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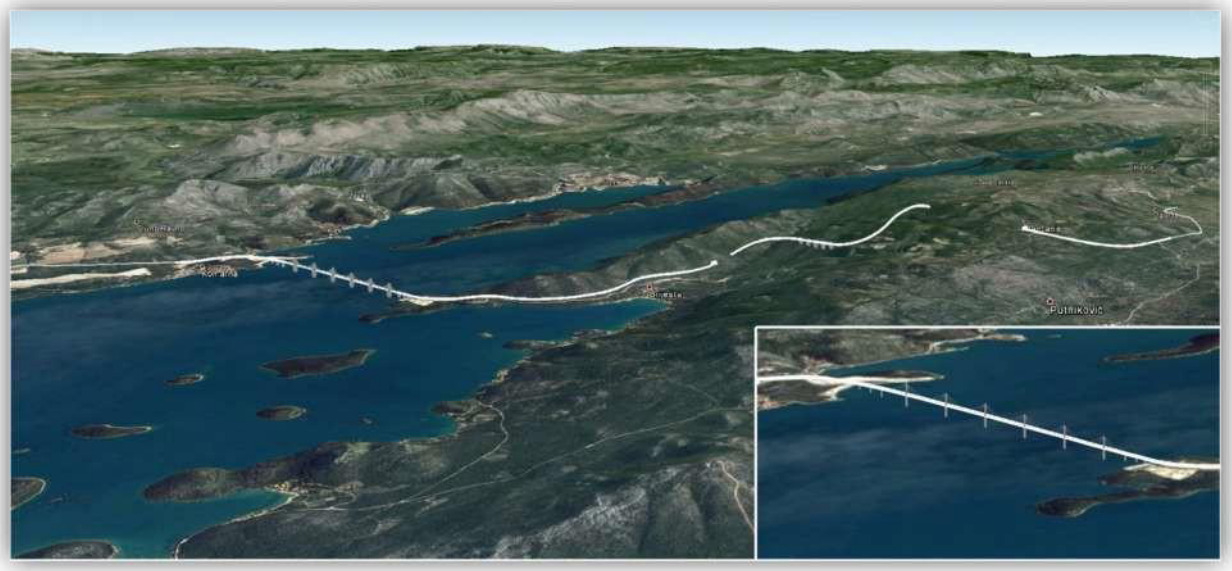
BRIDGE MAINLAND – PELJEŠAC WITH ACCESS ROADS

ENVIRONMENTAL IMPACT ASSESSMENT STUDY

NON – TECHNICAL SUMMARY



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Zagreb, June 2015

Content

CONTENT

1) PROJECT DESCRIPTION

Overview

In accordance with Annex 1, point 12 of the amendments to the Directive on the assessment of the effects of projects on the environment:

> 15. – the construction of state road, 2000 m and more in length
> **Bridge: mainland - Pelješac with access roads**

In accordance with the legislation, the Environmental Impact Assessment Study for the Project in question has been carried out, as well as the Acceptability Assessment for the Ecological Network. In addition, the Main Acceptability Assessment for the Ecological Network has been prepared in compliance with the Nature Protection Act (OG 80/13).

It was necessary to analyze the environmental impacts of the proposed project, to propose protection measures and monitoring program and, among other procedures, to assess the environmental impacts of the project in accordance with the Nature Protection Act (OG 80/13, 153/2013) and Regulation on the assessment of impacts of interventions on nature (OG 61/14).

Within the framework of the Study in question and in accordance with the mentioned legislation, the Acceptability Assessment for the Ecological Network has been carried out as well as the Main Acceptability Assessment for the Ecological Network in compliance with the Nature Protection Act (OG 80/13). In addition, in accordance with the Water Act (OG 153/09, 130/11, 56/13 and 14/14), Regulation on water quality standards (OG 73/13), Regulation on the quality of bathing waters (OG 51/10), Regulation on the emission limit values for wastewater (OG 80/13), Regulation on the conditions for establishing zones for sanitary protection of water sources (NN 66/11, 47/13), Water management strategy (OG 91/08), River basin management plan (OG 82/13) and taking account of data collected on the status of surface waters and groundwater (both transitional and coastal waters), the impacts that the Project in question may have on the water body have also been assessed.

Except in accordance with the current legislation, this Study has been prepared according to the changes in the planning documentation, planned amendments to the technical solutions, and preparation of the application procedure for funding available from the Structural Funds.

In this EIA, the Developer has used results of all recent research available to the Contracting Authority and competent institutions including other information and data available within the research works that have been conducted for the purpose of this Study (Oikon, May 2015).

The Project/Intervention covered in this Environmental Impact Assessment Study is **the Bridge: mainland - Pelješac with access roads** of the total length of **14.46 km**. The access roads run from the bridge to the D8 state road on the mainland and from the bridge to the D414 state road on the Pelješac peninsula.

In the Spatial Plan of the Dubrovnik-Neretva County, for the purpose of ensuring optimal connection within the County and connection between the County and the rest of Croatia and Europe, the following has been planned:

- Construction of A1 motorway Zagreb – Dubrovnik in the Adriatic – Ionian corridor
- Construction of fast road passing through Pelješac, including the Pelješac Bridge.

The Dubrovnik–Neretva County is the only Croatian county whose territory is partly physically separated from the rest of the territory of the Republic of Croatia. Because of its specific and remote location at farthest south-east of the country, the wider area of Dubrovnik (Dubrovnik coastal area) requires and deserves particular and priority attention and treatment in terms of its physical connectivity with the other parts of Croatia, and in terms of interconnection between parts of Europe within that area (from the direction of Italy towards Monte Negro, Albania and Greece).

In the Spatial Plan of the Dubrovnik–Neretva County, within the context of such connection thorugh road traffic, it is stated that the optimal connection within the County and between the County and other parts of Croatia and Europe should be ensured by constructing roads that will enable a fast-flowing and efficient through traffic within the County area in a way to create an optimal road traffic system with beneficial effects for the local population.

The Intervention (access roads and bridge) is entirely located in the corridor intended for road infrastructure and defined by the Spatial Plan of the Dubrovnik–Neretva County.

The road passes through Municipalities of Slivno and Ston, that is, through Cadastral Municipalities of Slivno, Brijesta, Dančanje and Putniković.

The proposed Intervention is covered in the existing and planned spatial planning documentation including as follows:

1. Physical Planning Strategy of the Republic of Croatia (1997 – 2013)
2. Physical Planning Programme of the Republic of Croatia (1999 – 2013)
3. Transport Development Strategy of the Republic of Croatia 2014 – 2030 (2014)
4. Spatial Plan of the Dubrovnik–Neretva County (OJ of DNC no 6/03, 3/05-complying, ~~3/06~~*, 7/10, 04/12.-corr. and 09/13 i 2/15- complying, * - Judgment from High Administrative Court of RC Number: Usoz-96/2012-8 of 28/11/2014, OG 10/15 of 28/1/2015
5. Spatial Plans of cities/municipalities
   - 5.1. Spatial Plans of Municipality of Slivno (Neretva Journal, 1/02, 5/08 and 6/13)
   - 5.2. Spatial Plans of Municipality of Ston (OJ of DNC, 9/10, 5/15)

The access road passes above the level of all unclassified, local, county and state road in order to maintain unobstructed traffic on the access road.

The Intervention of the Pelješac Bridge access roads starts within the existing Adriatic tourist road, D8 state road, between the settlements of Raba and Duboka. The access roads branches off left of D8 state road, thus becoming the main direction towards the Pelješac peninsula. At km 0+685.00 Duboka junction is located allowing a link with the existing D8 state road in the direction of Neum and Bosnia and Herzegovina (further in the text BIH). From there, the route crosses D8 through an underpass at km 1+258.04 to continue, above settlement of Komarna, towards Cape Međed, and to arrive by taking a right curve to the Pelješac Bridge, L=2404 m. By passing through the bridge, the route crosses Malostonski Channel and, from there, it continues further along Rošćica Glavica on the Pelješac peninsula.

Service areas of type D with parking surfaces, sanitary appliances, and rest and recreation

area, PUO Komarna and PUO Blaca, are planned at km 1+800.00 on the mainland part (right) and at km 4+880.00 on the Pelješac side(left).

By crossing to the Pelješac side, the route reaches its lowest elevation at 30.27 m a.s.l., from where it starts to ascend by alternately passing through side-hill cuts and through cuts south of Oštri vrh, and then running on steep slopes north of Brijesta. A service road is planned at km 4+714.79 in order to enable accessing the bridge abutment, and a walkway for pedestrians and animals through the roadbed is planned at km 6+691.71.

The route of the access roads passes over Kamenice through a tunnel, L= 499 m, from which Doli viaduct, L=156 m, continues. Immediately after Doli viaduct, at 8+320.00, a control and traffic management center (CKP) Brijesta is located for the purpose of managing all traffic systems, ventilation systems, lighting, power supply, and etc. for the tunnels of Debeli Brijeg and Kamenice, as well as for the Pelješac Bridge.

Next, the route runs south of the hill of Kobinja Glava, from where it spans Dumanja Jaruga via bridges, Dumanja jaruga I, L=488 m, and Dumanja jaruga II, L=80 m. The route continues to climb for another kilometer, and then it stretches to the southeast to turn right in a southwest direction and pass through the tunnel of Debeli Brijeg, L=2467 m. It is in this tunnel where the route reaches its highest elevation at 262.23 m a.s.l. From there, it starts to descend towards the so-called Pelješac road, D414. The south portal of the tunnel is located southwest of the village of Dančanje.

Next, upon leaving the tunnel of Debeli Brijeg, the route starts to descend slowly and take a left turn to join the D414 state road, where it reaches its final chaniage at 14+460.00. The Zaradeže junction is located at chainage km 14+019.93, and this is where the Pelješac Bridge access roads link to the D414 state road.

The L 69030 local road linking the settlement of Brijesta and D414 state road remains ‘intact’ – the route passes through a tunnel and links to the access roads, that is to the D414 state road, at the Zaradeže junction.

Technical elements of the access roads are designed in accordance with the Ordinance on the basic conditions for public roads outside settlements and their elements from the aspect of traffic safety.

Dimensions of the elements of horizontal, vertical and transverse geometry of the route of the road were calculated for a design speed Vr=90 km/h.

The tunnels were designed for speed Vr=80 km/h.

The cross section of the road is designed as one pavement with one traffic lane in each of the directions.

The width of the traffic lanes for the calculated speed amounts to 3.5 m, whereas marginal strips are 0.50 m wide. Emergency lay-bys equipped with telephone system for emergency calls (TPS) are planned.

Road junctons are designed as grade separated. The clearance above the road amounts to 4.8 m from the highest pavement elevation.

The access roads pass through uninhabited landscape with a poorly developed road network (mostly county, local and different unclassified roads) and thorugh a developed relief, so there are a certain number of structures, tunnels, overpasses and crossings.

The pavement structure of the access roads is flexible and consists of asphalt pavement surfacing on the base course made of unbound crushed stone material.

The road drainage system is based on the requirements necessary to ensure road pavement drainage, safe driving conditions, conservation and protection of the existing water regime of the wider basin, and protection of the environment from negative impacts.

The internal drainage system is a drainage system that collects and discharges, either freely or by means of buried and/or open impermeable channels, surface runoff waters from the road catchment. When necessary, runoff waters are purified to the required level of efficiency inside various protective structures and then, either in a concentrated or dispersed form, realased into the environment.

The internal drainage system is closed, impermeable and entirely controlled, and it deals with the discharge of the total amount of surface runoff waters, including their purification inside separation tanks (first phase of purification) and highly efficient structures located behind the separation tanks (stabilization ponds and infiltration trenches). Transverse pavement slopes ensure that runoff waters are being dhscarged into side ditches. The slopes of shoulders and berms are directed towards side ditches, thus ensuring that all runoff waters are drained through grids into drainage gullies, from where they are being discharged through cross-sectional drainage pipes of the drain system into the main drainage channel located below the roadbed. The drainage pipe is laid along the edge of the road.

The hydraulic calculation of the collectors and other internal drainage system structures is based on drainage surfaces of PUO Komarna and CKP Brijesta.

The bridge drainage shall be ensured through the closed drainage system. Water shall be drained through cross-sectional drainage pipes to longitudinal pipes placed inside the box, which will then drain the water to the separation tanks placed at the ends of the bridge, within the access road areas on the shores.

External drainage, that is, the protection of road cuts and embankments from hillside waters that uncontrollably run towards slopes of cuts and foot of embankment is carried out by means of trapezoidal channels placed inside the foot of embankment and on the top of the cut. The collected water is being drained through channels into the culverts, which then carry it below the roadbed to the other side. The water collected within the boundary channels shall be discharged into the surrounding terrain, at locations where such water cannot endanger slopes of cuts and embankments of the road or lead to erosion.

The ecological status of a body of surface water shows the quality of the structure and functioning of aquatic ecosystems and it is determined based on relevant biological, physical-chemical and hydro-morphological quality elements.

The chemical status of a body of surface water indicates the presence of priority substances and other relevant pollutants in surface water, sediment and biota.

Estimation of general hydro-morphological status is based on available data on wter structures and other physical interventions on rivers that have, for that purpose, been collected and systematized by Croatian Waters.

For the purpose of conducting activities aimed at improving the status of waters, in further phases, it is necessary to design a closed drainage system that will include landscape discharge (favorable depressions or lagoons) after waters are purified in grease interceptors (oil separation tanks).

The final drainage regime for individual sections of the route in terms of drainage methods, level of protection (efficiency of purification) and methods of final discharge shall be defined in accordance with water protection requirements and environmental impact study for the road.

There are two **junctions** proposed enabling the link between the existing road network, the D8 and D414 state roads, and the Pelješac Bridge access roads.

Duboka junction is located at chainage 0+685.00. This is a trumpet-shaped junction, sloping under the main route in order to avoid geologically unfavorable terrain to the maximum extent possible, and connecting the new route to the existing D8 Adriatic tourist road in the direction towards Neum and BIH.

The Zaradeže junction is located at chainage 14+019.93. This is a diamond-shaped junction, enabling the newly designed route to link to the existing D8 state road in the direction towards the hinterland of Pelješac and Korčula, and link to the L69030 local road.

Among **other structures,** at chainages km 4+714.79 and km 6+691.71travel routes are planned, service roads for accessing lagoon and abutment of the Pelješac Bridge, parallel routes and deviation at the Duboka junction, as well as service areas - PUO Komarna, PUO Blaca and CKP Brijesta.

The **structures,** underpasses and passages, planned along the access roads are the following:

1.	Underpass at Duboka junction	km 0+685.00	O = 11.1 m
2.	D8 underpass	km 1+261.50	O = 13.0 m
3.	Passage	km 4+714.79	O = 4.0 m
4.	Passage	km 6+731.92	O = 4.0 m
5.	Underpass at Zaradeže junction	km 14+019.93	O = 10.6 m

And viaducts and bridges

1.	Doli viaduct	from km 8+090.00 to km 8+246.00	L = 156 m
2.	Dumanja Jaruga I bridge	from km 9+264.00 to km 9+752.00	L = 488 m
3.	Dumanja Jaruga II bridge	from km 9+964.00 to km10+044.00	L = 80 m

There are two tunnels designed along the route of the access roads:

1.	Kamenice tunnel	from km 7+546.00 to km 8+045.00	L=499 m
2.	Debeli Brijeg tunnel	from km 10+915.00 to km 13+382.00	L=2467 m

Bridge mainland – Pelješac is 2404 m long with spans:

84.0+108.0+108.0+189.5+5x285.0+189.5+108.0+108.0+84.0 m. The total width of the cross section on the pavement surface is 22.50 m. The bridge superstructure is an **orthotropic steel deck** 4.50 m in height. Pylons are 75.4 – 90.8 m in height above the sea surface. The construction approach for this deck is a cantilever approach from pylon to pylon. The dimensions of navigational clearance are 250 m in width, and 55 m in height.

The traffic surface of the bridge consists of two roadways, each 8.0 m in width

(2×3.5+2×0.5) and a marginal strip 3.0 m in width. Outside the traffic surface, there are service routes, each 2.0 m in width, within which barriers and anchors of vertical hangers are located. The total width of the superstructure is 23.02 m. On both sides, outside this width, semi-circular masks – swirling regulators, 0.81 m in width, shall be constructed, covering the entire vijenac in their height. The total width of the bridge is 24.64 m. The barrieers along the outer edge of the bridge have been constructed based on the type recommended by French road authorities (type BN4, H3 level of protection). This shall also

serve as a safety barrier used to prevent vehicle from running off the edge of the bridge. The height of the barrier is 110 cm, with a width of 50 cm at its root. The barrier consists of anchored vertical columns and three horizontal bars. In that way, the transparency of the barriers shall be ensured.

Taking into consideration the underwater research conducted so far at the location of the Pelješac Bridge, it is concluded that the foundation works shall be carried out on piles.

The bridge foundation works shall be conducted on driven and bored piles of a large diameter (2.0 m), reaching down from 55.0 to 125 m in depth (max 65 m below the seabed).

The driven piles (steel pipes) are being driven by means of special pile drivers from a platform placed on the sea surface. Since the execution of the foundation works does not require any soil excavations, there shall be no significant adverse impact on the submarine zone within the bridge construction area.

Boring of piles (remaining part of the piles that has to get into the solid rock) shall also be conducted from a platform placed on the sea surface. Excavation of sludge is conducted using steel casing protection, so there there shall be no silting up in the area as this shall also be sucked out and carried to the platform.

All material collected during foundation works shall be placed into containers on the barges, in accordance with the legislation on handling the excess of excavation that represents mineral raw material when performing construction works.

