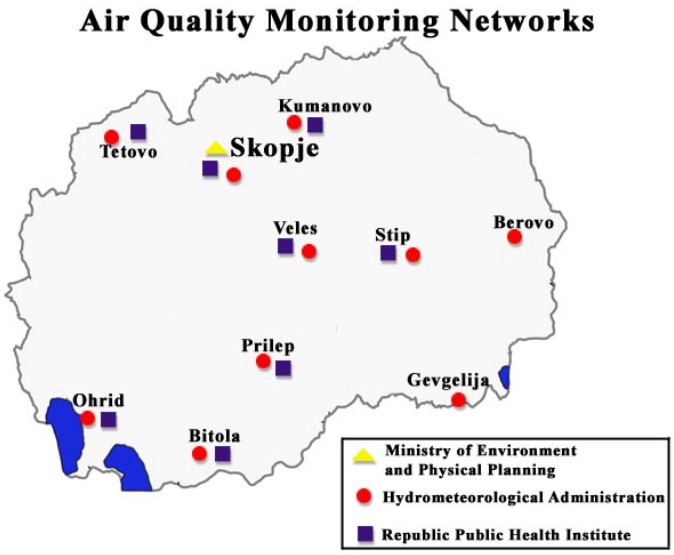

Fig. 10. Map of automatic monitoring stations for ambient air in Republic of Macedonia.

There are 20 monitoring stations for measuring of air quality

VIII.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.

Tab. 50. *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 CO2 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 fuel consumption on the new alignment has to be compared with the amount being emitted by alternatively using 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. Fuel consumption per kilometre under these conditions is approximately 2 – 3 times lower than in a city.

VIII.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.

VIII.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.

VIII.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).

VIII.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.

VIII.3.11.2. Odour

Sources of bad smell are not expected along the road corridor.

VIII.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, 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 town Demir Kapija (Alternative B) and village Udovo (Alternative A) 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.

VIII.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.

Tab. 51. *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.

VIII.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.

[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.

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

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.

VIII.3.14. THE LANDSCAPE CHARACTERISTICS

The overall effect within the area of the Alternative B 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.).

VIII. 4. IMPACTS PRODUCED FROM THE FUTURE DEVELOPMENT IN THE REGION

IDENTIFICATION OF EFFECTS OF CONSTRUCTION OF HIGHWAY DEMIR KAPIJA - SMOKVICA

The effects which are expected from construction of highway for the area and its surroundings and wider mainly are included:

- Establishing of adequate transport of goods and people;
- New employments of persons from local population in different accompanied objects of highway;
- Further retention and intensification of the demographic structure of the inhabitants in rural settlements;
- Increased agricultural and farm producing;
- Opening of small production objects;
- Construction of modern local infrastructure and
- Increased functional importance of region.

These expectations should be a result of different indirect and direct activities, which will be related to the road corridor.

IX. MITIGATION MEASURES

Construction of the projected highway section, 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 B alignment. However, even in cases when the data were 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 B if it is accepted. They can serve particularly for bringing the final decision on the adjustment of the proposed alignment.

IX. 1. MEASURES FOR THE PREPARATORY PHASE

The following prevention, elimination, mitigation and/or compensation measures are proposed for the preparatory phase:

- 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.
- Propose technical and operational measures to minimize negative impacts of the construction on the environment.
- 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.

IX. 2. MITIGATION MEASURES DURING THE ROAD CONSTRUCTION

The remarks mentioned above are particularly valid for the road construction phase. The measures listed bellow, were proposed on the basis of the alignment in the preliminary design for the Alternative B. It is almost definite that the investigated area of the road corridor (1 km wide) will cover the future alignment of the road, which makes the proposed measures valid and usable.

IX.2.1. GENERAL MEASURES

General measures refer to the measures that should be implemented on the whole construction site (the whole length of the highway corridor) and during the whole construction period. These measures are applicable no matter that final road design does not exist.

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 colours and thinner, etc.) in particularly labelled 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.

IX.2.2. 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 Boshava 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
  - Bela Voda cave
  - 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)

IX.2.3. SPECIFIC MEASURES

IX.2.3.1. Mitigation measures for flora and fauna

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 exiting 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.
- If Alternative A is approved for construction, 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.

2. Highway construction in the lower sections of the corridor

To prevent unneeded breeding and foraging habitat loss for many species, accessory roads for highway construction should follow already existing paths and roads, and should be wide just enough to provide the necessary working conditions. All excavated material should be removed from the construction site.

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).

IX.2.3.2. 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.

Mitigation measures during construction are set in the Environmental Management Plan.

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.

IX.2.3.3. Forestry

Direct destruction of forests (Chapter VIII.2.1.1.) during the construction of Alternative B 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 aforestation activities by respective amount of money in the frames of the aforementioned forestry districts. Aforestation should be performed with native (autochthonous) tree species as stated in the Law on Nature Protection. Aforestation costs per one hectare at present conditions are about 2000 €. It means that about 23.5 ha should be afforested (47000 € divided by 2000 € per ha).
In the case of Alternative A similar compensation measures should be applied. Aforestation should be done on a scale that corresponds to the value of cut timber in the adjacent forestry units (approximately half amount).

IX.2.3.4. Agriculture

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.). 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. Some of these measures consider forestry since forest roads will be cut. Enabling good connection between forest land on both sides of the highway is essential for accessibility and interventions in case of forest fires.

