

Client

EUROPEAN BANK
FOR RECONSTRUCTION AND DEVELOPMENT

RIJEKA BYPASS PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT
UPDATE
Draft Report

URBING d.o.o.
Physical Planning and Environmental Protection

Zagreb, June 2004

Client:

**EUROPEAN BANK
FOR RECONSTRUCTION AND DEVELOPMENT**

One Exchange Square, London EC2A 2JN
United Kingdom

Co-ordinators:

Alessia Di Domenico
Mikko M. Venermo

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Contractor

URBING d.o.o. - Physical Planning and Environmental Protection
Zagreb, Maksimirska 81

Director

Darko Martinec, B.Sc.Arch.E.

Co-ordinator

Ljiljana Doležal, B.Sc.Arch.E.

Working Group

Darko Martinec, B.Sc.Arch.E.

Ljiljana Doležal, B.Sc.Arch.E.

Vitomir Štokić, B.Sc.Arch.E.

Aleksandar Marković, B.Sc.C.E.

Prof. Stanko Lulić

Contract No: C13659

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Zagreb, June 2004

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EXECUTIVE SUMMARY

1. INTRODUCTION

1.1 Background

The development of the Croatian economy as a whole is directly linked to the development of the tourist industry. Croatia is one of the most attractive destinations in Europe, and the success of the tourist industry depends directly on development of the Croatian road network and its integration into the Central European, Adriatic, and Mediterranean road network. The arterial international motorway routes connecting Budapest – Zagreb – Rijeka – Trieste and Rijeka – Split – Dubrovnik – Podgorica – Skopje are the most important road corridors in Croatia.

These two very important directions (a longitudinal one towards Italy, Istria, and Slovenia extending to the Adriatic road direction in the direction of Lika and Dalmacija, and a transversal towards Zagreb, Budapest and Vienna) will intersect on the Rijeka Transport Junction, also called the Rijeka Bypass because of its physical and functional connections at the state, regional, and local levels. The construction of the motorway section Orehovica – Križišće is an imperative for completion of the Rijeka Transport Junction, as well as the completion of the second extension of the section Orehovica – Matulji.

Since the Bypass section from the interchange Škurinje towards Bakar, Crikvenica and on has not been built yet, most of the transit and longitudinal traffic heavily burdens the town road network. The existing roads take over long-distance transit, regional traffic, and city and intercity traffic (connections with the County centre and the tourist areas). None of the mentioned traffic levels is satisfactory, it is a cause of traffic jams during rush hours and frequent car accidents, and the travel speed is reduced. This very much affects the quality of life of local population and performance of business entities (tourist industry in particular).

1.2 Objectives of the Project

With completion of the road network a fast and a good quality link will be provided at the level of state roads. The Rijeka road network will be relieved of heavy traffic and its operation and the quality of life in the housing areas along the roads, which are currently burdened with transit traffic, will improve. By relieving the heavily congested city centre, the Adriatic highway will also become free for local transport thus improving the quality of life in the villages and the residential areas.

The newly constructed section will integrate the eastern economic zones into the international road network and connect the tourist settlements on the coast and on the island of Krk to the motorway network. Security will improve in all types of transport and the travel time and costs will be lower.

1.3 Objectives of EIA Update and Executive Summary

The Croatian Roads Company has asked the European Bank for Reconstruction and Development (EBRD) to participate in the Project funding. Prior to making a funding decision, the EBRD has commissioned an *Environmental Impact Assessment (EIA) Update* to ensure that the Project would not result significant adverse environmental impacts and that all necessary mitigation measures to minimise any adverse change in environmental conditions would be included in the Project design and the construction programme. The purpose is to update the Environmental Impact Assessment of the Bypass sections Orehovica – Vitoševo – Križišće carried out in 1986 ensuring that all relevant environmental or socio-economic issues associated with the Project will have been addressed.

The EIA Update has reviewed the 1986 EIA Study and other available environmental and technical and physical planning information that have relevance to the Project. It has verified and amended, as needed, the information on potential environmental, cultural, socio-economic and land use issues and settlement and traffic pattern changes and impacts (both positive and negative) resulting from the Project. It has also assessed the adequacy of the mitigation measures and emergency response plans and, where needed, it has determined further mitigation measures to ensure the Project meets the Croatian's and European Union's environmental standards.

This Executive Summary is made to give a non-technical abstract of key findings and conclusions of the EIA Update.

1.4 Description of Environmental Impact Assessment Update Process

The EIA Update is being carried out in three phases:

Phase I – Scoping

The scoping carried out to ensure that all potentially significant issues, including adverse impacts on the human and natural environment, are assessed in the EIA Update, and that efficient mitigation measures are incorporated in the Project. A Scoping Document describing the Project and the key findings and conclusions of the 1986 EIA study as well as the Public Disclosure and Consultation Plan were prepared and made available to the public at the beginning of March 2004. A round table discussion was held on March 18 in Rijeka to discuss the scope of the EIA Update and the process of public involvement.

Phase II - Preparation of EIA Update

The EIA Update has been prepared to address all the issues identified during the scoping phase. It amends the 1986 EIA Study to correspond with the current environmental and social status within the corridor and in its vicinity and the detail technical design as well as to meet the EBRD's EIA requirements. It has also amended the mitigation measures and emergency response plans. The draft report has been discussed with the local communities.

Phase III

The Draft EIA Update has been made available to the public for a review and comments in the local library, municipal offices and the website of Croatian Roads and

EBRD from 1 July 2004. The public is invited to express their views on the assessment of environmental impacts and recommended mitigation and environmental protection measures. The public has been informed on the availability of the EIA Update in national and local newspapers. A timeframe of 120 days will be allowed for the expression of comments and suggestions, closing on 28 October 2004.

2. PROJECT DESCRIPTION

2.1 Geographical Location

The state road D-8 is part of a network of the road routes being of wider European importance and therefore included in the European Network of Roads. They are:

D-3: Letenje – Zagreb – Karlovac – Rijeka – Trieste (E – 65, E – 71, E-63)

D-8: Koper – Pula – Rijeka – Split – Dubrovnik (E – 751, E – 65 – E – 80)

The section of the state road D-8 Sv. Kuzam – Križišće is the end of the eastern section of the Rijeka Bypass that extends between Orehovica – Draga – Sv. Kuzam. The corridor (reserved area) for the bypass along the stretch Matulji – Diračje – Škurinje – Orehovica – Sv. Kuzam – Križišće was included in the Rijeka Town Master Plan already in 1974. Neither on the motorway route nor in its imminent vicinity there are properties that could be an obstacle for constructing the bypass.

At the Hreljin interchange a road connects to the state road D501. At the Križišće interchange there is a road diverging to the state road D102 to the island of Krk (to the newly built intersection of the county road Ž5064 and the state road D102) north of the interchange Šmrika to D8 (The Adriatic Tourist Road).

The section of the motorway Sv. Kuzam – Križišće is a replacement for the existing Adriatic Tourist Road running through the Bakar Bay and Kostrena and bypassing the urban areas of the eastern part of Rijeka (Kostrena, Bakar, Bakarac, Kraljevica, and Šmrika).

2.2 Technical Characteristics

The Project involves the construction of the Rijeka bypass between Sveti Kuzam (Vitoševo) and Križišće. It starts at km 6+355.00 and ends at km 14+720.00 and is 8.365 km long. Two interchanges have been planned on the section, one at Hreljin and the other at Križišće.

The bypass will be constructed to a dual two-lane standard, with a high structural content, including five viaducts (total length of 2.47 km) and three tunnels (combined length of 1.33 km). There will also be bridge works associated with the Hreljin interchange. Approximately 45% of the mainline motorway will be constructed either on viaduct or in tunnel. At straight sections the corridor comprises 100 m, with extensions in the interchange areas.

2.3 History of the Project

The construction of the state road D-8 is a spatial intervention that has undergone all legally prescribed procedures to determine the location: (i) environmental impact assessment, (ii) conformity of the Project with the physical planning documents and obtaining the location permit.

The environmental impact assessment (EIA) for the State road D-8 was made in 1986. At that time was not compulsory to grant the public an insight into such studies. The public consultation has been carried out as a part of the public physical planning procedure for the adoption of physical plans. Public participation has been ensured through public access to information and the public consultation procedures for each physical plan.

The construction of the state road D8 is planned in accordance with the relevant physical planning documentation: (a) Physical Planning Program of the Republic of Croatia; (b) Physical Plan of Primorsko Goranska County, and (c) Physical Plans of local communities, Town of Bakar, and Town of Kraljevica. The Physical Plan of Primorsko Goranska County, the Physical Plan of Bakar Municipality and the Physical Plan of Kraljevica Municipality were developed and adopted and defined in the context of the national traffic infrastructure strategy and the master plan. In accordance with the national master plan the Rijeka-Split Motorway (D-8) is an integral part of the national traffic network system.

The **Location Permit** for construction of the road Sv. Kuzam – Križišće from km 6+355,00 to km 14+720,00 and a connection road from Križišće junction to the state road D102 – Kraljevica D8 – Krk – Baška has been obtained (November 2002). The main design necessary for obtaining the building permit is being developed and the construction may start when the building permit is obtained.

2.4 Alternatives Considered

Alternative stretches for the road have been analysed through several generations of physical planning documents. All limitations and possibilities of space have been considered with regard to the existing natural resources and to the needs for a new road network. This analysis confirmed the selected location of these roads and resulted in selection of the corridor.

According to the legislation, when the physical planning documents are adopted, the discussion about alternative stretches is finished and is no longer a part of the design process of the roads. The road route has to run on the corridors approved and adopted by the State.

3. CURRENT ENVIRONMENT

Climate

The seaside i.e. the area through which the state road D-8 runs has the Mediterranean climate. It is **temperate warm rainy climate with no dry season and with hot summer** (classification Cfa). The mean temperature in the warmest month of the year is higher than 22°C but with no explicitly dry period.

In the area studied only sedimentary deposits have been identified, which according to the geological age belong to the Permian, Triassic, Jurassic, Palaeogene, and Quaternary periods.

Soil and geology

The subsection Sv. Kuzam - Hreljin is almost entirely situated within the complex of carboniferous consolidated rock; primarily carbonate rock (limestone). The terrain is naturally stable. The subsection Hreljin-Križišće is situated in the complex of finely-grained solid rock with cover of semi-consolidated and unconsolidated rock. A cover of semi-consolidated and non-consolidated rock that has relative stability, and is unstable in some places follows the complex of fine-grained clastic rock. The subsection of intersection Križišće – Connection to Kraljevica and the bridge Mainland – Island of Krk is situated in the complex of carboniferous consolidated solid rock (limestone and dolomite).

The motorway section considered has been located in the epicentral area of Rijeka. The highest recorded seismic intensity was VII-VIII degrees MCS.

Groundwater

The area studied is located in the littoral catchment region. In the motorway route area, the geological structure of the ground resembles karst characteristics with no distinguished surface hydrographic network. Water flows away by subsurface passages. Because of high degree of ground permeability waters penetrate quickly into deeper strata where they form ground watercourses emerging near the seacoast or under the sea level as submarine springs. In the Bakar Bay a large number of such submarine springs can be found that confirms a large distribution of limestone base.

Surface water

The subsection Sv. Kuzam - Hreljin is located in the catchment area of the water sources in Bakarski bay downstream (II sanitary zone of protection) of the water supply facilities. The subsection Hreljin - Križišće, connection with Kraljevica and the bridge Mainland – Island of Krk is located in the catchment area of the sea-shore in the Bay of Bakar (according to the Regulation concerning the categorization and classifications of the sea, it has been included in the Category II to prevent the contamination of the coastal sea).

Ecology and biotic resources

Most of the coastal area is a zone covered with deciduous sub-Mediterranean vegetation. It consists of degraded forests and underbrush of oriental hornbeam and pubescent oak, and rocky pastureland and dry grassland. At altitudes of 350 m and higher, hop hornbeam replaces oriental hornbeam thus creating a Mediterranean-

mountain vegetation belt. Negative human impact has substantially contributed to the basic physiognomic characteristic. In addition to low and undergrown forests, rocky and bare rocky ground cover a considerable part of the area. In such a typical Mediterranean ambient, preserved forest associations are especially noticeable. In the area studied there is an area with pubescent oak forests westward of Hreljin.

In accordance with currently available data there are no recorded habitats of rare and endangered plant and animal species in the bypass corridor.

Ambient air quality

The measurement results of air pollutant concentration show that the air quality in the greater part of the County is of the Category I – clean or slightly polluted air.

Noise

No systematic tests of noise level have been conducted to indicate the general noise condition and threat to the inhabitants because of noise.

Landscape

The corridor of the studied motorway section passes through an area recorded as a valuable natural landscape. Only on its outskirts it passes through the area of cultivated landscape.

Cultural heritage

A special place is the area of steep slopes along the Bakar Bay. Continuous series of drystone walls – luxuriant vineyards in the past – dominate the landscape. Today they are only a vivid example of harmonious relationship between man and nature. In addition to the exceptional landscape value, traces of long-term operation of natural processes are clearly seen on these surfaces. The Bakar Bay with its ethno zone of drystone walls, a natural heritage value that should be preserved in the present form to the maximum possible degree, is an ambient that stands out in the natural environment by its distinctive appearance.

There are many protected and registered localities and buildings in the construction area of D8 Motorway Section Sv. Kuzam – Križišće that belongs to the cultural and historic heritage of the Republic of Croatia. They are the ethno-zone of Bakarski prezidi (vineyards – Bakar drystone walls) and the ethno-zone that covers the villages of Krasica, Praputnjak, and Hreljin, the rural settlement of Križišće, the archaeological sites of Turčin, Rebar and Crni Vrh, the old town of Hreljin, the Church of Holy Trinity, and the graveyard Hreljin.

Land use and settlements patterns

The entire section Sv. Kuzam – Križišće passes through an area of free nature and outside of the area of villages. The corridor does not get into any building land area intended for the purposes such as tourist, commercial, and business facilities.

4. SIGNIFICANT ENVIRONMENTAL IMPACTS AND PLANNED MITIGATION MEASURES

4.1 Groundwater Resources

The bypass section Sv. Kuzam-Križišće will pass through an area, which serves as a catchment area for drinking water supplies. The construction of the bypass will be imminent risk for pollution of the groundwater.

In order to mitigate these effects a watertight system for collection of run-off water (storm water) and possible oil spillage, hazardous material, etc. will be built along the entire section. The collected water will be diverted to a treatment plant, and only then discharged into the sea. The plant is equipped with a buffer tank, in order to make it possible to collect the spillage from a vehicle carrying liquids that require additional chemical treatment before its discharge. The buffer tank also provides the possibility to collect the liquids for recycling.

4.2 Ambient Air Quality

Rijeka bypass road runs on terrain that enables higher natural circulation of air at these higher-elevation areas and together with decreasing the transit traffic it will significantly contribute to the reduction of the local air pollution.

Construction of the Rijeka Bypass would considerably relieve the existing traffic network. The Rijeka Bypass Motorway would take over the majority of the transit traffic, a significant portion of the origin–destination traffic as well as the local traffic heading across longer distances. All previously mentioned is going to significantly reduce the air pollution in the town of Rijeka caused by emission of motor vehicle exhaust gases.

The road corridor runs close to the building land area of the villages Hreljin and Mali Dol. When approaching the village Hreljin the road runs through a tunnel so no degradation of air quality is expected.

During the construction phase of the road the impact on air quality (dust and smoke) in the villages near the construction area (Hreljin, Mali Dol, and Križišće) is possible. However, this impact will be limited in time and extent.

4.3 Ecology and Biotic Resources

The construction of the road will affect the vegetation, flora and fauna. Direct consequences of the road construction will be unavoidable intrusion in the top-soil cover by mechanical force (construction machinery or explosive), the force that will considerably affect macro - and micro region of soil and vegetation, with further consequences in terms of fauna degradation. Indirect ruining and damages will be occurring permanently. Various agents from air and water, as well as human activities, may weaken the biological properties of the entire flora.

EXECUTIVE SUMMARY

It is necessary to restore, shape, horticulturally arrange and afforest all the route parts with autochthonous plants to reduce harmful and unfavourable impacts. The preservation of autochthonous plants is essential.

The road route is situated inside the urbanized area so high quality game, specially the big game, has already been pressed aside. Only the small-feathered fauna, of interest for hunting activities, can be expected to survive and remain in the area.

During the design activities fences must be envisaged along the entire section. Special attention must be paid to the construction of the fences in the parts where the viaducts and bridges end, at the beginning of the fence, and at potential sites where animals enter on the motorway area, which has to be strictly prevented.

When designing the road it shall be checked if all the planned viaducts meet fully the requirements for facilitating game crossing.

4.4 Geology and Soil

The subsection Sv. Kuzam - Hreljin is almost entirely situated within naturally stable terrain. With proper choice of slopes for cuts and side cuts, adverse impacts of construction will be reduced to the minimum.

The subsection Hreljin-Križišće is situated within relative stable, and partly unstable (in some places follows the complex of fine-grained clastic rock) terrain. In addition to given geological and hydrological conditions on the slope, critical impact on stability is generated by drained groundwater, in the contact of base and cover. The impact of human activities on semi-stable slopes is also important.

The subsection intersection Križišće – Connection to Kraljevica and Bridge Mainland – Island of Krk is situated in a complex of carboniferous consolidated solid rock (limestone and dolomite). Because of stable terrain, small excavations, and the number and size of structures, the impacts of construction on the ground are expected to be negligible.

The design should include the results of stability analysis of the natural condition as well as of the as-built condition on the entire slope along the route (general stability). Design solutions of cuts and side cuts, partly also fill, are usually retaining structures that contain also have drainages in the contact of base and cover. Enclosed drainage of the surface runoff on the carriageway along the route is essential. Collected water should be taken by the enclosed impermeable ducts to the stable areas of natural (or regulated) waterbeds able to receive quantities of water that would have otherwise disturb natural drainage flows and distribution of water.

During construction the stability could be affected by various impacts, which has to be taken into account in the construction methods.

The impact on soil is manifested through a permanent conversion of the land use and represents a significant impact on the environment. The soil covered with asphalt will permanently lose their productive and protective functions and the ground used for

the verges and the road slope is usually subject to different changes (sweeping off, removal, covering, concreting, impregnation, compacting, etc.) that often result in far-reaching and irremediable consequences for the soil/ground.

4.5 Noise

The terrain configuration is from acoustic point of view rather unfavourable. Since the road route is laid mainly in the free, un-built terrain, increased traffic noise could influence only residential area of Hreljin and Mali Dol.

The noise barriers (acoustic walls) and the hedges (trees) will be planted along the road where needed.

The construction of the bypass will divert the transit traffic from the existing road running through the villages, which will decrease current high noise in the villages.

4. 6 Visual Impacts

The terrain at this section is very difficult, steep and visually very much exposed from all the sides, from the sea particularly. Special attention should be paid to the aesthetic aspect of the Project that is the roadbed design and good horticultural development of the broader area. In aesthetic terms, with respect to visually prominent edge of the plateau above the Bay of Bakar, any fills and disposal of excess material on the slopes could cause significant changes. Natural material is recommended as well as landscaping of fill on the southwestern side of the road.

4.7 Modified Communal Infrastructure

To ensure normal life in the villages near the road, new pedestrian and road passages and crossings will be constructed as a replacement during the interruption caused by the road construction.

