

## **SPLIT BY PASS PROJECT, SECTION PLANO - SOLIN SUMMARY FOR PUBLIC DISCLOSURE**

The **Solin-Plano section** of the state road D-8 is the main longitudinal link of conurbation of Split, stretching from the town of Trogir in the west, through Kaštela and Split, to Omiš in the east. It was constructed and opened to traffic in 1963 as a two-lane, bidirectional road for mixed traffic.

In the traffic census of 2001, at the traffic count site 018 (located on the road D8 in Kaštel Sućurac), the traffic volume recorded as AADT was 17774, while as ASDT it was 23611 vehicles/day.

A steady increase in traffic demand, the growth of the vehicle population in the country, the increase of the total traffic volume on the section, and requirements for safe and efficient traffic are the major reasons for this proposal to reconstruct the Solin-Plano section of state road D8. The fact that today there are over 300 direct accesses to the main route tells about the condition of the Solin-Plano section.

The purpose of reconstruction – raising the quality of road traffic on the proposed section of road D-8 to the level required to meet the demands of modern road traffic – is in conformance with all relevant master and regional plans in force, and with those which are being prepared.

The reconstruction of the Solin-Plano section of state road no. 8 will be implemented in phases and stages, in accordance with traffic demands, financial resources, and other possibilities. The stages will include segmental reconstruction of the section. The first segment to be reconstructed is Solin-Kaštel Sućurac. An essential criterion is to reconstruct the segments in succession, in such a way that each segment is operable immediately upon completion. The phases will be determined according to the construction designs of intersections and traffic control (signals). In the first phase, described in the EIS (herein and in preliminary design), the intersections will have traffic lights both at grade and grade separated, whereas in the second phase all intersections will be grade separated (in accordance with traffic demands and financial resources. In later phases of design development traffic signals will be synchronized in order to achieve effect of "green wave" in the main traffic streams.

The criteria for selection of a junction type were to enable undisturbed traffic flows, land acquisition issues and availability of land for grade separated junctions, as well as available financial resources. The length of entry-exit ramps, which are integral parts of at grade junctions, was the main reference used to determine minimum distance of junctions with traffic lights (signals). On parts of alignment where the required length of entry-exit ramps could not be applied, grade separated junctions were placed, or junctions with right turns only.

Engineering solutions of civil engineering structures on the section Solin-Plano of the road D-8 were selected according to efficiency and aesthetic values.

The developers of the preliminary design defined various elements of the reconstruction of the route, described below. The total length of the section is 15.3 km.

The elements of reconstruction design are the following:

- The existing transversal paths shall be grade separated and shall pass under or above the main alignment, wherever possible, with minimal disruption of private property and structures.
- The existing direct access points to the main route shall be reduced to a minimum.
- Widening of the road with two additional lanes and a median shall be made on the north side of the existing road.
- The design has allowed for future construction of all junctions as grade separated, which will increase the level of service.

- In the ground plan, the axis of the alignment was placed to follow the axis of the existing carriageway, as much as it was possible. This resulted in minimum requirements for reconstruction of the south carriageway
- Cross section of the highway consists of two carriageways separated by the median (central reserve). The main width of the median is 3.00 m. Each carriageway has 2 lanes, 3.5 m wide each, with marginal strips 0.5 m wide, which makes the total of 8.0 m. Lanes for exit/entry, having a width of 3.5 m were added where necessary. Shoulders/berms are 1.5 m wide. The median and shoulders are higher than the pavement surface (+15 cm). Runoff drains will be placed within the marginal strip, but drainage through gutters will also be possible. In places where it is not possible to fully connect structures to the alternative network, it will be necessary to construct the pedestrian corridor 3.0 m wide to include the present accesses to the main route and divert them to the places for access. The corridor will be separated from the main route by the green belt 3.0 m wide, at least 1.5 m. Through dense residential areas there will be pedestrian corridor 3.0 m wide at both sides of pavement or only at one. The road crossfall is 2.00 % for optimum adjustment to the geometrical elements of the existing pavement and for cost efficiency in the reconstruction of the existing pavement.
- There will be 11 junctions on the section. Among these, two will be grade separated junctions of the diamond type (intersections 3 and 9); two junctions with right turns only (intersection 5 and 8) and all remaining are junctions at grade, with traffic lights. Junctions at grade include lanes for left and right turns in order to relieve traffic and thus improve traffic flow capacity. Pedestrian islands with elevated curbs (+15 cm) shall be constructed for improved safety of pedestrians. Ramps will be installed at the zebra crossings to accommodate the disabled.

## DRAINAGE

Drainage system will be closed system for the Solin-Plano section segment which crosses the zone III of sanitary protection of water source Pantan. This system will prevent spilling of effluents and runoff water from the road and over the adjacent land into the ground. In case of accident of freight trucks and tank trucks, effluent spilled over the road should be collected through the above mentioned closed drainage system and stored in impermeable concrete receptacle, which will be emptied by emergency services.

Above the ditches adequate openings with sufficient vertical clearances shall be provided as an integral part of the system of streams and channels for regulation of torrential streams. The culverts must be side at least 4 m, and high at least 2.5 m.

The construction of the state road D-8, Solin-Plano section will result in a series of environmental impacts which will require implementation of environmental mitigation measures during planning of the project, during construction and operation.

The alignment in the length of approx. 1.3km passes through the zone III of the sanitary protection of water source Pantan, an in its larger part through the watershed of torrents in the region of Kašela. Measures of protection of water from the pollution generated by traffic will be ensured by the construction of the above mentioned closed drainage system with auxiliary structures. Torrential streams will be solved through a special system for regulation of torrents under the responsibility of Croatian Water Authority.

