Project name: Preparation of Feasibility Study and Study of Environmental Impact Assessment for the road M-17.3 Buna–Neum, Section Neum–Stolac

Phase: **Environmental Impact Study (EIS)**

Client: Public company Road Directorate of Federation of Bosnia and Herzegovina

Contractor: Roughton International in association with TRL Ltd, United Kingdom and Energoinvest, dd Sarajevo, Bosnia and Herzegovina

Team leader: Belma Čongo, B.Sc.Arch.Eng.

Other members: dr. Izet Čengić, B.Sc in agronomy
mr. Arifa Fetahagić, B.Sc.Techn.Eng.
Amela Vražalica, B.Sc.Arch.Eng.
mr. Nermina Mujezinović, B.Sc.Arch.Eng.
Ivan Buntić, B.Sc. in Biology
Kerim Hasanagić, B.Sc.Civil Eng.
Suada Pamuk, B.Sc.Geol.Eng.
Munira Ademović, B.Sc.Techn.Eng.
Amra Cerić, Prof. of Biology

Translation: Aida Mukić, Prof. of French language and literature

Graphic processing: Dženita Mesić, B.Sc. Arch.Eng.
Vedran Mujanović, civil techn.
Damir Hamza, arch.techn.

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NON-TECHNICAL SUMMARY

Problems of environmental protection for the planned main road M-17.3 Buna - Neum, section Neum - Stolac have been analyzed as part of a special study documents (Feasibility Study), at the level of content of previously done Previous Environmental Impact Assessment and, at the present stage, Environmental Impact Study.

The construction of modern road would enable faster and better access to the sea in Neum. The proposed project of the future road would have also interstate importance, because it would shorten the path to the Dubrovnik region. For the population in this area, the construction of modern road, is of multiple significance, particularly to encourage and improve the development process and urbanization of settlements.

Whithin the Environmental Impact Study, it has been analyzed the natural resources, their structure and use values. It has been analyzed also environmental-ambient features, cultural - historical heritage, then the energy, transport and industrial infrastructure.

With the analysis of these elements, it has been made two sets of synthesis maps; the first set represents the existing status and potential impacts, and the second set are maps with mitigation measures of negative impacts.

DESCRIPTION OF THE PROJECT

The future main road alignment extends to a length of 38.3 kilometers, and given that it is in various stages of design and implementation, the entire alignment can be divided into three sections. The first section is on the line Stari Neum - Kiševo (approximately 3 km), which is currently under construction, the second section is on the line Kiševo - Broćanac (approximately 8.5 kilometers), for which is done the Main design and the third section is Broćanac -- Drenovac (approximately 28 km) for which the Preliminary design is almost at the end of preparation.

Start of the alignment (first section) is defined at the crossroads of the old road to Metković and existing main road in Stari Neum. Immediately after this, it is completed integration of the new alignment to the existing road, which leaves the corridor of this road and diverges left across downhills of hill Žrnjevo, bypassing the existing facilities. At this line, the road alignment is in the significant cutting. At the beginning of section (km 0 +220) is located crossroad through which the existing road is connected to the new main road.

After this initial cutting, in the further course, the alignment was carried out in mild notch and light fall of grade level, by slope above Vranjevo village, without disturbing the village. At the site of nearest contact with the village, the alignment is carved in small rocky ridge, which is suitable from the standpoint of protection against noise.

In the further course, the alignment was carried out on the significant cutting of slope on the edge of "field" Blace, and then, by a large embankment bypasses a branch of aforementioned field, crossing in the notch on the other slope. Although it is a relatively large embankment, but its position is selected so that in the ambient sense, it "blends" with the slope on the edge of the field. To broke the monotony of a large side slope of the embankment, on half of its height some bermes have been made, which would eventually need to form vegetation, and also have an important role in the stability of embankments.

Continuation of the alignment is carried out by alternate cuttings and embankments with some significant rise going to a small plateau, where the grade level reached the required height, so that until the end of the section, the alignment grade level is carried out in a small rise.

In the situation sense, it is important to note that the alignment has been carried out by slope below Kiševo village, by rim of one more cultivated karst sinkhole, without direct cutting of the same (which is also occasionally flooded), in order to not ruin the ambient, i.e. preserve the fertile land.

The alignment at the end of the section is set so that in the sequel, by one right curve radius, is passed to the next valley, where begins the second section.

The second section can be divided into four specific sub-sections.

The first sub-section includes a part from Kiševo village up to the curve.

The second sub-section is from the curve up to Babin do village.

The third sub-section is from Babin Do settlement up to Oštrovac tunnel near Dobrovo settlement.

The fourth sub-section is a section from Oštrovac tunnel to Broćanac, which develops in a large radius on the slope above the village Dobrovo, and further following slightly rolling terrain to the end of the section, which is located in the embankment and the notch.

The third section begins at the end of section Kiševo-Broćanac, ending in front of the settlements Broćanac at level 220.00 m. By mild longitudinal slope, the alignment leaves the small valley of Broćanac settlements and by the rise it arrives to the curve Hadžibegov grad. The alignment overcomes the curve by a tunnel and descends down the slope above strip track formation in the valley of Hutovo settlements.

Upon crossing the valley and the strip track formation by right slope, the alignment climbs to the plateau Cerovica - Crnoglav. On the plateau, it uses a corridor of old road.

From Cerovica point, the designed road advances right from the air line that connects the beginning and end of the alignment to the ridge Stražnica, Meteri and Crnoglav. In

this part, the alignment is farthest from the air line which connects the end-points of the alignment.

In succession, the designed road climbs to the plateau Kadića, Dubrava-Cerovica, at the direction of air line of end points of the section.
After crossing the plateau, the alignment descends by longitudinal slope to the end-point of the existing road that leads towards the town of Stolac.

The section, as well as the alignment, ends within a little less Drenovac, and at the point of beginning of the section Drenovac-Masline of the main road M-17.3 bypass of the town of Stolac.

Basic technical characteristics of road are:

- Calculating speed 60-80 km/h;
- Roadway width 2 x 3,25 m;
- Width of marginal strips 2 x 0,30 m;
- Width of shoulders 1,00 m;
- Traffic motor two-way.

DESCRIPTION OF ENVIRONMENT
The main road M-17.3 Stolac - Neum is planned in the length of 38.3 kilometers and passes through the corridor where there is currently a road of regional character, unsatisfactory technical features.

Area, where it is foreseen implementation of the project of the main road M-17.3 Stolac - Neum, represents a stable karst terrain, where alternate Mediterranean and sub-Mediterranean climate, with a large amount of solar insolation. It includes a small amount of precipitation, higher average annual temperature regarding continental regions, long vegetation period, but greater windiness. All this had impact to the development of vegetation specific for this area.

Vegetation is represented by the character xerothermal on karst background with appropriate characteristics associated with sub-Mediterranean and Mediterranean climatic influences. Eumediteranean zone includes a narrow part around Neum, and makes it communities of always green forests and maquis, holm oak and its degradation stages. The sub-Mediterranean zone occupies the largest areas with its appropriate forest communities. Climazonal vegetation consists of trees and underbrushes of downy oak and hornbeam, within which appear more communities, depending on the degree of degradation. All grassland communities are originally diverse, and classified in a number of associations and facies.

Fauna mainly consists of small and medium-big game, and a large number of birds that seasonally reside in this area, but a significant number of species that are retained during the whole year. Due to the proximity of Hutovo Blato, many groups of amphibians and insects that are considered very important link in the chain of specific ecosystems represented in the wider area of the proposed project.

Geological analysis confirmed that the entire alignment passes through the typical karst terrain, which is characterized by large water permeability. Visiting the site it has not observed any surface flows in the area of the future road.

Since this area of road line M-17.3 Buna - Neum is without industrial pollutants, which reflects directly on the quality of air, here dominant role in air pollution has traffic. However, having in mind that this is a road alignment with very low frequency of vehicles, it can be considered that the air in the area of operation is relatively clean.

Microregion, through which passes the road section considered, is extremely rich with cultural and historical heritage of different type, functional type and chronological determination.

In a wider scope of the alignment, which includes territory related to close geographic-regional and historical- cultural features, there are 35 *national monuments*, and, a large number of *registered* assets of heritage, diverse in character. In this area - which is the subject of our general reviews – we find the assets of architectural, archaeological and sepulchral heritage; registered as *individual monuments* (historic buildings and archaeological monuments), and monumental unities (archaeological areas, architectural, natural and architectural and historical entities).
A large number of archaeological and historic areas is multilayer and, to them, there are material remains from several periods.

For the whole general area, there is characteristic and specific landscape, which, for centuries, was the physical environment to create a separate regional expressions. Vernacular and rural units of this area have a special expression and seal, characterized by dry stone walls, the walls of rubble, reservoirs, olive-wood, white, rustic lime surfaces, stone cover, etc. These ensembles represent a particular value, given that this is an authentic expression, which is quite typical for this area, and extremely well integrated in the natural environment.

By analysis of wider coverage in the project corridor, it is showed that the alignment does not threaten directly the natural values. Specifically, Hutovo Blato is outside of influence.

Corridor of the future main road passes through mostly rural areas of the municipality of Stolac and Neum, except in the area of Stari Neum, which is considerably more urban.

IDENTIFICATION AND ANALYSIS OF IMPACT

According to available data, various positive effects of construction and use of main road M-17.3 Buna - Neum, section Neum - Stolac have been identified. The construction of the future leg will increase degree of the availability and interconnection of some settlements, but its most important positive impact is to connect our only way out to the sea, with the rest of the country, which will disburden the existing route via Čapljina and Metković, and thereby provide a high quality way to the sea without crossing the border. Each project on the land itself may produce a negative impact on the environment. However, most of the possible negative impacts, particularly during the period of construction, are of the low intensity of the current and local character. In Environmental Impact Study, the possible negative impacts on the environment were identified and analyzed, and so in order to minimize and mitigate them, it has been proposed some appropriate measures. Results of the analysis are given in the following tabular view.

REVIEW OF NEGATIVE IMPACTS DURING CONSTRUCTION	
Impact	**Prevention, reduction or mitigation of negative impacts**
On population and settlements ▪ As the most important impacts on material resources of the local population, there are those that relate to individual buildings in the area included by the project. ▪ Communication and infrastructure facilities could be cut. ▪ Operation of construction machinery and means of transportation, which are used for transportation of construction material, causes increasing the noise level and vibration of soil. ▪ Decrease in air quality due to operation of construction machinery, which makes smoke and dust and emits gases . ▪ Transportation of construction materials will impede traffic.	▪ If the facilities that are located in the zone of operation cannot be avoided, it is necessary to provide fair compensation for the same. ▪ It is necessary to avoid a maximum of infrastructure facilities to ensure easy communication of local population. ▪ Other preventive measures are covered by other aspects of environmental protection.
The significance of impacts: **significant**	
On micro-climate ▪ Roads with its construction will not affect the change of micro-climate of the area through which it passes.	▪ Mitigation measures are not necessary.
The significance of impacts: **negligible**	

On waters ▪ Surface waters are not registered, and they do not come into collision with planned road. ▪ Construction works (blasting, excavations, destruction of top layer and etc.) may disturb some natural lines of feeding, and with removal of top layer and creation of some new catchment areas, stir up or otherwise polluted water can quickly drain into the underground. ▪ Possible environmental incidents caused by accidents in road transport of chemicals, liquid fuels, lubricants and other hazardous substances.	▪ It is necessary to carefully store and handle with all motor oils and fuels, as well as other waste material. ▪ To organize the Site with the goal of minimum encroachment in the area out of direct operation of the road. ▪ To apply a special way of mining in order to not disorder underground water flows. ▪ Municipal and hazardous waste created during construction in the site zone should be disposed in a prescribed manner. **General measures** Investor / user is required: ▪ To comply with all relevant legislation. ▪ To monitor and control all activities in the field of water protection. ▪ To establish adequate trained and equipped emergency response teams. ▪ To arrange regular monitoring of the quality of surface and groundwater (monitoring). ▪ To store and analyze data obtained by measurements, take the necessary actions in case of exceeding the allowable emissions. ▪ To send monitoring reports to the competent authorities and inform the public about the state of water quality. **Special measures** ▪ Require to perform permanent controls in the course of construction works. ▪ In the contract documents, which the Investor will form with Contractors it should require explicitly implementation of protection measures for waters, which are determined by the environment impact study. ▪ In the tender documents for the works to require from the bidder to demonstrate that

	his company has a service for environment protection, which will ensure the enforcement of environmental protection requirements, which will be prescribed by environmental permit. **Technical measures** ▪ Owner of building (Investor), must ensure that the Contractor will perform the construction with an appropriate machinery and in accordance with the adopted dynamic of works, to comply with the approved design documentation, and to comply with all statutory regulations. ▪ Owner of building (Investor), must ensure adequate construction, geotechnical and hydraulic control of works and insist on the prescribed controls of performance and quality embedded material. ▪ Owner of building (Investor) through the supervisory authority must control that on the site mechanical service of machines or storage of fuels and lubricants does not perform. Fuelling should be supervised to ensure prevention of penetration of possible fuel spills into the ground (laying of impermeable polyethylene sheeting on the ground during decating), and the means to neutralize the possible fuel spills. ▪ Excavated material shall not be used for construction, it must be disposed to a specialized location. ▪ During construction it should organize regular health control of all employees and take all necessary sanitary measures with continuous monitoring inspection services and water supply, to prevent water pollution. ▪ During works it should monitor the status of water quality, according to the monitoring program. ▪ In order to not disturb hydrogeological relations in the underground, it is necessary to control the realization of phase blasting, to avoid seismic shocks too big, blasting should be carried out with an electric phase igniter with relay. ▪ Used water from the site to accept by safe system of sewage, collect in appropriate

	tanks and scrub in the prescribed manner (either on the spot, whether at the distant location), and prior to discharge into the recipient. ▪ At the site locations for needs of workers, to provide ecological toilets. ▪ Restrict the repair of machinery, as well as change the oil in areas of high risk of water pollution. ▪ Provide areas with impermeable base for the storage and servicing of machines, beyond the area defined as a zone of high risk of water pollution. ▪ Oily storm water from this areas to be collected and purified on sand /grease separator before discharge to the recipient. ▪ In the case of accidents, it is necessary urgent intervention in accordance with the operational plan of emergency measures in various accident situations.
The significance of impacts: **significant**	
On soil and agricultural land ▪ Damages to the soil in order to establish the construction site, warehouse, depot, settlements. ▪ Contamination of soil with chemical pollutants because of inadequate storage or inadequate use of chemical means. ▪ Damages or permanent loss of the soil as a natural resource because of placing of the project alignment in the area where there are good quality soils. ▪ Damage to the agricultural productive area and decrease of product quality	▪ Realization of all positive legislation envisaged measures with the use of modern technology. ▪ Proper use of chemical means with implementation of the prescribed measures of protection and avoiding of using dangerous means or their complete exclusion from use during construction or an adequate replacement with less hazardous means. ▪ Placing of the alignment in the area with lower categories of the space usability, where soils of less production capabilities are presented. ▪ Increasing protection plant zone between the road and agricultural areas. ▪ The choice of cultivation methods and crops that will be adapted to the new situation. ▪ To be brought under control impacts on land, and other media, it is particularly

	important to monitor waste streams, which is especially important during the construction of roads
The significance of impacts: **significant**	
On forests ▪ Damages to trees. ▪ Cutting trees. ▪ Fires.	▪ Realization of all, the positive legislation envisaged measures, with the use of modern technology.
On flora and vegetation Impacts resulting from: ▪ Establishment of the site , workplaces and landfills, which will be manifested through a reduction in the number of populations and areas of particular plant communities. ▪ The effects of mechanization, which would disrupt the natural balance of the soil and restrict the growth of plant species. ▪ Impacts of wastewaters, which is reflected in possibilities of its further swelling, and contamination of underground waters, which leads to further degradation of plant communities.	▪ Prior to the commencement of construction it is necessary to construct the landfill and access roads and temporary parking spaces for machinery. The landfill must be provided in those places where it will be the least harm vegetation and habitats for animals ▪ Limit the load of wastewater in a wider area around the place of intervention. ▪ During construction it is necessary to supervise and consult with the specialized and trained staff. ▪ After the completed works the access roads must be repaired and construction and waste material must be removed from the landfill. ▪ Other preventive measures are covered by other aspects of protection.
The significance of impacts: **negligible**	
On fauna Impacts resulting from: ▪ Disturbance of habitats and reducing the migration of reptiles and other animals ▪ Emission of exhaust gases and dust during and after construction. ▪ Also, some natural breeding places and watering places are often endangered.	▪ The measures taken to protect flora apply also for the protection of fauna. ▪ It is very important that during construction to provide temporary breeding places and watering places for animals.
The significance of impacts: **negligible**	

On landscape ▪ During construction ther will be a disturbance of visual perception of the landscape, but this impact is short-time.	▪ Included with other measures of protection from various aspects of environment protection in this study, and it is not necessary to single out them specially.
The significance of impacts: **negligible**	
On protected areas ▪ In the area that is planned for construction of the future road, there are not protected natural areas, which would be directly threatened by the project.	▪ Not required.
The significance of impacts: **negligible**	
On cultural-historical heritage ▪ During the construction of cultural and historical good in the field of operations could be directly affected by building the route, since the precise locations of archaeological sites are unknown.	▪ Detailed archeological recognition in the wider area. Depending on the reports of the results, and performance of trial-probe, and if necessary, protected archelogical excavations. ▪ Correction of certain section, which will eventually be made depending on the results of detailed archeological recognition / test investigations. ▪ Obligatory– continuous supervision of archaeologists and conservators in the wider area, and their permanent consultative participation during construction of certain section. ▪ Prohibited crossing of access roads, waste disposal and stationing of heavy equipment on the site. ▪ Adjusting of operation technologies to the situation on the site and undertaking of protection measures against all factors that can adversely affect the matter or change its properties. ▪ Prohibited crossing of access roads, waste disposal and stationing of heavy equipment on the site. ▪ Obligatory– continuous supervision of archaeologists and conservators in the wider area, and their permanent consultative participation during construction of certain section

	▪ Monitoring –observation of any anomalies caused by work execution ▪ The investor is obliged to inform the appropriate institution about any newly discovered archeological site. ▪ Dislocation of the route -in case of physical destruction or endangering core values of cultural assets. ▪ Relocation of cultural assets-for all cases where this is possible without endangering the core values of cultural goods. ▪ Protection of cultural assets at site-for all cases where the cultural assets and its core values are possible to protect by special measures at the existing location. ▪ Research and documentation of cultural assets-measures to be implemented for all the endangered cultural assets, and including the conservation of movable archaeological finds from the affected sites and zones.
The significance of impacts: **negligible**	
On air quality ▪ Operation of machinery, blasting of rock mass and laying of asphalt concrete and smoke formation. These impacts are of limited scope and exist only in the performance of works.	▪ To use the blasting holes it is necessary to use a drill with collecting dust in plastic bags. ▪ During construction works in dry period to use tanks for spraying with water to reduce the emission of excessive dust. Also, exit to a public road from the wheels must be removed mud formed by dust. ▪ During transport of soil from excavation and asphalt mixtures to use tarpaulins for covering goods in order to reduce the emission of gases and dust.
The significance of impacts: **negligible**	
On noise level ▪ During mining and operation of construction machines it comes to increase of noise level.	▪ To carry out proper selection of construction machines and vehicles, i.e. machinery that will burden, as less as possible, the environment with noise.

	▪ Construction activities should be planned so that parallel activities of multiple devices near the receiver are avoided. ▪ Mining should be carried out at specific time intervals and according to the relevant regulations and standards. ▪ In case of exceeding the allowable values, to provide workers with protective equipment at work and to apply occupational safety regulations.
The significance of impacts: **negligible**	
On infrastructure ▪ Regulation of traffic in case of disruption of traffic on existing roads.	▪ To provide a temporary solution for the flow of traffic during work execution. ▪ It should provide repair of local roads after its exposure to construction vehicles and machinery.
The significance of impacts: **negligible**	
Environmental Accident ▪ As a result of natural disasters that may occur in the form of floods and earthquakes.	▪ It is necessary to make the Operating plan for emergency measures, and comply with it if necessary

REVIEW OF NEGATIVE IMPACTS DURING OPERATION	
Impact	**Prevention, reduction or mitigation measures of negative impacts**
On population and settlements ▪ There is no negative impact.	▪ Mitigation measures are not needed.
The significance of impacts: **negligible**	
On micro-climate ▪ There is no negative impact.	▪ Mitigation measures are not needed.
The significance of impacts: **negligible**	
On waters ▪ Negative impacts occur as a result of contaminants able to penetrate into the underground water flows, and sources, as a result of environmental accidents on the	▪ General and special protection measures are equal in construction and operation phase of the road, which means that they are already listed above.

roads and storm water from the pavement that may not be released untreated.	**Technical protection measures** ▪ In areas of high risk of water pollution it should be carried out very rigorous measures and conditions of purification of pavement wastewater with the use of project solutions that include a closed drainage system. Conduct a complete drainage of pavement wastewater ▪ In the open part of the section,it is necessary to design vertical barriers (guard rails or concrete blocks-New Jersey), to protect vehicles against skidding outside of controlled corridor. ▪ In areas of moderate risk of water pollution to implement less stringent measures of protection, noting that this does not exclude a mechanical wastewater treatment in grease separators. ▪ It is necessary to develop appropriate operational plans at the stage of operation and maintenance of the road.
The significance of impacts: **significant**	
On soil and agricultural areas ▪ The negative impact occurs by accumulation of physical and chemical pollutants in and on the ground.	▪ Realization of all, positive legislation envisaged measures and regular monitoring and maintenance of such sites. ▪ Realization of, by the project foreseen, physical barriers in areas of conflict or the implementation of biological barriers. ▪ Transportation of hazardous cargo with accompaniment.
The significance of impacts: **significant**	
On forests ▪ Damages to trees. ▪ Cutting trees. ▪ Fires.	▪ Realization of all, positive legislation envisaged measures with the use of modern technologies
On flora and vegetation ▪ Plant communities will be affected the impact of exhaust gases.	▪ They will be provided through other protection measures.
The significance of impacts: **negligible**	

On fauna Negative impact will be reflected through: ▪ Violation of natural habitats, as well as reducing the possibility of migration. ▪ Due to exhaust gases.	▪ Construction of passage that will allow the movement of animals. ▪ It will be provided through other protective measures.
The significance of impacts: **negligible**	
On landscape ▪ Applied technical elements of the alignment are mutually conformed, so the overall appearance of the alignment is attractive.	▪ There is no need to implement protection measures
The significance of impacts: **negligible**	
On protected parts of the nature ▪ The area that is planned for future construction of the road does not have protected natural areas, which would be directly threatened by the project.	▪ Not required.
On cultural-historical heritage ▪ The possibility of harmfull impacts of motor traffic on material of monuments, by physical, physical-dynamic or chemical mechanisms of action.	▪ Monitoring- observation of dynamic effects of motor traffic, and air quality changes, and regular inspections by competent protection services. ▪ Gradual recultivation with autochthonous vegetation, general revitalization of the environment, forming of "green barriers“.
The significance of impacts: **negligible**	
On air quality ▪ Air pollution caused by components that are products of combustion resulting from the operation of internal combustion engine.	▪ It is not necessary to implement additional protection measures
The significance of impacts: **negligible**	
On noise level ▪ Increase of noise level resulting from the use of the road.	▪ Protection measures during use are not necessary.
The significance of impacts: **negligible**	

On the urban area ▪ Possible negative impact on the urban area may occur if uncontrolled connection to the main road does not prevent.	▪ Respect the prohibition of construction in the protection zone. ▪ Restrict connection to the main road and physically prevent connection by setting fence, greening beside the road, drainage ditches, dikes, etc.
The significance of impacts: **negligible**	
On infrastructure ▪ There is no negative impact on infrastructure during use of the road.	▪ There is no need to implement protective measures
Environmental Accident ▪ If the planned protection measures during the use proves unsuccessful ▪ In case of accidents of vehicles transporting hazardous and dangerous substances (chemicals, fuels, etc.). ▪ As a result of natural disasters that may occur in the form of floods or earthquakes.	▪ If there is a damage to the vehicles that carry some hazardous goods in powder (granulated) state, it should stop the traffic and submit a request to a specialized services, which should carry out an operation to remove the hazardous cargo and cleaning up of the road. Bulk granulated materal must be removed from the road only mechanically (by returning to the new appropriate packaging, by cleaning, suction, etc.), without rinsing with water. ▪ If there is a damage to the vehicles with liquid hazardous materials, it should stop immediately the traffic and engage a competent specialized services for repairing damages. Spill material is removed from the road with special sorbents. If the liquid reached out of the profile and contaminated the soil, remediation is done by its removal. All material collected in this manner are treated according to special procedures of regeneration or deposited on landfills foreseen for such material. ▪ The lanned road is required to equip with the appropriate horizontal and vertical signalization, which includes all aspects of the required prohibitions and notices in the areas of potential water pollution (zones of high risk of contamination). Traffic signs have an impact on the participants in traffic, transporting hazardous materials in a manner to reduce speed limits, prohibit

	passing a truck, to increase the level of attention and prohibit stop of vehicles on the road.

MONITORING OF THE ENVIRONMENT

Given the possible potential negative impacts identified during construction and use of the planned road, it is necessary to monitor and analyze the state of the basic components of the environment that has proven to be exposed to negative impacts. To be able to observe any eventual changes, it is necessary to establish an environment monitoring system. The basic role of monitoring the environment is consideration of the effects of mitigation measures and the introduction of necessary improvements and corrections. In the context of the above said, it is necessary to have a previously observed zero status of environment quality.

Soil and agricultural land area – it is necessary to carry out additionaly a complete analysis of the state of physical and chemical properties of the highest quality soils.

Forests and forest land area – it is necessary to define the character of the forest communities and its economic categories, and to define the sensitivity to harmfull impacts.

Flora and fauna - before the work, it is necessary to determine the size of populations of rare, endemic and endangered species of plants and animals, and game migration routes.

Water - it is important to establish the existence of sources and springs, which are in the supply system of the surrounding villages. Observation during the construction phase should be carried out at the source of Blace, due to the potential impact of used equipment and human factors on groundwaters. After putting the road into operation, it is necessary to carry out the control of water for drinking in the same source.

Monitoring the environment during road construction, in aspects of cultural and historical heritage, should be performed in positions where - due to technical and technological needs of work execution, there is a possibility of physical damages, movement and deformation of structure of monuments. Monitoring the environment during the course of traffic should be made to positions where there is a possibility of negative impacts of the motor traffic on material of monuments, where the potential causes of damages are of physical, physical-dynamic or chemical nature.

DESCRIPTION OF ALTERNATIVES

An alternative to construction of the main road M-17.3 Buna - Neum, section Neum - Stolac in the considered area, means its non-construction. Scenario "without project" would not change the current road route, which is characterized with a very modest

technical characteristics, which make worse over time. Positive effects of construction of the main road can be expected during its operation period.

Since the project is analyzed at various stages of design and implementation, the whole alignment is divided into three sections. The first section is in the stage of execution, while for the second it is made the main design. For the third section, it has been considered two alternatives (blue and red), of which the first option (blue) with its sub-alternative. By analysis of alternatives from all aspects, it comes to the conclusion that the blue alternative is most favorable.

Considering that construction of the future main road, with undertaking of all prescribed measures with the aim of protecting the environment will not have negative impacts, the alternative of non-construction is not acceptable.

CONCLUSION

Whithin the Environmental Impact Study for the road M-17.3 Buna - Neum, section Neum – Stolac, it has been analyzed data from the physical planning, civil-technical characteristics of the planned road and features of the environment of inner areas of the road, and where needed, wider. After that it has been assessed the potential negative and positive impacts that may appear upon construction of the future main road, as well as measures that can prevent the negative effects or mitigate.

For analysis and assessments of the direct impact of the road on the environment, it has been considered the area of corridor and namely from 0 to 100 meters on both sides from the road belt. Wider area of impact from the above mentioned corridor is treated in a part of the Previous Environmental Impact Assessment.

By impact analysis during construction of the road and during its operation period, on the individual component parts of the environment, all the negative effects of construction of the main road M-17.3 Buna - Neum, section Neum - Stolac will be removed or reduced to the minimum, with strict adherence to the proposed measures for protection of the environment and providing of environment monitoring, and it can say from this side that the planned project will not have a significant negative impact on the local area on the subject site. In addition, it is estimated that the project will have a positive socio-economic impact on the region in which it is located.

1 INTRODUCTION

Project of the main road M-17.3 Buna – Neum, section Neum – Stolac, is made in order to build and improve the quality of road network in Bosnia and Herzegovina, which is, in the past war, heavely damaged.

The first phase of activity relates to the preparation of Previous Environmental Impact Assessment, while the second phase in the project, relates to the development of Environmental Impact Study.

In the Environmental Impact Study it has been considered as follows, all the impacts, starting from impact during construction period, but also during operation period. These impacts include impacts on climate and hydro network, air and noise, then natural and cultural - historical heritage, flora, fauna and landscape, but as a very important issue considering the issue of geology, and land properties on the proposed alignment. As important aspects, it takes into consideration also the impacts on population, existing infrastructure, etc.

By the construction of this road, it certainly would enable faster and better way to our only outlet to the sea, to Neum, which would certainly have significant influence to the development of tourism, otherwise a very important branch of economic development of Bosnia and Herzegovina. Also, the road should facilitate access to some objects of cultural and historical heritage, which there is a lot on this line (Buna, Radimlje, Stolac, Počitelj), and which significantly contribute to the development of tourism. Considering that this road will use those which destination is Dubrovnik region, we can say that the same will be a part of an international network of roads.

1.1 Basis for realization of Environmental Impact Study

According to requirements of Tender documentation and Terms of Reference for preparation of the Feasibility Study for the road M-17.3 Buna - Neum, section Neum - Stolac, for examination of all relevant parameters related to the environment, it has been foreseen the preparation and specific study documentation on the level of the Environment Impact Assessment Study.

Environmental Impact Assessment (EIA) aims to identify and assess actual and potential impacts of the planned future road construction project on the environment and to propose appropriate measures to mitigate negative impacts, which would take into account when designing, building and use of the procedure, in order to achieve a high level of environment protection. Analysis and evaluation of existing environmental conditions and possible impact assessment that is consequence of the road construction, show that it can get to the unambiguous quantified data only on the basis of comprehensive analysis.

Environmental Impact Assessment for the above project was done in two phases:

- Previous Environment Impact Assessment
- Environment Impact Study.

The Previous Assessment determines the need for full implementation of EIA procedures and the development of Environmental Impact Study (EIS) for the project of main road M-17.3 Buna - Neum, section Neum - Stolac.

Project documentation with graphics, on the basis that the Previous Assessment is made, was in the scale 1: 25 000. Subject of the Previous Environment Impact Assessment, having in mind that this is an early stage of design, was wider spatial coverage of primary corridor. It has been considered two possible alternatives including the zero alternative - without intervention.

Project of the main road, on the basis of Art. 3. and 4. of *Rules on facilities and plants for which preparation of the Environment Impact Assessment is mandatory and facilities and plants that can be built and put into operation only if they have environmental permit* (Official Gazette of Federation BiH ", no. 19/04), is in the list of those for which the Environment Impact Assessment is mandatory, before the issuance of environmental permits. The procedure of Environment Impact Assessment of the project involves consultation with the public, business people and community activists, elected leaders and NGOs. Whithin the procedure of Previous Environment Impact Assessment, and in accordance with Art. 36. of Law on Environmental Protection, the documentation for the Previous Environment Impact Assessment for preparation of the Feasibility Study and the Environment Impact Assessment Study for the road M-17.3 Buna - Neum, section Neum - Stolac was available to all interested parties on the website of the Federal Ministry of Environment and Tourism (http://www.fmoit.gov.ba).

By submitting the decision on preparation of Environment Impact study number: UPI/05-23-77/09 of 08.06.2009., which is given in the appendix, it begins the realization of the same.

Environmental Impact Study was prepared at the same time creating a Preliminary design which allowed the environmental requirements to fully incorporate into the project.

1.2 Legislation

Environmental Impact Study was prepared in accordance with the obtained Decision, applicable legal provisions and appropriate relevant regulations, which were created some of the legal assumptions in the broader domain of environment, and have a certain significance for the interpretation of the relationship arising from the construction and exploitation of the planned road. Used legislation, which is still in force in the Federation of BiH, is given in the chapter of Data Sources.

1.3 Metodology of EIS preparation

Problems of environment protection for the planned road M-17.3 Buna - Neum, section Neum - Stolac, were analyzed within the specific study documentation on the level of contents of Previous Environment Impact Assessment (PEIA), and the final Environment Impact Study (EIS). Study documentation was prepared in accordance with statutory legislation of the Federation of BiH (Law on Environment Protection, Official Gazette of F BiH, no. 33/03).

The whole problem was analyzed in the framework of some special units that include the basis for the research, characteristics of the planned road, characteristics and evaluation of existing conditions, a complex analysis of the impact on the environment, the necessary measures to protect the environment and a description of alternative solutions.

Subject of the Previous Environment Impact Assessment, having in mind that this is an early stage of design, and that considered alignments were not at required level of technical elaboration, was wider spatial coverage of primary corridor. It has been considered two possible alternatives including the zero alternative - without intervention. According to the results of the analysis of relevant impacts, it was possible to make a conclusion that some impacts are present for all analyzed alternatives. Based on the analysis of possible impacts and the necessary protection measures, it has been carried out the evaluation of alternative corridors on the basis of synthesis map of limits.

The aim of the previous environment impact assessment was a consideration:

- environment states of the considered road,
- Identification of potential impacts on environment and possible loss of quality of the environment,
- Identification of those impacts that must be avoided due to legal requirements or valuable qualities of natural and cultural-historical heritage,
- Mitigate the impacts of those that there is no the obligation to avoid, but there is a professional assessment that those mitigations are environmentally justified.

Environment Impact Study (EIS) for the said project is made on the basis of the Decision on drafting of Environment Impact Study, No. UPI/05-23-77/09 of 08.06.2009. issued by the Federal Ministry of Environment and Tourism, and to manage further proceedings on the environment impact assessment for the purpose of issuing environmental permits. EIS is made for the adopted alignment and timely is adjusted to develop Preliminary design for the planned road.

EIS preparation is based on several related activities, which took place in several phases:

- Preparation of research, which included the organization of the working team (different experts for environment), the organization of site visit, defining of methodology for obtaining the necessary data from primary and secondary sources and a detailed work plan on the EIS;
- Consideration and analysis of input data from physical planning documentation;
- Collection and analysis of all data relevant to the issues of environment necessary for making EIS;
- Making two sets of synthesis maps in scale 1:5000; the first set presents the current situation and potential impacts, and the second set are maps with mitigation measures of negative impacts;

Approach and methodology of the EIS preparation are based on the analysis of data from primary and secondary sources. Data from primary sources is collected during the field part of research, and apply to all research.

Analysis of secondary sources has included collecting and analyzing of available data and information from public companies and institutions relevant to the state of the environment, and data from earlier made studies, programs and plans, in order to base EIS preparation on the relevant data.

Description of the environment that could be threatened by the project is done from various aspects: socio-economic, climate and meteorologic, geomorphologic, geological, engineering-geological and geotechnical, hydrological and hydrogeological, pedologic and agriculture, flora and fauna, forestry and hunting areas, landscape, protected areas, cultural and historical heritage, population and populated areas, infrastructure, state of noise and air quality, endargement by mine-explosive materials.

As a result of activities in future road construction were identified, analyzed and evaluated the positive and negative environmental impacts for the construction phases and road use as well as direct and indirect impacts on: population, climate, water, soil and agricultural land, flora and fauna, ecosystems, landscape, cultural and historical heritage, hunting, air and infrastructure.

Analysis of the impact of the planned road on the environment is shown that, given the nature of impact and its importance, it can consider that the construction of the road causes the positive and negative impacts on the environment as a result of the construction of its physical facilities, construction activities and use.

Measures to mitigate the negative impacts include a wide range of necessary activities within each of the analyzed impacts and in the construction phase and operation period of the road. These measures are systematized into two basic groups: general and technical mitigation measures of negative impacts on the environment.

Considering some possible potential negative impacts identified during construction and road use, a methodology for EIS preparation foresees the adoption of monitoring program of long-term impacts of road construction on environment and proposed measures for environment protection. The purpose of monitoring is surveillance of polluting emissions (in the air, water, soil....),and changes of environment parameters (air quality, noise levels, groundwater quality, changes of soil quality). Monitoring system aims to check all systems of which depends on the quality of the environment (treatment of wastewater that is collected on the road, maintenance of these devices, the regularity of action in case of accidents - spills of chemicals on the road and similar. On the basis of results of the monitoring, it undertakes some additional organizational or investment measures.

Environment and accidents that occur, are interrelated so that the degradation of the environment influences on natural processes, changing the basic human resources and increases their vulnerability. In this sense,the Environment Impact Study foresees some extraordinary conditions and risk of inadequate protection measures, risk of some accidents during the construction and maintenance, risk of accidents in the transport of hazardous goods, risk of natural disasters.

Although the probability of events of these accidental situations are usually small and is in the function of several factors, the consequences thereof are substantial and serious, which is actually the reason for the analysis of this impact in the process of environment impact assessment of the road.

2 DESCRIPTION OF THE PROJECT PROPOSED

2.1 Objectives and purpose of the Project

Road route M-17.3 Buna - Stolac - Neum is characterized by a very modest technical characteristics, the most important of which are the following: width of roadway between 3 and 5 meters, with a sharp horizontal and vertical curves, sporadic large longitudinal slopes (even at 15%), without continuity in the horizontal leading of the alignment and with inadequate drainage solution.

In addition to these technical shortcomings, the existing alignment, in terms of position, presents a concept that is contradictory with contemporary solutions and requirements that road of this level should meet. Because the existing road was built on the alignment of the former macadam road, paved and widened in places, passing through the centers of small urban areas, cutting the most fertile terrain in this area. It is clear that the road can not satisfy contemporary traffic, required capacity and level of service. This type of road can be classified only in the ranking of local roads. For these reasons, it can be concluded that the construction of main road M-17.3 Buna - Neum, section Neum - Stolac is justified and that it has a priority, taking into account the improving level of services of road users, the requests for improvement of the socio-economic development and increase of safety in traffic.

The main objective is to build a main road Neum - Stolac, in order to improve the system of transport infrastructure as one of the factors that affect the economic, social and spatial development of individual regions and even country.

The analyzed project will allow better and faster access to the Bosnian only outlet to the sea, towards the town of Neum, which has significant development plans that imply quality road access. In addition, the purpose of the project is to enable better linkages between the interior of Bosnia and Herzegovina and the Adriatic coast, which will get more benefits, such as avoiding customs-administrative procedures, etc.

Improvement of transport conditions should affect the quality of life which will be manifested through: a) savings in travel time for passengers and the transport time for goods compared to the existing road, b) reduce the costs of goods and passengers,
c) evaluation of geo-traffic position of BiH, d) cost savings resulting in accidents compared to the existing travel route, e) mitigation of negative environmental impact, by directing traffic to a new future road, which does not pass through the center of settlements and f) better conditions of transport services would have caused better living and work conditions of the local population.

All realized research studies, testing and findings indicate that the subject project will inevitably have an impact on the environment. However, with the implementation of prescribed environmental protection measures and the implementation of environmental monitoring, especially during construction, and with ready and rapid response to possible state changes of the environment, which would be demonstrated by monitoring

the parameters prescribed by the appropriate monitoring of the environment, we believe that the project is acceptable for the environment.

2.2 General description of the project

The road network in Bosnia and Herzegovina are: main, regional and local roads, whose total length of 22,501 kilometers. Thereof 3.750 kilometers is the length of main roads, 4.751 kilometers is the length of the regional, and 14,000 kilometers are local roads.

Considering the specific socio-political organization in BiH, the main roads are managed by entity companies for the road. Regarding regional roads, management competency is given to the cantonal directorates of roads or in the jurisdiction of the cantonal ministries.

As for the subject alignement M-17.3 Buna - Stolac - Neum, it has been for some time classified in the main direction, although technical road characteristics do not correspond to the rank of the road. Existing road, is characterized by a very modest technical conditions, which largely complicate flow of traffic on this section, and the frequency of vehicles is very low, with mostly dominated by heavy vehicles. Road direction Neum - Stolac extends the area of Neum and Stolac municipalities, mostly to their rural areas.

The main road covered by this project is long approximately 38.3 kilometers and is divided into three sections

1. Stari Neum – Kiševo, length of app. 3 km
2. Kiševo – Broćanac, length of app. 8,5 km
3. Broćanac – Drenovac, length of app. 27 km

For sections of Stari Neum - Kiševo and Kiševo - Broćanac, it has been made the Main design while the third section - Broćanac - Drenovac, Preliminary design is preparing. Making the Study of the adopted alignment is timely adjusted to preparation of Preliminary design.

The planned alignment of the main road M-17.3 Neum - Stolac, passing the southern region of Bosnia and Herzegovina, precisely Herzegovinian karst, and its construction would have no doubt, a great socio - economic significance. That would be the only route that would link Neum - our only outlet to the sea, with the rest of Bosnia and Herzegovina, which would avoid customs - administrative barriers for citizens of Bosnia and Herzegovina.

2.3 Data and spatial planning documentation of the considered area

2.3.1 Planning documens from the wider environment

Major infrastructure systems, such as the main road are important for the development of the area through which it passes, and in the period of planning and design, and especially in the period of construction and operation. They certainly should be

incorporated into spatial planning documents as the framework of area development. in the text that follows, we will mention the individual studies that are done for these communities, and who have the characteristics of insight into the characteristics of options and planning of area development.
In the meantime, we had the possibility of insight into the spatial-planning documentation made for the municipality of Neum. It is a Spatial plan of the municipality of Neum, completed in 1986 , and for the period 1985-2008, which summary follows below.

2.3.2 Planning documents at the level of municipality and other documents essential for the projectt

Municipality Neum

Development of urban areas of Neum community began in the seventies of the last century as a result of tourism development and positioning of Neum as a transit center in the line of the Adriatic tourist road between Ploče and Dubrovnik. There are essential documents of spatial-planning documentation:

- Spatial Plan of Municipality Neum, from 1986.
- Town-Planning Plan
- Master plan for settlements: Centar I and II, Surdup I and II, Jazine-Kamenice, Tanko-Sedlo and Opuće, Ograde and Bregovi.

These plans have been repeatedly updated and supplemented in accordance with legal regulations and requirements. Recently it has been made Neum Municipality Development Strategy (2006-2010), as a significant document with the considered possibilities of community and plans for further development. It has been recorded a problem of growing concentration of population in the coastal area of the municipality and some activities should orientate towards the hinterland. It has been given guidelines with regard to development for all areas and specific tasks of which is in first place the construction of this main road Neum-Stolac.

Municipality Neum – overview on Spatial plan (1985.-2008.)

-Settlement system-

- General characteristics of settlement systems -
Neum is one of the youngest and smallest municipalities. During the period when the spatial plan of the municipality is made (January, 1986.) the Municipality had 27 settlements with a total of 4507 people, divided in 5 local communities. It was formed as a rounded geographical, natural settlement and functional unit with the development trends and important role in future development. Coastal areas of the republic should be activated as a new natural resource for tourism purposes and to give the town of Neum role of carrier of the entire development. Projected dimensions of intensive economic

development of the Municipality and the town of Neum initiated the establishment of the first process of urbanization in this area, with some features such as:

- connections to the structure, the second system of settlements of coastal towns of Dubrovnik and Makarska riviera
- very low employment rate and the epithet of least developed community in the region, with a very low standard
- significant depopulation of this area during this period.

Neum is one of few towns that do not have city characteristics according to planning criterions, (min. 2000 population and the corresponding structure of employment). Town of Neum had 1100 habitants in 1985. that already had a formed physionomy of the town.

Considering size structure and genesis of the settlement of this municipality it can say that these are very small and underdeveloped settlements, with an average 0.17 st/ha.

-Social infrastructure-

The continued delay in the economic development of this underdeveloped municipality, permanent depopulation, low comunal and personal standard of living are certainly the main reason of the underdeveloped functions, content of total social standard. The first impulses of development of Neum coast - tourism is the beginning of state changes in the field of social standards.
It has been analyzed the following areas of social infrastructure:

- management and administration
- education
- health care
- children and social care system
- culture and physical culture
- trade and catering services.

Like most municipalities in BiH, the development of social infrastructure mainly followed the socio-economic development. But it is not at a satisfactory level at the moment of preparation of spatial planning documents. However, rational planning of social infrastructure has its own laws, requires a certain demographic size of the gravitational field.
Tourism and agriculture should be the main economic activities in this area.

-Long-term development objectives-

General objectives

In accordance with results of analysis of the situation and suppositions for future development, main basic objectives are:

- intensive development of socio-economic relations
- developing settlement systems in the municipality – intensification of settlements medium-sized
- development of the town of Neum
- stop the trend of emigration, especially the younger population
- development of the municipality in direction of development of touristic and its complement economies, as well as maritime economy in the coastal area, agriculture and food industry.

Special objectives

Frames of some particular and specific objectives and development of the municipality haves been indicated:

- formation of the central settlement of urban type with features of coastal – touristic town
- defining the position and role of the town of Neum
- establishing a network of settlements (in addition to the municipal centre) with a maximum of two central settlements
- directing the entire development of coastal area in the direction of tourism – commercial, sport – recreational capacity
- providing conditions for the construction of the property with facilities
- providing conditions for organization of sea fishing
- providing conditions for the protection and exploitation of marine flora
- improvement of agriculture
- development of infrastructure systems - transportation, water, energy, PTT networks

- Proposal of the concept of long-term development -

Population and settlement system

Population and birth rate in this area is very low, until this period (eighties), but this began to change with migration to urban areas. Birth rate began to rise. By the analysis of migration, it led to the knowledge that emigrations were performing by longer period to other areas because the area of Neum was unattractive. After the 80th - 85th it was changed and by the development of the city it began to change.

- Development of agriculture contribuated to the reduction of migration between village – town, which is very positive in terms of spatial shifts of population.

- For phyisical planning and organization and community development planning, forecasting any specific contigents of population was significant such as : the number of pre-school children, the number of school children, the number of youth, of working - age population.

Economic Structure

From projection of the age structure shows that in the planning period is expected to strengthen the participation of a working - age population. However, the level of activity will largely depend on the objective conditions and employment opportunities of the population.

Settlement System

The possibility of establishing an appropriate system of settlements in the Municipality of Neum is meant defining the mutual functional relationships between settlements.
Development plans of the then Republic of Bosnia and Herzegovina were based on the activation of economic development in this area.
The basis for defining the settlement system of Municipality of Neum are settlement structure and its physical characteristics and potentials.

-Economic Development-

Physical position of Neum municipality has significance for its future socio - economic development in terms of the tourist economy, and development of agriculture and industry. It is significant that there is, in relative proximity, the Port of Ploče.

Development Concept

By the constant analysis of the area and its potential, development should be directed to:

- touristic economy

- small industries (complementary tourist economy)
- primary agriculture
- trade and supplying the wholesale and retail
- handicraft and small industry.

Water supply system

Water supply is one of the major problems in activating the economic development of the Adriatic coast. This problem will be resolved in the modern manner, by implementation of regional water supply system.

Disposition of waste water

It is designed the sewerage network of Neum, which can be expanded as needed. Other villages in the hinterland will solve this problem by building the local sewage network.

Electricity - Energy

Based on analysis, the estimated electro-energetic indicators meet its needs for electricity by the end of the planning period. (2005.).

Development concept of PTT network

It should give priorities to the development of postal transport, as well as telegraph and telephone traffic.

Socio Economic Development

It has been made a special study within the physical - planning documents related to this issue, where analysis of existing conditions were realized and concepts and projections provided.
The analysis of previous development is made and the conception and projections of long-term development are given.
Objectives of socio - economic development are given.
Basic resources of the normal area are those of direct interest for the development of tourist industry, then the agricultural area and traffic in a good position.