4.8 Cultural Heritage

There are many protected and registered localities and buildings in the construction area of D8 Motorway Section Sv. Kuzam – Križišće categorized as cultural and historic heritage of the Republic of Croatia. Because of the vicinity of construction, the localities could be damaged. The vicinity of construction could also decrease the visual values of the broader surrounding of the individual sites. This particularly refers to the Bakar vineyards because of close vicinity of the motorway route (only 20 m distance from the route axis). Special attention should be paid to that site during the motorway construction to avoid potential damage to their value given their historic importance.

If during the motorway construction the presence of new individual historic sites not known thus far is found, this could be considered a positive impact of the motorway construction.

4.9 Land Acquisition

Croatian Roads will acquire the land for construction of the road D-8. The land acquisition for the adjacent section Orehovica - Draga – Sv. Kuzam has been completed. On the section Sv. Kuzam - Križišće the land acquisition process is still ongoing, and the compensation will be provided in accordance with the Croatian Law, which stipulates reimbursement at prevailing market prices.

4.10 Resettlement

There is no need for resettlement on the road route.

4.11 Environmental, Health and Safety, and Social Benefits

Substantial environmental and other benefits will result from construction of this section of motorway D8:

- Increase in traffic safety - The road has been designed according to high traffic standards with technical elements of a motorway.
- Relieve of the city road network from trucks is considered the largest improvement in the traffic situation.
- The transit will be routed to the bypass road thus avoiding the residential areas in the city and the city centre, and resolving many conflicts with complex traffic situations in the city.
- City areas will be directly connected to the bypass road by a junction.
- Shorter connections to the Rijeka port basin through Škurinje junction, Sušak basin through Draga junction, and Bakar basin through Vitoševo junction.
- Interconnection of the city parts (1/3 of the total foreseen traffic is of local character).
- The use of the natural conditions (succession of the valleys and mountains along the road route for execution of connections to the existing and planned city roads), which are the most economic ones on the route foreseen.

5. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

An Environmental Management Plan (EMP) has been developed to define all the activities that require recording and monitoring and to identify the responsibility for supervision and implementation of the EMPs, training needs, and reporting requirements. The Croatian Roads, a co-ordinator for environmental issues, will guarantee the compliance with the EMP. In addition, the Rijeka County Branch of the Ministry of Environment will control on a regular basis that the requirements set out in the EMPs are followed.

EXECUTIVE SUMMARY

MONITORING PLAN

MONITORING PLAN						Cost		Responsibility	
						Install	Operate	Install	Operate
Phase	What <i>parameters to monitor?</i>	Where <i>to monitor the parameter?</i>	How <i>to monitor the parameter / type of monitoring equipment</i>	When <i>to monitor the parameter – occasional or continuous measurement?</i>	Why <i>to monitor the parameter (optional)?</i>				
Operate	<ul style="list-style-type: none"> • Air quality • Water Quality • Bio-monitoring (state of epiphyte lichen) • Hunting • Noise • Equipment 	<ul style="list-style-type: none"> • Control points • On the exit of the separators • Some permanent stations need to be established near the route • On the specific distance from the road • On wider area around road route • Along the road • control points at border of residential areas • Drainage and separators • Whole route, especially junctions, viaducts 	<ul style="list-style-type: none"> • SO₂, black smoke, NO₂ sediment (Pb) • Measurement of a series of law-regulated parameters • Measuring of cellular membrane • Lead concentration • Tree drying • Changes of plants and animals • Monitor and report all accidents involving game or damages to the rail • Measurement of noise intensity on control points • Condition of drainage and separators • Condition of equipment for traffic managing, surveillance and control 	<ul style="list-style-type: none"> Continuous measurement Quarterly in relevant hydrological conditions (period of first rain, especially after dry period), Before and after the road was in function Continuous Quarterly Twice a year Monthly 	<ul style="list-style-type: none"> Population protection Legal requirements Sea and Groundwater protection Legal requirements Vegetation and animals protection Animal protection Population protection Legal requirements Groundwater protection Groundwater protection 			<ul style="list-style-type: none"> Croatian Roads Qualified Organizations Croatian Roads Croatian Roads 	<ul style="list-style-type: none"> Tests at qualified organizations Tests at qualified organizations Tests at qualified organizations Authorized person Authorized person

OPERATIONAL CONTEXT**C. INSTITUTIONAL STRENGTHENING**

1. Equipment Purchases – After adoption of Main (final) design.
2. Training/Study Tours – not necessary
3. Consultant Services – not necessary
3. Special Studies - not necessary*

D. SCHEDULE

The construction of the road is a part of medium-term plan for 2005-2008. All activities considered with mitigation and monitoring will be coordinated with start and end of construction and during operate of the road.

E. INSTITUTIONAL ARRANGEMENTS

Responsibilities for mitigation and monitoring	Environmental information flow (reporting—from who to whom and how often)	Decision making chain of command for environmental management (to take action, to authorize expenditures, to shut down, etc.)	
		Activities	Responsibility Institution or person
HRVATSKE CESTE (Croatian Roads)	HRVATSKE CESTE (Croatian Roads) to Ministry for Environmental Protection, Physical Planning and Building (MEPPPB), Environmental Protection Division	Monitoring the implementation of Environmental Management Plan	HRVATSKE CESTE - Head of Project Team, Authorized Person Environmental Inspector - Environmental Division (MEPPP) Sanitary Inspector - State Directorate for Water Management, County Department
		Data collection and analysis	HRVATSKE CESTE (Croatian Roads) Environmental Inspector - Environmental Division (MEPPP)
		Monitoring Reports to Environmental Division (MEPPPB) – quarterly	HRVATSKE CESTE - (authorised organization)
		Operational Plan for an emergency cases - yearly	Head of the HRVATSKE CESTE Environmental Inspector Environmental Department (MEPPPB)

The organisational structure of the state and local governments in the Republic of Croatia guarantees the implementation of certain environmental protection measures and the control of their efficiency by monitoring. The implementation is controlled institutionally through the Ministry of Environmental Protection and Physical Planning and through the organisational units in the Counties.

* The study of impact on cultural and historic heritage conditioned by Location Permit was completed at the beginning of 2004.

OPERATIONAL CONTEXT

The Investor is responsible for financing, implementation of the measures prescribed and monitoring the environment condition. The implementation of prescribed protection measures (mitigation measures) and monitoring will be supervised during construction and carried out during operation by HC (Hrvatske ceste).

During construction phase implementation of prescribed protection measures (mitigation measures) is responsibility of contractor. Control of implementation of mitigation measures in this phase is by Ministry of Environmental Protection, Physical Planning and Building, Inspection Division, Construction inspector.

During operation phase implementation of mitigation measures are responsibility of the owner, and control of their efficiency by monitoring is responsibility of either MEPPPB (Environmental Protection Division and county environmental inspector), or State Directorate for Water Management, County Department.

The monitoring of the environment condition in the Republic of Croatia is performed by the organisations authorised by the Ministry of Environmental Protection, Physical Planning and Building.

6. PUBLIC CONSULTATION AND INFORMATION

The public disclosure and consultations will follow the EIA Update process and consist of three phases:

Phase I - Scoping

The Scoping Document describing the Project and the key findings and conclusions of the 1986 EIA study as well as the Public Disclosure and Consultation Plan were made available to public at the beginning of March 2004. A round table discussion was held on 18 March in Rijeka and will address the scope of the EIA Update and the process of the public involvement. The purpose of the scoping was to ensure that all potentially significant issues, including adverse impacts on human and natural environment are assessed in the EIA Update, and that efficient mitigation measures are incorporated in the Project.

Phase II

The draft EIA Update together with this Executive Summary has been made available to public for review and comments for 120 days public comment period between (1 July and 28 October) at:

- Local library,
- Municipal offices, and
- The website of Croatian Roads and EBRD

The public has been informed on availability of the EIA Update in national and local newspapers invited to express their views on the assessment of environmental impacts and recommended mitigation and environmental protection measures.

Phase III

Final EIA Update, with a summary of public comments and a description of how they have been taken into consideration in the Project, will be disclosed to public at the same locations as the draft EIA Update during phase II by the end of October 2004.

7. INFORMATION SOURCES

- **EIA 1986**

- The disclosure package (EIA in Croatian and English)
- Strategy of Republic of Croatia
- Physical Planning Program of Republic of Croatia
- Physical Plan of Primorsko-goranska County
- Physical Plan of Town of Bakar, 2003.
- Physical Plan of Town of Kraljevica, 2003.
- The Report of the Current State of the Environment in Primorsko Goranska County, 2003.
- Preliminary design for Adriatic Highway, section Sv. Kuzam – Križišće with connection to junction Šmrika, 1991.
- Preliminary design for construction of the road D8, section Sv. Kuzam – Križišće and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk – Baška, 2003.
- Location permit for construction of the road Sv. Kuzam – Križišće and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk – Baška

1.0 Operational Context

The section Sv. Kuzam – Križišće, a part of the state road D8, is an extension of the section Orehovica – Sv. Kuzam, which is under construction. At the interchange Križišće, the state road D102 will be linked to the interchange Šmrika by a connection road by which this part of the road network will be completed and made operational.

A location permit has been obtained for this motorway section. The main design documents have been developed, which will be a basis for obtaining the construction permit.

The property relations, being a legal basis for obtaining the construction permit, have to be solved during the construction permit application process. For that purpose the Croatian Roads have to purchase more land for construction of the motorway and for the interchanges planned on the section. All land purchased for that purpose is paid in line with the applicable laws prescribing the remuneration following the prices prevailing in the market.

Neither on the motorway route nor in its imminent vicinity there are any built houses that could be an obstacle for constructing the motorway.

When the construction permit is obtained, the works on the working design documentation will start. Together with the main design documentation they will be a basis for competitive bidding for the most favourable contractor and the construction may start when it is selected. The beginning of the works is scheduled in spring 2005 and the construction should take 24 months. The Croatian Roads will co-ordinate all the works and activities during the construction.

1.1 Purpose and Need

The time in the Croatian economy from 2000 to 2010 is a period during which it will be necessary to ensure economic stability through economic policy measures, as well as economic growth, employment, production, and export increase. It is also necessary to increase the efficiency of the entire economy and restructure inefficient economic sectors as a basis for further faster increase in production. Economic growth in the next period is expected to reach the growth rate of more than 5% a year and a stronger recovery of industry is projected. The process of reorganization and privatisation is a prerequisite that should encourage the inflow of foreign capital into export-oriented industries, establish a market, and ensure the transfer of technology, modern organization and management. This will enable the modernization of industrial production and productivity increase and, as a consequence thereof, the projected economic growth.

Development of the Croatian economy as a whole, and particularly development of tourism being one of the most attractive destinations in Europe depends directly on development of the Croatian road network and its integration into the Central

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European, Adriatic, and Mediterranean road network in which the arterial, international motorway routes Budapest – Zagreb – Rijeka – Trieste and Rijeka – Split – Dubrovnik – Podgorica – Skopje are the most important road corridors in Croatia.

These two very important directions (longitudinal towards Italy, Istria and Slovenia extending to the Adriatic road direction in direction of Lika and Dalmacija, and the transversal towards Zagreb, Budapest and Vienna) will intersect on the Rijeka Transport Junction, which is also called the Rijeka Bypass because of its physical and functional connections at the state, regional, and local levels. To complete the Rijeka Transport Junction, the construction of the motorway section Orehovica – Križišće is an imperative as well as the completion of the construction of the second extension of the section Orehovica – Matulji.

Since the Bypass section from the interchange Škurinje towards Bakar, Crikvenica and on has not been built yet, most of the transit and longitudinal traffic heavily burdens the town road network. The existing roads take over long-distance transit, regional traffic, and city and intercity traffic (connections with the County centre and the tourist areas). None of the traffic levels mentioned is satisfactory. It is a cause of traffic jams during rush hours and frequent car accidents, and the travel speed is reduced. This very much affects the quality of life of local residents and performance of business entities (tourist industry in particular).

With completion of the road network a fast and a good quality link at the state level will be provided. The Rijeka road network will be relieved of heavy traffic and its operation and the quality of life in the housing settlements along the roads, which are currently burdened with transit traffic, will improve. By relieving the heavily congested city centre, the Adriatic highway will become free for local transport, which will improve life in the villages and the housing settlements.

The newly constructed section will integrate the eastern economic zones into the international road network and connect the tourist settlements on the coast and on the island of Krk to the motorway network. Security will be higher for all types of transport and the travel time and costs will be reduced.

1.2 Legal and Institutional Framework

In the Republic of Croatia the environmental issues are governed by the legal acts which completely encompass the protection of the environment, its rational economy, restoration of its previous conditions and planning of all the environmental actions and procedures, the goal of which is the balance of the natural and man-made elements in their mutual correlation.

The legal system of the Republic of Croatia contains a number of specific acts and laws which are governing the measures of environmental protection, which all indicate the integrity of the existing legislation aiming at encompassing the entire area of the environmental protection in the State.

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Legal acts that basically deal with the environmental protection regulations are included into the so-called general ecological legal acts. They define the institutional framework and practical implementation in the field of environmental protection, the status and functions of the central government bodies and agencies, and the local authorities responsible for environmental protection, special instruments of the programme, the assessment of the environmental impact, and the accessibility of information about environmental protection.

A number of fundamental laws and legal acts governing environmental protection issues has been enacted, such as the Law on the protection of nature, the Law on the protection of environment, the Law on waste, the Law on communal economy, the Law on waters, the Law on the protection of air etc. Together with above-mentioned laws which regulate certain aspects of the economic and social life, other equally important regulations addressing the measures for protection of certain areas of the environment have also been passed, such as the Maritime law, Law on Agricultural Land, Law on Forests, Law on Fishing, Law on Concessions, etc.

Environmental protection is additionally regulated by numerous by-laws such as the Statute on environmental impact assessment, the Regulation concerning the sea quality standards at beaches, the Regulation on classification of waters, the National plan for protection of waters, the Regulation on the limit values of indicators of hazardous substances in liquid waste, the Regulation concerning the medical quality of drinking water, the Action Plan in environmental protection, the Regulation concerning the types of waste, the Regulation on the emission inventory, the Statute on recommended and limit values of air quality, the Regulation concerning the limit emission of pollutants into air from stationary sources, the Statute on protection of agricultural lands from contamination with hazardous substances, as well as many others which are not directly related to the subject of this Study.

In order to avoid consequences caused in the environment by individual actions, especially in the coastal areas, the principle of viable growth is the basic measure taken into consideration when making the Study.

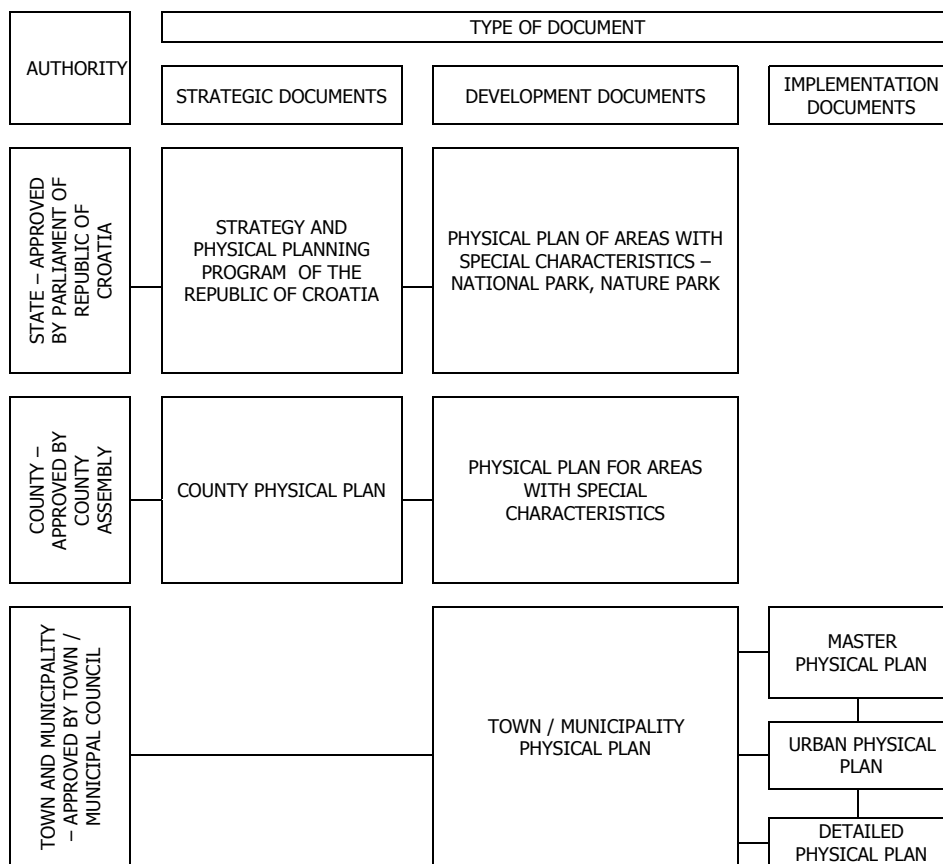
Law on Physical Planning¹ as a principal law regulates the system of physical planning in Croatia. This law imposes the obligation for preparation of various physical plans, both in terms of their level and scope. The higher-level physical plans determine the strategy and concept of development, while the lower-level physical plans determine further conditions for physical planning. The standard method of making and elaborating physical plans (physical planning documents) is determined by the Law on Physical Planning and the Rule Book on the contents, criteria for mapping, required spatial indicators and the standard of the physical planning studies³.

The **Physical Planning Strategy**² and the **Physical Planning Program of Croatia**³ are the documents that establish basic guidelines for long-term development of the area at the national level and are the starting point for physical planning in the Republic of Croatia (they involve space and all environmental elements, as well as the state policy of environmental protection).

The Strategy determines long-term goals of physical development and planning in accordance with an overall economic, social and cultural development, and includes the basis for co-ordination and direction of physical development, the physical organization (settlement pattern) of the State, priority development as well as the planning systems with common physical and developmental characteristics that will be the subject matter of the physical plans or other physical planning documents.

The Physical Planning Program of Croatia provides the measures and activities for the implementation of the Strategy and it is a key document all the physical planning documents at the lower level shall comply with. In addition to more specific goals of physical development, it includes the criteria and guidelines for designing physical and other entities, as well as a proposal for priorities to achieve the goals of physical planning. On the basis of natural, economic, social and cultural starting positions, it determines the basis for settlement pattern, and protection, use and purpose of space/land, environmental protection and development, the system of central populated areas and the system of the state development infrastructure.

Picture 1. Illustration of physical planning system



The next in the hierarchy of the spatial/physical plans resulting from the Spatial/Land Planning Program are the **Physical Plans of the Counties. The County Physical Plan**, by recognizing the natural, cultural, historical and landscape values, elaborates the principles of physical planning and determines the goals of physical development, as well as the settlement pattern, protection, use and purpose of the

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space/land. The Physical Plan includes the County's physical and economic structure, the system of central populated areas of regional importance, the development system of regional infrastructure, bases for physical planning and protection, measures and guidelines for economic development, preservation and improvement of natural, cultural and historical, and landscape values, measures for the advancement and protection of environment as well as other elements important for the county. The county, i.e. the city assembly, issues the physical plan after obtaining consent from the Ministry of Environmental Protection and Physical Planning on its compliance with the State Strategy and Program of Physical Planning and the provisions of the Law on Physical Planning.