Protection of fauna (primarily marine mammals and larger fish) from vibration produced during driving and boring of piles may be possible. If so, this can be predicted by using the ‘air bubble courtain’ system that is used worldwide and has been proved while constructing structures of this type. Additional protective column is placed around the piles in which air bubbles are first retained and then they come out to the surface, thus preventing spreading of bubbles and, consequently, vibrations, which may affect fauna.

Elements of the Bridge

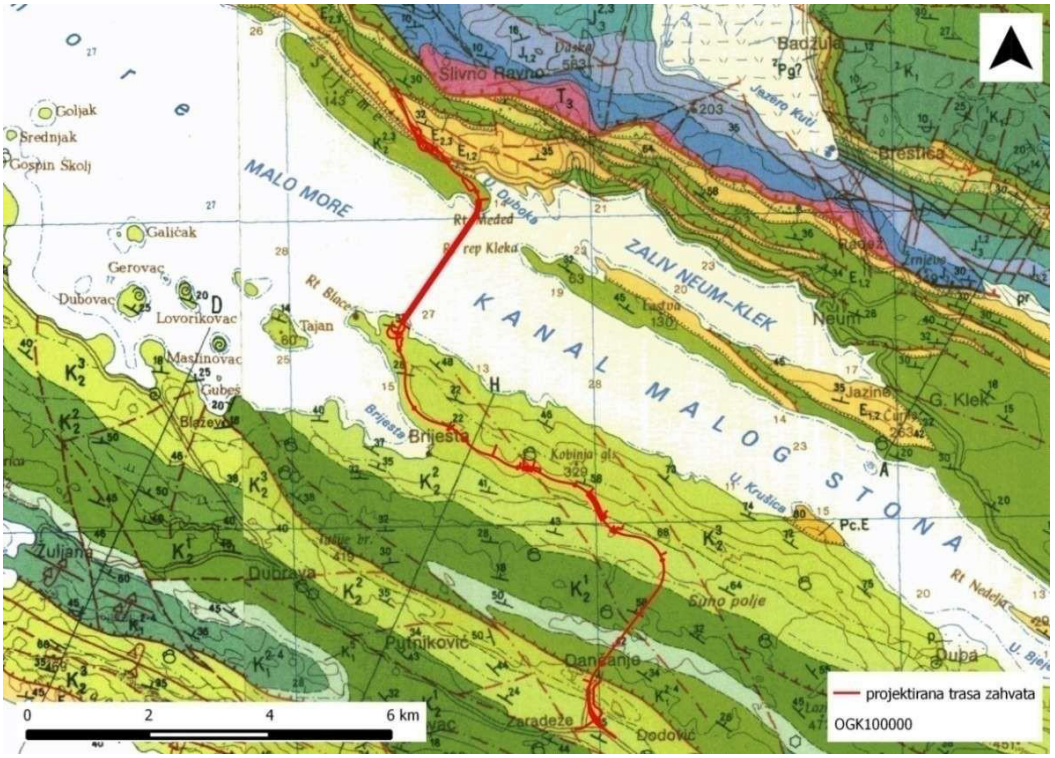
During the concrete works conducted on piles and other parts of pier structures (e.g. pile caps), steel casings and impermeable box formwork shall be used in order to prevent cement slurry or even concrete from leaking into the sea.

For the access roads and the bridge, **engineering-geological characteristics of space,** restrictionas and guidelines for design development, are covered in a special study for the development of the study.

Overall, it may be concluded that, in terms of its engineering-geological characteristics, the selected alternative of the route is a good one because it stretches across the terrain composed mostly of well-lithified carbonate rocks, which are favorable considering these characteristics. Structure discontinuity systems (SS, AR and ⊥b) are to a large extent favorably oriented in relation to the route. Northern entrance and southern exit portals of the Kuvaja Hill tunnel are vertical in relation to bedding (SS) and cleavage of the axial plane of the structure (AR). On both sides, the abutments of the bridge are palced in a compact, well-bedded rock mass.

All material excavated in the tunnel, side-hill and through cuts may be used for embankments. At locations where the route passes along embankments, there are tightly bound carbonate rocks except on Eocene marly flysch deposits, so the possibility of settling is remote and related to potential underground caverns.

According to the seismological map of the Republic of Croatia, scale 1:100.000, for the return period of 500 years (Kuk et al. 1987), the investigated project area belongs to an area of a magnitude of 8° in accordance with MSK intensity scale (Medvedev-Sponheuer-Karnik, 1964; this scale is used in the countris of Eastern European countries and it has 12 intensity degrees, similar to the MCS - Mercalli-Cancani-Sieberg scale).



pr	Proluvium	K_1^5	Limestone with dolomite inserts - Albian
b	Organogenic-marsh sediments	$K_1^{2,4}$	Limestone and dolomite - Hauterivian - at least - Aptian
$E_{2,3}$	Flysch; Eocen clastic sediments; marls and calcarenite	$^2K_1$	Limestone with Orbitolinas and Salpingoporella
$E_{1,2}$	Alveolina-nummulitic limestone	$^1K_1$	Limestone and dolomite with Favreina
			Limestone and dolomite with Clypeina;
K_2^3	Keramosphaerina and rudist limestone - Senonian	$J_3^{2,3}$	Clypeina limestone – Kimmeridgian - Portland

Rudist limestone and dolomite – Senonian

Limestone - Senonian

Limestone and dolomite With Chondodronta

Cenomanian-Turonian

Limestone and dolomite - Cenomanian

Dolomite, dolomite limestone, and dolomite–Albian-Cenomanian

Fault without characteristic markings: identified, covered or imprecisely located and photogeologically observed

Limestone with Cladocoropsis – Oxfordian-Kimmeridgian

Oolitic and pseudo-oolitic limestone with Selliporella – Lias-Dogger

Limestone with Lithiotis and Orbitopsella - Lias

Dolomite and limestone with Megalodon

Elements of dropping layers: individual measuring, upturned and vertical layer

Front of overthrust: identified and covered

The analysis of the traffic model and its assessment within the framework of what has been investigated, has dealt with a systematic assessment of the traffic, that is, of the traffic flows and traffic behavior within the existing and anticipated traffic system, at present and taking into consideration the aspect of future objectives.

Based on the conducted research, travel matrices for road motor vehicles running between 107 zones in total (59 zones of narrow and 48 zones of the wider area) were formed at the level of AADT (average annual daily traffic). These travels were classified according to the type of vehicle, objective of travel (passenger vehicles), and type of load.

The mentioned research was carried out within the scope of the *Feasibility Study for upgrading road infrastructure at location mainland – Pelješac – mainland, Construction of the Pelješac Bridge and bridge access roads (to D8 SR that is to D414 SR) with a new route for the Pelješac road within the Zaradeže – Đonta Doli section*, Civil Engineering Institute of Croatia, Zagreb, 2012. In addition, the research was supplemented with analyses and data from a new *Feasibility study for transport connection of separate territory of the Republic of Croatia* (TFP Consortium, Trenecon COWI, 2015).

The volume and structure of the anticipated future traffic flows of the relevant road network located within the area of the planned road infrastructure upgrade - at location mainland – Pelješac – mainland with investment, have been assessed through various time periods, and the study presents traffic volumes in detail, that is, AADT in time periods.

The analysis of the socio-economic value of the Intervention has also been carried out. The analysis has been conducted in accordance with the guidelines of the European Commission for infrastructure projects (DGREGIO). The HDM-4 software package was used for the assessment of economic sustainability of the Project.

The results of the socio-economic analysis show economic NPV amounting to € 101.4 m. In that case, the internal economic rate of return is 6.88% which proves that the economic project is sociologically positive, that is, higher than a limit 5.5%. Therefore, in terms of its socio-economic sustainability and need of transport connection, it may be concluded that the construction of the Pelješac Bridge and bridge access roads (to the D8 state road, that is D414 state road), including a new route of the Pelješac road at the location: Šparagovići (Zaradeže) - Đonta Doli, is in accordance with the EU guidelines defining the development of the road network of the area within which the proposed Intervention is located.

Alternative solutions

The objective of this Study is to assess the environmental impact of the Intervention of Bridge: mainland – Pelješac with access roads for the route passing in its entire length along the corridor designated for road infrastructure projects according to the Spatial Plan of the Dubrovnik–Neretva County.

In accordance with the Spatial Plan of the Dubrovnik–Neretva County, the Preliminary Design deals with the analysis of alternative forms of junctions at the start of the route (link to D8, Duboka) and at its end (link to D 414, Zaradeže). According to the Spatial Plan, both at-grade and grade-seoarated junctions are possible, so both alternatives have been analyzed for each of two junctions. Grade separation has been conducted in two

alternatives; diamond and trumpet.

The final proposal covered in this Study concerns the construction of Duboka and Zaradeže junctions as grade-separated diamond-shaped junctions, because as such they remain within the planned corridor, and in terms of traffic fluidity, left turns are eliminated, thus enabling even links of local network to the access roads.

2) DESCRIPTION OF PROJECT LOCATION AND POSSIBLE IMPACTS

2.1. Settlements and population

Any intervention in an inhabited, and even uninhabited, area brings various changes – some for better, other for worse, while some aspects generally remain unchanged. According to the analyses conducted so far, the planned construction of the Pelješac Bridge has been assessed as favorable, needed and of a wide social significance. In terms of the assessment of the project impacts on the existing socio-economic structure, it has been determined that the project has significant social benefits as it shall improve the connections within the territory of Croatia, providing the Pelješac peninsula and islands of Korčula, Mljet and Lastovo with a new impetus towards development, due to a consideral improvement in their accessibility resulting from the construction of this bridge.

The construction shall undoubtedly lead to *various consequences* – both on the mainland and the peninsula, in the immediate surroundings of the direct impact zone, and indirectly even in a wider area, especially in parts of the peninsula that have so far been relatively undeveloped. First, a *direct accessibility* of Pelješac shall improve significantly through the most direct and the shortest route, resulting in a boost in some both new and various kinds of already existing activities on the peninsula. Furthermore, the construction of the bridge shall most likely lead to *improved overall connections between the mainland - in a wider sense - and the peninsula*, thus reducing travel times to distant destinations and producing an *increase of the level of attractivity of* facilities on the peninsula aimed at improving the performance of the existing and encouraging the new activities. The roads and traffic routes which were of a secondary significance until completion of the bridge, shall have to respond to new demands in terms of traffic volumes and increased service levels in a relatively undeveloped and poorly-urbanized area. Because of diverse potential consequences, all aspects should be taken into consideration and each of the potential consequences should be carefully examined.

The analyzed area is primarily the local zone of impact in the vicinity of the settlement of Brijesta on the peninsula, because, considering a number of elements, the area on the mainland side has already been developed and is located within the zone of impact of an existing busy arterial route, so the situation within that zone is largely defined, examined and clear. Therefore, the most important social impacts may be analyzed and anticipated primarily on the peninsula side of the zone of impact.

Numerous *direct and indirect consequences* and impacts of the planned construction of Bridge: mainland – Pelješac shall most likely occur as a consequence of the construction. Possible impacts of the bridge construction may therefore be considered as *direct and indirect, short-term and long-term, and predictable and unpredictable*.

In the area of impact on the *mainland side*, in immediate narrow zone of impact, there are several small settlements that are primarily inhabited by small indigenous population and a large number of intermittent inhabitants – weekend vacationers. Those settlements are Duboka, where the census of 2011 reported a population of 160 and Komarna of 176 inhabitants. Since those are small settlements, already within the zone of impact of an existing road, the Adriatic Highway – main route connecting Croatian northwest and south areas, it may be assumed that the bridge construction *shall not cause any significant changes* in the use of land or occurrence of new forms of economic development considering the new aspect of transport, except for an increase in traffic volumes.

In the zone of impact of the Pelješac Bridge *on the Pelješac side*, the main settlement in the immediate and most narrow zone of impact is a small settlement (village) of Brijesta, which, together with hamlets of Bogićevići, Gornje Selo, Donje Selo, Baldasan and Žuronja,

have a total of only 58 inhabitants (according to the census of 2011). Furthermore, within the zone of impact, there is also settlement of Dančanje which, with hamlets of Prčevići, Bantovići, Šašare and Radetići grouped around it, has a total of 27 inhabitants. As these data reveal, the settlements next to which the new road shall pass are *very sparsely populated*, and some hamlets are partly abandoned. The existing elderly population is mainly active in agriculture (olive growing, winegrowing, farming) on small plots, as well as in shellfish farming and fishing, whereas tourist industry is still in its infancy.

The increased traffic volumes, increased demand for services, and anticipated interest in the construction of vacation homes, including the interest of the local population in selling their (neglected) land, may certainly have impact on an *increase, as well as decrease of interest* in the existing indigenous activities. On one side, the agriculture and fishing activities may be stimulated by increased passenger traffic, as this shall consequently stimulate consumer's interests. However, if this type of interest fails to develop (e.g., no restaurants are built, and, as a result, there cannot be any promotion of products), such production may continue to decline.

2.2. Traffic system

The proposed Bridge: mainland – Pelješac belongs to the planned corridor of the future fast road connecting to the Ploče – Dubrovnik motorway through the Slivno and Doli junctions, according to the Spatial Plan of the Dubrovnik-Neretva County. In terms of its functionality, this road shall carry long-distance traffic (related to the County: through traffic and origin-destination jouneys, and part of internal traffic) from the present D8 Adriatic Highway and part of D414 Pelješac highway.

The most significant road is D8, the so-called Adriatic Highway, carrying the greatest volume of traffic in the area. Besides linking the County with the rest of the Republic of Croatia and Europe, it is a link between the County and the neighboring countries – Bosnia and Herzegovina and Montenegro – and, through them, with the rest of the countries of Southeast Europe.

Almost all county roads are connected to it.

However, the areas of Pelješac and Korčula are not satisfactorily linked to the road network of Dubrovnik-Neretva County, and the planned road and the Bridge: mainland – Pelješac shall replicate the role of D8 and one part of D414 but at a much higher level of service, thus making the area of the County more attractive in terms of road transport travel. This primarily refers to the tourist travel.

2.3. Waters

During the construction works, at locations where the route passes over watercourses, there may be a negative impact consisiting of increased turbidity or pollution of waters. The biggest threats present accidents during which uncontrolled emissions of pollutants from machinery or vehicles may occur or inadequately stored waste material produced at the construction site. Well-organized construction sites and activities conducted in compliance with the relevant legislation, in particular regarding specific construction requirements by Croatian Waters, shall ensure that such impacts are prevented.

Potential negative impacts on the groundwaters are possible during construction works as a result of drainage of pollutants from waste through the soil, or in case of uncontrolled leakage of mineral oil caused by faulty machinery. Acting in compliance with construction

regulations and requirements can prevent such impacts.

The Intervention is located within the area of water body O313-MNE (type O313). The impact that the construction works shall have on the biological elements of the quality of coastal waters has been assessed.

The zone of potential impact includes the area in which, according to the model presented in EIS, a maximum range of suspended material in the most unfavorable conditions (currents that are present over 90% of time - weaker than 0.2 m s-1 in the surface layer, and weaker than 0.1 m s-1 in the benthic layers – with a range of up to 5 km from the source of sediments). The real spreading of suspended sediments is influenced by several factors (direction and velocity of sea currents, quantity and status of lifted sediments), so this zone represents an area of potential impact of suspended material.
During the execution of works, there shall be a permanent loss of the surface of seabed at the location where piers are going to be driven. Marine flowering plant, *Posidonia oceanica,* has not been registered at the project location, so the construction of the bridge shall not exert any direct impact on this biological quality element of coastal waters within this impact area.

The impact on transparency of waters and quantitiy of nutrients may eventually lead to some changes in the process of primary production (concentration of chlorophyll a), and, consequently, to changes in the composition of phytoplankton community. Furthermore, an excess of nutrients coming from the seabed into the water column may result in red tide, as well as in bloom of toxic dinoflagellate. Besides that, the impact on phytoplankton communities, lifting-up and later deposition of sediments may have a negative impact on the biological quality elements: macro-algae, *Posidonia oceanica*, and benthic invertebrates in terms of covering within the area of a wider zone of impact.

An adverse impact on surface waters and groundwaters may be possible during traffic flows due to wearing out of the road surface layer, wheels and other vehicle parts, leakage of fuel and lubricants, and use of agents for road treatment in winter periods.
Collisions and negative impacts on the organization of watercourses and waters may occur at the locations where that organization system crosses over or passes immediately adjacent to the road. Significant level of water pollution may be possible in cases of traffic accidents (car crashes, car skidding, overturning, etc.).

2.4. Meteorological and climate characteristics

An overview of the basic climate parameters is provided on the basis of years of meteorological records and observations at Ploče and Komarna weather station.

As the basis for the analysis of meteorological circumstances within the mentioned location, data obtained from measuring air temperature, precipitation, wind speed and direction within a 10-year period, from 2005 to 2014, shall be used. The analysis of wind patterns shall be completed through processing measurement data of wind speed and direction at the location of Komarna. Measuring wind speed and direction at the mentioned locations shall be carried out digitally (through impulses) by mikroM measurement system.

For the purpose of preparing the Environmental Impact Assessment Study for the Bridge:

mainland – Pelješac, a brief overview of basic climate characteristics, including a special emphasis on temperature, precipitation and wind patterns typicall of this area shall be presented.

The following analysis includes:

- Average, absolute maximum and minimal recorded and expected air temperature,
- Number of days with precipitation
- Daily maximum levels of precipitation, recorded and expected,
- Annual and seasonal wind roses,
- Annual and seasonal distribution of wind speed parameters,
- Maximum recorded and expected 10-minute and present wind speed.