Municipality Stolac

Physical-planning documentation for the municipality of Stolac is quite deficient. There was a Spatial plan of Stolac municipality from 1987., which is not available, given the events in the previous period.

A few years ago, it is made the **Strategy of economic development of Stolac municipality**. In addition to analyzing the current situation and SWOT analysis, it is given the concept of economic development of the community. Development strategy refers to programs of agriculture development, tourism development, development program of organically produced food, and programs to improve business opportunities and complete image of the community.
These documents are certainly important for the development of any community, especially in the period when are in progress development of new Physical - planning documentation of certain municipalities and of course the Spatial Plan of the Federation, whose segment.

2.4 Socio-economical significance of the Project

Considering the current very complex socio - political and socio - economic moment in BiH, the construction of the aforementioned road is of great interest to the state of Bosnia and Herzegovina, and for the population that gravitates Neum area. Realization of this project would significantly impact on improving the quality of life of local residents, while the effects on the wider area of Neum would be far higher, given that in the Development Strategy of Neum municipality, the town chose as a priority the development of tourism.

Construction of this road will provide faster transport of goods and people to the area of Neum, where will eliminate the long-term retention on the border.

Given that the road will not pass directly through populated areas, by its construction, this segment of the quality of life in the subject area will be satisfied.

However, as the biggest and best socio - economic impact, we would emphasize the connection of Neum with the rest of Bosnia and Herzegovina, and that doing so it does not have to use the road route through Metković, which involves crossing the border. This will make Neum even more accessible for citizens of BiH. Also, during the construction of the road it is possible to employ local people, which is mostly unemployed, or its existence realize by seasonal work in neighboring Republic of Croatia.

Considering that at the aforementioned line, there are a number of shrines, by building the road, they would be made available for tourists in transit through BiH, which would probably increase the number of spending nights, but the percentage of their retention in our country. For most of them on the road to the Adriatic Sea, the background of this area of Neum remains unknown, since the direction towards Metković circumvents these localities.

Also, the positive effect of the road construction, would be on smaller populated places in the municipality of Stolac, through which passes the aforementioned direction. Joining the implementation of the project would be one of the possible ways to revive the area.

Therefore, this project is provided by multiple positive impact on all segments of society and life.

2.5 Technical description of the proposed route

2.5.1 Spatial characteristics of the project

Starting from Stari Neum next Kiševo, Babin Do and Dobrovo to Broćanac, the terrain is hilly, covered with macchia. In this area there are two natural barriers (higher valley - Blace and hilly terrain in the village Kiševo), and four populated places (Vranjevo Selo, Kiševo, Babin Do and Dobrovo). From Dobrovo, the hilly terrain descends to the valley of Broćanac settlement.
From Broćanac, slight rise goes to Hadžibegov grad located in a flat limestone plateau, after which a slight decline passes through the valley area of the place Hutovo between peaks Kičin and Orlovići toward Cerovica. From Cerovica, it comes across the ranges Stražnica, Meteri and Crnoglav, but also valley areas behind the ranges, after which the lower slope downs to the valley of Udora settlement. From Udora by slight rise the terrain rises to the plateau Kadića Dubrava-Cerovo. After crossing the plateau, the terrain downs by slope to the end point (Drenovac). The landscape of this area consists of different degradation stages of forests of Downy Oak, black and white elm, and the surface covered with olive groves and vineyards.

As regards the general characteristics of this area, we can say that it is stable karst terrain, with a large amount of solar insolation and a small amount of precipitation, which influenced the development of vegetation typical for this area.

Field work is not identified the existence of surface watercourses, which indicates the scarcity of water in this area.

2.5.2 Technical characteristics of the project

Since the analyzed project is at various stages of design and implementation, the entire alignment can be divided into 3 (three) sections.

- First section Stari Neum – Kiševo, 3,021 km long
- Second section Kiševo – Broćanac app 8,50 km long
- Third section Broćanac – Drenovac app 27,00 km long

The best alignment alternatives for the sections of Stari Neum - Kiševo and Kiševo - Broćanac have already been selected and the Main designs for these two sections are made.

For the third section Broćanac - Drenovac it has been also selected the most favorable alignment alternative and currently the Preliminary design is almost finished.

First section

The most important elements and guidelines that determine the character, function and ranking of the road, some of which are especially important (Main design of the main road M 17.3 Buna-Neum, section Stari Neum-Kiševo; DIVEL doo – Sarajevo, April 2004.), are the following:

- hilly to mountainous terrain
- calculating speed……..70 (60) km/h;
- roadway width…….2 x 3,25 m;
- marginal strip width ……...2 x 0,30 m;
- shoulder width…….....1,00 m;
- section length.....3,00 km

Composition of the roadway structure is:

- splitmastiks asphalt SMA 11 4 cm, as a wearing course;
- bearing course BNS 22s 12 cm (2x6) , as a base bearing course;
- sub-base 40 cm, as a bearing subbase;
- final course of the backfill made of stone material of small fraction with max. grain Ø 150 mm.

Start of the alignment is defined at the crossroads of the old road to Metković and existing main road in Stari Neum. Immediately after this, it is completed integration of the new alignment to the existing road, which leaves the corridor of this road and branches left across the slopes of the mount Žrnjevo, bypassing the existing facilities. At this line, the road alignment is in important cutting, so that the noise impact on surrounding buildings will be minimal. At the beginning of section (km 0 +220) is located crossroad through which the existing road is connected to the new main road.

After this initial cutting, in the further course, the alignment was carried out in mild notch and light fall of grade line 3.35%, slope above the village Vranjevo, without disturbing the village. At the site of the nearest contact with the village, the alignment is carved in small rocky ridge, which is suitable from the standpoint of protection against noise.

In the further course, the alignment was carried out by significant cutting of the slope on edge of "fields" Blace, and then, by large embankment bridges over a branch of aforementioned field, crossing in the cutting on the other slope. Although a relatively large embankment, but its position is selected so that in the ambient sense it "blends" with the slope on the edge of the field. To broke the monotony of a large side slope embankment on half of its height, bermes were constructed, which would eventually need to establish vegetation, and also have an important role in the stability of embankments.

Continuation of the alignment leads by alternating cuttings and embankments with some significant rise of 5.35%, to exit on a small plateau, where the grade line reached the

required height, so that by the end of the section, the alignment grade line is conducted in a small rise of 1.60%.

In the location sense, it is important to note that the alignment was conducted by a slope below Kiševo village, rim of one more cultivated doline within a radius R = 250.00 m, with no direct cutting of the same (which is also occasionally flooded), so as not to spoil the ambient, or preserve the fertile land.

The alignment, at the end of the section, is set so that in the sequel, by one right curve of radius R = 250.00 m, continued in the next valley, where begins the second section.

Facilities on the alignment of the section

On the alignment are anticipated following facilities:

- crossroad at level on station (km 0+220)
- passage way L=5,00 m on station (km 1+450)

Drainage

The concept of drainage is provided so that in the cutters, the water from roadway and side slopes is accepted in concrete moulds, which are to be placed directly on the roadway.
At higher dikes it is envisaged construction of concrete gutters, to protect high side slopes from destruction. Along shallow embankments at several places on the alignment it is foreseen the creation of concrete segmental ditches made of prefabricated elements.

Along the alignment is assigned the required number of culverts, to accept the water from the aforementioned line elements, and its implementation through the road structure.
For lowering of water from gutters and culverts down at side slopes of the dikes, it is envisaged laying of concrete prefabricated channels.

On some culverts on the alignment, where the input shaft of the culvert is situated directly on the roadway (water from moulds is directly accepted in the culvert), for the safety reasons, it is necessary construction and installation of steel grid, which for the purposes of cleaning of the culvert can be easily removed.

Functional and geometric characteristics of the alignment

Given that the initial section (Stari Neum - Kiševo) on the main road M-17.3 in the Topographic-morphological sense is probably the most complex section of the whole line where is planned construction from Neum to Stolac (Drenovac), it can be said that there was remarkable level of geometric elements applied on the alignment. This is somewhat

facilitated by favorable geological and geotechnical characteristics of the terrain over which the alignment is to be led.

From the applied elements of the alignment geometry it is interesting to mention the following:

- alignment length: 3021,00 m
- minimum radius of horizontal curve: R = 250,00 m
- maximum slope of the grade line is: i = 5,35 %, other 3,35 % and lesser
- minimum radius of vertical curve is: R_v = 3.500,00 other R_v=6.000,00 m

Second section

The most important elements and guidelines that determine the character, function, and the ranking of the road, some of which are especially important following (Main design of the main road M 17.3 Buna-Neum, section Kiševo-Broćanac; DIVEL doo - Sarajevo, June of 2008) are:

- road of the 3^d class (3000 – 7000 vehicles/h)
- hilly terrain
- calculating speed……..80 km/h;
- roadway width……2 x 3,25 m;
- marginal strip width ……...2 x 0,30 m;
- shoulder width ……..…..1,00 m;
- extension of the curve for the passage of two trucks with trailers.

Adopted road structure from the precedent section:

- asphalt concrete HS-SMA 11 4 cm
- bearing course BNS 22s 12 cm (2x6)
- sub-base 40 cm
- final course of the backfill 50 cm (maximum fraction Ø100 mm)
- backfill made of stone material up to max. size 300 mm

The second section can be divided into four specific sub-sections.

First sub-section includes a part of the Kiševo village up to the curves. The beginning of the section is determined by the position of the very end of the previous section, which, in succession of the tracing, conditionned the alignment position. Start of the alignment is located in the cutting with depth of approximately 8.00 m, in radius curve of 250.00 m and slope of 1.6%. Later, the route is in embankment of the average height from 8.00 to 10.00 m and rise of 5%, which surmounts the bend in vertical radius curve of 6.00 kilometers, which is the curve level 211.00 m above sea level.

Second sub-section is from the curve up to the village Babin Do. The curve is to be surmounted by deep cutting approximately 20.00 m, in the vertical curve. Since this is a very quality material, it is foreseen to be fully embed in dikes. Design engineer, during designing, took care of the leveling of masses from the excavation and embankment. Cutting is fully open for viewing, maximum protection and security of participants in traffic and possible falling out of degraded cracked rock mass in the upper layers of rock.

In places where the rock cracks appear more distinctive, a designer predicted protection with hexagonal protective wire net. On the parts where it is possible that faults occur between rock blocks, the designer provides making concrete beams. To stabilize the large stone blocks that can be run during the execution, the designer proposes placing of geotechnical anchors to a depth determined by the supervisory authority at the site. Width of the berme in cuttings is 2.50 m, and can serve to deposit fell material. At deep cuttings, such as at the curve at a height of 10.00 m, some bermes are designed at side slope 4.00 m wide with a protective wire fence, which prevents to roll away the fell stone material by its kinetic energy and rotation down the slide slope on the road. Furthermore the alignment is in decline from 4.78% in the length of 1.324 kilometers in the low dikes of average height of 2.00 m to 4.00 m.
During the excavation, if it proves justifiable, the contractor, with the consent of the supervisory authority may carry out the excavation at a part of deep cutting by blasting method, in which must be taken into account that the blasting project must be done in accordance with the necessary and required standards and laws, with maximum protection of workers on the site and surrounding buildings.

Third sub-section is from the Babin Do village up to the Oštrovac tunnel near the Dobrovo village. The alignment is situated in a mild decline of 1.24% on a length of 1.456 kilometers, in horizontal radius curve 800.00 m. On the P85 profile, the designer envisaged a bridge with length of 10.00 m. Below the bridge, a junction road passes connecting the newdesigned main road, inhabitated place Babin Do with the existing main road.
Communication of the junction road with the main road is achieved through a "T" junction, where a drop is designed for traffic flow separation. Width of this roadway
2 x 3.30 m. The free height of 4.50 m below the bridge, which allows the passage of fire engines and ambulance. Local road to the village Babin Do is joined on this road in the roadway width of 3.00 m.
On the P138 profile, before the Oštrovac tunnel, the grade line of the designed road is situated on the rise of 2%, where a bridge is planned of length of 10.00 m over the local road connecting the village Dobrovo and Oskrušnica. Further, the alignment passes through the tunnel with length of 190.00 m.
For the purposes of bus transportation, the designer envisaged a bus stops, located and adapted to the needs of the local population.

Fourth sub-section is a section from the Oštrovac tunnel up to Broćanac, which develops in a large radius on the slope above the village Dobrovo, and further following slightly rolling terrain up to the end of section, which is located in the embankment and the notch.

On the line from P162 to P179 profiles there are rock complexes in which cracking and degradation of rocks are significantly more distinctive. During exploatation and atmospheric influences it may occur fallout of rock blocks, and thus directly endanger the safety of participants in traffic. At the turn designer predicted placing of galvanized protective hexagonal net at high side slopes.

Facilities on the alignment of the section

On the alignment are anticipated following facilities:

- bridge L=10,00 m on station 5+309.50
- bridge L=10,00 m on station 6+724.0
- passage way 5x3.50 m on station 7+272.0
- passage way 5x3.50 m on station 8+682.0
- passage way 5x3.50 m on station 10+540.0
- Oštrovac tunnel of length L=190,00 m

Planned passage ways are arranged so as to allow full communication with the existing estates, and as such can be used for undisturbed passage of livestock and agricultural machinery.

Drainage

In the cuttings, the water from side slopes is accepted by asphalt gutters and than it is lowered down at side slope. On embankments, the water is run from the roadway over a shoulder. At high embankments for protection of side slope of the road structure, the designer provided concrete gutters, which accept controlly the water from the roadway and than lower by canals on the terrain. At the locations of natural bays, where there is the possibility of higher concentrations of water, the designer provided the construction of tubular culverts, which can serve as a necessary passage for the animals.

Functional and geometric characteristics of the alignment

From the applied elements of the alignment geometry it is interesting to mention the following:

- alignment length: 8.713,938 m
- minimum radius of horizontal curve at the beginning of the section: R = 250,00 m, other radius are: 300,00; 360,00; 600,00; 700,00; 800,00; 1.500,00 m.
- maximum slope of the grade line is: i = 5 %, other slopes are: 4.78%, 1.23%, 2%, 0.5%, 2.23%.
- minimum radius of vertical curve is R_v = 6. 000,00 m, other radius are:10.000,00 and 20.000,00 m.

Third section

The most important elements and guidelines that determine the character, function, and the ranking of the road, some of which are especially important following (Preliminary design of the main road M 17.3 Buna-Neum, Neum-Stolac section; Broćanac-Denovac section; TZI - Inženjering - Sarajevo, July 2009.) are:

- road of the 3 class (3000 – 7000 vehicles/h)
- hilly terrain
- calculating speed……..80 km/h;
- roadway width……2 x 3,25 m;
- marginal strip width ……...2 x 0,30 m;
- shoulder width ……....1,00 m;
- extension of the curve for the passage of two trucks with trailers.

Adopted road structure from the precedent section:

- asphalt concrete HS-SMA 11 4 cm
- bearing course BNS 22s 12 cm (2x6)
- sub-base 40 cm
- final course of the backfill 50 cm (maximal fraction Ø100 mm)
- backfill made of stone material up to max. size 300 mm

The section starts at the end of Kiševo-Broćanac section, ending in front of the Broćanac settlements at level 220.00 m. By mild longitudinal slope, the alignment leaves the small valley of Broćanac settlements and by rise of 4.92% comes to curves (on left approximately 1.00 kilometers from the existing road) - location Hadžibegov grad. The alignment overcomes the curve by a tunnel of length 780.00 m at level 390.00 m, and descends down the slope above narrow track formation, in the valley of Hutovo settlements by longitudinal slope of -4.95% up to the valley at level 285.00 m.

After crossing the valley and the narrow track formation by right slope, slopes of 2.62 and 4.94%, the alignment climbs to the plateau Cerovica - Crnoglav. On the plateau (level from 370.00 to 430.00 m) a corridor of old road is used with an average longitudinal slope of 1.30%.

From Cerovica, the designed road passes right from the air line that connects the beginning and end of the alignment because of the ridges Stražnica, Meteri and Crnoglav, level from 46300 to 58900 m, and the valleys just behind the ridges at level 135.00 m. In this part, the alignment is the most distant from the air line which connects the end-points of the alignment approximately 3.00 kilometers, in order to pass over, in the limits of maximum longitudinal slope <= 5% the valley of Udora settlements at level 223.00 m.

Further the designed road climbs by slope of 4.91% to the plateau Kadić, Dubrava-Cerovica, at the direction of air line of section end points.

After crossing the plateau, the alignment descends by longitudinal slope -4.85% up to the end-point – at the existing road that leads towards the town of Stolac. At the end of the designed road due to appeasement of horizontal flow, minimum radius of horizontal curve are used Rhmin = 180.00 m.

The section, as well as the alignment itself, ends something before Drenovac, and at the point of beginning of Drenovac-Masline section of the main road M-17.3 Bypass the town of Stolac.

Facilities on the alignment of the section

On the alignment are anticipated following facilities:

- 4 frame passage ways, for access to properties, housing and economic buildings of the local road
- crossroad at location km 12+000, in the level of lane for left turn, as a branch for Broćanac and existing road (connects Prapratnica, Hadžibegov grad and Hutovo)
- crossroad at location km 22+000, in the level of lane for left turn, connects the road that leads to the road M-17.5 Čapljina-Dračevo-borders of R.Croatia (connects places Cerovica, Hutovo, Meduljići, Vinine, Rabrani)
- crossroad at km 34+600, in the level of lane for left turn, connects a local road (Boljuni, Kadića Dubrava, Drenovac, Pušišta, Ober, Udora and Doluša)
- viaduct of length L=123,00 m on station (km 15+260)
- tunnel of length L=780,00 m on station (km 16)
- length of overbridge L=25,00 m on station (km 36+460) connecting Drenovac, Gornja and Donja Duboka, Dulaći etc.

Construction conditions are very favorable. It can access to the alignment throughout the line from the existing road. Conditions of traffic diverting are favorable as well as conditions of construction organization. It is possible engagement of the local labour force.

At the road section Drenovac-Stolac it keeps completely the existing state of the road. Design development of the bypass around Stolac is not the subject of this study.

Drainage

In the cuttings, the water from side slopes is accepted by asphalt gutters 75 cm wide and than it is lowered down at side slope. On embankments, the water is run from the roadway over a shoulder. At high embankments for protection of side slope of the road structure, the designer provided concrete gutters 50 cm wide, which accept controlly the water from the roadway and than lower by canals on the terrain.
At the locations of natural bays, where there is the possibility of higher concentrations of water, the designer provided the construction of tubular culverts Ø100 cm, which can serve as a necessary passage for the animals.

Functional and geometric characteristics of the alignment

From the applied elements of the alignment geometry it is interesting to mention the following:

- alignment length: app 30.000,00 m
- minimum radius of horizontal curve: R = 180,00 m
- maximum slope of the grade line is: i = 5,00%, other 4,95% and lesser

2.5.3 Traffic

Road route M-17.3 Buna-Stolac-Neum has been for some time (twenty years ago) declared as a main road, although its technical characteristics of the longer section (between Stolac and Neum), do not correspond to approximately rank of roads where it is put.

The road route is characterized by a very modest technical elements, the width of the roadway is between 3.00 and 5.00 meters, with a sharp horizontal and vertical curves, sporadic large longitudinal slopes (even at 15%), with no continuity in the horizontal and vertical route running and inadequate drainage solution.

In addition to these technical shortcomings, the existing alignment in terms of position presents a concept that is inconsistent with contemporary solutions and requirements that road of this level should meet. Since the existing road, built on the route of the former gravel road, paved and widened in places, passes through the centers of small urban areas, crossing the most fertile terrains in this area, it is clear that this type of road can not meet contemporary traffic and required capacity and level of service .

Existing road will continue to play an important function in a traffic infrastructure. It means primarily to its role in the local traffic, because of its technical elements and position (passing through the center of a series of settlements), correspond the most to the ranking of local roads and will serve as service road. It has been predicted junctions of the existing road to the alignment of the new main road, which will enable an undisturbed flow of people and vehicles, thereby establishing a unique traffic flow of road network, and connection of all populated places in the area.

Just before the war, one part of the main route of M-17.3 Buna-Stolac-Neum is built, and namely on the line: Drenovac-Stolac and Masline-Buna, as well as one short line at the exit of Neum.
In the coming period it expects the accelerated construction in this direction, ie on the line of Stari Neum-Drenovac. Additional importance to the road gives the fact that this main route is the only direct connection between the Adriatic coast and the interior of Bosnia and Herzegovina, whose construction will get more benefits, such as avoiding customs administrative procedures, etc.

Creating the Main design, it has been anticipated the development and adoption of the Concept solution, by which it is abandoned the idea (a solution before the war) to build the main road for the most part based on the reconstruction of the existing road with sporadic leaving and returning again to the same, according to the existing corridor. This is done for several very important reasons as follows: it avoids passing of the new more modern road (with Voček. ≥ 80 km / h) directly through populated areas, minimizes the devastation and usurping a significant portion of fertile arable land, avoids the critical longitudinal slopes (over 8%) and high curves that in the corridor of the existing road will be inevitable, significantly shortens the alignment and reduces the "lost slopes" without the use of expensive facilities (bridges, tunnels), etc.

If we take into account that a new alignment for most of its part leads through the karst terrain, which provides a good building with good material, construction of modern roadway structure and application of adequate drainage, and other technical solutions, with favorable climatic conditions, it should obtain a road, which will be for a longer period good traffic connection to the main road.

The designer does not have data on the size and structure of traffic on the existing road, nor have any knowledge that such information are collected any time soon in this area. However, by fieldwork in collecting field data for the purposes of this project, it was observed that in the traffic structure on the existing road, a substantial percentage is heavy trucks.

It is realistic to expect that after the completion of this section it will come to a sudden and muliple increase in traffic, which will "attract" new modern road, and in the future, this main route should be much more interesting travel direction.

First section

The alignment is placed on relatively rough terrain, since in the direction of its course there are two significant natural barriers (higher Blace valley in the central part of the section, in the form of miniature karst field, which during the rainy season overflows, and the hilly terrain in the narrow region of the village Kiševo on section end), and two populated places (Vranjevo selo and Kiševo).

The alignment, after the initial separation from the existing road, goes by the slope above the Vranjevo village (not coming in conflict with the settlement), and then the mentioned "field" goes on its narrowest place. Further course of the alignment is passing of mountainous part in the region of Kiševo village. In this direction it was also important to avoid any fertile valleys that occasionally overflow.

Second section

The alignment horizontally passes from Kiševo through the cuvre over the Dobrovo village (which are eliminated the shortcomings of partial cutting of fertile plateau of Gradačačko polje and passage between settlements Dobrovo and Nerađa), and by the slope goes to Broćanac.

Most of its alignment goes through karst terrain, which provides construction in a good building material and with construction of modern road structure, application of adequate drainage, and other technical solutions, with favorable climatic conditions, it should obtain a road, which will be, for a longer period, good transport connection to the main road.

Third section

Broćanac is connected to Drenovac, by local paved road. Air line distance between these two places is approximately km 19 +500. Distance by an existing paved road is 30 +200 km.

Generally, the existing road is being developed in the direction of extreme point. In places of curves, Hadžibegov grad level 420.00 m, Crnoglav and Udora valley, it departs from the shortest connection line approximately 4.00 kilometers. On the part of the descent from the curve of Hadžibegov grad, the alignment is developing back and descends from three serpentines to the place Hutovo from the left side.

Upon leaving Hutovo, the existing road is being developed by right slope, to climb to the plateau on the left side of Cerovica. This part of the existing road is very unfavorable with serpentine and modest horizontal and vertical elements. Behind Cerovica place approximately 500.00 m there is a left branch-road – a junction to the main road M 17.5 Čapljina - Dračevo – border of R.Croatia.

Further in the direction of Stolac, the existing road is only of local importance connecting villages Vinine, Crnoglav, Udora, Kadića Dubrava. Width of asphalt road approximately 3.00 m with a rare passing places.

The existing road throughout its length does not cut some active water flows. There were frequent junctions to estates, economic and housing facilities.

The third section begins at the end of Kiševo-Broćanac section, ending in front of the settlement Broćanac, by mild longitudinal slope leaves little valley of Broćanac settlement and by the rise comes to curve - location Hadžibegov grad. The curve is surmounted by tunnel and descends down the slope into the valley of Hutovo settlements. Further the alignment climbs to the plateau Cerovica - Crnoglav.

From the point Cerovica the alignment passes by the ridge Stražnica, Meteri and Crnoglav, then the valley just behind the ridge, so that in the slope crosses the valley of Udora settlements, climbing a slope to the plateau Kadića Dubrava-Cerovica.

By the turn of the plateau the alignment descends by longitudinal slope to the end point - the existing road that leads towards the town of Stolac.

Performance conditions are very favorable. The alignment can be accessed throughout the line from the existing road. Favorable are conditions of diverting traffic, because it generally follows the existing road corridor, M-17.3 Neum-Stolac.

The alignment passes close to the large number of settlements (which enabled faster and easier access to the same, and through the intersection), while configuration of the terrain is to be resolved by tunnel and viaduct. Connections of settlements with each other, access to estates, economic and housing facilities, is achieved by passages and overbridge.

2.6 Drainage system

In terms of traffic safety related to security of road alignment it should apply existing standards for drainage. For highways and motorways according to U.C4.020 standard, from the alignmet it is necessary to ensure unimpeded outflow of relevant rainfall of return period of 10 years, while for the main roads it has been prescribed period of 5 years.

In accordance with the water management conditions and practices to protect the environment from the negative impacts of flow from the road, then the concrete situations on the subject alignment, there are no specific requirements for controlled drainage of surface waters, except on the section Stari Neum-Kiševo in the area of water protection zone where close to the alignment there is Blace source that supplies with water town of Neum. On the remaining part of the planned road alignment, drainage from the road is in function of traffic safety, and all the collected water is discharged spread along road, or concentrated on the sections where it is needed to build channel system. Such drainage is possible on those sections where along the road there is a natural or created protective belt of soil and vegetation, or in locations where groundwater is not endangered.

Section 1. Stari Neum -Kiševo
Drainage is designed so that in the cuttings the water from the road and side slopes is accepted into the concrete moulds, which were placed directly along the road. Moulds are relatively of small depth (10 cm) with a rounded surface, so that they are suitable for machine cleaning and easily maintainance.

At higher embankments it is envisaged construction of concrete gutters, to protect high side slopes from destruction. Close to shallow embankments at several places on the alignment it is envisaged the creation of concrete segmental ditches made of prefabricated elements.

Along the alignment is arranged the required number of concrete tubular culverts, to accept the water from the aforementioned line elements, and its implementation through the road structure.
For water sinking from gutters and culverts downward side slopes of embankments, it is envisaged laying of concrete prefabricated canals.

On some culverts on the alignment where the entry shaft of the culvert is situated directly on the roadway (water from the mould directly is accepted into the culvert), for the safety reasons it is necessary production and installation of steel grid, which for the purposes of cleaning of culvert can be easily removed.

Since the main road alignment passes through the water protection zone of the Blace source, on this direction it is necessary to build, what the designer did not foresee in the Main design, a watertight drainage system of the road with grease and oil separator and concentrated discharge of collected waters into water bodies or drainage facilities because it is necessary to protect underground waters that supply the Blace source, with possible subsequent successful intervention after the accidental contamination.

Section 2. Kiševo-Broćanac
In the cuttings, the water from side slopes is accepted by asphalt gutters 75 cm wide and than it is lowered down at side slope. On embankments, the water is run from the roadway over a shoulder. At high embankments for protection of side slope of the road structure, the designer provided concrete gutters 50 cm wide, which accept controlly the water from the roadway and than lower by canals on the terrain. At the locations of natural bays, where there is the possibility of higher concentrations of water, the designer provided the construction of tubular culverts Ø100 cm, which can serve as a necessary passage for the animals.

Section 3. Broćanac-Drenovac
Drainage from the road at the Broćanac-Drenovac alignment is designed identical to the 2. section Kiševo-Broćanac.

2.7 Waste materials

Waste produced as a result of the construction and use of roads by periods of origin can be divided into:

1. Waste produced during the execution of works
2. Waste produced during period of use

Waste, produced during the construction, as well as during the operation, must be treated in a manner to avoid:

- risk to human health
- threat to wildlife

- pollution of water, soil and air above the prescribed limit values
- uncontrolled disposal and burning
- explosion or fire
- violation of public order and peace.

1. Period of work execution

Inert and harmless waste

Geological and geotechnical conditions along the road allow the construction of cuttings, where all the excess excavated material can be used for backfill works, either by direct backfilling, or with the previous grinding. This means that when managing this waste will not be a need for depositing the excess material from the excavation, which will reduce the negative impact on the environment.

Construction of the road foundations requires excavation and disposal of surplus excavated material of poor quality from the construction site (marly earth, earth with a high percentage of biodegradable material), to be transported to a local landfill of waste material.

When handling waste materials, temporary landfills, etc., it should comply with the Guidelines for the design, construction, maintenance and control on roads.

For roadway and other road structures it uses granulates - gravel, crushed stone and sand and other materials such as cement or asphalt - concrete and brick.

Solid (communal) waste created by workers on the site is necessary to collect to the required place in appropriate containers and promptly transport to the city landfill. It should separate waste by type of packaging: glass, plastic, cans, paper, bags, etc.

When it comes to solid waste generated during construction, it is recommended:

- All material stocks remaining after the construction of embankments, is necessary to use, after seed, in the construction of road,
- Remains of the material must be transported to the places for waste transport, where it is necessary to take measures for restoration of such areas for later use. Also, the remaining material can be used as covering material on the municipal and city landfills, to reduce emissions into the atmosphere and access to people and animals,
- Metal waste produced during construction, possibly to re-use.

Toxic and hazardous waste

Toxic and hazardous materials can be: fuel (diesel) and lubricants necessary for the operation of machinery and transport means, as well as paints for marking the road.

Toxic and hazardous waste to delivery to an authorized collector, to store temporarily in marked hermetic barrels on impermeable base protected from atmorpherics in a covered point.

Machinery delivered to the construction site must be technically correct, with executed technical review and changed oil and lubricants. Change the oil in engines and other parts of the machines and trucks to perform after each working season in an authorized workshop. It is necessary to carry out regular control of equipment to avoid leakage of oil from the machines.

Also, maintaining, changing batteries and tires, is done in special workshops, and not on the site.

Paint for road marking shall be delivered in a sealed containers and unloaded with an appropriate machinery. Empty tanks are to be returned to manufacturers or distributors.

2. Period of use

Inert and harmless waste

During the use of road, besides the waste that is specific for road traffic, it appears the waste due to improper behavior of participants in traffic (throwing waste in the run). This waste along the road, and those from the parking space, is to be transported by services responsible for maintaining roads.

With water drainage from the roadway, especially after the first rain, it rinses out different waste materials from the road (fuel, released lubricants, traces of dust from the brakes) and takes into manholes. All of these solutions the designer should work out in an As-built design, because the same requires detailed elements such as longitudinal slope of the road, places of manholes for water drainage and more.

Toxic and hazardous waste

Works to maintain the road require the use of some types of materials that belong to a group of toxic and hazardous substances. The most common products are: diesel fuel, gasoline, lubricants, paints and varnishes, thinners.

Problems can arise when the companies responsible for maintenance and repair of roads use these products and when handle with them. Employees of these companies must comply with specific working rules to perform works in conditions of complete safety. Tanks used to be in good working condition.

3 DESCRIPTION OF THE ENVIRONMENT AFFECTED BY THE PROJECT

3.1 Population and settlements

3.1.1 Background

Municipality Neum is the only municipality in Bosnia and Herzegovina, which has direct access to the sea. Located on the Adriatic coast, which belongs to the Federation of Bosnia and Herzegovina, and bordering municipalities: Čapljina (FB&H), Stolac (FB&H), Ravno (FB&H), Ljubinje (RS) and the municipalities of Dubrovnik (RH) and Metković (RH).

Municipality area stretches from the Adriatic coastline in the northeast direction by the depth of land of about 25 km. Length of developed coastline is 24 km, and the air line between the borders approximately 8 km.

Municipality of Neum covers an area of 226 km2 with 27 inhabitated areas, 5 local communities, about 4.857 people, with a population density of 21.5 inhabitants per km^2 area.

Municipality of Stolac

Stolac municipality is located in the southeastern part of Herzegovina-Neretva Canton and Bosnia and Herzegovina. It borders with five neighboring municipalities and namely in the Federation of Bosnia and Herzegovina with Neum, Čapljina and Mostar, and in the Republika Srpska with municipalities Ljubinje and Berkovići.

The area of Stolac municipality covers an area of approximately 286 km^2 (total area of the municipality Stolac was 545 km^2. By Dayton Peace Aggrement, 52% of the territory belongs to F B&H, and to RS 48%). According to statistics, the population on the territory of the municipality of Stolac in 2005 was 13,334. The average population growth rate for the period 2001-2005t was 6.3%. Number of settlements in the municipality is 27, and 3.334 households. Population density is 44.6 inhabitants per km^2 territory of the municipality.

3.1.2 Population and Demography

Municipality Neum

Neum Municipality includes the following populated places:: Babin Do, Banja, Brestica, Broćanac, Brštanica, Cerovica, Crnoglav, Cerovo, Ćukova Greda, Dašanica, Dobri Do, Dobrovo, Dračevica, Donji Drijen, Dubravica, Duži, Grabovice, Glumina, Gornje Hrasno, Gradac, Hotanj, Hutovo, Ilino polje, Jazine, Kamenice, Kiševo, Kolojanj, Mošević, Mramor, Neum, Nerade-Podstjene, Opuće, Oskorušnica, Prapratnica, Praovice, Previš, Podkula, Rabrani, Radež, Radetići, Vinine, Vranjevo Selo, Zelenikovac and Žukovica.

In the zone of interest are the following populated places: Vranjevo Selo, Kiševo, Babin Do, Dobrovo, Broćanac, Prapratnica, Hutovo, Cerovica, Vinine and Crnoglav.

By the last census in 1991 in the municipality of Neum lived 4.325 people. According to the demographic structure, the population, except in very narrow area of Neum, is elderly, while the national structure the Croats represent 90% of the total population at last census from 1991. , Serbs 4.3%, Muslims 3.7% and others 2%.
Significant settlements in the discussed area are Hutovo with 31 inhabitants, Gradac with 345 inhabitants and Neum with 1651 inhabitants (all according to the census from 1991).
All the settlements are mainly composed of small central settlements with scattered villages and hamlets, so they are pretty jagged on large surfaces. Because of this, population density of the municiplaity is low of only 21.5 people per km^2 area.

Population in the municipality of Neum, except in the narrow area of Neum, has emigratory characteristics. The biggest reason is the economic situation in the region where there was not economic development, or even creation of some new jobs.

Since according to the demographic structure, the population of the municipality of Neum is elderly whose fertility is very low, the main impact on the development of the number of inhabitants will have immigration flows of the population under age or working age population from the neighboring municipalities of Bosnia and Herzegovina and the Republic of Croatia.

To assume that in the next 10 years the natural population growth of todays Neum municipality will not have a significant impact on the numerical increase in population of the municipality and the town of Neum.

Municipality Stolac

Stolac municipality includes the following populated places:
Poplat, Gornji Poplat (within the wider area of the villages there are the hamlets: Mihića Mahala, Bodiroge, Zilića Mahala, Vukičevići), Donji Poplat (within the wider area of the village there are the hamlets: Humac, Radića Mahala, Bukvićevina, Bovan, Marića Mahala, Podbačnik, Podbrđe), Kruševo (within the wider area of the village there are the hamlets: Udno Polje, Podkula, Cerevo), Bačnik (within the wider area of the village there are the hamlets: Orahovica, Bačnik), Burmazi (within the wider area of the village there are the hamlets: Drenovac, Grdijevići, Donja Duboka, Gornja Duboka), Bjelojevići (within the wider area of the village there are the hamlets: Derani-Londža, Boljuni, Kadića Dubrava, Bjelovčeva Mahala, Matića Mahala, Pušišta, Doluša, Ober, Udora, Riđica), Barane, Ošanjići, Komanje brdo, Njivice, Basilije, Dragovilje, Poprati, Borojevići (within the wider area of the villages there are the hamlets: Masline, Podglavice, Obradovići, Grivna), Pješivac (within the wider area of the village there are the hamlets: Pješivac kula, Pješivac greda), Prenj (within the wider area of the village there are the hamlets: Dolumi, Strajnik, Kapetanovina, Hadžibegovina, Brestovača, Prenj), Aladinići-Crnići (within the wider area of the village there are the hamlets: Pjana Brda, M.Crnići, Pileta, Crnići-Greda, Jasoč, Kosovac, Smarlovina), Hodovo (within the wider area of the village

there are the hamlets: Ljuca, Kozice, Glavice, Kapića Avlija), Trijebanj (within the wider area of the village there are the hamlets: Kula, Mustafića Mahala, Odžak, Vučine), Rotimlja (within the wider area of the village there are the hamlets: Orašlje, Dretelj, Dolovi, Huskovići, Kula).

In the zone of interest are the following populated places: Ober, Udora, Matića Mahala, Grdijevići and Drenovac.

According to the last official census in 1991, Stolac municipality had 18.681 inhabitants, placed in 36 settlements. After the Dayton agreement, pre-war municipality of Stolac is divided into two municipalities: the municipality Stolac, which entered into the composition of the Federation of Bosnia and Herzegovina and the municipality of Berkovići, which entered into the composition of the Republika Srpska. According to the national structure in the municipality of Stolac Bosniaks had 8101 inhabitants, and made 43.36% of the total population by the last census in 1991, Croats 6.188 (33.12%), Serbs 3.917 (20.96%), Yugoslavs 307 (1.64%), other, undecided and unknown 168 (0.92%).

National composition of population for the town of Stolac, the census from 1991.: a total of 5.530 inhabitants, Bosniaks 3.426 inhabitants and made 61.95% of the total population by the last census in 1991, Serbs 1.111 (20.09%), Croats 653 (11 , 80%), Yugoslavs 239 (4.32%), other, undecided and unknown 101 (1.84%).

According to statistics, the population on the territory of the municipality of Stolac in 2005 was 13.334. Natural population growth rate is positive. Although the number of population accreation is humble, this can be considered encouraging, since there are more and more examples in BiH where there is the negative natural accreation.

By age, population structure is favorable, where 69% of the population is of age from 15 to 64 years. This is a population that can be considered as the main carriers of the community development.

A decline in employment has been recorded in the long series of years. The average rate of employment decline for the period 2001-2005 is -7.5%. Such a significant decrease is due to reduced levels of use of economic capacity in the municipality, which first reflects in the number of workers. Qualification structure of employees in the municipality can be considered very favorable, since it is far greater participation of qualified and professional staff. Structure of employees by age intervals is very favorable. High participation of workers is aged 20 to 54, which is the most productive work force.

Data on unemployment in the Stolac municipality indicate a large number of unemployed and increase of unemployment, with already expressed tendency of decrease in employment. For the period 2001-2005 , growth rate of unemployment was 25.3%. Upon qualification structure of unemployed with a status in February 2006, secondary school qualifications and skilled workers participate with 67%, while semi-skilled with 27%. Low level of economic activity substantially affects unemployment.

3.1.3 Access to education, health and other services

Municipality Neum

In the municipality of Neum operate four primary schools, of which eigth years in Neum and Hutovo and four years in Gradac and Brštanica.
Two secondary schools exist (economic and tourism and hospitality school).
In the town of Neum there is a kindergarten.

In Neum there is a Medical Centre, within there are an emergency room, as well as an ambulance.

Municipality Stolac

In the municipality of Stolac, there are a primary school „Stolac“ in town of Stolac, than a primary school „Crnići“ in Crnići with sections „Masline“ in Borojevići, „Rivine“, „Hodovo“ and „Prenj“. Four years schools in Kruševo, Burmazi and Poplata are out of function.
In the town of Stolac there is a high school centre.

Considering medical centres, in Stolac there is a Medical centre, as well as an ambulance in Crnići.
In Drenovac there is an ambulance in ruins.

There is no relevant data on cultural capacity, but it is evident that, if any, all is located in the town of Stolac.

3.1.4 Sacral objects and necropolis/sepulchral monuments

Municipality Neum

Considering sacral objects and necropolis/sepulchral monuments in the zone of interest are:
Vranjevo selo 1 chapel, 1 cemetery with a chapel; Kiševo 1 cemetery; Babin Do 1 cemetery; Dobrovo 1 church with a cemetery; Gradac 2 churches and 2 cemeteries; Broćanac 1 church and 1 cemetery; Prapratnica 1 church with a cemetery; Cerovica Svetište kraljice Mira, 1 church with a church property (in the churchyard perpendicular to the church several buildings in the row), 1 chapel at the junction and 1 cemetery with a chapel; Vinine 1 cemetery and 1 cemetery with a chapel.

Municipality Stolac

In the zone of interest are of sacral objects and necropolis/sepulchral monuments: Ober 1 cemetery with a chapel; Matića Mahala 1 cemetery with a chapel.

3.1.5 Economy

Municipality Neum

Proceeding from the strategic goals and objectives in economic development of Neum and the municipality of Neum, and with respect for natural resources that this area has, it is possible to point to some elements of the concept of economic development in this area.

Municipality Neum by their configuration of the terrain can be divided into two parts

- coastal part (a temperate Mediterranean climate, oriented to tourism and trade)
- continental part (a moderate continental climate, oriented to agriculture and animal husbandry

Neum is located near the port of Ploče (Republic of Croatia) as one of the largest ports on the Adriatic coast and several major industrial centers in the immediate coast and the hinterland of the continent (Ploče, Dubrovnik, Čapljina, Mostar). Continental Neum connection with the same area, as well as urban and industrial centers of the wider area, present the basis for future development in this area. Development of Ploce-Mostar direction is intense concentration of population and economy, whose demands for rest and recreation and binding of tourist activities and outside of tourism, largely will contribute to the development of Neum area, and expansion of the influence in the wider area.
This area is underdeveloped and open to economic exploitation, and in addition it has significant natural resources.

The main tourist flows in order to move north-to-south, and to move west-south-east along the Adriatic coast, pass through this area, and directly through town of Neum. Natural, cultural and historical heritage, the exploitation system of the wealth of the Adriatic are only some elements of tourism development. By all objective indicators, the highest valuation and market reach in world-scale achieve areas of the Mediterranean, and whose components, although very small, make the coastal area of Neum.

The structure of the current economic development is fundamentally different on the continental part of the municipality of Neum than those in the coastal area. The continental part of the community is dominated by agriculture and animal husbandry, while in the coastal area there are more tourism and trade, and farming of fish and shells.

Climate of the area serves for agricultural production, as well as organized livestock, beekeeping and fishing production.

Agriculture

Of the total area of the municipality of Neum, social land covers an area of approximately 1.171 hectares or about 7.6%, while private piece of land covering about 13.839 ha or about 92.4%.
From the data on the population, the municipality of Neum has a total of 4.857 inhabitants, of which the active agricultural population is 30%. This data suggests that the possible solution of the current economic situation is in credit financing of individuals engaged in that branch of the economy which is important for the municipality.

Agriculture of the municipality of Neum is one of the most important branches of the economy, although the current situation points to reduce the number of people who deal with the same. Of the total area of agricultural land in the municipality of Neum of 15.010 ha, it uses as arable land and gardens 853 hectares, as orchards and vineyards 51 ha, meadows and pastures 14.059 hectares, valleys and the rest 47 ha.

In the group of cereals, the most important place occupies 94 ha of barley and wheat is 92 ha.
Considering vegetables, most areas are under potatoes, about 65 ha, then cabbage, lettuce, peppers, cucumbers and more. In recent years, something more intensive is vegetable cultivation under plastic, mainly along the route of the aqueduct.

It is also an increased interest in planting olive trees. It estimates that in the municipality of Neum there are about 12,000 olive trees, and recently planted another 3.000 trees. It plans in the coming period to stimulate and encourage the purchase and planting of olives. Municipality of Neum each year, through its programs and financial plans, provides about 1.000 plants, and through the Olive Producers Association distributes them to some interested producers.

Agricultural areas of the community should be directed towards the production of organically produced food that would be supplied the wider tourist area, and other customers.

Neum area is known for its medicinal herbs, plenty of sage and heather, indicating the possibility of organizing plantation cultivation of medicinal plants. Given the stated, conditions are favorable for the bee breeding. In the area of the municipality is registered a Beekeepers Association "Kadulja". Beekeeping could be larger represented than it is today.

Livestock

Livestock species that are represented in the municipality of Neum are: cattle, sheep, goat, pig, horse breeding, poultry farming, fisheries (marine and freshwater) and beekeeping. Livestock production is in decline. The same should be encouraged because there are favorable conditions, climate, terrain configuration.

In the municipality of Neum, two hatcheries of fish and sea bass are registered in the Bay of Neum-Klek. In the Bay of Neum-Klek it grows mussels mussels and oysters. Of freshwater fisheries it is set aside the area of Hydro power plant PHE Čapljina, dam lake Vrutak in Hutovo and channel that runs through the Popovo polje. Fishing association „Vrutak" takes care of overfishing and ranching of the same. Fishing spieces in the bay are carp, tench, grass carp, adriatic dace, brown bullhead.

Industry

Tourism and trade are the leading branches of economy in the municipality of Neum. The present level of industry development is reduced to a minimum. In the industrial structure of Neum municipality before the war is dominated the timber industry, then the meat industry, and partly plastic processing industry.

To stop the emigration of population from this area, it is necessary to activate pre-war industry, as well as the creation of new industrial plants, all in order to create new jobs. Here it can only develop so called "clean" industry, in order to preserve the current environmental inviolateness of areas of the Neum municipality.

Pre-war Factory for cork processing Šipad, which was the largest manufacturing enterprise in this municipality, is privatized and continued to work with the revised production program (wood products).
Farm for the production of chicken meat in Hutovo is not in function due to nonprofitable business and loss of interest of private investors.
Inside the hall for the production of boats in Hutovo a company was formed for the production of plastic, which is completely devastated.

Town of Neum, recent years, is characterized by intensive construction of housing and office buildings, and construction of some major infrastructure facilities. In addition to family homes, apartment buildings, it is built a lot of business premises related to tourism, trade and catering facilities.

Tourism

The former tourism development of the municipality of Neum is intense only in the coastal area.
Neum and its environment, by its geographical position and rich cultural and historical heritage, exclusively is oriented to the development of tourism. Past warfare led to a sudden decrease in the number of tourist visits, but there has been an increase in the representation of other economic sectors, especially trade.

In the further development of tourism, it should encourage the development of the continental part of the municipality of Neum. Wider hinterland of Neum is rich in archaeological sites that could be used in tourism purposes. It is especially necessary to give the emphasis to rural tourism (tourists stay in the environment of old Herzegovinian home, with local folklore, healthy food and drinks from this area). So far these are tours

of family houses in Gradac and Brštanica.Tourist offer of this kind could include visits to archaeological sites and places rich of unspoilt nature of this area.

Within the tourist offer of Neum hinterland is Vjetrenica cave, which, in addition to attribute of the most beautiful of its kind, is an important habitat for endemic species. Area that includes: Neum oast, the wider area of the municipality Neum (Hutovo, Hrasno) Vjetrenica cave, compensation basin Hutovo (compensation basin of hydro power plant Čapljina suitable for sport fishing) and Hutovo Blato marshlands is complex, which certainly should be included in the tourist offer.

The richness of cultural and religious heritage is respectable: Vranjevo selo, Glumina, old church in Neum, Moševići, Gradac, Broćanac, Drijen, D.Hrasno, chapels in Hotonj, Gradac, Prapratnica, Shrine of the Queen of peace in Cerovica, Stari grad in Hutovo, native house in Hutovo and Cerovica.

Trade and catering certainly follow aspects of tourism and the opening of shops and restaurants improve the quality of tourist attractions.