The physical plan of the areas with special characteristics determines, with regard to common natural, cultural and other characteristics, the basic settlement pattern, the measures for use, design and protection of the area following the identified priority, measures for environmental improvement and protection, and, when necessary, determines the obligation of drawing up detailed physical plans for smaller units within the physical plan. The physical plan is compulsory for the national parks and for the nature parks, as well as for the areas that have to meet that obligation according to the State Physical Planning Program or the Physical Plan of the County.

The municipality or town physical plan determines the conditions for physical planning of municipal or city areas, determines purposeful use, purpose, landscaping, reconstruction and recovery of building land and other areas, environmental protection and protection of cultural heritage and particularly the protection of valuable parts of the nature in the municipality, i.e. the City. The physical plan provides a basis for physical development, goals of physical planning, purpose of the space, standards, guidelines and terms of use, protection and design of the space, as well as other elements important for the district, i.e. city area. The district or city physical plan is issued by the district, i.e. city assembly, upon obtaining consent from the county institute on its compliance with the county physical plan.

The master physical plan determines the basic settlement pattern, protection of natural, cultural and historical values, use and purpose of the areas with a proposal for the planning priorities. **A detailed physical plan** determines in detail the purpose of areas, the modes of physical planning, methods for providing communal, traffic and telecommunications infrastructure, conditions for construction of buildings and for other activities in the area, as well as other elements important for the areas covered by the Physical Plan.

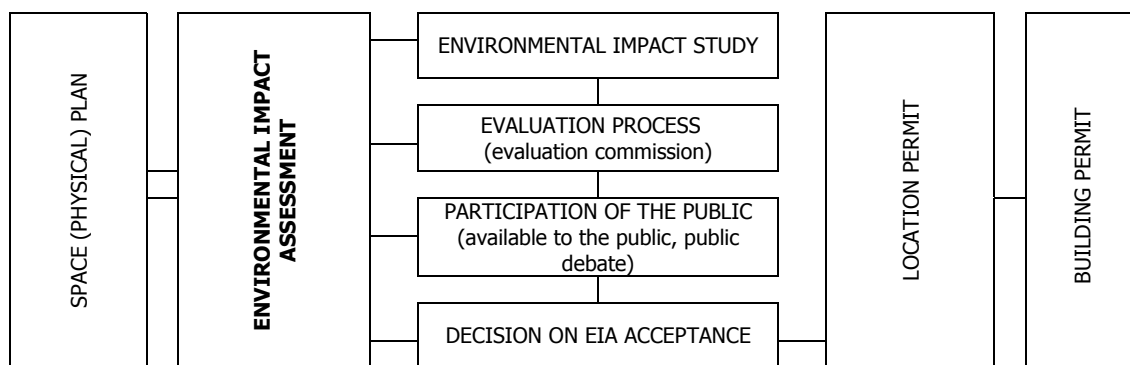
The participation of the public in the process of physical planning is legally ensured. During the adoption process all physical planning documents must be put up for public debate on the physical planning proposal. The governmental administrative bodies, local self-government and government units, legal entities having public authorities also participate in this process.

PRECONDITIONS FOR CONSTRUCTION

Every intervention in space is carried out in accordance with the physical planning documents, special regulations, and the location permit. **The Location Permit** is an administrative decision issued on the basis of the physical planning documents and special acts and regulations based on that legislation. The Ministry of Environmental Protection and Physical Planning issues a LOCATION PERMIT for the buildings of special national interest and for interventions in space which cover the areas of two or more counties. The Government of the Republic of Croatia determines the structures of special national interest. The LOCATION PERMIT also includes the excerpts from physical planning documents on the basis of which the permit is issued and it is a prerequisite for issuance of the building permit.

Some interventions in the space require an assessment of the environmental impact, which is done on the basis of the Environmental Protection Law⁴ and a special regulation – a **Bylaw on Environmental Impact Assessment**⁵, which determines the interventions that require an assessment of the environmental impact (A List of Interventions is an integral part of the Bylaw). The obligation to make the EIA can also be stipulated by the physical plans. The obligation of drawing up an environmental impact assessment for an intervention in space is fulfilled by making the technical documents for the environmental impact assessment – an Environmental Impact Assessment Study.

Figure 2. Procedure for obtaining the building permit for interventions in space of national interest



The environmental impact assessment is a procedure of evaluating the adequacy of the intended intervention in the environment and identification of necessary environmental protection measures, i.e. before issuance of a LOCATION PERMIT or other approval for an intervention that does not require a LOCATION PERMIT.

The commission for the assessment of adequacy of an intervention makes the assessment of the environmental impact of the intervention and develops a study, which is made available to the public and their participation in the process. The commission gives a proposal whether to approve or refuse to approve the intended intervention. If the environmental impact assessment is required, the LOCATION PERMIT is issued only after the approval of Environmental Impact Study for the intervention in question.

The Building Permit⁶ is a document (administrative decision) on the basis of which the construction of a building can be initiated. It establishes that the master plan, i.e. the basic design has been made in conformity with the regulations and requirements the structure on that particular location has to meet, and that all the construction prerequisites have been met. The Construction Law regulates the building permit issuance⁷.

The construction of state road D8, section Sv. Kuzam - Križišće is an intervention in the space of national importance. That means that the Ministry of the Environment and Physical Planning is authorized for issuing the BUILDING and LOCATION PERMITS. With regard to the importance of the intervention, an environmental impact study should be made before the issuance of the location that is the building permit.

1.3 History of the Project and the Alternatives Considered

The construction of motorways and fast roads on the major traffic routes in the State has been established as one of the goals of the traffic system development in the Physical Planning Program of Croatia. The priority by the year 2005 is the construction of bypass roads on the state roads in all larger populated areas and connection of the traffic-isolated parts in the State, as well as the construction of already started road section and the new motorway and fast road sections.

When the Environmental Impact Assessment (EIA) for the State Road D 8 was made (1986), public consultations were not compulsory and the public did not have to have an insight in EIS. This deficiency was remedied through the procedure of the physical plan adoption, which enabled the participation of the public through public debates that became compulsory for each physical plan.

However, the Physical Plan of Primorsko Goranska County (Official Gazette No. 14/00), the Physical Plan of the Bakar Municipality (Official Gazette No. 21/03) and the Physical Plan of the Kraljevica Municipality (Official Gazette No. 1/03) were developed and adopted and defined in terms of concept and physical plan of the traffic infrastructure as a part of the national infrastructure system, in which the Rijeka - Split motorway (D 8) became a part of the Croatian traffic system.

In line therewith, the works on completion of the Bypass have continued. The section Meja - Orehovica (a two-lane single motorway) has been partly finished and it has been in operation for more than ten years. Currently the section Orehovica - Sv. Kuzam is under construction.

So far the following documents, necessary for obtaining location and building permits, have been made:

- The environmental impact study, Adriatic Coast Highway Rijeka – Split – Dubrovnik

Section: D. Orehovica – Sv. Kuzam – Križišće (current designation **D8**) with the connection road Križišće – Bridge Mainland – Island of Krk (current designation **D102**)

Client: RSIZ za ceste SRH, Zagreb Vončinina 3
Contractor: Rijekaprojekt, Rijeka, Moše Albaharija 10a
Date: September 1986.

A Conclusion of adopting the final EIS for the Project of Adriatic Highway, section Orehovica – Vitoševo – Križišće with a connection to the Mainland – Island of Krk Bridge:

Class: 002-05-89-02/18(5)
Number: 2170-02-01-89-001
Date: April 1989.

- Preliminary design for Adriatic Highway, section Sv. Kuzam – Križišće with connection to junction Šmrika
Client: Hrvatske ceste, Zagreb Vončinina 3
Contractor: Rijekaprojekt – Vodogradnja, Rijeka, Moše Albaharija 10a
Date: 1991.
- Technical Documentation for Location permit for the road D8, section Sv. Kuzam – Križišće
Client: Hrvatske ceste, Zagreb Vončinina 3
Contractor: Rijekaprojekt, Rijeka, Moše Albaharija 10a
Date: April 2002.
- Preliminary design for construction of the road Sv. Kuzam – Križišće from km 6+355,00 - km 14+720, 00 and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk - Baška;
Client: Hrvatske ceste, Zagreb Vončinina 3
Contractor: Rijekaprojekt, Rijeka, Moše Albaharija 10a
Date: July 2003.
- **Location permit** for construction of the road Sv. Kuzam – Križišće from km 6+355,00 - km 14+720, 00 and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk – Baška has been obtained:

Class: UP/I-350-05/02-01/0047,
Number: 531-08/2-02-15/SŠ
Date: November 2002.

Development of the Main Design has been in progress and it will be a basis for applying for the construction permit thereupon the construction of the motorway may start.

ALTERNATIVE STRETCHES for the roads were analysed through several generations of physical planning documents. All restrictions and possibilities of the space have been analysed in terms of the existing natural resources and to the needs for a new road network. This analysis has confirmed the selected locations for those roads. The road routes (locations) for D-8 and D-404 were established and approved 20 years ago and since then throughout all physical planning documents those corridors have been kept and preserved from any construction. Environmental impact studies were made for those established routes in accordance with that time valid legislation. The final routes of these roads were selected and confirmed in the valid physical planning documents (Physical Plan of Primorsko Goranska County and Physical Plan of Bakar and Kraljevica) in accordance with the Law on Physical Planning as well as with the Physical Planning Program of the Republic of Croatia (all physical planning documents must respect the provision of this Program).

It is important to mention that the location of this road was also determined and approved in regard to the existing buildings, adjacent road infrastructure, connecting points and land configuration. The Bypass road, section Orehovica – Sv. Kuzam, is actually only a part of the state road D-8, which was determined and approved by the Physical Plan of Primorsko Goranska County as explained above. It is much more unfavourable to construct this road on the plateau above Rijeka, because in terms of environmental protection the situation is getting more and more tense. The hinterland of Rijeka is an area from which water is strained into the underground, springs in the sea close to the coast. The road through the hinterland of Rijeka is much more dangerous because of pollution and what is even more important the contaminated waters would have to let through the separators and then into the ground. It would be impossible to conduct them to the sea due to the distance, 4-6 km. Construction of the Bypass road started with construction of the section Meja - Škurinje – Orehovica, which has been in use for the past ten years. The section Orehovica – Sv. Kuzam is under construction, and the section Sv. Kuzam – Križišće is eastern continuation of the planned Bypass road.

According to the legislation, after adoption of the physical planning documents, the discussion on the alternative stretches is finished and is no longer a part of the road design process. The road routes have to run on the corridors agreed.

DESCRIPTION OF THE OPERATION**2.0 Project Description**

The State road D-8 is a part of the road routes, which is of wider European importance and therefore included in the European Network of Roads. They are:

D-3: Letenje – Zagreb – Karlovac – Rijeka – Trieste (E – 65, E – 71, E-63)

D-8: Koper – Pula – Rijeka – Split – Dubrovnik (E – 751, E – 65 – E – 80)

The section of the state road Sv. Kuzam – Križišće is the end east section of the Rijeka Bypass that extends to the section Orehovica – Draga – Sv. Kuzam. It starts at km 6+355.00 and ends at km 14+720.00 and is 8.365 km long. Two interchanges have been planned on the section, the interchange Hreljin and the interchange Križišće.

At the interchange Hreljin a road connects to the state road D501 and at the interchange Križišće there is a diverging road to the state road D102 to the island of Krk (to newly built intersection of the county road Ž5064 and the state road D102) north of the interchange Šmrika to D8 (The Adriatic Tourist Road).

A section of the motorway Sv. Kuzam – Križišće is a replacement for the existing Adriatic Tourist Road running through the Bakar Bay and Kostrena and bypassing the urban areas of the eastern part of Rijeka (Kostrena, Bakar, Bakarac, Kraljevica and Šmrika).

According to the traffic count performed in 2000, the average daily traffic (ADT) per year on the road D8 was 11,053 vehicles/day and the average daily traffic (ADT) in the summer period was 18,781 vehicles/day. According to the traffic projections, the traffic burden on the section is expected to be as follows:

Year	ADT / year	ADT in summer
2010	16,750	27,300
2020	26,000	39,500
2025	32,400	47,600

The section route runs mostly on the ground made of carbonate rocks (limestones and dolomites) and its smaller part on flysch, siltstone, marl, and sandstone sediments.

The section Sv. Kuzam – Križišće runs through morphologically very developed topography in the imminent vicinity of the Bakar Bay hinterland.

In terms of hydrogeology, the ground is permeable carbonate complex of rocks and impermeable small-grained clastic complex of rocks. Permeable rocks are the catchments of temporary and permanent coastal springs in the Bakar Bay.

The ground in the area planned for the interchange Križišće is made of siltstones, marl, sandstones, breccia, and conglomerates characterized by poor or no permeability, and a high coefficient of surface water runoff. In the flysch area, the

DESCRIPTION OF THE OPERATION

surface runoff creates a network of torrents that causes erosion and instability of the slopes and landslides.

The section Sv. Kuzam – Križišće runs on the edge of the plateau above the Bakar Bay. Most of its length runs on the sea side of the north Bakar Bay slopes to Hreljin and from there it turns towards the south-west and passes south of the state road D501. North of the planned section route, along the County road Ž5050 the villages of Krasica, Praputnjak, Hreljin, Ružić selo, Mali Dol and Križišće are situated.

The route of the section Sv. Kuzam – Križišće has all the technical elements for the design speed of $V_p = 100$ km/h. Following the Bylaw of Public Roads it belongs to the first category of the roads with two dual-lane carriageways and a dividing lane.

The axis of the section route has been designed in 14 counter-direction curves of $R=750$ m to $R=2000$ m with 988.85 m long straight line in the area of planned marshalling yard at Krasica. The lengths of the crossings range from 130 to 170 m, which is more than $I_{min}=75$ m for the foreseen speed of 100 km/h. In the areas where the tunnels Gradina, Burlica, and Kuk have been foreseen, the separate axes have been designed at a distance of 20 m, which will enable construction of the tunnel tubes.

All the crossings with the existing roads and the pedestrian lanes, as well as other communications will be solved at two levels with regard to the Bypass main route. The section route runs in the vicinity of the village area so it will be necessary to construct a series of passages and crossings to establish the communications that have been cut:

- Pedestrian passage Jelovka at km 7+550.0
- Pedestrian crossing at km 8+580.0
- Reconstruction of the road Bakar – Meja (Ž5060) at km 10+216.0
- Road crossing Turinovo – Hreljin I at km 11+836.0
- Pedestrian passage Turinovo – Hreljin II at km 12+640.0, and
- Reconstruction of the carriageway Turinovo – Križišće (Baretića Village) at km 14+120.0.

In addition to the above road and pedestrian passages and crossings, it will be necessary to re-lay the current infrastructure that has been cut by construction of the section (electric installation, phone installations, water and gas pipelines).

To overcome the land topography, the following viaducts and tunnels are planned on the section:

- Viaduct Tabor, 280 m long (north axis) and 315 m long (south axis),
- Viaduct Vršina, 455 m long
- Tunnel Gradina, 530 m (north axis) and 350 m (south axis),
- Viaduct Praputnjak, 400 m (north axis) and 395 m (south axis),
- Tunnel Burlica, 741.5 m (north axis) and 748.5 m (south axis),
- Tunnel Kuk, 135 m (north axis) and 115 m (south axis),

DESCRIPTION OF THE OPERATION

- Viaduct Kuk, 326 m (north axis) and 343 m (south axis),
- Viaduct Sv. Trojica near the interchange Križišće, 840 m long (north axis) and 990 m (south axis).

The route level has been determined by the land topography and the points it has to pass because of other communications intersection with it and because of the route connection with the existing road network at the interchanges Hreljin and Križišće. The limit characteristics are: ascent/incline 4.8%, the highest elevation at the section 235 m, the lowest elevation 167 m, the highest fill 12 m, and the highest cut in the axis 13 m.

The carriageway structure has been determined on the basis of the traffic analysis and the traffic forecasts for a 20-year period and it is the same as the carriageway structure adapted for the previous section (Orehovica – Draga – Sv. Kuzam).

The drainage system includes the drainage of the carriageway and the surface runoff. The carriageway drainage will be performed as a closed drainage system because the section is located in the second zone of sanitary protection of springs. The runoff from the carriageway is collected by the sewers and conducted to the intercepting traps. After separation of oil and grease, the runoff is conducted to the recipient by a watertight sewer. In the cuts, at the lowest side of the carriageway, 75 cm wide concrete intercepting ditches are foreseen and on the other parts of the route 15 cm high kerbs will be provided.

Surface runoff from the hilly side of the motorway will be collected by a system of peripheral ditches and conducted by outlets through the roadbed.

At the places where according to the geological data there is an aquifer overlaying siltstones, drainage of seepage water has been solved by a drain system to insure the stability of the roadbed. Occasional springs located on the route or endangering the stability of the roadbed or the structures will be intercepted and drained outside the roadbed.

The motorway will be provided with the lighting and the power supply, safety equipment for the tunnels, control system, SOS communication, phone installations – a signalling cable, tunnel ventilation, fire alarm, and wind protection if necessary.

DESCRIPTION OF THE CURRENT STATE OF THE ENVIRONMENT**3.0 Description of the Current State of the Environment⁸**

Following its natural geographic, economic and social and historical and cultural characteristics the territory of Primorsko Goranska County can be divided into three sub-regions of much the same size. They are **coastal, island and mountain** regions. The differences in the region quality and the road network and connections are considerable.

The D8 motorway section Sv. Kuzam-Križišće runs through the area of Bakar and Kraljevica towns in the coastal part of the County.

3.1 Climatic Conditions

The climate in the County is very different due to diverse land configuration and the influence of the sea and the continental hinterland. The climate on the islands and on the seaside is the Mediterranean climate, the sub Mediterranean climate is at the mean altitudes (400-900 m), and continental in the mountain region.

The climate in the Primorsko Goranska County is affected by many factors of which the most important are the impact of the sea on the coastal part and on the islands and the impact of the mountains in the remaining part of the County.

According to the most frequently used the Climate Classification by Köppen, the climate in the narrow coastal belt (Opatija, Rijeka, Bakar, Kraljevica, Crikvenica, Novi Vinodolski) and the most northern part of the island of Krk (Omišalj) is **temperate worm rainy climate with no dry season and with hot summer** (classification Cfa). The mean temperature in the warmest month of the year is higher than 22°C but with no explicitly dry period. Following Köppen this climate is called the **climate of camellia**.

The data on the climate are supplemented by an ANALYSIS OF CLIMATE IN PRIMORSKO GORANSKA COUNTY⁹ made for the Physical Plan of Primorsko Goranska County and the Report of the state of the environment in Primorsko Goranska County¹⁰

The climate analysis has been made on the basis of the data on the selected meteorological parameters measured at the weather stations in close vicinity of the area surveyed and at the weather station situated in close vicinity of the motorway.

Data on the weather stations geographic co-ordinates, altitude, and the length of the processed series of data are given in the table below.