Throughout the entire year, the wider area of the planned Bridge: mainland – Pelješac is located within a circulation area of mid-latitude where atmospheric condition is very changeable with frequent climate changes. In summer periods, uniform pressure fields with occasional development of convective clouds and torrential rain prevail. Colder months of the year, from November to March, are characterized by frequent high cyclone activity and passage of the cold front accompanied by strong winds.

According to the Köppen climate classification system, which observes significant characteristics of average annual air temperatures and levels of precipitation, this location belongs to the region of Csa climate type. C indicates a moderately warm rainy climate, prevailing in a large number of mid-latitude regions, where the average temperature of the coldest month is above -3°C and below 18°C. The average monthly temperature is above 10 °C during more than four months. There are no dry months (s), summer months have a minimum level of precipitation, whereas winter month the mxdimum. Finally, *a* indicates warmest month average temperature above 22°C with at least four months in a row averaging above 10°C.

The air temperature has varied from one year to another, mostly in February (largest standard deviation). Average annual temperature in the period from 2005 to 2014 was 15.9°C. The warmest year of the investigated period was 2014 with 16.4°C, and 2005 was the coldest with 14.8°C.

The absolute maximum temperature recorded at the Ploče weather station was 38.8°C, measurerd in July 2007, whereas the absolute minimum temperature recorded was –7.2°C in February 2012.

Since we are dealing with a bridge in this case, air temperatures measured 5 cm above the ground level are also of importance. The annual air temperature measured 5 cm above the ground level in Ploče also shows a maximum recorded in July (16.6°C) and a minimum in January (1.0°C).

With wind, precipitaton represents the most variable meteorological element, both in terms of space and time. The precipitation pattern of a specific area depends on the geographic location of the observed area and general circulation of the atmosphere, and it can be modified by local characteristics, such as relief, distance from the sea or larger water surfaces, etc. In this Study, precipitation patterns are presented in terms of average monthly or maximum daily levels of precipitation, of a number of days with a specific daily precipitation level and analysis of the measured maximum daily precipitation levels.

At the Ploče weather station, in the period from 2005 to 2014, the average annual precipitation was 1220.4 mm. The maximum precipitation was recorded in 2010 with 1768.0 mm, whereas the minimum with 772.9 mm in 2011. Such differences in annual precipitation

amounts result from irregular frequent presence of frontal systems associated with cyclonic activity over the Atlantic Ocean and Gulf of Genoa.

For the purpose of design development, construction and use of every structure, and of systems aimed at collection and drainage of runoff waters in particular, knowing expected precipitation extremes is of particular importance. The calculation of expected precipitation extremes was carried out using the method of general extreme values distribution. The obtained results show that, in the average climate conditions in Ploče, it may be expected that the daily precipitation level of 105.5 mm is exceeded once in 10 years. The expected return period for daily precipitation level of 122.9 mm is 50 years.

At the location of the planned Bridge: mainland – Pelješac, a somewhat higher level of precipitation may be expected (see Zaninović et al., 2008, Climate atlas of Croatia), more precisely, on average 100-200 m more precipitation a year.

For the purpose of planning, design development, construction and use of the Bridge: mainland – Pelješac, knowing the distribution of wind direction and speed is of immense importance.

The wind patterns of a specific area are defined by its geographical location, distribution of general circulation system, impacts of the sea and hinterland, of part of the day and year, etc. Certainly, some locations are under the impact of other factors such as their exposure, concave or convex relief structures, elevation, etc.

The entire wider area of Ploče is characterized by wind of low speed, particularly in summer and winter when long-term steady states of atmosphere prevail. Therefore, the average 10-minute wind speed lower than 3 m/s (lower than Beaufort 3) blows through the year in 71.8% of measurement intervals, and speed higher than 9 m/s in only 0.4% of cases. The wind speed higher than 9 m/s (strong wind) occurs most frequently in winter, and least frequently in summer, which is reflected in the annual pattern of average monthly wind speed.

In the investigated period, the average 10-minute wind speed >9 m/s were recorded in Komarna in 8% of annual measurement intrvals, that is, in 14% in winter. The highest 10-minute wind speed of 22.4 m/s was measured for the wind in ESE direction in March 2009, whereas the strongest gust of wind of 33.2 m/s was measured in Komarna in July 2014.

The maximum 10-minute wind speeds measured year-round at Ploče weather station ranged between 11.5 m/s in 2014 and 15.0 m/s in 2008, and maximum present annual speeds range between 20.7 m/s in 2014 and 28.5 m/s in 2012. The highest speeds were measured for winds blowing from SSW and NNE directions. The maximum 10-minute wind speeds measured in Komarna in that same 10-year period was 22.4 m/s for wind in ESE direction, and the present speed is higher than 33 m/s measured for wind in NNE, ESE-SSE and W directions. Therefore, the maximum wind load for the planned structure can be expected in case of wind blowing from these directions.

On the basis of data recorded at the Ploče weather station, the measured reference speed of wind shows that the wider area of Ploče is located within the wind load zone 1 (V_o< 25 m/s). In contrast, Komarna and the entire area of the Bridge: mainland – Pelješac belongs to the wind load zone 3 (30 m/s < V_o< 35 m/s). The highest speed can be expected for wind blowing from ESE direction (jugo).

The maximum current wind speed (maximum gust), which may be expected to exceed once in 50 years on average, reach 41.7 m/s in Ploče for wind in SSE direction and 44.2 m/s in Komarna for wind in NNE direction.

In winter period, the increased cloud cover and relative air humidity indicate a possible occurrence of fog and mist in the area of the planned road. Due to that, visibility may be reduced along the future route, resulting in unfavorable driving conditions.

Adapting to climate change

The most important climate factors affecting the road infrastructure are average temperature and precipitation, and extreme values of these parameters. Since the Intervention is located in the coastal area, a bigger impact of increased levels of salinity, that is, the impact caused by spreading of particles generated by wind, on the road surfaces is possible. Extreme wind may exert impacts on the traffic safety aspects.

Anticipated climate changes within the intervention location

For the area of the Republic of Croatia, Meteorological and Hydrological Service has made climate change projections using regional climate (Meteorological and Hydrological Institute; Branković, Güttler, et al. 2010; Branković, Patarčić, et al. 2012). The planned Intervention is located in the Dubrovnik-Neretva County.

According to the results of these projections, at the intervention location, in the period by 2070, a statistically significant decline in precipitation is expected in summer periods, whereas a slight increase of no statistical importance is expected in winter periods.
The results of models show an increase in average temperature in all seasons, with growth amplitude larger in period 2040 to 2070 than in period by 2040. The increase in average daily temperature is higher in summer than in winter, and it is lower than 1.6°C in winter, that is lower than 3°C in summer for the period 2040 to 2070 at the intervention location.

In future, at the Adriatic coast, a considerable increase in number of hot days is expected (days with temperature higher than 30°C), and in some parts of Southern Croatia, the increase in number of hot days compared to the reference climate includes more than 20 days.

The average number of days with precipitation higher than 10 mm shall increase for most of the coastal Croatia in winter, whereas the number of days with such significant precipitation shall decline in summer.
Strengthening of wind and unstable weather in general is expected in Southern Croatia, which may affect the traffic safety aspects.
One of the consequences of the increase in average temperatures and decrease in precipitation is the increase in salinity of the Adriatic.

Taking into consideration the above mentioned changes of climate parameters which are expected within the intervention locations, the increased temperatures shall have a major impact on the road infrastructure. The increase in temperatures affects road surface characteristics, that is, it causes damage to asphalt. In addition, increased salinity may also result in road damage and bridge damage in particular. Therefore, as adaptation measures, projections of future temperatures should be considered while selecting asphalt and asphalt binder, since they can be anticipated with great certainty, as well as increased concentration of salt which shall be carried onto the road surfaces by wind. It is expected that the measures related to the use of asphalt and asphalt binders shall be regulated at the level of the European Union as well (Nemry and Demirel 2012).

2.5. Air quality

In view of air pollution levels, the territory of the Republic of Croatia is classified into zones and agglomerations (OG 001/2014). The zones refer to larger areas as counties, whereas the agglomerations refer to bigger cities (Zagreb, Split, Rijeka, etc.). The area within which the construction of the Bridge: mainland – Pelješac with access roads is planned is entirely located in the Dubrovnik-Neretva County (HR5).

According to the tables shown in the Study, the concentration of SO2, NO2, benzene and

Pb, As, Cd, Ni is below the lower limit values, whereas the concentration of PM10 is somewhat higher but still within the permissible levels, below estimated upper threshold.

There are no larger cities and sources of hazardous environmental pollutants in the vicinity of the Intervention. At the location of the HR5 zone, the existing problems are related to the traffic density (urban and sub-urban, railway, air and maritime traffic) which is higher during touris season. The Port of Ploče, also located relatively close to the planned Intervention, has an important role in the marine traffic of southern Dalmatia, Bosnia and Herzegovina, and Hungary, and the traffic density is also higher in that area. Due to the configuration of terrain, there is a possibility of the current channeling effect resulting from the environmental impacts of the city and Port of Ploče, as well as of the transboundary impacts due to immediate vicinity of BIH. In addition, marine and road traffic, whose density is expected to increase during the tourist season, may lead to the existing environmental impacts. Spreading of pollution is primarily influenced by coastal circulation which a year-round dominant circulation, except in colder part of the year when more extreme wind speed occurs from NE direction (bora) and from W direction (WSW) (jugo) during summer.

According to the Report on Air Quality for 2013, within the zone fo HR5 agglomeration, on the basis of model values for pollutants as SO2, NO2, and concentration of Ni, Cd, As B(a)P in PM10 particles, the quality of air is in compliance with environmental protection objectives set out in Directive 2008/50/EC and 2004/107/EC. At the stations measuring air pollution within the area of Dubrovnik-Neretva County (Opuzen, Hum and Žarkovica), in view of O3, the assessed category of air was II, and in view of total disposed sediment (UTT), and UTT specific constituents (Pb, Cd, Ni, Tl, As and Hg), the air quality was assessed as bio I category.

GHG emissions from traffic

On the basis of the Feasibility Study, for measuring of the GHG emissions from moveable sources of air pollution, the following traffic loads have been used:

In 2046, on the Pelješac Bridge, the average annual daily traffic (AADT) is 15.305 vehicle/day in Alternative (1), where D414 on Pelješac is designed as a 4-lane road, that is, 13.081 vehicle/day (2) if the access road and D414 are designed as a 2-lane route. The percentage of goods vehicles is 8%, of which only 5% of heavy goods vehicles (BUS included).

The methodology of 2012 Guidelines to Defra / DECC's GHG Conversion Factors for Company Reporting was used for measuring.

Based on the mentioned data, loads for each vehicle type for AADT and average summer daily traffic (ASDT) for both alternative solutions were calculated, regarding the length of

each as well.

Furthermore, average fuel consumption was considered in relation to the type of transport (passenger car, goods vehicle and heavy goods vehicle) per 100 km.

According to the methodology of 2012 Guidelines to Defra / DECC's GHG Conversion Factors, specific parameters were taken for measuring the greenhouse gas emissions. So, the measurements were carried out based on fuel consumption per route section and on the number of kilometers for AADT and ASDT for the two alternative solutions.

The obtained results of GHG emission measuring show that the lowest level of GHG emissions is produced in case of the alternative solution with two traffic lanes.

2.6. Soil and agricultural land

At the zone of impact of the planned Intervention (300 m, that is, 150 m left and right of the road axis), forest vegetation prevails with 68.56%, followed by 9.08% of agricultural surfaces, 14.70% of water surface, 7.04% of artificial (urbanized) surfaces, and 0.62% of natural vegetation.

In the category of agricultural land, there are agricultural surfaces (olive groves dominant) with a significant percentage of natural vegetation (31.24%), olive groves (25.58%), agricultural surfaces with a significant percentage of natural vegetation (15.02%), patchwork of various agricultural use with olive groves prevailing (11.30%), patchwork of various agricultural use with vineyards prevailing (6.77%), vineyards (5.39%), neglected agricultural surfaces (4.13%), and arable agricultural surfaces (0.59 %). The forest vegetation is dominated by maquis (72.04%), garrigues (13.09 %), coniferous forests (10.09%) and transitional area of maquis and forests (4.78%). There is a 7.04% of artificial (urbanized) surfaces.

The area of impact of the planned Intervention covers the area, that is, pedosystematic units in which the main pedogenetic properties are result of relief impacts. Among automorphic soils, there are rendzina on dolomite (37.20%), limestone dolomitic chernozem leptosols (32.27%), calcocambisol on limestone (11.85%) and (9.00%), and anthropogenous soil of flysch and karst syncline and colluvium (9.68%).

In view of the land quality, that is, agricultural productivity of the land, the dominant category consists of other agricultural land, forests and forest lands with 70.69%, and other arable land with 7.58%.

With regards to the soil, the major negative impacts expected are related to the period of construction works, when permanent or temporary change of use shall occur. Maneuvering of machinery over surfaces where they are handled shall lead to a temporary change in the use of soil and to soil damage. The temporary change in the use of soil shall cover roughly 178.83 ha of land, of which roughly 49.11 ha of land shall suffer permanent change in use, in particular within the construction works zone, where this may be caused by careless use and handling of equipment and machinery. Among liquids there may be: fuel (gas and diesel), motor oils, anti-icing agents, liguids for cooling systems, etc. Provided that constructions works are carried out in compliance with the relevant legislation, no additional negative impacts are expected.

There is a less likely possibility of impacts on the soil and agricultural land during the use of the road than in the process of soil preparation works and construction works. The morphological changes of the soil caused by cutting and filling, and similar construction works in the process of constructing the road shall be rehabilitated and restored to their original state.

2.7. Forest ecosystems and forestry

In terms of vegetation, the forests of the investigated zone of impact belong to the region of the Mediterranean forests, Mediterranean littoral vegetation belt. The distribution of forest communities is influenced primarily by lithological base, soil and relief, so the following forest communities are present:

As. *Fraxino orni-Quercetum ilicis* Horvatić (1956) 1958 – Mixed holm oak forest and maquis with manna ash
As. *Quercetum ilicis-virgilianae* Trinajstić 1983 – Mixed holm oak and English oak forests
As. *Myrto-Quercetum ilicis* (Horvatić 1963) Trinajstić 1985 – Pure evergreen holm oak forests and maquis with myrtle
As. *Pistacio-Juniperetum phoeniceae* Trinajstić 1987 – Maquis of mastic and Phoenician juniper

As. *Querco ilicis-Pinetum halepensis* Loisel 1971 – Mixed Aleppo pine and holm oak forest

The forests within the planned intervention area are partly state-owned and partly private. The state-owned forests are under the jurisdiction of Croatian Forests, Forest Management branch office of Split, forest management authorities of Metković and Dubrovnik.

In accordance with the last amendments to the Forest Act (OG 140/05, 82/06, 129/08, 80/10, 124/10, 25/12, 68/12, 148/13, 94/14) and Advisory Service Act (OG 148/13), the private forests and forest owners are within the jurisdiction of legal and advisory assistance of officers working for Adivsory services within counties. For the investigated intervention area, this role is performed by the Dubrovnik-Neretva County.

The total surface and ownership structure of the forests in the investigated zone of impact (100 m) and construction area (30 m) can be seen in Table 1.

Table 1 *Ownership structure of the forests in the zone of impact (100 m) and construction zone (30 m)*

Ownership structure	Zone of impact (100 m)		Construction area (30 m)	
	ha	%	ha	%
Commercial property of Česvinica	56.87	48.03	10.30	37.52
Commercial property of Slivno	4.42	3.73	1.03	3.74
State forests in totoal	61.29	51.76	11.32	41.25
Commercial property of Kuna Pelješka - Broće	44.77	37.81	12.40	45.17
Private forests - neglected	12.34	10.42	3.73	13.57
Private forests in totoal	57.11	48.23	16.13	58.74
Forests in totoal	118.40	100.00	27.45	100.00

Shrubland surfaces (maquis and garrigues) of poor spacing cover 90% of the investigated Project area, therefore, the economic value of the forests within the proposed route area is very low. As a result, the negative impact on forests and forestry is acceptable.
The impacts on forests and forestry during the execution of any construction works

(earthworks) are primarily reflected in a permanent loss of forest areas resulting from a direct occupation of forest and agriculturally productive areas.
Based on the calculated data, an area of 27.45 ha of forests and forest lands shall be lost as a consequence of the direct occupation. The total value of beneficial functions of forests is 6.988.385.40 points, of which 11.32 ha and 2.775.256.40 points belong to state forests and 16.13 ha and 4.213.129.00 points to the private forests.

Even if the economic value of forests within the investigated area is low, their beneficial functions are very valuable as they are partly located within the area of Special Nature Reserve of Malostonski Bay.

Negative impacts may occur during the execution of construction works, and these refer to occupying a larger surface than what has been planned, to the fragmentation of forest ecosystems (leaving small/narrow surface areas of forest stands after the laying out of the route), damaging forest edges with heavy machinery, opening new forest edges within the construction area, appearance of forest pests and diseases caused by abandoned cut down timber, and accidents that may occur during the execution of construction works and generate environmental pollution.

2.8. Economic activities

Taking into consideration the current socio-economic structure of the population, with an increase in the transport of vehicles, goods and persons, all areas that have so far been marginalized and poorly connected to the main road D414 Orebić-Ston will most probably undergo a transformation in terms of the existing business conditions and of creating opportunities for the development of new activities. Primarily, the stimulation of the following activities may be expected:
In accordance with the spatial planning documentation, **the main determinants of the economic development** shall continue to be the tourist industry, agriculture and the use of sea waters for the economic and transport purposes.
In future, the economic development will be oriented towards winegrowing, olive growing, then towards fishing and mariculture, hospitality and tourist industry, shipping, road and marine transport, and, in terms of ecology, a perfect production.