Municipality Stolac

Stolac is on the line that passes through Hercegovina and connects mountainous industrial hinterland in Bosnia with the coastal regions: Neum, Dubrovnik and Montenegro. These are roadways: Sarajevo-Mostar-Stolac-Neum and Mostar-Stolac-Trebinje-Dubrovnik. Stolac region connects also western and eastern Hercegovina by communication: Imotski-Ljubuški-Čapljina-Stolac-Bileća.

Agriculture

Municipality of Stolac disposes of arable land in the amount of 1.630 ha or 53% of the total territory. In addition, there are meadows 36.0%, 1.0% of orchards and 10.0% of vineyards

Of total 1.630 ha of arable land, it was treated 1.030 ha or 63.1%, which indicates that there are significant reserves that are not processed. Pastures occupy 32.237 ha.

High yields of specific cultures (especially potatoes, apples, grapes), which is higher than the Herzegovina-Neretva Canton, indicates the benefits of the agricultural development of the community. In favor of it, again began to work a society "Zemljoradnička zadruga Crnići.

Agricultural areas of the community should be directed towards the production of organically produced food that would be supplied the wider tourist area, and other customers.

Livestock

Livestock species that are represented in the municipality of Stolac are: cattle, sheep, goat, poultry farming and beekeeping. Livestock production is in decline. The same should be encouraged because there are favorable conditions, climate, terrain configuration.

State of livestock in certain types of domestic animals and poultry suggests that there are some potential in this regard, and that given the wealth of natural conditions, the development of this sector should be given special attention to.

Forestry

Municipality of Stolac has modest areas under trees, so that it can not be considered for industrial purposes. The total area of forest land is 23.000 ha. Wood mass is 299,000 m^3, which amounts to 13 ha/m^3 of wood mass.

In the municipality of Stolac, a large part of the surface is considered as forest land, although in fact it is not a forest land. The tendency is to transform this "forest land" into agricultural land.

Conversion of land of lower quality into the land of higher quality would open the possibility of planting new vineyards and orchards, which would lead to new jobs and increase of revenue.

Industry

The municipality of Stolac, before the war, designated the southern part of Stolac as industrial ie the economic zone. In this area were built in numerous production capacities in the field of metal-processing sector, wood-processing production, cardboard packaging, agricultural sector, healthcare, service industry and other. Municipal infrastructure in the zone already exists, and companies that are located in this zone today have large unused areas of business premises which constitutes a solid guarantee that the coming period with a small investment can arrange a new small and medium enterprises.

Some indicators that are available indicate that 367 business entities are registered in the municipality in various forms of business organizations: business entities, business entities as a dislocated parts of business entities whose headquarters are outside the territory of the municipality and craftsmen. The artisans are very important sector, and can certainly be treated as the holders of future development in addition to the already established industrial enterprises in the municipality. According to the number of economic entities, the greatest participation have commercial entities, then the catering. It should note that in the community exist in a total of 31 economic entities that are engaged in manufacturing activity.

Of companies that represent the most significant economic potential and future holders of the development should be pointed out: TGA d.d. (The factory of building reinforcement), Metal Ferrum doo (manufacture of metal furniture), MP Cartonprint Co (graphic-printing business), Hercegovinainvest d.o.o. (company from the construction sector), DD for the purchase and processing of tobacco, AK "EL & GO" doo (technical inspection services, service and car sales), Stolački podrumi d.o.o. (production of wine and brandy).

Tourism

One of the essential elements of economic development in the municipality of Stolac is certainly the development of tourism. The Municipality of Stolac is an open book of history and has significant potential for the development of various aspects of tourism and associated activities. These resources are reflected in the historical sights and natural beauties that can attract a large number of visitors (tourists) who gravitate to the narrower and wider region. It should be pointed out:

- Radimlje (3 km from Stolac) with tombstones necropolis
- Hutovo Blato nature park (hunting, fishing, safari)
- Protected areas: old Illyrian city Daorson (Ošanjići); Badanj cave (16.000 BC); Tarmanjača cave; Cave Crvena pećina; Drenovac cave; Bregava river.

Disposition of ancillary facilities for tourism, primarily its complementary productions and food processing, then the development of trade and wealth of services must be made by dispersion in other municipal towns, and thus define the functional scheme of planned settlements.

3.2 Climate and Meteorological Characteristics

Treated areas of the main road Stolac-Neum on its southern part has the characteristics of Mediterranean climate with long, dry and hot summers and mild, wet winters. By gradual moving further back from the sea, the climate gradually takes on the altered characteristics of Mediterranean climate with very hot and dry summers and relatively mild and wet winters, which are a little sharper than in the coastal zone.

Data for this analysis are taken from Climate Atlas of Yugoslavia where is treated the period 1931-60., and Meteorological Annuals of Yugoslavia.
In the text that follows is given special attention to temperature, precipitation and wind.

Analysis of air temperature

Average annual air temperature for the coastal zone around Neum is about 16 ^{0}C, mountain range north of Neum has a mean annual temperature of 14 ^{0}C, and the closer environment of Stolac has a mean annual temperature of 13 ^{0}C.

Number of summer days (when the maximum temperature exceeds 25 ^{0}C) in the coastal zone around Neum is about 100, on the mountain massif north of Neum is 80 days, and close area of Stolac is about 120 days.

Number of tropical days (when the maximum temperature exceeds 30 ^{0}C) in the coastal zone around Neum is about 40 days. On the mountain massif north of Neum, on an average, occurs 30 of these days, and a city of Stolac has an average 50 such days.

When it comes to the number of cold days (maximum daily temperature does not exceed 0 ^{0}C), in the coastal area of Neum this number ranges from 0 to 2 days, massif Žaba has an average of 5 of these days, and the closer environment of Stolac has about 2 such days.

When it comes to the negative temperature it should note that the maximum height of snow cover in the coastal area is within the limits of 0 to 5 cm, on the mountain massif Žaba maximum height of snow cover is about 20 cm, and the closer environment of Stolac has a maximum height of snow cover within the limits of 10 to 20 cm.

Analysis of precipitation

The average annual amount of precipitation in the coastal belt is moving from 1250 to 1500 mm, on the mountain massif Žaba it is 1750 mm, and the wider area of Stolac has a mean annual rainfall within the 1250 to 1500 mm.

Precipitation are very scarce in the warmer part of the year, and abundant in the colder part of the year. Direction Neum - Stolac is known as the area of very high intensity rainfall. The maximum monthly amount of precipitation is within the range from 300 to 500 mm, and there are not rare cases when only for a few hours fall more than half of the said monthly sum. Such a high intensity of rainfall can lead to the emergence of torrent streams which should take account in designing the alignment.

The increase in temperature is accompanied by reduced rainfall, and the decrease of temperature leads to increased precipitation.

Number of days with precipitation greater than 1 mm in the coastal zone of Neum is about 90 days, on the mountain massif Žaba about 100 days, and the wider area of Stolac about 105 days.

Number of days with precipitation greater than 10 mm in the coastal zone is about 45 days, on the mountain outback about 60 days, and in the wider environment of Stolac of 45 to 50 days.

Wind

For processing this climatologic parameter the observed data has been available from 4 weather stations: MS Neum, MS Stolac, MS Ljubinje and MS Čapljina. All 4 mentioned weather stations had different periods of observation of this parameter and the significant interruption. It is attached a graphic and tabulation of wind rose with a note that in the MS Neum is registered a frequency expressed in percentages and wind speeds, and in the remaining 3 weather stations are registered: frequency of wind expressed in percentages and the wind strength by Beaufort scale.

All 4 mentioned weather stations are located on the outskirts of the treated road line Stolac - Neum. Wind is not possible to linearly interpolate between two points, because it changes depending on several parameters such as differential air pressure, temperature, configuration of the soil, altitude etc.

In the weather stations of Neum, Čapljina and Ljubinje prevail winds from the northern and southern quadrants, and in Stolac there are winds coming from the east.

MS Stolac
Period: 1961.- 63. god.

PRIKAZ ČESTINA I SREDNJIH JAČINA POJEDINIH PRAVACA VJETRA

Pravac vjetra	C	N	NE	E	SE	S	SW	W	NW	SUMA
Čestina (%)	44,0	5,8	6,4	15,5	8,9	10,2	3,4	2,9	2,9	100,0
Jačina (Bofor)	-	3,8	4,0	3,1	3,1	2,7	2,7	2,8	3,3	-

Napomena: u godišnjacima postoje podaci vjetra samo za period 1961-63. god. za MS Stolac

MS Neum
Period: 1981.- 89. god.

PRIKAZ ČESTINA I SREDNJIH BRZINA POJEDINIH PRAVACA VJETRA

Pravac vjetra	C	N	NE	E	SE	S	SW	W	NW	SUMA
Čestina (%)	8,3	21,9	11,1	4,6	12,1	11,8	4,5	10,3	15,4	100
Brzina(m/s)		2,7	1,7	2	2,8	3,4	2,54	2,6	2,4	-

MS Čapljina
Period: 1961.- 70. god*.

PRIKAZ ČESTINA I SREDNJIH JAČINA POJEDINIH PRAVACA VJETRA

Pravac vjetra	C	N	NE	E	SE	S	SW	W	NW	SUMA
Čestina (%)	46,3	18,2	9,0	1,7	6,4	5,4	5,0	6,1	1,9	100,0
Jačina (Bofor)	-	1,8	2,2	1,7	2,9	3,2	2,5	2,2	2,1	-

*Nedostaju: podaci vjetra za 1962,1963,1964,1965,1970 za MS Čapljina

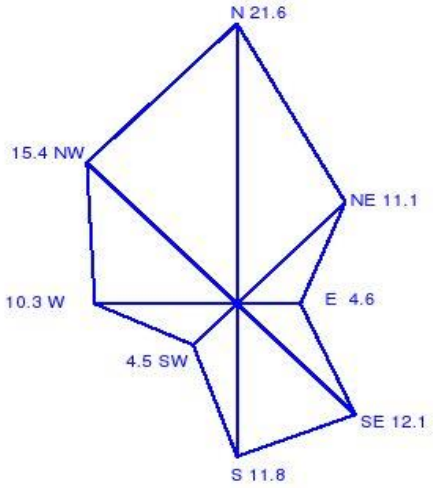
MS Ljubinje
Period: 1961.- 70. god*.

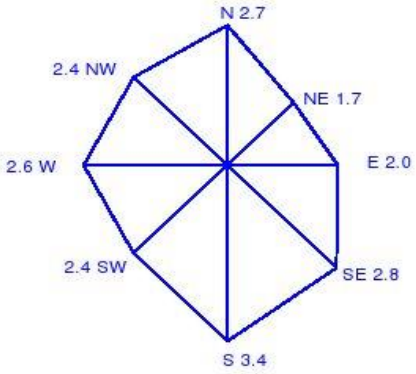
PRIKAZ ČESTINA I SREDNJIH JAČINA POJEDINIH PRAVACA VJETRA

Pravac vjetra	C	N	NE	E	SE	S	SW	W	NW	SUMA
Čestina (%)	24,8	13,2	2,0	1,7	15,4	14,0	3,2	4,5	21,2	100,0
Jačina (Bofor)	-	2,2	2,1	1,8	2,3	2,3	1,7	1,7	1,8	-

* Napomena: nedostaju podaci vjetra za godine 1964 i 1970. za MS Ljubinje

ČESTINE I SREDNJE BRZINE VJETRA ZA MS NEUM





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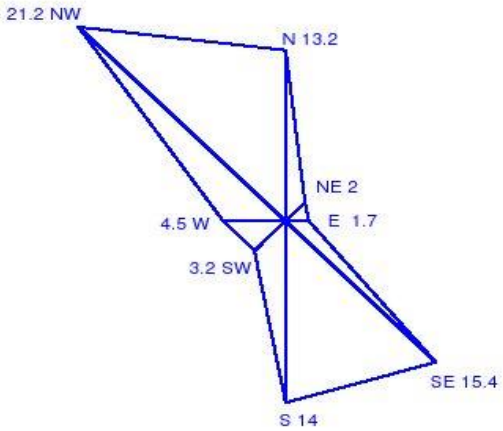

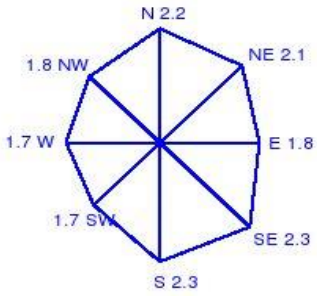

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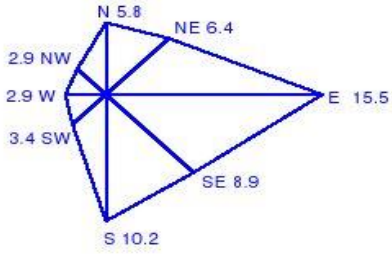
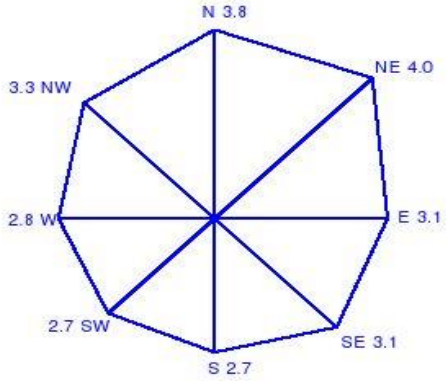
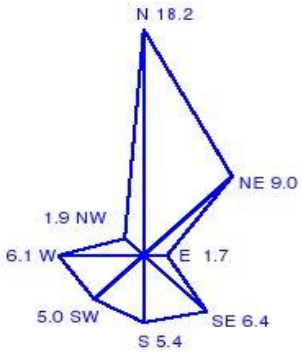
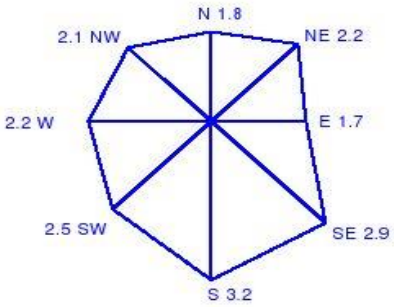




ČESTINE I SREDNJE JAČINE VJETRA ZA MS ČAPLJINA





3.3 Morphologic, geological, hydro-geological and engineering-geological characteristics

For the purposes of this Study, a field survey has been made, where the previous documentation is used, as well as results of previous realized geologic studies. As a starting point, some basic geological maps have been used, as well as sheets Ston and Metković in scale 1: 100 000 with interpreters. In the description of the geological structure, the observed alignment is divided into three sections:

- Section Stari Neum – Kiševo is approximately 3 km long and has already been built.
- Section Kiševo – Broćanac is approximately 8,5 km long and the Main design has been made.
- Section Broćanac – Drenovac app. 27 km long.

3.3.1 Section Stari Neum - Kiševo, km 0,00 - km 3+021

Morphologic characteristics
In morphological terms, the alignment is laid on a slightly rolling karst plateau with markedly karst relief forms. Along the alignment it notices many karst forms such as muzge, karrens, smaller karrens, kamenice and sinkholes formed by chemical decomposition processes of limestone under the influence of surface (rain) water. Karrens are represented with serrated čebelji, deeply carved in the rock mass. Sinkholes have relatively high frequency, the circular and oval shape with a depth of 10-20 m with cultivated flat bottom, covered with terra rossa and fine stone pieces. At the bottom of a karst sinkhole, beneath the covers there are usually masked abysses that allow rapid infiltration of surface water in the underground.

According to the degree of Karstification, the terrain along the alignment belongs to the so-called "pockmarked karst" with a high degree of Karstification. In the construction phase, it will require preparatory works for the closure (backfilling) of sinkholes on the alignment, landing low vegetation, Christ's -thorn and macchia, and the application of blasting work on the cutting breakthrough of the alignment.

Geological structure
Geological structure of the terrain in the wider environment is very complex. Considering geological formations it has been identified limestones; Paleocene - Eocene age (Pc, E), the lower, middle and upper Jurassic age (J_1, $J_{1,\ 2}$, $J_3^{1,\ 2}$) and limestone, dolomite and dolomite limestone of the lower and upper Cretaceous ($K_{1,\ 2}$, $K_2^{2,\ 3}$). Basically they make the geological substrate. This substrate partially covers Quaternary formations.
At the site of Stari Neum, Cretaceous limestones are slipped through the Paleocene and Eocene sediments and by systems of longitudinal and transversal faults are block fragmented into separate units and therefore give the character of the parquet bloc structure.

Quaternary formations are represented mainly by proluvium layers covering the geological substrate.

Hydrogeological characteristics of the terrain

In hydrogeological terms, the considered area, on the basis of porosity structure and drainage of litologic members, are basically rocks permeable to water and stones of intergranular porosity.

Rocks permeable to water are limestones and dolomites with split-karst porosity. They are characterized by good permeability to water and represent hydrogeological collectors, conductors. The largest part of the rainwater infiltrates quickly and strains into the deeper parts of the terrain. In the limestones with split-karst porosity, in the deeper parts it occurs to the formation of free ground water accumulation, broken aquifers along the network of crack canals and caverns that come up to the terrain surface in the level of local erosion bases in the form of sources or go underground to deeper parts of the rock massif.

Rocks of intergranular porosity are proluvium clayey stone particles concentrated on the bottom of sinkholes. They can form small lakes, but they quickly dry up or go over the abysses that are located at the bottom of the sinkholes.

In this section there is no surface flow, which indicates the very karst terrain. All surface waters in the zone of designed road infiltrate quickly in the underground so that in the construction phase there will not be a problem, and therefore safety measures are not foreseen.

Considering the surface flow, only a small lake is present (Vranjevo selo), which is located on the station km 1 +400, which is not drying up (see annex) and Vir source in karst depression. These flows are outside of our respective alignment and hence have no impact on the construction.

Engineering-geological characteristics of the terrain

The construction material of the natural terrain is represented by the following engineering-geological characteristics of the terrain: cohesive well petrified carbonated rocks and loose rocks.

Loose rocks are proluvium covers made of terra rossa mixed with limestone, but less dolomite stone particles and clay fractions. This covers are incurred by processes of physical decomposition of limestone and gradual erosion of decomposition products towards local depressions. Thickness of the proluvium cover is very variable depending of the Paleorelief of the substrate over which is aqueous.

During earthworks on preparation of the alignment upon backfilling of sinholes it will be required prior to remove the surface part of the cover up to the depth of 0,5 m.

Basic physical - mechanical parameters are given on the basis of previous investigation works and relate to:

- Angle of internal friction $\varphi_{sred}=30^0$
- Volume weight Y = 20,00 – 21,00 kN /m^3
- Cohesion c = 0 kN/m^2

Excavations in these covers according to GN 200 belong to the III - IV category.

The group of cohesive well petrified carbonated rocks consists of limestone rocksof different lithostratigraphic determination. They are widespread along the alignment. These are compact rocks, light grey to light brown colour, thick layered to banked texture and crystal to cryptocrystal structure. Tectonic are broken, with fracture discontinuitie, block separated and very karstified.
Position of stratification in relation to the disposition of the road and future facilities is very favorable. These layers due to tectonic processes have variable fall. Thus, the layers fall in the slope or gently inclined towards the road at an angle of 6 – 8^0
The rock massif are mostly represented by cracks right to the provision of stratification with elements of strata lay 226/72 (lay of the strata towards the road) and 138/48 and 66/54.
Besides the large crackings, these limestones have good physical-mechanical characteristics, and given the average values:

- Compressive strength in the dry state
  Maximum σ= 122,1- 128,0 MPa
  Medium σ = 94,0 - 96,0 MPa
  Minimum σ = 80,5 – 101,7 MPa
- Compressive strength in the water saturated condition 98,4 – 110,0 MPa
- Volume mass 2,65 – 2, 70 t/m^3
- Water absorption 0,16 – 0,22 %
- Persistence on the effect of frost steady
- Wear by grinding 12,8 – 13,8 $cm^3/50\ cm^2$

The terrain at the location is stable and suitable for building. According to GN 200, limestones belong to the V - VII category of the excavation, which means that in preparing the terrain to be essential use of explosives.

Considering the given hydrogeological and engineering-geological characteristics of the terrain, the road construction will carry out without major difficulties, except that in the preparation phase during the ground leveling some extended elevations in certain parts of the alignment need to be removed and that by use of explosives. This material can be used to create an embankment, and large isolated blocks can be placed in the embankment footing as a protection of embankment slopes. The embankment slopes of cuttings and notches must be able to customize the rock mass, i.e. degree of cracking, bloc separation and karstification, to avoid, in the phase of exploitation uncontrolled detachment and landslide of blocks on the road.
Slope of cuttings and notches, and according to experimental data, should range 2:1 to 5:1.
In the road construction phase, in notches of more cracked parts of limestones, the slopes are to be protected by wire mesh.

3.3.2 Section Kiševo - Broćanac, km 3+021- km 11+300

Morphologic characteristics

In morphological terms, the alignment follows mostly slightly rolling calcareous terrain with slope of 5-30^0 and reaches slopes of Dobrovo karst field and Žaba mountain. This field is a closed depression length over 2 km and a width of 1-2 km.

The road alignment starts from the Kiševo settlements and over areas of Lovornica passes 20^0 of slope by steep slopes, and then goes to the tunnel Oštrovac by slight slope of 2 - 5^0 . From the exit portal of the Oštrovac tunnel up to the Broćanac settlements, the alignment spans the eastern slopes of the mountain Žaba, which are very irregular slope of 2-20^0, local, and more.

Slopes are usually bare or covered with meager vegetation. Mostly karst-erosion processes are shaping contemporary forms of relief such as karrens, sinkholes, and karst depressions. This erosion is being developed under the influence of surface and underground waters.

All of these morphological forms have been conditioned and initiated by tectonic processes (putting on and reverse faults) and subsequently formed by denudation processes, chemical decomposition and surface erosion. Sloping processes are especially distinctive where there was an accumulation of small and large no root blocks, and its moving down the slope, as well as dispersal of solid rock masses.

Geological structure

Geological structure of the terrain make sediments of similar genetic backgrounds but different ages. These are the Upper Jurassic sediments ($J3^{2,3}$) and upper and lower Cretaceous ($^1K_1$, $K_{1,2}$, $K_2^{1,2}$) and quaternary sediments.

Upper Jurassic ($J_3^{2,3}$) is thick stratified and thinly stratified limestones, which extend from location Lovornica to the under local road for Babin do towards the tunnel Oštrovac. Thick stratified limestones are up to 1m thick, and thinly stratified (plate) 0,10-0,15 m. The dominant color of thick stratified limestone is white-gray, and thinly stratified limestones is gray-blue.

Lower and Upper Cretaceous ($^1K_1$, $K_{1,2}$, $K_2^{1,2}$) consists of limestone sediments with dolomite and dolomite limestones. It stretches from the entrance portal of the tunnel Oštrovac to the end of the alignment.

Limestones are massive, banked and thinly stratified texture. Thickness of stratified limestones ranges from 0,50-1,5 m, and thinly stratified 1 – 5 cm. Colors are white and white-gray.

Quaternary sediments in the form of a thin cover of eluvium-deluvium origin are very poorly presented. They are mostly dark brown clay with large or small blocks of solid rock masses. Thickness of clay with blocks of limestone is usually 1 to 2.5 m. In the deeper parts of the field, as a fill, appear clays-terra rossa that have got dark brown color from the remains of organic matter. They have poor geotechnical properties and should be removed.

In these rock masses tectonic movements caused significant mechanical damage. Sediments along the road alignment have three covers of "high karst" towards the village Dobrovo and Podžablje, i.e. spread on the southern slope of the mountain Žaba. In the central part there are two parallel reverse faults as well as a number of minor faults.

Hydrogeological characteristics of the terrain

By analysis of lithologic structure of the terrain, state of rock mass, structure, porosity, the possibility of movement and accumulation of ground water, these rock masses according to hydrogeological function can be extracted to hydrogeological collectors - conductors that make limestones and by smaller part the very rare and poor hydrogeological insulators in the cover. Limestones are intensely broken and present hydrogeological collectors of crack and cavernous porosity.

On the investigated terrain, there is no surface flows, because all the water from the surface goes and penetrates into the deeper parts of the terrain. The reason for this is expressed cracking and karstification of limestone.

The exception is only a small source on the station km 3+077.

So upon excavations of notches, cuttings and tunnels, bigger flow of the surface water is not expected, which mostly penetrates from the higher parts of the slope into the deeper parts of the terrain. During tunnel excavation, it may appear surface waters that directly penetrate in the form of a leak and drops.

On this part of the terrain, some significant hydrogeological phenomena are not asserted, except flooding of some lower parts of the karst field Dobravo during intense rainy periods. Then the estavel, which is located on its borders, cannot receive all surface waters and it comes to its outpouring. The designed alignment is located on hypsometric higher terrain so that it cannot come to the flooding of this part of the alignment

Engineering-geological characteristics of the terrain

Based on the general assessment of geotechnical conditions, this section is divided into 4 approximately homogeneous zone. The basic criterion for the separation of zones were lithological composition, engineering-geological, hydrogeological and geomorphological features of the terrain that are necessary for the performance of cuttings, notches, embankments and tunnels. Within these zones there are subzones and they are processed in details in the main design. In this part of the report it gives a brief overview of the field per zones with engineering-geological and geotechnical aspects. Featured zones include:

I zone from km 3+021 – km 5+806 total length 2785 m
II zone from km 5+806 – km 6+777, total length 957 m
III zone from km 6+777 – km 7+011, total length 234 m
IV zone from km 7+011 – km 11+735, total length 4724 m

Rock masses that build the terrain in a wider and closer area of the future alignment the engineering-geological terms can be divided into two groups: cohesive well petrified carbonated rocks and loose rocks.

The first zone is characterized by massive and very karst limestones, thick stratified and thinly stratified. Position of layers relative to the alignment is favorable.

The terrain is characterized by distinctive karstification process in which are formed karrens and small caves, as well as fissures in places with cavernous widenings full of clay fillings. Cracks and karstification processes adversely affect the development of the future road, because they separate rock mass and form unstable blocks so that during the excavation it may be a moving and falling out from future slopes of notches and cuttings.

Loose rocks made geologic cover made of dark brown clay with limestones blocks.
All excavations in this part of the alignment will be by GN 200, performed in limestones that are banked, layered and massive, and correspond to the VI category of the excavation.
The second zone is characterized by representation of thick stratified and thinly stratified limestones, Upper Jurassic period and massive banked limestones of upper and lower Cretaceous.
Slopes along this zone are slightly rolling, while the lower part of this zone is the flat part. It is characterized by distinctive karst forms of relief such as karrens, caves and small sinkholes. Tectonic terrain is quite broken with the presence of split families that stretch on stratification even. Geological substratum mainly builds a whole terrain, and only small parts are covered with humus cover up to 0.5 m thick.
According to GN 200 future excavations would be carried out mainly in limestones, which correspond to category VI.
The third zone covers an area of the route of the future tunnel Oštrovac. It is characterized by mountain relief with steep calcareous section at the entrance portal and the mild slope in front of the exit portal.
Limestone rock mass is strongly tectonically deformed, but has considerable balanced lithologic composition and geological structure. In this zone there are unstable slopes in the form of landslides of limestone blocks that occur on the slopes. They are located on the station km 6 +777- 6 +822.
Route of the tunnel is located in the homogeneous structural block that builds massive banked and thick stratified limestone from the entrance portal and thinly stratified limestone to the exit portal.
Calcareous sediments are very broken with numerous cracks perpendicular to stratification plane and superior small faults. Cracks are usually perpendicular to stratification plane, open (gaped) without fill or only in certain parts with the filling, and their walls are usually flat. In addition fraction forms, Karstification is distinctive in banked and thick stratified limestones along the stratification plane and cracks, as well as rootless blocks located on the surface of the ground above the entrance portal. In this part of the tunnel was observed phenomenon of instability that is expressed in the form of rock blocks and crumbling of crushed-clay material. At the exit of the tunnel, thinly stratified limestones have favourable course, perpendicular to the alignment and with a fall of stratification in the direction of the road.
In relation to the geological composition and according to GN 206, this tunnel is one of the easy tunnels. Excavation of the tunnel will be performed in 1 and 2 category.
Physical - mechanical properties of limestone rock massifs are given on the basis of geotechnical observations of the asserted soil and solid rock masses and using empirical data and relate to the massive, banked, stratified limestone.

Physico-mechanical properties of limestone massifs:

Massive, bankoviti and stratified limestones	Thinly stratified limestones
• Volume weight Y =26,0 kN/m^3	Y =26,0 kN/m^3
• Compressive strength σ=135 MPa	σ =92 MPa
• Angle of internal friction φ= 50^0	φ = 45^0
• Cohesion c = 0,4 MPa	c = 0,2 MPa
• Modulus of elasticity E_e =19 000 MPa	E_e =16 000 MPa

- Modulus of deformation E_d = 7614 MPa E_d = 4500 MPa
- Poisson's coefficient μ= 0,30 μ = 0,25

The fourth zone is characterized by banked, massive, layered, and thinly stratified limestones of Cretaceous age. Banked limestones are of thickness greater than 1 m, while the layered from 0.40 to 0.60 m and the thinly stratified 0.20 to 0.50 m.
In this zone some unstable covers appear in the form of rootless limestone blocks that are located on the slopes. In the future performance of cuttings and notches along these unstable zones it can reach to slip and slide. Area affected by this rock blocks includes a slope over the future alignment in the belt of 80 m width. These are zones of km 7+338 - 7+863 and km 11+257 - 11+506 (see appendix). In the rest of the alignment, the rocks are tectonically disturbed with distinctive tectonics and Karstification. Position of stratification and splits is more favorable from the standpoint of stability as influenced by tectonics they extend in a different direction, and mostly in a slope with the relatively steep slope angle. In this part of the field there is a dominant geological substratum - the limestone that by GN 200 can be placed in category VI. The cover in the form of clay component is mainly formed by chemical weathering of limestone and is formed in the lower parts of slopes or transported by atmospheric waters into the deeper parts of the terrain along the cracks and caverns. There is no greater importance for construction of the alignment. All excavations will be carried out in basic geological substrate - limestone.

3.3.3 Section Broćanac - Drenovac, km 11+300 – km 38+341

The alignment of the designed road, Broćanac-Drenovac, starts from the station km 11+300 and ends at station km 38+341. Total length of the road is 27,041 kilometers. This section is analyzed and marked in the map by blue color. The alignment starts east of the village Broćanac and generally follows the existing road corridor. The road alignment starts from the end of Kiševo-Broćanac section and then continues eastward to Papratnica and Hutovo where bends brusquely northwards to Cerovica. At km 13+000 it is separated from the existing road and at the station approximately km 15+200 to 15+400 and from km 15+660 to km 16+340, it enters the tunnel and by part of the sloping terrain continues through natural deep valleys up to Cerovica. At Cerovica the road alignment bends again eastward to Udor and Ober on station km 31+000, following the existing road, mostly from its right side.
From Udor the alignment bends again brusquely northwards to Kadic Dubrava, in km 34+000, then in a wide arch, turns to the east to the Drenovac at station km 38+341. Along this line, the alignment is mostly laid on a large mild rolling karst plateau with elevation from 340 to 360 m, and only in a small part it is sloping, from 13.0 to 17 km.
It is important to note that on the alignment from station, about 28 km to 29 km, and at the initial part of the alignment km 38+341, there is a minefield whose presence testifies clearly a warning sign next to the road.
Geological view of the terrain will be given in three parts. The first part discusses the line from Broćanac up to the valley between Osoja and Prisoja. The second part to the village Cerovica. The third part from the village Cerovica to the end of the designed alignment.

Morphological characteristics

In morphological terms, the first part of the alignment passes through a part of leveled plateau that gradually crossed over the saddle in the area of Obodina. Then, the alignment goes lower valley-type side that is transected by valleys, which would be bridged over by viaduct. Then the alignment enters into the massif of Kičin mount. Upon leaving the tunnel, the alignment goes rim of the massif. Along this part of the alignment in morphological terms it perceives a surface karst in the form of small karrens on level ground parts, while in parts of the sloping sides, the massives are built of layered limestones. They are the most widespread in this part of the field with a slight fall in the hill.

The second part of the route mostly follows a mild rolling calcareous terrain on sloping side of the hill Osoje and continues over the leveled plateau to Cerovica.

The third part of the alignment continues generally flat plateau covered with numerous sinkholes and karrens with a very mild slope. At the bottom of karrens the terrain is usually filled with terra rossa, where in some places is overgrown by vegetation in the form of low vegetation. According to the degree of Karstification that is usually pockmarked karst.

The morphology of the terrain along the road alignment is generally assessed as favorable, due to lower denivelations in longitudinal and transversal direction, but with standard karst topography. Given these geological particularities, we can conclude that the geomorphological forms vary by time of origin, material, course direction, shape and height.

According to the geological structure, in the observed field are allocated following genetic categories of relief

- fluvial - accumulation relief,
- gravitational - diluvial relief,
- karst – erosion relief

Fluvial - accumulation relief originated from accumulation processes within the contemporary casual and permanent water flows. In the structure of the fluvial-accumulation relief participate proluvial deposits of clay-sandy soil- gravel composition. At site these are smaller or larger flat fields formed by the connection of major karst sinkholes or small karst depressions. It occurs by erosion of fine grain material after snow melting or more abundant rainfall upon physical and chemical wear of carbonate rocks and the physical decay products in the local depressions in the karst.

South of Broćanac, outside the study area extends a large Gradačačko field, northwest - southeast, which is by a mountain massif Brštin - Malokrn - Trnovi Do separated from the smaller Broćansko field. Broćansko field extends from the beginning of the alignment at Podžablje and Broćanac to the station km 12 + 300, the average height of 212 to 220 m. The second field is located in Prapratnica. It was created by merging three smaller karst depressions, with only a small portion comes to the designed road between 14 and 15 km. From 16 to 18 kilometers, at the area of Hutovo, from the right side of the road alignment there is a large elongated depression along the stream bed of old dried water flow that is filled with small-grained material of proluvial origin. In the area of Cerovica from 21 km to 22 km in extremely karst environment there is a small field, and at Udora and Matića

quarters of two smaller fields in two different hypsometric levels, first at level 220 to 250 m, and the other at level 140 to 150 m. Bottom of the above-mentioned fields are leveled, covered with red to brown sandy clays mixed with a small-grained rock debris: The aforementioned fields are oases of arable surfaces where crops are grown. In the area of the Bročansko field there are olive seedlings.

Gravitational - diluvial relief is spatially limited, on sloping parts of the terrain beneath the steep limestone massifs and cliffs. The relief of this category consists of a steeply inclined sides of uniform slope, conical shape with expanded footing in the toe and narrow frontal part, which usually ends in the groove depression. These are actually rock creeps made of calcareous rock debris and blocks, which as a rootless bodies „swim“ in rock debris over the plastic substrate. In addition the rock creeps, in some places are represented stone jackets in a form of plazeva that mark the geological substrate, of the uniform slope. Gravitational-accumulation relief is isolated at the beginning of the alignment from the left side of designed road below the steep cliffs of Mount Glavica and at 24 km.

Karst - erosion relief has the highest spatial presence. Located along the road alignment, in terrains made of carbonate rocks, limestone and dolomite of Cretaceous and Paleogene age, in the area of Broćanac, Papratnica, Cerovica and Drenovac, then in the area of Ranče hills, this relief consists of a steep cliff hardly passable, among which there is a large mild rolling plateau with specific micro and mezzo-morphologic relief forms whose origin is related to complex karstification processes.

Otherwise, along the road alignment it may notice numerous karst micro-morphologic forms: muzge, karrens, smaller karrens, kamenice, sinkholes, smaller karst depressions and the aforementioned karst fields, whose origin is related to the process of chemical decomposition of limestone under the influence of surface (rain) water. In particular, karrens are presented with a serrated čebelji (partition walls), deeply carved in the rock mass, which complicate significantly porosity of the rocky soil. However, the most common forms of relief are karst sinkholes, with relatively high appearance frequency, circular to elliptical shape, of diameter 20 to 50 and more meters, the depth of 10 to 20 m. They are characterized by steeply sloping sides to the valley bottom with a flat cultivated bottom, filled with terra rossa, with fine rock debris. At the bottom of the sinkholes below proluvial cover there are usually masked abysses that allow rapid infiltration of surface waters in the underground. Sinkholes are often irregurally spaced in calcareous massive, and sometimes appear in the form of linear series covering faulting structures. In Drenovac next to the sinkholes there are also some smaller karst depressions.

Based on field observations, according to the frequency of appearance of micro-morphologic forms in karst areas, two categories of the karst are selected in the observed area by the degree of karstification:

- **Very karst field** with great appearance frequency of sinkholes (over 50 on 1km^2) of ring and funnel-shaped, with deep karrens and small karst depressions created by merging two or more sinkholes. Because of the characteristic forms of relief, terrains of this category are called „pockmarked karst“. Very karst ground is

isolated from the beginning of the alignment to 14.0 kilometers, and than from 18.0 kilometers to 23.5 kilometers

- **Medium karst field** is isolated along the road alignment from 14.0 to 18.0 kilometers and than from 23.5 kilometers to the end of the alignment. This category includes fields with 20 to 50 sinkholes on 1 km^2 of area. Sinkholes are usually ring shape, shallow, with terra rossa at the bottom, which masks the abysses in the rock massif.

In the construction phase of the road, and besides the favorable morphological conditions it will be required a performance of significant scope of preparatory works in those parts of the alignment where it passes through some karst sinkholes, because they need covering (backfilling) and removing of low vegetation, Christ's - thorn and application of blasting works on breakthrough of the road alignment. Therefore, upon implementation of the alignment through the very karstificated terrain, it is proposed to avoid maximum deep sinkholes and smaller karst depressions, and that the alignment mostly goes over ridges separating certain sinkholes. Given the easy communication of the current road towards the designed alignment a prosperity is that works on new road construction can take place simultaneously with the more offensive points.

Geological structure

Geological structure of the terrain consists of sediments of similar genetic origin, but of different age. These are the Upper Cretaceous sediments ($K_2^{1,2}$, $K_2^{2,3}$, K_2^3), the Paleocene and Eocene (Pc, E, E_1) and quaternary sediments (see appendix).

In lithological terms these sediments are mainly limestones and subordinate dolomites. Limestones and dolomite of the upper Cretaceous ($K_2^{1,2}$) build the southern slopes of the mountain Žabe as well as a narrower area of the village Udora. These are mostly good stratified limestones that alternate with dolomite and dolomite limestones. The thickness of layers varies from 30 - 60 cm, and the rarer thinner to 20 cm. Limestones are microcrystalized and crystal structure. They are usually brown, brown-gray and gray color.

Limestones and dolomite with rudists ($K_2^{2,3}$) are widespread west and east of the village Cerovica and north of High carst (northeast of the village Crnoglav until the end of the considered road alignment). In the northeastern part of the field are mainly present limestones of gray, brown-gray and light gray color. Its stratification is poorly expressed. They are usually massive and banked. In the southwestern part of the terrain these layers are developed differently as reflected in the narrow presence of dolomite. Dolomite layers are in packages over 20 m.

Limestones with keramosphaerina and rudists (K_2^3) are located in the northwest and north-east part of the field between Hrasno and Čavša on the edge of the Popovo field. Gray, light gray to white color. In the lower parts they are stratified, and in the higher parts unstratified. They often break down on the surface in laminated fragments where it is easy to see them on the ground.

Liburnian limestones (Pc, E) lie discordantly in relation to the upper Cretaceous sediments. On the terrain they appear as broad or narrow belts where peer beneath alveolina - nummulites limestone or they are stuck between the Cretaceous limestone

with reverse faults. They are usually preserved in the Cretaceous-Tertiary synclinals. At all sites they are presented as dark brown, brown, ash gray, and rarely black bituminous limestones. They are well stratified with layer thickness of 20-40 cm. They occur in the wider area of the village Crnoglav and west of the village Vinine and Kučinari.
Alveolina - nummulites limestones ($E_{1, 2}$) occur wherever there are Liburnian layers. Liburnian limestones are darker colors while alveolina- nummulites limestone are brighter, white and more crystalline. They are poorly stratified and are often massive and banked.
Quaternary deposits occur mainly in the form of a thin clay-rock debris covers that are concentrated in the valleys and karst sinkholes. Along the road alignment its presence is often neglecting. Proluvium and colluvium deposits are selected of Quaternary sediments. Proluvium deposits are sand, gravel and rock debris, and colluvium deposits are made of the physical processes of limestone decomposition.
In the structural-tectonic terms, this terrain is characterized by structurally - facial units Ston and overthrust of the High carst. According to realized tectonic reionization, the considered alignment belongs to the overthrust of the High carst, in which are selected three specific structural-facial units:

- Structural-facial unit Biokovo - Smokovljani
- Structural-facial unit Hutovo and
- Structural-facial unit Hrasno

Intense tectonic derangement significantly affected the engineering-geological properties of rock masses primarily to increased cracking, fragmentation and block fragmented carbonate rocks.

Hydrogeological characteristics of the terrain
By analysis of lithologic structure of the terrain, state of rock mass, structure, porosity, the possibility of movement and accumulation of ground water, these rock masses according to hydrogeological function can be extracted to:

- pervious areas with intergranular porosity and
- pervious areas with fissured and fissured-cavernous porosity

Pervious areas with intergranular porosity are made of proluvium clayey rock debris at the bottom of sinkholes. They represent pervious areas with intergranular porosity. According to its position in the terrain structure, pervious rocks represent the hydrogeological collectors conductors, which means that most of the rainwater quickly infiltrates to the deeper parts of the field, without the possibility of creating a reservoir of free groundwater, while only a small part of the surface waters stream.

Pervious areas with fissured and fissured-cavernous porosity are isolated in the Mesozoic carbonate rocks: limestones and rarely dolomites of the Upper Cretaceous ($K_2^{1\,2}$, $K_2^{2,3}$, and K_2^{3}), and Cenozoic, the Paleocene - Eocene limestone and Eocene age. In the limestone, due to tectonic deformation, large cracking and karstification, has been created a very specific surface and underground hydrography determined primarily by very complex tectonic processes and a high degree of Karstification.

These areas are characterized by good water permeability and transmissivity, water scarce on the surface, and in deeper parts these are waterabundant areas, of a large space, which empty in deeply cut river valleys. According to the structure of the porosity, in them are formed reservoirs of free groundwaters of broken type along the network of fissured channels, deep in the rock massif, which mainly depends on the depth and degree of karstification of carbonate rocks. Groundwater is usually drained to the level of local erosion bases through sources and springs of variable yield. Cretaceous limestones are the basic aquifer environment, and the direction of groundwater flow is primarily conditionned by the course of fault structures, i.e. which serve as the privileged directions for the migration of groundwater. Older faults of northwest - southeast have predominantly a function of barriers, while younger faults perpendicular to the Dinaric direction of the course, enable the migration in the cross direction to the southeast. Recharge, i.e. storage of groundwater reserves is carried out multiple:

- in areas where the Cretaceous limestones and dolomites are present on the terrain surface, recharge is done directly by influation and infiltration of atmospheric precipitation;
- underground inflow form west and northwest direction

Pervious areas are singled out in parts of the terrain where in the geological column limestones and dolomites alternate, i.e. rocks with fissured and fissured - cavernous porosity. This environment is characterized by generally changing the porous and poorly pervious rocks, but considering very variable presence of limestone and dolomites some aquifers are formed in them in variable yield. Dolomite and limestone of the upper Cretaceous ($K_2^{1,2}$ and $K_2^{2,3}$) belong to this category.

Poor pervious to waterproof areas have significantly less spreading in the investigated space. Larger parties of dolomites with fissured porosity represent aquifer areas of a very small yield, which in this case they represent the relative base hydrogeological insulator of karst collector of Cretaceous limestones. On parts of the terrain where the tectonic processes brought dolomites to the same level with limestones, they have the function of lateral hydrogeological barriers. The spatial position of pervious and waterproof rocks in the terrain structure conditioned discharge of groundwater from aquifers mainly to lower elevations of the terrain in the form of sources and springs, of variable yield.

A typical karst hydrography is developed in this area. This means that because of the large tectonic deformation, cracking and Karstification of rock masses there is no possibility to create a permanent surface flows, but in the deeper (waterabundant) parts of the rock masses it achieves the circulation of groundwater through the systems of karstified fault structures and the fracture systems that are interconnected to systems of underground channels. The fault systems are the main conductors of groundwater. In smaller karst sinkholes, during abundant rainfall, due to higher concentration of clayey material in the superficial parts of the terrain, some smaller ponds may be formed short time, which across the abyss at the bottom of the sinkholes relatively quickly dry.

During excavation of the notches, cuttings and tunnels it is not expected higher flow of surface water, which from higher parts of slopes mostly penetrate deeply to the terrain. Upon the excavation of the tunnel may appear surface water that directly penetrates in the form of a leak and trickle through the privileged directions of the cracks and faults.

At this part of the terrain some significant hydro-geological phenomena are not asserted except for a small pond located at Prapratnica and Hutovo. The designed alignment is located to hypsometric higher ground so that it can not endanger the existing alignment. It is characteristic and observed that at the entire length of the considered alignment there are a large number of cisterns (tanks). Some of them are used for water supply of surrounding villages.
Along the considered alignment of the designed road, only one periodic water flow is selected at Hutovo that intersectes the road alignment to 17 km. The source of this stream is located in the area of very karst terrain where, during the spring months after more abundant rainfall, an excess of water from the karst aquifers flows on the surface and in the area of Hutovo penetrates again in calcareous massif.

Engineering-geological characteristics of the terrain
In the structure of natural terrain are present the following engineering-geological characteristics of the terrain: cohesive well petrified carbonated rocks and loose rocks. In the group of cohesive well petrified rocks there are limestone and dolomite of different lithostratigraphic affiliation. They are spread along the alignment.
Limestone are brown, dark brown, light gray and white, stratified to banked and massive texture and crystal to the cryptocrystal structure. Limestones are laid down on the surface, along the alignment as a solid compact rocks, tectonic broken and with fissured discontinuities, block fragmented and karstificated with expanded fissure channels with or without clay filling. Stratification as a structure element has a variable spatial orientation from northeast to southwest.
Position of stratification in relation to the disposition of the road and future facilities is very favorable. Thus, the layers fall in the slope or gently inclined towards the road at an angle of 10 -15^0.
This is especially distinctive in the first part of the alignment in the area of the viaduct and tunnel. Layers fall into the slope. Stratified limestones are found in the route of the future tunnel. Excavations, such as notches, cuttings and viaducts according to GN 200 will be carried out in the VI category. Tunnel, according to GN of 206, based on the geological composition is one of the easy tunnels. Excavation in the tunnel will be performed in the 1. and 2. category. Detailed overview of the categories of excavation will be shown in subsequent phases of the project.
In the second part of the alignment, the road alignment is in tectonic broken massive and banked limestone and dolomite. Excavations in this part, according to GN 200 will be also carried out in V-VII category.
The third part of the algnment is characterized by mostly tectonically broken limestone, isolated and rootless calcareous blocks. These layers are mostly massive and banked. Flat parts of the terrain with sinkholes and karst depressions cover a thin clay – rock debris cover with calcareous rock debris. These are mainly loose rocks. Excavation which pass through these covers will be carried out in category III and IV, and excavations that will take place in the geological substrate-limestone, will be performed according to GN 200 in the VI category.

Generally, these limestones are of good physical - mechanical characteristics and favorable for construction conditions. Thus, besides cracking in limestone, the average values of the results of previous regional engineering-geological investigations are given. Average values of physical and mechanical properties of the Upper Cretaceous limestone (locality Broćanac-Stolac) are:

- Compressive strength
  In dry condition σ = 98,7- 118,2 MPa
  In water saturated condition σ = 88,2 – 100,6 MPa
  After 25 cycles of freezing σ = 84,0 – 88,0 MPa
- Volume mass with cavities and pores Y=2,62 – 2, 68 t/m^3
- Volume mass without cavities and pores Y=2,69 – 2, 70 t/m^3
- Wearing resistance by griding (cm^3/50 cm^2) =11,9-13,9
- Resistance of the edge to impact =5,02-6,6
- Wearing resistance (Los Angeles) =22,8-24,8
- Water absorption =0,21-0,38
- Frost resistance =resistant
- Porosity = 1,10-1,90
- Volume mass coefficient =0,98-0,99
- Contents of sulphate =0,01-0,02
- Contents of sulfides =0,10-0,11

The terrain at the concerned location is stable and suitable for building. According to GN 200, limestones belong to the V - VII category of the excavation, which means that in preparing the terrain to be essential use of explosives.
Dolomites are stratified, with banked and massive texture and crystal (saccharoide) texture. They are tectonically heavily damaged, block fragmented by split systems and surface decomposed. They are white, light gray to gray-white color. In the surface areas of the terrain, they are often grus and turned into sandy fraction, which by the local population is used as a building material instead of sand. Geo-mechanical properties of grus are relatively favorable, and the compressive strength within the rock mass varies significantly depending on the degree of surface weathering.