Location	Latitude	Longitude	Altitude m	Length of processed series of data
Rijeka	45° 20' N	14° 27' E	120	1960-1994
Omišalj, Airport	45° 13' N	14° 35' E	85	1948-1994
Crikvenica	45° 10' N	14° 42' E	2	1950-1994

DESCRIPTION OF THE CURRENT STATE OF THE ENVIRONMENT

Mean values of the weather elements have been calculated on the basis of the meteorological measurements and observations i.e. three daily data taken at 7 a.m., 2 p.m. and 9 p.m. local time. The seasonal mean values in climatological reviews of seasons are calculated according to the following rule:

Spring	- March, April, and May
Summer	- June, July, and August
Autumn	- September, October, November
Winter	- December, January, February

Air Temperature

From the analysis of the annual curve of the mean monthly air temperature the small amplitude (difference between the maximum and minimum) suggests the impact of the sea, which as a great accumulator of heat reduces annual oscillations of temperature that is the degree of the maritime characteristic of the climate for the coastal part of the County.

Extreme (absolute maximum and absolute minimum) air temperatures in the area surveyed show that in summer the temperatures higher than 38°C could be expected. Absolute minimum winter temperature measured in Crikvenica was – 13.1°C.

To have a more complete picture of the temperature regime in the area the following temperature conditions have been analysed:

Cool days	$t_{\min} < 0 \text{ }^{\circ}\text{C}$
Cold days	$t_{\max} < 0 \text{ }^{\circ}\text{C}$
Ice-cold days	$t_{\min} \leq 10 \text{ }^{\circ}\text{C}$

Cool days on which the air temperature drops below zero are rare in the coastal part. Ice-cold days are an extremely rare phenomenon same as cold days on which the air temperature during the whole day does not raise above zero.

The number of cool days with air temperatures below zero is 19.2 in Rijeka, 18.9 in Crikvenica, and 15.8 in Omišalj. The annual number of cold days with air temperature during the whole day below zero is very low e.g. in Rijeka (1.5), in Crikvenica (0.7), and in Omišalj (0.6), whereas the occurrence of ice-cold days has been recorded only in Crikvenica (0.1).

Precipitations

Precipitations are more frequent during the cold than during the warm part of the year, and they are the most frequent in autumn.

The mean number of rainy days (precipitation volume $\geq 0.1\text{mm}$) shows two maximums, one in June caused by early summer showers with thunder, and the second maximum in October or November caused by autumn cyclone rains.

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The number of days with snow in the coastal area is very small and almost insignificant. The snowy day is considered the day with snow and the quantity of precipitation from the melted snow of at least 0.1 mm. The number of snowy days in a year is 4.2 in Rijeka, 2.9 in Omišalj, and hardly 2 (1.5) in Crikvenica.

It can be seen from the analysis of the days with the height of snow cover ≥ 1 cm, ≥ 10 cm, ≥ 30 cm that the number of days with the snow cover ≥ 1 cm, that is the days with measurable snow cover on the ground, is very small, 2.4 in Rijeka, 0.9 in Omišalj, and 1.5 in Crikvenica whereas there are no days with the snow cover ≥ 10 cm, ≥ 30 cm.

Relative humidity of air

One of the important climate elements is the relative humidity of air that is the amount of water vapour in the air expressed in percentages, which was why mean annual and mean seasonal values of the air relative humidity are provided.

Mean annual relative humidity of air in Rijeka is 64%, in Omišalj 63%, and in Crikvenica 70% whereas the mean annual number of days with relative humidity higher than or equal to 80% at 2 p.m. was 53.8 in Rijeka, 47 in Omišalj, and 66.9 in Crikvenica.

Fog

Fog is a phenomenon of air turbidity with tiny suspended water droplets that reduce horizontal visibility to less than 1 km. It is an extremely unpleasant and dangerous phenomenon, for traffic in particular. Fog usually occurs during cooling of humid air under different conditions. That is why the occurrence of fog has its annual curve and its frequency can be higher on characteristic sites.

Fog is more frequent during the colder part of the year. The curve of the number of days with fog heavier than 80% suggests obvious interconnection of fog occurrence and high humidity of air during the day.

Wind

The occurrence of strong breeze and gale as a generally dangerous and unpleasant phenomenon because of possible damage caused to different kind of buildings and facilities by such wind particularly if it goes on for a few days continuously is very significant for roads designing. By definition, the strong breeze is the wind of mean speed of 10.8 m/s to 17.1 m/s (38.9 km/h – 61.6 km/h) or 6-7 Beauforts. The gale is the wind of 17.2 m/s or more (61.8 km/h) or 8 Beauforts and more.

The mean number of days with strong gale is higher in winter, in Rijeka (40.4), in Omišalj (42.3), and in Crikvenica (12.8), and the mean number of days with storm gale is in Rijeka (11.1), in Omišalj (12.8), and in Crikvenica (1.7). The average number of days with storm gale is several times lower than the days with strong gale.

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Generally, it can be said that the prevailing winds are from the NE quadrant. Stronger winds are rare but the occurrence of maximum wind squalls has been recorded.

3.2 Geomorphology and Geology¹¹

The area studied consists of four mutually distinguished natural-geographic wholes:

- Water area and contact littoral zone,
- Inland flysch valley,
- Divided zone of limestone-dolomite prealpine area,
- Sun-exposed slopes of the mountain framework

a) **Water area and contact littoral zone** has developed by tectonic and petrographic predisposition, in other words by contact of limestone and flysch. A narrow flysch belt extends with small interruptions from Vinodol to Rječina and on towards Slovenia with the Bakar Bay belonging to that belt. By operation of onetime running waters, which are today submarine springs, flysch has been subject to the highest degree of erosion and a bay has developed by postglacial rise of the sea level. The bay is a typical landscape example and identification of the area and its broader region. Alike other littoral zones the contact of limestone and marl can be easily noticed in the landscape because the steep slopes are surrounding the bay up to 200 m a.s.l. In the past, the entire sun-exposed slope was covered with vineyards so those landscape components were until recently main points of the area identity. By giving up cultivation of grapes, drystone walls and terraces have been subject to deterioration and natural vegetation has been spontaneously occupying the land.

In this area little towns of Bakar, Bakarac and Kraljevica are situated.

b) **Inland flysch valley** spreads at 200 to 300 m above sea level and this is where most of the town of Bakar villages is situated, from Kukuljanovo in the northwest to Hreljin in the northeast. With some qualifications, we could call this area a karst plateau, which is more than 10 km long and 1-2 km wide and characterised by cultivated land (agricultural landscape) and villages. The plateau spreads to the northwest and ends on the southeast.

The inland flysch valley is a separate relief formation surrounded by steep slopes of the littoral ridge and rock scarp of the continental slope. In the area within the Town of Kraljevica, the valley consists of two distinctive morphological segments having its own hydrography. These two segments are the segment of Bakar and the segment belonging to the Dubračina River catchment. A distinguished flysch divide near Križišće separate these two segments. The Bakar part of the flysch valley gradationally dips from Križišće towards the Bakar Bay. The Bakar Bay is actually an inundated part of the inland flysch valley where over the geological history powerful springs and streams eroded flysch sediments and cut deep strait

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through the limestone. On the other side of the Križišće divide the flysch valleys gently dips towards Drivenik morphological step outside of the Town borders.

Almost parallel to the Bakar segment of the inland flysch valley, a smaller valley beginning with Nedomišljina extends to the littoral ridge rock scar. On the lower side, the valley stops in the Luka area near Bakarac where a 55 m high limestone reef rises as an extension under which a lateral ephemeral flow of a short stream meanders in flysch.

The contact area towards the upper littoral slope is still in some places characterised by rocky ground because of greater human influence in that area and more distant regenerative points. In this contact area, a double karst Ponikve sinkhole stands out as a geomorphologic and landscape point of interest.

- c) **Divided zone of limestone and dolomite prealpine area** consists of three longitudinal series. The first, being the lowest, follows and defines the flysch area toward the inland to approximately 250-300 m a.s.l. The littoral ridge stretches parallel to Vinodol Valley and is clearly outlined by a steeply cut edge. The sun-exposed slope of Vinodol Valley is not as high and steep as the sunny continental slope. This is the place where the northern border of Kraljevica stretches on the outskirts of Vinodol Valley and starts steeply dipping towards the valley bottom. This steep sunny segment of Vinodol Valley gradually becomes higher from the Bakar Bay towards the south-east. A large ravine cuts the rock scar in the area of Pod Kut at the base of Hreljin and a smaller one above Baretićevo village near Križišće. In the other part, the steep sunny slope is simple and characterised by rocks and talus. From the steep edge, the littoral ridge gradationally dips towards the sea where on some places two morphologic steps are distinctive. The first higher step separates the main ridge from the lower plateau, which is mildly sloping seaward. The second series of average 300-400 m a.s.l. closes towards the first one a series of mildly curved longitudinal relief valleys with spacious sinkholes. The third and the highest series are located at 600 and 800 m a.s.l. and characterized by underbrush and tree stumps. The cultures of black pine planted on some places as windshields add quality to the landscape.
- d) **Sun-exposed slopes of the mountain prealpine area**, in terms of geography, they belong to Gorski Kotar (the mountain area) and generally have the characteristics of Gorski Kotar region. As regards the altitude, it is an area above 800 m a.s.l. In terms of geomorphology it is a well-covered and afforested karst area with developed mixed forest (beech tree, fir tree, and juniper tree)

Geology

In the area studied only sedimentary deposits have been identified, which according to the geological age belong to the Permian, Triassic Jurassic, Palaeogene, and Quaternary periods.

Palaeozoic Sediments i.e. early to middle Permian (P_{1,2}) consist of the flyschous series of clastites in which conglomerates, sandstones of different grain

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size, siltstones and shale alternate in gradational sequences. At the end of the clastic series, there is a limonite crust on some places with barite, barite and dolomite mixture, and dolomite deposited thereon. Outcrops of Permian sediments are visible in the far eastern part of the Town of Bakar in the area of Tuhobić.

Triassic period is represented by stratigraphic units of late Triassic period that are difficult to distinguish on some places, so they have not been separated completely and clear enough in terms of their stratigraphy. The lower part of the sediments consists of alternating pelite-argillaceous-dolomite, pelite-silty-acroze, and dolomite-arcose sediments with mica on bedding planes. Their colour varies from greyish green over brown-yellowish to red and red-violet shades. Towards the younger sediments, the share of dolomites in sedimentary series increases and the sediments become predominantly dolomitic. Locally, in the sedimentary series, in the bases of the sedimentation sequences, there are lenses of breccia conglomerates. Upper part of the sediments continually overlies the clastite sediments. They are dolomite by their composition of which the older types are from finely to medium crystalline, and the younger ones coarsely crystalline. Dolomitic limestone can be already found in the youngest part of the series. All sediments feature exceptional bedding. Outcrops of Triassic sediments are visible in two areas in the NE and E outskirts of the Town of Bakar, north of Tuhobić, and south of Risnjak.

Sediments of Jurassic period have developed in the area of Town of Bakar in its entire range. Although lithofacially different, they are predominantly carbonate rocks. They are deposits of early Jurassic (Lias), middle Jurassic (Dogger), and late Jurassic (Malm). Lias sediments (J_1) are dolomite-limestone. In the lower part of the lithologic column microcrystalline to coarsely crystalline dolomite with lenses of micrite limestones are predominant. The rock bedding is pronounced, on some places also of laminated texture and grey-brown to grey-black colour. Dolomites and limestones alternate in the upper part. The sediments have pronounced bedding and vary in colour from black to almost black. Dogger sediments (J_2) are made of micrite limestones of black to dark black colour and have observable bedding. Malm sediments (J_3) consist alternatively of black limestone and dolomites. The sediments have observable bedding. Limestones are predominant in the lower part of the lithologic column and dolomite in the upper part. Inside the carbonate rocks, there are lenses of breccia and marly limestone with chert. In Jurassic sediments hypsometrically higher and mostly uninhabited parts of NE part of town of Bakar territory have been formed.

Cretaceous sediments are also lithofacially different but as a whole, they are of carbonate composition. Visible are the outcrops of carbonate rocks from early Cretaceous period and those on the transition from the early to the late Cretaceous period as well as the sediments from the late Cretaceous period. The lower part of the column consists of carbonate rocks of early Cretaceous period (K_1) and then the rocks from Apt-Cenomanian period or the transition sediments ($K_{1,2}$). Upper Cretaceous sediments are the sediments from Cenomanian-Turonian ($K_2^{1,2}$) and Turonian-Senonian epoch ($K_2^{2,3}$).

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In the early Cretaceous sediments (K_1) breccia limestones are predominant, and then the limestones with lenses of breccia and dolomite. Sediments feature observable bedding. Transition Cretaceous sediments ($K_{1,2}$) mark the border between the early and late Cretaceous periods. They consist of calcareous-dolomitic breccia and porous limestones. Outcrops of the deposits of lower Cretaceous period are visible in the broad belt northeast of Škrljevo, Krasica, and Hreljin. Transition Cretaceous sediments follow the early Cretaceous sediments on the southwest side in a narrow and continuous belt. Transition Cretaceous sediments ($K_{1,2}$) are represented mainly by calcite-dolomite breccia. They consist of limestone and dolomite origin karst and calcareous binder. They have been found only sporadically on the Cape Lipica along the Rijeka Bay coast.

Sediments of Cenomanian to Turonian ($K_2^{1,2}$) consist alternatively of dolomite and limestone. Dolomites are poorly bedded, have large size of crystals and grey-brown colour. Limestones are crystalline with observable bedding and grey-brown colour. These sediments spread in a relatively wide belt on a plateau stretching from Grobničko Polje towards the southeast and northeast of the depression of the Bakar Bay and Vinodol Valley.

Sediments of Turonian to Senonian ($K_2^{2,3}$) are mostly made of rudist limestones. Their colour varies from white to brown and their structure is cryptocrystalline to crystalline. Limestone is generally present in thick beds and banks. They form the rocky slopes and tops of the NE side of Sušačka Draga (creek), the Bakar Bay, and Vinodol Valley.

Palaeogene sediments consist of older carbonate rocks (limestones) and younger clastic rocks (flysch and limestone breccia). The lithostratigraphic units are foraminiferous limestones of early to middle Eocene ($E_{1,2}$), flysch sediments of middle to late Eocene ($E_{2,3}$), and limestone breccia of late Eocene to early Oligocene (E_3Ol_1).

Foraminiferous limestones ($E_{1,2}$) are light brown and crystalline to detrital fabric. Limestones are detrital, of poorer bedding and contain numerous foraminifer fossils. Foraminiferous limestones extend on a narrow and often interrupted belt on the slopes around the Bakar Bay and Vinodol Valley.

Fine grained clastic rocks i.e. flysch ($E_{2,3}$) consist generally of siltstones and sandstones and a smaller part of marl, breccia conglomerates, and limestones. Graded bedding is generally very clearly seen. Presence of fine-grained sediments with prevailing argillaceous to sandy siltstones is predominant. With higher participation of sand, deposits convert into silty sandstone. In terms of petrography, sandstones are graywacke to sub-graywacke. In the flysch complex, they are present in a form of very thin horizons to a few meters thick banks. The depression bottom of the Bakar Bay and Vinodol Valley and the lower parts of the surrounding slopes and the bottom of Vinodol Valley from Bakarac to Križišće and Veli Dol, are formed of flysch sediments as well as the secondary belt on the SW edge of the valley from Sansovo valley to Medomišljina area. Bedrock is almost all covered with slope formations, fill, and marine sediments.

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Coarse grained clastic rocks i.e. breccia (E_3O1_1) consist of poorly sorted to unassorted fragments of angular to semi angular forms originating from Cretaceous sediments and sediments from older Palaeogene period and calcite, low-density dolomite to argillaceous binder that sometimes contain limonite. They appear sporadically in a form of isolated zones on older carbonate rocks.

Quaternary Sediments have very heterogeneous lithologic composition and genesis. They are terra rossa (ts), colluvial-delluvial deposit (d), active talus (s), alluvium (pr), and marine sediments (m).

Terra rossa (ts) often overlies limestone rocks. Deposits considered as terra rossa probably have different soil genesis on different locations. Some of the deposits have the properties of recent, other of relict and the third of paleo soils. Inside the terra rossa deposits, redeposited residues of flysch and loess could be found that had acquired red soil characteristics. By its composition, terra rossa is silty-argillaceous material. In depressions (karst sinkholes) terra rossa generally does not contain coarse fractions whereas on the elevations and slopes it contains the fractions originating from the rocky base. The thickness of terra rossa varies from very small to non-continuous accumulations on elevations and slopes to several meters high in depressions. Thicker accumulations of terra rossa cover deep depressions on karst plane that extends from Grobničko Polje to Hreljin and two depressions that extend from Carovo Valley and the harbour in the very centre of Kraljevica towards south-east.

Colluvial-delluvial deposit i.e. slope formations (d) is wide spread on the flysch complex bedrock on the slopes surrounding the Bakar Bay, in Vinodol Valley and also in the seabed and subsoil.

Talus breccia consists of fragmented limestone rocks and calcareous-argillaceous binder. It is found on some places on the slopes around the Bakar Bay but also in the seabed. Often several meters thick accumulations of slope formations are found on NE slopes of Vinodol Valley all the way to Bakarac, Križišće and Veli Dol towards the south-east.

Active talus (s) consists of various size angular fragments, mostly 5 to 20 cm, but also of larger blocks. Material is not bound together and is easy to move. Its thickness is mostly 1 to 3 m and in exceptional cases even more. Talus is often found at the base of cliffs around the Bakar Bay and on the northeast side of Vinodol Valley.

Alluviums i.e. torrent deposits (pr) consist of gravel and sand. Inside the sedimentary body, there are sometimes lenses of clayed gravel. This lithogenetic type was identified in hypsometrically lowest part of Vinodol Valley, in the area of Bakarac where a part of sedimentary body extends to the seabed and in the valleys of Lepenica and Kostanjevica streams whose upstream parts runs inside the area of the Town of Bakar.

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Marine sediments consist of loose and easy sand-silt material. They cover flat and deeper parts of the Bakar Bay seabed.

Subsection Sv. Kuzam - Hreljin is almost entirely placed within the complex of carboniferous consolidated rock; primarily carbonate rock (limestone). Zones of increased deformation of rock are placed transversally or diagonally to the route. Terrain is naturally stable.

Subsection Hreljin-Križišće is situated in the complex of finely-grained solid rock with cover of semi-consolidated and unconsolidated rock (geological and hydrological conditions and assessment of stability are same as on the part of section intersection Ortehovica- intersection Sv. Kuzam). A cover of semi-consolidated and non-consolidated rock that has relative stability, and is unstable in places follows the complex of fine-grained clastic rock.

Subsection intersection Križišće – Connection to Kraljevica and Bridge Coast-Krk is situated in the complex of carboniferous consolidated solid rock (limestone and dolomite).

The motorway section Sv. Kuzam – Križišće considered has been located in the epicentral area of Rijeka. The highest recorded seismic intensity was VII-VIII degrees MCS. According to the map of seismic micro-regionalisation of Rijeka, seismicity rates for the project area were identified, with relative micro-regional seismicity coefficients according to determined average engineering-geological properties of terrain.

Section Sv. Kuzam-Hreljin is in the area of micro-regional seismicity 7 and 7+ with corresponding micro-regional seismicity coefficient 0,02 and 0.027, because the entire section is situated in the complex of consolidated carboniferous rock. Exceptionally, above the place Bakar, the alignment of future project is placed in the border area of micro-regional seismicity 8- and corresponding coefficient 0,033.

Section Hreljin-Intersection Križišće is situated in the area of micro-regional seismicity magnitude 7+, and the corresponding coefficient of micro-regional seismicity is 0,033 due to the presence of fine-grained clastic rock complex. Possible bad geological properties of the terrain might be occurrence of fragmented rock (slope debris).