The construction of the Bridge and the access roads shall result in shortening of the travelling route in terms of time and space, and, consequently, it shall contribute to the achievement of the above mentioned objectives, being reflected thorugh the following activites:

Tourist industry:

The construction of the Bridge shall shorten travel in terms of its duration, and it shall also offer a higher standard of travelling comfort for both through traffic to Ston, Dubrovnik, and Orebić (Korčula and further on), and for local population commuting to the mainland.

Direct and indirect consequences of this shall be:

Increased development of the tourist industry activities thorugh a rise in number of hotels and apartment accommodation, that is, through the activation (change in use, construction and boosting) of lodging capacities by the existing local population, but also through an increase in the presence of potential investors;

Revitalization of the existing settlements (smaller, mainly abandoned) and creation of new (tourist) settlements and zones of the construction of weekend vacation settlements on Pelješac;

Development of new tourist capacities (lodging, but even longer-term offers for tourists – apartments, etc.), and various hospitality industry contents (restaurants, bars)

Service sector:

Increase in number of new working places, particularly in the tourist and hospitality industry, and in the service sector, an increase of the employment rate in relation to the local population, primarily in hospitality industry and providing various services (service, shops, workshops, etc.);
Most probably, an increase in land prices (weekend vacation construction).

Public services:

Expansion (construction) of the existing sewer and water supply network in the surroundings, more efficient provision of municipal utilities for new or revitalized tourist structures and zones, a need to expand the network of local routes and increase the level of accessibility of surrounding settlements, better accessibility of Mljet.

Agriculture and mariculture:

Increase in and improvement of traditional activities in the zone of impact – agriculture productivity and fishing (mariculture), resulting from better accessibility and increased transport of goods and persons. The rehabilitation of agricultural surfaces (planting new vineyards, olive groves, orchards, etc.), rehabilitation of livestock breeding, family farming and promotion of doorstep sale are expected.

Hunting:

In accordance with the Hunting Act, the designated hunting grounds are XIX/8 - Slivno Metković, XIX/114 – Kuna and XIX/115 Ston. Taking into consideration the cpnditions of game habitats, and pursuant to the Ordinance on contents and methods of development and approval of hunting management programmes, game rearing and game protection programmes, the hunting grounds belong to the Mediterranean type (including Eu-mediterranean and sub-mediterranean zone).

Among secondary and permanently protected game species of this area, there are jackal, badger, wildcat, marten, fox, sandpipers, Eurasian jay, etc.

2.9. Biological diversity

In the course of describing the biological diversity and assessment of impacts, the following zones of the intervention impact have been defined:

1. Narrow zone of the intervention impact includes:
    a. area within the scope of the Intervention, that is, the zone of direct and strongest impact in terms of permanent loss of the surface areas of the existing habitats (pavement surface of the access roads, road structures, other roads and tranffic surfaces, drainage system, slopes, cuttings and embankments, surface areas of habitats that shall be permanently lost as the result of bridge foundation works);
    b. estimated zone of the construction site which stretches on the mainland up to 30 m from each side of the axis of the planned route of access roads; this area includes machinery handling surfaces necessary during the execution of construction works and represents a zone of potential temporary and limited

impacts on the surrounding habitats;

2. Wider zone of the intervention impact includes:
    a. on the mainland, the estimated zone of up to 200 m from each side of the axis of the planned route of access roads and road structures, including:
        i. temporary construction site areas which are outside of the scope of of the Intervention and which should be rehabilitated upon completion of the construction works (including the present condition of the construction site area);
        ii. during the execution of construction works and traffic flows along the longest section route, the expected zone of a more significant noise impact and other impacts as road pollution.

Land habitats

Noticeable impacts on the land habitats result from the construction of the access roads and road structurs (junctions, service areas, control and traffic management centers, viaducts, bridges and underpasses). Within the wider project area, the dominant land habitats are holm oak maquis, garrigues (shrub land) and eumediterranean rocky pastures. A permanent loss of the existing habitats is expected within the investigated area, whereas a temporary loss and temporary change of the habitat conditions are expected within the construction site area. A greater loss of the existing natural habitats is expected within the Pelješac area, resulting from the planned construction of a longer road section. Compared to their total surface area within the zone of wider project impact, a relatively small surface area of land habitats shall suffer permanent loss. Therefore, this impact is assessed acceptable. In addition, the impact on habitats within the zone of the estimated construction site area is temporary, since the rehabilitation of vegetation is expected upon the completion of construction works.

The execution of construction works within karst area may lead to finds of speleological structures, which may result in a negative impact on underground habitats. The implementation of proposed protection measures may prevent or mitigate the negative impact on the underground habitats.

The execution of construction works leads to damaging habitats, and, consequently, to invasion and spreading of allochthonous, invasive and/or ruderal plant species. Within the area of degraded surfaces that have not been rehabilitated, the foreign invasive species may establish viable populations and invade the surrounding habitats, thus exerting a long-term negative impact on the open habitats, as grasslands and garrigues. In order to prevent the appearance of invasive species and/or their spreading within the area of the estimated construction site, their spreading should be monitored in collaboration with an expert (biologist-ecologist), and eventually removed.

The habitat impacts occurring during the use are a consequence of traffic flows, and they are reflected in the changes in soil and vegetation, primarily caused by road pollution. The scope of these impacts depends on the distance from the road and the topography of the surrounding area, whereas the magnitude of impacts depends on the road type and intensity of traffic flows. However, the execution of side-hill cuts and through cuts and the presence of shrub vegetation adjacent to the road shall reduce the area of spreading and deposition of pollutants. Due to developed topography of the surrounding area and presence of shrub vegetation, the impact shall be limited to the marginal strip, and the proposed closed drainage system shall contribute to minimizing adverse impacts on the soil and underground waters. Therefore, it is expected that the condition of rehabilitated vegetation and habitat types within the estimated construction site area shall be similar to their original condition.

Biocenoses – flora and fauna

During the execution of construction works, the potential negative impact on endangered and strictly protected plant species results from the changes in vegetation and habitats related to those species. Taking into consideration a small surface area of favorable habitats of endangered and strictly protected plant species found within the wider zone of the intervention impact, the impact of the construction of the planned road is assessed acceptable and without any negative impacts on the population of the mentioned species within the wider zone of impacts, provided that proposed protection measures are implemented. During the use, the potential impacts on flora result from the pollution of air, surrounding soil and underground waters due to the traffic flows. As these impacts are limited to area adjacent to the route, and as the proposed road drainage system is a closed one, they are assessed acceptable.

The potential impacts on fauna are reflected in a permanent loss of favorable habitats, disruption during the execution of construction works, and disruption and damage to certain species during the use. The loss of forest habitats and maquis, as well as of small surface areas of grass habitats within the section of the route located at the Pelješac peninsula is expected. The expected permanent loss of favorable habitats is relatively small in relation to the surface area of favorable habitats within the wider zone of project impact, and, as a result, it shall not affect the condition and spread of the population of animal species to a large extent. Disruption caused during the execution of construction works is the result of increased levels of noise, vibrations and emissions of dust particles. The maximum extent is that of the noise impact which may have a more significant negative impact on certain sensitive species. By avoiding the execution of construction works within the period of breeding season of birds and periods when other animal species are more active, the negative impact on fauna during the construction works can be alleviated. The predicted impacts on fauna during the use of the planned Interventio refer to a change in quality of favorable habitats within the adjacent road area, to roadkill, and potential habitat fragmentation. The expected increase in the traffic density on the planned route is considerably high and it may present an obstacle for animal species where the road passes through the territory where they live. The construction of planned road structures (tunnels, bridges, viaducts) shall minimize roadkill and potential fragmentation of favorable habitats. The road mortality of small animal species (mammals, reptiles) may be decreased by adjusting the culverts of external road drainage system so that they can be used by small animals. Killing of birds, which may result from collisions with windbreaks, may also be minimized provided that the windbreaks are adequately designed so the birds can notice them easily. Due to emissions of noise and particles of dust and soot, the traffic flows lead to changes in habitat conditions along the route. Since this route adjacent area is relatively narrow, consisting of a relatively small surface area of favorable habitats, this impact is not considered significant. Setting of public lighting along the access roads is also predicted by the Intervention, which may result in an increase in the level of light pollution, and consequently, in a risk for bats. By designing road lighting in accordance with the Act on protection from light pollution (OG 114/11) and using low-pressure sodium light bulbs, the mentioned impacts can be minimized or prevented.

Protected areas pursuant to the Nature Protection Act

The route of the planned Project, Bridge: mainland – Pelješac with access roads passes through a protected area - Special Reserve at Sea, Malostonski zaljev. The proposed Intervention passes through this area in a length of roughly 10 km (from chainage 0+020 to 10+044 km). In addition, there are other protected areas of different categories at a larger distance from the planned route:

- Special Reserve of ichtiological-ornithological importance – Delta Neretve – jugoistočni dio, located roughly 6.5 km northwest of the planned route;

- Significant Landscape **-** Uvala Vučina, located roughly 6.5 km southwest of the planned route;
- Significant Landscape – Uvala Prapratno, located roughly 8.8 km southeast of the planned route.

Because of its spatial distance and characteristics of the planned intervention, the possibility of impact on the protected areas of Special Reserve of ichtiological-ornithological importance – Delta Neretve – jugoistočni dio, Significant Landscape **-** Uvala Vučina, and Significant Landscape – Uvala Prapratno, as listed in the appendix, is excluded.

The protected area of Special Reserve, Malostonski Bay, encompasses the entire maritime environment southeast of Sreser-Duba line and the surrounding belt of the Malostonski Bay. The ecological conditions in the bay are mostly influenced by the impacts of the mainland, and, to a lesser extent, by the impacts of the open sea. The outer and middle parts of the Bay are occasionally strongly influenced by the inflow of freshwater of River Neretva, whereas the inner part is slightly influenced by this. That influence is particularly felt during the periods of high water level and stronger west winds. Strong underwater springs of freshwater located in the inner part of the bay most significantly affect the hydro-physical and ecological relationships in the bay. The ingress of organic matter coming from land (runoff waters and, in particular, submarine springs) is of great importance for the ecological and productivity relationships. The purpose of protecting this area is to preserve and extend the tradition of mariculture typical of this area. Because of high primary productivity and hydrographic characteristics of the bay, the tradition of seashell farming dates back to ancient times. Nowadays, this part of Croatia is of major importance in the context of mariculture.

Protected areas or proposed protected areas pursuant to the relevant spatial and planning documentation, and landscape features

In accordance with Spatial Plan of the Dubrovnik–Neretva County, proposed protected areas within the wider intervention area are as follows:

- Nature Park – Neretva Delta – the Intervention is located within the proposed protection area in a length of roughly 2.1 km (chainage 0+020 - 2+138 km);
- Significant Landscape **-** Waters of coves of Žuljana, Vučina and Kupinova on Pelješac – extension – the area is located roughly 6.5 km southwest of the planned route;
- Special Reserve of ichtiological-ornithological importance – the mouth of River Neretva – extension - the area is located roughly 8.6 km northwest of the planned route.

Because of its spatial distance and characteristics of the planned intervention, the possibility of impact on the proposed protection areas of Significant Landscape **-** Waters of coves of Žuljana, Vučina and Kupinova on Pelješac – extension and Special Reserve of ichtiological-ornithological importance - the mouth of River Neretva – extension is excluded.

Ecological network

The Ministry of Environmental and Nature Protection has issued a Decision (Class: UP/I 612-07/14-60/72, Reg.no: 517-07-1-1-2-14-4, of 11 July 2014) explaining that the possibility of significant impacts of the construction intervention of Bridge: mainland – Pelješac with access roads on conservation objectives and integrity of the ecological network cannot

be excluded, and stating the need to carry out the Main acceptability assessment for the following areas of ecological network: HR1000031 Delta Neretve, HR1000036 Srednjedalmatinski otoci i Pelješac, HR2001364 JI dio Pelješca and HR5000031 Delta Neretve, through which the planned route passes.

The identified negative impacts of the construction and use of the Intervention are mainly related to the permanent losses and change in quality of target habitats during the construction works and to habitat fragmentation, disruption and damage to the target animal species during the use of the bridge and access roads. A loss of relatively small surface areas of widespread habitats of maquis, garrigues and rocky pastures is expected, where the impact on target habitats has been assessed acceptable. The permanent loss of habitats in the process of construction shall result in unfavorable impact on the target species typical of the mentioned favorable habitats. This shall be a loss of small surface areas of favorable habitats, and this impact may further alleviated provided that the construction works are carried out before and after the period of breeding season and periods when target animal species are most active. Furthermore, during the construction works, a short-term impact on the change in habitat conditions is possible in the process of bridge foundation works. Due to the re-suspension of sediment, turbidity of the water column and covering of the benthic communities with sediment may occur. As Malostonski bay is under the influence of sediment being carried by River Neretva, occasional turbidity and depositionhappen as natural phenomena. Since the impact of sediment re-suspension is time-limited and does not present a significant deviation from what is considered a natural phenomenon, this impact is deemed negligible. The adverse impacts during the use of the Intervention are the result of the anticipated increase in traffic density and they primarily refer to the target species of reptiles and birds. By constructing the adequate road structures and adjusting the culverts of external drainage system, the impacts of fragmentation and roadkill of target species of reptiles may be minimized to the acceptable extent. Killing of birds is possible during flying over the road or feeding in case of birds of prey. Noticeable impact on the population of bird target species is not expected because of a small surface area of favorable habitats within the wider zone of impacts. In addition, the impact of roadkill of birds may be mitigated by ensuring shrub vegetation along the edge of the road, constructing access roads in side-hill cuts, and by regular removal of carcass from the area of the road corridor.

By analyzing individual and cumulative impacts of the construction of the Bridge: mainland – Pelješac with access roads on the conservation objectives and the integrity of ecological network, it may be concluded that the Intervention is acceptable provided that the mitigation measures for ecological network amd environmental protection measures as proposed by the Environmental Impact Assessment Study are implemented.

2.10. Cultural and historical heritage

From km 14+400, the route of the access roads and the Bridge: mainland - Pelješac passes through the areas of Komarna, Duboka, over Mali Ston Channel to Brijesta, Dančanje and Zaradeže on the Pelješac peninsula.

Among cultural and historical values within the zone of construction work impacts in these areas, the following structures have been indentified:

- *Archaeological localities:* listed separately as archaeological finds, but due to their density, the area of Brijesta settlement may be treated as an archaeological zone
- *Rural zones:* individual structures of cultural and historical values:
    - *sacral structures*
    - *defensive structures -fortifications*

- *Memorial cultural heritage*

1. Archaeological localities

This area is characterized by prehistoric sites – hillforts and tumuli, located on high hills and dominating the surrounding landscape. A concentration of classical antiquity material finds has been reported around the Church of St. Liborius in Brijesta, indicating an economic and residential complex (villa rustica). None of the sites has been systematically researched.

The following localities are mentioned:

- *Villa rustica, Brijesta, classical antiquity – Rome*
- *Jegulje, Brijesta, tumuli – prehistoric era*
- *Gradac-Na Grac, Bogičevići, hillfort - prehistoric era*
- *Mali Gradac, Dančanje, hillfort – prehistoric era*
- *Gradac-Na Grac, Bogičevići, hillfort – prehistoric era*
- *Mali Gradac, Dančanje, hillfort – prehistoric era*
- *Veliki Gradac, Dančanje, tumuli – prehistoric era*
- *Ždrijelo, tumuli – prehistoric era*

2. Sacral monuments are as follows:

- *Church of St. Liborius with cemetary, Brijesta, Baroque*
- *Church of St. Michael with cemetary, Dančanje, Medieval*

3. Rural zones

The rural settlements on Pelješac are medieval settlements, among which some (Brijesta) have a tradition dating back to the classical antiquity. These settlements are examples of the settlements of planned construction performed by the Republic of Ragusa (Dubrovnik) in the Pelješac area.

Their urban development concept and construction features represent highly valuable cultural heritage.

- *Brijesta – rural zone*
- *Dančanje - rural zone*
- *Zaradeže - rural zone*

4. Fortifications

The construction of fortifications is related to restless periods of the Middle Ages. These fortifications occur as standalone structures at strategically important high-hill locations, or they surround rural settlements, thus providing the population with adequate protection.

- *Glavica, Austrian fortification, 19th cent.*
- *Kula Kabužić, Brijesta, 16th cent.*

5. Memorial cultural heritage

- *Duboka – monument (memorial structure), 20. cent.*

2.11. Landscape

Area of Slivno Ravno (from chainage ≈0+200 to ≈2+300)and bridge over Malostonski Channel (from chainage ≈2+300 to ≈4+500)

Within the investigated area, the route is in a dynamic relief. At the locations where the route runs along slopes, that is, where it continues along a cut in Brijega slope, a more significant change in the natural morphology of the terrain shall occur by forming side-hill cuts and through cuts. That is where the route shall bring about most unfavorable change. In view of the changes in use of the surfaces, within a 1000 m-long area, where the route diverges from the existing D8 state road, it passes along an area of olive groves. The construction of the future route of access road shall result in an irreversible loss of one of the basic elements of the southern littoral landscape – fragmented, terraced agriculturally productive areas containing olive groves, since these areas shall be directly occupied by the roadbed. As the route continues, a part of the preserved natural landscape on the Cape Međed shall be lost for the purpose of constructing the access road to the Pelješac Bridge. After the route crosses the D8 state road via an overpass, it approaches the coast further away from the coastal strip, thus reducing the visual exposure of the route to a significant extent both from the land and from the sea. The visibility of the route shall be higher at the location where Duboka junction (chainage cca ≈0+500) shall be constructed over the settlement of Komarna. Continuing further along a platform terrain between Glavica and the Cape Međed, the route approaches the coast to reach the bridge to the Pelješac Peninsula. The bridge spanning the Malostonski Channel, as a structure of prominent physical characteristics and increased social importance, shall have an extremely high impact on visual and perceptive component of the landscape of the Malostonski Channel area of the sea and wider coastal area.