Based on the results of previous engineering-geological investigations of the South Adriatic from dolomite at Kučinar and Ranče hill, the following physical - mechanical parameters are obtained:

- Compressive strength
  In dry condition σ = 82,3- 129,2 MPa
  In water saturated condition σ = 78,2– 120,6 MPa
  After 25 cycles of freezing σ = 67,4 – 97,0 MPa
- Volume mass with cavities and pores Y =2,68 – 2,78 t/m^3
- Volume mass without cavities and pores Y =2,79 – 2,84 t/m^3
- Wearing resistance by griding (cm^3/50 cm^2) =11,6-30,3
- Resistance of the edge to impact =5,2-8,52
- Wearing resistance (Los Angeles) =24,3-33,0
- Water absorption =0,19-0,38

- Frost resistance =resistant
- Porosity = 1,10-1,90
- Volume mass coefficient =0,98-0,9
- Contents of sulphate =0,01-0,03
- Contents of sulfides =0,08-0,11

At grus fragments, a compressive strength has immeasurable value.
In the surface conditions, grus fragments of substrates are subject to relatively rapid processes of erosion destruction and denudation erosion. From the above-mentioned reasons, it is proposed, that in any excavation in these materials upon reaching the required depth, it should accede immediately to building in material and bury surplus of the excavation to prevent the devaluation of qualitative and quantitative properties of substrates.
According to GN 200 - dolomites belong to the IV - VII category of excavation.

Loose rocks are covers made of terra rossa mixed with limestones, less dolomite rock debris and clay fractions. Proluvium and colluvium covers make them.
Proluvium cover is identified in the flat bottom of large karst sinkholes, karst depressions and karst fields. In the cover there is a rare chance to meet single blocks, which as rootless bodies float in rock debris material. These covers are incurred by processes of physical decomposition of limestone and the gradual erosion of the decay products to local depressions. In these depressions, by the local population has made a cultivation of the surface layer in order to grow crops. Proluvium cover thickness is very variable depending on the paleoreilef of the substrate over which it is aqueous.
In the execution phase of earthworks on the preparation of the alignment during backfilling of sinkholes it will be required prior to remove the surface of the cover to the depth of 0,5 m. Rock debris with less participation of clay fractions can be used to create an embankment.

Basic physical - mechanical parameters are given on the basis of previous researches and relate to:

- Angle of internal friction $\varphi_{sred}=30^0$, $\varphi_{max}35^0$
- Volume weight Y = 20,00 – 21,00 kN /m^3
- Cohesion c_{sred} = 0 kN/m^2, c_{max}=10kN/m^2

Excavations in these covers according to GN 200 belong to the III - IV category.
Colluvium cover represents a product of decomposition of geological substrate under the influence of exogenous geological agents. It is located in hypsometric higher parts of the terrain. In terms of material composition these are pure or clayey calcareous rock debris with rare single isolated blocks who like rootless bodies „float“ in the rock debris material.
Geo-mechanical properties of the cover are favorable, so that it can be used to build embankments of road structure. Colluvium cover thickness is very variable and ranges from 2.00 to 4.0 m.

For the purposes of PSP Čapljina in the terrain massive was built a hydropower facility, feeder-drain tunnel. The tunnel passes between stations km 21 and 22, below the designed road part. The tunnel goes from Popov field, beneath Mount Treštnica, Gradina (626m), in the area Poljutak, Cerovica village and further in the area of Cerov up to Mlinsko hill north to Svitavsko blato (see appendix). When building the future alignment it should have this in mind.

3.4 Seismisity of the site

Defining the seismic hazard intends to provide the necessary information to determine some acceptable seismic risks, the concerned technical - technological systems. This system is integrated into the space that is defined by solid coupling of the terrain (natural environment)- the created system (highway) and the social environment posed by users. The natural environment makes the basis of road structure on which the traffic takes place, while the created system makes the road structure with the highway and the accompanying engineering facilities that participate as its integral part.
In the specificity of the highway it should include also its line character and, as such, it is on the seismological maps in areas of varying intensity. Current seismological map consists of more Oleate, which are made for different periods of time and on them, for the same area, there are different intensities of earthquakes. As the choice of Oleate of seismological maps is related to the category of object that is being built at a given location, and components of the highway are also objects of different category, to estimate seismic hazard and acceptable seismic risk for the highway is a complex task. In addition, some partial hazards and risks of individual buildings are present, which should be integrated in general, and thus define the acceptable risk of complex transportation system such as modern roads.
By innovation of Rules for high buildings in seismic areas, on choice of an appropriate seismological map, there was the desire to integrate, in rational designing, some elements of seismic risk method. The reason for this approach was that the occurrence of strong earthquakes during the period of exploitation of the facility are rarely seen, and the way itself of their influences has a great degree of uncertainty. Hence, the analysis of damage to structures is based on a certain level of acceptable risk, or confidence level of earthquake occurrence. For these reasons, in practice two concepts are introduced as follows:

1. **Designed earthquake** that can be expected to occur during the period of exploitation of the object one or more times. For this earthquake, a level of damage is to be controlled in the design phase and provides the basic seismic stability of the basic building constructive system, taking into account the nonlinear behavior of the object and allowing its constructive and nonconstructive slight damage.
2. **The maximum earthquake** is the earthquake which is expected to happen, with very small probability, during the period of exploitation of the object. As maximum earthquake, seismic effects are defined to check the seismic stability of the basic building constructive system, taking into account the nonlinear behavior of the object and allowing greater damage of constructive and nonconstructive

elements, but at the same time the overall stability of the object must not be endangered.

Assessment of seismic hazard, ie the base level of seismic intensity was performed on the basis of the current Seismicl maps and Seismotectonic map of Bosnia and Herzegovina. Since 1987. to assess the reference earthquake for a certain area, it uses the Seismic map of Yugoslavia, which consists of more Oleate. The investigated area around the highway is in different seismic zones for different return periods. So, on the basis of available seismotectonic data and data from Seismic map, a large area of Neum and Stolac belongs to the seismic zones of varying intensity. On the maps, for different time periods, it is shown the intensity of earthquake, whose probability of occurence at least once, in that time period, is 63%, which means that the default period is equal to return period of the earthquake.
Wider area of Neum belongs to the zone that is characterized by typical earthquakes of intensity of 7-9^0 MCS scale. In the wider considered area, a basic level of seismicity for different return periods for the alignment Broćanac-Drenovac is: 7^0 for the return period of 50 years, 8^0 for a period of 100, 200, 500 years and 9^0 for 1000 and 10 000 yr.
In the wider environment of Neum, there are more seismotectonic blocks with the specific mechanism and character of movement. However, on the basis of insight in the seismotectonic circuit of this area it can be noted that the area of Neum with near hinterland is activated by earthquakes mostly from the area of overthrust of the High karst, which follows the coastal belt, with a maximum registered earthquakes intensity of 9^o MCS scale. In this part, along the fault course the northwest - southeast following the overthrust of the High karst, there is a very active seismic zone with high frequency of earthquakes, which particularly endager the coastal belt around Neum and Dubrovnik.
In our current legislation, some buildings are categorized differently, so the question is how to use the above-mentioned maps and how to determine the seismic hazard for the given environment in a function of the defined period of exploitation of facilities.

Formula based on which we can determine the earthquake return period "T", ie which seismological map and its Oleate should use for the set lifetime of objects exploitation, "t" (measured in years) and the default risk, "Ri" (expressed in percentages) as follows:

$$T = \frac{-t}{\ln(1 - R_i)}$$

For example, using this formula we get that for the lifetime of objects exploitation of t = 50 years and the size of risk R = 10%, it should use the seismological map, for the return period of 500 years. On these maps, a basic level of seismicity for the wider area of the considered alignment is 8^o MCS.
Based on literature data, the narrower and wider area of Neum and Pelješac, belongs to the seismically active area that is activated by earthquakes from its own seismic focus. Maximum occured earthquake in the area of Ston was 1962. It had the intensity of the 8^0 MCS with magnitude of earthquake 6.4 Rihter scale and caused a great damage in the city and surrounding areas.

3.5 Hydrological characteristics

At the line of course, the road alignment does not come in conflict with any surface flows. Fissured structure of the existing terrain is such that it provides an excellent drainage, so it can be concluded that in hydrographic terms the conditions are favorable on the route.

Section Stari Neum-Kiševo
At the line from P57 to P59 in the rainy period comes to flooding of the field, so during construction of an embankment, it is necessary to make the replacement of the existing surface covers made of earthen material with stone material of larger fractions (broken stone) without substantial presence of fine grain particles, in order to avoid the risk of leaching of materials. Backfilling by such material is necessary to make up to the high of flooding.

Section Kiševo-Broćanac
Due to large fissure of rock masses that are permeable to water and waters from the upper parts of the slope for the most part will sink into the deeper parts of the terrain. Upon engineering-geological mapping of the terrain it is not identified some significant hydrogeological effects, except flooding the lower parts of Dobravskog karst field during intensive rainy periods when estavel which is on its edge can not accept all surface waters and it comes to its spills. At station km 3 +077 there is a smaller source.

Section Broćanac-Drenovac
Fissured structure of the existing terrain is such that it provides an excellent drainage, so it can be concluded that in hydrographic terms the conditions are favorable on the route. Due to large fissure of rock masses that are permeable to water and waters from the upper parts of the slope for the most part will sink into the deeper parts of the terrain. Upon engineering-geological mapping of the terrain it is not identified some significant hydrogeological effects, except for small ponds located at Prapratnica and Hutovo. The designed alignment is located at hypsometric higher ground, so that it can not endanger the existing alignment. The ravine of Vrtok field and Popovo field is the compensation basin RHPP Čapljina.

3.6 Soil and agricultural areas

Terms of reference envisaged an analysis of soil and agricultural land area in the corridor to 100 meters on both sides of the road band for the selected alignment.

Considering the physical coverage, three land use categories are defined: (i) forest land area, (ii) agricultural land area, and (iii) other land area.

It is stated the areas of defined land use categories, and isolated zones in the bonified and economic sense. Agricultural land area is completed into three zones: (i) the first agro zone with the most valuable agricultural soils, where most production is achieved with the most significant economic effects, (ii) the second agricultural agro zone where there are certain limitations on the production of agricultural and food products (soil characteristics, the use of machinery , the number of production cycles, etc.), and (iii) the

third category of agricultural land area where there are significant limitations and that in terms of the natural features of production space, and use of mechanized means, and in this sense it is possible to realize only extensive concept of agricultural production.

For the realization of this environmental segment were used:

- Analysis of the alignment from the project documentation at the level of Preliminary design,
- Visitings the alignment and stating the real situation,
- Analysis of the alignment and input of elements in the corridor with the set alignment on the background with ortho-photo records,
- Positionning and defining the present agricultural land area.

Analysis of the land area resulted in creating thematic maps:

1. Presentation of the use values of land area,
2. Presentation of the agro zones in the set corridor,
3. Presentation of the characteristic forests in the set corridor,
4. Presentation of the present categories of soil and agricultural land area.
5. Presentation of the present soil types in the set corridor.

Methodical approach

All stated elements are digitized in the form of GIS, and after vectorization surfaces were obtained for all defined categories of land area.

3.6.1 Analysis of used land area

The total area of land space in the corridor width of 200 m is 629,7768 ha. From this area, the agricultural land area covers 71,6776 hectares, forest land area is 557,2264 hectares, and other land area covered is 0,8728 ha. Relations among typical ways of using land area are illustrated by chart number 1.

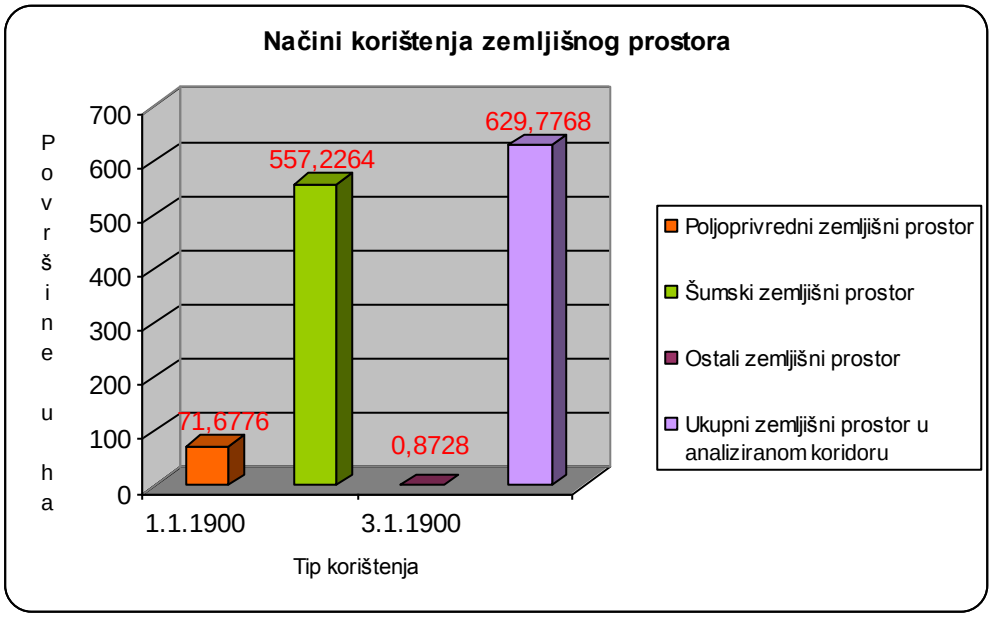


Chart no. 1. Typical ways of using land area

3.6.2 Analysis of agriculturall land area per agro zones

In the scope of agricultural land area and three agrozones, established areas are interpreted in the Table 1.

Table 1. Surface and percentage presence of agro zones in the analyzed corridor

Agricultural land area, corridor coverage 200m					
ha		%			
71,6776		100,00			
Agro zone I		**Agro zone II**		**Agro zone III**	
ha	%	ha	%	ha	%
7,3467	**10,25**	**15,2961**	**21,34**	**49,0348**	**68,41**

Typical relations between some agro zones in the corridor are illustrated by chart number 2.

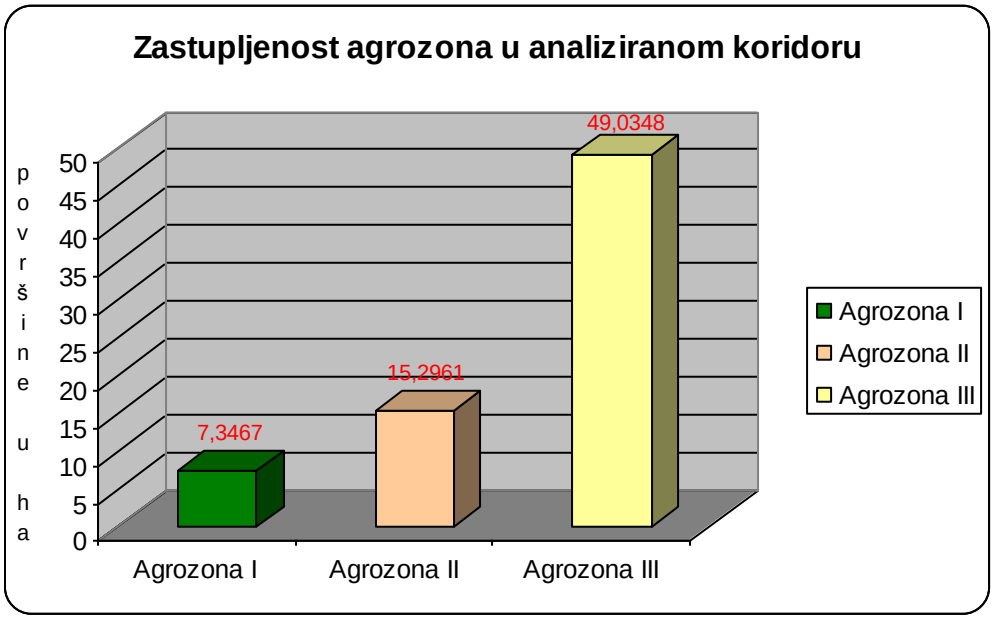


Chart number 2 Graphical interpretation present agro zones on the analyzed corridor

Agricultural land area is defined on the basis of the Law on agricultural land as follows: Section I, General Provisions, Article 3, Section II, the protection of agricultural land, the articles 8, 10, 11.

3.6.3 Possibilities of use of agricultural land area

Presentation of the agricultural land area is given according to the criteria of belonging to certain agro zones.

Agro zone I – is presented by highly valuable agricultural area, with present deep and extremely productive soils of the highest prudential values. This zone has the possibility of intensive and highly mechanized production of food products (vegetables, fruits, vineyard production), then the production of plant material and horticultural products, as well as the production of medicinal herbs. The scope of this agro zone represents the following soils of deep terra rossa, colluvium skeletal terra rossa and colluvium soils of karst fields and parts of karst fields and deep colluvium soils of sinkholes and karst depressions. Agro zone I covers the agricultural land areas where systems are installed for irrigation and / or drainage systems for excess water.

Agro zone II – is presented by moderately valuable agricultural land area, with present moderate deep and productive soils of high and medium high prudential values. This zone has the possibilities of semi-intensive production of agricultural and food products and other semi-intensive production, with limited possibilities of using machinery. Limitations are manifested in the form of surface rocky land, the difference in the depths of the soil in a small land area, pocket character in presence of the most productive soils.

The scope of the agro zone II represents the following soils: terra rossa in the karstification zones and cracks, with colluvium soils of sinkholes, colluvium terra rossa with distinctive rocky character and terra rossa with distinctive surface rocky charater, medium deep and deep colluvium soils, and Kalkokambisol - antropogenized with terra rossa. The agro zone II includes the agricultural land areas where there are limitations in terms of selection of corps and application of certain technological processes.

Agro zone III – is presented by the least productive agricultural production land area, with present shallow and moderately deep soils of low prudential values. This zone has a small possibility of agricultural and food production. These are areas with distinctive surface rocky character, where mostly there are thermophilic meadows. In addition to the distinctive limitations, some slopes are very present (sometimes more than 35^{o}). Comparative advantage of this agro zone is a possibility of growing medicinal herbs and beekeeping. The scope of the agro zone III is represented by the following ground: colluvium terra rossa and terra rossa with distinctive surface rocky character, lithosols and lithosols with terra rossa in the form of pockets, mosaic presented. The most important feature of this agro zone is its mosaic presence and intertwinement with the forest land area, and allocations of this agro zone are conceived on the basis of analysts' assessments and its determination to include or not include the land area in the agricultural land area or forest land area.

In scopes of the previously mentioned agro zones, five land use categories of agricultural land area are present as follows:

- Category I,
- Category II,
- Category III,
- Category IVb,
- Category V.

Surface and percentage presence of the defined categories is interpreted by table 2 and chart number 3.

Table 2. *Present categories and agro zones in the analysed corridor*

AREAS OF PRESENT LAND AREA CATEGORIES AND AGRO ZONES

PRESENT CATEGORY	AREA IN ha	%
Category I, present in the agro zone I	3,8001	5,30%
Category II. present in the agro zone I	3,5466	4,95%
Category III, present in the agro zone II	15,2961	21,34%
Category IVb, present in the agro zone III	10,8996	15,21%
Category V, present in the agro zone III	38,1352	53,20%
Total agricultural land area	71,6776	100%

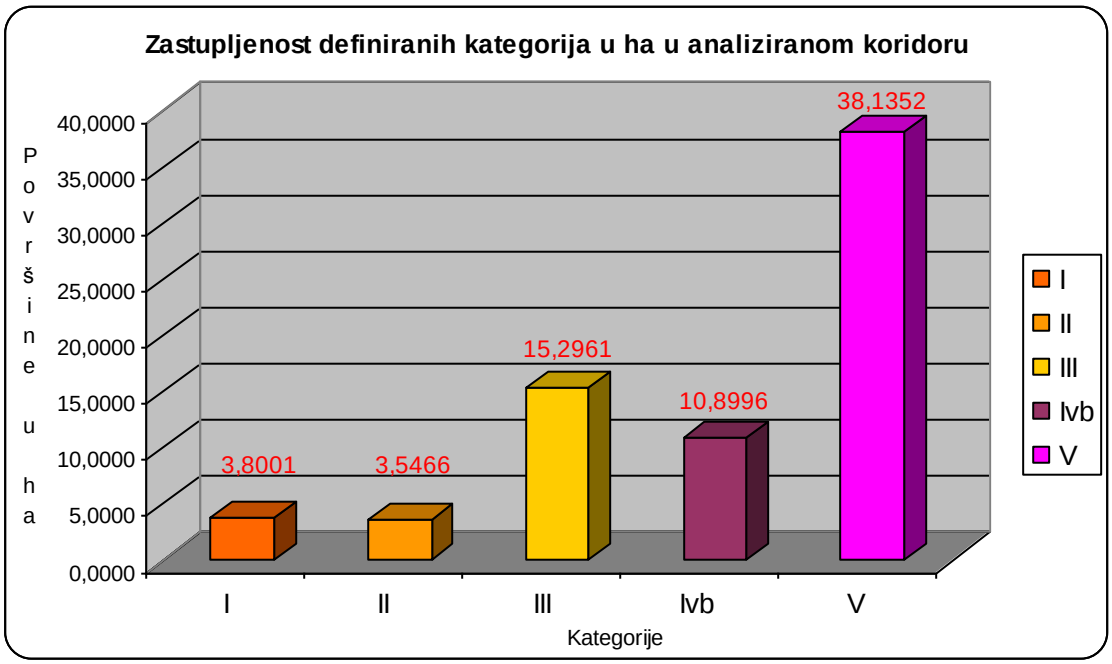


Chart number 3. Present soil categories in the analysed corridor

3.6.4 Soils and their properties

The analyzed corridor of planned project is characterized by specific soils. All isolated types or subtypes of soils, are characterized by belonging in one taxonomic section.

The importance and specificity of each allocated (in field conditions identified and cartographic defined) unit of soil, is the fact that regardless of the limited production properties, in most localities or geographical position, is a natural resource on which it must take extreme care.

The whole area is a zone of very strong Karstification and and tectonic deformations of the geological substrate. These are the reasons for the extreme susceptibility to erosion processes that are caused by water. Character of water erosion in these areas is not accentuated by relocation of soil, but its deep erosion, or by removal of soil in the underground parts of the porous geological substrates. Depth of erosion leads to permanent losses of the soil.

Due to character of the geological substrate that dominant chemically uses up, and which represents, we said, "clean" sediments of Cretaceous and Jurassic period, which the insoluble part does not exceed of 1% to 1.5%. The insoluble remainder represents the basis for formation of the mineral components of soil, which indicates an extremely long process of soil formation.

Another important characteristic of soils being present in the analyzed zone, is represented by their mineral component, which has a predominantly colloidal character. Mineral structure and mechanical dimensions are of very good chemical properties of soils in the analyzed corridor. Mineral structure and present dimensions of mechanical elements of soil, result in excellent physical and chemical properties.

Regardless of the present area of a typical unit or vertical potency of its solum, each site with soil in the area, has a potentially very good environmental and production conditions. It should emphasize that in the ecological sense, even the total annual rainfall quantities do not represent the limitation, except for their distribution (seasonal and monthly), and in this sense, It should take extreme care in the total area on the conservation of rain water and the important factors in the process.

Previously prominent features of present soils in the corridor of the planned project, indicate the unquestionable importance of mutual relationships between vegetation and soil. Such, established interconnections, in a specific way, represent a requirement for subsistence of pedosphere, which for the present environmental zones is very sensitive link, without which a biological existence is simply impossible.

In this sense, for the purposes of defining the presumed negative impacts on soil, as well as its ecological and production functions and the possible feedback influences of soil on the planned project, spatial units of soils are cartographic defined. Isolated units are not homogeneous in character, with the exception of land area in the scope of karst fields, karst valleys or depressions.

Most of the spatial units in pedologic context, are mosaics of different type, subtype and variety determination. In addition of mosaic presence of the lowest taxonomic levels, mosaics of soil are defined belonging to different classes on small spatial units.

As an important element of the inventory of natural resources, for the project provided coverage, were established following cartographic units:

1. deep colluvium anthropogenized soils of carst fields and depressions,
2. medium deep and deep skeletoidal and skeletal soils of karst fields and depressions,
3. kalkokambisol anthropogenized with terra rossa,
4. terra rossa in carst zones and in cracks with colluvium soils of karst sinkholes,
5. terra rossa and colluvium soils,
6. colluvium soils,
7. lithosol, lithosol and terra rossa mosaically present in the form of pockets,
8. colluvium terra rossa and terra rossa with distinctive surface rocky character,
9. lithosol and terra rossa in cracks (pockets with the soil),
10. humus terra rossa with distinctive surface rocky character,
11. colluvium soils with surface rocky character,
12. brown terra rossa with distinctive rocky character.

3.6.4.1 Comments on defined types of soils in the mapped units

In the comments of present soil types, some natural and the potential production possibilities of present types of soils and their limitations are given. This approach meets the most important environmental and ecological requirements.

In ecological terms are defined the following soils

- Rocky and very shallow soils,
- Shallow soils with a very high percentage of the surface rocky character,
- Shallow skeletal soils and shallow non-skeletal soils,
- Medium deep soils
- Deep skeletal soils and
- Deep non-skeletal soils

Rocky and very shallow soils

The group of thus defined soils is characterized by: lithosol, colluvium shallow soils, terra rossa with distinctive surface rocky character. Thus separated group of soils represents some very modest habitats, and in the current climate extremely xerothermal habitats. These environmental conditions result in meager vegetation, characteristic of sub-Mediterranean and Mediterranean karst. These are the soils present in the agro zone III. For these soils there are no legal restrictions in terms of their purpose and can be used without restrictions for the planning and designing some infrastructure facilities.

Shallow soils with a very high percentage of the surface rocky character

This is the group of soils where are present: humus terra rossa with distinctive surface rocky character, terra rossa in the form of pockets and colluvium shallow soils. These are the habitats of modest ecological conditions, but with sporadically present terra rossa in the form of pockets representing micro-zones of better ecological conditions. The zones with these soils are listed in the agro zone III. For land areas with such soils there are no legal restrictions in terms of their purpose and can be used without restrictions for the planning and design of infrastructure facilities.

Shallow skeletal soils and shallow non-skeletal soils

In this group of soils were singled out following types: colluvium soils, kalkokambisol - anthropogenized with terra rossa. These habitats are of modest to moderate environmental conditions. They represent, in the areas of the Mediterranean and sub-Mediterranean, xerothermal habitats regardless of the exposure and altitude. Zones with these soils are listed in the agro zone III. For land areas with such soils there are no legal restrictions in terms of their purpose and can be used without restrictions for the planning and design of infrastructure facilities.

Medium deep soils

Group of medium deep soils are: terra rossa in karst zones, colluvium soils of sinkholes. These are the habitats of moderate ecological features. In areas of the Mediterranean and sub-Mediterranean there are xerothermal habitats. Larger spatial components are in the agro zone III, and several sites are included in the agro zone II. For land areas with such soils there are no legal restrictions in terms of their purpose and can be used without restrictions for the planning and design of infrastructure facilities. It may, within the law, set some limitations in terms of conversion of such agricultural land area and its use for design and construction of infrastructure facilities.

Deep skeletal soils

Group of deep skeletal soils are: colluvium skeletal soils, colluvium skeletal terra rossa. These are habitats of good potential environmental opportunities. However, for the unequal annual balance of inputs and outputs of water, they have environmental constraints during the summer months. In areas of the Mediterranean there are xerothermal habitats. For their potential capabilities they are included mostly in the agro zone II. For agricultural land areas with these types of soils, there are certain legal restrictions to their use in non-agricultural purposes. For these soils and agricultural land area, it can be done a conversion, with obtained consent, and can be used for design and construction of infrastructure facilities.

Deep non-skeletal soils

Group of deep non-skeletal soils are: colluvium soils, deep colluvium anthropogenized soils, deep terra rossa and colluvium soils of sinkholes. These are the habitats of good environmental features. They have high potential and real production capabilities. Their exclusive purpose is the production of food products and also according to the legal framework cannot be used for other purposes nor can be realized their conversion. Spatial zones with these soils are listed in agro zone I. Agricultural land area with these soils can not be used for design and construction of infrastructure facilities.

3.6.5 Specified types of soils at the selected route of the project

In the defined corridor for the selected route of the project, are defined the following types of soils:

- Colluvium soils, which represent a good production spaces for the areas in which they are present,
- Colluvium soils, medium deep and deep anthropogenized, which represent the best production areas and whose protection from conversion is regulated by the law,

- Colluvium shallow and medium deep soils with deep anthropogenized terra rossa represent high quality production areas, although in these areas it applies extensive mode of production,
- Terra rossa in karst zones and cracks with colluvium soils, represent areas where agricultural production is possible,
- Terra rossa in karst zones and cracks with colluvium soils of sinkholes, are present in smaller areas, and the agricultural production is possible in areas of sinkholes,
- Humus terra rossa with distinctive surface rocky character represent the forest land area,
- Lithosols and terra rossa in cracks, represent the forest land area,
- Lithosols, lithosol and terra rossa mosaically are present inthe form of pockets.

3.7 Forest ecosystems and Forestry

3.7.1 Analysis of forest land area by represented vegetation communities

By the Law on Forests of the Federation of Bosnia and Herzegovina, the rules of the management and use of natural resources are prescribed. In article 1 of this law it stated that the forests are well in the general interest and are under special care and protection of the Federation and Canton. In the same article it emphasized that this natural resource can be used under conditions and in a manner that are prescribed by the appointed law. Forests and forest land area are a resource whose values are expressed in particular through their environmental, productive, social and economic functions.

In the analyzed zone and corridor of the proposed project, some ecologic, environmental and social functions of forest land area are expecially distinctive.

3.7.2 Forest communities in the analyzed corridor

Forest communities in the analyzed corridor are presented by degraded thermophile and xerophyte communities. Forest resources in the entire corridor have limited options in terms of its development, because of natural (climatic, geological) and anthropogenic constraints. The entire corridor is characterized by belonging to the forest communities of the Mediterranean and sub Mediterranean which in phyto geographical sense belong to the eastern province of the Mediterranean i.e. the Mediterranean region.

Parts of the corridor with lower altitudes by type belong to the forest communities of turkey oak and oriental hornbeam (*Querco - Carpinetum orientalis*), while elements with higher altitudes or in some locations, and north-exposed locations, belong to the forest community types of turkey oak and hop hornbeam (*Querco - Ostryetum carpinifoliae*). Along the entire corridor a state of forest communities is changed significantly by negative anthropogenic influences, for which we could say that represent „the tradition“;

in these areas. In recent years in the Mediterranean and Sub-Mediterranean, fires are frequent, which represents a great danger for the entire belt through which passes the corridor of the planned project. In the corridor, a deforested area mostly dominates that has the characteristics of rocks or open karst. Then, in significant part are identified: shrubbery, bushes and maquis. In the smaller part of the corridor there are still coppice degraded forests. In order to the above mentioned, forest systems are characterized by their fragmentation and mosaic mode of presence in a very wide interval of regression. Production functions of above mentioned forest stands, for their degradation stages, do not have a broader economic importance and mainly are used as Heating energy. Prominent features indicate that these forest communities have primarily a protective function, the function of soil conservation and soil moisture and ambient - aesthetic role, which in the zone of the Mediterranean and sub-Mediterranean, means very much.

3.7.2.1 Defined forest communities in the analyzed corridor

In the analyzed corridor the following types of forest communities are defined:
Defined as:

- Coppice thermophilic deciduous forests of sub-Mediterranean, and namely
  - Coppice communities of turkey oak and oriental hornbeam,
  - Coppice communities of turkey oak and hop hornbeam,
  - Coppice communities of completely degraded forests in the form of shrubbery and maquis
- Forest formations of shrubbery and highly degraded stands,
- Vegetation of rocky ground.

3.8 Flora and vegetation

Section Stari Neum – Kiševo – Broćanac

Studied area of future motorway, occupies the area above the town of Neum at an altitude of 183 m, to sites Podžablje - Broćanac.

From vegetable-geographical point of view, from south of Neum, the future fast road passes the Mediterranean region of the Adriatic provinces (Stefanović 1977, Lakušić 1980), which is differentiated in the eumediterranean zone of evergreen vegetation (unity *Quercion ilicis*), of very limited areal (Stefanović and ass. 1983, Kutleša and Lakušić 1964, Jasprica 2003).

In fact, the motorway Neum - Stolac stretches from eumediterranean evergreen vegetation (*Quercion ilicis*), and sub-Mediterranean deciduous vegetation (*Ostryo - Carpinion*). The starting point of the research is over Neum near an abandoned police station under Žrnjevo top (349 m), at 183 m a.s.l.

The eumediterranean zone of evergreen vegetation unity *Quercion ilicis*, includes a narrow area around the town of Neum, which extends to 350 m a.s.l., and dominated by limestone with mosaic of land types kalkomelanosol, terra rossa and marl rendzina on the flysch. Vegetation consists of degraded stages of holm forests (oak), *Fraxino orni - Quercetum ilicis*; maquis and gariques, with more communities among *Cisto - Ericetalia*, which reflect the degree of land erosion. Sporadic specimens of *Quercus ilex*, occur in the zone of Broćanac settlements, on the southern exposures, closing eumediterranean vegetation zone with ecosystems of order Fescua and Tor-grass (*Cymbopogo - Brachypodietalia*), typical for eumediterranean zone (ie area of holm), and slightly exceeding the lower sub-Mediterranean zone, characterized by forest communities of oriental hornbeam and turkey oak *Querco - Carpinetum orientalis (= Carpinetum orientalis "adriaticum)*, *unity Ostryo - Carpinion*, spread on shallow limestone areas: kalomelanosol, kalkokambisol and terra rossa. This type of forest shows a series of geographic variations in the form of degraded stages, from low forests, through scrub, shrubbery to dry grasslands and rocky pastures of order *Scorzonero - Chrysopogonetalia.*

The subject sites are specific, so that its southern slopes belong to the Adriatic province, i.e. to the Mediterranean region, where on the border there are vegetation of always green holm forests (*Orno - Quercetum ilicis*). In this vegetation, a dominant role has circum-Mediterranean species: *Quercus ilex, Quercus virgiliana, Phillyrea latifolia, Viburnum tinus, Myrtus communis, Pistacia lentiscus, Laurus nobilis,* etc*.*

This province is very narrow band between the coastal zone up to about 300 m a.s.l., on the south sides, while on the northern parts, this area is narrower and up to 100 m a.s.l.

Following the section of the future motorway to the localities "Podžablje-Broćanac" at an altitude of 189 m, end always green forests of *Quercus ilex*, which belongs to the Illyrian provinces, which otherwise includes the largest area in the territory of the Dinarides, from the upper border of always green vegetation of the Adriatic province, to its upper border of High - Dinaric Alps Nordic region.

Karst stripping and changing climatic and edaphic conditions, caused regression or complete withdrawal of forests with less favorable habitats, and led to major changes in the composition of the flora and vegetation.

The entire broader site is truncated by karst, which is covered by low devastated forests of Oak *Quercus pubescens Willd*. and Oriental Hornbeam *Carpinus orientalis Mill*., underwoods of white elm and black European ash, shrubberies of rose hip - *Punica granatum L.*, Holly - *Phillyrea latifolia L. var. media L. Scheneid*. and Christ's Torn - *Paliurus spina Christi Mill.*

The shrub layer includes: Cornelian Cherry - *Cornus mas L.,* Privet - *Ligustrum vulgare L.,* Hawthorn - *Crataegus monogyna Jacq. and C. L. oxyacantha,* Blackthorn - *Prunus spinosa L.;* Bladder Senna - *Colutea arborescens L.;* Fragrant Virgin's Bower - *Clematis flammula L.;* Mastic tree - *Pistacia lentiscus L..*

In the ground layer grow: Butcher's broom - *Ruscus aculeatus L.,* Wall Germander - *Teucrium chamaedrys L.,* Cyclamen - *Cyclamen neapolitanum Ten.*, Immortelle - *Helichrysum italicum Roth.,* Dusty miller - *Cineraria maririma L.*

Climatogenous association lost its typical physiognomy, and as the last regressive stage of vegetation development, occur karst rocky grounds with Sage *Salvia officinalis L.*, Heather *Satureia montana L*., Globularia - *Globularia bellidifolia Ten.* and rocky grounds with Inula - *Inula candida L.* and lichens on stone slabs.

Overview of the flora of some stations along the future motorway alignment

On the site above the town of Neum, below the top of Žujevo (349 m), at an altitude of 183 m, dominate the following species:

- *Qurcus ilex*
- *Pistacia terebinthus*
- *Olea silvestris*
- *Philyrea media*
- *Phillyrea latifolia*
- *Pistacia lentiscus*
- *Juniperus pheonicae*
- *Smilax aspera*
- *Spartium junceum*
- *Salvia officinalis*
- *Asparagus acutifolius*
- *Avena futta*
- *Convolvulus cantabricus*
- *Brachypodium ramosum*
- *Micromeria juliana* i dr.

At station Duži, dominate *Quercus ilex* and *Q. virgiliana* (dub), *Phillyrea latifolia, Juniperus oxycedrus, Paliurus australis, Laurus nobilis, Celtis australis, Cupressus piramydalis*. On the edges under level Crnč (240 m), the community *Fraxino orni - Quercetum ilicis* is developed with significant domination of *Phillyrea latifolia* and *Juniperus oxycedrus*.

At the site near the municipal landfill of the town of Neum, at an altitude of 172 m in karst sinkholes with distinctive soil, vegetation of community *Phillyrea latifolia-Carpinetum orientalis* is developed. On this site the following species are identified:

- *Paliurus australis*
- *Rubus ulmifolius*
- *Clematis flammula*
- *Oryzopsis miliacea*
- *Dactylis hispanica*
- *Pistacea terebinthus*

- *Satureja montana*
- *Silybium marianum*
- *Calina corymboza*
- *Teucrium polium*
- *Sedum polonense*
- *Senecio vulgaris*
- *Euphorbia Characias subsp. Wulfenii*
- *Salvia officinalis*
- *Ceterach officinarum*
- *Clematis flamula*

In places where the soil is deeper, but also because of intense grazing, it occurs some elements of the class *Chennopodietea (*orders *Onopordetalia and Chenopodietalia).*

Locality Babin Do 189 m s.l., is also a zone of unity *Ostryon - Carpinion orientalis* where is absent *Quercus ilex*, but dominate bushes of evergreen *Phillyrea latifolia, Juniperus oxycedrus, Rubus ulmifolius, Pistacia terebinthus, Paliurus australis*. Communities that cover this area are (*Carpinio - Quercetum virgiliane, Phillyreo - Carpinetum*, but it can meet also communities *Juniperetum oxycedrii*).

On deforested areas appear communities that belong to the unity *Satureion subspicatae,* where we can find *(Saturea subspicatae*, sporadically *Helichrysum italicum, Teucrium polium, Senecio vulgaris, Silbyum marianum, Calina carinaboza, Aethinema saxatile, Arum vitalicum).*

Carpinus orientalis is dominant, mixed with *Quercus virgiliane, Phillyrea latifolia*. In the ground floor we can meet also: *Cistus incanus, Asparagus acutifolius, Ruscus aculeatus, Cyclamen hederfolium, Micromeria juliana, Tunica saxfraga, Brachipodium ramosum, Centaurea jacea, Avena futta, while in the rock fissures can often see Ceterach officinarum* – Rustyback and others.

Furthermore, in the valley are visible greenhouses and arable fields where there are the common cultures. Above sites Dobrovo, definitely stop the ever-green forests of *Quercus ilex* and begin to develop also communities, which belong to the unity *Ostryon - Carpinion orientalis.*

North over this area there was a fire recently and rocky grasslands have been developed, where we meet *Brachypodietum ramosum, Salvia officinalis, Picnomon acarna* etc.

On the site, oposite to the village Nerade and Ćukova Greda there is a fertile field of the vineyards and meadows, while in the uncultivated part dominate *Quercus virgiliana, Celtis australis* and *Cronilla emeroides*.

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In marginal parts of the field are frequent *Fraxinus ornus, Juniperus oxycedrus, Phillyrea latifolia, Brahipodium ramosum*. In the southern part of the field some indvidual trees of

Quercus ilex are identified. The northern edge of fields of Brštin hill (244 m), are covered with: *Phillyrea latifolia* and *Juniperus oxycedrus.*

Entering the outer limits of the field we find *Fraxinus ornus, Quercus ilex* (southern exposures), with very little covering by *Quercus ilex*, and the most frequent are *Pistacia terebinthus*, while near settlements are frequent species, i.e. communities *Rhamnointermedie-Paliuretum australis, Punicetum hercegovinum, Coronilla emeroides.*

In the ground layer on southern exposures, we find the individual species of the genus *Cistus* in open structures, making separate stands – shrubs, with the following species: *Ruscus aculeatus, Asparagus acutifolius, Cistus incanus, Quercus ilex, Ciclamen hederfon* etc*.*

Northwest exposures towards Broćanac and Prapratnica were under fire (in the last 2 years), this is a huge land, which is deforested where dominate herbs *Brachypodium ramosum* (pioneer species after 1 year of fire), where we find the following species: *Helihrizum italica, Rubus ulmifolius, Picnomon azarum, Xantium italicus* and many other species. Also, on this site Macedoinian Oaks *Quercus trojene* are discernible.

In the eumediterranean zone (around Neum) on smaller surfaces are developed thermophile communities, which belong to the order *Cisto - Ericetalia*. This vegetation is identified by domination of beatiful, sometimes high bushes of the Tree heath *(Erica arborea)* with characteristic rock roses (*Cistus sp.).* Communities of this order are mostly low, heliophile underbrushes ("gariques" or rock roses), the most often presented by associations *Seslerio - Juniperetum phoeniceae*, *Erico - Calicotometum* and *Genisto - Ericetum manipuliflorae*.

Section Broćanac - Drenovac

From vegetable-geographical point of view, from south of Neum, the section passes the Mediterranean region of the Adriatic provinces (Stefanović 1977, Lakušić 1980), which is differentiated in the eumediterranean zone of evergreen vegetation (unity *Quercion ilicis*), of very limited areal (Stefanović and ass. 1983, Kutleša and Lakušić 1964, Jasprica 2003), while sub-Mediterranean zone and Mediterranean-hill belt of deciduous vegetation (unity *Ostryo-Carpinion*) occupy considerable larger spaces.

The eumediterranean zone of evergreen vegetation (unity *Quercion ilicis)*, includes a narrow area around the town of Neum, which extends to 350 m a.s.l., and dominated by limestone with mosaic of land types kalkomelanosol, terra rossa and marl rendzina on the flysch. Vegetation consists of degraded stages of holm forests (oak), *Fraxino orni - Quercetum ilicis*; maquis and gariques, with more communities among *Cisto - Ericetalia*, which reflect the degree of land erosion.

Sporadic specimens of *Quercus ilex*, occur in the zone of Broćanac settlements, on the southern exposures, closing eumediterranean vegetation zone with ecosystems of order Fescua and Tor-grass *Cymbopogo - Brachypodietalia*, typical for eumediterranean zone (ie area of holm), and slightly exceeding the lower sub-Mediterranean zone,

characterized by forest communities of oriental hornbeam and turkey oak *Querco - Carpinetum orientalis (= Carpinetum orientalis "adriaticum)*, *unity Ostryo - Carpinion*, spread on shallow limestone areas: kalomelanosol, kalkokambisol and terra rossa. This type of forest shows a series of geographic variations in the form of degraded stages, from low forests, through scrub, shrubbery to dry grasslands and rocky pastures of order *Scorzonero - Chrysopogonetalia.*

Following the section of the future motorway to the localities "Podžablje-Broćanac" at an altitude of 189 m, end always green forests of *Quercus ilex*, which belongs to the Illyrian provinces, which otherwise includes the largest area in the territory of the Dinarides, from the upper border of always green vegetation of the Adriatic province, to its upper border of High - Dinaric Alps Nordic region.

Karst stripping and changing climatic and edaphic conditions, caused regression or complete withdrawal of forests with less favorable habitats, and led to major changes in the composition of the flora and vegetation.

The entire broader site is truncated by karst, which is covered by low devastated forests of Oak *Quercus pubescens Willd*. and Oriental Hornbeam *Carpinus orientalis Mill*., underwoods of white elm and black European ash, shrubberies of rose hip - *Punica granatum L.*, Holly - *Phillyrea latifolia L. var. media L. Scheneid*. and Christ's Torn - *Paliurus spina Christi Mill.*

The shrub layer includes: Cornelian Cherry - *Cornus mas L.,* Privet - *Ligustrum vulgare L.,* Hawthorn - *Crataegus monogyna Jacq. and C. L. oxyacantha,* Blackthorn - *Prunus spinosa L.;* Bladder Senna - *Colutea arborescens L.;* Fragrant Virgin's Bower - *Clematis flammula L.;* Mastic tree - *Pistacia lentiscus L..*

In the ground layer grow: Butcher's broom - *Ruscus aculeatus L.,* Wall Germander - *Teucrium chamaedrys L.,* Cyclamen - *Cyclamen neapolitanum Ten.*, Immortelle - *Helichrysum italicum Roth.,* Dusty miller - *Cineraria maririma L.*

Climatogenous association lost its typical physiognomy, and as the last regressive stage of vegetation development, occur karst rocky grounds with Sage *Salvia officinalis L.*, Heather *Satureia montana L*., Globularia - *Globularia bellidifolia Ten.* and rocky grounds with Inula - *Inula candida L.* and lichens on stone slabs.

Overview of the flora of some stations along the future motorway alignment

Stations around the locality Podžablje - Broćanac are characterized by the following species:

- *Qurcus ilex* (very rare)
- *Pistacea terebinthus*
- *Olea silvestris*
- *Phillyrea media*
- *Phillyrea latifolia*
- *Pistacia lentiscus*
- *Smilax aspera*
- *Spartium junceum*
- *Salvia officinalis*
- *Asparagus acutifolius*
- *Paliurus australis* (Christ's Torn)
- *Rubus ulmifolius*
- *Clematis flammula*
- *Oryzopsis miliacea*
- *Dactylis hispanica*
- *Satureja montana*
- *Silybium marianum*
- *Carlina corymbosa*
- *Teucrium polium*
- *Sedum polonense*
- *Senecio vulgaris*
- *Euphorbia Characias subsp. Wulfenii*
- *Ceterach officinarum*

In the ground layer on southern exposures, we find the individual species of the genus *Cistus* in open structures, making separate stands – shrubs, with the following species: *Ruscus aculeatus, Asparagus acutifolius, Cistus incanus, Quercus ilex, Cyclamen hederfon* etc.

Northwest exposures towards Broćanac and Prapratnica were under fire (in the last 2 years). This is a huge land, which is deforested where dominate herbs *Brachypodium ramosum* (pioneer species after 1 year of fire), where we find the following species: *Helichrysum italica, Rubus ulmifoliuus Picnomon acarna, Xantium italicus* and many other species. Also, on this site Macedoinian Oaks *Quercus trojene* are discernible.