Section Intersection Križišće-Link for Kraljevica and Bridge Coast-Krk Island is situated in the area of micro-regional seismicity magnitude 7+, and the corresponding coefficient is 0,017 and 0,027, because of the presence of carboniferous rock complex.

3.3 Waters and Sea¹²

Water

The area studied is located in the littoral catchments region. The littoral catchment belongs to the catchment of Rječina River and the catchments of Dubračina,

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Novljanska Ričina, Bakarčki Rov, Javor Potok, and Klanska Ričina torrents, the torrents of the Liburnia coast, and some other smaller torrent flows. Among the watercourses mentioned Rječina stands out for its water capacity and continuity of flow in its bed. Other watercourses are generally occasional water phenomena with Dobrečina being to a certain degree an exception because the major part of its watercourse gets water from the catchment of high-mountain karst and is used for power generation purposes in Tribalj hydroelectric power station.

In the motorway route area, the geological structure of ground resembles karst characteristics with no distinguished surface hydrographic network. Water flows away by subsurface passages. Because of high degree of ground permeability waters penetrate quickly into deeper strata where they form ground watercourses emerging near the seacoast or under the sea level as submarine springs. In the Bakar Bay a large number of such submarine springs can be found that confirms large distribution of limestone base.

The torrent of Bakarčki Rov with pertaining catchment area of some 9.5 km² empties into the Bakar Bay. Already before the World War I, its lower watercourse through Bakarac was improved. According to the results of hydrologic calculations (Rubinić, 1992), the maximum flow rates at its mouth, dependent on the recurrence period, range between 13 m³s⁻¹ (Q₁₀) and 61 m³s⁻¹ (Q₁₀₀).

The catchments of coastal water springs in the Bakar Bay embrace drinking water springs in the Bakar Bay, which are included in the first category of drinking water quality (Perilo, Dobra, and Dobrica springs) and considered as particularly important. The hydrogeological and other water investigation works (performed from 1966 to 1994) determined the borders of the catchment areas of water springs in the Bakar Bay. The catchments have typical karst properties, which means that ground waters are exposed to different degrees of threat from surface pollution. All water springs in the Bakar Bay are typical karst springs with relatively high variation in their abundance. Three captured karst springs provide together approximately 390 l/s of good quality drinking water in summer dry periods:

- Captured intake Perilo 220 l/s
- Spring Dobra 60 l/s
- Spring Dobrica 110 l/s

Above-mentioned captured intakes are only a part of ground water flowing out on the north-east periphery of the Bay. A few other very important water-spring areas should also be mentioned. They are Lovrijenac in the Town of Bakar, Podbok in the bulk cargo harbour, coastal springs and submarine springs in Črno Cove and Žminjica Cove towards Bakarac. Large outputs of the water springs could cause considerable geotechnical problems in addition to hydrogeology problems because by occasional cutting of abundant watercourses which would be the cause of substantial washout of flysch and flysch cover, and land and rockslides. Namely, land and rockslides on the Adriatic Highway above the Bay happen frequently, and there are also problems with the foundation of the Port Authority office building, etc.

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Drinking water protection zones have been defined by the Decision of drinking water protection in the Rijeka area (Official Gazette 6/94, 12/94, 12/95, 24/96).

Section Sv. Kuzam-Hreljin (Tunnel Exit) is situated in a catchment area of the sources in the Bay of Bakar (II sanitary protection zone), with a series of water supply facilities and springs Brilo, Dobra, Dobrica and watersources Podblok Črno, Žminjca and others that yield drinking water. In construction of the road impermeable sewage system, safety barriers, facilities for storage and separation of spills should be provided and speed limits controlled.

After the treatment, waters from the road surfaces will be controlled before discharge into an open already built ditch of Bakar Industrial area.

Sea

Sanitary quality of the coastal sea¹³

The intended use and quality of coastal sea in the Republic of Croatia have been governed by two regulations: (1) Water Classification Regulation (Official Gazette 15/81) and (2) Regulations governing the Seawater Quality Standards on Sea Beaches (Official Gazette 15/81).

Pursuant to the above-mentioned regulations concerning the seawater quality standards on sea beaches, the coastal sea in the area studied is included in the Category II. Consequently, this is the water quality to be achieved and the water quality to be maintained pursuant to the Water Classification regulations. The coastal sea should also satisfy the conditions prescribed by the Decision on maximum permissible concentration of harmful substances.

The Section from Junction Hreljin to Junction Križišće and the connection with Kraljevica and Bridge Mainland – Island of Krk is outside the catchment areas that have significant sources of drinking water. However, since the seashore in the Bakar Bay was according to the Regulation of the categorization and classifications included in Water Category II to prevent the contamination of the coastal sea with oil, petroleum products and other dangerous and noxious substances, it is necessary to discharge the precipitation water into the ground by a sewage system and wells.

3.4 Landscape

In the north part of the town of Kraljevica area, from Bakarac to Križišće and further to Vinodol Valley, **a particularly valuable area of natural landscape** stretches. The conditions stipulated for use of the area are as follows:

- Preservation of original properties of the natural landscape.
- Prevention of construction on visually exposed parts of the area.
- Observance of structural features and conservation of alternating agricultural and forest land,
- Economical use and management of the planned area of protected Vinodol scenery,

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- Maximum possible degree of conservation and preservation of natural characteristics of the area when designing and constructing the motorway and arterial railway.

A particularly valuable area of cultivated landscape covers also the **north-eastern part of the Town of Kraljevica area**, the parts of the villages Križišće, Mali Dol and Veli Dol. The conditions for use of the area are:

- Observance of traditional way of constructing residential houses and supporting buildings with the use of autochthonous materials (stone, mission roofing tiles, wood).
- Observance of natural features of the landscape and adaptation of agricultural production to biological cycles with no pollution.
- Determination (by a Physical Plan for special areas) of optimal motorway route in the Vinodol Valley region to maintain the characteristics of the cultivated landscape.

The landscape protection has been determined primarily by reasonable settlement pattern and physical planning and by stringent criteria passed for construction outside of the building land area.

The corridor of the studied motorway section has been designed in such a way that in the area of the town of Kraljevica it passes through the area recorded as a valuable natural landscape and only on the outskirts it passes through the area of cultivated landscape.

3.5 Ecology and Biotic Resources

Vegetation

Most of the coastal area is a **zone covered with deciduous sub-Mediterranean vegetation**. It consists of degraded forests and underbrush of oriental hornbeam and pubescent oak, and rocky pastureland and dry grassland. At altitudes of 350 m and more, hop hornbeam replaces oriental hornbeam thus creating a Mediterranean-mountain vegetation belt. On the upper border of the Mediterranean mountain vegetation belt toward the continental vegetation belt a transitional bordering belt of littoral beech forests has developed, on Učka and Čićarija mountains in particular.

This zone is distinguished by sub-Mediterranean landscapes of mountain regions and in the transitional belt by littoral beech forests and bordering littoral landscapes of lower mountain regions.

Negative human impact has substantially contributed to the basic physiognomic characteristic. In addition to low and undergrown forests, rocky ground and bare rocky ground cover a considerable part of the area. In such a typical Mediterranean ambient, preserved forest associations are especially noticeable of which in the area studied there is an area with pubescent oak forests westward of Hreljin.

A special place is the area of steep slopes along the Bakar Bay. Continuous series of

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drystone walls – luxuriant vineyards in the past – dominate the landscape. Today they are only a vivid example of harmonious relationship between man and nature. In addition to exceptional landscape value, traces of long-term operation of natural processes are clearly noticed on these surfaces. Self-grown forest plants keep “conquering” the west side of drystone walls and on the eastern slopes drystone walls are more and more filled with erosion-affected material. Among these basic landscape characteristics, an observer can notice exceptionally outlined complexes (natural and man-made) as a concentration of particularly valuable elements.

The Bakar Bay with its ethno-zone of drystone walls, a wealth of the natural heritage that should be preserved in the present form to the maximum possible degree, is an ambient that stands out in the natural environment by its distinctive appearance.

Forests

Most of the forests of the Bakar Bay were in the past cut down and cleared, which converted the area into rocky pasture land, dry sub-Mediterranean grassland and agricultural land of which the most famous are Bakar terrace vineyards bordered with drystone walls. By giving up the agricultural production, forests have started growing again and taking back their former places. In the deserted terraces of vineyards one can again see little green forests of oriental hornbeam and small forests of black pine. Of course, they have started recovering only on those places that thanks to the high slopes have not been completely exposed due to erosion and converted into a talus land. In the past the, vineyards were well known for production of sparkling wine – Bakarska vodica. Today the monuments of human work heritage have been almost completely deserted although they deserve more attention than they been given thus far and adequate protection.

Woodland of the town of Kraljevica extends from 0 to 700-m a.s.l. and is characterised by different species of trees and developed topography. In this area, forests cover a smaller part of the area, which, because of orographic and pedologic conditions was not suitable for agricultural production and in the past, was mainly used as pastureland for livestock. By stopping the intensive grazing and under the influence of natural factors, the land used for haymaking was afforested, which increased the woodland area.

Following the intended use and in line with the provisions of the County Physical Plan, the area of **economic forests (Š1)** has been singled out. The forest management plan does not foresee any deforestation (annual cut) in autochthonous stands. However, cutting of affected pine trees is foreseen but also planting of pine cultures in autochthonous stands. Although by its intended use these forests are the economic forests, the regulations prescribe the conservation of the wood stock and compulsory afforestation aimed at improvement of the woodstock and healthy condition of the forests.

The corridor of the studied motorway section in the area of the villages of Hreljin runs through the woodland assigned only for the primary purposes – economic forests Š1 affecting area of 4,0 ha.

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Based on the soil quality assessment, the soil has been grouped in four protection categories and the way of its use has been stipulated by the protection measures.

The land protection Category I (land use category P1, P2 and partly P3) is the land included in the soil quality categories I-IV (partly also V). These soils are intended exclusively for primary agriculture and must not be used for other purposes. They are situated along the villages of Škrljevo, Krasica and Praputnjak, in the surrounding of Hreljin and Ponikve, in the area from Bakarac, to Križišće, Mali Dol and Veli Dol, and in numerous sinkholes and small round karst valleys.

The land Category II (land use category P3 and PŠ) includes the soil quality categories V and VI. Today they cover mainly deserted agricultural land of lower soil quality and stretch between Krasica and Praputnjak. They should be protected by adequate measures and only if necessary they should be afforested or preserved as pastureland.

The land Categories III and IV (land use category PŠ) are mainly woodland and pastureland in the mountain area. Special measures should be planned to protect the steep slopes from erosion.

The corridor of the studied motorway section runs on the periphery without affecting area of Dolčina at the base of Praputnjak – agricultural land P1 (at this point the motorway leaves the tunnel and runs on Vršina viaduct). It extends smaller agricultural land – other arable land (P3) in the area of the village of Hreljin.

Fauna¹⁴

Primorsko Goranska County is an exceptional area in terms of flora and fauna with a large diversity and abundance of species (extremely high degree of biodiversity). This region is a habitat of 81 species of mammals, 73% of species of amphibian, and some 78% of species of reptiles of the Republic of Croatia. Some areas of the County are particularly rich with invertebrates of which some groups are excellent bio-indicators of the environment natural quality (e.g. ferrets, butterflies, partridges, freshwater crayfish) because they respond to the smallest changes in the environment. Underground karst fauna¹⁵ has a special value and importance because of endemic and relict species living there.

Currently, some parts of the natural heritage of Primorsko Goranska County have not been uniformly explored and in most cases not sufficiently explored. Following the Physical Plan of Primorsko Goranska County, the broader area of the towns of Bakar and Kraljevica has been categorized as insufficiently explored area with potentially valuable fauna.

The species from the south regions come to this sub Mediterranean area such as Mediterranean bats, zecoušnjak, seagulls, terns, swifts, karst and littoral lizard fish of reptiles, brown snake lizard, horned viper, leopard snake, fierce cat snake, snake lizard, and common adder of snakes, Cicadidae, praying mantis, scorpions, centipedes, and spiders of insects,

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Big game lives in the mountain area of the town of Bakar such as deer, doe, wild boar, brown bear, wolf and lynx, and small game such as rabbit, fox, badger, wild cat, marten, weasel, polecat, dormouse, pheasant, crow, jay, quail, partridge, and many other. The birds living in that area are predatory birds such as hawk, sparrow hawk, buzzard, falcon, little owl, owl, woodpecker, etc.

According to currently available information and data there are no recorded habitats of rare and endangered species of fauna on the road corridor.

Protected Natural Heritage and Valuable Parts of the Nature

Near the motorway route, there are no specially protected parts of the natural heritage in terms of the Law of Protection of Nature and none are either included or proposed for protection by the physical plans. However, the road route passes nearby the following recorded and for the protection proposed valuable areas :

Area of the town of Kraljevica:

The far end of the north-western part of the Vinodol Valley has been proposed for protection pursuant to the Law of Nature Protection under the **category "Protected Landscape", Region of Vinodol**. It is recognised by impressive steep cliffs surrounding the valley giving it the quality of a special geographic whole.

This area, which is proposed for protection is situated eastern of the junction Križišće, outside of the road section Sv. Kuzam – Križišće.

Area of the town of Bakar:

The area of **Dolčine at the base of Praputnjak** is distinguished by its scenery and picturesqueness. In the past, this area, together with the drystone walls of Bakar was a valuable agricultural oasis. Today it is an important and last habitat of several very rare plant species such as kockavica (*Fritillaria meleagris*), orchidaceae, and others, which are threatened to become extinct in the area of Rijeka. This area is located in the part of the country, which is protected as Krasica-Praputnjak-Hreljin ethno-zone, whose protection has been proclaimed by the Law of Protection and Preservation of Cultural Treasures.

In botanical sense, the rocky sun-exposed lateral side of **Turčin Mountain above Bakar** is also an exceptional place. It is covered in evergreen bushes of mock privet and a very rare type of fern (*Petrarkina slezenica*), which was discovered by our famous florist D. Hick in 19th century.

Both these areas are located outside of the motorway corridor. Following currently available data, the road corridor does not cover the habitats in which rare and/or endangered species of flora and fauna have been recorded.

Minerals

The existing minerals in the County area are of high potential and their total reserves are sufficient to satisfy the County's demand for non-metal minerals. Carbonate rock (limestone, dolomitic limestone and carbonate breccia) covers most of the area and is visible on the land surface. It is easily accessible and mining could be readily set up

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in quarries. This primarily refers to the quarries for construction stones and less to the quarries for decorative stones used in architecture. The reason for that is considerable tectonic damage of the bedrock.

In the area studied, no new quarries have been planned for the time being.

3.6 Air Quality

In line with the provision of the Law of Air Protection, Primorsko Goranska County has established a local network of air quality monitoring¹⁶.

The program of air quality measurements includes monitoring of time and spatial distribution of pollutants discharged from industrial and power facilities, production processes, heating facilities, means of transport and diffuse sources. There are 18 measuring stations in the County and those that were interesting for this study were the measuring stations in the city of Rijeka and the Bakar Bay. The stations monitor SO₂ and smoke, depositions (total dissoluble and not soluble, pH, total insoluble substances, ash, combustibles, Pb, Cd, Fe, Cu, Zn, total dissoluble substances, sulphates, nitrates, chlorides, NH₄, Ca, NO₂, O₃, NH₃, Phenol, H₂S, PAH index, PAH, daily precipitation samples, suspended particulates and metals, and chlorides.

Air Quality Test Results

The measurement results of pollutant concentration in air are referenced to the recommended values (RV) and the limit values (LV) of air quality stipulated by the *Regulation for recommended and limit values of air quality*. Based on the comparison of the measurement results and the recommended and limits values of air quality and pursuant to the Article 21 of the *Law of Air Protection* and according to the degree of pollution air is grouped into the following categories.

- Category I – clean or slightly polluted air
- Category II – moderately polluted air
- Category III – excessive air pollution

The results of air quality monitoring in the Primorsko Goranska County for the year 2001 suggest higher degree of air pollution (same as the years before) only in the area of the City of Rijeka and the municipality of Kostrena. The pollution is the consequence of emission from local sources, first and foremost the industry (INA Oil Refinery in Rijeka – Urinj, INA Lubricant Production Facility in Rijeka, TPP Rijeka) and boiler rooms, traffic, and cargo loading in the Port of Rijeka.

The measurement results of air pollutant concentration show that the air quality in the greater part of the County is of the Category I. The Category II has been recorded on a relatively restricted area in the surrounding of large polluters and the centre of Rijeka. Road traffic accounts for the most of NO_x emission (59%), point sources (39%), and area sources (2%)

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In line with the provisions of the *Law of Air Protection*, the area assigned the Category I air should apply preventive measures to avoid degradation of the existing air quality. Adequate measures should be planned and implemented in the area having the Categories II and III of air quality to achieve short-term reduction of pollutant emission and the Category I of air quality in the long run.

Table 6 Air Quality Categories according to the air pollution degree

CRITICAL INDICATOR	CATEGORY I C<PV	CATEGORY II PV<C<GV	CATEGORY III C>GV
SO ₂	F. la Guardia Street Krešimirova Street, Draga, Volosko, Brseč, Kostrena, Bakar, Škrlevo, Kraljevica, Krasica, Omišalj, A Lake near Njivice, Vrana Lake, Delnice, Lividraga, Martinšćica, Krasica	Mlaka, Čandekova Street, Inženjering	
Smoke	Čandekova St., Krešimirova St., Mlaka, Draga, Volosko, Brseč, Kostrena, Bakar, Škrlevo, Kraljevica, Krasica, Omišalj, A Lake near Njivice, Vrana Lake, Delnice, Lividraga	F. la Guardia Street	
Depositions	Krešimirova St., Bakar, Krasica, Kostrena, Omišalj, Lake near Njivice, Ponikve Water Storage, Vrana Lake, Delnice, Lividraga, Bunar, Žurkovo Cove	Kraljevica, Top of Martinšćica II, Plumbum	
Lead in Depositions	Krešimirova St., Bakar, Krasica, Kostrena, Kraljevica, Omišalj, A Lake near Njivice, Ponikve Water Storage, Vrana Lake, Delnice, Lividraga	Plumbum, Martinšćica turn	
Cadmium in depositions	Krešimirova St., Bakar, Krasica, Kostrena, Kraljevica, Omišalj, A lake near Njivice, Ponikve Water Storage, Vrana Lake, Delnice, Lividraga		
NO ₂	Kraljevica, Inženjering, Martinšćica, Krasica	Krešimirova Street	
Total suspended particulates (TSP)	Inženjering	Krešimirova ulica, Martinšćica, Krasica Top of Martinšćica I	
Benzo(a)pyrene in TSP		Krešimirova Street	Mlaka
NH ₃	Krešimirova, Mlaka, Bakar, Kraljevica, Kostrena		
Phenol	Kostrena, Kraljevica, Mlaka		
H ₂ S	Mlaka, Kostrena, Kraljevica, Krasica		
Chlorides	Omišalj, A Lake near Njivice		
O ₃	Inženjering, Martinšćica, Krešimirova Street	Krasica	
SO ₂	F. la Guardia Street Krešimirova Street, Draga, Volosko, Brseč, Kostrena, Bakar, Škrlevo, Kraljevica, Krasica, Omišalj, A Lake near Njivice, Vrana Lake, Delnice, Lividraga, Martinšćica, Krasica	Mlaka, Čandekova Street, Inženjering	

* Although the area of Krasica is included in the Category II because of pollution by ozone, according to the monitoring results it would be more appropriate to include it in a transitional Categories II and III.