Area of south coast - Malostonski Channel (from chainage ≈4+500to ≈5+300)

Within the investigated area, the route is in a terrain requiring minimum changes in the natural morphology of the terrain during the construction works. To the largest extent, this terrain is comprised of vegetation cover including degraded forest vegetation and, partly, terraced agriculturally productive areas of olive groves. The section of the route within this area is shortest, being only 800 m long, so no significant landscape impacts are expected here due to relatively minor terrain alterations. However, a part of the preserved natural landscape shall be lost even within this area due to the construction of access road to the Pelješac Bridge. The change in the visual perception of the landscape, that is, the visual exposure of the route within the investigated area, shall not be significant, because of the length of this section (only 800 m) and sparse population inhabiting this area. Nonetheless, the planned Intervention shall affect the visual component and experience of this area in terms of the construction of the Pelješac Bridge, being a structure of large dimensions and visual exposure from the Pelješac coast.

Area of Brijesta (from chainage ≈5+300 to ≈12+400)

The Pelješac landscape is greatly different from the mainland landscape along which the route passes. The coastal area to the settlement of Brijesta is essentially natural landscape, followed by alternations of cultivated and natural landscape in the interior of Pelješac. In the area up to the 6th kilometer, that is, to the settlement of Brijesta, no significant impact on the landscape is expected due to relatively low relief dynamics and minor terrain

alterations, especially if landscape protection measures are implemented. The impact of the access road shall be greater between the settlement of Brijesta, Dumanja Jaruga, and tunnel portal, as the route passes from the terrain of favorable relief to more indented slopes uphill from Brijesta. In the area of Brijesta, there shall be a more significant visual impact due to the visual exposure of southern slopes of the coastal range from the very settlement of Brijesta and from the local road (L69030). Landscaping of the road adjacent area shall be of crucial importance in this part of the route, in order to ensure that the new infrastructure and the existing landscpate are perfeclty blended together, thus preserving the traditional cultural, historical and landscape heritage of the Pelješac hinterland. The intervention impact shall be more significant at the location where the route passes over the Doli viaduct at chainage ≈8+000 and two bridges (9+300 to chainage ≈9+750, and at the chainage ≈9+900 to the chainage ≈10+000), due to alterations of the physical structure of relief, which shall result in a higher visibility of the route.

Area of Dančanje (from chainage ≈12+400 to chainage ≈14+400)

From Dumanja Jaruga the route is again in a natural landscape and, to a large extent, it passes through a tunnel (L= 2170 m), thus minimizing its impact on the landscape. After leaving the tunnel downhill of the settlement of Dančanje and running to the D8 road junction, the landscape again starts to display characteristics of cultivated land. After leaving the tunnel, the route passes along a platform terrain between the existing road and the small hill of Mali Gradac to cross over the only two remaining small agglomerations of productive plots. Passing of the route and constructing the second junctions shall directly affect one part of agriculturally productive land, whereas, indirectly, this shall potentially lead to a change in use of land, loss of interest in further land cultivation and to the process of ecological succession. The visual exposure of the route within the investigated area shall be reduced to a great extent and this impact is considered largely negligible, because of scarse population inhabiting this area and the way in which the route passes through this area. Within this area, the longest section of the route is in a tunnel, ensuring efficient blending of the route with the surrounding landscape.

2.12. Noise

During the construction of the planned route, additional noise shall be emitted into the landscape produced by construction works. This noise is temporary and it shall cease once the construction works are completed, and, provided that the rules of good practice are obeyed, there should not be any negative impacts of noise on the surrounding inhabited areas. The calculation of the level of noise along the planned route was made on the basis of the anticipated average summer daily traffic (ASDT) in 2046, because this is when the highest traffic load is expected. Since the route is located in the immediate vicinity of the inhabited areas with the existing surrounding road infrastructure, the levels of noise being emitted around inhabited structures have been analyzed pursuan to Article 7 of the Regulation on maximum permissible noise levels in areas where people work and live (OG 145/04). Therefore, the night levels of noise have been applied as the criterion of exposure to noise which, in accordance with the mentioned Regulation, must not exceed the equivalent level of noise of 50 dB(A). On the basis of this calculation, it was determined that the planned route passes along four settlements (Komarina, Duboka, Brijesta and G. Selo) at such a distance that, without adequate noise protection measures, the structures of these settlements that are closest to the route would be exposed to the levels of noise exceeding the permissible levels, as set out in the mentioned Regulation. Therefore, in further phases of project development, a noise protection project shall be carried out for these locations. It should be mentioned that two stand-alone structure of the settlement of Komarina (M1 and M2) cannot be protected by means of barriers. Furthermore, control

measurements of noise shall be performed, determining the real condition before and after the protective barriers are installed, and consequently, the construction phase of barriers shall be defined according to the measurement results. The construction of future civil engineering objects shall be performed in compliance with the enclosed Map of noise levels so as to avoid exceeding permissible levels of noise within the corresponding locations.

2.13. Hunting

During the execution of construction works (laying out of the route, reconnaissance of terrain, construction works, etc.), there shall be a temporary impact of movement/noise that may disrupt game animals if the mentioned works are performed during breeding seasons.

The execution of bridge construction works, that is, construction works of access roads, there shall be a temporary adverse impact on the game inhabiting the area through which the future route shall pass, as the mentioned works shall result in disruption and migration of game. Noise produced by and maneuvering of the heavy machinery and other construction vehicles, as well as moving of people, shall disrupt game if the mentioned works are performed during breeding seasons. Therefore, the mentioned works shall be conducted in accordance with the Hunting Act, ensuring peace within the hunting area while females of furbearing game are in the final stage of gestation period or while they are nursing their cubs and birds (while brooding, feeding hatchling).

Furthermore, the leaseholders may also suffer sustainable damage during the construction works, resulting from an increase in damage caused to agriculture, forestry, game and hunting tourist industry. The leaseholders shall be informed about periods when construction works are planned to be carried out within their hunting grounds, and compensation shall be determined for hunting management facilities and hunting structures that shall potentially be removed or relocated.

The construction of the planned Intervention shall result in increased fragmentation of habitats, which shall consequently lead to separation of parts of population within a certain species. This shall affect the migraton patters of game necessary to meet their essential life needs. Therefore, the construction of Bridge may lead to an increase in roadkill as game try to cross from one side of the road to another.

The traffic flows of the future route shall exert an impact on game even after the construction works are completed, and a certain amount of time shall have to pass after the construction of the Intervention until normal relationships between habitats and game inhabiting these habitats are established.

2.14. Oceanological and archaeological properties of the submarine environment

The key objectives of the previously published research works were to define oceanological and archaeological properties of the submarine environment within the wider area of the Bridge: mainland – Pelješac.

Wave measurements conducted in the waters in front of the Port of Ploče were used for the expert assessment of surface wave elements caused by winds within the planned route of the future Bridge.

Field research works were performed from i/b Hidra vessel of the Hydrographic Institute of the Republic of Croatia, from 29 March to 4 April 2004.

The research area has been defined and the following properties of the sea have been analyzed:

Physical properties of the sea (temperature, salinity, density of the sea, transparency and color of the sea)

The measurements of thermohaline properties of the waters within the route of the Pelješac Bridge in late March and late April 2004 indicate a great influence of River Neretva on the distribution of temperature, salinity and density. As precipitation levels in the catchment of River Neretva were rather high during January and February, the discharge was increased in March, thus causing strong halocline in a layer of up to 5 m deep. In late March, the temperature maximum was found in the intermediate layer, and the distribution of density was predominantly influenced by salinity, with a strong pycnocline near surface. During April, significant changes occurred in the vertical distribution of temperature and salinity, a seasonal thermocline started to develop, and the salinity near surface increased, thus reducing vertical density gradient as well. A strong stratification continued to be observed due to low salinity and density in the the layer of up to 5 m deep. The parameters indicating the transparency and color of the sea confirm the strong impact exerted by River Neretva, which reduces transparency and causes turbidity of the water column.

Dynamics of the sea (sea currents, surface waves caused by wind)

In April, the current patterns were predominantly characterized by a coastal current component.

The most frequent directions were NW and SE, and in periods of strong northwest currents in the surface layer, the benthic layer exhibited a compensating predominant SE current. The maximum surface layer current velocity was about 55 cm/s, while the benthic layer current reached about 25 cm/s. The current energies were distributed in periods longer than a day, tidal oscillations were weak, and it is interesting that oscillations of a period about 2 hours long were recorded, representing the basic mode of standing waves in the area bounded by the Malostonski Channel and Malo More.

It should be noted that on 27 June 2003 a tidal wave affected one part of the Malostonski Channel, thus causing great damage to shellfish mariculture and corresponding production facilities. Based on the meteorological measurements, elevation and sea level, the maximum sea current velocities (vertically averaged) at the bridge locaton were estimated using a 2D hydrodynamic numerical model at about 120 cm/s. An expert assessment method was applied to determine the maximum and significant wave heights within the area of the planned route of the Pelješac Bridge. The maximum height of 4 m and the significant height of 2.7 m were estimated for NW wind, whereas the maximum height of 4.5 m and the significant height of 3 m were estimated for WNW wind, while 4.2 m is the maximum height and 2.8 m is the significant height of waves estimated for SE wind.

Based on the measurements conducted in the Split mareographic station, the total range of sea level oscillation in the investigated area is 153 cm, whereas the average diurnal sea level oscillation is 23 cm. In addition, it should be pointed out that a rapid change of meteorological parameters may cause generation of seiches with a period of about 2 hours.

Chemical parameters

In April, the distribution of nutrient salts in the water column also indicates higher values in the surface layer than in the intermediate and benthic layers.

Comparing the oxygen saturation levels and nutrient salts concentration levels measured in March and April 2004, it may be concluded that higher values were measured in March. The maximum values were measured in the surface layer during both of the measurements. The specified changes of the nutrient salts concentrations and oxygen saturation levels in the entire water column lead to a conclusion that the investigated sea area is greatly affected by River Neretva as well as by agricultural land located along the river.

Biological parameters (investigation of heterotrophic bacteria, phytoplankton, and composition and distribution of benthic vegetation and biocenoses)

The investigated area exhibits heterotrophic bacteria densities in a range of 105 to 106 cells ml-1, leading to a conclusion that the sea in the investigated area is a moderately eutrophic area, which is characteristic to the Croatian coastal waters of the Adriatic Sea.

The qualitative composition and structure of the phytoplankton association, as phytoplankton biomass, contribute to the conclusion that the area is naturally rich and well preserved, and that it needs to be further protected against any threat to this unique ecosystem of the Adriatic Sea. Namely, shellfish and fish mariculture facilities are located in the immediate vicinity of the intervention area, and there are more than fifty shellfish production facilities within the wider intervention area (entire Malostonski Bay). Since the shellfish largely feed on phytoplankton, any change in phytoplankton community would have an adverse impact on the shellfish production through food chains. Turbidity of seawater that may occur during construction of the Bridge would have a negative impact on the entire primary production process, and it would definitely result in changes of relationships between groups and species within the phytoplankton community. Furthermore, excess ingress of nutrients from the seafbed into the water column (excavation works and removal of silt) may cause red tides, as well as increased blooming of toxic dinoflagellates, thus bringing the shellfish production to a halt.

The zooplankton community in the Malostonski Bay is exceptionally abundant and specific in relation to the other coastal areas of eastern Adriatic Sea. The relationships within zooplankton community are very complex and affected by numerous factors. Great diversity and course of natural processes in the zooplankton community and in the entire ecosystem of the bay exist because a natural, undisrupted relationship between the bay seabed and pelagic zone above the seabed is maintained. Therefore, any degradation of the seabed of Malostonski Bay may exert impact on phases of life cycles of many organisms, that is, on cysts and durable eggs, thus disrupting, to a considerable extent, the natural balance of this exceptional area. So, during execution of the pier works of the planned Bridge, any risk of excessive silting up of this area has to be minimized to the extent possible in order to avoid causing danger to the majority of organisms filtering seawater to feed.

Based on the obtained results of the investigations of composition and depth distribution of the benthic vegetation and biocenoses within the area of construction works of the planned Bridge that shall span the mainland and the Pelješac Peninsula, the following may be concluded:

- The composition and depth distribution of the benthic algae vegetation and benthic communities (biocenoses) in the investigated area are characteristic for the natural channel and coastal areas of the central Adriatic which are affected by river inflow and where shores are predominantly rocky, rapidly transforming to gently sloping seabed composed of sandy-detritic and then silty material.
- The following benthic biocenoses were determined along the two benthic cross sections: biocenosis of supralittoral rocks, biocenosis of upper mediolittoral rocks, biocenosis of lower mediolittoral rocks, biocenosis of photophilic algae, precoraligenic aspect of coraligenic biocenosis, biocenosis of marine angiosperm Cymodocea nodosa meadows, biocenosis of coastal detritic seafloors, and biocenoses of coastal terrigenous muds.

During the construction of the Bridge, there is a potential risk of silting up of the bay in case of removal of larger amounts of mud from the bay if the removal process and technique are not taken into consideration.

The silting up may have damaging consequences for flora and fauna of the entire bay, and especially significant damage may be inflicted on the shellfish and fish mariculture facilities located in the vicinity of the planned route of the bridge, as well as in the lower part of the bay.

The assessments of silting-up hazard for natural population of filter feeders as well as plant species, and mariculture shellfish in some parts of the Malostonski Bay depends on the distance of the presumed source of contamination and velocity of resultant currents. Since the resultant flow direction of currents in the benthic layer is mainly incoming, a flow of mud in the direction of the Malostonski Bay can be expected in case of inadequate removal, which may lead to sedimentation of mud in the areas with intense mariculture activities. Therefore, regardless of the processes and techniques of mud removal, this should be carried out in periods of weaker currents, that is, in periods of the minimum flow rate of River Neretva and of calm weather without wind. In the process of removing mud, certain parameters shall have to be monitored so as to control potential impacts of silting up on the mariculture areas within the bay.

2.15. Archaeology and underwater archaeological reconnaissance

The archaeological heritage investigation works were performed using an underwater vehicle with a camera. The original programme consisted of a triple inspection of the planned route of mainland-Pelješac Peninsula, but, after the first inspection, the other two planned inspections were cancelled due to poor visibility caused by silty seabed. Due to that, it was decided to carry out longitudinal inspection of the two shores of the route, that is, coves, at a depth of 5 metres with 1-metre cross-sections to the boundary of the silty seabed at at depth of about 24 metres.

The planned and performed investigation works did not reveal any collective or scattered cultural heritage remains. Furthermore, there is a video, Pelješac-Mainland, substantiating what has been stated above.

However, if any archaeological finds are discovered during performance of the works, the Investor shall be obliged to immediately suspend all works and notify the competent Heritage Protection Office in Dubrovnik.

2.16. Morphological and hydrographic properties of the submarine environment

In order to determine the basic information on morphological, geological, seismological, seismotectonic and hydrographic properties of the submarine and coastal environment within the area of future bridge construction, preliminary investigation works were carried out from 29/03/2004 to 21/04/2004, and consequently presented in several studies:

- Assessment of engineering geological properties of rock mass and seismological study
- Investigation of shallow submarine zone
- Investigation of the sediment of shallow submarine zone
- Concluding remarks upon performing preliminary investigation works

The basic parameters of properties of the rocks within the bridge location are presented through concluding remarks:

Ingeneering-geological proterties of rocks

The investigated area consists mostly of carbonate complex rock forming limestone and dolomite rock mass. Those are consolidated brittle rocks characterized by numerous cracks usually exhibiting three-directional systems. The basic system consists of bedding planes, and cracks that are either nearly vertical or parallel to the B axis of the basic structures. The entire area is characterized by numerous reverse faults, generally of Dinaric orientation and forming belts of crushed and often mylonitized rocks. Transverse faults mostly consist of small horizontal

displacements generating diagonal cracks.

The rock mass is affected by weathering processes typical to the so-called Karst erosion. As a result, several weathering zones may normally be distinguished – cover and surface weathering zone, upper weathering belt and lower weathering belt, mainly reaching elevations corresponding to the sea level.

The cover and surface weathering zone is characterized by a high degree of weathering where the rock mass transforms into a mixture of clay, rock waste and small blocks.

Upper weathering zone rock is moderately affected by weathering; the cracks often exhibit gaps exceeding 5 mm and compressed highly plastic clay and fine grained, angular sand filling. Widened areas are mostly related to the so-called wear.

The lower weathering zone consists of relatively high quality rock, slightly to moderately weathered.

Within the carbonate limestone complex, there are two different lithological units - foraminiferous limestones with thin clastic sediment insets along reverse faults and rudist limestones. Since the coast and coastal areas contain rock mass represented as rudist limestones, the following text contains a geotechnical model characteristic for that lithological medium.