Furthemore toward the site Hadžibegov Grad – Cerovica, the largest number of species of climazonal (continental) vegetation (ass. *Querco - Carpinetum orientalis*), belog to various subgroups of mediterranean flora element, and in the spectrum of life forms dominate terophita. The most numerous families of vascular plants are herbs (*Poaceae*), than legumes (*Fabaceae)* and *Asteraceae, Cichoriaceae,* which also confirm Mediterranean and sub-Mediterranean character of flora.

In spring-summer aspect, for the mentioned above localities, including also the previous locality Papratnica, we meet in the ground floor the following species:

Euphorbia Characias subsp. Wulfenii, Tunica saxifraga, Galium lucidum, Salvia officinalis, Stachys italica, Eryngium amethystium, Rhamus myestris, Micromeria julijana, Brachypodium ramosum, Asparagus acutifolius, Spartium junceum.

Furthermore toward the first stations after Papratnica, we meet the following plants: *Inula verboscifolia, Clematis flamula, Clematis vitalba, Convolvulus elegantissiama Campanula sp.,* than toward localities Hadžibegov-Grad: *Nigella domascena, Helichrysum italicum, Prunus spinosa, Satreja montana, Hedera helix, Melica ciliata and Sedum acre.*

Near the entrance to the shrine we meet: *Echium italicum, Cirsium sp. Picnomon acarna, Galium sp., Ficus carica, Arum italicum (*in fruit*), Teucrium polium, Cardus nutans,* and in higher floor: *Fraxinus ornus, Carpinus orientalis, Pistacia terebinthus, Acer monspesulanum, Phillyrea media, Punica granatum etc*.

At station - Crnoglav at the altitude of 421 m, some degraded rocky surfaces are actually present, where dominate: *Helichrysum italicum, Juniperus oxycedrus, Eringium amethystnum*, *Carlina corinboza, Helianteum nummularium*. This site is in relativelly sufficient distance from Deransko lake, i.e. protected Nature Park Hutovo Blato, and in the vicinity of migration way of migratory birds.

The proposed alignment passes by degraded forest land areas, overgrown with *Quercus pubescens* and *Carpinetum orientalis,* and sporadically dominates also *Qercus trojana*.

In the higher floors of plants there are *Quercus trojana, Rubus ulmifolius, Fraxinus ornus*, *Prunus spinosa*, while in the ground layer, as a dominant species occurs *Brachipodium sp. Approaching to peak and also the final* sites, we meet *Petteria ramentacia* (Dalmatian laburnum), and *Juniperus communis* is identified on higher exposures.

Locality Drenovci, which is also final station of these investigations, is at altitude of 365 m, where we meet sub-Mediterranean rocky pastures, while near settlements Christ's Torn is frequent, because of antropogenous influences. On deforested surfaces it can identify: *Quercus trojana, Inula viscosa, Erningium ametistium, Echium plantagineum, Saturea montana,Calina corimbosa, Teucrium palium, Croxus sp., Dactylis gromelata, Hondrila juncea, Micromeria julijana, Bellis silvestris.*

In the unity *Peterio - Carpinetum orientalis*, we meet: *Celtis australis, Petteria ramentacea, Asparagus acutifolius, Ruscus aculeatus, Clematis vitalba, Fraxinus ornus, Pistacia terebintus, Euphorbia characias susp. wulfenii.*

Forest ecosystems

The future motorway Neum-Stolac stretches from eumediterranean ever-green vegetation (*Quercion ilicis*), smaller part, and sub-Mediterranean deciduous vegetation (*Ostryo - Carpinion*), the greater part of the alignment.

Climazonal vegetation of the wider area proposed for construction of the motorway Neum-Stolac, consists of forests and underwoods of oriental hornbeam and turkey oak (*Querco - Carpinetum orientalis*).
In most of the alignment is present the most thermophile variety of forest vegetation, with a large number of plant species of Mediterranean forests, which can be attributed to the strong influence of Mediterranean climate and low altitudes. However, these forests have suffered major anthropogenic influence, so that now in fragments or in full we find all their regressive (degraded) stages.
Within climatogene woods of the oriental hornbeam and turkey oak there is herzegovian - dalmatian part of disjunctive areal of the Macedonian oak (*Quercetum trojanae*). Where the degradation is advanced, base is stony, and the soil shallow and poorly, develop Christ's torns (*Rhamno - Paliuretum*). As a result of suppression of forest and scrub of communities *Querco - Carpinetum orientalis*, a very significant low and more or less open underwoods are developed, in the first stage of degradation, which according to some authors (Horvatić, 1963) can mostly belong to the community of *Rhamno-Paliuretum*, or represent its fragments.

Ecosystems of rocky pastures and dry meadows

Trees and shrubs in the area of the hornbeam, given the intensive harvesting, pasture and cultivation of land, are subject to degradation. So rocky pastures and dry meadows gradually arise. The most important vegetation order of dry grasslands and rocky pastures of eastern- Adriatic coastal belt is *Scorzonero - Chrysopogonetalia*, which is characterized by Gryllus Grass and Black Salsify, which generally coincide with a range of forest climazonal vegetation of unity black and white elm (*Ostryo - Carpinion orientalis*). On steep sides and slopes exposed to the storm, are formed rocky pastures of Feather Grass and medicinal Sage (*Stipo - Salvietum officinalis*). All grassland communities in its original form are highly diverse and characterized by a large number of species, and classified in a number of associations and facies, depending on the degree of degradation and exposure of soil, which largely depends on the influence and exploitation by humans (pastures, meadows). Communities of Black Salsify and Gryllus Grass (order *Scorzonero - Chrysopogonetalia*) are related to the sub-Mediterranean and Mediterranean-mountain zone (ie the area of distribution of downy), while the order of Fescua and Tor-grass *Cymbopogo - Brachypodietalia*, is typical for eumediterranean zone (ie area of holm).

Sinkholes with fertile fields alternately appear (usually depending on the depth of soil), where there are often Downy oak (tall trees of *Quercus pubescens*) and underwood of White Hornbeam (*Querco-Carpinetum orientalis*), as well as variants with Juniper, marked as a community Juniperetum oxycedrii. Thorn patches (*Rhamno - Paliuretum*), are common communities in the area.

At exposures to the closest western borders of Nature park Hutovo blato, the most common form of vegetation is *Querco - Carpinetum orientalis* (Jaspirca and Carić 2002), then *Quercetum trojanae* and *Phillyreo - Carpinetum orientalis*. According to the combination of species, grazing community may be marked as *Koelerio - Festucetum illyricae*. It is rich in species, which is more or less general feature of rocky pasture vegetation and dry grass of calss *Festuco - Brometea* (cf. Trinajstić 1992). In this community it is a great proportion of types of vegetation order *Scorzonero - Chrysopogonetalia*, with a number of elements that are generally characteristic of the typical Mediterranean class *Thero - Bracyhipodietea*.

Also, at an altitude of more than 500 m, developed the following communities: *Rusco - Carpinetum orientalis, Punico - Carpinetum orientalis, Querco - Carpinetum orinetalis, Quercetum trojanae, Ostryo - Quercetum pubescentis, Petterio - Carpinetum orientalis*, etc. (Jasprica 2003) . Most of the community is under significant anthropogenic influence with a clear changed structure and altered habitat elements. Some of these communities have a tendency to further degradation.

3.8.1 Rare and protected species

Types that can be found on the subject section Stolac - Neum, which are listed by Šilić (1996):

1. *Helleborus hercegovinus Martinis (=H. multifidus auct. non Vis.) (R)*
2. *Rhamnus intermedius Steud. et Hochst. (R)*
3. *Anthyllis illyrica G. Beck (R)*
4. *Genista sylvestris Scop. subsp. dalmatica (Bartl.) Lindb. (R)*
5. *Genista sericea Wulfen in Jacq. (R)*
6. *Petteria ramentacea (Sieb.) C. Presl (R)*
7. *Calycotome infesta Guss. (V)*
8. *Seseli tomentosum Vis. (R)*
9. *Chaerophyllum coloratum L. (R)*
10. *Cyclamen repandum Sibth. et Sm. (V)*
11. *Cyclamen neapolitanum Ten. (Syn.: C. hederifolium Aiton) (V)*
12. *Acanthus spinossisimus Pers. (V)*
13. *Teucrium arduini L. (R)*
14. *Stachys recta L. (aggr.)* /neki endemični oblici unutar ovog agregata/ (K)
15. *Satureja subspicata Vis. subsp. subspicata (V)*
16. *Origanum heracleoticum L. (V)*
17. *Campanula pyramidalis L. (R)*
18. *Edraianthus serpyllifolius (Vis.) A. DC. in DC. (R)*
19. *Tanacetum cinerariifoliurn (Trev.) Schultz Bip. (V)*
20. *Inula viscosa (L.) Aiton (Syn.: Dittrichia viscosa (L.) W.Greuter) (R)*
21. *Inula graveolens (L.) Desf. (Syn.: Dittrishia graveolens (L.) W.Greuter) (R)*
22. *Centaurea glaberrima Tausch (R)*
23. *Asphodelus fistulosus L. (R)*
24. *Ruscus aculeatus L. (lokalno!) (V)*

25. Sternbergia lutea (L.) Ker-Gawler ex Sprengel (V)
26. Romulea bulbocodium (L.) Seb. et Mau. (V)
27. Iris pseudopallida Trinajstić (R)
28. Gladiolus illyricus Koch (V)
29. Anacamptis pyramidalis (L.) Rich. (V)

In brackets after the name of each species are listed categories of threat (according to IUCN)

R – rare species
V – sensitive species
K- insufficiently known species

ŠILIĆ, Č. 1996. List of botanical species (*Pteridophyta and Spermatophyta*) for the Red book of Bosnia and Herzegovina]. Gazette of National Museum of Bosnia and Herzegovina N.S. 31, 323-367.

3.9 Fauna

This section will give short and the most impressive representatives of the fauna of the narrow studied area.

Some representatives of the fauna of this area are: Hedgehog (*Erinaceus sp.),* European Pine Marten (*Martes martes*), Fox (*Vulpes vulpes*), European hare (*Lepus europaeus*), Wild boar (*Sus scrofa*), Red Squirrel (*Sciurus vulgaris*), Weasel (*Mustela vulgaris*) .

It is known that the majority of Mediterranean bird species in their spreading along our coastal area uses the entire Mediterranean area, and it is a smaller number of those which are exclusively related to the one of vegetation belts.

The Mediterranean birds give a mediterranean meaning to the surrounding areas, widespread in the forests, woods, bushes and rocks, of which the most famous are: the Rock Partridge (*Alectoris graeca*), the Black-eared Wheatear (*Oenanthe hispanica*), the Orphean Warbler (*Sylvia hortensis*), the Subalpine Warbler (*Sylvia cantillans*) the Black-headed Bunting (*Emberiza melanocephala*), the Sombre Tit (*Parus lugubis*), the Rock Pigeon (*Columba livia*), the Wild Turtle Dove (*Streptopelia turtur*), the Barn Swallow (*Hirundo rustica*), the House Sparrow (*Passer domesticus*), the Green Woodpecker (*Picus viridis*), the Nightingale (*Luscinia megarhynchos*), the Jack Snipe (*Lymnocryptes minimus),* the Common Buzzard (*Butteo butteo*), the Eurasian (or Northern) Sparrowhawk (*Accipiter nisus*). the Mistle Thrush (*Tardus viscivorus*), the Fieldfare (*Tardus pilaris*), the Song Thrush (*Tardus philomelos*) and the Blackbird (*Tardus Merula*) winter in particularly large numbers feeding on the rocks, thickets and forests, mainly with fruits of the Juniper (*Juniperus oxycedrus*), and the Mock Privet (*Phillyrea media*) and the Common Ivy (*Hedera helix*).

The reptiles in these areas are the most important representatives of the family *Amodytes* – the Horned Viper, then for this region is characteristic the Scheltopusik (*Ophisaurus apodus*), the European Green Lizard (*Lacerta viridis*), the gecko (*Tarentola turcicum*).

This region abounds with a large number of insects (*Inseecta*), spiders (*Aranea*), centipede (*Myriapoda*), etc.

As for the wildlife and hunting, in the municipality of Neum there is a registered Hunting Club "Jadran" who cares about hunting and game farming. According to data of this hunting club, this area is most represented by the following autohton species: the Wild Boar *(Sus scrafa*), the Rock Partridge (*Aleoctoris greca*), the Brown Hare (*Lepus europeus*), the Fox (*Vulpes vulpes*) and other game.

3.10 Landscape characteristics

The area in which the construction of road has been foreseen, is characterized by the landscape values that are typical for this part of Herzegovina. The landscape of the area has a large presence of vegetation consisting of low bushes and wicker, which is closely bound by many types of creeping plants, and it is difficult to make passable. The landscape is additionaly completed by arable land and numerous olive groves intersected by dry stone walls, otherwise a typical scene for debris of the Herzegovina.

The area of the mountain Velika Žaba makes a geographical boundary of a landscape wholes of high and low Herzegovina. Landscape features of these areas are determined by the specific climatic impacts, which are alternated spatially and temporally.

In the karst of Herzegovina prevails evergreen vegetation, which makes the area lively throughout the year. In addition to the area densely covered with low vegetation, in the landscape of Herzegovina we meet also rocky ground on the borders of hills, where often there are traces of burning. In parts of the plains it is evident the oak tree with white and black hornbeam, whose thermophilic communities give a special value in a hot stone of the Herzegovina.

Although this may not seem real at first glance, this area is considered to be extremely rich variety of life forms, both in floristic and in faunistic composition. Specifically, it considers many groups of insects and reptiles characteristic of this area.

The macchia, otherwise very popular in this area, as one of degradated stages, is the best witness of expressed human activity, but also the scene very common in the Mediterranean region. It is also a witness of severe microclimate conditions in which the habitat itself battles often with physical drought.

Numerous chapels and shrines built of Herzegovina stone are almost perfectly fit with the verdant hardly passable undergrowth, with the often isolated slender cypresses, which gives to the observer's eye one unforgettable experience.

3.11 Protected parts of nature

Considering protected parts of nature in the area of the municipality of Stolac, it should point out particularly:

- nature park Hutovo Blato
- cave Badanj (16.000 BC)
- cave Tarmanjača
- Crvena pećina (Red cave)
- Drenovačka cave
- river Bregava

Hutovo Blato, as the largest bird reserve area is extremely valuable, not only for the fauna of birds, but also for other groups of living organisms, such as reptiles, amphibians, and insects that are considered to be largest group of organisms in the world.

These characteristics of Hutovo Blato are a result of the warm sub-Mediterranean climate, a small amount of precipitation and the diverse vegetation with a long vegetative season, which is very suitable for the preservation and development of many animal and plant species.

In the zone of interest there is not any of these areas, and it will not be under the direct impact of the project

Hutovo Blato is not far from the zone of impact (approximately 2.5 km), which direct impacts are excluded as possible, but as a potential indirect effects occur.

This group of impacts is important from the viewpoint of increasing of the concentration of pollutants in the air, which will occur as a result of the increased frequency of traffic, and which will result in ablation of pollutants in the area Hutovo Blato under the influence of southern and southwest winds that blow in this area.

Other areas, especially caves with rich flora and fauna are not in the zone of impact and they will not be endangered.

3.12 Game and Hunting

The proposed alternative of the future road Neum - Stolac, is located spatially in the Canton No.7 (Herzegovina-Neretva), Bosnia and Herzegovina, ie, the Federation of Bosnia and Herzegovina.

Table 3 General information about the Canton No.7

Municipality	Surface (in 1996)	% of the former municipalities
Konjic	1.094,00 km^2	99
Rama	477,00 km^2	100
Jablanica	289,00 km^2	10
Mostar	1.235,00 km^2	95
Čitluk	2.181,00 km^2	100
Stolac	**281,00 km^2**	**52**
Čapljina	249,00 km^2	100
Neum	**230,00 km^2**	**100**
Ravno	325,00 km^2	27% of former municipality of Trebinje

Legal regulation

For coverage of this issue, the Law on Hunting is in effect.

Today in Bosnia and Herzegovina exist three (3) Hunting Association:

1. Association of hunting organisations of B&H.
2. Hunting Association HR H-B**
3. Hunting Association of RS (Republic of Srpska)

In the zone of interest of the proposed alignment of the future road, there are two (2) hunting areas, and there two (2) Hunting asociations operate :

Table 4 Hunting area of hunting associations and the number of members

Hunting association	Hunting area (ha)	Number of hunters
Kamenjarka - Stolac	29.067,00	250
Jadran - Neum	22.000,00	160

Outer borders of neighboring hunting grounds are also given in tabular view:

Hunting association	Hunting area (ha)	Number of hunters
Galeb - Čapljina	25.636,00	240
Lisac - Ravno	44.700,00	92

The hunting grounds are within the limits of the municipality of Canton 7, formed after the Dayton Agreement. They stretches to mountain area, through the two belts

(Mediterranean and sub-Mediterranean), what actually characterizes the subject and neighboring municipalities, with all its other specifics.

The tables that follow give the overview of game, which resides in the hunting grounds in the area of the project road, and number of game per hunting ground in particular.

Table 5. Game that resides in the hunting grounds in the area of the project road

Domestic name	***Latin name***
Wolf	*Canis lupus*
Wild Boar	*Sus scrofa L.*
Roe Deer	*Capreolus capreolus*
Mouflon	*Ovis canadensis*
Hare	*Lepus europeus Pall.*
Red Fox	*Vulpes vulpes L.*
Beech Marten	*Martes foina EHR.*
European Pine Marten	*Martes martes*
European Wildcat	*Felix sp.*
Jackal	*Canis aureus*
Mongoose	*Mungus mungo*
Badger	*Meles meles*
European Polecat	*Mustela putorius L.*
Weasel	*Mustela vulgaris*
Common reddish-brown Squirrel	*Scirius vulgaris*
Pheasant	*Phasianus sp. L.*
Jack Snipe	*Lymnocryptes minimus*
Rock Partridge	*Alectoris graeca*
Partridge	*Peredix peredix*
Rock Pigeon	*Columba livia*
Turtle Dove	*Streptopelija turtur*
Green Woodpecker	*Picus viridis*
Common Buzzard	*Buteo buteo*
The Eurasian (or Northern) Sparrowhawk	*Accipiter nizus*
Falcon	*Falco peregrinus L.*
Owl	*Bupo bupo L.*
Blackbird	*Turdus merula*
Magpie	*Pica pica L.*
Hooded crow	*Corvus corone cornix L.*

The above species in the hunting-ground can be split into major and others, hunting and not hunting, as well as those protected and unprotected, while some in certain hunting-

grounds can be hunted for their numbers, but the same can not be hunted in the other hunting grounds because of its paucity.

Table 6. *Abundance of game in hunting associations*

Hunting associations / Type of game	*Jadran-Neum*	*Kamenjarka-Stolac*
Roe Deer	20	25
Mouflon	35	20
Jackal	5	3
Mongoose	-	-
Wild Boar	500	500
Wolf	50	70
European Wildcat	30	40
Red Fox	350	300
Hare	550	500
Beech Marten and European Pine Marten	350	300
Badger	70	50
Rock Partridge	1000	1000
Partridge	150	100
Quail	350	300
Jack Snipe	800	500
Pheasant	200	250
Wild Pigeon	1000	1000
Turtle Dove	*100*	150
Rock Pigeon	100	150
Falcon	30	30
Hawk	60	50

Abundance shown in the table is made from contacts with presidents, secretaries and hunters of hunting societies, and they vary because many species cross from hunting-ground to other hunting ground, so these results should be treated with reserve and count plus-minus 10 - 15%.

Breeding game:

Table 7. *Breeding game in the hunting association*

Hunting associations / Type of game	*Kamenjarka*	*Jadran*
Mouflon	30	30
Wild Boar	10	5
Hare	-	-
Rock Partridge	-	-
Partridge	-	-
Quail	-	
Pheasant	-	-

Game that is aquired:

Table 8. *Game that is procured from the neighboring countries*

Hunting associations / Type of game	*Kamenjarka*	*Jadran*
Wild Boar	-	-
Hare	50	20
Rock Partridge	150	-
Partridge	100	-
Quail	-	-
Pheasant	50	50

3.13 Cultural-historical heritage

General overview: general area of the main road

Micro-region through which passes the road section considered, is extremely rich of cultural and historical heritage of different types, functional type and chronological determination.

In a *wider scope* of the alignement, which includes territory related, close to the geographic-regional and historical and cultural features, there are 35 *national monuments*, and, a large number of *registered* assets of heritage, diverse in character. In this area - which is the subject of our *general* reviews – we find assets of architectural, archaeological and sepulchral heritage; registered as *individual monuments* (historic

buildings and archaeological monuments), and *monumental unities* (archaeological areas, architectural, natural and architectural and historical entities).
A large number of archaeological and historic areas is multifaceted and, to them, there is material remains from several periods.

Given the very long continuity of settlement in this area, it is not surprising fact that it is characterized by a large number of sites of prehistoric times, some of which are extremely valuable. In this context, the valley Bregave is especially significant where there are many archaeological sites.
Although it is not in immediate contact zone of the road, from which it is relatively far away, it is impossible to not mention a rich Paleolithic and multilayer cave site Badanj, dating to the late period of the early Paleolithic- late epigravettien, ie 13,000 to 12,000 years BC. It is especially important a drawing - engraving in the rock, which is one of the oldest monuments of art in Bosnia and Herzegovina.

Hellenistic urban complex Daorson in Ošanići, is also valuable archaeological area, with a single exemplar of megalithic wall.

Considering medieval heritage we should mention a number of necropolis with medievel tombstones (stećci), which have the character of archaeological or historic areas, some of them are extremely important - for example, national monuments in the areas of Hutovo, Boljun, Radimlje, Hodovo, Glumine, Brštanica, Vranjevo village, etc.

An interesting representative of the architectural heritage is the Catholic church of St. Anne in Gradac near Neum, built some time before 1619., which has the status of a national monument.

Heritage of the Ottoman period is particularly characteristic of the historic core of Stolac, where there are a large number of various monuments of different types and species; there is are more valuable objects and architectural ensembles; for example, ensembles of Begovina and mills on Bregava represent distinct "symbols" benchmarks - not only in local, but also in Bosnian-herzegovian framework.

For the whole general area, the landscape is characteristic and specific, which, for centuries, was the physical environment for creation of a separate regional expression. Vernacular and rural units of this area have a special term and seal, characterized by dry stone walls, the walls of rubble stone, water cisterns, olive groves, white, rustic plaster surfaces, stone cover, etc. These ensembles represent a particular value, given that this is an authentic expression, which is quite typical for this area, and extremely well integrated in the natural environment.

<u>Cultural - historical heritage in "impact zone" of the main road and on contact with it.</u>
Consideration of cultural and historical heritage that we found in the wider area, was the subject of the Preliminary assessment of the impact of the main road on the environment; thereby the classification of cultural assets has been carried out on the basis of their *status of protection*: a distinction is made between the *recorded assets* and assets that are declared as *national monuments.*

For the purposes of the Preliminary study, or the Preliminary design, this categorization was rational, given the objectives and tasks of the working stages: upon the choice of the optimal alternative alignment, it was the most significant to estimate justly the amount and the "weight" of the overall limiting factors. As for the analysis of heritage assets a *valorisation* is one of the most important elements, *the status of cultural assets* - on which it depends to a large extent - was the most important, and quite sufficient parameter of the evaluation.

However, the type and quantity of data; a way of its classification and presentation, and, the working methodology in general, upon the development of the Study, were quite different.
Since its final result should be the impact assessment of the road to cultural and historical heritage in the contact zone with proposed protective measures for *each specific position*, here the main subject of consideration are cultural assets located within a single "impact zone" [1] ([1]"Impact Zone" set as a zone of 200 m (per 100 m, left and right from the alignment), unique to all restrictive factors), ie, assets that are in direct contact with the alignment or subject to indirect impacts of varying intensity and character.
It is logical, then, that the relevant methodological elements: the level of detail, the method of analysis and classification, quality and quantity of data, the selection of relevant information, etc., in this phase of work, significantly vary from those applied in preparing the preliminary assessment.

One of the essential differences is the *method of determination* of registered units; the analyzed locations and facilities are here, for valid quantitative and qualitative assessment of potential impacts, determined - and then classified, on several bases.

As the *type of cultural assets* is one of the important elements for identification, and then - and for the analysis and final evaluation of the impact, we determined assets, registered in the subject area, as:

- the archaeological area / archeological sites;
- cemetery, necropolis (cemetery units);
- natural – architectural units, rural ambients;
- individual facilities.

This determination is based on the classification applied by the Commission to Preserve National Monuments, and it is adapted to the specific context, ie, needs, goals and tasks of the Study [2] ([2] See: decision on the declaration of assets as national monuments)

The type and intensity of impact, among other things, are specified by the chronological determination of building / sites. From the time of occurrence - mostly - depend the type and quantity of material remains *in situ*, ie, the state of the material itself of monument. Therefore, for all locations / facilities registered in the subject area, in the available documentation, sources, relevant literature, data on dating is examined.

On the treated area, the assets are registered that come from

- prehistoric times
- antiquity (mainly late antiquity) and Roman times
- the Middle Ages
- or are multilayer, ie, belong to different periods.

Natural-building (rural) units are not dated, because the positions within the subject area belonging to this category for the most part are *natural formations*, with a very small percentage of built ("artificial") structures. Human interventions in these environments, are mainly represented by dry stone walls of autohton expression: fencing or supporting; water cisterns, etc.
Basic quality of these units is exceptional beauty of the natural environment, and harmony of nature and the "creation".

Defined as *a single object*, *an archaeological area*, or *rural ambient*, dating to *prehistory, Middle Ages* or *Roman times*, each individual position is identified also by codes - identification number. In doing so, however, it should be noted that for some archaeological areas, the boundaries of the marked areas can be taken more orientation, because they affect fairly large areas with spatial continuity or without it.
On the other hand, some sites are very hardly accessible or they are - due to erosion, rinsing, technogene activities, overgrowing and subsidence of overhead structures or devastation by a man, in very bad condition. For certain areas, therefore, no detailed archaeological recognition and specific documentation (eg, cadastral plans with marked parcel borders, etc.), practically it is impossible to precisely define the boundaries of spatial coverage. The fact, however, has been taken into account in defining mitigation measures, and, in such positions, some more detailed field recognitions are provided.

Some difficulties in precise identification of borders of the zone of historical / archaeological area or unit, in some positions, are presented also by the absence of the background in a huge scale; therefore on the alignment section *Stari Neum - Kiševo - Broćanac*, we marked relevant sites on the maps by scheme, but the impacts and proposed mitigation measures are given per the identical principle as the rest of the alignment.

Recorded sites, buildings, units that can be exposed to the impacts of different types and intensities, in the process of building the road or its use, are:

PLACE, NAME AND DESCRIPTION OF SITE / UNIT / BUILDING — IDENTIFICATION NUMBER

UDORA

UDORA, Udora, Stolac.....SV①
Medieval necropolis from the late Middle Ages.

The literature states that the necropolis of about 80 tombstones is preserved (plates, coffins, high crates, sarcophagus), some of which are decorated by borders, tendrils, frieze rosette, cross, arcades, figurative scenes, or with labels.

By field inspection we found that the necropolis is located in a very nice, fairly preserved natural environment; a state of some tombstones is different, many are overgrown, but the general state of the necropolis - compared to many others, where some tombstones are completely immerged, heavily devastated / used as secondary material / not recognized – after all is relatively well. (photo - Annex "1").

CEROVICA

OBALJENO GROBLJE, Cerovica, Neum.....SV→②

Medieval necropolis from the late Middle Ages.

The existing sources mention the 11 tombstones in a shape of coffin, preserved by the Catholic cemetery, some of which are decorated with symbols and symbolic depictions of weapons, and note that other tombstones are destroyed and secondarily used, what we could conclude at site (photo - Annex "2").

PRAPRATNICA

In the zone of Prapratnica, the literature has recorded more sites with cultural and historical heritage, which have the character of the archaeological areas and the necropolis (photo - Annex "3"):

PRAPRATNICA 1, Prapratnica, Neum

Ancient tumuli (burial mounds) from the Bronze and Iron Age .....P⑤

The sources mentioned a group of about 20 stone piles of diameter 8-15 m, height of 1-2,5 m, which are located at different locations in the wider spatial coverage.

PRAPRATNICA 2, Prapratnica, Neum

Medieval cemetery from the late Middle Ages.....SV③

In the literature, seven tombstones in the shape of plates and boxes are recorded, preserved by the Catholic cemetery. We note that some of tombstones are decorated with symbolic signs, and that the others were destroyed.

KAPINA, Prapratnica, Neum..... P④

Prehistoric ruins of the Bronze and Iron Age. The site recorded as a fortified village with a little plateau established by dry stone wall in the shape of ellipses.

BROĆANAC

In the area of Broćanac, the sources have recorded more sites with cultural and historical heritage, which have the character of the archaeological area and the necropolis (photo - Annex "4"):

BROĆANAC, Broćanac, Neum

Prehistoric tumuli (burial mounds) from the Bronze Age..... P⑧

In the literature referred to earlier researches on the site - one of several stone tumuli is excavated by Ć. Truhelka in 1893.

KUĆETINE, Broćanac, Neum
Prehistoric ruins and Roman settlement from the early Iron Age and Roman times, 1-3 A.D..... P_R⑦

Registered remains of drywall structures and drywall construction wall, with the findings of numerous fragments of rough Ancient ceramics, as well as the remains of houses covered with masonry prismatic stones in the same area, to which were found fragments of pottery, pieces of Roman tiles, etc.

ZACRKOVNICA, Broćanac, Neum
*Medieval necropolis from the late Middle Ages and the remains of the church.....*SV⑥

The sources mention 23 tombstones in a shape of plates and boxes, some of which are decorated by borders, shield with a sword, and the foundations of older structure, probably the church.
At site we can conclude that the tombstones are very immersed and overgrown.

GRADINA, Broćanac, Neum

Prehistoric ruins of the Bronze and Iron Ages..... P⑨

Recorded as the area of a fortified village surrounded by dry stone walls, where few fragments of Ancient ceramics are found.

PODŽABLJE

(photo – Annex «5»).

*Natural-architecturalensamble.....*⑬

MALOKRN

MALOKRN, Gradac, Neum

*Roman settlement from 1-4 A.D.....*R⑫

Through the literature recorded the remains of Roman structures with the findings of building materials. (photo - Annex "6").

DOBROVO

GREBLJE, Dobrovo, Neum
*Medieval necropolis from the late Middle Ages and the remains of the church.....*SV⑪

The sources mention about 100 tombstones in a shape of coffin and sarcophagus with the decorations in the form of spiral-shaped bands, borders, tendrils, symbolic characters, a shield with a sword, figurative representations, as well as the foundations of an older church in the locality called Crkvetine.

VRANJEVO VILLAGE

VRANJEVO VILLAGE, Vranjevo Village, Neum.
Roman settlement, late antique basilica and necropolis and a medieval necropolis
Roman and late antique period, 1-6 century and the late Middle Ages,

14-15.A.D.....AR_SV⑩

In the literature it can find information on previous researches, found ornamental architectural fragments, several urns and a tombstone inscription, and, discovered remains of walls of late antique basilica, a pillar with a cross of altar partition and impost with a cross in the form of rosettes, and the tombs of tegula. Registered a larger quantities of building materials (bricks and tiles), and ceramics.
According to sources, on the medieval necropolis there are about 150 tombstones in the form of plates, boxes and wall crests, arranged in two groups. Some tombstones are decorated with tendrils, crescent, rosettes, cross, lilies, hand with a sword, figurative scenes, inscriptions.
Recent reserches (Institute for Protection of cultural and historical heritage in Mostar) also resulted in the discovery of significant findings.
The site has been proclaimed *a national monument*.

GRADAC

The Catholic Church of St. Anne..... O⑭

Object / historical building, has declared a national monument.

Note: The object is not in the "impact zone" of the road, and here is more mentioned in the context of other connotations of its construction: the affirmation and popularization of heritage, which should be one of the imperatives of tourism, or one of its positive effects.

3.14 Air quality

Energy for the movement in traffic, today's road motor vehicles obtain only through the internal combustion engine, which in fact mostly use liquid fossil fuels. This type of drive will remain dominant also in the near future, certainly with significant technical improvements and increasing the use of various types of gases as fuel. Some of them, depending on the concentrations in which they appear in the air can adversely affect humans and other living beings. These gaseous substances can be divided into those who have a global impact and those who work at the local level.

Matters of global impact are carbon dioxide (CO_2), which along the roads is not harmful, but it contributes the most to appear greenhouse effect. Sulfur dioxide occurs mostly in diesel engines and cause the phenomenon of acid rain. Traffic participates in total emissions of sulfur dioxide with only 5%, while the main sources are of industry and home furnaces.

In the matters of local impacts include carbon monoxide (CO), nitrogen oxides, carbon hydrogens, diesel soot and lead. Carbon monoxide is created by incomplete combustion in engines and using the catalyst can be almost completely removed from the exhaust

gases. The gas in common concentrations along the roads is not harmful to humans and the environment, but indoors can quickly reach concentrations toxic to humans.

Nitrogen oxides are formed at high combustion temperatures. In the engine itself arises mainly nitrogen monoxide (NO), which is under the influence of the atmosphere mainly transformed into more toxic dioxide (NO_2). This, further, depending on the temperature and the presence of ultraviolet light, participates in the formation of ground-level ozone, which is a particular problem in the cities. Nitrogen dioxide has irritating effects on the respiratory system.

Hydrocarbons are in fuel, and they appear by incomplete combustion within the engine. Using a catalyst they can be largely removed from the exhaust gases. Most of the hydrocarbons, which appear in normal concentrations in the environment, relatively quickly break up and do not adversely affect. Exceptions are polycyclic aromatic hydrocarbons (PAH), of which benzene, formaldehyde and some other have carcinogenic effect on humans.

Diesel soot is created by combustion in diesel engines under high load. At higher concentrations, together with other flying particles (dust), can due to deposition on leaves and needles of plants adversely affect the photosynthesis and other functions of plants. There are some assumptions that diesel soot at long-term exposure has carcinogenic effect on humans, and independently, and in combination with carbon hydrogens accumulated on soot particles. These assumptions are not clearly proven, and uniform limit values of allowed imissions are not adopted.

Toxic effects of lead on humans manifest, according to current knowledge, especially in hindering the synthesis of hemoglobin, and the impact on the nervous system. With the increasing use of unleaded petrol, this problem becomes less significant, and as expected, unleaded petrol will completely supplant one with the lead.

Air quality in the region largely depends on the distance of a point where the air is observed from the source of pollution, as well as on air currents and the configuration of the terrain. The configuration of the terrain is associated with air currents and changes their direction and speed, but also affects the rate of exchange of air. In the closed valleys or canyons comes to slower air exchange, and the polluted air accumulates in these areas, while on the slopes of hills or in the lowland areas air exchange is faster and so pollution is less. Generally it can be said about the flat configuration of the terrain that the concentration of pollutants decreases relatively rapid with stand further from the source, due to the process of diffusion of pollutants in the air, which causes dilution of the concentration.

Because this area of road line M-17.3 Buna - Neum is without industrial pollutants, which reflects directly on the quality of air, here a dominant role in air pollution has the traffic.

However, having in mind that this is a road line with the very low frequency of vehicles it may consider that the air in the area of operation is relatively clean.

3.15 Noise

One of the most significant impacts caused by traffic is exposure of people to noise living in villages near the route alignment. The biggest cause of communal noise is the traffic with about 80%, and other sources such as industry, restaurants, street noise of different origin and noise in the households are present to a lesser extent. Although overall progress in the recent production of vehicles has resulted in lower vehicle noise, road noise level increases as a result of the increased number and speed of movement of motor vehicles. This is, in varying extent, true for all types of roads, whether it is about highways, main, regional or local roads. Noise is unwanted sound by definition, because it damages hearing, makes impossible voice communication, disturbs concentration and causes a drop in efficiency, with harm to human health. Hearing damage is cumulative and irreversibly. The most important is immateriate source of pollution in road transport and in origin it is a complex phenomenon that has a stochastic character.

The unit for measuring noise level is the decibel (dB) which is based on logarithmic table. In acoustics, the decibel are often used for comparison of sound pressure in the air with a reference value. The reference value is $20x10^{-6}$ Pa, what is the sense of hearing of young healthy person, and corresponds approximately to the sound of clock ticking at distance of 7m. Acoustic scientists use dB scales because the quantities that are considered within the large range of sizes, and logarithmic scale compresses this area. Another reason is that the human ear interprets a loudness by logarithmic, and not by linear ratios. This means in practical terms that for example the intensity of doubled source (for example, doubled load of traffic) will show the increase of +3 dB. On the other hand, with the receptor, the subjective impression of human beings that the noise is doubled requests an increase of approximately +10 dB. Generally, the changes that are less than 1 dB are not considered as significant changes. In most European countries the criterion of ISO R 1999 has been adopted according to which is acceptable a dose of noise, which will not result in hearing loss, exposure to noise of 90 dB(A) during 8 hours. For instance, in the case of exposure to noise of 93 dB(A), the maximum allowed time that will not damage hearing is 4 hours.

Until today, the standards for noise levels are not specified by the Government of Bosnia and Herzegovina. Protection, ie. the degree of protection, and the highest allowed noise levels in an environment where people live and reside are defined on the basis of present legislation in BiH:

- Regulation on the allowed limits of sound intensity and noise, (Official Gazette SR BiH, no. 46/89)
- Law on Noise Protection (Official Gazette of Sarajevo Canton, no. 26/07)

Criteria for noise protection of the road are identical to the Regulation on the allowed limits of sound intensity and noise and the Law on Noise Protection of Sarajevo Canton, and it is not disputed which the current criteria is acceptable to the planned road.

By the regulations on permitted limits of sound intensity and noise, the allowed noise levels of imission in the open air are given in the following table:

Table 9. *Permitted levels of external noise for the planning of new facilities or sources of noise*

Area (zone)	Purpose of area	Maximum permitted levels dB(A)		
		Equivalent levels L_{eq}		Peak level
		day	night	Ll
I	Hospital-sanatorium	45	40	60
II	Tourist, recreational, health resort	50	40	65
III	Housing, education and health institutions, public green and recreational areas	55	45	70
IV	Trade, business, housing and housing to **transport corridors**, storages without heavy transport	60	50	75
V	Business, administrative, commercial, handicraft, service (municipal services)	65	60	80
VI	Industrial, warehouse, service and traffic areas without housing	70	70	85

Permitted levels in this table relate to existing space purposes, and according to Article 7 of the mentioned Regulation in the designing and planning of noise protection it must meet the values for 5 dBA lower than those allowed in the table above.

Knowing that rural villages along the section have mixte character to residential and commercial use, for the planned project, as a reference area to the Regulation on the allowed limits of sound intensity and noise, the zone IV was determined for populated areas. For assessment of the potential negative impact of noise it is relevant the noise level of 60 dB(A) during daytime and 50 dB(A) during the night. Limiting, ie critical day and night noise levels should be the basis for the protection of natural and residential environment from excessive noise, and therefore the above limiting levels must not be exceeded.

The applied standards of 60/50 dB(A) can be compared with those that apply to the regulations of WHO (World Health Organization) and the regulations of European Community. Sources of noise must not cause the noise that exceeds levels specified by standards for noise.

3.16 Infrastructure

3.16.1 Water Management Infrastructure

3.16.1.1 Water supply

Municipality of Neum

For supplying the town of Neum it uses sources Gabela and Blace. Water supply of Neum municipality is from the Regional water supply system Gabela-Svitava-Neum. Gabela waterwell with two bored wells yield 50 to 100 l / s is in alluvion of Neretva River in the municipality of Čapljina. This system is designed so that supplies parts of the community of Čapljina, settlements in Popovo Polje, today Municipality of Ravno, some villages in the hinterland of Dubrovnik coast of the Republic of Croatia, the town of Neum, and all the villages in the municipality of Neum, which are located along the route of the Regional water supply, and for all consumers of specified areas: population, livestock, industry, fire reserves and farmsteads to 200 m^2.

The whole system is complex and demanding with approximately 38 km of long distance pipelines, 3 pumping stations and 5 system reservoirs of the total capacity over 5000 m^3. Subsystems that rely on main system are also very complex (a long pipe lines, pumping stations and numerous smaller reservoirs).

Such long pipeline, with a big raising heights of water approximately 370 m, a small consumption (except in summer) is very expensive to maintain. In finding solutions to reduce the high costs of water supply, in 2005 the municipality of Neum built and put in function a waterwell Blace in the vicinity of Neum. Blace waterwell with two bored wells in the capacity of 14 l / s (total of 28 l / s) meets the needs of the town until beginning of June. In the summer season when consumption is increased, it uses a combined Regional water supply and water from sources Blace.

Population from some settlements that are not connected to the Regional water supply system is traditionally supplied with water accumulating rainwater in their own tanks (water cisterns), or bringing water from distant sources.

Water quality of Blace source
By the project of reactivation of Blace waterwell, some investigation works are carried out and the analysis of water quality is done from boreholes of two wells to depths of 40 m. It was shown that the water is chemically correct with minor bacteriological pollution.

Table 10. *Measurement results of analytical parameters of water quality from source Blace from wells 1 and 2*

Item no.	Parameter Name	Well 1	Well 2	Unit measure	MDK
1.	Muddiness	0,72	0,4	NTU	4
2.	Color	none	none	mg/Pt/Co scale	20
3.	Smell	none	none		none
4.	Taste	none	none		none
5.	Electrical conductivity	418	441	μScm^{-1} at 25°C	
6.	Conc. H^+ ion	7,6	7,7	pH - unit	6,5-8,5
7.	Consumption $KMnO_4$	1,66	1,54	O_2 mg/l	3
8.	Iron	0,022	0,024	Fe mg/l	0,5
9.	Ammonium	0,00	0,00	N mg/l	0,1
10.	Nitrite	0,00	0,00	N mg/l	0,03
11.	Nitrate	0,29	0,33	N mg/l	10
12.	Sulphates	0,9	0,7	SO_4	
13.	Chloride	30,0	30,0	Cl^- mg/l	200
14.	Total coliform	180	110	br/100 ml	0
15.	Fecal coliform	32	40	br/100 ml	0
16.	Fecal streptococci	2	6	br/100 ml	0
17.	The number of bacteria at 37 ° C	310	200	br/1 ml	10
18.	Sulph.reduc.clostridia	2	0	br/20 ml	1

Source Table: Department of Public Health, Mostar 2002 (Study of "Integral development of the coastline and marine resources of Bosnia and Herzegovina", Faculty of Civil Engineering University of Mostar, 2002.)

According to data obtained from the Agency for the water area of the Adriatic Sea, Mostar, the first analysis of the quality of Blace source, after investigation works will be available in September of the current year.

Department of Public Health of the Federation BiH, Department for Hygiene and Health Ecology, continuously performs quality analysis of drinking water (samples taken by end users). Water quality meets the requirements of the “Regulations on the hygienic quality of drinking water” (Official Gazette of RBiH no. 2/92), and the results of analytical parameters are presented in Table 11

Table 11. *The results of physico-chemical and biological parameters of drinking water*

Item no.	Parameter Name	Results	Unit measure	MDK
1.	Muddiness	0,00	NTU	4
2.	Color	0	mg/Pt/Co scale	20
3.	Smell	none		none
4.	Taste	none		none
5.	Electrical conductivity	446	μScm^{-1} at 25°C	
6.	Conc. H^+ ion	7,4	pH – unit	6,5-8,5
7.	Consumption $KMnO_4$	0,77	O_2 mg/l	3
8.	Free chlorine	0,15	mg/l	0,5

9.	Ammonium	0,00	N mg/l	0,1
10.	Nitrite	0,00	N mg/l	0,03
11.	Nitrate	0,33	mg/l	10
12.	Chloride	17,0	Cl^- mg/l	200
13.	Total coliform	0	br/100 ml	0
14.	Fecal coliform	0	br/100 ml	0
15.	Fecal streptococci	0	br/100 ml	0
16.	The number of bacteria at 37 ° C	1	br/1 ml	10

Source Table: Department of Public Health of the F BiH, Mostar 2009

Blace Water Source Protection Project, which should include the zones of sanitary protection with precise set limits, sanitary regime and other measures, is currently under construction.

Municipality of Stolac

Stolac and its suburbs are supplied with water from the source Do, which is located near the springs Bregava, municipality of Berkovići in RS.

Considering water supply of rural settlements of the municipality of Stolac, which are in the scope of our review, there is no water supply system. Population is supplied with water, and many villages in this karst area, from its own tanks (cisterns), or bringing water from distant sources.
Attempt of inhabitants of the Bjelojevići settlements to water supply from underground was not successful. Upon drilling wells to over 100 meters of depth the water is found, a local water network and reservoir have been built, located approximately 250 m of the planned main road. Given the structure of the field and its large water permeability, water is lost from the wells (which shows that the groundwater level is deep enough) and the well has remained without water, and residents of Bjelojevići have returned to traditional water supply from the tanks.

3.16.1.2 Sewage Systems

Municipality of Neum

Faster economic and social development, as the coastal parts of Bosnia and Herzegovina, and the coastal part of Croatia, as well as the use of high quality natural resources of marine waters, imposed the need to quickly solve problems of environment protection, and especially protection of the coastal belt from wastewater pollution.

By the sewage system Komarna-Duboka-Klek-Neum-Ston wastewater is transported by the main collector in "raw" state to the central device for the treatment and by the mechanical operation discharged in the submarine of Mljet channel. The total planned length of the collector is 38 km, a realized section Neum-Ston is about 22 km.

Mostly larger facilities are connected on the sewage system (hotels, residential buildings, businesses and fewer private facilities). Settlements above the main road are not

connected to this system, but the problem of waste water evacuation is solved indvidually by septic pits. Secondary sewerage network is not performed, and the coverage area of the town of Neum with the sewage system is approximately 30%. Major problem of the town of Neum is resolution of the rain water, which can cause considerable damages to facilities.

Municipality of Stolac

In the municipality of Stolac, only in the town a sewage system was built for the reception and evacuation of rainwater and wastewater, which are directly discharged without treatment into the river Bregava. Existing sewerage network are the main collector (total length of approximately 1500 m) with corresponding sewage network.

In the scope of our consideration there are the settlements which are not connected to this system, but the problem of waste water drainage is resolved individually by septic pits.

3.16.2 Electricity network

Municipality of Neum

Electrical energy network is at a satisfactory level and does not constitute an obstacle to the development of the community in terms of this potential. The whole area is covered with air lines DV 10 kV and DV 35 kV, following corridor of the existing road and providing all the surrounding villages with electricity.
Electrical circuit DV 110 kV Opuzen -Neum goes to substation in Neum, and from Neum DV 110 kV Neum-Ston.

Municipality of Stolac

Electrical energy network is at a satisfactory level and does not constitute an obstacle to the development of the community in terms of this potential. The whole area is covered with air lines DV 10 kV and DV 35 kV, following corridor of the existing road and providing all the surrounding villages with electricity.
Electrical circuit DV 110 kV Mostar-Stolac goes to substation in Stolac, and from Stolac DV 110 kV Stolac-Bileća. In parallel with the 110 kV route, two 220 kV route are extending:
DV 220 kV Mostar -Trebinje, the system I and DV 220 kV Mostar -Trebinje, the system II.

3.16.3 Telecommunication network

Municipality of Neum

Telecommunication network is at a satisfactory level and does not constitute an obstacle to the development of the community in terms of this potential. The town Neum is covered with a network with appropriate facilities, extending in the northwest-southeast

direction, with branches for adjacent places. One branch of the network follows the road M-17.3 Buna-Neum, section Neum- Stolac, to Gradac. Another branch of the network stretching, also, in the northwest-southeast direction, line Borut-Kolojani-Brštanica-Cerovica-Rabrani-Podkula, with branches for adjacent sites: Kolojani, Cerovo, Kozarica, Cerovica, Zaušje, Crnoglav.

Municipality of Stolac

Existing telecommunication network is at a satisfactory level and does not constitute an obstacle to the development of the community in terms of this potential.

3.16.4 Gas transport

The existing main gas line to transport natural gas is in the direction of Zvornik-Sarajevo and Semizovac -Zenica direction.