Tab. 52. *Overview of the intersection of the highway route of **Alternative A** with different types of existing local (unpaved) roads*

Existing measure in the highway design	Kilometre	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

Tab. 53. *Overview of the intersection of the highway route of **Alternative B** with different types of existing local (unpaved) roads*

No.	Kilometre	Local road
existing	5+620	village road (bridge)
not existing	6+700	forest road
not existing	7+300	forest road
existing	7+700	path
existing	10+130	road (bridge)
not existing	13+100	forest road
not existing	13+530	forest road
not existing	15+200-15+500	path
not existing	16+900	path
existing	17+100	forest road (overpass)
not existing	17+600	path
not existing	19+100	path
not existing	19+200	forest road
not existing	20+600	path
not existing	21+100	PTT optical cable
not existing	21+850	path
not existing	22	path
existing	22+250	pipeline (bridge)
not existing	22+650	village road
existing	22+950	village road
existing	23+050	forest road (overpass)
not existing	24+600	path
not existing	25+750	path
not existing	26+700	path
not existing	27+300	village road
existing	27+520	road (overpass)

IX.2.3.5. Waters

The potential for impacts to occur should be minimised 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 bunded safe area within the site compound;
- All drums and barrels should be fitted with flow control taps and should be properly labelled;
- The placing of any wet concrete in or close to any watercourse should be controlled to minimise 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;
- Before any discharge of water is made from the site, adequate provisions should be made to ensure that it is not polluting, for example by incorporating silt settlement techniques. The techniques to be employed should be suitable for the particular site. Techniques may include settlement lagoons, use of straw bales for silt trapping and use of flocculants;
- All pumped drainage from the construction works including areas used for temporary storage of construction materials or excavated soils, should be passed through silt settlement treatment prior to discharge to surface watercourses or drains; silt settlement treatments may, for example, include straw bales, grassland soak away, silt settlement lagoons;
- All roads and hardstanding 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;
- 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;
- Storage compounds for fuels, oils or other liquid chemicals should be sited away from surface water drains.
- Where practicable, drainage from storage compounds would be passed through oil interceptors prior to discharge;
- Topsoil/vegetation along watercourses should be retained to aid attenuation and sediment infiltration.
- Protection and development of the rivers and streams riparian vegetation by keeping a distance of at least 10 meters from the banks free of roads and agricultural use.
- 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.
- Protection from erosion and enhancement of the habitat function by developing riparian vegetation on the banks of rivers and streams.
- Preservation and planting of shrubs and trees in the catchments areas for enhancing the water retention capacity, especially in agricultural areas and on non-wooded or sparsely wooded hill slopes.

During construction of the alignment of the highway, it is very important to avoid

pollution near existing reservoir Kalica and future reservoir on Petrushka River which are designed for irrigation. 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 or) on site, during the whole construction period.
The thermal source in Smokvica are used the hydrothermal energy for heating of 6 ha greenhouse. 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. 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.

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.

IX.2.3.6. Biodiversity compensation measure

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 tenths of thousands of Euros.

IX.2.3.7. Archaeological sites

If the highway pass along the existing motor road, than extreme measures of precaution during the construction should be undertaken as also continuous presence of archaeologist during the preliminary and excavation works of the road corridor..

Anyway, there is no the 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.

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 ha 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.

IX.2.3.8. Air

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 is not considered 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 very significant. Considering the temporary character of this impact there are no measures foreseen. Dust control as usual procedure at construction sites is recommended.

IX.2.3.9. Noise and vibrations

IX.2.3.9.1. Noise

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.

Irrespectably 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.
The special care must be undertaken during mining work for making the new tunnel which should be as close as possible to the existing tunnel. To avoid disturbance from noise pollution to vulture's populations during breeding period (laying eggs, incubation period and fledging, from January to July), the construction work in this area must be restricted only in the autumn period (September to January). All works should be carried out under expert supervisions (ecologist or biologist).
Open cast mining operations cause noise pollution at the workers at 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.

IX.2.3.9.2. 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.

IX.2.3.10. Borrow pits

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 analysed region, recommendations are as follows:

- 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.

- 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.).
- Necessary quantities of carbonate material (limestone, marble) shall be provided from the reserves of the open quarry between the villages Kosturino and Memesli that have been mentioned previously, and the same have large quantities of balanced reserves that because of the good communications and the vicinity of the larger part of the analysed alternatives will be easily accessible.
- The gravels and the sands from the alluvial stratum should be exploited from the existing localities at Przhdevo and Gevgelija.
- It is necessary to prepare environmental input data Environmental Impact Assessment and Design of re-cultivation of all fields of structural stone, gravel and sand, and especially for the alluvial findings it is necessary detail hydro-geological analysis (level of underground water, regime of feeding etc.). Whole named documentation is to be submitted for insight and evaluation to the Agency for environment and nature protection, and afterwards the exploitation conditions are to be insight and evaluation to the Agency for environment and nature protection, and afterwards the exploitation conditions of these resources are to be determined.

It is really significant the necessity of determination of the adequate location for disposal of these materials from the excavation that are not going to be used for the highway construction and conditions of their disposal, as from the aesthetic environmental aspect as also from the aspect of the landfill stability.

IX. 3. 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 B (if accepted) due to the specific relief and other environmental characteristics.

IX.3.1. 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.

IX.3.2. SPECIFIC MEASURES

IX.3.2.1. 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.
- Detailed landscape plan has to be elaborated.

IX.3.2.2. 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.

IX.3.2.3. Waters

IX.3.2.3.1. 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 exist). Additionally, waste dumping of gravel pits after the construction phase must be excluded.

IX.3.2.3.2. 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.

IX.3.2.4. Air

IX.3.2.4.1. 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.

IX.3.2.4.2. Ambient air

The Alternative "A" and "B" 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.

IX.3.2.5. Noise and vibrations

IX.3.2.5.1. 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.