3.7 Noise

Basic regulation for implementation of the noise protection is the *Noise Act* (Official Gazette No. 17/90). Thus far, not much attention has been paid to the noise issue in Primorsko Goranska County. No systematic tests of noise level have been conducted

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to indicate the general noise condition and threat to the inhabitants because of noise. Continuous measurements of noise level are conducted only in the area of municipality of Kostrena in the surrounding of the Oil Refinery in Urinj and the Shipyard "Viktor Lenac". Single noise measurements performed in the centre of Rijeka and the municipality of Kostrena suggest higher noise level around the industrial facilities and along the roads than prescribed by the law.

3.8 Ground

Ground - Geotechnical Adequacy

Basic geotechnical zoning has been performed on the basis of available data but with no further field investigation. Six geotechnical categories of soil have been identified. They are:

I. Geotechnical Category – Bare Karst Zone

- Carbonate bedrock visible on the ground surface with terra rossa overlying it.
- Ground not deformable under additional load of buildings.
- No danger of instability except for very steep slopes covered with active talus.
- Absorption and permeability of ground is in its entirety good, possibility of erosion very small.
- Ground is in its entirety adequate for building, less adequate places are cave formations and wider fault zones, and very steep slopes.

I.a. Geotechnical Category – Covered Karst Zone

- Carbonate bedrock fully covered with terra rossa, thickness > 2 m.
- Ground is deformable under additional load of buildings.
- No danger of instability.
- Ground absorption is lower than of the bare karst, water permeability is in its entirety good, possibility of erosion small.
- Ground is in its entirety suitable for building taking into consideration less favourable geotechnical properties in reference to bare karst. Less favourable places are caving formations under terra rossa.

I-II. Geotechnical Category – Triassic Clastic Carbonate Rocks

- Bedrock is made of Triassic clastites and dolomites that can be seen on the ground surface or are partly covered with disintegration argillaceous crust to slope formations.
- Ground is not deformable under additional load of buildings except for the places with thicker argillaceous cover.
- Ground is mostly stable under natural conditions and instability can occur when making cuts.
- Ground absorption is low, clastites are water impermeable and dolomites have low water permeability.
- Possibility of erosion is on some places substantial.
- Grounds of this geotechnical category are in its entirety adequate for building providing less favourable geotechnical properties with regard to the Category I ground are taken into account.

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- Less adequate places are broader zones and slopes covered with potentially movable argillaceous sediments.

II. Geotechnical Category – Palaeozoic Clastic Rock Zone

- Bedrock is made of Palaeozoic clastic rock of very heterogeneous lithologic composition (argillaceous to sand shale, sandstones and conglomerates) mostly covered by disintegration argillaceous crust and partly by slope formations;
- Ground is partly deformable under additional load of buildings.
- Ground is on some places unstable under natural conditions and further instability could occur when making cuts.
- There is a possibility of smaller landslides.
- Ground absorption is exceptionally low. Clastic bedrock is not permeable and possibility of erosion is substantial.
- Ground of this category is suitable for building if less favourable geotechnical properties of the Category I zone are taken into account. Less suitable places are broader zones and the slopes covered with potentially movable argillaceous sediments.

III. Geotechnical Category – Flysch Zone

- Flysch bedrock is partly covered with argillaceous disintegration crust < 2m.
- Ground is deformable under additional load of buildings.
- Ground is stable under natural conditions and instability can occur when making cuts.
- Ground absorption is exceptionally low, flysch bedrock is water impermeable, and possibility of erosion is substantial.
- Ground is in its entirety suitable for building providing less favourable geotechnical properties with regard to bare karst are taken into account.

III.a. Geotechnical Category – Flysch Zone Covered with Slope Formations

- Flysch bedrock is all covered with slope formations on some places more than 10 m thick.
- Ground is deformable under additional load of buildings.
- Parts of the ground are stable under natural conditions whereas on some places active and dormant landslides are visible. Danger of instability occurrence when cutting or filling is high.
- Ground absorption is in its entirety low, flysch bedrock is not water permeable and the cover has varying permeability. Possibility of erosion is substantial.
- Ground is only on some places suitable for building providing preliminary in-depth investigations are carried out.

IV. Geotechnical Category – Alluvium Zone

- Alluvium has varying size composition.
- Ground is deformable under additional load of buildings.
- Ground is stable under natural conditions and instabilities can occur when making cuts.
- Ground absorption and permeability is from poor to good.
- Ground water level is high.
- Ground is not suitable for building.

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Most of the town of Bakar are isf bare karst (Geological Category I). Thicker layers of terra rossa overlaying karst (Geotechnical Category Ia) spread on the plateau above the Bakar Bay where most of the villages is situated. Triassic clastic-dolomite rocks (Geotechnical Category I-II), Palaeozoic clastites (Geotechnical Category II), and alluvium (Geotechnical Category IV) form hypsometrically higher and mostly uninhabited parts of the town of Bakar. Particularly problematic are the slopes around the Bakar Bay including the town of Bakar itself.

The corridor of the studied road section has been proposed to run mostly through the area of the Geotechnical Category I – Bare Karst Zone, and only the interchange Križišće is situated inside the Geotechnical Category III – Flysch Zone.

3.9 Socio-Economic Issues

The section of Sv. Kuzam – Križišće motorway, and the section of D8 state road is an integral part of Rijeka Transport Junction. After numerous analyses and studies of the area, the Rijeka Transport Junction has been adopted (defined in Physical Plan of Primorsko Goranska County) as a single transport model, which will compensate the hierarchical drawback of the transport network in a very small and specific area with Rijeka Bypass being its backbone. The following road directions identify the Rijeka Transport Junction:

- Adriatic Road direction from Matulji via Orehovica to Bakar and Križišće (Rijeka Bypass)
- Transversal road from Rijeka (Orehovica) to Oštrovica
- Road links and connections, which at interchanges connect Rijeka Bypass with the city residential zones, the port, industrial zones, and free trade zones.

The Transport Junction will enable the realisation of two very important national directions (longitudinal direction extending to the Adriatic Highway, eastward in direction of Lika and Dalmacija and westward in direction of Italy, Istria, and Slovenia and the transversal road towards Zagreb, Budapest and Vienna. The Rijeka Transport Junction will allow the integration of the sea and road transport (roads and railways) when entering the Republic of Croatia.

The characteristic of the current transport system is its incompleteness, which is a serious burden for the city transport network caused by longitudinal traffic and origin-destination traffic (port, railway terminals). Current roads carry long-distance transit traffic, regional traffic (connections with the County centre and tourist destinations), and local traffic. None of the traffic levels is performed in a satisfactory way, they cause jams during rush hours, travelling speed is low, and car accidents are frequent. This considerably affects the quality of life of local inhabitants and has impact on performance of economic subjects (tourist industry in particular).

The completion of the system will produce many organisational and economic benefits, such as:

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- Relief and improvement of the Rijeka City street network,
- Increase in the quality of life in some urban areas,
- Higher security on the existing roads by reducing the traffic intensity,
- Increase in the value/attractiveness of tourist and economic zones,
- The Adriatic highway will be relieved of heavy traffic and be free for local transport,
- Time and travelling costs from/to targeted places of Rijeka and within the town will be reduced.

3.10 Cultural and Historic Heritage

In 1986 an Environmental Impact Study was made that did not contain the data on the protected cultural and historic heritage so the special conditions have been determined for issuance of the location permit. The Directorate for protection of cultural heritage in Rijeka prescribed the special conditions on 24 May 2002. The document provides the special conditions to be obeyed by the investor who, together with the authorized institutions and professional groups, has to make a study of impact on cultural and historic heritage for the motorway section Sv. Kuzam – Križišće. The investor of the motorway construction has agreed with the special construction conditions and the study of impact on cultural and historic heritage was completed at the beginning of 2004.

There are many protected and registered localities and buildings in the construction area of D8 Motorway Section Sv. Kuzam – Križišće, that belong to the cultural and historic heritage of the Republic of Croatia. The analysis of the cultural and historic heritage has been made on the basis of the existing documentary evidence of the Ministry of Culture (data on recorded, protected, and registered cultural assets, etc), on the basis of written and other published and not published data, and the field visits. The analysis includes the data on the cultural and historical values in the zones affected by construction (Nomenclature pursuant to Clause 7 of the Law of Protection and Conservation of Cultural Assets, Gazette 69/99).

Following the current lists of cultural assets in the official records of the Ministry of Culture and the lists based on published and unpublished sources, and on the basis of the field investigations, the cultural assets in the zone of direct impact are:

A. ETHNO-ZONES (PROTECTED LANDSCAPE)

- A.1 Ethno-zone of **Bakarski prezidi** (drystone walls / terraces - vineyards) (the closest is 20 m south of the route axis, Cart. No. ZK-1) is situated between 8+500 km to 10+000 km of the designed route and consists of hand-made stone dry walls and terraces.

The land was used for growing grapes but with the development of industry at the middle of 20th century, the vineyards were deserted. By breadth and length of the cultivated area the stone dry walls in the area of Bakar and Bakarac are one of the greatest man-made works on the Adriatic coast.

The Bakar vineyards are a protected landscape and as such included in the Register of Cultural Monuments under No. 290 of 3 February 1972. Because of

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the vicinity of the Motorway route construction, the ethno-zone of Bakar vineyards is in the zone of direct impact and the protection measures are required.

- A.2 Ethno-zone (Cart No. ZK-2) that covers the settlements of **Krasica** (min 250 m away from the route axis towards the north, Cart. No. RN-1), **Praputnjak** (min 250 m away from the route axis towards the north, Cart. No. RN-2), **Hreljin** (min 150 m away from the route axis towards the north with a part of the connection road passing through the village, Cart. No. RN-3) is situated between 7+500 km to 11+000 km of designed route. The villages and agricultural land around them are entered in the Register of Immovable Cultural Monuments under No. 383, Decision No. 612 of 18 December 1975 – Directorate for Protection of Cultural Heritage – Conservation Department in Rijeka.

Within the registered ethno-zone there are preserved examples of traditional residential architecture from the end of 19 century characterized by use of stone as basic building material. Beside the architecture, the ethno-zone covers also the surrounding vineyards surrounded by stone dry walls. Because of the vicinity of the motorway route construction the ethno-zone is in the zone of direct impact and the protection measures are required.

B. VILLAGES

- B.1 The rural settlement of **Križišće** (the route passing on the periphery of the village, Cart. No. RN-4) is situated between 13th and 14th km of the designed route. In the village there are well-preserved examples of traditional residential architecture and sacral buildings, St. Anton Chapel and the Church of the Most Sacred Heart of Jesus from 19 century. Because of the vicinity of the motorway route the ethno-zone is situated in the zone of direct impact and the protection measures are required. The Conservatory's Study of impact on cultural and historic heritage identified the protection measures that cover the investigations and provision of documentary evidence about the traditional residential architecture in the village.

C. ARCHAEOLOGICAL SITES/LOCALITIES

- C.1 The locality of **Turčin** (140 m south of the route axis, Cart. No. AN-1) is situated between 6th and 7th km of the designed route. The locality of **Rebar** (130 m south of the route axis, Cart. No. AN-2) is situated between the 7th and 8th km of the designed route, and the locality of **Crni Vrh** (the route passing under the locality (tunnel), Cart. No. AN-3) is situated between the 8th and 9th km of the designed route. The localities belong to the prehistoric era and are characterized by a semicircular form and stone defence walls. Within the sites some broken ceramics have been found that also date from the prehistoric era.
- C.2 **The old town of Hreljin** (min 120m north of the route axis, Cart. No. AN-4) is situated between the 13th and 14th km of the designed route. The site has been included in the Registry of Immovable Cultural Monuments under No.

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383, Decision No. 612 of 18 December 1975, Directorate for Protection of Cultural Heritage – Conservation Department in Rijeka.

The old town of Hreljin is a fortified mediaeval walled settlement from 13th century with round and square towers. Inside the walls there was a settlement with residential and sacral architecture. In the centre there is a church of St. George from 13th century that was expanded in 16th and 17th century. On the north side of the church there was a St. Mary's Chapel built in 17th century. The town of Hreljin is mentioned in the Vinodol Codex one of the oldest written legal documents in Croatia (13th century).

D. INDIVIDUAL OBJECTS OF CULTURAL AND HISTORICAL IMPORTANCE

D.1 The Church of Holy Trinity, a baroque church from 18th century, (min 230m south of the route axis, Cart No. SO-1) is situated between the 13th and 14th km of the route. A single-nave church of the Holy Trinity belongs to the early mediaeval era and was subject to occasional rebuilt with the last restoration in 18th century.

D.2 Graveyard Hreljin (distance of the route axis, Cart No GR-1) is situated between the 12th and 13th km of the designed route, graveyard from 19th century with cultural and historical importance.

3.11 Land Use and Settlement Patterns

The corridor along which the motorway route is situated in the littoral part of Primorsko Goranska County and the section Sv. Kuzam – Križišće passes through two local self-government units: towns of Bakar and Kraljevica.

Basic purpose of the land is divided into:

- a) Building land area
- Areas with settlements,
 - Areas outside the settlements intended for other purposes

The areas for development of settlements have been defined by the building land area borders within the construction of residential buildings and other-purpose buildings intended for operation of settlements and all necessary infrastructures has been planned.

The borders of the building land area define the areas outside of the settlements intended for special purposes, such as:

- Economic,
- Catering establishments and tourism,
- Sport and recreation,
- Infrastructure,
- Cemeteries, graveyards

In the area of the town of Bakar there are nine statistical villages: Bakar, Hreljin, Krasica, Kukuljanovo, Plosna, Ponikve, Praputnjak, Škrljevo, and Zlobin. The corridor

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(100 m from the road axis on both sides) passes through the area of the villages of Bakar, Krasica, Praputnjak and Hreljin and does not get into the building area of any of the villages. It gets in contact only with the building area of the village Hreljin on its periphery with the road running through the tunnel (Burlice, Kuk). Broader area of impact (500 m from the road axis on both sides, 1000 m altogether) covers the parts of the building areas of the villages in question.

In the area of the town of Kraljevica there are six statistical villages: Bakarac, Kraljevica, Križišće, Mali Dol, Šmrika, and Veli Dol. The corridor passes through the area of the village Mali Dol and the contact with the building land area with villages/settlements is on its periphery. Broader area of impact covers the parts of the building areas of the villages Bakarac, Križišće and Mali Dol, and the area of the village Kraljevica, whose building land area has not been encompassed.

Local self-government Unit	Statistical village/settlement	Surface area of the building land area Total (ha)	Inhabitants – Projections 2015	Inhabitant/ha
Town of Bakar	Bakar	31,77	1620	50,99
	Krasica	81,69	1350	16,52
	Praputnjak	26,58	600	22,57
	Hreljin	126,9	2100	16,50
Town of Kraljevica	Bakarac	18,18	296	16,29
	Križišće	4,46	418	25,64
	Mali Dol	16,46		
TOTAL		306,04	8399	27,44

The 100 m corridor does not get into any building land area intended for other purposes. The projects planned in the broader area (500 m) of the town of Bakar in the village Krasica, are the infrastructure project IS3 and a cemetery, a building area for recreational purposes R4 in Praputnjak, a building area for economic-business purposes K7 and K3, and a cemetery G7 in Hreljin, a recreational area R4, a port Luka L1 of national interest, a port for public traffic of the County importance, and the building areas for economic and business purposes K5 and K6 in Bakar. In the area of the town of Kraljevica the 500 m corridor gets only in the building area intended for other purposes such as tourist, commercial, and business facilities in Kraljevica along the connection road to the bridge of Krk.

4.0 Description and Assessment of Significant Environmental Impacts of the Project at the Local, Regional, and Global Levels

In the Republic of Croatia the environmental issues are governed by the legal acts which completely encompass the protection of the environment, its rational economy, restoration of its previous conditions and planning of all the environmental actions and procedures, the goal of which is the balance of the natural and man-made elements in their mutual correlation.

The legal system of the Republic of Croatia contains a number of specific acts and laws which are governing the measures of environmental protection, which all indicate the integrity of the existing legislation aiming at encompassing the entire area of the environmental protection in the State.

Legal acts that basically deal with the environmental protection regulations are included into the so-called general ecological legal acts. They define the institutional framework and practical implementation in the field of environmental protection, the status and functions of the central government bodies and agencies, and the local authorities responsible for environmental protection, special instruments of the programme, the assessment of the environmental impact, and the accessibility of information about environmental protection.

4.1 Impacts Associated with Construction

The areas benefit from the constructed roads but the roads are also a risk for the region, especially for ground waters because vehicles constantly release lubricants and fuel and sometimes the traffic accidents may cause greater contamination of the area.

4.1.1 Geology

The subsection Sv. Kuzam - Hreljin is almost entirely situated in a naturally stable terrain. With proper choice of slopes for cuts and side cuts, adverse impacts of construction will be reduced to minimal extents.

The subsection Hreljin-Križišće is situated on a relatively stable, and on some places unstable terrain. In addition to given geological and hydrological conditions on the slope, critical impact on stability is generated by drained groundwater, at the contact of base and cover. The impact of human activities is also important on semi-stable slopes.

The construction of the road can affect the ground stability so it is necessary to fully adapt the technical side of the construction.

The subsection of intersection Križišće – Connection to Kraljevica and Bridge Mainland – Island of Krk is situated on naturally stable terrain. Because of the stable terrain, small excavations, and the number and size of structures, the impacts of construction on the ground are expected to be negligible.

4.1.2 Water and Sea

Water

The road route is laid within the borders of water protection area of drinking water sources. Therefore the risk of pollution by waste substances entering the subsurface transported by run-off rainwater is very evident, especially in the karstic area.

Section Sv. Kuzam - Hreljin is located in the catchment area of the drinking water sources in Bakarski bay downstream (II sanitary zone of protection) of the water supply facilities. The consequence of the road construction will be the increase in the surface runoff. By opening of cuts in the terrain, the groundwater flow is drained, and soil humidity in the wider belt area decreased. Fills do not reduce the groundwater level, but frequently alter or modify the run-off flow pattern of surface waters. Thereby the possibility for their sinking into subterranean passages is lower.

Construction of tunnels makes hydrographic changes in the catchment area possible, particularly in the karstic area. By cutting groundwater flows, and by changing the structure of cavities in the karst, impacts on groundwater drainage patterns become possible. As the consequence, surface watercourses can also be changed – due to relocation of the surface water rise from the spring. In case groundwater flows that can be captured are detected in the route of tunnel construction, they will be used for water supply of the area concerned. Viaducts have no significant impact on surface- or groundwater flows.

A special problem is the material produced by excavation of cuts, waste cement and other building material generated during construction. The spoil area for the excavated soil and rocks should be determined before starting the works and all the material should be transported to the spoil area only. Surplus cement (waste) and the building waste should be in no way dumped on any other place, but should be taken straight from the building site to the spoil. Special attention should be paid to blasting during construction because of the underground characteristics and possible caving in of karst formations that would have negative impact on ground waters because of wash out of the material blasted.