Development of the pre-investment Study of gasification of the Herzegovina-Neretva, West Herzegovina and Livno canton is in progress, fwhich is scheduled to be completed in November 2009. In principle, the main gas pipeline route will follow the alignment of the motorway on Corridor Vc, while the alignments of branch-roads for the municipalities of Neum and Stolac will be specified by the Study.

3.16.5 Traffic infrastructure

3.16.5.1 Road network

Municipality of Neum

In the Republic of Croatia, considering road traffic is significant a main traffic route connecting Split-Dalmatia Canton with Dubrovnik-Neretva Canton and crossing the territory of Bosnia and Herzegovina. This road is also significant because it passes along the Croatian coast from the town Rijeka and further to Europe. Road load is very high, so in the coming period it is also planned a construction of new roads including the Adriatic-Ionian highway, parallel to the coast. The same is removed from Neum coast to hinterland about 16 km of the air line, and cuts the Neum municipality. It relies on the direction of Budapest-Sarajevo-Ploče on the east side and along the Adriatic direction as coast relying and as the shortest connection of central Bosnia area with wider zone of Split-Ploče.

Advantageous geopolitical position of traffic which is characterized by good transport connections with the coast and the hinterland, is also defined by the nearby airports in Dubrovnik, Mostar, Split, and one smaller in Ploče.

Proximity of the railway traffic from the port of Ploče provides good connections in this area and goes into the hinterland to Čapljina, Mostar, and towards the interior of Bosnia and Herzegovina. Nearby there are also three major ports: Split, Ploče and Dubrovnik.

Total length of local roads in the area of the municipality is about 82 km, of which about 66,5 kilometers is with the asphalt coat, and about 15.5 kilometers with the macadam coat.

The main road M-17.3 Neum-Stolac with branch-road in Donje Hrasno to Čapljina, length 53 km, is the only link of Neum with the interior of Bosnia and Herzegovina, because transiting through the Republic of Croatia is everyday problem. This is especially distinctive during the high tourist season. This road is very narrow and winding, so use of the same is rather difficult and dangerous. Some of the necessary interventions are done in this road, but the final and priority solution is extension of the road for more another lane, and find the optimal alignment of the same. Elaboration of the project is in progress.

Municipality of Stolac

Stolac municipality has a modest transport infrastructure, ie roads, which is in discordance with the environment. It is necessary to do all that this situation can be improved, especially the connection with Neum.

Of the main roads there are sections: Trebižat-Stolac-Žegulja (length 38 km) and Buna-Stolac-Neum (length 72 km), both in poor condition, of the regional roads section Stolac-Berkovići (length 8 km), also in poor condition .

Within the same community Stolac there are main roads with total length of 35 km, regional roads in length of 21 km and local roads in length of 98 km.

3.16.5.2 The railway network

Municipality of Neum

Planum remains of narrow-gauge Čapljina-Trebinje-Dubovnik, which is not active since the seventies.

Municipality of Stolac

No relevant data about the existence of the railway network.

3.17 Endangerment by mines

According to the "Map of mine situation Neum Stolac“ scale 1:50.000 (which dates from the 7th of January 2009.) done and submitted by the BH MAC, on the alignment, at Stolovo, some areas are marked as" suspect area "(station km 28 +000 to km 28+670) and the "risk area" (station km 28+070 to km 28+560). A small area is characterized as an "area without defined risk (station km 27+320 to km 27+800).

4 DESCRIPTION OF THE POTENTIAL PROJECT IMPACTS ON ENVIRONMENT DURING CONSTRUCTION AND DURING OPERATION

4.1 Impact on population and settlements

4.1.1 Impact during construction period

The investigation on the socio-economic status along the road shows that direct impact on population is a critical issue related to indirect impacts on residential areas such as: noise, impacts on landscape, historical and archaelogical sites, and impacts on air quality which are described in the other chapters.

The potential impacts of the road project on the socio-economic environment during construction period have been identified and analysed regarding: type of impact (positive or negative); nature of impact (direct or indirect); magnitude and significance (low, medium, high etc.), extend/location of impact.

The indicators that have been evaluated for the construction period are:

1. Population and settlements:
   - Impact on settlement development prospects
   - Population directly affected by construction works
   - Resettlement/displacement of people

2. Social structure and cultural values:
   - Social disturbance

3. Property values:
   - Removal of houses and other buildings
   - Loss of agricultural land

4. Safety:
   - Accidents due to construction works/machinery

5. Economic Development

In detail, the following impacts during the construction period have been identified:

Population and settlements:

- Impact on settlement development prospects: Settlements or construction land in the corridor of the road being passed by the road without having intersections, undepasses and overpasses will be affected by interruption of traditional settlement structure, including interruption of social cohesion. The location of intersection will influence settlement development characteristics due to possible

extension of settlement elements along access roads. The impact is a long-term impact and requires mitigation measures regarding adoption of the urban plans of the affected municipalities.

Possible negative impact on urban space, if it does not prevent the uncontrolled connection to the main road.

- Population directly affected by construction works: Population in the area of direct impact will be affected by the construction works regarding noise and air pollution and dust caused by the construction works (see also noise and atmospheric environment). Furthermore, disturbances will be related to construction camps in the vicinity of settlements and traffic congestion. Population will be directly affected ba the construction of the new road in the following sections:

  First section (Stari Neum-Kiševo)
  Vranjevo Selo, Kiševo

  Second section (Kiševo-Broćanac)
  Babin Do, Dobrovo, Nerađe

  Third section (Broćanac-Drenovac)
  Podžablje (of km 12+000,00 to km 12+100,00)
  Broćanac (of km 12+00000 to km 12+250,00)
  Prapratnica (of km 14+850,00 to km 15+100,00)
  Hutovo (of km 16+700,00 to km 17+400,00)
  Cerovica (of km 20+75000 to km 21+900,00, of km 22+800,00 to km 23+000,00)
  Vinine (of km 23+850,00 to km 24+300,00)
  Crnoglav (of km 25+30000 to km 25+800,00, of km 26+100,00 to km 26+300,00)
  Ober (of km 31+550,00 to km 31+700,00)
  Udora (of km 31+35000 to km 31+700,00)
  Matića Mahala (of km 33+200,00 to km 33+450,00, of km 34+000,00 to km 34+100,00)
  Grdijevići (of km 35+950,00 to km 36+300,00)
  Drenovac (of km 36+200,00 to km 36+400,00)

  Also the impact is on the graveyards / cemeteries and religious objects:

  Third section (Broćanac-Drenovac)
  Cerovica (of km 21+500,00 to km 21+650,00)
  Vinine (of km 24+350,00 to km 24+400,00)
  Ober (of km 31+870,00 to km 31+950,00)

  The impact will be related to the construction period (short-term) and will require mitigation.

- Resettlement/displacement of people: The construction of the road will require expropriation and in some areas resettlement of people. The sections of the road

passing directly through settlements have been identified and areas probably being subject to resettlement activities are listed below:
Third section (Broćanac-Drenovac)
Hutovo (of km 18+200,00 to km 18+350,00, of km 19+350,00 to km 19+450,00)
Cerovica (of km 20+900,00 to km 21+200,00)
Vinine (of km 23+850,00 to km 24+000,00)
Crnoglav (of km 25+300,00 to km 25+600,00, of km 26+100,00 to km 26+300,00)
Grdijevići (of km 36+150,00 to km 36+300,00)

Social structure and cultural values:

- Social disturbance: The construction of the road will require construction camps and most of the crew are likely to live in temporary facilities. Camps can harm local social system in various ways, e.g. the camps can promote undesirable behaviours. Although local labour is expected to be used where available, the project contractors are likely to employ semi-skilled and skilled workers from outside the area. The arrival of large group of workers, mainly men, to the camps can have severe impacts to the local community. In general the camps are well accepted due to employment opportunities also for local people. The possibility of ethnic conflicts is small, however, occasional and personal conflicts will be expected due to many reasons, often due to drinking. The more cash availability among migrant workers might cause personal conflicts. If careful planning, communication and other mitigation measures are undertaken, social problems concerning conflicts between workers and local communities will be minimal.

  Indirect disturbances during construction works are likely in not directly through-passed settlements too. These impacts are related to traffic congestion during the construction period in locations of intersections, bridges, viaducts, passage ways, overpasses or crossings with the existing roads. Mitigation measures as traffic management or other measures should be implemented to minimise this impact.

  Locations likely to be affected are:

  intersection:
  First section (Stari Neum-Kiševo)
  Intersection at level at station (km 0+220,00)

  Third section (Broćanac-Drenovac)
  Intersections in the lane level for the left turn, at stations
  (km 12+000,00; km 22+000,00; km 34+600,00);

  bridges:
  Second section (Kiševo-Broćanac)
  Bridges of length 10,00 m at station (km 5+309,50; km 6+724,00)

  viaduct:

Third section (Broćanac-Drenovac)
Viaduct of length 123,00 m at station (km 15+260,00)

passage ways:
First section (Stari Neum-Kiševo)
Passage way of length 5,00 m at station (km 1+450,00)

Second section (Kiševo-Broćanac)
Passage ways 5,00x3,50 m at stations (km 7+272,00; km 8+682,00; km 10+540,00)

Third section (Broćanac-Drenovac)
4 frame passageways

overpasses:
Third section (Broćanac-Drenovac)
Overpass of length 25,00 m at station (km 36+460,00)

Crossing with existing roads:
Third sections (Broćanac-Drenovac)
At stations (km 12+350,00; km 13+470,00; km 18+140,00; km 18+660,00; km 19+350,00; km 20+900,00; km 20+910,00; km 21+320,00; km 21+760,00; km 22+910,00; km 24+170,00; km 24+860,00; km 25+150,00;) km 26+110,00; km 26+275,00; km 27+370,00; km 27+835,00; km 30+260,00; km 31+750,00; km 31+910,00; km 33+090,00; km 33+620,00; km 34+065,00; km 34+745,00; km 35+760,00; km 36+030,00; km 36+135,00)

Property values:

- Removal of houses and other buildings: The construction of the road will require maybe expropriation and in some areas houses will have to be removed. The sections of the road passing directly through settlements have been identified and correspondingly the areas probably being subject to expropriation. None of the houses are located directly on the road. Removal of houses and buildings is likely in the settlement areas listed below. The impact is a long-term impact and requires mitigation. A detailed analysis of expropriation requirements has to be conducted according to the related legislation.

  Third section (Broćanac-Drenovac)
  Hutovo (of km 18+200,00 to km 18+350,00, of km 19+350,00 to km 19+450,00)
  Cerovica (of km 20+900,00 to km 21+200,00)
  Vinine (of km 23+850,00 to km 24+000,00)
  Crnoglav (of km 25+300,00 to km 25+600,00, of km 26+100,00 to km 26+300,00)
  Grdijevići (of km 36+150,00 to km 36+300,00)

Land acquisition and compensation consider also the removal of houses and other buildings. Estimation of compensation and quantity of houses to be removed is as follows:

Third section (Broćanac-Drenovac)
Hutovo 4 houses with infield
Crnoglav 2 houses with infield

Detailed treatment of this aspect in the project of acquisition and compensations.

- Loss of agricultural land: Due to completely new construction of the road there will be an impact on agricultural land properties. The impact on agricultural land is high and has to be considered for the whole road section. The impact is long-term impact and requires mitigation and a detailed analysis of expropriation needs has to be conducted according to related legislation.

  Furthermore, the road will interrupt present structures and access roads to these areas. The access to agricultural land for owners should be guaranteed by the provision of local access roads and and accordingly mitigation measures are required.

  There will be also temporary losses of agricultural land during construction due to access roads to the construction site, construction camps, storage sites, asphalt plants etc. Site locations have not yet been identified, however proper planning should be done in advance and compensation should be paid and based on the value of the lost crop for one or two years, depending on the time the area is used.

Detailed treatment of this aspect in section 4.5 Impacts on soil and agricultural land area.

Safety:

- Accidents due to construction works/machinery: Construction works will cause accidents due to construction traffic and machinery used during works. Furthermore, drivers on local roads interfering with the road under construction are more vulnerable to road accidents and congestion and mitigation measures are required.

Economic development:

- During the construction phase, the road will have a positive effect on the economic development in the area due to the creation of job short-term opportunities related to construction works. Construction works will bring people into the area for a relatively long period. Local suppliers can profit from the influx of workers on the site and income-generating activities will be developed, which could remain also after completion of works. Mitigation measures regarding contract obligations could support and facilitate the positive nature of the impact.

4.1.2 Impact during operation period

The potential impacts on the socio-economic environment during operation of the road have been identified and analysed regarding: type of impac (positive or negative); nature of impact (direct or indirect); magnitude and significance (low, medium, high etc.), extend/location of impact.

The indicators, which have been evaluated for the operation period, are:

1. Population and settlements:
   - Population directly affected by the built road

2. Social structure and cultural values:
   - Social disturbances
   - Impacts on cultural heritage sites

3. Access to social services:
   - Improved access to education facilities, health facilities, transport, urban centres

4. Safety:
   - Reduction of accidents due to upgrading of road and improved design
   - Increasing accidents due to increasing motorisation and travel speed

5. Economic Development

In detail, the following impacts during operation period have been identified:

Population and settlements:

- Population will be directly affected by operation of the raod due to noise and air pollution, but the impact is insignificant.

Social structure and cultural values:

- Social disturbance: The realisation and operation of the road will have a direct impact regarding socail disturbance in case of through-passed settled areas. Traditional settlement systems and settlement functions as well as communication between inhabitants will be disturbed and interrupted. The impact is a long-term impact and requires mitigation. The affected settlements correspond to the settlements listed in Paragraphe 4.1.1 Population and settlements directly affected by construction works.

- Impacts on cultural heritage sites: During the road operation, The road will not degrade the cultural resources as most monuments and important sites areas located off the road and will not be affected by operation of the road.

Nevertheless, a positive impact is the decrease of bypassing traffic on the existing roads, diminishing possible negative impacts due to air pollution. On the other hand, sites could be easer accessible and better recognised due to better transport infrastructure. Mitigation measures are not necessary.

Detailed analysis of this aspect in Paragraphe 4.12 Impact on cultural and historical heritage.

Access to social services:

- Improved access to education facilities, health facilities, transport and urban centres: Road improvements can greatly affect accessibility to facilities and services as roads provide a crucial link between physical resources and users in rural and suburban centres. The project road is important for providing possibilities of improved transport on local and regional level. The road improves the access to education or health facilities located in urban centres, but the improvement will only be for those people who can afford a car or public passenger transport.

Safety:

- Reduction of accidents due to upgrading of road and improved design/ Increasing accidents due to increasing motorisation and travel speed: The realisation of the road will bring reduction of accidents due to improvement of design, pavement and signalling, and due to avoiding the dense settled areas and difficult terrains of the road. On the other hand, the project will contribute to the increase of accidents due to higher travel speed and increasing motorisation. During the road operation, accidents are caused by various means: over speed, carelessa/negligence, improper overtaking, mechanical defects, road obstructions, driver inexperience, passenger disruptions and other. Traffic accidents on the road in the future are likely to be more a function of traffic volume, rather than condition of improved road. During its operation, the new road cam improve traffic safety overall, but emergency response and service capabilities need to be developed. Traffic related safety difficulties due to operation of the road are expected to be significant at intersections. Mitigation measures to improve overall safety and emergency response are required.

Economic development

- The new road in general will have a positive effect on the economic development in the area due to:

  - creation of job opportunities related to maintenance/management works in the operational phase;
  - creation of income opportunities during operation of the road due to the development of related economic activities along the road, especially in the area of intersections;
  - Improvement of the connection between the major economic centres

The road is passing through an area with potential for development related to tourism and related services. The road can support various economic development possibilities, as for example the developmentj/revitalisation of unused industrial areas. The better transport connection can attract new investments and can support the sustainable development of urban areas. Due to positive nature of impacts, no mitigation measures are required.

4.2 Impact on micro-climate

4.2.1 Road impact on micro-climate

Microclimate of the area where the road is passing has the characteristics of sub-Mediterranean climate with very hot and dry summers and mild rainy winters. The distribution of rainfall during the year is very uneven and unfavorable, ie. most precipitation falls in the colder period, and lesser in warmer vegetation part of the year. Winds typical for this area are cold north wind-storm, which further dries the soil and makes this climate dry and moist south-wind -sirocco.

The road construction will not affect the change in the current microclimate in the areas through which it passes.

4.2.2 Micro-climate impact (wind) on road

By terrain recognition, talking with the domicile population at site, and additional analysis it is necessary to find sections of the road exposed to extreme winds, and in order to set protective structures that will reduce the harmful effects of wind on the participants in traffic. It is not ruled out setting up of measuring instruments which continuously measure wind speed at sections which are rated as critical regarding the impact of this parameter.

4.3 Impact on geological environment

Construction of this road in geological terms is very favorable. Rating conditions and methods of construction has been analysed in the geological section (Paragraph 3.3).

4.4 Impact on waters

During construction of the planned main road, the impact on the quantity or the possible changes in water regime are almost non-existent. The road alignment and associated facilities with its position, dimensions, construction procedures and the use do not come in conflict with any surface water flows, because these do not exist. Thereby they are not disrupting the natural relations of water regimes and from this aspect, measures of prevention, reduction or mitigation of impacts are not necessary.

Impact on water quality and measures to reduce the negative impact should be viewed in the context of relations between the road alignment and technical elements in certain parts of the alignment to the underground water systems.

As is evident from the geological, hydrogeological and hydrographic relations on the road alignment there are no significant rivers or lakes, and it is the area free of surface flows and water reservoirs (Hutovo Blato is outside of impact). Except during the rainy season when the relevant rain intensity is much higher than average when it may cause short-term effects of the torrent on and around the route and in the small karst valleys, due to higher concentration of clayey material, in the surface areas of the terrain it may form short time some small ponds, which through the abyss on the bottom of the karst valley quickly dry.
On section Stari Neum-Kiševo to the line from P57 to P59 in the karst depression on the station km 1 +400, near the planned alignment there is a source with two drilled wells for water supply and small pond that is not drying up throughout the year, and during the rainy season the whole depression is under water.
Also, on section Kiševo - Broćanac during periods of intensive rain, rain waters from the higher parts of the slope will mostly infiltrate through a water permeable rock mass in the deeper parts of the field, leading to flooding of the lower parts of Dubravsko karst field when the estavela located on its edge cannot accept all surface waters and it comes to its spills.
On section Broćanac - Drenovac, as well as on the previous section, there is no surface flows. All surface waters in the zone of the designed road infiltrate quickly in the underground.
Litologic materials of the site and state of rock masses are such that the possibility of maximum infiltration of surface water is inherent ie. any waters that fall or pour into this environment practically without delay, infiltrate in the underground and get at the deeper parts of the terrain in the zone of horizontal circulation of groundwaters. According to earlier studies that were conducted in 70-ies, and for the construction of HPP Čapljina and HPP Trebišnjica, in Popov field is carried out staining the abyss and wells. It has been proven the abyss connection in the area of Svitavsko mud and on the Adriatic coast in the area of Slano and its hinterland. This suggests to us that the abyss connection is quite outspread.

Hydrogeological relations in the alignment area are an important factor on the basis of which we can predict the level of risk which the alignment on certain lines affects the groundwaters ie. the environment as a whole, since the water in nature is an element, which is a very efficient means of transport that can carry pollution at large distances.

A risk of pollution is represented in case of accident situations, especially those involving heavy vehicles transporting dangerous cargo (traffic accidents, breakdowns), due to the temporal and spatial unpredictability.

Imact of the main road on waters will be seen through two aspects:

- Impacts during construction period of the main road
- Impacts during operation period of the main road

4.4.1 Impacts during construction period

When carrying out construction works on the alignment there are a number of activities that can cause negative effects on water, in this respect, the greatest danger are:

- Construction works (blasting, deep excavations, demolition and removal of the natural top layer, etc.) that can disrupt the natural recharge routes, and removal of top layer and the creation of new basin surfaces, muddy or otherwise contaminated water quickly drains into the underground
- Construction vehicles – potential risk of spills or accidental spill of petrol and petroleum products, rejection of motor oils and similar waste.
- Environmental incidents that construction equipment may cause by spills or accidental outpouring of liquid fuel, rejection of motor oil and similar waste that can cause contamination of groundwater
- Uncontrolled disposal of an excavated material and setting plants for machinery or asphalt plants near sensitive areas.
- Uncontrolled sanitary water drainage in the area of camps for accomodation of workers.

Along the main road alignment, unless Blace source, it has not been identified other local underground sources of permanent or temporary character. The Blace source is in the public water supply system for the town of Neum, located near the planned alignment of the main road, and we can expect a significant negative impacts on the regime and groundwater quality of the same. This is particularly reflected in the form of blurring of the source due to very karst terrain, but also disturbance of the hydrologic regime of flow in the case of large-scale application of blasting and pollution by various harmful substances used during construction and operation of construction machines.

4.4.2 Impacts during operation period

During the road operation period there is a constant pollution of the road and direct belt near it that negatively affects the water quality and relates to:

- Pollution of rainwater that falls on the road due to loss from the operation system and lubrication of motor vehicles (motor fuels, motor oils, coolant, etc.), of the rubber waste and wear layer, then emission of the products of motor fuel combustion (lead and lead compounds, not burn hydrocarbons, nitrogen oxides, soot and tar). These contaminants initiated by rainfall can get into groundwater and thus pollute it.
- Accidental / sudden pollution caused by traffic accidents during the transport of chemicals, liquid fuels, lubricants and other hazardous substances. Usually the accidents which lead to spillage of oil and petroleum products that have great ability of diffusion in the field and the underground and due to the complexity of

the flow and water retention in the underground, the pollution has long-term character of the action.

In this situation, an important threat to ground water refers to a qualitative change resulting from contaminated substances that alter the physical, chemical and biological water quality. More significant contamination can occur in the presence of pollutants in surface waters that flow on the road (rainy periods) and in cases of accidents or negligence in the freight traffic or transport of special liquid fuels.

As it is the case during construction of the main road and in the operation phase, the source of Blace can be most exposed to the harmful impacts, whereas in the horizons of deeper aquifers, the construction of the main road does not represent a factor of risk in respect of pollution.

The all predicted negative impacts on waters in the construction and operation periods can be avoided or reduced by measures proposed in paragraph 5.2.3.

4.5 Impacts on soil and agricultural areas

Upon analysis of the project, in which the variant I is accepted, it has been considered the presumed negative effects on important receptors and active and potential negative effects during project implementation and during the use of the completed project. The corridor to 100 meters has been analyzed on both sides from the road belt.

4.5.1 Presumed negative effects during construction

Using current methods, we analyzed the soil, agricultural land area and forest land area, as important receptors, and we came to the following assumptions about the negative impacts and to the following stations:

- Section from 0 to 11 km

Kiševo - Babin do:

Here there is terra rossa in the karst zones, with colluvium soils and soils of karst sinkholes. In the area of Kiševo settlement, there are zones with agricultural land area, which is extensively used. These are areas with lower use value categories (V and VI) and belong to the agricultural zone II.

Presumed negative effects will be expressed through physical damages and disappearance of the soil, because the project alignment cuts through this area.

It will be difficult agricultural production and impaired quality of products that have the character of an organic or traditionally produced food. It is possible the cutting properties which will further impede production and reduce holdings.

Babin do - Dobrovo:

Here there is terra rossa in the karst zones, with colluvium soils and soils of karst sinkholes. There are some garden areas fenced by dry wall where there is a deep terra rossa.
In the line of Dubrava, the planned alignment passes through the zones of agricultural manufacturing space that are in function of Babin do settlement.
Presumed negative effects will be expressed through physical damages and disappearance of the soil, because the project alignment cuts through this area.
These are areas with lower use value categories and belong to the agricultural zone II.
It will be difficult agricultural production and impaired quality of products that have the character of an organic or traditionally produced food.

- Section from 11 to 12 km

  There is a potential danger. It gets in the zone of settlements Broćanac and potentially in the agricultural zone of the I category.

- Section from 12 to 13 km

Podžablje - Broćanac

In the zone of Broćanac settlements, a deep terra rossa and deep colluvium soils are present.
This represents a zone of zero ("zero") conflict. The planned alignment is dislocated in the northern direction, and does not cut more the best agricultural areas and the best deep terra rossa and colluvium soils. After this dislocation of the agrozones I, with the coverage of the I use category of land area, it remains in its primary purpose, but there is a potential risk of contamination by products of combustion from motor vehicles. In this zone there are some transitions from the best agricultural areas, through olive groves and downy forests, and the belt of evergreen vegetation of holly to the meager vegetation zones of southern exposure, which in the higher zones have the character of semi-desert areas.
Potentially there will be a possibility of adverse impact on agricultural production and distortion of quality of the products that have the character of an organic or traditionally produced food.

- Section from 15 to 16 km

  There is a potential danger. The alignment passes over the agricultural area and Prapratnica settlement. There are degraded and burned forest vegetation of the downy, white and black hornbeam, and other low vegetation. This is the zone of the viaduct and the tunnel entrance.
  The possibility of the negative impacts is presumed, caused by explosion, construction works and excavation deposit.

- Section from 16 to 17 km

  Indirect impacts on agricultural land area, which is covered with I agricultural zone and II and III use category of agricultural land area.

- Section from 19 to 20 km

  Humus terra rossa is present in karst zones and cracks with a typical surface rocky characteristic and colluvium soils of sinkholes.
  Potential negative impacts in the zone of settlement Meki pod. It represents a very small space of extensive agricultural area of the agro zone II and VI and agricultural land of the land use category VII.

- Section from 25 to 26 km

  It represents soils with lithosols, terra rossa in cracks with typical surface rocky characteristic and colluvium soils.
  Potential impacts on exstensive agricultural areas for settlements Vinine and Crnoglav in the agricultural zone III, which are covered with land use category V and VI.

- Section from 26 to 27 km

  It represents soils with lithosols, terra rossa in cracks with typical surface rocky characteristic and colluvium soils.
  Potential impacts on exstensive agricultural areas for settlements Crnoglav uin the agricultural zone III, which are covered with land use category V and VI.

- Section from 31 to 32 km

  It represents soils with lithosols, lithosols and terra rossa in crakcs and in pockets with typical surface rocky characteristic.
  Potential impacts are on extensive agricultural areas for settlement Udora in the agricultural zone II, which are covered with land use category V.

4.5.2 Presumed negative effects during operation

Negative effects on soil and agricultural land area will be present during the entire period of project operation.
Some active negative effects will be expressed through the disposal of pollutants from exhaust gases in the direct environment along the road.

The negative effects will be felt as a result of movement of defective vehicles by the road, through the physical presence of the fallen parts, such as : metal, plastic and rubber waste, which will fall behind on road or along the road. In addition to the mechanical parts, the negative effects will be felt from spilled lubricants and fuels from some defective vehicles or after traffic incidents. Spilled lubricants and fuels, after traffic

incidents, will represent a real danger for contamination of storm water, which will flow in the recipients, and then not purified go through the soil or porous geological substratum in underground aquifiers

The negative impacts on agricultural land area probably will be felt also from the stationary traffic. As the stationary traffic, here some parkings and rest areas are provided along the road. Previous experience with these sites indicates a high level of negative impact of size waste on surrounding agricultural land area.
All the emphasized aspects of negative impact will be very important and probably intense at the stations that are listed in the preceding chapters as well as conflicting positions with individual receptors.

4.6 Impacts on forest and forestry

4.6.1 Presumed negative effects during construction

Through the previous discussion and analysis, it was stated that along the planned alignment of the project are present the degraded forest communities with elements of the bush, and plant communities of rocky ground. Presumed negative effects on these "forest" systems during the project implementation, could mostly consist of the following. It is possible some rejections of old lubricants and fuels in the area of the corridor, then there is likely to be discarded surplus building materials in the area of the corridor during construction period of the road. We believe that the greatest dangers will exist during the summer months when it will be very high risks of fire in these areas. Due to the nature of forest communities such potential damages in the corridor may have significant environmental consequences. Greatest environmental damages at this stage can be expected in areas of residential camps, in the areas of construction bases and machinery plants.

4.6.2 Presumed negative effects during operation

Negative effects on forests and forest land area will be present during the entire period of project operation.

Active negative effects will be expressed through the disposal of pollutants from exhaust gases in the direct environment along the road. In addition to this form of damage, if it does not sanction the activities of disposal of surplus building materials and construction waste in the forest zones, which are analyzed in the scope of the corridor, such activities will be the greatest danger to the environment during operation period.

The negative effects will be felt as a result of movement of defective vehicles by the road, through the physical presence of the fallen parts, such as : metal, plastic and rubber waste, which will fall behind on road or along the road. In addition to the mechanical parts, the negative effects will be felt from spilled lubricants and fuels from some defective vehicles or after traffic incidents. Spilled lubricants and fuels, after traffic incidents, will represent a real danger for contamination of storm water, which will flow in

the recipients, and then not purified go through the soil or porous geological substratum in underground aquifiers. Plants with root systems will adopt pollutants and thus will reduce the resistance of forest systems. In addition to this form of damage or negative impact, some high risks will be reflected in the possibilities of fire break out as a result of burning or self-ignition of fuel and lubricants during the summer months.

The negative impacts on forests and forest land area probably will be felt also from the stationary traffic. As the stationary traffic, here some parkings and rest areas are provided along the road. Previous experience with these sites, and especially in forest areas, indicates a high level of negative impact of size waste on surrounding forest land area.

4.7 Impact on flora and vegetation

4.7.1 Impact during construction period

During construction of the alignment, it expects to be a direct negative impact on flora and vegetation, which will be manifested through the reduction of size of the population but also of areas of individual plant communities. Although we meet in this area very sparse vegetation dominated by rocks and shrubbery, in this sense, the impact is even more expressive, as rare areas covered with trees (in various stages of degradation), have great importance for this area, given that enable the survival of other species of organisms. In addition, as these have great influence to stop erosion process in the soil.

Significant impact on flora and vegetation will have works undertaken during construction of tunnels, viaducts, bridges and crossroads. Negative impact on forests will be reflected in the permanent loss of forest areas, where the biggest losses are in the domain of impact on the water regime, soil fertility, and production of oxygen.

As a result of the use of heavy equipment, surface layer of soil will be exposed to the biggest pressure, which will disrupt the natural balance of soil, which will cause reducing the number of plant species.

Exhaust gases and dust in the air have also harmful effects on vegetation. The most expressive impact of this kind will appear during breaking the tunnel and viaduct construction.

It is highly important to emphasize that all these works undertaken during the road construction will have a significant impact on some rare and endangered plants. One of them is Dalmatian laburnum (*Petteria ramentacea*), whose communities are noted in these localities, very rare.

In addition, construction of temporary disposal sites and borrow areas of building materials, will further burden the land, and thus reduce the number of species that may exist here.

Frequent fires whose frequency could increase during the construction, represent an additional threat to the flora and vegetation.

4.7.2 Impacts during operation

During operation period, the biggest negative impact will appear due to the potentially greater pollution by gases from cars, but also the appearance of subsequent new landfills.

Frequent fires whose frequency could increase during operation period, represent an additional threat to the flora and vegetation.

4.8 Impact on fauna

4.8.1 Impacts during construction period

Interest area is under anthropogenic influence, although the road does not pass through the settlements. Building the future road will have a negative impact, especially on the fauna of reptiles and medium-big game, because of the disturbance of their natural habitats and cutting migratory routes and the impossibility of exchange of genetic material between individuals of populations of the same type, which during road construction remained cut off from each other , ie isolated.

Harmful consequences for the game can leave also intersecting of roads to their natural watering-troughs and feeding place, which should be taken into account.

All this may have as a result reducing the size of their populations. Noise and vibration that are unavoidable during construction period, will certainly have a harmful effect on fauna of this area.

During the construction of tunnels and works, which imply drilling or indentation of hills, there could be a possible violation of the present underground habitats.

4.8.2 Impacts during operation period

In addition to the negative impact of emissions, a great importance when it comes to negative impacts, will have also cut of migratory routes, which can affect the abundance of animal populations.

Due to the road construction, can come up with the allocation of group of individuals on both sides of the road, and therefore communication between them will be difficult. It is possible that there will be an increase in the number of animals that will die in the attempt to cross the road.

4.9 Impact on landscape

4.9.1 Impact during construction and operation period of the road

Impact on the landscape in this case is a result of the operation, which includes indentation of slopes. Considering to take into account future road to be incorporated into the landscape, not impairing significantly its features, it can be concluded that this road will not significantly change the landscape features of space.

Of course, there are certain areas that should be excluded from these statements. There are primarily thinking of the parts on which is planned construction of tunnels, viaducts and crossroads, where due to the scope of works and procedures that will need to take, it must come to something greater distortion of the landscape.

After the road construction, a planting of a wider area is certainly planned taking care of presence of some types of speacies that will fit into the landscape and contribute to the richness of visual impression.

Thus, the impact is insignificant, but it is important to apply protective measures.

4.10 Impact on protected areas

4.10.1 Impact during construction and operation period of the road

In the area that is designed for future road construction, as noted, there are no protected natural areas, which would be directly threatened by the project.

From areas that have this status only in the course of the road operation could be threatened Hutovo Blato, but not directly. This is an important area for migratory bird species, and this fact is taken into account when defining the protection measures.

4.11 Impact on game and hunting

4.11.1 Impact during construction and operation period of the road

Possible impacts of the road construction will be manifested in two aspects. The first one is the road impact on the hunting areas as spatial units, and the other is the impact on the game in immediate and wider surrounding.

The impact on the hunting areas will be expressed by greater or smaller reduction of hunting surface in the specific hunting areas.

For each hunting area, sectioned by the alignment or located in its vicinity, for the analysis of the road relationships and impacts, the hunting area boundaries have been analysed as well as 25,00 m wide zones, counting from the pavement edge. After that, the surfaces of specific hunting areas and the total surface have been calculated.

Total reduction of the hunting area along the entire alignment (for the zone of 25,00 m) amounts to 197,50 ha.

Furthermore, a negative impact is present in the hunting areas unfavourably cut in two or more fragments by the road in a way that the remaining part can not be efficiently included in the main hunting area. If the surface of the separated part is larger, it is necessary to obtain a good connection between such parts.

This kind of negative impact exists to a certain measure in almost all hunting areas.

Apart the direct loss of the hunting area due to the road itself, one has to have in mind also the areas of fenced in protective strip along the foad, not encompassed by the hunting area. Furthermore, the road is directly disturbing ecological conditions of the habitat, determining numerousness of the game that can inhabit the considered area without having bigger impact on environment and other animal species.

In the other hand, the road alignment is cutting centuries-old natural migration paths of some game.

It practically means that, after the final alignment is set out, it will be necessary to redefine the existing hunting area boundaries, in order to maintain them as one rounded continuous entity, in accordance to the Law on hunting (Official Gazette SR B&H no.7/77) whose Article 25 unambiguously says that „the hunting area boundaries are set in the land and water areas representing natural and continuous hunting entity and where there are ecological and other conditions....“.

Impact on game

Generally, in case of the road passing through the hunting areas, especially through the enclosed hunting areas and game rising areas, there are problems of game migration (daily and seasonally), game disturbance and physical endangerment and theft. There is also a problem of game injuries due to the traffic, which will exist in spite of fence installation.

Impact on the game will result in decreased living area (habitat surface, surfaces for feeding, watering and movement), and more difficult communication during daily and seasonal migrations.

Seasonal migrations are expected to deer.

Bus stations, ie. rest areas do not bring major negative impacts on the game, although they should not be designed near bigger forest complexes.

4.12 Impact on cultural-historical heritage

General considerations: conflicting points, possible impacts

Any built structure - whether it is building design and construction or construction engineering, always, in a certain way, affects the surrounding area. Consequences of impacts, active in the process of formation of structure and (or) during its use, can - depending on various factors, be very different.

In the case of the main road construction - a new element into the existing natural and architectural context, a registered cultural-historical heritage is potentially exposed to certain harmful impacts. If we do not take appropriate measures on time, it can endure the devastation of different types and volumes. Therefore we have, in the process of preliminary evaluation of various alignment alternatives, treated as one group of *limiting factors*; here, however, considered as a "*risky group*", within which each position is separately discussed and analyzed.

In this context, the meaning of the field recognition and reserches of documentation base and literature, whose results are given in Section 3.13. and photo annexes, where identification of the *conflicting positions* on the subject section, ie. the identification and determination of harmful impacts that cultural goods in contact with the alignment, may be exposed to by the road construction.
In this, it needs no special mention that the ultimate goal of the entire study, and, thus, this phase of work, is finding technical solutions and making recommendations aimed at the elimination / neutralization of the potentially damaging impacts, ie, their harmful effects.

As the *conflicting positions* we have determined as follows :

- recorded sites, buildings, units that are located *within* unique «zone of impact» of the alignment, *in contact with it* or from it can endure indirect impacts;
- recorded sites, buildings, units *in a wider area of the alignment*, indicating the possibility of existence of other, now unknown / unexplored founds in a narrow zone of the alignment.

Recorded and protected assets facing to the alignment belog to the first group of the conflicting positions. They are located in its "impact zone" or in contact with it (archaeological area, cemetery and natural-building units). In the process of construction or operation of the road, they can endure a *potentially* negative impacts on the physical and / or immaterial aspect.

Generally speaking, negative impacts on the *recorded* assets can be divided in two main groups:

- Impacts on physical structure – material degradation
- Impacts on aesthetical / visual quality, historical or cultural character of the Property

Conditionally, it can be also defined the third group of impacts, which, by its degradation mechanism, can belong to each of the mentioned groups. It would include an impact on

ambient, ie. environment what is frequently an integral part of heritage property. This is particularly important in cases of natural – architectural or rural entities because a total space quality results from natural and artificial component and/or their full complementation.

In the second group of conflicting positions are so far unknown, non-recorded and unexplored archaeological sites.

Theoretically, it could find the archaeological findings during the execution of works on any section of the alignment. (In devising protective measures / mitigation measures, it has taken care of it, and it has proposed some appropriate protective measures.)
However, the "impact zones" on certain sections have an increased potential of "vulnerability", given that in the wider environment, there are the existing archaeological sites or medieval necropolis. Given the often more multifaceted nature of our sites, we can conclude that, in contact with evidenced archaeological areas, the increased likelihood of existence of the other, currently unknown findings that by different technical and technological interventions in the construction of roads may be damaged or destroyed.

If we observe *the manifestation of the impact period*, and the type and extent of degradation that they can cause, we can generally conclude that - during construction, negative effects of the greatest "weight" are related to the degradation of the *physical material* recorded (but, so far unknown) of assets.
During exploitation, however, negative effects also are relevant related to *visual quality*, *historical or cultural character of the building*, *site or entity*. Consequences that impacts active during operation can, however, have to a matter, are gaining importance in the rheological observation; they are, so mostly cumulative per character.

We also mentioned here - very significant - "harmful impacts" present in the design phase.
Because, objectively, there is the possibility of inadequate positioning of the alignment in terms of heritage protection, we have established a special impact category, conditionally naming the "*harmful effects of designed road":* a category that includes the possibility of " transit" of the alignment through the site of cultural goods. A such possibility, no doubt, should mean violation of its integrity - a break of continuity of the entity (the entity and the environment) because of "crossing" of the area that represents the spatial, historical, formed, natural or other entity - but also devastation of physical materials.
The meaning of this study is precisely in pointing to such possibilities and their elimination, and some recommendations for these cases are provided within the mitigation measures.

By field recognition executed by the methodology of *«rapid survey»,* and, by study of the documentation base and relevant literature whose results are given in Section 3.13. photo-annexes, we have identified several conflicting positions on the subject section; the positions are listed in the table below (Table "12").
Table «12»

AREA	SITE	IDENTIFICATION CODE / MARK ON MAP
UDORA	Udora	SV①
CEROVICA	Obaljeno groblje	SV→②
PRAPRATNICA	Prapratnica 1 Prapratnica 2 Kapina	P⑤ SV③ P④
BROĆANAC	Broćanac Kućetine Zacrkovnica Gradina	P⑧ P_R⑦ SV⑥ P⑨
PODŽABLJE	Podžablje	⑬
MALOKRN	Malokrn	R⑫
DOBROVO	Greblje	SV⑪
VRANJEVO SELO	Vranjevo Selo	AR_SV⑩

Due to the specificity of problems, different types of spatial coverage and type of stated assets, each of these mentioned positions is treated in detail in the graphic documentation of this work: on the maps using the appropriate symbol, all the harmful effects are presented, which, due to road construction, each specific property may be exposed to.

Impacts that are negative in character, we have processed separately because they do not require the implementation of protective measures, and represent a positive basis for the presentation and popularization of heritage, its integrated protection and tourism development.

4.12.1 Impacts during construction period

After analysis of the conflicting positions, during which we took into account various factors, we found that the following negative impacts can be manifested on them during construction of the road:

- The possibility of physical devastation of structures below the ground level and surface archaeological findings on *known* sites

- Increased likelihood of physical destruction or damage of potential (*so far unknown*) archaeological findings

- The possibility of physical damage, dislocation and deformation of overhead structures due to technical and technological needs of the execution of works (vibration, material disposal, formation of access roads, etc.)

- The possibility of physical devastation of natural ambient due to technical-technological needs of the execution of works.

Each of indicated impacts, in the zone of risk, is present to a larger or smaller measure; acting dominantly or in combination with the other impacts. Therefore, each specific location has been analysed separately.

Depending on factors of the analysis (mentioned above), possible consequences of the identified impacts on cultural assets in the «risky zone», are elaborated in detail in the Table below (Table «13»).

Table «13»

	Known / recorded archaeological sites	Archaeological sites unknown until now	Structures-individual buildings and entities	Cemeteries and individual tombstones	Natural and architectural entities
Excavation, cuts and all kinds of earthworks	*Possible disturbance of cultural layers, damage or complete destruction of the existing archaeological findings of all kinds*	*Possible complete destruction of potential archaeological findings and locality devastation, due to non-existance of the data and unexplored area.*		*Moving and sinking of tombstones, depending on a position of cuts in reference to the cemetery, engineering-geological category and geological composition of the treated rock.*	*Ambient devastation (depending on distance)*
Material disposal	*Destruction of surface findings, if any*	*Destruction of potential surface findings*		*Ambient devastation (depending on distance)*	*Ambient devastation (depending on distance and kind of the material)*

Driling, explosions and other «aggressive» excavation technologies applied in hard rock mass	*Possible is a disturbance of cultural layers, damage or complete destruction of the existing archaeological findings in surface layer*	*Possible is a complete destruction of findings on so far unknown archaeological localities in surface layer due to data non-existance and unexplored area.*	*Technologies are followed by vibrations that can cause cracking or other deformations.*	*It can cause cracking, dislocation from post, sinking etc.*	*Damaging effects on material can manifest in different ways, depending on distance and characteristics of the specific good.*
Communication, construction site organisation, Construction of access roads, heavy machinery traffic	*Destruction of surface findings, if existing*	*Destruction of potenital surface findings*	*Physical damage and devastation of ambient, depending on distance*	*Physical damage and devastationof ambient, depending on distance*	*Physical damage and devastationof ambient, depending on distance*

4.12.2 Impacts during operation period

After analysis of the conflicting positions, during which we took into account various factors, we found that the following negative impacts can be manifested on them during operation of the road:

- The possibility of damaging effects of the road traffic on the matter of monuments, where the potential causes of damage have physical, physical-dynamic or chemical impact mechanisms
- The possibility of devastation of cultural-historical character of building/site/entity (visual or functional disharmony, aesthetic degradation)
- The possibility of devastation of natural ambient existing independently or as an ambience of built structures or as integral part of naturally formed entity

Each of indicated impacts, in the zone of risk, is present to a larger or smaller measure; acting dominantly or in combination with the other impacts. Therefore, each specific conflicting position has been analysed separately.

Depending on factors of the analysis (mentioned above), possible consequences of the identified impacts on cultural assets in the «risky zone», are elaborated in detail in the Table below (Table «14»).

Table «14»

	Known / recorded archaeological sites	Structures-individual buildings and entities	Cemeteries and individual tombstones	Natural and architectural entities
Damaging effects of the road traffic with physical and dynamic impact mechanisms	*On the localities with above-ground remaining in situ: negative vibration impacts on matter, depending on distance and geological composition of the ground.*	*Can be manifested through negative vibration impacts on physical structure of the building depending on distance and geological composition of the ground.*	*Can be manifested through negative vibration impacts on physical structure depending on distance and geological composition of the ground.*	*Can be manifested through negative vibration impacts on physical structure depending on distance and geological composition of the ground, and through negative noise impacts in the zones of significant ecological character and valuable natural component.*
Possibility of direct physical contact	*Physical damage if there are above-ground structures*	*Physical damages*	*Physical damages*	*Physical damages*
Damaging effects of the road traffic with chemical impact mechanism	*Possible cumulative impact of polluting materials on above-ground structures, if any*	*Possible cumulative impact of polluters on natural construction materials*	*Possible cumulative impact of polluters on natural stone*	*Possible cumulative impact of polluters on natural construction materials, air quality and entire natural environment*
Devastation of historical and cultural charachter	*Devastation of cultural-historical character. If there are above-ground monuments in situ, possibility of visual disharmony and aesthetic degradation*	*Devastation of cultural-historical character; Possibility of visual disharmony and aesthetic degradation*	*Devastation of cultural-historical character; Functional non-coordinationt, possibility of visual disharmony and aesthetic degradation*	*Devastation of distinct ecological character of built structures and devastation of preserved natural environment; Possibility of visual disharmony and aesthetic degradation*

4.13 Impact on air quality

When it comes to air pollution which causes a new facility of transport infrastructure, in this case roads, we distinguish:

- Pollution during construction period: machinery operation, operation of the asphalt plant, dust raise during transport by temporary roads, and dusting upon manipulation with raw materials.
- Pollution during operation period: operation of the engine with internal combustion and petrol vaporization.

4.13.1 Impacts during construction period

During construction of the mentioned road it leads to the creation of dust and gases during the operation of transport means and other equipment, loading, unloading and transportation of materials, and on the work surfaces due to execution of earthworks. Any blasting will also further contribute to increasing the concentration of dust in the air. Also, the dislocation of large earth mass during the construction of road structure (cutting, dyke) causes a raise of large amounts of dust in the atmosphere, which can cause negative effects on population and vegetation. Operation of the asphalt plants and placement of asphalt mass on the road alignment, lead to emissions of easily volatile organic compounds (VOC), which consist of a significant percentage of polycyclic aromatic carbon hydrogen (PAH), whose impact on the incidence of cancer in the population is confirmed.

Therefore, a direct and the greatest impaired air quality impact is on the workers on site, but also on the vegetation in the area surrounding the planned operation. Given the limited time of the execution of works and these effects are also limited and change with time.

4.13.2 Impacts during operation period

Airspace along the road is loaded with a line, continuous source of pollution which are harmful gases and particles from burn out fuel and raised dust of already sedimented harmful material. Complex mechanism for the spread of pollution in the air space is called the turbulent diffusion or dispersion, and it calculates that the imission rapidly is falling with distance from the source.

The main components of harmful and hazardous substances from the exhaust gases are carbon oxides (CO and CO_2), nitrogen oxides (NO_x), sulfur dioxide (SO_2), lead and lead compounds and a considerable amount of solid particles, soot and heavy metals.

Particularly harmful to human health are polycyclic aromatic hydrocarbons, which occur exactly at large engine load.

Polluted matters, which are emitted from the traffic, dilute in the atmosphere and scatter to the winds. Therefore, the concentration of pollutants ie. the air quality in the environment depends on the distance of a point where the air is seen from the source of pollution, on the local topography and local climatic conditions such as wind speed and direction, temperature inversion and rainfall.

Since the closer area through which the future road passes, is sparsely populated, without major industrial polluters with very low frequency of vehicles, which is reflected in the air quality, and the air can be considered relatively clean. It is estimated that average daily concentrations of harmful materials from the effects of the planned traffic, will not burden the surrounding area over the level of limit values prescribed by the Regulations on air quality limit values. Impact of interventions on air quality can be assessed as acceptable.