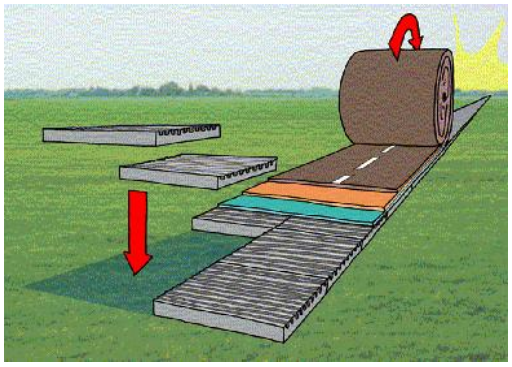

Fig. 11. Example of a prefabricated modular road surface (Pictures courtesy of DWW)

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.

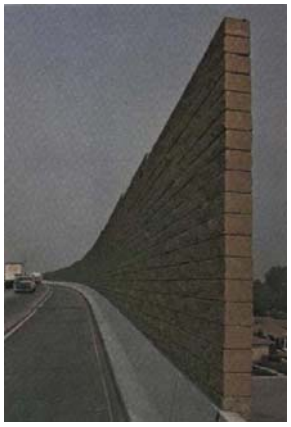

Fig. 12. Abrupt endings on wall

Fig. 13. 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 alignments 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.
Thermomineral 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 xceeding 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.

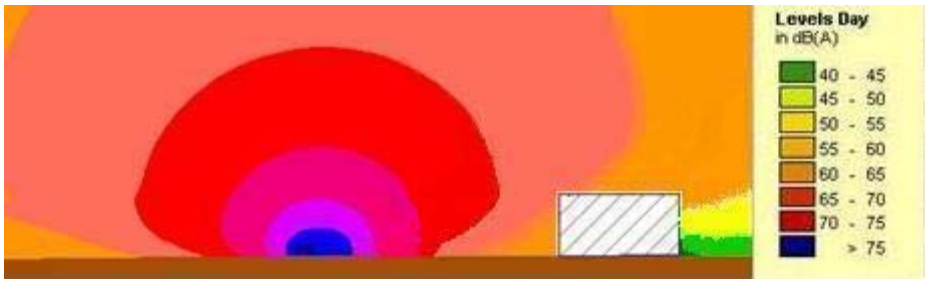

Fig. 14. Noise contours without noise protection barrier

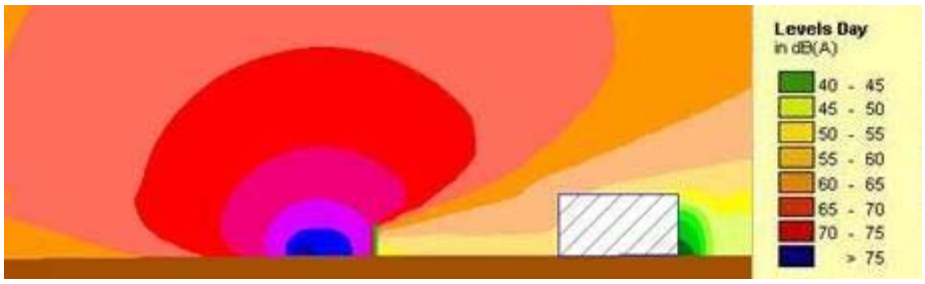

Fig. 15. Noise contours with noise protection barrier

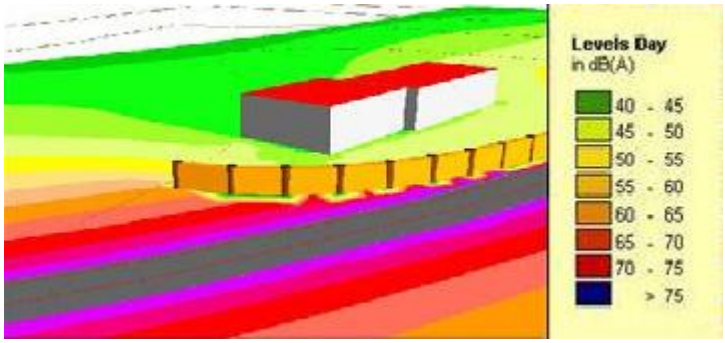

Fig. 16. 3D view on effect of noise protection barrier

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 autochtonous 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.

Tab. 54. *Noise pollution prevention management plan*

	Mitigation Measures	**Implementation 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
Opera-tion	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

IX.3.2.5.2. 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).

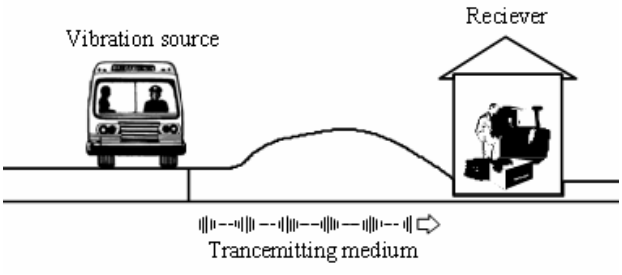

Fig. 17. Traffic vibrations can be characterized by a source-path-receiver scenario

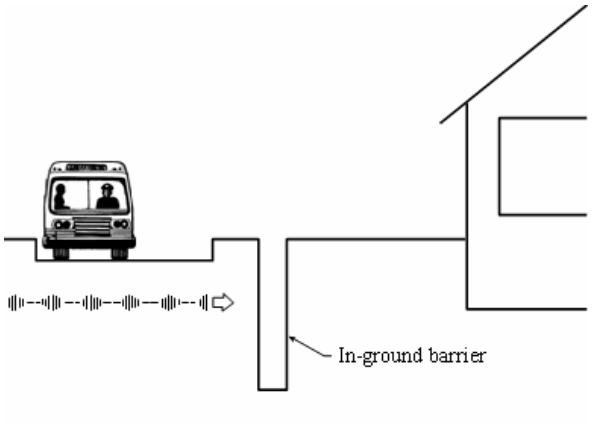

Fig. 18. Schematic illustration of an in-ground vibration barrier

X. ANALYSIS OF ALTERNATIVES

Two basic options were considered for comparison of alternatives within this Study:

- First option - Alternative A (Upgrading of existing motorway from the left side of the river Vardar)
- Second option - Alternative B (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)

In case of Alternative A - construction works will comprise widening of exiting road for its use as two lanes' road in one direction and construction of another two lanes in opposite direction next to the existing road.