Acceleration and intensity values

The Pelješac Bridge is located in an active seismic and tectonic region. The Ploče–Dubrovnik fault is the most active fault. The boundary faults extend from its general zone, along the coast, precisely at the location of the mainland part of the bridge. The zone contains reverse faults of 74 – 76° slopes with a hanging wall displacement to the right at an angle 76 – 80°. The displacement is parallel to orientation of the bridge. At the surface, limestone strata slope to the NE at an angle of 30 – 40°. At the locaton of the Pelješac Bridge on the peninsula side, there is the Ston fault, tracing the most active faults of the system.
The limestone strata are aligned as on the mainland, but at a steeper slope of up to 58° in some areas. No greater seismic activity is attributed to the Ston fault. The Pelješac–Dubrovnik fault zone is associated with earthquakes taking place at depths greater than 8 km below the location of the bridge.
The Pelješac Bridge is located at Ston seismic source with estimated maximum possible magnitude Mmax= 6.5. For focal depth of h=13 km, the maximum values of acceleration ($\mathbf{a_{max}}$) and intensity ($\mathbf{I_{max}}$) are calculated:

$$\mathbf{a_{max} = 0.41\ g}$$

$$\mathbf{I_{max} = 8.6°MCS}$$

The mentioned values define properties of P2 type earthquakes, that is, the maximum earthquake which may occur at the locaton of the Pelješac Bridge according to deterministic approach.

In this study, a probabilistic approach to determining the parameters (P1 type earthquake properties) was based on Cornell method using McGuire algorithm. The following **design values** of the maximum horizontal acceleration ($\mathbf{a_{max}}$) and intensity ($\mathbf{I_{max}}$) were computed:

$$\mathbf{a_{max} = 0.291\ g}$$

$$\mathbf{I_{max} = 8.6°MCS}$$

The specified values pertain to the **base rock level**, that is, the level characterized by transversal wave velocity of vs = 700 m/s. If the bridge foundations are to be executed in less consolidated strata, those values should be increased adding appropriate gains caused by amplification.

For vertical accelerations, 2/3 of the specified horizontal acceleration values should be adopted.

Basic submarine zone investigation works

The investigation works were carried out in the Malostonski Channel area, between Popova Bay east of the settlement of Komarna on the mainland, at the foot of Glavice Hill and at the foot of Roščica Glava east of Tiha Bay on the Pelješac Peninsula.

The following works were carried out within the basic investigation:

- Bathymetric survey used for measuring depth along 5 cross sections
- Side Scan Sonar survey used for determining if there are any larger objects at the seabed within the wider area of defined cross sections which might present any problems during performance of the investigation works.
- Determining properties of geological structure of shallow submarine zone (subbottom profiler), where the basic geological character of sediments beyond the rock mass was defined along 5 nearly parallel cross sections
- Magnetometric detection used for determining the presence of any foreign, anthropogenic objects on the seabed which may create obstacles during further investigation works and which contains a sufficient quantity of steel that can be detected
- Sampling of the most recent sediments on the seabed

It should be stated that the survey conducted by Side Scan Sonar and magnetic detection did not reveal any foreign objects which might cause problems during the performance of further investigation works.

The soil sampling revealed that the seafbed possesses a markedly uniform structure, consisting of nonconsolidated high-plasticity clays of semi-fluid to highly-malleable consistency.

Shallow reflection investigation

On the basis of the analysis of all obtained results, the following can be concluded:

A similar geological situation is found at all the cross sections. The carbonate rock supporting the Quaternary sediments slopes steeply, from one shore to the other, at an angle of 28°- 30°. Progressing to the centre of the cross sections, boundary of the carbonate base and upper sediments becomes less steep. The depth of the boundary in the central part of the P2 cross section is 130 m, measuring from the level of sea surface.
The sediments above the carbonate base are divided into five zones (sections) considering the similarities they share and their reflection density. The zones are marked S1, S2, S3, S4 and S5 starting at the seabed, moving down, and coloured differently (see graphical appendix).
The S1 zone consists of non-consolidated clay. It is of a uniform depth (6-7 m).
Zone S2 exhibits very fine and frequent streaks, so it can be assumed that it consists of clays with thin streaks of various blends of silt and fine-grained sand. It may also be concluded that the sediments in this zone are of semifluid consistence and loosely compressed. Depth of the S2 sediment averages 10-12 m.
The S3 sediment zone provokes a greater interest. Sediment in this zone was most likely deposited during a turbulent sedimentation stage. The original high-scale seismic cross sections reveal reflection shapes indicating existence of fossilized

riverbeds or meanders. In such sedimentation conditions, occurrence of coarse-grained sand and gravel is possible, and of clay and silt as well. It is justifiable to assume that the sediment in this zone is considerably better compacted compared to that in the S2 zone. Depth of the S3 zone sediment ranges from 9 to 12 m.
The following, subjacent S4 sediment zone is, on average, 20 m deep. It reveals reflection boundaries representing bedding contacts, but the strata are considerably deeper than those in the S2 zone. Considering greater depth and age of these sediments, a slight increase of their density is expected. Highly to poorly malleable clays are to be expected in this zone, and lightly to moderately compacted strata and lens of sand.

The final, S5 zone of the sediment, is marked in red and purple in the graphical appendix. It encompasses sediment from the lower boundary of the S4 zone to the contact with the carbonate base rock. Partings are less frequent there, and reflections exhibit smaller amplitudes. That points to a higher compaction of the sediments and potentially a certain degree of their petrifaction. There is a probability, even though low, that the sediments in this zone consist of Neogene sediments (marls?).

Assessment of the geotechnical model

After completion of the investigation works, it is possible to provide a simplified projection of composition of soil and rocks within the planned location of the Bridge as follows:

• The coast and coastal zones of the area of construction of the planned bridge consist of carbonate sediments represented as limestones and very rarely as dolomite seams.

• Foundations may be executed in rock mass, in so-called base rock below the upper weathering zone, where geological strength index in GSI = 60–70 range should be expected, and where settling under the foundations may be expected to comply with limit values applying to such structures as the Bridge.

• The seabed is largely found at a depth of roughly 27 m below the sea surface, forming a submarine platform with no greater oscillations of elevation.

• Between the seabed and depths of 16–18 m, there are non-consolidated sediments, largely composed of high-plasticity clays of semi-fluid, highly-malleable consistency with thin streaks of silts and most probably very fine-grained sands.

• The following zone indicates turbulent sedimentation by its seismic cross section responses, therefore this zone may be expected to contain layers genetically related to fossil riverbeds and meanders, and these conditions of sedimentation may allow occurrence of sands and gravels, that is, a zone of greater density or compaction relative to the preceding, non-consolidated sediment, zone. Expected non-coherent materials shall be compounded in spots by lens of clay and silt. Compaction of the non-coherent materials should match the loosely-compacted materials. The sediments are 9 to 12 m deep.

• Deeper on, layers of clay, silt and sand of somewhat increased density should be expected, that is, it is expected that these are layers of highly to poorly malleable clays with thin, elongated lens of loosely to moderately compacted sands. These layers are marked S4 in the graphical appendix.

• The deepest sediments filling in depressions immediately over the rock mass indicate a greater sediment compaction as well as possible occurrence of lithification, according to their seismic cross section responses. Furthermore, the possibility that these sediments belong to the most recent Neogene sediments, such as clayey marls, should not be excluded.

• The maximum depth where limestone sediment palaeorelief, that is, the rock

mass, occurs is about 130 m.

In the course of further investigation works, it shall be necessary to determine precisely lithological properties of the submarine sediment using in situ experiments, while laboratory tests should determine physical and mechanical properties, as well as strength and compressibility parameters of the soil. It is also necessary to determine rock mass properties accurately.

Assessment of possible loading of the Malostonski Bay by suspended sediment particles during construction of the Pelješac Bridge

Inorganic particles in seawater may affect marine life forms through their size, chemical properties, surface properties and concentration. Various marine life forms exhibit different responses to effects of the suspended particles. The responses also depend on momentary physiological conditions of the life forms.

The investigation of impact of quartz and kaolin clay on the survival of larval stages of *H. americanus* in suspensions containing 15 to 105 μm diameter particles. Particles 30-35 μm in size cause death of the larvae obstructing flow of water around their gills, rather than by abrasion of the gills. Mortality of the larvae is directly linked to particles exceeding 44 μm in size. Iron oxide suspension of 0.5 g/100 ml causes lugworm *Arenicola marina* to die in six hours, that is, suspension of 210 mg/dm3 concentration was found to be lethal. Blue mussel Mytilus edulis bivalve reduces (62%) dry mass of some tissue parts when exposed to 7.46 mg/dm3 suspension of iron hydroxide. Bivalve filtration rate may be reduced in cases of exposure to the suspended particles. Thus 0.1 to 4 g/dm3 reduces *Crassostrea virginica* filtration rate by 57% to 94%, depending on particle type. Adult specimens of *Argopecten irradians* exposed to suspensions of 0.5 and 1 g/dm3 exhibit increased oxygen consumption rates.

Types of effects of the suspended particles on fish may be: 1) direct impact on swimming, reduced growth and mortality; 2) blocking of corresponding stages of development of eggs and larvae; 3) change of natural migratory patterns; 4) reduction of available food quantities.

An experiment involving *Fundulus heteroslitus* fish indicated that 96-hour retention in a 14 g/dm3 suspension of unpolluted marine sediment does not cause fish mortality, but the same sediment concentration in polluted areas causes certain changes in blood. The mortality of *Agonus cataphractus* in 33 g/dm3 red mud suspension over 72 hours is 100%, and 60% in 10 g/dm3 suspension, while 3.3 g/dm3 suspension does not cause death. Long-term exposure (12 months) to the iron hydroxide suspension caused stunted growth of Pimephales promelas fish. It is revealed that the fine marine sediment in a suspension (0-1000 mg/dm3) has no impact on hatching of *Perca flavescens* and *Morone saxatilis* species larvae in concentrations up to 500 mg/dm3. However, in concentrations above 500 mg/dm3, survival of the larvae is greatly reduced.

Published examples of impact of the seawater suspended particles lead to a conclusion that only extremely high concentrations may have a harmful effect on marine life forms. In realistic situations, high concentrations of the particles suspended in seawater may only occur locally, on limited time scales, during an anthropogenic activity such as backfilling or dredging.

3) MAIN ASSESSMENT OF ACCEPTABILITY FOR ECOLOGICAL NETWORK

The area of this Intervention, Bridge: mainland – Pelješac with access roads, is situated within the ecological network area, according to the Regulation on ecological network (OG 124/13). According to the Nature Protection Act (OG 80/13), ecological network assessment procedure has to be carried out for projects that alone or in combination with other projects could have significant impact on target objectives and integrity of the ecological network.

The Competent Authority for this Project (Croatian Roads Ltd.) submitted the request to the Ministry of Environmental and Nature protection, on 17 June 2013, with the aim to carry out the Assessment procedure for ecological network for the Project of Bridge: mainland – Pelješac with access roads. Within this procedure the Ministry of Environmental and Nature Protection requested the expert opinion from the State Institute for Nature Protection (SINP). Having an insight into the received documentation and according to the SINP expert opinion, the Ministry of Environmental and Nature Protection has issued the Opinion from 27 August 2013. (Class: 612-07/11-01/2509, Regno: 517-1-1-2-13-8) stating that the Main Assessment for the ecological network with assessment of other suitable options has to be carried out for the planned Intervention.

In the Main Assessment shall be included as follows:

- analysis of the ecological network protection objects initial state,
- analysis of the potential direct, indirect, temporal, permanent and cumulative (combined), impacts on target objectives and ecological network coherence,
- proposed mitigation measures for possible adverse effects of the planned intervention, on the target objectives and ecological network coherence, and if needed proposed Monitoring Programme of target species and habitat types, monitoring of proposed mitigation measures efficiency.

Taking into consideration that the Assessment procedure is conducted in order to reduce the impacts of the project on the reasonable dimension, the aim of the Main Assessment is to identify the level of significant impacts which are possible during building phase and using phase of the bridge land – Pelješac, on target species and ecological network coherence and propose mitigation measures important for adverse impacts of the intervention, if during the Main Assessment procedure these impacts are identified.

The planned Bridge: mainland – Pelješac with access roads, is situated in the area important for birds HR1000031 Delta Neretve and HR1000036 Srednjedalmatinski otoci i Pelješac and in the area important for special protection of species and habitat types HR2000364 JI Pelješac, HR4000015 Malostonski zaljev and HR5000031 Delta Neretve.

For the Main Assessment procedure information and data are collected as follows:

- data on the intervention, envisaged works which will be conducted for the need of the planned intervention,
- data on the ecological network areas, target species and habitat types and factors that influence on the area state of condition,
- analysis and aspect of the planned intervention which could have negative impact on the ecological network protection objectives, if needed with mitigation measures.

The field visit of the intervention area was conducted during September 2014. Expert and scientific literature was consulted, with special attention to the data connected to ecological condition of the ecological network target species and available data on target species and habitat types distribution within the intervention area. The aim of the field visit was to collect data on the environment of the location of the intervention and assess the condition of the favorable habitats and ecological network target species in the area of the possible impacts of the intervention and/or target habitat types.

In the Main Assessment every ecological network area features are described in details, intervention impacts (alone and cumulative) on the ecological network are described and mitigation measures of negative impacts are proposed.

Measures proposed in the Chapter *Mitigation measures for adverse impacts of the intervention on ecological network and monitoring program* as well as environment protection measures, proposed in the Environmental Impact Assessment Study, identified adverse impact of the intervention shall be avoided and/or mitigated to the level where no adverse effects on target species and ecological network coherence will be present, as well as to the level where the intervention will not cause significant adverse changes in the ecological network area.

Considering all alone and cumulative impacts of the proposed Intervention, Bridge: mainland – Pelješac with access roads, on target objectives and ecological network coherence, the Intervention is acceptable provided that mitigation measures for adverse impacts on the ecological network are implemented, including protection measures proposed in the Environmental Impact Assessment Study.

4) PROPOSED ENVIRONMENTAL PROTECTION MEASURES

4.1. Measures during design development and preliminary works

4.1.1. General measures

1) Further stages of the design development (after the planning stage) shall include development of the access road on Pelješac running from Brijesta towards west (investigated corridor), and L 69030 local road junction with D 414 shall be shifted to Zaradeže junction, approximately at km 14+020.
2) The surfaces required for the organization of construction site and works (provisional storage of construction material and waste, parking and maneuvering area for machinery, fueling site, concrete plant, asphalt mixing plant) shall be planned within the route corridor. Already degraded areas shall be used for this purpose, and there shall be no further degradation within the existing vegetation.
3) The sediment excavated for the bridge foundations shall be disposed of outside the area of the Special Nature Reserve of Malostonski zaljev, in accordance with the relevant Regulation.
4) The connection of individual building plots to the route of the Intervention in question shall not be permitted.
5) During preparation of the works and execution of construction works, it should be taken into consideration that the construction machinery and transport trucks are not allowed to pass through Ston and Komarna.
6) In stages of the development of Main Design, a landscaping project covering the area adjacent to the road shall be prepared by a competent expert.
7) The projects covering bridge construction processes shall provide that the bridge foundation works are executed successively, that is, they shall not be executed simultaneously at all locations of piers in order to minimize lifting of sediment and corresponding negative impacts.

4.1.2. Protection measures for economic activities

Forestry

8) During preparation and design development, the Forest management program, including constructed and planned forest roads (firebreaks, forest infrastructure), shall be used or new access paths shall be defined in collaboration with the competent forest management authorities for the purpose of rational use of the area.
9) Area with torrential streams shall be stabilized by means of gabions, rocks and terraces and by using adequate indigenous vegetation as prescribed by the Forest management program.
10) Discharge of water being collected in boundary channels shall be planned for the purpose of protecting side-hill cuts, through cuts and embankments. This shall be done so that the water discharged into the surrounding land does not produce new erosion processes on valuable forest ecosystems (seed stands) or pose any threat to cultivated karstic fields.

Hunting

11) In collaboration with competent departments of hunting ground concessionaires, the existing paths and wildlife crossing zones shall be taken into consideration so as to assure a timely implementation of all appropriate measures for preventing potential damage. Routes for the movement of people and construction machinery during the construction of bridge and access roads shall be defined as well. All existing hunting structures (shooting stands, feeding sites) shall be relocated to other sites or replace with new structures.

12) For the purpose of preventing road mortality among people and animals, road maintenance service shall record all cases of roadkill in order to respond timely by introducing additional protection measures.

13) Traffic signs warning of the presence of game shall be used. However, where game roadkills are frequent, the additional measures aimed at preventing such accidents shall be introduced by placing prismatic mirrors for repelling game.

14) There are structures proposed on access roads (viaducts, underpasses, passages, tunnels, etc.) at chainages (according to the table below) that shall mitigate fragmentation of game habitats and enable their free movement, migrations, with a special attention to big game inhabiting this area (mouflons, wild boar).

Underpass at Duboka junction – km 0+520.00
Culvert – km 1+170.00
Underpass for D8 – km 1+258.04
Passage – km 4+714.79
Culvert – km 5+190.00
Culvert – km 5+880.00
Culvert – km 6+280.00
Culvert – km 6+390.00
Culvert – km 6+691.00
Passage – km 6+691.712
Kamenice tunnel – 7+546 – 8+045
Doli viaduct – km 8+090.00 – km 8+246.00
Culvert – km 8+740.00
Culvert – km 10+580.00
Debeli Brijeg tunnel – 10+915 – 13+382
Underpass – km 14+019.93

4.1.3. Landscape protection measures

15) In further stages of design development, the type of the bridge structure shall be defined in accordance with the examined alterntives. Where possible, the underwater sections of bridge pier foundations shall be designed so as to remain hidden beneath the sea surface. The final phase of bridge construction, exterior details and bridge superstructure with the roadbed and traffic route elements (windbreaks, etc.) shall be developed architecturally within the civil engineering design. Shape of those elements shall aim to minimize visual impact of the structure and to the effect of 'lightening' the structure (selection of color, materials and surface treatment methods).