Sea

The section Hreljin - Križišće, a connection with Kraljevica and the bridge Mainland – Island of Krk is located in the catchment area of the coastal sea in the Bay of Bakar (according to the Regulation concerning the categorization and classification the sea has been included in the Category II. All waters have to be treated in accordance with that regulation.

4.1.3 Landscape

The motorway construction will require wide excavations with the cuts of different inclination and will be executed in different soil category with extensions for tunnels and viaducts and similar purposes, which will create "open wounds" in the existing karst land with no high vegetation.

The terrain at this section is very difficult, steep and visually very much exposed from all the sides, from the sea particularly. Special attention should be paid to the aesthetic aspect of the Project that is the roadbed design and good horticultural development of the broader area.

4.1.4 Ecology and Biotic Resources

Vegetation

The construction of the road will definitely affect the vegetation, flora and fauna. Direct consequences of the road construction will be unavoidable intrusion in the top-soil cover by mechanical force (construction machinery or explosive), the force that will considerably affect macro - and micro region of soil and vegetation, with further consequences in terms of fauna degradation.

Since the newly designed road route is longitudinally surrounded by rugged rocky terrain, sporadically even completely bare, or covered by a thin top-soil layer of earth, overgrown by arid vegetation elements/sorts, and including also underbrush or brushwood, the economic loss of forest constituents will be felt much less in this type of terrain than in larger forest areas.

Indirect damages will be occurring permanently. Various agents from air and water, as well as human activities, will certainly weaken the biological properties of the entire flora. Toxic exhaust gases from fuel combustion in motor vehicles driving along the road will be superimposed to already widely present agents in the area. Year by year they will continue to leave their harmful effects to flora and fauna. Direct and indirect damages will create favourable conditions for biotic factors (diseases, insects, and pests); together with extreme temperatures and disturbed water/precipitation regime, the vegetation will be devastated. The only to remain, and therefore to overwhelm the majority of the terrain, will be the most resistant vegetation. Unless no intervention in the area is preformed, autochthonous vegetation species of higher quality will be lost from the area concerned.

It will be difficult to rehabilitate devastated vegetation on steep and prominent slopes, particularly the areas with the Bakar terraces. Vegetation should be planted to act as a soil stabilizer and to prevent rockslides and erosion on the slopes of fills and cuts.

Forests

Only small part of the motorway runs through the area categorized as forests intended for primary use only – the economic forest covering 4.0 ha.

Agricultural Land

The motorway corridor does not get into the area categorized as valuable agricultural land.

Fauna

The road route is situated inside urbanized area so high quality game, specially the big game, already pressed aside. Only the small-feathered fauna, of interest for

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hunting activities, can be expected to survive and remain in the area, unless human intervention is taken. Along with the above-mentioned activities affecting survival and improvement of flora and fauna, a series of newly formed sociological relationships (man and society) will follow – such as towards ownership issues and long-term planning frequencies and intensity. Such an expected relation should be overcome by performing actions that suggest the indivisibility of general benefits of the road functions with/from the same functions of the surrounding environment.

4.1.5 Air

During the construction phase of the road, the impact on the air quality (dust and smoke) in the villages near the construction area (Hreljin, Mali Dol, and Križišće) is possible.

4.1.6 Noise

It is likely that the noise generated during the construction phase of the road by the construction machinery also increase the noise level above the limits permitted in the areas where the road approaches the villages of Hreljin, Mali Dol and Križišće.

4.1.7 Land

Loss of the basic purpose of land is manifested through permanent conversion of land use and represents a significant impact on the environment. The most drastic form of change is covering the ground with a carriageway. The soil covered with asphalt will permanently lose their productive and protective functions and the land used for verges and road slopes is usually subject to various changes (sweeping off, relocation, covering, concreting, impregnation, compacting, etc.) that often result in far-reaching and irremediable consequences for the land.

4.1.8 Cultural and Historic Heritage

The impact of the Motorway construction on cultural and historic heritage is addressed as a direct and indirect impact. The direct impact is any physical demolition of buildings/localities inside the planned zones of impact – the Zone A is the space inside 250 m on both sides of the route axis as a bordering space of impact on archaeological sites and cultural and historical buildings/structures. The indirect impact is disruption of the integrity of the pertaining space of the cultural asset – Zone B is the area inside 500 m on both sides of the route axis as a bordering space of impact on cultural assets with physical features.

In the zone of direct impact of the motorway construction there are the following sites/localities of cultural and historic heritage: 2 ethno-zones **Bakar vineyards** and the area of villages of **Krasica, Praputnjak** and **Hreljin**, 1 rural settlement of **Križišće**, 4 archaeological sites – the locations of **Turčin, Rebar** and **Crni Vrh**, and the old town of **Hreljin**, and **The Church of the Holy Trinity** and **The graveyard Hreljin**. Because of the vicinity of construction the sites could be damaged. The

vicinity of construction could also decrease the visual values of the broader surrounding of the individual sites.

This particularly refers to the Bakar vineyards because of close vicinity of the motorway route (only 20 m distance from the route axis), so special attention should be paid to that site during the motorway construction both because of its value and importance, and avoidance of their damage.

If during the motorway construction the presentation of individual sites is realized, not addressed so far, this could be considered as a positive impact of the motorway construction.

4.1.9 Land Use and Settlement Pattern

Construction of the road would not cause significant changes in the intended land use since the route is laid through undeveloped area. The whole section Sv. Kuzam – Križišće passes through an area of free nature and outside of village area. The “Križišće” junction, located at the slopes between Baretićevo village and existing road Kraljevica – Križišće, is located close to the existing village but the road level elevation is favourable (the road should be at least 10 to 15 m lower of the closest houses), no special protection measures will be required even in this case.

Since the road route runs near the villages, the following connections will be interrupted:

- Pedestrian passage Jelovka
- Pedestrian crossing Lovrinovo
- Road Bakar – Meja (Ž5060)
- Road crossing Turinovo – Hreljin I.
- Pedestrian passage Turinovo – Hreljin II. and
- Reconstruction of the carriageway Turinovo – Križišće (Baretića selo).

During the road construction the existing road network will be used that might have impact on traffic on the local roads used by the local inhabitants.

4.2 Impacts during the Road Operation

4.2.1 Air

Rijeka bypass road runs on terrain that enables higher natural circulation of air at these higher-elevation areas and together with decreasing the transit traffic it will significantly contribute to the reduction of the local air pollution.

Construction of the Rijeka Bypass would considerably relieve the existing traffic network. The Rijeka Bypass Motorway would take over the majority of the transit traffic, a significant portion of the origin–destination traffic as well as the local traffic heading across longer distances. All previously mentioned is going to significantly

reduce the air pollution in the town of Rijeka caused by emission of motor vehicle exhaust gases.

The corridor passes in the vicinity of the building land area of the villages Hreljin and Mali Dol. When the road approaches the villages it runs through a tunnel so no air quality degradation is expected.

4.2.2 Noise

The terrain configuration is from the acoustic point of view rather unfavourable. Since the road route is laid mainly in a free, unbuilt terrain, higher level of traffic noise could possibly have impact only on the housing settlements in Hreljin and Mali Dol. The road route near Hreljin runs through a tunnel so no negative impact on residential area is expected, but in Mali Dol the road route approaches the houses closely (nearest house is only 45 m from road axis) so noise levels and impact of the traffic could exceed not only the existing noise levels, but also the noise limit values.

Although the motorway runs through a cut and it is located at a lower elevation than the houses mentioned, the noise level will have to be controlled and if necessary adequate noise protection should be provided.

In addition to other benefits, by constructing this road the transit traffic will be diverted from the existing road running through the villages, which will reduce currently too high noise in the villages.

4.2.3 Land Use and Settlement Pattern

The road construction has a positive impact on the land use and pattern at the local and regional level because the local road network will be relieved of the transit traffic.

In order to avoid disturbance of local residents and negative impacts on their quality of life due to the road traffic, care should be taken that new residential buildings are not located and built close to the road.

4.3 Positive Effects of the Road Construction

Substantial environmental and other benefits will result from the construction of this section of motorway D8:

- Higher traffic safety - The road has been designed according to high traffic standards with technical elements of a motorway.
- Relieve of the city road network from trucks is considered the largest improvement in the traffic situation.

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- The transit will be routed to the bypass road thus avoiding the residential areas in the city and the city centre, and resolving many conflicts with complex traffic situations in the city.
- City areas will be directly connected to the bypass road by a junction.
- Shorter connections to the Rijeka port basin through Škurinje junction, Sušak basin through Draga junction, and Bakar basin through Vitoševo junction.
- Interconnection of the city parts (1/3 of the total foreseen traffic is of local character).

4.4 Summary of Environmental Impacts

In following table is a review of all possible environmental impacts caused by construction of the road D8, section Sv. Kuzam – Križišće.

AREA OF IMPACT		IMPACTS						
		NEGATIVE			POSITIVE			
		SMALL	MEDIUM	SUBSTANTIAL	SMALL	MEDIUM	SUBSTANTIAL	
NATURAL RESOURCES	GEOLOGY		•					
	WATERS			•				
	SEA			•				
	LANDSCAPE			•				
	NATURAL RESOURCES	VEGETATION						
		FORESTS		•				
		AGRICULTURAL LAND	•					
		FAUNA	•					
		AIR QUALITY						
		NOISE						
		LAND USE AND SETTLEMENT PATTERN		•				
		TRAFFIC SAFETY	•					
		AIR QUALITY		•				
DURING OPERATION	AIR QUALITY						•	
	NOISE						•	
	LAND USE AND SETTLEMENT PATTERN						•	
	TRAFFIC SAFETY						•	

4.5 Identification of Key Uncertainties and Data Gaps

From the data analysed it can be seen that a Preservation Study should be made to precisely determine the route with regard to the location of the cultural heritage objects by which their full conservation would be secured.

Since the issuance of the location permit is conditioned by development of a Preservation Study, the works on the Study are underway.

With regard to the above mentioned and to the characteristics of ground it will be necessary to make the boreholes to identify the carrying capacity of the ground on the motorway route to obtain reliable data for a detail design being a standard practice for road construction.

4.6 Comparison of Impacts Associated with Alternatives Including the Do-Nothing Alternative

Alternative stretches for the roads were analysed through several generations of physical planning documents. All limitations and possibilities of space were analysed in relation to existing natural resources and to the needs for a new road net. These analyses confirmed the selected locations of these roads.

The plateau above Rijeka is the only possible solution for the location of this road. In terms of environmental protection the situation is getting more and more tense. The hinterland of Rijeka is an area from which water is drained into the ground, springs in the sea close to the coast. The road through the hinterland of Rijeka is much more dangerous because of pollution and what is even more important the contaminated waters would have to let through the separators and then into the ground. It would be impossible to conduct them to the sea due to the distance, 4-6 km.

Do-nothing alternative is not realistic because the road section Sv. Kuzam - Križišće is a part of the Bypass road, which has been partly finished (on the section Meja - Škurinje – Orehovica and has been in use for the last ten years), one of its part is still under construction (section Orehovica – Sv. Kuzam), and by construction of Sv. Kuzam - Križišće, the Bypass road will be fully completed.

If the last section of the Bypass road, which includes connection road to the island of Krk, is not constructed, all effects of already built sections will be minimized.

5.0 Mitigation Measures and/or Measures to Enhance Environmental Benefits

General protection measures

Limit the movements of heavy construction machines during the construction of the road, so that the area affected by construction works would be as small as possible. In other words, the existing road network and paths could be used but they must be rehabilitated after the construction works are completed.

Obligatorily perform a frequent and controlled disposal of waste material and municipal waste to legal dumping places, prohibit any temporary or permanent removal of the above-mentioned waste material in the environment and provide impermeable waste containers.

5.1 Geology

Subsection Sv. Kuzam - Hreljin

With proper choice of slopes for cuts and side cuts, adverse impacts of construction will be reduced to minimal extents. In aesthetic terms, with respect to visually prominent edge of the plateau above the Bay of Bakar, any fills and disposal of excess material on the slopes could cause significant changes. Natural material is recommended as well as landscaping of embankment on the southwestern side of road.

Subsection Hreljin-Križišće

The design should include results of analysis of stability of natural status as well as built status on the whole slope along the route (general stability). Design solutions of cuts and side cuts, partly also embankment, are usually retaining structures that contain also drainages in the contact of base and cover. Closed drainage of surface runoff on carriageway along the route is essential. Collected water should be taken in closed impermeable ducts to stable areas of natural (or regulated) waterbeds able to receive quantities of water that would have otherwise disturbed natural drainage flows and distribution of water.

Various impacts to stability may occur during construction; therefore this has to be taken into account in construction methods.

5.2 Water and Sea

Water

The road runs through the area that is covered by and processed in the Decision on establishment and maintenance of sanitary protection areas and the measures for protection of drinking water sources in II sanitary protection areas (drinking-water sources, strict regime areas). The second sanitary zone (the strict regime area cover immediate hinterland of drinking-water source) for protection of sea has to be arranged in the following way:

- All free surfaces must be developed as a green belt.

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- All the precipitation from the road and the surfaces with impermeable base, as well as sanitary wastewater, must be conducted by impermeable drainage system out of this protected area.
- Roads with higher traffic frequency must have lateral fenders to prevent vehicles from going off the traffic surfaces. They must also have objects and separators for acceptance of fuel and other harmful effluents.
- Transport of harmful and noxious substances (poisons, oil and similar) on the existing roads must be performed with speed limitations. Therefore, adequate traffic signs should be set up.
- In this zone road construction is permitted providing special measures for protection of ground waters are applied.

During construction of the road and its objects, a special attention should be drawn to the zone II, with an emphasis to the following:

- Workshops for construction machinery and vehicles, fuel stations, warehouses for hazardous substances should not be placed there.
- Surfaces around and inside workshops, warehouses for construction material and offices must be made impermeable.
- Impermeable surfaces must have waterproof drainage, which will drive away the precipitation outside the II zones.
- Sanitary effluents can be discharged into hygienic waterproof buffers, which need to be under permanent control and emptied on a regular basis.
- Field blasting has to be preformed in such way that does not affect ground water streams.
- Dumping of excavated material down the hill slope is not permitted. All excavated material must be taken to fills or dumps.
- The slopes of the cuts should be chosen according to natural angles of friction for a particular category of ground to reduce the energy effects to minimum.

SECTION: SV Kuzam - Hreljin is situated in the catchment area of the springs in the Bay of Bakar. Waters from the road surfaces will be collected in a waterproof drainage, and after treatment, it will be conducted to already built open ditch of Bakar Industrial area and controlled before discharge.

During the construction works, the parking lots for vehicles and machines used for execution of the works must be impermeable and the rainwater has to be treated in a separator. These parking lots should be located within the areas intended for construction, without the devastation of surfaces intended for other purposes.

During the operation, the drainage system must be maintained in compliance with the professional rules and regulations.

Sea

SECTION: Hreljin - Križišće, connection with Kraljevica and bridge mainland – Krk is outside the catchment areas that have significant sources of drinking water. We must take into consideration the seashore in the Bay of Bakar was sorted out according to the Regulation of the categorization and classifications in II category

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because of the prevention of contamination of seashore with oil, petroleum products and other hazardous and noxious substances. Therefore it is necessary the precipitation water to be collected by a waterproof drainage, and after treatment discharged into the ground by a drainage system by water-well.

The most important thing when we speak about the operation of the facilities/objects is keeping them in proper working condition. The facilities/objects object must also satisfy the measures prescribed.

5.3 Fauna

During designing on the whole section fences must be envisaged. Special attention must be paid to the construction of the fences in the parts where the viaducts and bridges end, at the beginning of the fence, at the potential sites where animals enter on the motorway area, which has to be strictly prevented.

During development of the road design, it should be checked if the planned viaducts satisfy fully the needs for free crossing of game.

The project of horticultural development shall provide planting of adequate vegetation, which will force the adaptation of animals to the new situation in the area and provide them with an environment resembling as much as possible the natural one.

During the road operation the road objects/facilities, which enable the communication between the areas in the north and south of the motorway, must be maintained in a serviceable condition, including the maintenance of the horticulture in their surrounding.

The fences should be regularly maintained. If any damage or undercut is noticed on any place, the fence on those places should be reinforced and adequately adapted for its purpose.

5.4 Landscape

It is necessary to restore, shape, horticulturally develop and afforest with autochthonous plants (according to the list from EIA from 1986) all the route parts on which cutting, barriers and dams are built, and the works for construction of miscellaneous buildings executed (viaducts, tunnel portals) to reduce harmful and unfavourable impact on the landscape.

All measures taken for preservation and improvement of the affected state of natural landscape are the measures within the environmental protection program. They relate to construction, technical and bio-technical works, as well as forest cultivation measures and the horticultural work.

There will be wide excavations, cuttings of various inclines in different soils, expansions (by plateaus) for necessary services and other buildings, tunnels,

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viaducts, subway crossings etc. Therefore, it would be necessary to improve the aesthetics with the responsible and professional approach.

Measures involving planting of vegetation take time, they are more sensitive, and require special solutions in order to be resemble the autochthonous (original) vegetation. This is of great importance for this section, since larger part of the route passes through intensive karst, with very devastated vegetation and no cultivation value. The new appearance on completion of the road will be very difficult to integrate into the authentic landscape. This especially relates to the road section above Bakar terraces, which has been left as a heritage of a special value and is under protection. Therefore, if they are damaged during the execution of the works, a special attention shall be paid to their recovery.

In order to achieve better integration of the road into the natural surrounding and to implement successfully the measures for protection of the nature and remedy the damages caused by mechanical caving in during construction, special attention should be paid to the recovery of the vegetation. The conservation of autochthonous plants is of essential importance. Everything that has been damaged or becomes a seat of potential permanent pathogenic phenomena should be removed.

Old and broken trees and vegetation, the stumps and the like should be removed. When the works are completed it shall be necessary to register the types of vegetation, level of degradation and cultivation measures. The evaluation of vegetation should be done at the beginning and after the vegetation is selected. The vegetation should identify the object in the space.

Special attention should be paid to the design of structures required to reduce the impacts of the road on the environment by for instance the parries for protection against excessive noise and strong wind. A special design of acoustic walls shall be necessary for protection against noise.

After the completion of the works all the surfaces around the roadway (used for construction works) must be restored in a way that all the works at the construction site are removed and the surface soil layer is brought to a state enabling quick growth of autochthonous vegetation. In the places where this measure is not sufficient for enabling the natural succession, it is necessary to perform a biological intervention so that the area could be brought to its original state as soon as possible. All the works must be performed on the basis of a design so that potentially attractive views could be preserved.

5.5 Air Quality

Since considerable traffic density has been foreseen on certain Sections, it is of greatest importance that the Bypass alignment and the corridors are as much open as possible in the direction of the dominant winds of this region (from east and northeast quadrant). Care should also be taken that the position of the nearby buildings does not prevent the natural air circulation.

5.6 Noise

When making the detail documents for protection against noise, it shall be necessary

- a) to determine levels of noise that are expected according to planned vehicles frequency in different periods, for all crossroads near settlements/villages whose distance from residential objects is less than 300 m,
- b) to record the existing residential objects in zones and make the assessment of the noise to be caused by the traffic planned,
- c) to design the noise protection for all the existing objects where noise from the bypass is above the limits allowed,
- d) to determine the most convenient kinds of soundproof screens and build them wherever needed.

It is also necessary to employ a specialized organization to perform all the work involving the protection from noise. The contractor engaged has to guarantee that the noise level in populated areas will be reduced to the permitted levels. These measures are the part of the special conditions and the area development conditions.