In case of Alternative B construction works will comprise construction of a completely new highway on the most of its length.

For technical details of both alternatives see Chapter II.

In this Chapter, advantages and disadvantages of each alternative will be presented and analysed 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 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 are 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 with natural and seminatural ecosystems and habitats. In addition, basic economic activities (agriculture and forestry) are discussed as well.

It was not possible to perform Full Cost/Benefit analysis due to the lack of data, especially in sense of economic parameters.

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 obvious that participation of very high sensitive and high sensitive ecosystems and habitats (for meaning of the level of sensitivity in sense of construction activities, see Chapter VII.1.) in Alternative B is much higher than in Alternative A. On the contrary, medium sensitive ecosystems and habitats are much more represented in Alternative A (see also Sensitivity map-Appendix). Fig. 19 presents the area of different sensitivity classes in both alternatives, whole Fig. 20 presents percent contribution of different sensitivity classes in both alternatives.

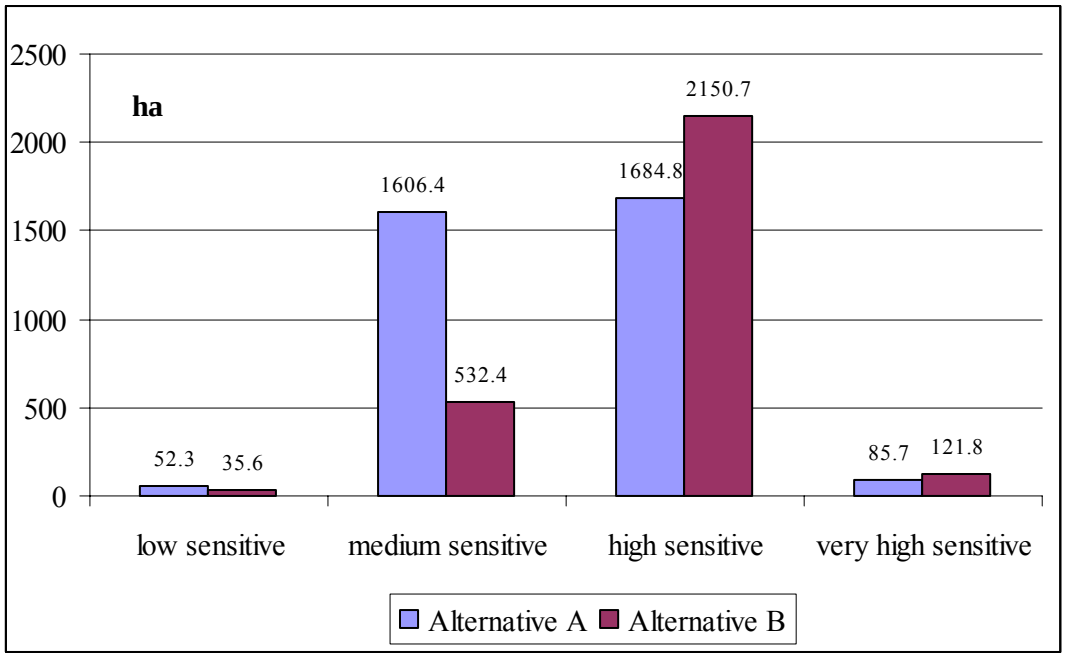

Fig. 19. Comparison of the sensitivity levels in Alternative A and Alternative B.

It is obvious (Fig. 20) that very high sensitive and sensitive habitats particapate with larger percent in Alternative B (51.8% in Alternative A and 79.5% in Alternative B).

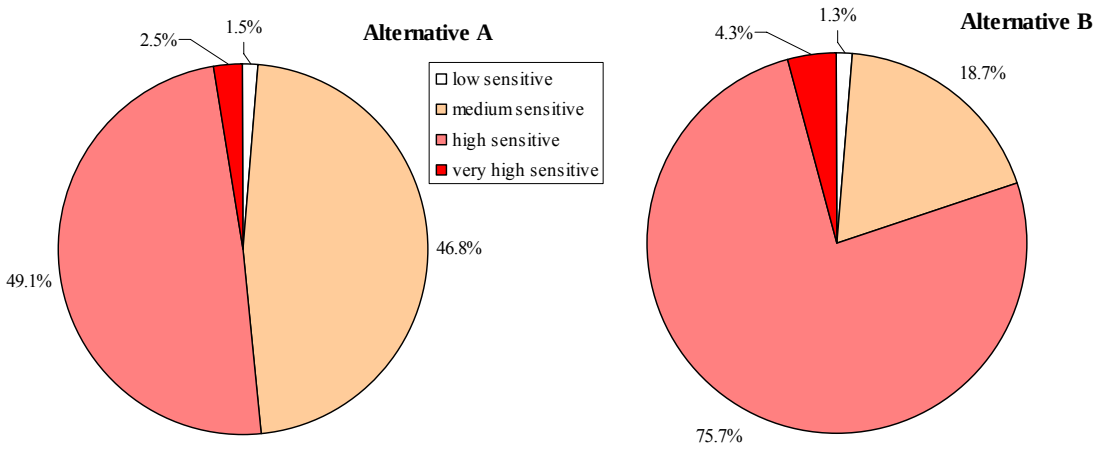

Fig. 20. Percentage of the area with different sensitivity levels in highway corridors of Alternative A and Alternative B.