16) Windbreaks of appropriate size shall be designed in their entire height, with vertical markings (lines) in bright colors over the entire surface.

17) Due to its visual exposure, the construction of the viaduct shall be done so as to fit the structure into the landscape as much as possible taking account of its shape, color and material – aim at a structure that shall be as 'light' as possible and minimally high.

18) The landscaping project shall define, in detail, slopes of side-hill cuts and through cuts for the purpose of achieving a minimum and visually acceptable intrusion into the natural morphology of the area, and in terms of shape and material, they shall be adjusted to the characteristics of the natural landscape of this area – stone. Areas where greening of slopes of side-hill cuts and through cuts is to be carried out, in order to minimize the visual impact of the route, shall be defined.

19) In relation to the space planning around the first kilometer of the route, the development of the landscaping design shall take into consideration the original land use and visual appearance of the area, as well as the nearby terraced olive groves.

20) Particular attention shall be paid to the shaping of tunnel portal, which shall be finished in stone material (using a color most suitable to the surrounding rock).

21) All side-hill cuts, through cuts and tunnel portals shall be finished in natural materials – stone or planted with indigenous plant species. Use of shotcrete shall not be permitted.

22) Setting up construction site in the vicinity of the worthy agricultural cultural landscape (only on one side of the route) shall ensure the protection of valuable structure elements (terrace, drystone walls) and prevent the unnecessary damage and demolition.

23) Drystone walls damaged by construction activities shall be rehabilitated, that is, they shall be reconstructed using the same material to the edge of construction site area.

24) Only plant species indigenous to the vegetation communities typical of the wider area of construction site shall be used for rehabilitation.

4.1.4. Protected areas and biological diversity

25) The preliminary works related to the construction of access roads (clearing of vegetation, site clearing) cannot be carried out during the breeding season of birds and periods when other animal species are more active. In other words, the execution of mentioned works shall be planned from September 15 to March 15 in order to decrease impacts on fauna.

26) In case of transparent windbreaks, their design shall be such so as to avoid using any reflective materials. Instead, vertical markings (tapes) of brighter color shall be used over the entire transparent surface of windbreaks so as to prevent birds from colliding into them.

27) In order to reduce light pollution and potential impacts on bats, external lighting of the road shall be designed in accordance with minimal requirements necessary for functional use of the designed structure, including the use of environmentally friendly lighting emitting light in the direction of ground and other structures, with a minimum necessary level of emitted light and use of low-pressure sodium light bulbs.

28) In order to maintain the integrity of habitats and decrease the road mortality of small animal species (in particular reptiles), a sufficient number of passages for

small animals shall be designed under the road on locations where the route does not pass through tunnel/over viaduct. In doing so, the distance between each passage shall not be larger than 200 m. Culverts used for external drainage may be used as passages for small animals. Passages under the roads and culverts for external drainage shall be designed so that they can be used by small animals:

Structures of rectangular shape with minimum dimensions 0.5 x 0.5 m,
Bottom and sides made of concrete,
Bottom shall be designed to provide a dry crossing for animals even when there is water in the structure,
Sides of output channel of the structure shall be made by combining concrete and stone with a side inclination of 20-40^0 to make the channel suitable for animals,
Structures shall be designed so as to avoid passing of animals over the road but to direct them towards openings of culverts/passages. Such movement of animals shall be enabled by constructing fences along the edge of the road and directing animals by means of planting shrub vegetation around these openings. The dimension of these fences shall be around 2-4 cm^2.

29) Prior to commencing works, speleological reconnaissance of land shall be carried out along the route of the access roads corresponding to the width of the estimated construction site area, for the purpose of finding speleological structures and examining structures documented within the wider impact zone (200 m to the left and right of the route) in order to determine their layout. The reconnaissance shall be performed by experts (expert in bio-speleology and speleology-geology), and reports on the conducted research (including location, description, assessment of the importance and recommendations for protection measures for speleological structures) shall be submitted to a central state administration body for nature protection issues. In case any speleological structures are discovered, it shall be necessary to act in accordance with the decision issued by competent authorities.

30) Competent public institution for managing protected natural values shall be informed about the commencement of works.

4.1.5. Noise and vibration protection measures

31) In later phases of design development, based on detailed designs, the calculations of road traffic noise shall be made on locations of structures which are potentially threatened by high noise levels. On locations of the route where those levels exceed permitted noise levels, appropriate noise protection measures shall be proposed, primarily in terms of barriers, including time dynamics regarding the construction of anti-noise barriers.

32) Anti-noise barriers shall be designed/shaped of materials suitable to natural and/or cultural characteristics of the surrounding landscape, thus incorporating them maximally into the space, that is, making them less conspicuous. Within the scope of main design in relation to the noise protection, landscape rehabilitation and shaping of anti-noise barriers shall be defined.

4.1.6. Protection measures for cultural and hystorical heritage

33. Archaeological site 1.6. Ždrijelo, tumulus – southeast of Zaradež, within the zone of direct impact, shall be archaeologically researched and documented.

34. Detailed documentation shall be developed for the fortress of Glavica (4.1) within the zone of direct impact and it shall be protected in situ.

35. Prior commencement of construction works along the entire section of the underwater part of the Pelješac Bridge, archeological reconnaissance of the terrain shall be conducted.

4.2. Protection measures during construction

4.2.1. General measures

1) During construction works, the movement of heavy machinery shall be restricted, that is, the existing road network shall be used as much as possible, and this network shall be rehabilitated upon completion of the construction works. New access routes shall be formed through natural vegetation only when that is unavoidable, and these routes shall be planned in coordination with the competent forest management authorities.
2) Frequent and controlled separation and disposal of municipal waste and hazardous waste shall be carried out in accordance with the relevant legislation. In other words, any temporary or permanent disposal of waste material onto the surrounding soil shall be prohibited. Furthermore, impermeable waste containers shall be provided.
3) All excavation material, which shall not be used for construction activities, shall be disposed of at sites designated for such purposes according to relevant legislation (Ordinance on handling the excess of excavation that represents mineral raw material when performing construction works, OG 79/14).
4) All areas under temporary impact of the construction site shall be restored to their original state, that is, rehabilitated (indigenous plant species shall be used for rehabilitation).
5) Pile driving and boring shall be carried out by using the system of 'air bubble protection' in order to minimize the level of vibrations transferred to the sea.
6) All material collected during the construction of piles shall be sucked out through the pile pipes, placed into impermeable waste containers on the platform (barges), and disposed of to designated areas.
7) The Developer shall have to prove that all machinery used for works conducted in and on the sea are serviced and function flawlessly, and that there shall not be any leakage of oil from the hydraulic system or fuel into the sea. Through contracting supervision provided during the construction works, the Investor should also contract adequate supervision of engineering experts.
8) The mentioned masures and other necessary measures for conducting marine construction works in a safe manner shall be presented in detail in terms of items of the main design bill of quantities.

4.2.2. Soil and agricultural land protection measures

9) Where possible, the existing roads and paths shall be used as access routes to the construction site.
10) During performance of earthworks, the excavated topsoil shall be disposed of and then, upon the completion of works, returned (where possible) as base layer.
11) Works on the route shall not be executed in periods when the agricultural crops within areas of extensive agriculture are in their ripening phase preceding harvest.

12) Settlement of terrain, avalanche and erosion along the bridge and constructed access road shall be monitored (twice a year) and, if necessary, any caused damage shall be repaired.

4.2.3. Forest ecosystems and forestry protection measures

13) During preparation works, rehabilitation of areas adjacent to the construction site shall be taken into consideration in order to prevent felling of trees on newly created edges or landslide.

14) During performance of the construction works, particular attention shall be given to handling highly flammable materials and open flame, as well as to the tools that may produce sparks. All relevant regulations and procedures for protection of forests against fire shall be respected. This refers in particular to the areas where the proposed route passes through coniferous forest (from the initial chainage to chainage ≈1+250.00, and from chainage ≈11+600.00 to chainage ≈12+800 00).

15) Immediately after the laying out the route, all cut down timber shall be driven away, thus restoring and maintaining forest balance.

4.2.4. Landscape protection measures

16) All earthwork material shall be reused in embankments and slopes or used for rehabilitation of area adjacent to the future route. Potential excess of soil material shall be disposed of at sites designated for such purposes according to relevant legislation.

17) All temporarily used areas (construction site and access routes) shall be restored to their original state or rehabilitated in accordance with the landscaping design.

4.2.5. Protected areas and biodiversity

18) During the execution of construction works, protection measures against the pollution of sea, waters and soil shall be implemented:

The Developer is obliged to use machinery and vehicles that function and run flawlessly in order to prevent any leakage of fuel and/or lubricants into the soil or underground, as well as any excess emissions of noise (machinery and vehicles have to comply with the prescribed technical requirements relating to the permissible levels of noise).

Controlled separation and disposal of municipal and hazardous waste shall be carried out in accordance with the relevant legislation. In other words, any temporary or permanent disposal of waste material onto the surrounding soil shall be prohibited, and impermeable waste containers shall be provided.
Manipulation of oil, petroleum products, oil and lubricants, as well as replacement of batteries on construction machinery and vehicles shall be conducted at specific locations designated for such activities with adequate protection measures for sea, waters and soil (an area with impermeable grating shall be defined equipped with means to neutralize spilt fuel and lubricants).

19) During performance of the tunnel construction works, constant bio-speleological supervision shall be ensured. This supervision shall be carried out by qualified experts (in bio-speleology and speleology-geology). Data on the conducted supervision shall be submitted to a competent state administration body for

managing protected natural values within the territory of Dubrovnik-Nerretva County.

20) In case any speleological structures or one of their part are discovered, all works shall be immediately stopped and, without delay, a central state administration body for environmental protection issue and State Institute for Nature Protection shall be informed of this matter and, consequently, activities in accordance with the decision issued by competent authorities shall be conducted.

21) In case of appearance or spreading of invasive species reported within the construction site area, they shall be permanently removed in collaboration with an expert by means of the methodology of eradication based on current research and findings related to preventing the spread of invasive plant species within the construction site area during the construction of the Intervention.

22) All excavation material, which shall not be used for construction activities, shall be disposed of at sites designated for such purposes according to relevant legislation (Ordinance on handling the excess of excavation that represents mineral raw material when performing construction works, OG 79/14).

23) All embankments, side-hill cuts, through cuts and tunnel portals shall be finished in natural materials – stone or planted with indigenous plant species. Use of shotcrete shall not be permitted.

24) Upon completion of works, all construction site surface areas, construction site access roads and other zones of temporary impact which are not within the scope of the Intervention shall be restored to their original state by means of rehabilitation. Only plant species indigenous to the vegetation communities typical of the wider intervention area shall be used for rehabilitation.

4.2.6. Noise and vibration protection measures

25) During construction works, additional noise shall be emitted as a result of construction works. Such noise is temporary, and the maximum permissible noise levels defined in accordance with the Regulation on maximum permissible noise levels in areas where people work and live (OG 145/05). In brief, the mentioned Regulation proscribes: 'Regardless of the zone from Table 1, Article 5 of this Regulatin, the permissible equivalent daytime level of noise is 65 dB(A). From 8 a.m. to 6 p.m., the permissible level of noise may be exceeded by an extra 5 dB(A). While performing construction works by night, the equivalent level of noise must not exceed values given in Table 1, Article 5 of this Regulation.'

26) In special cases, exceeding the mentioned levels shall be allowed: 'Exceptionally, regulations set out in paragraph 1, 2 and 3 of this Article shall not apply and exceeding permissible levels of noise shall be allowed by 10 dB(A), where this is required by construction process not lasting longer than one (1) night, that is, two (2) days during a thirty (30)-day period.' By maintaining discipline in terms of time required to perform works, methods applied while doing so, and in terms of positive professional engineering practices, the mentioned requirements from the relevant Regulation shall be fulfilled.

4.2.7. Protection measures for waters, water bodies and sea

27) Road and bridge drainage system shall be designed as impermeable, with an internal sewage system and system for wastewater purification included, where disposal of

sludge is necessary.

28) Areas where workers are accommodated shall be equipped with sanitary facilities with controlled sewage disposal. All runoff waters shall be discharged into impermeable containers, which shall be controlled frequently and emptied regularly, or connected to the existing drainage system.

29) Area for parking vehicles and construction machinery shall be organized on impermeable surface, and runoff waters shall be discharged by means of oil separators.

30) Harmful and hazardous substances and materials, oil, fuel, lubricants, etc. cannot be stored within the construction site. Machinery shall be handled with utmost care.

31) Brackish spring on the Pelješac peninsula and submarine spring in the bay of Brijesta shall be protected. Additional protection measures shall be implemented to prevent percolation into the area of faults in karstified limestone, in karstic fields and sinkholes.

32) Appropriate protection measures against lateral skidding of vehicles on all potentially dangerous locations within the water protected zone shall be foreseen.

33) Runoff waters collected from road surfaces and accompanying structures, as well as from control centers and traffic management centers (including administrative building and parking area) shall be treated as those from access roads, whereas sewage waters shall be treated by means of bio-disc systems.

34) During the performance of works and organization of construction site, particular attention shall be paid to avoid pollution of waters and surrounding area with fuel, oils, lubricants, bituminous products, and other dangerous and hazardous substances.

35) For locations of construction site, services, asphalt mixing plant, concrete plant and other structures, relevant water management requirements shall be fulfilled.

4.2.8. Protection measures for existing traffic system

36) If the existing network of roads and paths is used during construction works, these roads and paths shall be rehabilitated and restored to their original state upon completion of these works.

37) Since regardless of the defined technology of constructing the Bridge: mainland – Pelješac with access roads, the collision between the construction site and existing traffic on the D8 and D414 state roads cannot be avoided, the approaches to construction site areas shall be analyzed comprehensively, and adequate project for temporary traffic regulation during the execution of construction works shall be defined.

4.2.9. Existing infrastructure protection measures

38) Protection measures of other infrastructure lines (power-transmission lines, telecommunication lines, water supply pipelines, etc.) and the potential reconstruction of the mentioned lines shall be proscribed through specific requirements provided by competent institutions within the process of obtaining location permit.

4.2.10. Meteorological conditions protection measures

39) Access roads and bridge, as a functional unit in terms of transport, shall be equipped with a system of variable message signs and equipment announcing adverse driving conditions in all typical and atypical situations (climate changes, etc.).

40) During the execution of construction works, an anemograph shall be set to record and analyze the direction and speed of winds at the location. That is, lines indicating duration of the winds of specific speeds shall be drawn and the collected data shall be controlled and, potentially, details of technical solutions for the bridge shall consequently be corrected.

4.2.11. Protection measures for cultural and historical heritage

41) During preliminary works and construction of the planned route, constant archaeological supervision is mandatory for archaeological sites in vicinity of Brijesta (1.1 Villa rustica, 1.2 Na Grac or Gradac, and 1.3 Jegulja), and archaeological sites in vicinity of Dančanje (1.4 Mali Gradac and 1.5 Veliki Gradac) within the indirect impact zone of the road.

42) During the performance of tunnel construction works (rock blasting), constant supervision by heritage conservation services shall be required in order to prevent potential damage to the St. Michael's church.

43) In case any archaeological discoveries are reported during performance of the works in the submarine area, all works shall immediately be suspended and competent Heritage Protection Office in Dubrovnik shall be notified.

4.2.12. Protection measures for protected natural values

Protected areas - Special Reserve at Sea Malostonski zaljev - marine area

44) The construction works on the seabed, which may result in a certain amount of sediments being generated in the water column, shall be executed in periods when outflow currents from the bay are prevalent in the benthic layer or when vertically averaged velocity of inflow currents does not exceed 0.1m s-1 within 3 hours.

45) For the purpose of decision-making regarding the execution of submarine works, automatic current meters with telemetric data gathering capacity shall be installed.

46) The control of suspended particles in the bay shall be carried out through in situ measurements in order to avoid potential disputes arising from damage caused to mariculture, which may be caused by other activities not related to the construction of the Bridge.

47) During the execution of marine works, parameters for the control of potential impact of silting up on farming areas in the bay shall be monitored (in accordance with the environmental monitorin program – current direction, current speed at surface (up to 3.0 m from level), current speed at bottom (up to 4.0 from the seabed).

4.3. Protection measures during use

4.3.1. Forest ecosystems and forestry protection measures

48) Area adjacent to the roads shall be cleaned and maintained regularly to minimize hazard and potential damage caused by fire.

4.3.2. Landscape protection measures

49) Regular maintenance of areas adjacent to the route and surface areas around junctions and adjacent structures shall be carried out.

4.3.3. Protection measures for waters, water bodies and sea

50) Prior to flowing into the recipient, runoff waters from road surface shall be purified in order to attain adequate emission limit values as prescribed by specific regulations. If the monitoring of water bodies shows that this is necessary, higher emission limit may be determined even at a later time in order to ensure that the status of water body used as the recipient does not deteriorate.

51) The road and both the road and bridge drainage systems shall be regularly maintained, including cleaning and monitoring of functional status of the internal drainage system as well as the system for purification of runoff waters. Furthermore, the waste material (residue) produced from purification of runoff waters shall be treated adequately. In winter periods, if necessary, snow and ice shall be cleared from pavement.

52) In winter periods, standard environmentally friendly agents shall be used for road maintenance (substances preventing ice from forming) so as to protect the waters. The use of agents shall be minimal and this shall be achieved by providing accurate forecast of pavement conditions and applying right quantities.