By adopting the Law on air protection in Federation of Bosnia and Herzegovina („Official Gazette of F B&H“, no. 33/03), and implementation regulations related to this Law, significant improvement can be expected in the system of air quality management. It is also expected that air pollutant emissions will be decreased in the coming period, as a result of engine technology development and decreased fuel consumption, optimised combustion and treatment of exhauster gases. In addition to the mentioned, legal limitations will be changed, i.e. diesel will be forbidden as a fuel for motor vehicles from January 1, 2010 if the content of sulphur per weight is higher than 0,2%, and from January 1, 2015 if the sulphur content is higher than 0,1%. Lead emissions will decrease as a result of lead-free gasoline use, as prescribed by the Law on air protection. This law will forbid use of leaded gasoline from January 1, 2010.

4.14 Noise impact

Noise effects on the environment, or burden of the environment by noise is not easy to define, because the noise on the environment affects significantly different from all other forms of pollution and to the following reasons:

- The definition of noise is subjective. A sound is pleasant and satisfying to some people, but to others is a disturbance,
- Noise is transient, once the pollution i.e. the noise emission stops, the environment is completely liberated from effect, ie no further impact, which is not the case with the waste and harmful substances that are released into the air, water and soil,
- Contamination by harmful substances can be measured, but it is impossible to measure the cumulative effect or limit when the damage occurs

One of the negative impacts of road construction is the increasing a noise level in the vicinity of the road. This impact is reflected in the construction phase and in operation phase. In the construction phase the noise is created by construction machinery and possibly mining, and in operation period it is a traffic on the main road. Noise impact in

construction phase is temporary and usually limited to a few months, while the noise created by traffic on the main road is permanent and continuous (24 hours a day).

4.14.1 Impacts during construction period

Noise, which is emitted into the environment as a result of carrying out construction works and other works together with other already existing sources of noise in the environment may be the cause of overload by the regulations of allowed limit values.

Noise which workers are exposed to in construction period, is the sum of noise from construction machines and noise from transport vehicles. Some workers, machinery operators and those working near the machine, are particularly affected by noise. Noise created during construction of the road also affects the present species of animals by making them afraid and chasing them, and adversely affects the population in nearby villages.

Impacts related to the noise during the construction can be considered from two aspects:

- Almost complete mechanization of building highways causes a lot of noise and vibrations in the area of carrying out construction works. A particular problem is the use of blasting for the excavation of rocky material - especially in the open air (on the alignment, in quarries-borrow pits and tunnels), but also in areas of prefabrication (crushing plants and separations, concrete fabrication plants, asphalt plants);

- Noise produced by the machinery and trucks in relation to the construction works.

This impact can be assessed as insignificant and short-term, and can be mitigated with additional technical measures.

4.14.2 Impacts during operation period

Noise produced on the roads through the flow of traffic affects the environment through which the road passes, and contributes to degradation of quality of life and interfere with wildlife. Quality of life is reduced by exposure to noise psychologically, as well as physiologically. Disruption of wildlife occurs due shy animals to cross the road where the traffic takes place. Because of that the roads often become barriers to the regular course of wild animals moving from one area to another

Motor traffic on the roads creates a noise:

- Motor system in motor vehicles: a source of noise is operation of the engine and exhaust gas system, and in a smaller volume operation of the cooling system, and
- Movement of vehicles: the noise that occurs due to rolling, which produces rubber adhesion to the road, together with - and what determines the speed - noise that

creates air resistance, and also impact of road flatness on the existing state of the chassis / car body or its load.

Having in mind that this is a road direction with the very low frequency of vehicles, as well as the planned alignment passes through less populated area, near several small towns, villages and hamlets, the impact of noise on the population is negligible.

4.15 Impact on infrastructure

4.15.1 Impact during construction and operation period of the road

Water Management Infrastructure

To determine a collision of the main road alignment with the infrastructure for water supply and drainage it has been used the Main design "Water supply of the coastal area of SR BiH, Steel water conductor tunnel Hutovo-Neum, Book II/1, in 1980.", then "Development Strategy of the municipality of Neum, December 2005 " and other planning documents for the municipality of Neum, „The main design of Main road M-17.3 Buna-Neum, section Stari Neum-Kiševo, July 2004, " The Main design, Main road M-17.3 Buna-Neum, section Kiševo-Broćanac, June 2008, "Preliminary design, Main road M-17.3 Buna-Neum, section Broćanac-Drenovac, currently under construction", and information obtained from representatives of municipalities and utilities in the municipalities of Neum and Stolac and oral information obtained at site from inhabitants of the area.

The main road alignment is in collision with the existing infrastructure for water supply in the municipality of Neum. Collisions are given below per sections of the main road.

At station km 1+400, the right of the alignment in Blace valley, at distance of app. 150-500 m there is a water intake Blace with two drilled wells and a pump station.

At station km 5+309, at the site of Babin Do, the main road crosses the existing pipeline for water supply of the village. At the site of crossing the pipeline is passing under the bridge and its foundations should be secured against flushing effect of water occurred by pipe bursting.

At station km 12+060, the main road crosses the pipeline for water supply of Broćanac settlement. Left of the main road grade level above the village, at distance of approximately 300 m towards the north, there is a reservoir Broćanac (V = 100 m) with bottom level 300 m above sea level

At station km 13+300, the main road touches the Regional water supply pipeline Gabela-Neum, a diameter of DN 350 mm.

At station km 13+480, the main road intersects the existing local pipeline to supply the village Praovice.

At station km 15+500, the right of the alignment grade level, towards the south at a distance of about 100 m there is a reservoir "Prapratnica“ (V = 150 m^3) with bottom level of 367.70 m above sea level.

From station km 15+550 to 16+150, the road alignment passes through approximately 50 m above the pipeline tunnel "Hadžibeg“ for the Regional water supply Gabela-Neum. At this road stretch it occurs an overlapping of the road alignment (which at station km 16+000 is entering the tunnel in length of 780 m) with pipeline tunnel of length of 773,5 m, bottom level 370 m above sea level, diameter of water pipes DN 500 mm.
At the same stretch at station km 15+700 and 16+000 comes to crossing the road alignment and the planned tunnel of the road with the pipeline tunnel. The pipeline tunnel was built without a concrete foundation, and blasting during construction of the road tunnel could cause the collapse, and backfilling of the existing tunnel, and therefore damage the water supply pipes.

At station km 16+250, at the site Hutovo, the right of the main road grade level in the tunnel at the exit of the pipeline tunnel, there is a reservoir Hutovo (V = 2x500 m^3) at a distance of about 120 m, with the bottom level of 364 m above sea level.

At station km 18+120, at the site Mramor, the main road is intersecting the Regional water supply pipeline Gabela-Neum, a diameter of DN 500 mm.

At station km 21+170, at the site Cerovica, the main road is intersecting the Reversible tunnel of SHPP Čapljina.

During operation period of the main road, the negative impacts on this infrastructure are not expected

Electricity network

The planned road alignment is intersecting the existing and planned transmission and distribution electrical power lines in several places.

Impacts of the road on the existing distribution network is mostly of a technical nature, because in the case of non-compliance with the prescribed construction and layout requirements, the underground and overhead HV power lines must be reconstructed in order to meet the conditions required. Those conditions are: prescribed distance between the poles, prescribed minimum height of cables above the road pavement surface, and mechanical protection of underground electrical cables against mechanical load of variable intensity that could damage the underground cables.

There are also the impacts of the overhead electrical cables, taking place especially at the road intersections. The first kind is concerning the rear but theoretically possible situations of cables falling down on the carriageway lines due to collapse of the poles under conditions of natural disasters. Further, during regular network maintenance, some shorter traffic gridlock can happen. Electromagnetic impacts of HV power lines are completely negligible at these voltage levels, under condition of minimal height of cables

above the road pavement surface as prescribed and short time of car passing under the power line.

From the Elektroprivreda's point of view, the adopted road alignment is acceptable under condition of undertaking some necessary reconstruction works on the electrical networks (which are the subject of separate elaborate).

At several locations along the course, the alignment comes into collision with overhead lines of the electrical network placed on wooden or concrete poles, and it is necessary to relocate the same, taking into account the free profile of the new road.

First section (Stari Neum-Kiševo)
at stations (km 0+198,00; km 0+235,00; km 1+361,00; km 1+453,00;
km 1+471,00; km 1+479,00; km 2+598,00; km 2+631,00; km 2+768,00;
km 2+814,00)

Second section (Kiševo-Broćanac)
at stations (km 5+309,50; km 6+950,00)

Third section (Broćanac-Drenovac)
at stations (km 12+075,00; from km 13+030,00 to km 13+400,00; km 21+190,00;
km 22+700,00; km 24+300,00; km 27+750,00; km 31+560,00; km 34+050,00;
km 36+325,00)

Telecommunication network

The planned road alignment is, in several places, intersecting the underground immovable telecommunication cables of different ranks and performances.

Impacts of the planned road on underground telecommunication cables is mainly of technical nature, since all cables have to be reconstructed and placed into hoses for protection against mechanical damage caused by variable intensity load.

Under condition of protection measures applied and some respective reconstruction works done, the planned road alignment is acceptable in respect of immovable telecommunication networks.

At several locations along the course, the alignment comes into collision with overhead lines of the telecommunication network placed on wooden or concrete poles, and it is necessary to relocate the same, taking into account the free profile of the new road.

First section (Stari Neum-Kiševo)
at stations (km 0+198,00; km 0+235,00; km 1+361,00; km 1+453,00;
km 1+471,00; km 1+479,00; km 2+598,00; km 2+631,00; km 2+768,00;
km 2+814,00)

Third section (Broćanac-Drenovac)
At stations (km 12+075,00; km 21+760,00; km 22+375,00; km 22+910,00; km 24+860,00; km 26+110,00)

Traffic infrastructure

Transportation network

A road as the part of the traffic network has the limitations in respect of spatial position and functional organisation, what makes it a rigid spatial element. The strongest disturbances and limitations occur in respect functional organisation of space, and thus the impact on transportation and traffic system is important and must be adjusted to the new limitations imposed by use of the planned road.

Road network intersecting the planned road, should be, when crossing the same, with elements of shaping according to their category and role within the transportation network. The substantial impact is expected on the systems of the existing country roads (uncategorised roads). In some cases, the existing functional organisation of the space and primarly access to the agricultural land will be disturbed.

The planned road alignment will not significantly impact the local transportation systems functions, if sufficient number of passages for cars and passengers is provided in the road structure itself.

Locations where there are the intersections of the existing roads

First section (Stari Neum-Kiševo)
at stations (km 0+220,00; km 1+450,00)

Second section (Kiševo-Broćanac)
at stations (km 5+309,50; km 6+724,00; km 7+272,00; km 8+682,00; km 10+540,00;

Third section (Broćanac-Drenovac)
at stations (km 12+000,00; km 12+350,00; km 13+470,00; km 15+260,00; km 18+140,00; km 18+660,00; km 19+350,00; km 20+900,00; km 20+910,00; km 21+320,00; km 21+760,00; km 22+000,00; km 22+910,00; km 24+170,00; km 24+860,00; km 25+150,00; km 26+110,00; km 26+275,00; km 27+370,00; km 27+835,00; km 30+260,00; km 31+750,00; km 31+910,00; km 33+090,00; km 33+620,00; km 34+065,00; km 34+600,00; km 34+745,00; km 35+760,00; km 36+030,00; km 36+135,00; km 36+460,00)

Railway network

The planned road alignment is, in several places, intersecting the existing route of narrow-gauge Čapljina-Dubrovnik, which is not in function from the seventies.

5 DESCRIPTION OF THE MITIGATION MEASURES FOR NEGATIVE IMPACTS ON ENVIRONMENT

5.1 General mitigation measures for negative impacts on environment

The focus of this paragraphe is to summarize the main mitigation measures proposed by the Consultant. The aim of the following mitigation measures is to eliminate or in any case to reduce the potential impacts on the environment affected by the Project. The Consultant propose also mitigation measures during the Construction phase.

Mitigation measures during design phase
Already at this stage, it will be applied during design phase a maximum number of mitigation measures for negative impacts, because at this stage, the same will be avoided (realignment where possible to detour exceptional areas, identified by prior surveys; realignment to avoid important migratory routes, providing appropriately design and located crossings and passages; use an architectural design to "blend" with the landscape, including physical barriers to noise in plans).

Mitigation measures during construction phase
Collect and recycle lubricants; install and operate air pollution control equipment; protect susceptible surfaces with mulch or fabric, and plant erodible surfaces as soon as possible; set up plant and animal sanitation service and related checkpoints.

5.2 Specific measures for mitigation of negative impacts on environment

5.2.1 Inhabitants

Population and settlements:

- Impact on settlement development prospects:
  - Measures should be planned prior to commencement of construction works and in order to establish new communication structures for settlements where traditional ways of communication are interrupted by the road. This could be done through the rpovision of passage ways, bridges, viaducts overpasses;
  - The municipalities/towns should update their urban plans and adopt extension areas according to the location and the possible effects of the intersection and the connection to the road. Development plans for industrial/residential areas should be revised and updated.
  - Respect prohibitions of construction in the protected zone;
  - Restrict connection to the main road and physically prevent uncontrolled connection through setting up fences, vegetation beside the road, drainage ditches, dikes, etc.

- Population directly affected by construction works:
  - The sites of construction camps must be selected in a way to not create conflicts with present settlements;
  - Local Authorities should undertake measures to avoid that camps turn into permanent settlements.

- Resettlement/Displacement of People:
  Where displacement is unavoidable, resettlement plans have to be developed. Main steps of a resettlement plan should include the following:

  - Clarification of organizational responsabilities
  - Organisation of community participation
  - Site Survey
  - Analysis of legal framework
  - Valuation of and compensation for lost assets
  - Land tenure, acquisition and transfer
  - Implementation schedule, monitoring and evaluation

  Displaced persons should be: compensated for their losses at full replacement cost prior to the actual move; assisted with the move and supported during the transition period in the resettlement site; assisted in their efforts to improve their former living standards, income earning capacity, and production levels, or at least to restore them. Particular attention should be paid to the needs of the poorest groups to be resettled.

  Community participation in planning and implementing resettlement should be encouraged and appropriate patterns of social organization should be established. Existing social and cultural institutions of resettlees and their hosts should be supported and used to the greatest extent possible. Resettlees should be integrated socially and economically into host communities so that adverse impacts on host communities are minimized. The best way of achieving this integration is for resettlement to be planned in areas benefiting from the project and through consultation with the future hosts. Land, housing, infrastructure, and other compensation should be provided to the adversely affected population, ethnic minorities, and pastoralists who may have usufruct or customary rights to the land or other resources taken for the project. The absence of legal title to land by such groups should not be a bar to compensation.

Social structure and cultural values:

- Social disturbances occured by construction camps

  - In general, the construction campsite should be located in less vulnerable areas. Furthermore, the contractor must be obliged to meet the local regulations. Location of construction plants and camps must be planned in co-operation with the local community,
  - Local regulations for the construction of camps must be respected,

- To ensure that construction camps, temporary works and lifestyle of construction workers do not negatively affect adjacent communities, workers should be prevented from using resources held in common by local population.

- Social disturbances due to traffic congestion

  - Implement traffic management measures in locations where crossing the existing road.

- Impacts on cultural heritage sites

  - Specify rules and means regarding preservation and recovery of cultural remains discovered during construction,
  - Clarify exact localization of important sites,
  - Determine possible sensitive sites before project start up to avoid construction/excavation activities in these localities,
  - Contractor has to be informed in advance on exact location of the site,
  - The contracting documents for the construction works should specify the rules for the preservation and recovery of cultural remains discovered during the construction phase and specifies means to protect specific features or additional work that may be called for,
  - Movement of material has to be planned accordingly.

Property values:

- Removal of houses and other buildings:

  The following steps required under Bosnian legislation for expropriation have to be followed:

  - Detailed site surveys, showing the locations of all properties potentially affected by the project;
  - Detailed design of the project is prepared, to the level that the extent of land requirements can be defined;
  - Preparation of allotment plans, showing the relationship between the road scheme and the land or structures to be expropriated;
  - The Federal Ministry of Physical Planning and Environment has to accept the proposal;
  - Copy of the Land Plan has to be obtained from the Cadastre/Register of Municipality. This should be checked against latest survey information from the field;
  - Detailed allotment numbers affected have to be submitted;
  - The Federal Government of Bosnia and Herzegovina declares a public interest and provides the means for expropriation;
  - Municipalities have to be informed about the construction of the project and the Municipalities have to be requested to provide teams for execution of the expropriation process for land and buildings;

- Site surveys to be carried out by values;
- Municipal authorities enforce resolutions;
- Request is made for premature entrance onto the property before statement on validity of the claim is issued by the Federal Ministry of Planning and Environment;
- Entrance onto the property is obtained for representatives of the responsible authorities;
- Arguments before the municipal authorities on compensation;
- Arguments before the courts on compensation.

▪ Loss of agricultural land:

Expropriation of agricultural land has to follow the procedure as described above. Furthermore, during construction the following measures should be implemented:

- The contractor must be obliged to carry out works so as not to interfere unnecessarily or improperly with the access to, use and occupation of public or private roads and footpaths to and from properties;
- Private property shall not be used for storage purposes, detour roads and other construction facilities and plants without written permission of the owner or lessee and payment to him if necessary;
- The contractor shall also select, arrange for and if necessary pay for sites for detours, for the storage of equipment or other uses necessary for construction works;
- After completion of works, the area used must be cleaned up and restored to the satisfaction of the landowner;
- Any long-term loss of agricultural land has to be compensated according to Law. If land is occupied for more than one cropping season, loss of crop has to be compensated accordingly;
- In case of usage of grazing land, reseeding immediately to minimize disturbance and losses should rehabilitate the area;
- Access roads to local agricultural property should be guaranteed after completion of the road.

Safety:

▪ Accidents due to construction works/machinery:

- In general, safety rules for construction sites have to be fixed through contract obligations;
- To reduce risks of accidents during construction (detour roads etc.), warning signs specifying speed limits, fencing of construction sites, lighting at light if necessary must be installed also at detour roads, access roads to base camp, quarry and other construction related sites. Detour and access roads must be regularly maintained to an adequate standards (provide speed bumps where necessary);
- Speed limits have to be fixed on construction traffic, fencing of quarries and borrow pits and exclusion of the public where heavy machinery is

working is to be provided, as well as appropriate safety training for workers;
- Storage and construction activities have to be regulated and indicated clearly in the contracting documents to avoid danger or obstruction to passing traffic.

Economic development:

To ensure that employment opportunities are available for local population, the contractor should maximize the use of local labour supply. It must be made sure, that the contractor recruits all large proportion of local labour force and provides training when necessary. This includes consultation with local authorities on establishing local labour relations.

5.2.2 Geology

Based on the general assessment of geotechnical conditions for construction of the discussed sections, we can say that the geotechnical conditions are quite uniform from the aspect of geotechnical and construction problems.
All notches, cuts, viaducts and tunnels would be done in the cracking and karstified massive, banked and thick layered to thin layered limestones and less in dolomites. These limestones are tectonically quite broken. Interstratified cracks in the surface areas under the influence of external factors have led to instability of certain parts of the field in terms of moving rootless blocks or their falling out during cutting (see appendix). The spatial position of the layers is of favorable orientation where the spread is approximately perpendicular to the alignment with the fall on the hill.
In the flat parts of the site where a prolluvium cover is isolated and the eluvial - diluvial should be removed, and then make backfilling the field with calcareous rock debris. In hydrogeological terms, these limestones within the field represent hydrogeological collectors – conductors of groundwater. So in future excavations it should not expect a flow of surface and groundwater that would endanger the excavations.
Generally it can be concluded that the geological, hydrogeological and geotechnical conditions along the alignment are very favorable. Slopes of cuttings and notches in the limestone must be able to customize the rock mass, ie the degree of cracking, bloc split and karstification, to avoid uncontrolled detachment and landslide of blocks on the road in the phase of road exploitation. Cuts, notches, given the geological structure can be with the slope inclination to 2:1 and even steeper. It is necessary to protect by the wire mesh slope inclinations intensely cracked and tectonically quite broken. Foundations of individual facilities will be carried out in the geological substrate.
Embankments can be built of calcareous rock debris and material from the excavation. Embankment slope inclinations should be from 1:1,5 - 1:1.
Material from all excavation is very advantageous as building materials and can be used to create a dike and road structure. A Limestone is recommended as aggregate for concrete, which can be provided from the excavation of tunnels and cuttings.

5.2.3 Waters

The main road causes changes in the environment to a greater or lesser extent depending on the method of construction and operation. The impacts on waters can be avoided in the design phase by appropriate design solutions of drainage system, construction site organization and application of prevention measures during construction, and operation period in the maintenance of the built facilities for drainage.

5.2.3.1 Mitigation measures during preparation and construction period

General measures

Investor / user is required:

- Comply with all relevant legislation.
- Monitor and control all activities in the field of water protection.
- Establish adequate trained and equipped emergency response teams.
- Organize regular monitoring of the quality of surface and groundwater (monitoring).
- Store and analyze data obtained by measurements, take the necessary actions in case of exceeding the allowable emissions.
- Send monitoring reports to the competent authorities and inform the public about the state of water quality.

Special measures

- It is necessary to make, as soon as possible, a Project of the Blace water source protection, as well as Project for waste water drainage from the road.
- Require a permanent control during construction works.
- In the contract documents, which the Investor forms with contractors, explicitly require to implement water protection measures, which are defined by environment impact study.
- As part of the tender documents for the works to require from a bidder to demonstrate that his company has a service for environment protection, which will ensure the enforcement of environmental protection requirements, which will be prescribed by environmental permit.

Technical measures

- Owner of building (Investor) must ensure that the contractor is performing the construction with an appropriate machinery and in accordance with the adopted dynamic of works, complying with the approved design documentation, and complying with all legal regulations.

- Owner of building (Investor) must ensure adequate construction, geotechnical and hydraulic control of works and insist on the prescribed controls of performance and the quality of built materials.
- Owner of building (Investor) through the supervisory authority must control to not perform mechanical servicing of machines on site, or storage of fuels and lubricants. Fuelling should be under control, ensuring prevention of penetration of possible fuel spills in the ground (laying of impermeable polyethylene sheeting on the ground during decanting operations), and the means to neutralize the possible fuel spills.
- To plan and organize the area of construction site with the aim of minimum interfere of the road structure in the space outside the direct intervention.
- In the project of site organization, a parking for vehicles and construction equipment involved in the works should be carried out tightly, with rain water treatment. This car parkings should be located within the zones provided for the construction, without devastation of surfaces of other purposes.
- Excavated material, which will not be used for subject construction activities, must be deposited at the specified locations.
- During construction it should organize regular health control of all employees and take all necessary sanitary measures with continuous monitoring of inspection services and water supply, to prevent water pollution.
- During works it should monitor the status of water quality, according to the monitoring program.
- In order to not disturb hydrogeological relations in the underground, it is necessary to control the realization of phase blasting. The blasting should be carried out with an electric phase igniter with relay to avoid seismic shocks too big.
- To accept used water from the site by safe system of sewage, to collect in appropriate tanks and purify in the prescribed manner (either on the spot, whether at the distant location), and prior to discharge into the recipient
- At the site locations to ensure for workers the ecological toilets.
- Communal and hazardous waste created during construction in the site zone are to be disposed in a prescribed manner.
- Prohibit a repair of machines, as well as changing the oil in areas of high risk of water pollution.
- Provide areas with impermeable base for the storage and servicing machinery, outside the zones defined as zones of high risk of water pollution.
- Oily storm water from this area should be collected and purified on sand /grease separators before discharging to the recipient.

- In case of negative impact on the source used for water supply, in the shortest possible time to provide alternative water supply for residents in the affected area.
- Set a warning plate on the pass through a zone of high risk to groundwater, and the plates with speed limit of the vehicle, and plates with prohibition of stopping for vehicles transporting hazardous and harmful substances to the water.
- In case of accidents, it is required urgent intervention in accordance with the operational plan of emergency measures in case of accidents.

5.2.3.2 Mitigation measures during operation period

General and special protection measures are equal in phase of construction and operation period of the road, which means that they are already listed above.

Technical protection measures

- In areas of high risk of water pollution it should carry out very rigorous measures and conditions of waste water from the road using design solutions that include closed drainage system. Conduct a complete drainage of waste water from the road.
- In the open part of the section,it is necessary to design vertical barriers (guard rails or concrete blocks-New Jersey), to protect vehicles against skidding outside of controlled corridor.
- In areas of moderate risk of water pollution to implement less stringent measures of protection, noting that this does not exclude a mechanical wastewater treatment in grease separators.
- It is necessary to develop appropriate operational plans at the stage of operation and maintenance of the road.
- The system of collection, drainage and treatment should be regularly controled, in case of accidental flow of large quantities of pollutants the cleaning should be approached immediately.

5.2.4 Soil and agricultural land area

As an important measure of protection against negative impacts are considered, well-maintained sites, in full, with the rules of the profession and its all preventive and protective infrastructure. In addition to this it should arrange borrow pits and storages of material in accordance with applicable rules of the profession, National and international legislation. Regardless of such set principles, it should try that all construction sites, construction machinery bases, residential camps, warehouses and other working facilities are located outside the zones that are important agricultural areas.

All waste waters which have their flow in areas with soil and karstified geological substratum, must undergo purification processes of the mechanical and chemical pollution. Dimensions and positions of these facilities will be defined in the Main design.

Agricultural land area and soils represented in them, may be under the impacts of chemical contaminants which are contained in exhaust gases from cars and other means of transport in road traffic. Prevention of such negative impacts can be successfully carried out as follows:

- Using the new transport means,
- Use of fuels that does not contain lead or other metals and hazardous organic compounds as fuel additives,
- Incorporating physical barriers that will be provided in the project, to prevent radial expansion of the exhaust gases and their deposit in the agricultural area. So, possibilities of soil contamination by different hazardous pollutants would be significantly reduced
- Establishment of more serial and more floor biological barriers, which respresent, the same as a mechanical barriers, excellent protection from permanent negative impacts on soil and agricultural land area.

The proposed protection measures against the negative impacts of the project on soil and agricultural land area, should especially realize in the parts where conflicts with the receptors cannot be avoided.

As an important measure of protection from polluted pavement storm waters, it is proposed to implement measures of wastewater treatment by the appropriate technological procedures.

5.2.4.1 Mitigation measures during construction period

As a major mitigation measures during construction of the road it is recommended the following:

- To start construction of warehouses, borrow pits of construction materials (quarries), construction machinery bases, storages of hazardous, flammable and explosive materials and residential camps in areas that are not in nearby villages and local domestic population, because these are the most important agricultural land areas,
- Set up physical barriers in the areas of agricultural land area to protect this area from mechanical contamination,
- Wetting the sections in the area of agricultural production during the summer months as an additional measure or to make temporary paving of such sites.
- To design and implement out of the agricultural zone the construction of roads that are used for transport, and which are in a function of project implementation,

- To perform an organized collection and storage of old lubricants and worn out parts,
- To perform regular service and washing of the machinery in a defined area.
- The choice of cultivation methods and crops that will be adapted to the new situation.

5.2.4.2 Mitigation measures in operation period

During operation period of the road, mitigation measures should be constantly improved, which will be based on the results of monitoring the immediate environment. Important measures will be:

- Maintaining vegetation protective strips in areas of agricultural land area,
- Forming more floor vegetation strips in the critical zones,
- Maintenance of gulleys used for drainage of rainwater from the pavement,
- Use proper and not very old vehicles,
- Establishing a good and active fire protection systems.

As an important mitigation measure of negative impacts on soil and agricultural land area, we emphasize the necessity of re-applying previously removed and deposited soil, in dispositions that were damaged during the project implementation, and where opportunities for such activities are open during the use of the project.

As important protection measures, the establishment of vegetation protective strips are proposed in areas north of Vranjevo Selo (dispositions are located on maps M = 1:25000), then at the sites Kiševo, with both sides of the road. The following site is in the area of Babin Dol, also, with both sides of the road, then in the zone of Dobrovo on the south side that will protect the agricultural area. The same principle should be applied in the zone of Nerađ. For the agricultural area in the zone of Broćanac settlement it should make compensation of the agricultural area for a minimum of secular economic effect, or it should dislocate the road from this zone. Relocation of the road is proposed to maintain the continuity of the settlement.

The establishment of vegetations protective strips of evergreen species with established dense structure, as effective protection measures, are proposed in the settlement areas Hutovo, Cerovica, Vinine, Crnoglav and Udora.

5.2.5 Forests and Forestry

As an important measure of protection against negative impacts on present forests and forest land area, are considered well-maintained sites, in full, with the rules of the profession and its all preventive and protective infrastructure, which are preferably located outside the best forest zones. In addition to this it should use a cutting down trees, but only in necessary cases, in accordance with applicable rules of the profession,

National and international legislation. It will be required immediately upon completion of works regardless of the stage of construction to start reconstruction of incurred damages and revegetation of the damaged area. After completing the extraction of construction materials, immediately access to the arrangement of the borrow pit of material. The same methods are to be applied at material disposal sites Regardless of such set principles, it should try that all construction sites, construction machinery bases, residential camps, warehouses and other working facilities are located outside the zones of important and for this area quality forest communities.

Forest land area and forests, as well as soils present in these zones, may be under the impacts of chemical contaminants which are contained in exhaust gases from cars and other means of transport in road traffic. Prevention of such negative impacts can be successfully carried out as follows:

- Using the new transport means,
- Use of fuels that does not contain lead or other metals and hazardous organic compounds as fuel additives,
- Incorporating physical barriers that will be provided in the project, to prevent radial expansion of the exhaust gases and their deposit in and on soils close to the road. So, possibilities of soil contamination by different hazardous pollutants would be significantly reduced.

The proposed protection measures against the negative impacts of the project on forest and forest land area, should especially realize in the parts where conflicts with the receptors cannot be avoided. The conflicting positions are marked on maps.

5.2.5.1 Mitigation measures during construction period

As a major mitigation measures during construction of the road it is recommended the following :

- To start construction of warehouses, borrow pits of construction materials (quarries), construction machinery bases, storages of hazardous, flammable and explosive materials and residential camps in areas that are less exposed to the risk of big damages for accident cases,
- To design and implement out of valuable forest areas, the construction of roads that are used for transport, and which are in a function of project implementation,
- To perform an organized collection and storage of old lubricants and worn out parts,
- To perform regular service and washing of the machinery in a defined area..

5.2.5.2 Mitigation measures during operation period

During operation period of the road, mitigation measures should be constantly improved, which will be based on the results of monitoring the immediate environment. Important measures will be:

- Set up physical barriers in the areas of valuable forests,
- Maintenance of gulleys used for drainage of rainwater from the pavement,
- Use proper and not very old vehicles,
- Establishing a good and active fire protection systems.

As an important mitigation measure of negative impacts on forests and forest land area, we emphasize the necessity for reforestation of damaged forest land areas and implementation of appropriate protective-breeding operations. Positive effects of mitigation of negative impacts will be visible if the prohibition of illegal cutting down in forest areas would be implemented.

5.2.6 Flora and Vegetation

5.2.6.1 Mitigation measures during construction period

As part of measures taken to prevent and mitigate the negative impacts on flora and vegetation, it is important prior work, take protective measures, which imply the organization of temporary disposal sites and borrow pits of construction materials.

All excavated humus material is to be disposed in the space provided for it, so that later could be used during the greening areas.

It is also necessary to restrict the movement of heavy equipment in order to preserve the vegetation as a greater extent as possible. It is necessary to predict also some parking areas for machinery, and to prohibit the servicing vehicles in the area.

Also, because of the nature of substrate (karst), it is important to restrict the disposal of waste water in the wider area of operation. In organizing the construction site, it should attempt to violate, as little as possible, the existing vegetation.

It is important to take into account the storage of waste, especially those from the categories of hazardous waste (fuels, lubricants) in order to minimize damages to surfaces. In this regard, waste disposal to be carried out controlled on legal landfills.

Also, it is necessary to take into account the preservation of habitats for rare and endangered plant communities, such as those with Leguminose shrub (*Petteria ramentacea*).

In order to fire prevention, it is necessary to set up alerts that pertain to the prohibition of throwing cigarette butts and glass packaging, which is the most common cause of fires in the summer.

5.2.6.2 Mitigation measures during operation period

After construction, a revitalization of plant communities with indigenous plant species is the primary task, which surfaces, uncovered during construction period, will be again enriched, and doing so in order to not violate the authenticity.

The largest volume of these works will be undertaken in the vicinity of the tunnels (entrance and exit), viaducts and intersections.

During operation period of the road, given the nature of the road area and high temperatures, it is necessary, in an adequate manner, to place signs on the road to draw attention to the strict prohibition of throwing cigarette butts, glass bottles and other objects, which could cause a fire.

In order to fire prevention, it is necessary to set up alerts that pertain to the prohibition of throwing cigarette butts and glass packaging, which is the most common cause of fires in the summer.

5.2.7 Fauna

5.2.7.1 Mitigation measures during construction period

Due to the threat of natural habitats during the execution of works, some passages for animals have been planned in the project development, which will compensate for the cut off migratory pathways. During the construction it is necessary to provide supplementary feedings and watering troughs for animals. Also, in cooperation with hunting associations need to consider the established paths used by game in order to take protective measures on time. Setting up meshes, the number of injured animals will be reduced, and their installation is necessary.

When it comes to noise and vibration, it is important to note that with the time limit of duration and day time course of the same, it is trying to reduce its impact to a minimum.

Also, during the execution of works on breaking through the tunnel a supervision of the speleologist is recommended in case of threat to underground habitats.

5.2.7.2 Mitigation measures during operation period

During the road operation, passability of migratory paths will be maintained through the built passages for animals and setting up protective nets to places where it needed to, to prevent the injuring of animals that might try to cross the road.

Also, the organic waste produced on site is a major problem. Organic waste (waste from food), in which the predators gather (foxes and wolves), causes loss of innate fear of humans, because of easily available food, and as such represent a potential danger to nearby road facilities and the surrounding villages (sylvatic rabies).

In order to monitor the situation at site during the road operation it is necessary to keep a record of the injuries of game, to respond timely with additional protection measures.

5.2.8 Landscape

5.2.8.1 Mitigation measures during construction period

Negative impact during construction is inevitable, and it is important to have in mind the protection measures that ensure its preservation.
Complete organization of the working areas and facilities, should be directed towards the violation as less as possible of existing landscape features, and therefore upon planning of landfills, borrow pits, temporary parkings, and facilities for the workers, it should take also into account the obligation to preserve the existing values of the landscape. After the completed construction, the existing landscape should be returned as soon as possible to its original state.
Also, the protective measures are included with other protection measures from various aspects of environmental protection in this Study.

5.2.8.2 Mitigation measures during operation period

Measures to be applied during the road operation in order to preserve landscape values imply planting seedlings of autochtone plant species, which will revitalize the area, and contribute to increasing landscape values of this area.
We note that most of the works related to planting new vegetation takes place immediately after the completion of construction works, while in the operation period of the road an additional planting and maintaining of plants should be made.

5.2.9 Protected parts of nature

By the project the area includes roads that are not in contact with the protected parts of natural heritage. During the execution of works it should preserve as much existing vegetation that is characterized by significant biological diversity. Construction site organization and construction works in general should be adjusted to this fact.

5.2.10 Game and Hunting

During preparation, construction and operation period it is necessary to take the following protection measures:

- In order to eliminate negative impacts resulted from isolation of smaller and bigger parts of hunting area, it is necessary to rearrange the hunting area, in order to mitigate cutting the area off on the opposite side of the road. It is necessary to provide an adequate connection between the parts of the hunting area in the case of the hunting area divided to larger parts.

- In order to reduce negative impact on game, it is necessary to provide acceptable condition of game movement along present and future migration directions. Thus, it is recommended to establish the corridors for game's crossign the road, in order to mitigate habitat degradation and provide for as good as possible possibility of daily and seasonal game migration. It is necessary to establish good communication along direction east-west and vice versa.

- Base structures for establishment of necessary communication corridors are: culverts for water, underpasses and overpasses for movement of people and vehicles, viaducts and bridges and special structures for enabling movement of animals.

Mentioned structures must be built in a way that they, apart their basic function, enable undisturbed movement of animals and communication between the eastern and western part of the hunting areas.

By insight into the road alignment, the following types of game corridors have been analysed:

- Self-contained game passes
- Game passes in the frame of other structures
- Possible passes for game over the structures of different purpose

Self-contained game passes

A self-contained game passes or so called green corridors are the structures bellow or above the road, with the main purpose of enabling migration of game and other animals, e.g. crossing from one to another side of the road, in order to meet their biological needs.

It should note that the chamois will rather cross over the road above its level, than below, and this fact should be taken into account while designing the road, if possible in respect of landscape disruption, cost etc. If possible, it would be desirable to predict somewhat wider overpasses and underpasses (50,00 – 75,00 m).

At the considered road alignment, it should predict self-contained game passes, since that constructive elements of the same are mostly in cuttings and embankments.

Game passes in the frame of other structures

At the future road, game passes are predicted in the frame of other structures, such as viaducts, bridges etc. There are 12 such structures in total and there location cannot be influenced. Leaving enough space for undisturbed movement and passing of the game should be taken into account while designing the road.

This is to increase the traffic safety on the road, avoiding possibility of crash between the cars in motion and the game that can be fatal. Without passes, the game will instinctively try to overpass the road, jumping over the protective fence that does not represent a problem for chamoises. From that reason, on the places of game passes it is necessary to erect the 3m-heigh fence, 500 m length on both sides of the pass. The game should be directed towards the pass under the bridges and viaducts by green strips and high wire protective fence (minimum 3 m heigh).

Possible passes for game over the structures of different purpose

Structures of other purpose, but suitable for game crossing the road are box culverts, smaller overpasses and others. They are mostly of smaller dimensions, but in any case, it is necessary to use that space to the maximum extent and enable passing the game, reducing the habitat fragmentation.

Again, it is necessary to note safety aspects on places of game passes, and this is to erect somewhat higher wire fence around a multipurpose-structures, e.g. passes. Bottom of the fence should be well secured and fixed to the ground in order to prevent passing of smaller game (rabbits, foxes, badgers), but also wild boars.

The game should be directed towards the passes by planting hedges of autochtonous plants and trees. That provides minimum protection from noise and lighting, as well as sence of security. That also provides better insertion of the passage to the landscape.

Tunnel-shaped passes predicted for frogs and amphibie will also be used by small game (badgers, foxes, martens, weasel etc.). Therefore, construction of them is considerably justified and necessary.

5.2.11 Cultural – historic heritage

General considerations: type of mitigation measures / protective measures and the dynamics of their implementation

Potentially endangering effects of the main road construction – concerning both material degradation of cultural property or reduction of visual quality and devastation of its cultural-historical character, must be avoided, neutralised or minimised (brought to the measure at which they cannot represent any risk to the property). It is possible to achieve through implementation of "packages" of protection measures, which consists of: performing the previous researches, guidelines and recommendations for the design / execution of works; constant supervision of competent experts in the field of heritage protection, the application of appropriate technical-technological solutions and long-term monitoring / surveillance .

In the preparation phase of the working design, ie, during preparations for the execution of works, the protection measures given in this study for the entire section and each individual conflicting position, should be developed in detail at the operational level, and,

applied with the inclusion and cooperation of the competent services for heritage protection wherever necessary.

Suggestions of mitigation measures, ie, protection measures, are resulting from the identification of impacts that may be active during the road construction and operation and, the resultant consideration of their - potentially harmful, consequences and manifestations. In this context, they can, in general, be classified into three groups, depending on the character (preventive or active), type, time of implementation and the "weight":

- Mitigation and protection measures to be implemented in conflicting points, as the cultural properties are located *within* a single "impact zone " / *in contact with it*, or they may suffer indirect impacts from it;

- Mitigation and protection measures to be implemented in conflicting points, where cultural properties located in the wider area indicate also the possibility of existance of other, currently unknown findings that may be destroyed / damaged by performing the works;

- Preventive protection measures to be implemented across the entire length of the alignment, in order to protect all currently unknown and unexplored, archaeological areas that can be endangered by building the road.

It is necessary to apply measures from the first two groups to the specific conflicting positions; a third group of preventive measures should be implemented on the entire alignment.

Due to the expressed differences in the concentration of conflicting points from section to section, as well as differences between the proposed mitigation measures, they are all - regardless of which group they belong to - shown in details in the graphic documentation of the work. On the maps, using appropriate symbols, some interventions are shown that should be undertaken in various stages in the conflicting position, in order to protect the registered cultural and historical heritage from harmful impacts, which, due to road construction, may be potentially exposed to.

According to the dynamics of implementation, the proposed mitigation and protection measures can be divided into:

- Mitigation measures / protection measures during designing period
- Mitigation measures / protection measures during construction period
- Mitigation measures / protection measures during operation period

The stated categories indicate development phases of the Project in which the intervention takes place for prevention, neutralisation and minimisation of the negative impacts, i.e., stages related to the road construction during which the protection measures should be implemented.

In this sense, we emphasize that the first category - in fact – represents the «response» to «*the harmful impacts*» that may occur already in the design phase. Within the "package" of measures, in fact, we made a proposal to eliminate possibility of inadequate positioning the alignment in terms of heritage protection, on the appropriate maps, and we suggest this category of mitigation measures, conditionally calling *«Mitigation measures during designing period».* It includes a recommendation for the correction of the alignment section, which should be made:

a) in accordance with a protective zone that will be, for the specific case, prescribed by the competent services for heritage protection

or,

b) depending on the results of a detailed archaeological recognition - if some highly valuable finding are discovered.

We note also that - unless mitigation measures proposed in this Study, during designing, construction and operation period of the road the *general protection measures* should be applied that are prescribed by legislation of different domains, whether related to assets within the "impact corridor" of unique, key-width, or the assets out of it, situated in a wider area.
As an example, we can provide compliance with the all measures, prescribed by different laws, to make safe the construction site, people and facilities during the performance, and application of valid standards and norms, which will avoid the harmful effects of the road operation.
Application of the general protection measures, is partially described in other chapters of this Study, or in specific segments of the Working design of the motorway, and here, mainly, we think the value of noise, vibration, air pollution, which should be within the range allowed and without a negative consequences for the environment, but, also on safety at work, organization and technology of a construction site, etc., complying with the applicable laws. Most of the general protection measures are regulated, however, by the applicable legislation in the field of cultural-historical heritage protection. In this sense, general protection measures include prohibition of destruction or damaging to a heritage assets or to potential heritage assets, the foundation of general protection measures.

Given that the mitigation measures during construction and operation period are considered in some separate chapters, in the conclusion of this - general considerations, we give a comparative overview of the possible, potentially damaging effects and mitigation measures by which they are eliminated / neutralized. Hereinafter, more detailed measures are developed.

POSSIBLE «HARMFUL IMPACTS» DURING DESIGNING PERIOD	PROTECTION AND MITIGATION MEASURES
Inadequate positioning of the alignment in terms of heritage protection --the possibility of its "transition" over the site / site part of cultural goods.	Recommendation for correction of the alignment section, which should be made in accordance with a protective zone that will be, for the specific case, prescribed by the competent services for heritage protection.

POSSIBLE HARMFUL IMPACTS DURING THE ROAD CONSTRUCTION IN THE CONFLICTING POINTS	PROTECTION AND MITIGATION MEASURES
The possibility of physical devastation of structures below ground level and surface archaeological findings on *known* sites	Recommendation for correction of the alignment section, which should be made depending on the results of a detailed archaeological recognition. Detailed archaeological recognition in a wider zone.[1)] ([1)] *In cooperation with the competent service of protection, it should define the zones in which detailed recognition should be made in the preparation phase for the execution of works)* Depending on the report of the results of a detailed recognition, performance of test-borehole and, if necessary, protective archaeological excavations Required - continuous supervision of archaeologists and conservators in the wider area and their permanent consulting participation during the execution of the section Forbidden transition of access roads, waste disposal and the stationing of heavy equipment at the site
Increased likelihood of physical damaging or destruction of potential (so far unknown) archaeological finds	Detailed archaeological recognition in a wider zone.[1)] Depending on the report of the results of a detailed recognition, performance of test-borehole and, if necessary, protective archaeological excavations. Required - continuous supervision of archaeologists and conservators in the wider area and their permanent consulting participation during the execution of the section
The possibility of physical damage, dislocation and deformation of the overhead structures due to technical and technological needs of the execution of works (vibration, material disposal, formation of access roads, etc.)	Adjustment of the working technologies to the condition at site and taking measures for the protection of all the factors that can adversely affect the matter or change its properties Forbidden transition of access roads, waste disposal and the stationing of heavy equipment at the site Required - continuous supervision of archaeologists and conservators in the wider area and their permanent consulting participation during the execution of the section Monitoring –observation of any anomalies caused by performing the works

The possibility of physical devastation of the natural environment due to technical and technological needs of the execution of works.	Forbidden transition of access roads, waste disposal and the stationing of heavy equipment at the site Adjustment of the working technologies to the condition at site and taking measures for the protection against all the factors that can adversely affect the matter or change its properties
Control archaeological and conservation survey after stacking out on the entire alignment length	
Supervision of archaeologists and conservators in the wider area if necessary on the entire alignment length	

POSSIBLE HARMFUL IMPACTS DURING THE ROAD OPERATION IN CONFLICTING POINTS	PROTECTION AND MITIGATION MEASURES
Possibility of harmful impacts of motor traffic on the matter of monuments, where the potential causes of damage have physical, physico-dynamic or chemical mechanisms of action	Monitoring- observation of the road traffic related dynamic effects and air quality modification, and regular insights of the competent services for protection. Gradual recultivation of autochthonous vegetation, general revitalisation of the environment, forming "green barriers".
Possibility of devastation of cultural and historic character of facility / sites / units (visual or functional anticoincidence, aesthetic degradation)	Recommendation for correction of the alignment section, which should be made in accordance with a protective zone that will be, for the specific case, prescribed by the competent services for heritage protection.
Possibility of devastation of the natural environment that exists independently or as an environment of built structures, ie, an integral part of a naturally-formed entity	Gradual recultivation of autochthonous vegetation, general revitalisation of the environment, forming "green barriers".

The abovementioned comparative overviews are given as a general «form» of solving problems. Given the diversity in character and «weight» of impacts and mitigation measures, each conflicting point, however, is treated as a separate case, and - according to its specific characteristics, analyzed in detail. In the graphic documentation for each site, using appropriate symbols, some mitigation measures are shown that should be taken to eliminate / neutralize / minimize the harmful impacts which, due to road construction, the registered assets can be exposed to.

At the end of this consideration, we would like to note that the analysis of impacts and the proposals of mitigation measures, done for all the conflicting points, are registered *in the complete length of the alignment Drenovac - Stari Neum*, regardless of what is the current phase of activities to build the road. Thus, for example, in the section of Stari

Neum - Kiševo, the effects are analyzed and protection measures are given for the site Vranjevo Selo (national monument), although the work are performed, and in the sections Kiševo - Broćanac for Dobrovo site, although the Main design is currently working .

5.2.11.1 Mitigation measures during construction period

Depending on the type of impacts that are active during the road construction, and, given the nature / specificity of conflicting points, we suggest the following mitigation measures:

- Control archaeological and conservation survey after stacking out on the entire alignment length

  Protection measures should be applied to the entire length of the alignment.

- Detailed archaeological recognition in a wider zone.[1)] Depending on the report of the results of a detailed recognition, performance of test-borehole and, if necessary, protective archaeological excavations.

  Protection measure proposed:
  - *In conflicting points where the recorded archaeological areas go down in the "impact zone " / in contact with it, or they may suffer indirect impacts from it;*
  - *In conflicting points where cultural properties located in the wider area indicate also the possibility of existance of other (currently unknown findings) and in immediate environment of the road that may be destroyed / damaged by earthworks and technical-technological operations.*

- Supervision of archaeologists and conservators in the wider area:
  a) If necessary – occasionally

     Protection measures should be applied to the entire length of the alignment.
  b) required - continuous monitoring and permanent consultative participation during construction of the section

     Protection measure proposed in all conflicting points where the recorded archaeological areas go down in the "impact zone " / in contact with it, or they may suffer indirect impacts from it or located in the wider area indicate also the possibility of existance of other currently unknown findings and in immediate environment of the road.