The most sensitive sites are the cave Bela Voda and the whole Demir Kapija canyon (particularly because of the vulture colonies on the limestone rocks), than Oriental plane woodlands and belts along the streams Golema Javorica (in the region of the bridge in case of Alternative B), Mala Javorica tributaries and Kalica - upper flow. Most of these sites are distributed in Alternative A. In case of Bela Voda cave, realignment of the proposed alignment (Alternative B) is inevitable.

Sensitivity of sites of human interest

For both alternatives, the number of objects (settlement/ archeological site/ agricultural land) with low sensitivity is equal (see Fig. 21).
Medium sensitivity objects are mostly presented in corridor of alternative A (in ratio 8:3 with alternative B) because of the short distance of most of the settlements (and two of the archaeological sites) from the future planed highway.
Alternative B is critical concerning high sensitivity due to the short distance of most of the settlements (and archaeological sites) from the future planed highway.
Maybe the most important criteria for comparison is very high sensitivity class because of the highest impact on the environment taken as a whole. Alternative A has no “very high sensitive" points and alternative B is critically approaching to 3 of the archaeological localities in a very short distance. In this case, a realignment of the future road must be considered.

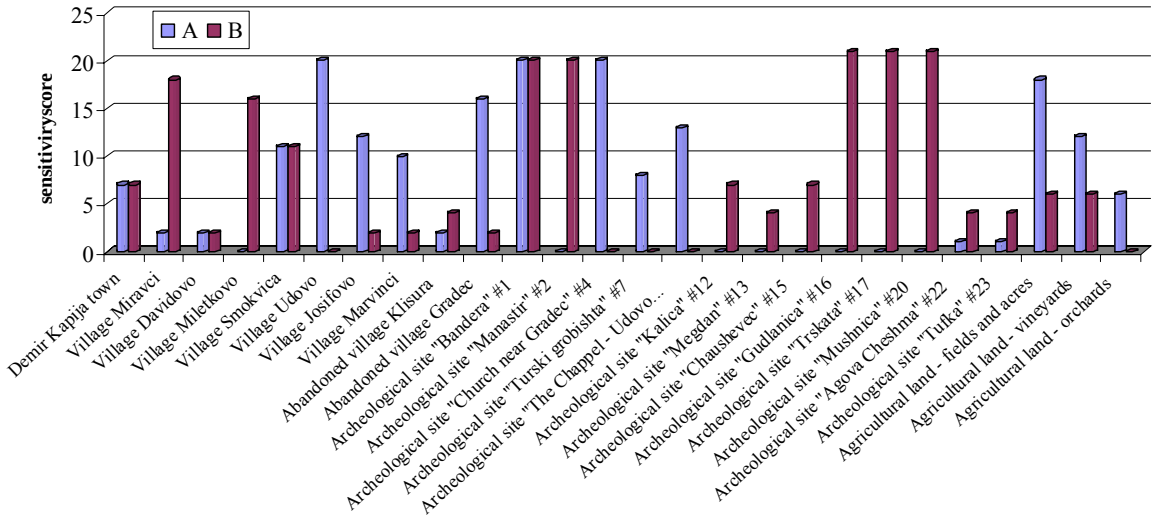

Fig. 21. Comparison of sensitivity of sites of human interest in alternatives A and B.

If the Alternative A is accepted, the following situation will occur in the area around the both alternative highway alignments from Demir Kapija to village Smokvica:

- There will be no significant increment in terms of traffic and emission of pollutants produced by the traffic and other facilities along the whole length of the Alternative A route; on the contrary, much of current unfavourable conditions will be improved
- There will be no increments in terms of traffic and emissions of pollutants produced by the traffic and other facilities along the whole length of Alternative B, predominantly natural landscape and particularly at the edge of Demir Kapija town, at the intersection of very high sensitive streams and villages Miravci and Miletkovo.
- The destruction of natural habitats will be les significant compared to the case of Alternative B scenario, especially in case of high sensitive habitats; high rate of disturbances to threatened species will be restricted to the region of Demir Kapija canyon.
- There will be no destruction of very high and high sensitive habitats and sites, particularly the cave Bela Voda, 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 not be threatened

If the Alternative B is accepted, the following situation will occur in the area around the highway from Demir Kapija to village Smokvica.

- Most of the situations described above will be opposite
- 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 high scale

Socio-economic parameters

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

- No matter which of the alternatives will be accepted, 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.
- Irrespective to the chosen alternative, 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 B solution is about 5 km shorter and much cheaper variant compared to Alternative A.
- Construction of Alternative B highway will require high expenses for mitigation measures.

XI. 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 165 ha (Alternative A) and 140 ha (Alternative B) of natural and agricultural land 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 A) and surrounding of the village of Miletkovo (in the case of Alternative B).

One of the mitigation measures was to minimize the alteration with the “agricultural” roads. During the construction of the highway these road 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 forest areas, existing forest roads should be used. In the case of Alternative B, 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 of 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.

It is not possible to make final decision in this study which alternative will be the most appropriate due to the lack of necessary information for Alternative B. Much of the conducted analyses suggest that Alternative A is environmentally more suitable especially form biodiversity point of view. During the following process of finalization of the design, analysis of different stakeholders' interests has to be done, economic parameters have to be evaluated and measured against the environmental concerns

described in this study. In any case, full implementation of mitigation measures is necessary.