53) The Investor is obliged to ensure monitoring of the functioning of drainage system, as well as regular control of treated water discharged from the device.

4.3.4. Protection measures zaštićenih područja i biološke raznolikosti

54) In order to prevent the possibility of birds of prey getting killed, a regular removal of carcass from the area of the road corridor shall be arranged for.

55) Regular supervision and cleaning of the area inside culverts and passages shall be provided in order to ensure that they can be easily accessed by small animals, thus assuring the continuity of habitats and animal movement.

56) In case of appearance or spreading of invasive species reported within the road adjacent area, they shall be permanently removed in collaboration with an expert by means of the methodology of eradication based on current research and findings related to preventing the spread of invasive plant species.

4.3.5. Protection measures in case of accidents

57) In case of accidents involving specific heavy goods vehicles where sudden uncontrolled leakage of harmful and hazardous substances into the area surrounding the route may occur, activities pursuant to the State Plan for Water Protection, that is, pursuant to operational programmes in cases of accidents shall be conducted.

5) PROPOSED MONITORING PROGRAM FOR ENVIRONMENT

5.1. Protected areas and biological diversity

1) During traffic flows, frequency and distribution of roadkill shall be monitored, with particular attention focused on reptile target species of site HR5000031 Delta Neretve and HR2001364 JI dio Pelješca and bird target species of HR1000031 Delta Neretve and HR1000036 Srednjedalmatinski otoci i Pelješac.
Monitoring roadkill shall be conducted during a one-year period, each month (3 times along the entire route of access roads, every 3-4 days) expect in winter months (November, December, January and February). In April, May, June and September, more frequent monitoring shall be required (6 times along the entire route of access roads, every 3-4 days) primarily due to reptiles whose activity reaches its peak in that particular period. Once this one-year period of monitoring is completed, analysis of roadkill locations and taxa affected by roadkill shall be carried out, and, eventually, protection measures shall be corrected. After protection measures are implemented, monitoring shall be repeated in order to assess the efficiency of protection measures. The monitoring results shall be submitted to a central state administration body for nature protection issues.

2) Appearance and spreading of invasive plant species in the construction area shall be monitored. In case of appearance and spreading of invasive species reported within the maintained area adjacent to the road, the permanent monitoring and removal of all non-native invasive plant species shall be arranged for during entire period of construction and one year after the construction period. Experts shall be consulted (biologist – botanist) in order to identify plant species and select relevant removal methodology.

5.2. Noise and vibration

3. Upon completion of the road, at the locations of structures that are most exposed to high levels of noise, control measurement of noise levels shall be carried out and the obtained results shall be compared with computed noise levels. Further measuring of noise levels shall be ensured as soon as the following measuring shows an increase of 25% in the intensity of traffic flows compared to the intensity calculated during the previous measuring. For each single measuring, noise shall be measured at the locations that are most exposed to high levels of noise coming from the new route. The measuring, lasting for 24 hours, shall be conducted in summer periods, in accordance with the Noise protection Act.

4. If further measuring shows that levels of noise exceed permitted daytime and nighttime noise levels of 65 dB(A) and 50 dB(A) (according to the Regulation), noise protection measures shall be implemented to reduce noise to acceptable levels.

5. The efficiency of additional noise protection shall be examined by means of further measuring once these additional measures are implemented. Detailed measures shall be defined in the noise protection design.

5.3. Waters, water bodies and sea

5.3.1. Monitoring during construction works

Coastal waters

Monitoring program is regulated in accordance with the Regulation on water quality standards (OG 73/13) Table (5.3-1).

Table 5.3.-1. List of parameters proposed in the monitoring program

Monitoring program for following elements	Frequency of sampling and analyzing	Sampling site location
Chlorophyll a (every 5 m, depending on the depth of measuring unit).	• immediately prior to commencement of the works (zero condition) • 1 day after completion of the first borehole • every 3 days until completion of the works	Construction site area and wider project area
Composition of phytoplankton biocenosis	• in case of considerable change in concentration of chlorophyll, analysis of the composition of phytoplankton biocenosis shall be conducted	
Macro-algae	• prior to commencement of the works (zero condition) • if necessary, during works • upon completion of the works	
Posidonia oceanica	• prior to commencement of the works (zero condition) • if necessary, during works • upon completion of the works	
Benthic invertebrates	• prior to commencement of the works (zero condition) • upon completion of the works	
Presence of invasive species	• prior to commencement of the works (zero condition) • upon completion of the works	

5.3.2. Monitoring during use

With respect to a 'combined approach' to water protection, monitoring program for potential impacts of the Project on water bodies shall be planned, thus ensuring emissions below limit values and preventing deterioration of the status of recipient. Therefore, the proposed environmental monitoring shall consist of 1) monitoring of emissions after purification and 2) of relevant parameters illustrating the status of water body. Parameters selected for monitoring shall be those parameters that can be found in waste waters depending on the type of the project, and they shall be monitored in accordance with specific adequate regulations[1].

5.3.3. Emission monitoring

After runoff waters are purified, and before being discharged into the recipient, at least the following parameters shall be monitored: physical-chemical parameters, BPK5, KPKcr, TOC, total hydrocarbon, pesticides, PAH, copper, zinc, cadmium, total chromium, manganese, nickel, lead, iron, sulfates, and total phosphorus. Limit values and frequency of this monitoring are prescribed by specific regulations.

[1] Regulation on the emission limit values for wastewater (OG 80/13)

5.3.3.1. Monitoring of status in the sea water column

During construction works concentration of the following parameters in the sea water column shall be monitored: lead, cadmium, nickel, pesticides and PAH, in the nearer and wider construction area.

5.4. Wind speed monitoring

For precise estimation of average and extreme expected wind speed on the location of the bridge, the direction and speed of winds shall be measured within a 10-minute interval at the location of the future route of the Pelješac Bridge (Komarna), thus enabling the verification of the recorded results.

5.4.1. Monitoring during construction works

1) During performance of the tunnel construction works, constant bio-speleological supervision shall be ensured. In case any speleological structures or one of their part are discovered, all works shall be immediately stopped while the speleological team shall conduct the research and propose necessary fauna and habitat protection measures.
2) In case of any speleological objects during construction works and later tunnel use, permanent monitoring shall be assured.
3) Parameter monitoring in order to control possible submarine silting up.
4) Sea status monitoring, connected to silting has to be done as follows
   - Developing warning system that shall determine periods when works at the seabed can be performed which are expected to generate certain quantity of sediment mass in the water column.
   - Occasional recording of the status of concentration of suspended particles in Malostonski Bay.
5) Besides the above mentioned parameters, it will be necessary to monitor parameters to control indirect impacts of silting up in the farming area of the Bay.
   Therefore, additional parameters shall be monitored:

- Chlorophyll a concentration
- Composition of phytoplankton biocenosis (composition of phytoplankton biocenosis is already monitored within all farming areas in the Malostonski bay by means of the existing monitoring of farming area)

Sea samples for the analysis of chlorophyll a concentration shall be taken on the surface and at the seabed in the envisaged areas. Samples shall be taken as follows:
- Immediately before commencement of the construction works (zero status)
- One day after the first drilling work
- Until the end of the construction works every 3 days

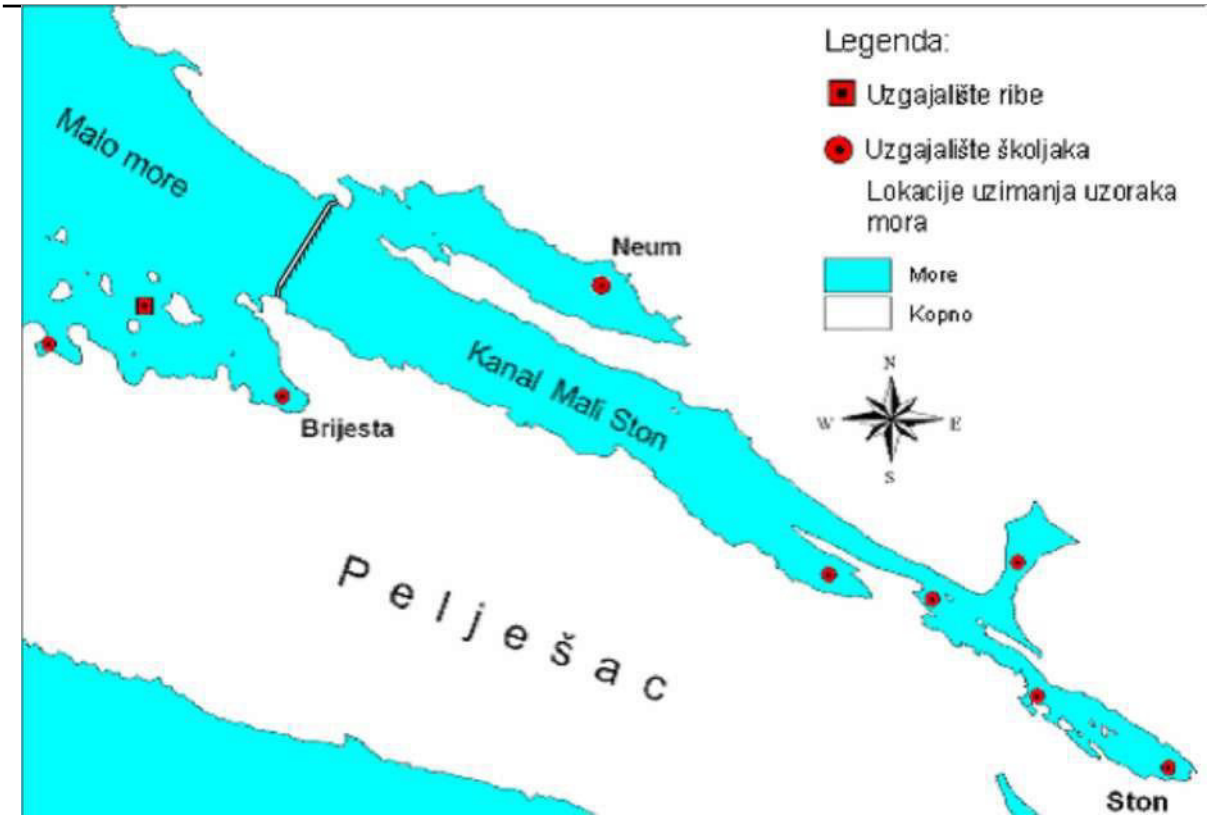


Figure 5.4.1.Sampling site locations

Where levels exceed the permissible levels, the construction works shall be brought to a halt until permissible levels of thses very parameters are achieved.

6) TRANSBOUNDARY IMPACTS (COMPLIANCE OF INTERVENTION WITH CROATIAN INTERNATIONAL OBLIGATIONS)

Negative transboundary impact is not expected, on the contrary, the opening of a new road communication will ensure better transport connections between the two countries, that is, the area of Neum and Pelješac (Korčula, Lastovo, and Mljet). Furthermore, as a consequence, more effective economic cooperation between both countries is expected within the intervention zone.

Traffic impact

The project of Bridge: mainland – Pelješac with access roads starts at the Duboka junction on D8, not far from the Klek/Neum border crossing. The existing D8 state road links the new Intervention with the Klek/Neum border crossing, and the link to M17.3 towards the interior is located in Neum (see Table 1 Road network of BIH – source: bihamk.ba).

Development objectives defining the development of all transport systems in Bosnia and Herzegovina are still being formulated.

The construction of the Intervention shall have a positive impact on travels from BIH towards Pelješac and neighboring islands in terms of shortening travel time, ensuring direct accessibility, decreasing vehicle costs, reducing the costs of accidents, lowering emissions of pollutants, and reducing the costs of CO2 emissions.

Water impact

Within the zone of the proposed Intervention, there is no risk of impact of pavement drainage on groundwater or surface waters in BIH. On the contrary, within this part of terrain, the direction of flow of surface waters and groundwater is for the most part directed towards the Pelješac side. The bridge and road drainage system is a closed drainage system with purification devices used before the water is discharged into recipients.

Economy impacts

Even though the primary purpose of constructing the bridge and road is to connect the separate parts within the Dubrovnik-Neretva County, and the County with the rest of the state territory likewise, the positive impacts of the construction of this route shall increase to a significant extent the number of opportunities for transboundary economic cooperation. This certainly refers to the use of tourist and all other capacities on Pelješac and neighboring islands for the purposes of tourist industry and opportunities for export of agricultural products from Herzegovina to these areas.

The other aspects of transboundary economic cooperation shall depend mainly on the general state of the economy on both sides of the border. In addition, shorter travel time and substantial improvement of travel conditions open up an opportunity for the development of tourist industry in both directions. Intensity of the development of the transboundary tourist industry shall also depend primarily on the state of the economy on

both sides of the border, as well as on the simplicity or complexity of the border crossing. In near future, this border will become a part of the Schengen area, which may delay this aspect of economic development until BIH becomes a member of the European Union.

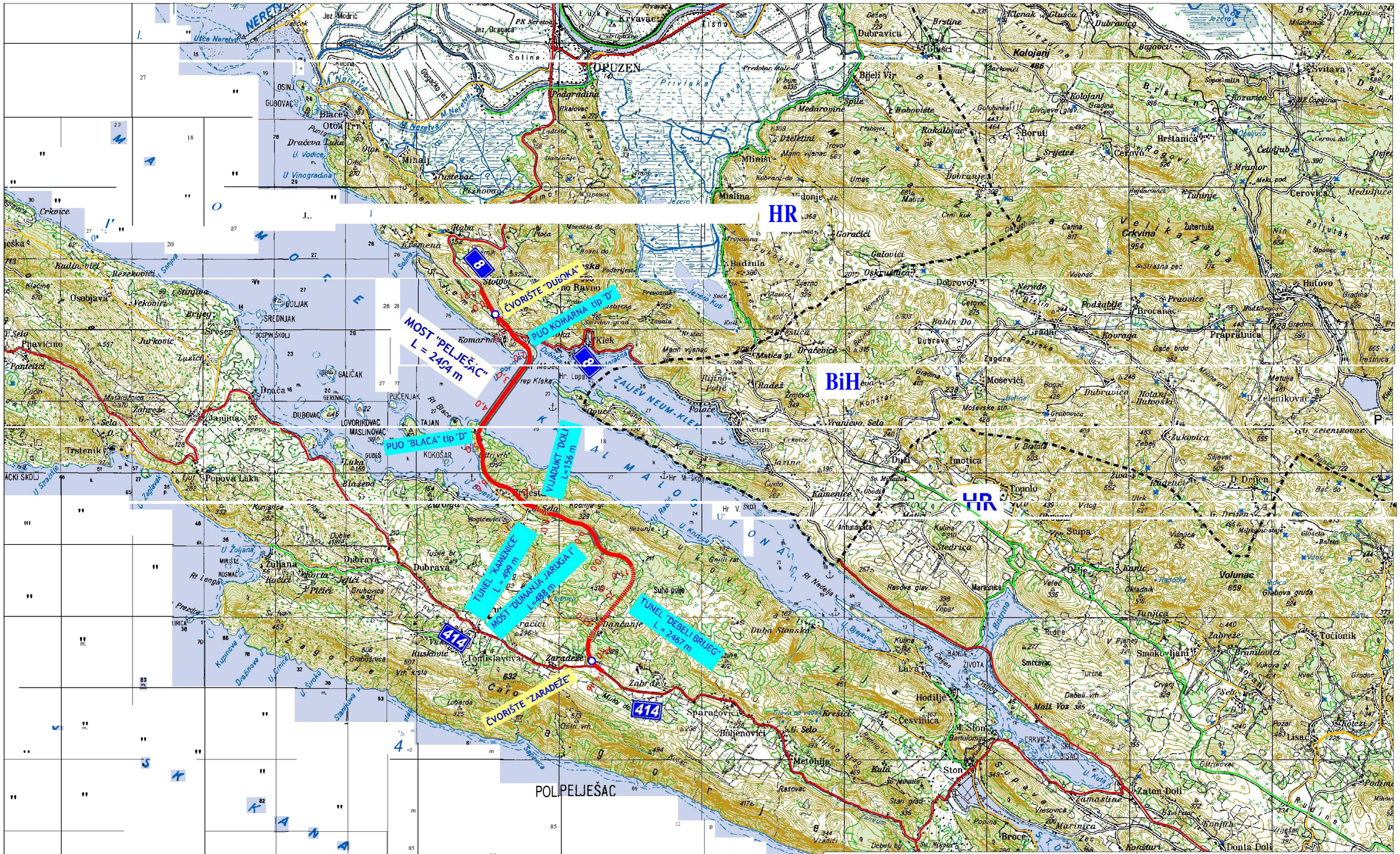
Overall, the transboundary impacts of constructing the Bridge: mainland – Pelješac with access roads on physical aspects of the environment are not expected, whereas the economic impacts can be assessed as positive.

Impacts on health of population

In all of its aspects, the Project shall not exert any negative impact on the health of population of neighboring countries, as on part of the traffic from these areas shall be diverted, thus lowering the level of traffic pollution (exhaust gas, water pollution, air pollution, etc.) in relation to the present levels of traffic pollution. Therefore, in respect of the impacts on health, Intervention will actually have positive impacts.

7) GRAPHICAL APPENDIXES

(general layout)



Nositelj Interventiona: HRVATSKE CESTE, doo ZAGREB

Izradivac studije: Institut IGH, dd ZAGREB

STUDIJA O UTJECAJU NA OKOLIS
MOSTA KOPNO- PELJESAC S PRISTUPNIM CESTAMA

Voditelj izrade studije:
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