- Forbidden transition of access roads, waste disposal and the stationing of heavy equipment at the site

  Protection measure proposed in all conflicting points, where there are recorded archaeological areas, necropolis / cemetery, natural and architectural unities and individual buildings / historic buildings.

- Adjustment of the working technologies to the condition at site and taking measures for the protection against all the factors that can adversely affect the matter or change its properties

  Protection measure proposed in all conflicting points, where recorded archaeological areas, necropolis / cemetery, natural and architectural unities and individual buildings / historic buildings are located in the zone of impact of performance technologies and site organization.

- Monitoring –observation of any anomalies caused by performing the works

  Protection measure proposed in all conflicting points, where recorded archaeological areas, necropolis / cemetery, natural and architectural unities and individual buildings / historic buildings are located in the zone of impact of performance technologies and site organization.

5.2.11.2 Mitigation measures during operation period

Depending on the type of impacts that are active during the road construction, and, given the nature / specificity of conflicting points, we suggest the following mitigation measures:

- Monitoring- observation of the road traffic related dynamic effects and air quality modification, and regular insights of the competent services for protection.

  Protection measure proposed in all conflicting points, where recorded archaeological areas, necropolis / cemetery, natural and architectural unities and individual buildings / historic buildings are located in the zone of impact of road traffic, during operation period.

- Gradual recultivation of autochthonous vegetation, general revitalisation of the environment, forming "green barriers".

  Protection measure proposed in all conflicting points in which there is a possibility that the natural ambience in the immediate environment of cultural properties or natural-building units, are devastated during works or exposed to negative effects during the operation.

5.2.12 Air

5.2.12.1 During construction period

With the project of site arrangement it should determine and later, during the execution of works, carry out all the necessary measures to reduce the impact of construction on air quality. To limit the impact of construction on air quality, particularly in the receptors that are located near or within the zone of construction, the following mitigation measures are proposed:

- Humidifying the excavated places for taking material to prevent raising of dust during hot, dry weather conditions, especially in the windy period;

- Upon blasting for excavations in rock massif it should choose a type of explosive that has the least harmful impacts on the environment;
- Covering trucks with tarpaulin during transport of construction crushing materials;
- Use correct technical machinery;
- Carefully maintenance of construction machines and machine off when not in use;
- Regular (periodic planned) and exceptional technical inspections of machinery and vehicles to ensure maximum accuracy and functionality of the system of fuel combustion, to use (and regular control) a fuel with a guaranteed quality standard.

5.2.12.2 During operation period

Since this impact is insignificant, the measures to mitigate adverse consequences are not necessary, since it does not expect to the impact that is not acceptable according to existing legislation.

5.2.13 Noise

Reducing the negative impacts of noise on the environment can be successfully executed only if fairly and based on different well-known mitigation measures are properly applied. Noise protection measures must prevent the emergence of the noise or reduce existing noise on permitted levels.

5.2.13.1 During construction period

The contractor who opens the construction site, will be required to predict and apply measures in the plan of site arrangement to prevent the spread of noise from the construction site above the permitted level. Exceptionally, in certain cases, when it is not possible to apply measures to prevent the spread of noise from the construction site above the permitted limits, the contractor is required to provide in the plan of site arrangement, measures to protect workers and citizens, and to specify the time of execution of works. Noise protection measures must prevent the noise emerging or reduce the existing noise on permitted levels. To limit the possible impact of sound pollution on human health during construction, the following mitigation measures / environmental protection are proposed:

- Carry out a proper selection of construction machines and vehicles i.e. machinery that will as less as possible burden the environment with noise;
- The equipment that is noisy, should preferably be placed away from sensitive receivers;
- Construction activities should be planned so that parallel activities of multiple devices near the receiver are avoided;

- During the execution of works to maintain machinery (construction equipment and vehicles) in good condition and to use it only as needed. The equipment that is not used at that moment to be switched off in order to prevent and mitigate the intensity of noise;
- At all construction machinery and vehicles used in construction, it should install a sound protection / isolation of the propulsion motor and other circuits that produce or contribute to the development of noise. Also, it is necessary to restrict activities that potentially produce a lot of noise (eg pile driving, blasting and other activities) only during working hours during the day (7:00 to 19:00, Monday to Friday, and 7:00 to 13:00 Saturday) and avoiding Sundays, and if the noise levels are exceeded at night, some exceptions may be applied for certain facilities such as tunnels;
- In case of blasting for excavations in rock massifs, to select a type of explosive that has the least harmful impacts on the environment, to apply the technique of millisecond activation of mine charging with the directed explosion action, in order to reduce the effect of superposition of dynamic shocks (vibration), noise and dust emissions. Alternatively to use the technique of excavation using hydraulic hammers or mechanical excavation by millings , "mole" and the like;
- In case of exceeding the allowable values, to provide workers with protective equipment at work and to apply occupational safety regulations.

5.2.13.2 During operation period

The purpose of protection against noise is to reduce noise levels to acceptable levels prescribed by the regulations, or to a level suitable for the use of the premises, and not entirely removal of noise.

Having in mind that this is a road direction with a very low frequency of vehicles, and considering the alignement of the new road passes by sparsely populated area, near several small towns, villages and hamlets, the noise emerging from the road does not require special measures of protection against noise.

5.2.14 Infrastructure

In the phase of the road preparation and construction, it is necessary to undertake certain measures for protection of infrastructure which the road is intersecting with.

Water management infrastructure

At a high level of design, to determine the exact location of water supply facilities (pipelines, tunnels, reservoirs, sludge and air valves, etc.) that come into conflict with the main road alignment.

The planned main road alignment in several locations passes over the route of the existing water systems. During the construction phase, planned works are to be carried

out according to current legislation and the project that provides adequate technical solutions to all places where the main road alignment intersects with this infrastructure.

To avoid cracking and collapsing of pipeline tunnel that has no protective concrete lining, which may lead to the backfilling and damage of water pipes, it is necessary to implement the phase-controlled blasting in the pipeline tunnel "Hadžibeg. In order that seismic shocks are not too big, blasting should be carried out by phase electric lighters with retardants.

In the Main design it is necessary to develop alternative ways to water supply to the population in the periods when construction works are carried out on bridging the infrastructure, with a mandatory co-operation with utilities companies that manage the infrastructure.

For all the planned pipelines along the main road, technical solutions should be coordinated with the design solutions given in the entire project of the main road.

Electrical power network

Protection measures related to the existing and planned electrical power network are contained in specific regulations on the construction of electric power network. These measures are related to a prescribed protection of people, property and environment.

Protection measures treat also cable lines in the places of the road crossings and interchanges.

Important protection measure is lighting installation at all boarder crossings and road interchanges, what significantly increase traffic safety, e.g. decrease possibility of traffic accidents and damaging environmental impacts.

Telecommunication network

Protection measures for protection of immovable telecommunication network cables encompass reconstruction of the same in accordance with specific regulations.

Transportation network

Planned road alignment is crossing the existing of the different category in several places. In order to mitigate the impacts of the road, the mitigation measures are undertaken during preparation, construction and operation period.

A Traffic management plan is prepared: planning of sign location, bumpers to be constructed/placed etc. This is undertaken in the phase of the project preparation and construction.

- Identification of critical areas and construction of speed bumps and passage points;

- Informing neighbouring population in advance on the detour roads alignment and preparation of time schedule of the planned works;
- Timely installation of traffic signs and warnings on the construction site;
- Detour roads repair after construction works;
- Functional maintenance of the local roads;
- Silent pavements (extremely smooth asphalt).

Apart the above mentioned the main measure for providing of undisturbed every day life is construction and utilisation of underpasses in the body of the road, in the required places.

Measures during operation period

Protection measures of other infrastructure objects during the road operation consist of a regular technical status control and regular maintenance, in order to avoid that possible defects cause negative consequences on the environment, human health and property.

5.2.15 Protection from mines

5.2.15.1 During preparation

As described in chapter 3.17 Threats from mines of the Environmental Impact Study, on the official maps of MAC BiH on the areas where the alignment passes, it has been recorded "suspicious areas", "risk areas" and "areas without specified risk." It is therefore necessary before the execution of works to realize a site visit by experts for mines and for the third section Broćanac - Drenovac, for the adopted blue variant, in order to eliminate suspicions and ensure safe execution of works.

5.2.15.2 During construction period

During construction period in the mentioned section Broćanac - Drenovac it is necessary to perform the works with extra care and safety measures in case of accident. In case of any doubt it should contact the MAC BiH for consultation and further instructions.

5.2.16 Organisation and space use

5.2.16.1 During preparation and construction period

Restrict movement of heavy equipment during construction of the road, so that area of agricultural land destroyed by works would be less as possible, or use an existing road network, which should be repaired after the construction works.

5.2.17 Technical measures

Landscape

The planning of an ensamble of environmental landscape insertions to be connected with the realization of a road project, is considered as a fundamental phase to proceed

to the re-qualification of the environmental landscape characteristics in the context in which there is estimation of intervention and of improvement of the peculiar elements.
The environmental arrangements are based on the individuation of restoration works that allow the recovery of the areas touched by the realization of the project and the improvement of the elements created by it. The purpose is to recreate the continuity of the existing signs and views in the realization of the work and to confer a landscape value to the project elements.

The use of green plants does not have the purpose of offering only an aesthetic re-qualification but also should operate a reconstruction of natural elements that, as observed before, represent sporadic events. So, this type of intervention belongs to environmental recovery system that includes all the interventions finalized to the spontaneous recovery of the autochthonous vegetations.

The first phase of environmental-landscape interventions planning considers a preliminary analysis with the purpose of studying current characteristics of the natural elements not derived from human activities and the general potentials of transforming and developing of the territory examined.
Reaching this purpose it will have to be analysed the bioclimatic and geomorphic characteristics of the area and also the main vegetation types available.

Concerning tha animal communities, they react particularly sensitivelly to the structure of the vegetal consortiums because the presence of arboreal and shrubbery elements and their specific location provide the opportunity of alimentation and hiding for different faunal areas.
The vegetal aspect assumes a relevant role in the success of all the insertions using additions, „artificial plant“, which balance should be holding in particular consideration.

The project and the distribution of the plant have been planned trying to copy the natural shapes, supporting mostly the landscape insertion with the around area and assuring the perfect connection between the new and the existing.
These actions should keep, where possible, the recovery of the autochthonous vegetation and fauna in order to evolve the system to a more natural state.

Respecting the identity of the local vegetation, it is necessary to make a selection of species of flora, and in accordance with the geomorphological and climatic conditions of the area.

In landscape and environmental designing a role of primary importance may be carry out by the bioengineering interventions and planning. Bioengineering is a technology that projects with vegetation and particular materials (geotextile, biomat, wire mesh, stones, wood, straw) to solve the erosion and washout phenomenon.

Within the landscape treatment it should certainly treat the greening alongside the body of the road.

6 DESCRIPTION OF POSITIVE PROJECT IMPACTS

Positive impact on the population

The construction of the future road section will increase a degree of the availability and interdependence of some settlements, but its the most important positive impact is to connect our only way out to the sea, with the rest of the country, which will unburden the existing route via Čapljina and Metković, and thereby provide a high quality way to the sea without crossing the border. In addition, this route may be considered as a transit way for those who travel to Dubrovnik region.

Also, building and increasing the number of passengers on this section, shall be increased opportunities for the development of tourism and catering facilities, which there are no now in this region, and which will contribute to the prosperity of this region, and its inhabitants. This allows the survival of young people who currently go to larger centers in search of employment.

Positive impact on air quality

Construction of the future main road will unload the existing road, which means crossing the border of Bosnia and Herzegovina, and thus will reduce the large air pollution, which in this area reaches high values in summer months, and represents a major problem for local population.

Positive impact on cultural-historic heritage

Positive effects of road construction can be expected during its operation period.

One of the major potentially positive effects is to improve the physical accessibility of assets registered in the impact and wider zone – of the availability which is currently very poor. Many of them, namely, are accessible only to local low-level communications - often: very narrow country macadam roads with large slopes and curves. In most cases, it can not even come close to the sites themselves by motor vehicle. Therefore they, as potential destinations of *cultural tourism*, are completely "dead."

In this context, improving the connection of this microregion with the rest of the country, ie, increasing the frequency of movement of people and goods throughout the region, can be a positive impact on heritage through the economic and tourism "*benefit".*

In populated areas, construction of the subject road will undoubtedly be accompanied by the development of service activities, catering, shops and other facilities. This could be another positive effect as expected in the context of heritage, because the active protection of cultural and historical assets includes the creation of appropriate "background" in the form of advanced service facilities and environment in general, and, good promotion, popularization and presentation.

The third positive effect is the effect of information and communication.
Most of the registered heritage sites are located in areas which have not been in any way promoted or not renowned as target points of cultural or tourist itineraries, and exist far away from real development. In this regard, use of the frequent road, which connects two important tourist destinations: Stolac and Neum, should be understood as an extraordinary opportunity for the presentation and affirmation of cultural, historical, natural, ethnological, traditional and all other values of the area, and, for the designed longer term marketing activity of Tourist Boards, based on the heritage potential. Along the entire section it is possible, through visual communications, to offer an appropriate information, thus, affirm the values of heritage. Great wealth of heritage resources in the contact zone (Gradac, Hutovo, Boljun, etc.) and, in a wider area (Stolac, Badanj, Glumina, Ošanići, etc.), it certainly deserves.

Assuming that the proposed protection and mitigation measures will be here implemented consistently; that recorded assets and so far unexplored sites in any way will not be destroyed, the above effects can have its full effect in terms of improving the status and condition of heritage in the explored zone.

Positive impact on urban space

The main road M 17.3- Stolac - Neum, by its construction will make an useful space that until now did not have its function, because all sites have not been used as arable land areas. The existing road is very worn out and does not correspond to the traffic intensity to be moved to the area. Construction of the future road will provide faster and better transport of passengers to the sea.

Given that on the path to this section it passes through Stolac, positive effects will be reflected in this town, and it would be open in the future the possibility of building the road infrastructure of the same, but also a possible revival of the economy, which has long faded away. This building will provide connectivity of the this town to the south, but also to the smaller places in the environment.

Traffic connection of Stolac and Neum will be improved, and through them, the other towns. In particular, the connection of nearby places Gradac and Hutovo will be improved which will become an integral part of the wider urban area. This will allow the survival of the population in the wider area, better use of the function of centers, and relieving of the same from the housing function overloading. Proper way of tangent lines of settlements besides which passes the road, enables faster and better urban development.

Furthermore, the road would be useful as a connection of industrial zones, the existing and re-active to each other and with the regional environment.

7 DESCRIPTION OF ALTERNATIVE SOLUTIONS

7.1 Description of alternatives and selected alternative

Since the project is analyzed at various stages of design and implementation, the entire alignment can be divided into 3 (three) sections.
The first section Stari Neum – Kiševo, in the length of 3,021 km is in performance stage.
For the second section Kiševo - Broćanac in length approximately 8,50 km the Main design is done.
For the third section Broćanac – Drenovac in length of app. 27,00 to app. 28,00 km (depending of alternative), the Preliminary design in in final stage.

The best alignment alternatives for the sections Stari Neum - Kiševo and Kiševo - Broćanac have already been selected and the Main designs for these two sections are made.

For the third section Broćanac – Drenovac, the Preliminary design is currently nearing completion, within which are considered two alternatives (blue and red) of which the first alternative (blue) with its sub-alternative.

Blue alternative

The first considered alternative (blue) of the road alignment is starting east of the village Broćanac, from the beginning of the road in Stari Neum. Generally it follows the existing road corridor between Broćanac and Drenovac and passes north of the village Hutovo. Along the first section, the alignment gradually climbs. This alternative is characterized by steep climbs.

Due to the difficult terrain at the beginning of the blue route, a subalternative has been made, which earlier crosses Hutovo valley to the right slope with a viaduct. So steep climbs are avoided, but it is necessary to build a viaduct of length of 215,00 m, in order that the road crossed the valley.

The main facilities on the route of the blue alternative include a tunnel with length of 780,00 and viaduct 123,00 m long (as noted above, within one subalternative an another viaduct 215.00 m long is provided).

Also, it is important to note that this alternative does not cut the populated areas directly, but passes by them.

According to the MAC map on the route of the blue alternative and its subalternative, "risk areas" near Stolovo, much larger areas in Bjelojevići before the end of the section, immediately before Drenovac, the surfaces in a series on sharp curves of the road (where the section ends), form long ellipsis ring, besides which this alternative, only slightly touching it, is going north.

Conditions for execution of the blue alternative are very favorable. The route can be accessed throughout the stretch from the existing road. Conditions of traffic diverting are favorable, because it generally follows the existing road corridor, M-17.3 Neum-Stolac.
Route of the blue alternative passes close to a number of settlements (which faster and easier access to the same is enabled, and through the intersection), while configurations of the terrain are to be resolved by tunnel and viaduct. Connections of settlements with each other, access to estates, economic and housing buildings are achieved by passages and overpass.

Red alternative

The second proposed alternative (red) also begins east of the village Broćanac, from the beginning of the road in Stari Neum. Route passes south of the village Hutovo and passes near the village Glumina. It avoids by this altenative a section Gradina-Hadžibegov Grad-Kičin and 780,00 m long tunnel, which is required under the blue alternative.

The main facilities include viaducts 750.00 m and 360.00 m long, and tunnels of length of 220.00 m and 400.00 m.

The existence of surface watercourses is not recognized by field work, which indicates the scarcity of water in this area.

On the route of the red alternative, "risk areas" near the place Zelenikovac at the place Glumina two larger surfaces with the same tags. The route continues across Stolovo (which is treated within the blue alternative), in the direction Gleđevci, to place Drenovac (where it ends as the blue alternative), passing through the ring of surfaces described in the blue alternative.

It is obvious that the red alternative goes through far more "suspicious" and "risky" areas, whose technique reconnaissance and cleaning of the same would, in addition to material costs, require also time, and which would again, all together increase the price of the project cost and extend time of realization.

Conditions of execution of red alternative are somewhat less favorable compared to the blue alternative. To access the route at several points need to reconstruct the local roads, or build new ones. The red alternative gives less possibilities of economic development of the local population, as it connects a less populated places (which it is necessary to allow faster and easier access to the same, and through the intersection), while the configuration of the terrain is to be solved by tunnels and viaducts. Connections of settlements with each other, access estates, economic and housing buildings are achieved by passages, which is twice more than the blue alternative.

7.2 Alternative „Zero – without project“

Road route M-17.3 Buna-Stolac-Neum has been for some time (twenty years ago) declared as a main road, although its technical characteristics on the long section (between Stolac and Neum), do not even nearly correspond to the rank of roads where it is classified.

The road route is characterized by a very modest technical elements. Width of the roads is between 3.00 and 5.00 meters, with a sharp horizontal and vertical curves, stationary large longitudinal slopes (even at 15%), with no continuity in the horizontal and vertical route running and inadequate drainage solution.

In addition to these technical shortcomings, the existing alignment in terms of position represents a concept that is inconsistent with contemporary solutions and requirements that road of this level should meet. Since the existing road, built on the route of the former macadam road, paved and widened in places, is passing through the centers of small urban areas, crossing the most fertile terrains in this area, it is clear that this type of road can not meet contemporary traffic as well as required capacity and level of service.

Just before the war, one part of the main direction of M-17.3 Buna-Stolac-Neum was built, and on the stretch: Drenovac-Stolac and Masline-Buna, as well as one short stretch at the exit of Neum.
In the coming period is expected to resume accelerated construction in this direction, ie on the stretch Stari Neum-Drenovac. An additional importance to the road gives the fact that this main direction is the only direct connection between the Adriatic coast and the interior of Bosnia and Herzegovina, whose construction will get more benefits, such as avoiding customs administrative procedures, etc.

Therefore, the existing road has a role only in local traffic, because of its technical elements and position (through the center of a series of settlements) the most correspond to the rank of local roads and serves as a service road.

Conclusion:

Analysis of alternatives from all aspects, leads to the conclusion that the blue alternative is the most favorable.

8 PROTECTIVE MEASURES IN CASE OF ACCIDENTS

Under the impacts on the environment it is most often imply events occurring continuously (air pollution by products of combustion), and those that occur in a short period of time (emergency events or accidents).

Given the genesis of their origin, they can be divided into natural and those created by man's activities. Also, accidents may occur on the road or outside, and be the cause of accidents of different proportions. There is no 100% safety when it comes to appearance of accident situations, although there are ways of their prediction and mitigation.

A key impact on the environment as a result of ecological disaster takes place only during the accident (fire, explosions, spills of fuel and lubricants, breakdown of freight vehicules), and after the accident it does not expect any further contamination of the environment. Therefore, the possible ecological disasters are primarily related to the current threat to life and health of people and destruction of material goods (if the environmental disasters in the subject sparsely populated areas occur even in the vicinity of people and settlements).

Effects that occur as a result of accidental situations may arise during construction and in the course of the road operation. Possible ecological disasters or emergency events that may occur in the phase of the construction and operation of the planned road and that can endager the environment and cause danger to life and health, can be divided into four groups:

- The first group of potential risks is present in all situations when the planned environmental protection measures in the phase of exploitation have failed
- The second group of potential risks is related to accidental situations that can happen in the phase of work execution and maintenance works on road during the operation.
- The third group of potential risks is related to accidental situations as a result of accident of vehicles which transport the hazardous materials.
- The fourth group of potential risks appears as a result of natural disasters that may occur in the form of floods and earthquakes.

Although the probability of accidental situations events of the mentioned types is usually small and in the function of several factors, the consequences thereof are substantial and serious.

In accidental situations (during construction and operation), many of these impacts may occur as the acute effects of incomparably stronger intensity than in normal conditions.

Mediums by which the pollution is transfered, are the air and rain water. Solid particles and not volatile components of liquids deposited on the pavement are usually transmitted by rain water. These pollutants are transfered in the belt close to the road, at the distance to app. 10 meters.

In the accidental situations, which are usually breakdowns of freight vehicles that carry large amounts of materials harmful and dangerous for the environment (during construction and exploitation), there is an impact load, which in the case of penetration into the subsoil extends to far greater distances than in the normal road operation. Such damages usually occur in bad weather conditions, which further complicates the intervention. Because of the weather and spatial unpredictability, such situations are the biggest threat to underground waters and sources.

8.1 Risk of accidents during construction period

During construction period there are possible accidental situations regarding incorrect site organization, which may have as a result the following:

- Soil and water pollution by petroleum products and waste waters from construction sites. In the event of spillage of petroleum products, they will very quickly impregnate in the soil and underground,
- Fires outside,
- Accidents caused by force majeur (thunderbolt, extremely unfavorable weather conditions, etc.), technical failure and / or human error,
- Collisions of vehicles and machines at the entrance and exit to the area of operation.

These accidental situations are mostly the cause of accidents during construction works, which cause exposure to hazardous chemicals or injury of workers.

Also, construction of the road means also risks to health and risks in the field of safety of performance of works for workers who handle with machinery, hazardous materials, power sources, or are exposed to unfavorable spatial conditions during the execution (exposure to dust and toxic vapours from the chemicals used in the works etc.).

There is no effective measure to reduce this impact, but respect of the basic principles in the field of occupational safety will provide a significant reduction of possible risks in the execution of works. Limiting time of exposure to dust particles, chemicals and noise, protective clothing and wearing protective glasses for special works can reduce the risk of unwanted consequences. Procedures on the handling of toxic substances, explosives and other hazardous substances must be developed in detail.

8.2 Risk of accidents during operation period

Precisely the accidental situations present the biggest impact on the environment (collisions, leaping and overturn of cars, spills of oil and petroleum products and other harmful substances in the environment) in which there may be environmental disasters

of large proportions. Repair of such events is very uncertain and time-consuming, and the consequences for the underground and ground water are serious.

During operation period, some different accidental situations may arise due to:

- inadequate driving conditions compared to the characteristics of road, traffic conditions and weather conditions,
- due to maladjusted driving conditions to the nature of cargo being transported,
- overstrain of drivers, as well as other conditions that affect the quality of driving.

In line with reducing the possibility of accidents, and the issue of driving conditions, it is necessary to adjust the allowed speeds on some sections with radius of curve, and inform drivers about driving restrictions.

Regarding the type of cargo being transported, it is very important to take into consideration the nature thereof. Namely, the transport of hazardous materials is a particular risk. Under the Hazardous Substances imply those matters that have very toxic, oxidizing, explosive, flammable, and self-flammable and ecotoxic properties that make them dangerous to the life of people and the environment. In these hazardous materials include: flammable liquids (gasoline and diesel fuel, and various machine motor, hydraulic and emulsion oils), gases (propane, butane), oxidizing substances (chloride and peroxides), corrosive substances (sulfuric, hydrochloric and nitric acid) and toxic substances (pesticides and herbicides).

Emergency situations on the road may be the result of car accidents that occur due to overstrain of drivers and defective vehicles. In the event of an accident it is necessary to inform the competent authorities (police, ambulance and fire department). To make possible this process, it is necessary to set along the road also a notification of the phone numbers of emergency services, and with appropriate telecom operators to agree a permanent coverage of the road by GSM signal.

Also, accidents may occur also at the location of petrol and gas stations as a result of crash of vehicles, which transport the oil and petroleum products, or during pouring. However, they are considered as events with little likelihood of emergence, and are therefore difficult to quantify. In such situations, the biggest problem is the current very high concentrations of hazardous substances that are either spatially or in time can not be predicted. Due to spills of oil and petroleum products, so as not to endanger the environment, it is necessary to carry out the reconstruction and the procedure itself of reconstruction should be an integral part of environmental protection measures of the petrol station.

In the case of accidents, depending on the event, it should act in accordance with the Operational Plan of emergency measures, and relevant bylaws and legal regulations. The Operational Plan of emergency measures should contain at least the following elements:

- If a damage occurs to vehicles carrying dangerous goods in powder (granulated) state, it referrs the request to some specialized services, which should perform an operation to remove hazardous cargo and rehabilitation of the road. Bulk granular material must be removed from the road only mechanically (by returning to the new appropriate packaging, cleaning, aspiration, etc.), without flushing with water.
- If a damage occurs to vehicles carrying liquid hazardous materials, traffic immediately stops and it alerts the competent specialized rehabilitation services for the damages. Spill material is removed from the road with special sorbents. If the liquid reached out a profile and contaminated the soil, remediation is done to remove it. All material collected in this manner are treated according to special procedures of regeneration or deposited on disposals provided for such matters.
- The planned road is required to equip with the appropriate horizontal and vertical signalization, which includes all aspects of the required prohibitions and notices in the areas of potential water pollution (zones of high risk of contamination). Traffic signs have an impact on the participants in traffic, transporting hazardous materials in a manner to reduce speed limits, prohibit passing a truck, to increase the level of attention and prohibit stop of vehicles on the road.

Regardless of all the above, it is necessary to enable workers to work safely. The same is true for all participants in traffic, which is necessary to comply with any restrictions set on the road. In the case of accidental situations it is necessary to comply with the principles of public data.

9 CROSS-BORDER ENVIRONMENTAL IMPACTS

This segment of the complex impacts refers to the impacts that the Project may have on certain aspects of life in the neighboring country. Their importance is reflected, among other things, also in the fact that can contribute to the harmonization of construction of the international obligations of Bosnia and Herzegovina, and in terms of reduction of cross-border environmental impacts.

Section of the road M-17.3 Neum-Stolac, on the stretch Stari Neum-Kiševo-Broćanac-Drenovac, by its entire length passes through the territory of FBiH. However, taking into account the spatial dimension of the section, there is, although minimal, a risk and probability that the project may have a cross-border impact on the territory of Croatia.

These impacts can be divided into the following: impact on population, impact on water, air, flora and fauna and protected areas of nature, and soil and agricultural land.

Impact on population

Cross-border impact on population is probably reflected in the following:

- increasing traffic of people, vehicles and goods in the territory of the Republic of Croatia,
- increasing the possibility of different accidents occurred due to increased traffic of vehicles,
- increasing influx of tourists in Croatia,
- increased availability of certain parts of Croatia,
- impact on the strengthening or selective redistribution of existing economic activities in the narrower and wider part of the Croatian regions (the increased international availability enables the development of tourist activities in the part of Croatia, as well as redistribution and / or reduction of other activities such as agriculture, etc.).

Impact on water

Cross-border impacts on water are very complex group of impacts, given that the area of interest does not have one of the surface watercourses, while the underground network of waters is very developed. These precipice watercours are related with the same in Croatia, or they are their integral part.

Given the very specific karst terrain, and easily plunge of the surface water, in the case of accidental situations, some impacts are possible in the form of transport of pollutants through the cavernous and cracking groundwater transport system. This could lead to pollution of groundwater flows in Bosnia and Herzegovina (and considering the connected network of ground waters), as well as in Croatia. It supposes that several sources relevant to this area arises from drainage of underground flows.

Although the probability of vehicle accident with dangerous matters is small, they should be kept in mind, and it should take all measures to reduce the possibility of their emergence.
It is necessary to establish the appropriate trained and equipped team for emergency intervention and develop appropriate operational plans in various accident situations. Through the coordination, the competent authorities in both countries are obliged to provide the functionality and effectiveness of the proposed measures.

Impact on soil and agricultural land

Soil

Possibility of negative cross-border impacts can be assumed for incidental damages in the transport of hazardous, bulk or liquid cargo. In order to porosity of the soil and parent substrate, there may be contamination of underground water flows that drain through the karstified underground and have their outflow in the neighboring Croatia. This may represent a potential threat to the soil, which, however, fall into the category of theoretical settings.

Agriculture

It can not expect direct negative effects on agricultural production in the neighboring country.
Assumptions may be possible to move in the spheres of eventual consumption of agricultural products, from this region in the nearby coastal area, if the production would be endangered in some localities ie, the soil polluted by increased contents of pollutants from car exhaust gases.

Forests and Forestry

By analysis of set road corridor in the area, we came to the assumption that there will not be negative cross-border impacts on forest systems.

Impact on flora and fauna

Respecting all prescribed general, special and technical protection measures, it is not expected to be more significant adverse cross-border impact on flora and fauna in Croatia.

Impact on protective parts of nature

Respecting all prescribed general, special and technical protection measures, it is not expected to be more significant adverse cross-border impact on protective parts of nature in Croatia.

Impact on air

Gases are produced as an unavoidable product of fuel combustion in car engines. The main components of harmful and hazardous substances are: carbon monoxide, carbon dioxide, nitrogen oxides, sulfur dioxide, lead and lead compounds, and a substantial amount of solid particles, soot and heavy metals.

Looking at the local level, it predicts that pollutant emissions will not pose a problem for human health along the road, so analogously it can be concluded that cross-border impact will be negligible.

Looking globally, emissions of these gases, especially CO_2 will have its share, though small, in global greenhouse gas emissions, which represents the effect of the existing engine technology of the road traffic and for now it is impossible to avoid it, if we want to develop road transport.

10 DESCRIPTION OF MEASURES PLANNED FOR MONITORING

Given the possible potential negative impacts identified during construction and use of the planned road, it is necessary to monitor and analyze the state of the basic components of the environment that has proven to be exposed to negative impacts. In addition, it is possible to establish after the construction of the road that some of the foreseen measures to mitigate the environmental impacts are not enough, or even the planned activities were not fully implemented. To be able to track any changes it is necessary to establish a system of monitoring the environment (environmental monitoring), which is an integral part of the perception and evaluation of changes occurred in the environment. In the context of the above said, it is necessary to have a prior observed zero status of the environment quality, and before performing any construction works.

In this regard, it is necessary to foresee the establishment of a monitoring system of the environment state in the area of impact of the planned road, both during the construction period, and during the operation period of the future road.

Given the size and complexity of the planned intervention, and in order of more appropriate consideration of the mentioned impacts, the proposed measures for monitoring the environment state are given below.

10.1 Situation before start of work execution

Soil and Agricultural land area

Before start of works it should additionally carry out some complete analysis of state of physical and chemical properties of the highest quality soils and their burden by heavy metals and other non-organic and organic pollutants. Besides specifying areas that are given through cartographic representations, this would be an opportunity for the establishment of the cadastre of the condition and load of soils by pollutants in agricultural land areas along the route.

Forests and Forest land area

Before the start of project implementation it will be necessary to establish the following:

- Presence and type determination of forest systems in the corridor area of direct and in the corridor area of indirect impacts,
- Define the nature of forest communities and their economic categories,
- Identify areas of sensitivity to adverse impacts from mechanical damages and from damages caused by contamination,

- In the total forest land area, according to the common methodology, conduct analysis of soil, equivalent to analysis that will be carried out for the agricultural land area.

Flora

Before beginning the execution of works it is necessary to establish the zero status:

- determine the spatial distribution of Leguminose shrub (*Petteria ramentacea*) along the route,
- accurately determine the size of the populations of other rare, endemic and endangered species.

In determining the zero state it should implement a mapping of flora. Assessment of the abundance and cover should be carried out using the Braun-Blanquet combined assessments of the abundance and cover (Braun-Blanquet 1964.).

Fauna

It is necessary to determine the migration pathways of medium big and small game species, and during the execution of works the same should be kept in mind, to avoid the isolation of populations, and also threats to their survival, as a result of cutting pathways to feeding and watering places.

Waters

In our study area along the route of the main road, lies the source of Blace, which is located in the public water supply system of the town of Neum. On the basis of available data collected during development of the study, in paragraph 3.16.1 a rating state of groundwater quality is given.

10.2 Environmental monitoring during construction period

Soil and Agricultural land area

During the execution of the preparatory and construction works it shall come to damage of the soil and agricultural land area. Depending on the site organization and dynamics of works it will determine the locations of monitoring. On these sites the soil will be sampled and complete the analysis will be carried out. Then, damages and permanent disappearance of soil and agricultural land area will be cartographic interpreted with photo documentation annexes. Emerging situation will be interpreted cartographic with appropriate text attachments as the required part of supporting documentation.

Forests and Forest land area

It is quite certain that will come, during the project implementation, in some localities, in order to set the route, and then for making cuttings and embankments, to the complete or significant destruction of some parts of the forest. These locations will be accurately recorded and quantity and quality of the wood mass and economic damages resulting from such interventions will be calculated. All locations with the incurred damages or permanent disappearance of forests will be interpreted cartographic with appropriate text attachments as the required part of supporting documentation.

Waters

During construction works of the main road on the section of Stari Neum-Kiševo, due to the potential impact of used equipment and human factors on groundwater, it is necessary to realize also a monitoring of groundwater quality. Monitoring during the construction phase should be carried out at the source of Blace. Quality control includes control of hygiene of drinking water in accordance with applicable regulations in the weekly interval, a detailed analysis of the characteristic parameters should be done at least once a month.
Typical indicators to be analyzed at the monitoring the road impact on groundwater are:

- Smell
- Colour
- Taste
- Turbidity of water
- Temperature
- Electrical conductivity
- pH value
- Consumption $KMnO_4$
- Fluorides
- Chlorides
- Sulphates
- Heavy metals (cadmium, lead, iron, manganese)
- Ammonia, nitrites, nitrates
- Total fat
- Mineral oil
- Total phenols
- PAH-total

Testing and evaluating the quality of water can be made only by an authorized laboratory, which has authority in accordance with the Law on Water.
A report on the completed analysis of groundwater quality conditions must be submited by the investor or the contractor to the relevant authorities and institutions in the sector of water and the environment in FBiH.

Cultural-historic heritage

Environmental monitoring during construction of the road, in the aspect of cultural and historical heritage, should be performed in positions where - due to technical and technological needs of the execution of works (vibration, disposal of material, formation of access roads, etc.), there is a possibility of physical damage, dislocation and deformation of monument materials. In such cases, monitoring should imply observation of the physical structure condition by different methods (primarily visual, and - if necessary, by different equipment, using measurements, etc.), and in the purpose of registering any anomalies caused by performing the works.

Another type of observation that we have suggested is supervision of qualified experts: curators and / or archaeologists, to be carried out continuously or periodically - depending on the type and the "severity" of problems at site. We predicted continuous monitoring in cases where there is a possibility of physical devastation of the structures below ground level and surface archaeological findings on known sites; increased likelihood of destruction or damage of potential (so far unknown) archaeological findings, and the possibility of physical damage, dislocation and deformation of overhead structures by technical-technological interventions in the works.

10.3 Environmental monitoring during operation period

Soil and Agricultural land area

Monitoring of soil and agricultural land area during operation period will be organized by systems of measurements at predefined sites that will have the character of fixed points, so that changes can be monitored and commented on the set of scientific principles, and data will be used for international exchange.

Results of analysis and changes of condition in soil during operation period, will point out measures that should be implemented in order to protect agricultural land area, so that the negative effects of increased vehicle traffic would be under control and that the consequences of intensive traffic would be reduced to the minimum in areas of agricultural production.

Forests and Forest land area

In zones of forests and forest land area, there will be physical damages during operation period. However, unlike these damages, it will increase very the risk of fire, and in this regard it will need to adjust fire protection systems, with totally different conditions from those that existed in this areas before the construction of the road.

For the existence of the road, i.e. in order to improve communication conditions, it will create the conditions for successful afforestation and improvement of forest communities in a wider strip of the analyzed corridor.

Flora

After completion of construction it is necessary to determine the condition of flora, using the Braun-Blanquet combined assessment of the abundance and cover.

It is necessary to carry out monitoring of at least five years after opening the section, in order to monitor the presence of plant species, and evaluation of the new situation at site.

Fauna

During the course of traffic, it is necessary to monitor the frequency and distribution of injury of animals on the road (by transport vehicles).

One year after the monitoring, it is important to make the analysis of incident places and taxonomic affiliation of killed animals and to make an additional correction of protection, in terms of placing additional traffic signalization in places where animals pass.

Waters

From the aspect of the impact of waste water from road surfaces on the quality of groundwaters that may have been their future recipients, it should be noted that in the Main design a wastewater treatment from the road did not foresee, on the stretch where the road passes close to the source of Blace. Therefore, it is necessary to make the Project of water sources protection, as well as Project of drainage and wastewater treatment from the road.

After putting the road into operation, it is necessary to make the monthly control of hygiene of drinking water at the source of Blace, at least five calendar years, while the analysis of characteristic parameters to be executed at least four times a year, during the two hydrological minimum and maximum.

If during this period it found that main road has no impact on this source during operation period, then the number of frequency in the analysis should be reduced in accordance with the requirements of the Law on water of FBiH, which requires a minimum number of prescribed inspections.

Also, during the road operation it should ensure regular monitoring of drain protection system as provided in relevant projects and special provisions as in the ordinary and in extraordinary circumstances

Cultural-historic heritage

Monitoring the environment during the course of the traffic in the aspect of cultural and historical heritage, should be performed in positions where there is a possibility of

damaging effects of motor traffic on the matter of monuments, where the potential causes of damage are of physical, physical-dynamic or chemical nature.
This type of monitoring would require observation of the dynamic effects of motor traffic, and changes to air quality, through regular inspection of the competent services of protection.

11 POTENTIAL DIFFICULTIES DURING REALIZATION OF EIS

For preparation of the Environmental Impact Study, for the aspect of spatial-planning documentation, it has been taken in advance the spatial-planning documentation of Neum municipality, by the Federal Ministry of Physical Planning and with the consent of the Major of Neum municipality.
It is presented for inspection the following documentation:

- Textual annexes of Spatial Plan of Neum municipality, made by the Urban Development Institute of Bosnia and Herzegovina, Sarajevo, 1985.

  - Analytical documentation basis, Synthetic materials, 1986
  - Natural conditions and resources, Documentation 1, 1985
  - Socio Economic Development, Documentation 2, 1985
  - Population, Documentation 3, 1985

- Graphic annexes of Spatial Plan of Neum municipality, made by the Urban development Institute of Bosnia and Herzegovina Sarajevo:

  - Condition of Physical Planning – Synthetic presentation scale 1:25000
  - Study of settlements and urban areas – Syinthetic presentation, scale1:25000

Mentioned documents, dating from 1985., do not adequately show the current status of the area, due to the distance of time and political events in the area of the region in general, cause the obsolescence of these data, and therefore fallowness of the same for the purpose of Environmental Impact Study development.

During the war, all documentation of Stolac municipality was destroyed, and had no ability to see the same.

Incompleteness of data on air quality and noise levels along the existing road alignment M-17.3 Buna-Neum, section Neum-Stolac and the proposed new alignments of the road, has caused a limited treatment of these aspects.

For the aspect of water supply, some partial projects have been presented for inspection, without adequate data.

All the above-mentioned aspects are elaborated at a level that documentation given for inspection and site visits allowed.

12 CONCLUSION

In the Environmental Impact Study for the road M-17.3 Buna-Neum, section Neum-Stolac are analyzed data from the physical planning, construction and technical characteristics of the planned road and the environment features of narrower area of the road, and where needed, also wider. After that, it has been assessed the potential negative and positive impacts that would be created by construction of the future main road, as well as measures that can prevent i.e. mitigate the negative effects.

In order to analyse and assess the direct impact of the road on the environment, the area of the corridor and namely from 0 to 100 metres on both sides from the road zone has been considered. Wider area of impact from the above mentioned corridor is treated in the part of the Previous Environmental Impact Assessment.

By analysis of impacts during construction and operation period, on some component parts of the environment, all the negative effects of building the main road M-17.3 Buna - Neum, section Neum - Stolac will be removed or reduced to the minimum, with strict adherence to the proposed measures for protection of the environment and ensure monitoring of the environment, and from this side it can say that the **planned project will not have more significant negative impact on the local area on the subject site**. In addition, it is estimated that the project will have positive socio-economic impact on the region in which it is located.

13 DATA SOURCES

Regulations:

1. Law on Environment Protection („Official Journal F B&H“, no. 33/03);
2. Law on Nature Protection („Official Journal F B&H“, no. 33/03);
3. Law on Water Protection („Official Journal F B&H“, no. 70/06);
4. Law on Air Protection („Official Journal F B&H“, no. 33/03);
5. Law on Waste Management („Official Journal F B&H“, no. 33/03);
6. Book of regulations on the plants and installations for which the environment impact assessment is compulsory and which can be built and put in operation only if they have an environmental permit („Official Journal F B&H“, no.19/04);
7. Book of regulations on limiting values of air quality („Official Journal F B&H“, no.12/05);
8. Book of regulations on air quality monitoring („Official Journal F B&H“, no. 12/05);
9. Law on spatial planning and land use at the level of Federation of Bosnia and Herzegovina („Official Journal F B&H“, no. 2/06, amendments no. 72/07 and 32/08);
10. Law on cultural-historical and natural heritage protection (Official Gazette SR B&H“, no. 20/85);
11. Law on roads of Federation of Bosnia and Herzegovina („Official Journal F B&H“, no. 6/02);
12. Law on agricultural land („Official Journal F B&H“, no. 2/98);
13. Book of regulations on allowed limits of sound and noise intensity („Official Gazette SR B&H“, no. 46/89);
14. Law on noise protection („Official Journal of Sarajevo Canton“, no. 26/07);
15. Law on construction („Official Gazette of Hercegovina-Neretva Canton“, no. 5/04);
16. Law on spatial planning („Official Gazette of Hercegovina-Neretva Canton“, no. 4/04);
17. Law on environment protection of Hercegovina-Neretva Canton („Official Gazette of Hercegovina-Neretva Canton“, no. 7/04);
18. Law on nature protection („Official Gazette of Hercegovina-Neretva Canton“, no. 3/05);

19. Law on air protection („Official Gazette of Hercegovina-Neretva Canton“, no. 3/05);
20. Book of regulations on activities, facilities and plants that can be built and put into operation only if they have an environmental permit („Official Gazette of the Herzegovina-Neretva Canton ", no. 1 / 05);
21. Law on protection of cultural and historical heritage in the Herzegovina-Neretva Canton („Official Gazette of the Herzegovina-Neretva Canton ", no. 2 / 06);
22. Guidelines for designing, construction, maintenanceo and supervision of the roads (Roads Directorate of Federation B&H and Public Enterprise „Putevi Republike Srpske“, Sarajevo/Banja Luka 2005.).

Spatial planning and other relevant documents

1. Spatial plan of Neum muncipality, 1986
2. Highway on the Corridor Vc, Feasibility study, Final Report, Sarajevo, Decembre 2006.
3. Annex with Feasibility study, Highway on the Corridor Vc, Estimate of financial market analysis of the Project by sections of construction, Sarajevo, Decembre 2006
4. Traffic study, highway on the Corridor Vc, Lot 6 Sarajevo South (Tarčin) – the southern border, a draft of the final report, Book 1, Zagreb, Septembre 2005
5. Traffic study, highway on the Corridor Vc, Lot 6 Sarajevo South (Tarčin) – the southern border, a draft of the final report, Book 2 annexes, Zagreb, Septembre 2005,
6. Main design of the main road M-17.3 Buna – Neum section: Kiševo – Broćanac, June 2008
7. Main design of the main road M-17.3 Buna – Neum section: Stari Neum – Kiševo, April 2004
8. Biršl Z. Halilčević N., a report on the engineering geological characteristics of soil on the road M-17.3 Neum – Buna on section Kiševo – Broćanac
9. Jevremović D., 2003., Engineering geology
10. OGK, sheets Ston and Metkovići 1 : 100 000, with comments - Federal Geological Institute - Beograd
11. Rokić Lj., A report on the engineering geological characteristics of the terrain along the road M-17.3, section Buna – Neum, Sub – section Stari Neum – village Duži
12. Rokić Lj., Study on the engineering geological characteristics of the terrain, section Broćanac-Drenovac
13. Seismic map of SFRJ, 1987

14. Systematic development of the coast and marine resources of BIH – 2002
15. Environment Impact Study, Corridor Vc Motorway Mostar North - South, LOT 4, Zagreb, March, 2007.;
16. Environment Impact Study Corridor Vc Motorway: LOT 1, LOT 2, LOT 3, LOT 4, 2007.;
17. Convention on the transboundary environment impact, Espoo, 1991.;
18. Systematic development of the coast and marine resources of Bosnia and Herzegovina, Neum Municipality, Faculty of Civil Engineering, University of Mostar, the Ministry of Construction Engineering HNŽ/K and UNESCO, 2002.;
19. Development Strategy of the Municipality of Neum 2006 - 2010. The Working Group of the Municipality of Neum, XII 2005.;
20. Opening symposium of LIFETCY99/BiH/035 Project, "Present and Future of Hutovo Blato wetland“, Čapljina, V 2000.;
21. Final symposium of LIFETCY99/B&H/035 Project, Čapljina, XII 2002.;
22. Scientific Conference "Growing fish in the water storages - the ability of management and environmental protection“, Neum XII 2007.;
23. Feasibility Study for municipal waste disposal project for the area of the Herzegovina-Neretva Canton and the West Herzegovina Canton, Faculty of Civil Engineering, University of Mostar, I 2005.;
24. Scientific symposium „Water in carst of Cetina, Neretva and Trebišnjica river basins“, Neum, 2003.

14 ANNEXES

14.1 Results of Preliminary Environmental Impact Assessment and decision on realization of EIS

14.2 Photo documentation:

14.2.1 Photo documentation of the proposed route area
14.2.2 Photo documentation for soil and agricultural land area
14.2.3 Photo documentation for flora and fauna
14.2.4 Photo documentation for cultural-historical heritage
14.2.5 Photo documentation for water management infrastructure

14.3 Maps:

14.3.1 Geological map in route area 1:50.000
14.3.2 Synthesis map of the existing environmental status and potential project impacts, 1:25.000 (1 section)
14.3.3 Map of mitigation measures proposed, 1:25.000 (1 section)
14.3.4 Synthesis map of the existing environmental status and potential Project impacts, 1: 5.000 (7 sections)
14.3.5 Map of mitigation measures proposed, 1:5.000 (7 sections)