Promotion of environmental quality in the region of Demir Kapija gorge could be done by compensating the damage to some sites by conservation of other part(s), namely Demir Kapija canyon.

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 monitor 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

XII. REFERENCES

APHA. (1985): Standard method for the Examination of Water and Wastewater. 16th ed. American Public Health Ass, 1266 pp.

Apostolski, K., Petrovski, N., Popovska, O., Sidorovski, M., (1956): Fish in Macedonia, Dept.of Fishery of SRM, Skopje.

BirdLife International (2004). Birds in Europe: population estimates, trends and conservation status. Cambridge, UK. BirdLife Conservation Series 12, 374 pp.

Brotons, L. & Herrando, S. (2001): Reduced bird occurrence in pine forest fragments associated with road proximity in a Mediterranean agricultural area. Landscape and Urban Planning, 57: 77-89

Coste, M. (1978): Sur l' utilisation des diatomees bentiques por l'appreciation courntes methodologie comparee et approche tipologique. These, Univ. Besancon, 287, 43 pp.

Council Decision of 3 December 1981 concerning the conclusion of the Conservation of European wildlife and natural habitats (87/72/EEC). Official Journal of the European Communities No L 38/1, 10.02.1982

Council Directive of 21 May 1992 on the conservation of natural habitats and f European wild fauna and flora (92/43/EEC). Official Journal of the European Communities No L 206/7, 22.07.1992

Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (85/337/EEC). Official Journal of the European Communities No L 175/40, 05.07.1985

Cox, E.J. (1991): What is the basis for using diatoms as monitors of river quality? In: Whitton & Rott (Eds.) - Use of algae for monitoring rivers, University of Innsbruck.

Curt Meine, ed. (1998): Bulgaria's Biological Diversity: Conservation Status and Needs Assessment, Vol. I and II. Washington, D.C.: Biodiversity Support Program

Decision for the determination of rare tree species in forests. Official Gazette of the Republic of Macedonia, May 19th, 1998, 1350, N^{o} 23.

Descy, J.P. (1979): A New Approach to Water Quality Estimation Using Diatoms. Nova Hedwigia 64: 305-323.

Detailed Design of Upgrading of the E75 Road, Section Demir Kapija/ Udovo and Udovo/ Gevgelija, Stage 1: Feasibility Study and Preliminary Design, Final Report, Scetauroute, July, 1999

Devai, I., Horvath, K. and Devai, G. (1973): Sulphate content determination of natural waters and description of a new photometric procedure.Acta Biol.Debrecina, 10-11: 129-142.

Dimovski, A. (1971): Seasonal changes of the ornithofauna of the community of prnar (*Quercus coccifera*) in Macedonia. Ann. Biol. Tome 23, 45-54.

Dimovski, A., Grupce, R., (1972): Ichtiofauna of river Vardar, God.zb.PMF. T25.

Donevski, L. (1984): Entomofauna (Lepidoptera) of oak (Quercus coccifera) in SR Macedonia

Em, H. (1950): The Mediterranean vegetational region in Macedonia. Forestry review 1-3, Skopje

Em, H. (1967): Synopsis of the denedroflora of Macedonia, 127 pp.

Environmental Impact Assessment Study, Road, Section Kumanovo- Tabanovce, RI-Opusproekt, d.o.o., Skopje, 2006

Gasevski, M. (1978): The basic characteristics of the river network in SR Macedonia. Soc. de Geogr. de la SR Macedonie. 15-16, 29-42.

Géroudet, P. 1965. La Buse féroce, *Buteo rufinus* , au défilé de Demir-Kapija. *Larus* 19:156-157

Grubac, B. 2002. Prilog o kratkoprstom kopcu *Accipiter brevipes* (Severtzov, 1850) u Srbiji, BJR Makedoniji i Grckoj. *Zbornik radova o fauni Srbije* 6:61-72

Grubac, B. 1994. La situation di Faucon lanier *Falco biarmicus* in Mediterranee et specialement das le centre des Balkans. Paper presented at Biology and conservation of mediterranean raptors .

Grubač, B. R. 1989. The Egyptian Vulture *Neophron percnopterus* in Macedonia. Paper presented at Raptors in the Modern World, at Berlin, London & Paris.

Grubač, B. R. 1999. Distribution and Ecology of the Long-legged Buzzard (*Buteo rufinus* Cretzschmar, 1827) in the Central Balkans. Contributions to the Zoogeography and Ecology of the Eastern Mediterranean Region 1:125-130.

Hieke, F. (1981): Die Carabidae einer Sammelreise nach Mazedonien. Acta Mus. Mac. Sci. Nat. 16: 71-101, Skopje

Horvat, I. (1963): Forest associations of Yugoslavia. Forest Encyclopedia.

Intensive rainfalls in Republic of Macedonia, Shkoklevski, Zivko, Todorovski, Blagoja, Faculty of Civil Engineering, Hydrotechnical Institute, Skopje, 1993

Karadelev, M. (1993): Contribution to the knowledge of wood-destroying fungi in the Republic of Macedonia, Fungi Macedonici I, Young.Exp.Mac., p.p. 1-78, Skopje;

Karadelev, M. (1995): Lignicolous Aphyllophorales (Basidiomycetes) on Greek juniper (Juniperus excelsa M.Bieb.) in the Republic of Macedonia. Mycotaxon, Vol.LVI, pp.467-472, Cambridge, USA.