The execution of the construction works in the vicinity of the villages or other settlements shall be restricted to the time from 6 a.m. to 11 p.m.

5.7 Cultural and Historic Heritage

The general protection measures include permanent archaeological and conservation supervision during execution of the works on the entire road section. In case archaeological finds are discovered, the possibilities and methods of their protection and conservation will be analysed by the following measures:

- Conservation by backfilling the archaeological finds.
- Relocation of the finds.
- Relocation of the parts of the find and conservation of the remaining archaeological site by backfilling.
- If the archaeological finds are of extraordinary value, the road route relocation may be requested.

The special protection measures depend on the kind of objects protected:

A. ETHNO –ZONES (PROTECTED LANDSCAPE)

Ethno-zone **Bakarski prezidi (Vineyards – Bakar drysone walls)** and ethno zone covering the villages **Krasica, Praputnjak** and **Hreljin**

The protection measures during design and preparation works consist of the investigations and provision of documentary evidence about the ethno-zone to identify the changes from the time of the first registration (3 February 1972) to date. In addition to the investigations and provision of the documentary evidence, the protection measures also include a permanent professional monitoring throughout the construction of the motorway route and exclusion of blasting during the tunnel construction (between 6,5th and 11th km).

B. VILLAGES/SETTLEMENTS

Rural Settlement of **Križišće**

The protection measures during design and preparation works consist of the investigations and provision of documentary evidence about the traditional residential architecture in the village and occasional professional monitoring throughout the construction of the motorway route.

C. ARCHAEOLOGICAL SITES

Localities of **Turčin, Rebar, and Crni Vrh**

The protection measures for Localities **Turčin** and **Rebar** consist of the archaeological sounding investigation and provision of documentary evidence during design and preparation works. Occasional professional monitoring has been stipulated throughout the construction of the motorway.

The protection measures for the locality **Crni Vrh** (the route runs through the tunnel under the locality) consists of archaeological investigations and documentary evidence during the design phase and preparations works and permanent professional monitoring during the road construction. Archaeological investigation includes the conservation of possible mobile or stationary finds and relocation of mobile finds from the affected locality. During the road construction the use of blasting for the construction of tunnel is not recommended.

Old town of **Hreljin**

The protection measures for this locality consist of archaeological investigations and documentary evidencing during the design phase and preparation work to identify the current condition of the locality. Occasional professional monitoring during the preparation and earth works is necessary. Because of its importance and position with regard to the motorway, the investor of the motorway construction has been suggested to organize the presentation of the locality.

D. INDIVIDUAL OBJECTS OF CULTURAL AND HISTORICAL IMPORTANCE

The church of the Holy Trinity

The system of the protection measures consists of investigations and provision of documentary evidence to identify the changes at the locality from the time of its first registration (18 December 1975) to date, and occasional professional monitoring during the construction.

5.8 Land Use and Settlement Pattern

In order to reduce the impact during the road construction to the minimum, a site organization plan should be made and agreed with the towns of Kraljevica and Bakar. The plan will define:

- Service routes and dumping sites for excavated and waste material
- Technological and access roads, and other production excavations and devastations
- Parking lots for machinery and a land for accommodation of people

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- An assessment of the construction impact on the local roads used during the construction. Road damage and damage remedy.
- Measures for prevention of accidental and unscheduled damages and devastations during the construction, the measures for prevention of unnecessary air pollution, excessive noise level, watercourses, etc.

On completion of the road construction it is necessary to secure functioning of the existing facilities and their intended uses. For that purpose vehicular and pedestrian accesses have been envisaged in the preliminary design. It is necessary to preserve the existing pedestrian communication or predict new ones:

- Pedestrian passage Jelovka
- Pedestrian crossing Lovrinovo
- Reconstruction of the road Bakar – Meja (Ž5060)
- Road crossing Turinovo – Hreljin I.
- Pedestrian passage Turinovo – Hreljin II. and
- Reconstruction of the carriageway Turinovo – Križišće (Baretića selo).

5.9 Potential Ecologic Accidents

The issue of protection of ground and surface water courses from pollution due to ecologic accidents happening on the motorway and involving toppling of vehicles carrying large quantities of hazardous cargo and the outflow of hazardous substances on the roadway and surrounding land is specific and it shall be solved in a way similar to that on other motorway sections. The "Operational plan of prevention measures in case of sudden pollution" should deal with the problems regarding the protection in such emergency situations. This plan envisages the following activities:

- 1 The estimate of possible causes of sudden pollution
- 2 The scope and risks of sudden pollution
- 3 Preventive measures against sudden pollution
- 4 The estimate of threat to waters by sudden pollution
- 5 Organization of the procedure in case of sudden pollution
 - 5.1 Urgent intervention service
 - 5.2 Signalling, reporting and informing
 - 5.3 Procedure after reporting
 - 5.4 Activities on the location after sudden pollution
- 6 Road maintenance service
 - 6.1 General principles of organization and work
 - 6.2 Urgent interventions service
 - 6.2.1 Equipment
 - 6.2.2 Staff for execution of necessary measures
 - 6.3 Training program
 - 6.4 Removal of the material collected in the drainage system
- 7 The service and approvals of the operational plan of intervention measures in case of sudden pollution
- 8 An outline of the procedure in case of sudden pollution

MONITORING**6.0 Environmental Monitoring Plan during the Road Construction and Operation**

Neither the Environmental Impact Study nor the Location Permit stipulates the provisions of the Environmental Monitoring Program. Because of the sensitivity of the area it is necessary to regulate the measures for the Environmental Monitoring Program during the process of issuing the building permit. The monitoring during the construction phase and during operation will include:

WATER:

- Four times a year in relevant hydrological conditions (period of first rainfalls, particularly after the dry season), checking the condition of the waste water treatment plant (WWTP), testing the water quality leaving the WWTP before being discharged into recipient.

AIR:

- Continuous measurement of SO₂ emission, black smoke, NO₂ and suspended matter (Pb),
- Bio-monitoring (before the construction and during operation):
The best results in bio-monitoring of air quality can be expected by monitoring the state of epiphyte lichen.
 - According to Pearson, simple biologic test is recommended (Alebić-Juretić and Ark-Pijevac, 1989) to identify the damage of the lichen cellular membrane.
 - Lead concentration test in biologic objects (lichen, moss, or spicule wrinkle) on a specific distance from the road is recommended,
 - It is necessary to monitor the tree drying on wider area around road route, in order to determine possible harmful impacts that road have on forest vegetation.
 - It is necessary to examine and monitor the changes of plant and animal life after the new road is commissioned with a special stress on rare, endangered, and protected species.

NOISE:

When the road construction is completed, the noise level measurement shall be performed along with simultaneous traffic monitoring:

- Measurement of noise level once in every season on the outskirts of residential areas / villages located adjacent to the road.

On the basis of the monitoring and revised traffic forecasts the noise protection measures should be taken where necessary. After the construction, the efficiency of the protection measures applied must be confirmed by repeated measurements.

HUNTING

During the motorway operation, it is necessary to monitor and report any accident involving game or fences damaged by undercut, so that the measures could be taken to mark and/or repair such places, in order to avoid game accidents and potential traffic endangering.

ENVIRONMENTAL MANAGEMENT PLAN

7. Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) has been prepared to define all the activities involving monitoring, the responsibility for supervision and implementation of the EMPs, training needs, and the reporting requirements. The coordinator for environmental issues within Croatian Roads will guarantee implementation of the EMP. In addition, the Rijeka County Branch of Ministry of Environment will control on a regular basis whether the requirements in the EMPs are observed.

The Environmental Management Plan consists of:

- a. Mitigation Plan
- b. Monitoring Plan
- c. Institutional Strengthening
- d. Implementation Schedule
- e. Institutional Arrangements

ENVIRONMENTAL MANAGEMENT PLAN

b. MONITORING PLAN

b. MONITORING PLAN						Cost		Responsibility	
Phase	What <i>parameters to monitor?</i>	Where <i>to monitor the parameter?</i>	How <i>to monitor the parameter // type of monitoring equipment</i>	When <i>to monitor the parameter – occasional or continuous measurement?</i>	Why <i>to monitor the parameter (optional)?</i>	Install	Operate	Install	Operate
Operate	<ul style="list-style-type: none"> • Air quality • Water Quality • Bio-monitoring (state of epiphyte lichen) • Hunting • Noise • Equipment 	<ul style="list-style-type: none"> • Control points • On the exit of the separators • Some permanent stations need to be established near the route • On the specific distance from the road • On wider area around road route • Along the road • Three control points at border of residential areas • Drainage and separators • Whole route, especially junctions, viaducts 	<ul style="list-style-type: none"> • SO₂, black smoke, NO₂ sediment (Pb) • Measurement of a series of law-regulated parameters • Measuring of cellular membrane • Lead concentration • Tree drying • Changes of plants and animals • Monitor and report all accidents involving game or damages to the fences • Measurement of noise intensity on control points • Condition of drainage and separators • Condition of equipment for traffic managing, surveillance and control 	<ul style="list-style-type: none"> Continuous measurement Quarterly in relevant hydrological conditions (period of first rain, especially after dry period), Before and after the road was in function Continuous Quarterly Twice a year Monthly 	<ul style="list-style-type: none"> Population protection Legal requirements Sea and Groundwater protection Legal requirements Vegetation and animals protection Animal protection Population protection Legal requirements Groundwater protection Groundwater protection 			<ul style="list-style-type: none"> Croatian Roads Qualified Organizations Croatian Roads Croatian Roads 	<ul style="list-style-type: none"> Tests at qualified organizations Tests at qualified organizations Tests at qualified organizations Authorized person Authorized person

ENVIRONMENTAL MANAGEMENT PLAN**C. INSTITUTIONAL STRENGTHENING**

1. Equipment Purchase – After adoption of Main (final) Design
2. Training/Study Tours – not necessary
3. Consultant Services – not necessary
4. Special Studies - not necessary*

D. SCHEDULE

The construction of the road is a part of medium-term plan for 2005-2008. All activities considered with mitigation and monitoring will be coordinated with start and end of construction and during operate of the road.

E. INSTITUTIONAL ARRANGEMENTS

Responsibilities for mitigation and monitoring	Environmental information flow (reporting—from who to whom and how often)	Decision making chain of orders for environmental management (to take action, to authorize expenditures, to shut down, etc.)	
		Activities	Responsibility Institution or person
HRVATSKE CESTE (Croatian Roads)	HRVATSKE CESTE (Croatian Roads) to Ministry for Environmental Protection, Physical Planning and Building (MEPPPB), Environmental Protection Division	Monitoring the implementation of Environmental Management Plan	HRVATSKE CESTE - Head of Project Team, Authorized Person Environmental Inspector - Environmental Division (MEPPPB) Sanitary Inspector - State Directorate for Water Management, County Department
		Data collection and analysis	HRVATSKE CESTE (Croatian Roads) Environmental Inspector - Environmental Division (MEPPPB)
		Monitoring Reports to Environmental Division (MEPPPB) – quarterly	HRVATSKE CESTE / authorised organization
		Operational Plan for an emergency cases - yearly	Head of the HRVATSKE CESTE Environmental Inspector Environmental Department (MEPPPB)

The organisational structure of the state and local governments in the Republic of Croatia guarantees the implementation of the environmental protection measures and the control of their efficiency by monitoring. The implementation is controlled

* The study of impact on cultural and historic heritage conditioned by Location Permit was completed at the beginning of 2004.

ENVIRONMENTAL MANAGEMENT PLAN

institutionally through the Ministry of Environmental Protection and Physical Planning and through the organisational units in the Counties.

The Investor is responsible for financing, implementation of the measures prescribed and for monitoring the environment condition. The implementation of prescribed protection measures (mitigation measures) and monitoring will be supervised during construction and operation by HC (Hrvatske ceste). HC do not have environmental divisions so they will engage authorized organisation to provide all necessary works as usual.

During the construction phase, the implementation of prescribed protection measures (mitigation measures) is the responsibility of the contractor. The Ministry of Environmental Protection, Physical Planning and Bulding, Inspection Division, Construction inspector is responsible for supervision of implementation of mitigation measures in this phase of the works.

During the operation phase, the implementation of mitigation measures is the responsibility of the owner, and the control of their efficiency is responsibility of either MEPPPB (Environmental Protection Division and the County's environmental inspector), or the State Directorate for Water Management, County Department.

The monitoring of the environment condition in the Republic of Croatia is performed by the organisations authorised by the Ministry of Environmental Protection, Physical Planning and Building.

MAPS**MAPS:**

1. PHYSICAL PLANNING STRATEGY AND PROGRAM OF THE REPUBLIC OF CROATIA, ROAD TRAFFIC, PRIORITIES TO 2005

2. SITUATION

EXCERPTS FROM PHYSICAL PLAN OF TOWN OF KRALJEVICA AND TOWN OF BAKAR:

3. LAND USE AND SETTLEMENTS PATTERN

4. INFRASTRUCTURE SYSTEMS

5, 6 AND 7. CONDITION OF USE, MAINTENANCE AND PROTECTION

DOCUMENTATION**Documentation:**

- Planning Program Strategy of Republic of Croatia, Decision of Croatian Parliament, 1997.
- Physical Planning Program of Republic of Croatia, (Official Gazette 50/99)
- Physical Plan of Primorsko-goranska County, Rijeka (Official Gazette of Primorsko – goranska County 14/2000 – July 2000.g.)
- Physical Plan of Town of Bakar (Official Gazette
- Physical Plan of Town of Kraljevica (Official Gazette
- The Environmental impact study, Adriatic coast Highway Rijeka – Split – Dubrovnik
Section: D. Orehovica – Vitoševno – Križišće with junction road Križišće – the bridge and the land- Krk (present day indication **D 102**)
A Conclusion of adopting the final EIS for the Project of Jadranska highway, section Orehovica – Vitoševno – Križišće with a connection to the Mainland – Krk bridge
- Preliminary design for Adriatic Highway, section Sv. Kuzam – Križišće with connection to junction Šmrika, 1991.
- Technical Documentation for Location permit for the road D8, section Sv. Kuzam – Križišće, April 2002.
- Preliminary design for construction of the road Sv. Kuzam – Križišće from km 6+355,00 - km 14+720, 00 and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk – Baška, July 2003.
- Location permit for construction of the road Sv. Kuzam – Križišće and connection road from Križišće junction to the state road D102 – Kraljevica D(8) – Krk – Baška, November 2002.
- The study of impact of construction of the state road D8, section Sv. Kuzam – Križišće on cultural and historic heritage

FOOTNOTES¹ **List of regulations concerning physical planning:**

1. Law on Physical Planning (Official Gazette 30/94, 68/98 i 61/00)
2. By-law on public hearing in adoption procedure of Physical Planning Documents (Official Gazette 101/98)
3. Rules concerning the content, mapping scales, compulsory spatial indicators and standard of physical planning documents (Official Gazette 106/98)
4. Rule book of list of intervention with no request for Location permit (Official Gazette 98/99)
5. Order of buildings of importance of Republic of Croatia (Official Gazette 6/00)
6. Rule book of spatial standards, urban and technical conditions for prevention architectonic-urban barriers (Official Gazette 47/82)
7. Rule book of protection measures for natural and war disasters (Official Gazette 29/83, 36/85 i 42/86)

² **Physical Planning Strategy of Republic of Croatia**, Decision of Croatian Parliament June 1997.

³ **Physical Planning Program of Croatia**, (Official Gazette 50/99)

⁴ List of regulations on environmental protection:

General

Law on Environmental Protection, 82/94, 128/99

National Environmental Strategy, 46/02

National Environmental Action Plan (NEAP)

Bylaw on Environmental Impact Assessment, Official Gazette no. 59/00

Bylaw on Quality Standards for Liquid Oil Fuels, 8/97

Contingency Plan for Accidental Marine Pollution in the Republic of Croatia

Environmental Protection Emergency Plan 82/99, 86/99, 7/97

Bylaw on Conditions for Issuing Permits for Performing Professional Environmental Activities, 33/96

Bylaw on Beach Water Quality Standards

Bylaw on Environmental Information System 74/99, 79/99

Rule Book on Environmental Emission Inventory 36/96

Rule Book on Awards and Prizes for Environmental Achievements 1/99

Rule Book on Environmental Inspectors' Official Identity Card 79/95

Rule Book on Environmental Label 64/96

Instructions on the Form, the Tenor and the Manner of Keeping Records of Inspections Performed by Environmental Inspectors 79/95

Air

Law on Air Quality Protection 48/95

Bylaw on Recommended and Limit Air Quality Values 101/96, 2/97, 140/97

Bylaw on Limit Values of Pollutant Emissions from Stationary Sources into the Air 7/99, 20/99

Bylaw on Substances Depleting the Ozone Layer

Waste

Law on Waste 34/95

Bylaw on Requirements for Handling Hazardous Waste 32/98

Rule Book on Container Waste Management 53/96

Rule Book on Waste Management Requirements 123/97

Rule Book on Waste Types 27/96

List of Professional institutions with Authority of Publishing Reports on Testing Physical and Chemical Properties of Waste 51/96, 93/96

Nature

Law on Nature Protection 30/94, 72/94

⁵ Bylaw on Environmental Impact Assessment 59/00

⁶ The Ministry of Environmental Protection and Physical Planning issues building permits for the following structures: traffic structures, power plants, water structures, industrial structures, structures for handling waste and special-purpose structures.

FOOTNOTES

- ⁷ **Construction Law** (Official Gazette /Official Gazette/ no. 52/99, 75/9 and 117/01)
- ⁸ This clause has been completed pursuant to the Physical Plan of Primorsko Goranska County, final documents, and pursuant to PPUG documents for Bakar and Kraljevica
- ⁹ The analysis of climate in Primorsko Goranska County, The Hydro Meteorological Institute of Croatia, The Maritime Meteorological Centre, Split 1997
- ¹⁰ The Report of the state of the environment in Primorsko Goranska County, Primorsko Goranska County, County Office for Sustainable Development and Physical Planning, Gazette 3/03
- ¹¹ The basic documents for description of the geological features were the sheets from Crikvenica and Delnice geologic map (Scale 1:100.000) that also covers the areas of towns of Bakar and Kraljevica. The map contains systemized data on the geological features of the area, which are also completed with the new investigation results (PPUG Bakar and PPUG Kraljevica).
- ¹² Physical Plan of Primorsko Goranska County, Natural Hydrological Characteristics of Surface Water Phenomena – Institute of Civil Engineering of Croatia, P.C. Rijeka, March 1997
- ¹³ Physical Plan of Primorsko Goranska County, Sea Condition and Purpose, Institute for Development, Directorate of Physical Planning and Environmental Protection.
- ¹⁴ Physical Plan of Primorsko Goranska County, kopnena i slatkovodna fauna Primorsko-goranske županije, Ekspertna znanstvena studija, Rijeka 1997.
- ¹⁵ Protection of fauna is made pursuant to the Law on protection of nature and separate by-laws on protection of some fauna species – By-law on protection of mammals, By-law on protection of reptiles, By-law on protection of some kinds of insects, and other. There are applicable rates for compensation of damage for each protected species and for development studies.
- ¹⁶ Law on Air Protection stipulates the "air quality monitoring" as a systematic measurement of air quality in the area following a time schedule that is as a systematic measurement of air pollution concentrations (ground level concentrations).