Karadelev, M., 1993: Contribution to the wood-destroying fungi in the Republic of Macedonia, Fungi Macedonici I, Young. Exp. Mac., p.p. 1-78, Skopje.

Karaman, Z. (1971): Fauna of Macedonia I. Scolytoidea (Coleoptera, Insecta). 178 pp., Skopje

Khan, I.S.A.N., (1990): Assesment of Water pollution using Diatom Community Structure and species Distribution - A Case Study in Tropical River Basin. Int. Revue ges Hydrobiol. 75. (3), 317-338.

Krstic, S. (1992): Microalgal flora changes in Anska Reka as indicator of pollution degree. M.Sci. Thesis., Faculty of Natural Sciences - Skopje.

Krstic, S. (1995): Saprobiological characteristics of microflora in reka Vardar as indicator of the intensity of antropogenic influence. Ph.D. Thesis Faculty of Natural Sciences - Skopje.

Krstic, S. and Melovski, Lj. (1994): Preliminary results of the saprobiological investigations on river Vardar. Procc. of workshop: Monitoring of the environment in Republic of Macedonia. The Soc. of Ecologists of the R. of Macedonia, Vol. 2. 151 - 159.

Krstic, S. and Stojanovski, P. (1994): Comparative microflora analysis in mouth waters of river Boshava and Anska, Macedonia. Ann. Biol. 46, 101-110, Skopje

Krstic, S., Melovski, Lj., Levkov, Z. and Stojanovski, P. (1994): Complex investigation on river Vardar. I. Approach and description of the investigations. Ecol. Protection Environ., Vol. 2, No.1, 63-72.

Krstic, S., Melovski, Lj., Levkov, Z. and Stojanovski, P.(1994): Complex investigations of the river Vardar. II. The most polluted sites in the first three mounts. Ecol. Protection Environ. Skopje. Vol. 2. No. 2, 13-29.

Law for Environmental Protection and Promotion, Official Gazette of Republic of Macedonia No 69/96

Law for Environmental Protection, Official Gazette of Republic of Macedonia No 67/ 04.10.2004

Law for Protection of Cultural Heritage, Official Gazette of Republic of Macedonia No 20/ 02.04.2004

Law for water, Official Gazette of Republic of Macedonia No 4/98

Makatsch, W. (1950): Die Vogelwelt Macedoniens. Leipzig, Akademische Verlagsgesellschaft Geest & Portig K.-G.

Markoski, B. (1986). Funkcionalni karakteristiki i nivno znacenje za razvoj na opstina Krusevo. Magisterska rabota odbraneta na Institut za geografija pri PMF, Skopje (rakopis).

Matthysen, E. Lens L. Van Dongen S. Verheyen G. R. Wauters L. A. Adriaensen F. & Dhondt A. A. (1995). Diverse effects of forest fragmentation on a number of animal species. Belgian Journal of Zoology, 125:175-183.

Matvejeva, J. (1982): The Ruderal Vegetation in SR Macedonia. MASA, Skopje

Micevski, K. (1985): The Flora of SR Macedonia. Vol. I, Book 1, 1-152, MASA, Skopje

Milan Ivanovski: -1988, Opis na arheolo{kite lokaliteti za delnicata Udovo - Ggevgelija (dopis na Republi~kiot zavod za za{tita na spomenicite na kulturata ispraten do GRO-Granit od Skopje a po negovo predhodno barawe).

Milenkovski Q: -1987, Prirodno geografskite uslovi kako faktor za razvoj na zemjodelstvoto vo Gevgelisko-Valandovskata Kotlina, geografski razgledi, kn. 26, Skopje.

Milenkovski Q: -1988, Stocarstvoto - znacajna zemjodelska granka vo Gevgelisko - Valandovskata Kotlina, geografski razgledi, kn. 26, Skopje.

Nastov A. & Petkovski S., (2004): Macedonian Nationl Report of the Implementation of the agreement on Bats. Ministry of Environment and Phisical Planning. Presented at the 9th Meeting of the Advisory Committee to EUROBATS (AC9). 11 pp.

Naumovski, M., (1995): Fish in Macedonia, Skopje.

Naumovski, M., (1998): Study on integrated water resources development and management master plan in the Republic of Macedonia - Final report on environmental survey.

NEAP - National Environmental Action Plan (1996). Ministry of urbanism, civil engineering and protection of the environment, Skopje

Panov M.: -1993, Selata vo Republika Makedonija - sostojbi, problemi i mo`ni pravci na razvoj na selskata sredina, kn. 1, Prostorni i populacisko agrarni obele`ja, Skopje.

Panov M.: -1993, Selata vo Republika Makedonija - sostojbi, problemi i mo`ni pravci na razvoj na selskata sredina, kn. 2, Transformacii na mre`ata na selskite naselbi i funkcionalna klasifikacija na ruralnite podra~ja na naselbite, Skopje.

Patrick, R. and Palavage, D. (1994): The value of species as indicators of water quality. Proce. Acad. Nat. Sci. Phyl. 145: 55-92.

Peris, S. J. & Pescador, M. (2004): Effects of traffic noise on passerine populations in Mediterranean wooded pastures. Applied Acoustics, 65: 357-366

Petkovski, S. (1998): Project: Mammals of Macedonia. Final Report 1995-1997, Macedonian Museum of Natural History. Skopje. pp 131.

Petrovska, Lj. (1965): Limnological investigations on river Vardar. Final report. Skopje.

Phare CBC Programme MA- 96061, E75 Road, Section Demir Kapija- Gevgelija, Detailed Design of the Upgrading, Feasibility Study, Final Report, Scetauroute, January, 1999

Reijnen, R., Foppen, R. & Meeuwsen, H. (1996): The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. Biological Conservation, 75: 255-260

RGU: -1982, SR Makedonija niz katastarska evidencija, Skopje.

Rott E. (1997): Indikationlisten für Aufwuchsalgen. Teil 1: Saprobielle indikation. Bundesministerium für Land- und Forstwirtschaft. Wien. pp73.

Rott, E. (1991): Methodological aspects and perspectives in the use of periphyton for monitoring and protecting rivers. In: Whitton, Rott and Friedrich (Eds.) - Use of algae for monitoring rivers, University of Innsbruck.

Sabater, S. and Sabater, F. (1988): Diatom assemblages in river Ter. Arch. Hydrobiol. 111, 3: 397-408.

Scheider, P., Jakšić, P. 1989. Die Tagfalter von jugoslawisch Mazedonien. Selbstverlag Paul Scheider. 227 pp.

Simova-Tosic, D. (1979): Fauna of Macedonia II. Tipulidae (Diptera, Insecta), Skopje

Skopje ByPass, ERM GmbH, Lahmeyer Internacional, PLANUNG+UMWELT, Environmental Impact Assessment Study, September, 2002

Skopje ByPass, ERM GmbH, Revised Environmental Impact Assessment, Final Report, March, 2006

Sladecek, V. (1973): System of water Quality from biological point of view. Arch. fur Hydrobiol. Heft. 7: 1-218.

Slater, F. M. (2002): An assessment of wildlife road casualties - the potential discrepancy between numbers counted and numbers killed. Web Ecology, 3: 33-42

Steindachner, F., (1892): Uber einige neue und seltene Fischarten aus der ichthyologischen Sammlung des Nat. - Hist. Hofmuseums, Denkscher, der Akad. D.Wiss, Wien, Bd. LIX.

Stevanovi}, V. & Vasi}, V. eds. (1995): Biodiversity of Yugoslavia with species of international importance. Ecolibri, Belgrade

Stojanovski, P., Krsti}, S., Kungulovski, D`. and Sidorovska V. (1990): Floristic - saprobiological investigations of some tributaries of river Vardar Macedonia. Ann. Biol., Tome 41-42: 235-249

Stresemann, E. (1920): Avifauna Macedonica. Die ornithologischen Ergebnisse der Forschungsreisen, unternommen nach Mazedonien durch Prof. Dr. Doflein und Prof. L. Müller-Mainz in den Jahren 1917 und 1918. München, Dultz & Co.

SZS: -1964, Popis stanovni{tva, 1961 godina, Naselenie po pol i starost, Beograd.

Thurner, J. (1964): Die Lepidopteren fauna Jugoslavisch Mazedoniens II. Bombyces et Sphinges. Spec. ed. Natural History Museum of Macedonia, 169 pp, Skopje

Thurner, J. (1964): Die Lepidopteren fauna Jugoslavisch Mazedoniens I. Rhopalocera, Grypocera and Noctuidae. Spec. ed. Natural History Museum of Macedonia, 169 pp, Skopje

Tolman, T. 1997. Butterflies of Britain & Europe. Harper Collins Publ. 320 pp.

Tortich, M., 1987: Characteristic species of Aphyllophorales in the Mediterranean area of Yugoslavia. Biosistematika 13, 101-113, Beograd.

Tortich, M., 1988: Materials for the mycoflora of Macedonia. MASA. Skopje, 64p.

Tortich, M., Karadelev, M., 1986: Lignicolous macromycetes in Submediterranean part of Macedonia (Yugoslavia). Acta Bot. Croat. 45, 109-117, Zagreb.

Van Dam, H., Martens, A. and Sinkeldam, J. (1994): A coded checklist and ecological indicator values of freshwater diatoms from Netherlands. Neth. Jour. of Aquatic Ecology 28 (1): 117-133.

Vangjeli, J., Ruci, B. & Mullaj, A. (1995): Red Book: Threatened and rare plants species of Albania, 169 pp., Tirana

Veljanovski, A. (1977): The content of Pb, Zn and Cd in surface waters in S.R. Macedonia in 1973 - 1975 period. Procc. of the Conference: Program sanation of hygienic-epidemiologic situation in the frame of activities for environmental protection. 13-15 X 1977, Ohrid.

VGI: -1970-1975, Topografski karti 1:25000, sekcii Demir Kapija - istok, Demir Kapija -zapad, Valandovo, Negorci, Kon~e, Gevgelija i Miravci; Belgrad.

Washington, H.G. (1984): Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosistems. Wat.Res. 18: 653-694.

Watanabe, T. (1981): A new approach to Water quality estimation using the specific compsition of the benthic diatoms in epilithic forms based on the discusion to several problems on indicator organisms. Environm. Poll. Coutr. 17: 13-18.

Watanabe, T., Asai, K. and Houki, A. (1986): Numerical Water Quality Monitoring of Organic Pollution using Diatom Assemblages. 6th Diatom Symposium. Budapest, Hungary.

Watanabe, T., Asai, K. Houki, A. and Sumita, M. (1990): Numerical simulation of organic pollution based on attached diatom assemblage in Lake Biwa. Diatom 5: 9-20.

Watanabe, T., Asai, K., Houki, A. and Yamaida, T. (1988): Pollution spectrum by dominant diatom taxa in flowing and standing waters. Prooced. of the 10thDiatom Symposium 563-571.

Zavod za statistika na Republika Makedonija: -1996, Popis na naselenieto, domakinstvata, stanovite i zemjodelskite stopanstva vo Republika Makedonija, 1994 godina, Vkupno naselenie, domakinstva, stanovi i zemjodelski stopanstva, Skopje.

Law on Nature Protection. Official Gazette of RM 67/200.