## AIR

Pollution particles which pollute the air are generated by exhaust fumes of construction machinery and vehicles on the road. It has been assessed that the pollution generated by traffic will not exceed recommended threshold values of pollution stipulated by law. Vegetation belt will be planted along the road to mitigate spreading of pollution through the air. Hedges for protection of agricultural soil will be placed on the side of the alignment where the agricultural soil is placed.

## NOISE

The calculation indicated that the levels of noise generated by traffic has already (on the existing road) exceeded permitted levels of traffic noise both during the day and night, and that all exposed structures are located within 25 m from the edge of pavement. In residential areas the protection from noise will include placing of noise barriers. Noise barriers will also reduce spreading of air pollution to the surrounding soil, vegetation and wildlife. The choice of the type of screen and their location will be determined in a special design in the later phases of design development of reconstruction of the state road D8, Solin-Plano section.

## SOIL

The reconstruction of the road will result in the loss of valuable agricultural land. The use of arable land for agriculture in the protected zone-belt, of the width 25 m at both sides of the road, will be restricted.

## WILDLIFE

In the project area of the road D-8, Solin-Plano Section, there are no sensible, endangered or protected wildlife species. The existing habitats with wildlife in this part will be devastated, but these species have a wide ecological valence and will migrate to the surrounding regions with less impact from the road. Because of segmentation of the land by the road which will be wider than the existing one, it was recommended to include wildlife passages for movement of animals across the land and construction of fences along the proposed section.

## VEGETATION

The reconstruction of the road in the proposed section will result in destruction of olive groves, orchards and vineyards located on valuable agricultural land. During construction of the road the humus topsoil shall be removed and relocated to some other location, in order to preserve the valuable land. During the construction of the section special care shall be taken in order to reduce destruction of the vegetation cover, or agricultural crops, adjacent to the project area. Any damage shall be repaired after the construction.

## CULTURAL AND HISTORICAL SITES

In order to protect historical and cultural sites in accordance with the rules and criteria of conservation, it will be required that the authority in charge prepares a survey/report on the protection of cultural heritage.

## CONCLUSION

It is recommended to establish services for routine control and maintenance of the road and road furniture and signs. A service of permanent supervision of engineering structures shall also be established to timely notify services in charge on any accidents or extraordinary events on the structures and in their vicinity. It is recommended to establish an emergency service for environmental accidents in municipalities or counties.

Monitoring shall be permanently implemented by authorized institutions and persons, with implementation of required mitigation measures in cases when any threshold or recommended values stipulated by the Croatian environmental legislation are exceeded.

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CIVIL ENGINEERING INSTITUTE OF CROATIA  
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# **ENVIRONMENTAL IMPACT STUDY RECONSTRUCTION OF STATE ROAD D8**

## **SOLIN-PLANO SECTION**

Split, April 2003

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## D. SUMMARY FINDINGS AND CONCLUSIONS

### 1. JUSTIFICATION OF SELECTED ALTERNATIVE

The Solin-Plano section is the main longitudinal link of conurbation of Split, stretching from the town of Trogir in the west, through Kaštela and Split, to Omiš in the east. It was constructed and opened to traffic in 1963 as a two-lane, bidirectional road for mixed traffic. Transversal road links connect the road section Solin – Plano with the “Old Kaštela Road” and with villages in the hinterland. The Solin-Plano section has acquired suburban features, due to the vicinity of Split and the level of building development in the wider region.

The Solin-Plano road section has many junctions of irregular geometry. Traffic streams intersect at single level road junctions, and there are no additional lanes (for left or right turns) to relieve the main traffic streams. On the project section, there are about one hundred various access points for vehicles, all constructed without legal permits. Horse-drawn vehicles and tractors are also present on the road although it is classified as a state road. Within the right-of-way zone of the road (a protected area), a large number of residential buildings and farming facilities have been constructed. All of these factors mentioned above have adverse effects on road safety.

In the traffic census of 2001, at the traffic count site 018 (located on the road D8 in Kaštel Sućurac), the traffic volume recorded as AADT was 17774, while as ASDT it was 23611 vehicles/day (PA units).

A steady increase in traffic demand, the growth of the vehicle population in the country, the increase of the total traffic volume on the section, and requirements for safe and efficient traffic are the major reasons for this proposal to reconstruct the Solin-Plano section of state road D8.

The upgrade will result in an increased capacity of the main vehicle flow. Intersections with a traffic control system (traffic lights), lanes for left and right turns, and grade separated junctions will ensure improved road safety, which is a major problem on the proposed section at present.

The purpose of reconstruction – raising the quality of road traffic on the proposed section of road D-8 to the level required to meet the demands of modern road traffic – is in conformance with the main objectives of the long-term development of the road network as described in the Strategy of Transport Development of the Republic of Croatia (NN 139/99).

The need for reconstruction of the road has been identified in the following regional planning documents:

- *Program of Construction and Maintenance of Public Roads 2001-2004*, enacted by the Government of the Republic of Croatia (NN 19/10),
- *Spatial Plan the Republic of Croatia*,
- *Master Plan of Kaštela*, 1991, Volume 1 (Urban Development Institute of Dalmatia),
- *Master Plan of Kaštela*, 1991, Volume 2, (Urban Development Institute of Dalmatia, 1991),
- *Master Plan of Kaštela* 1992 (Official Gazette of the Municipality of Kaštela 6/92),
- *Regional Plan of the Municipality of Kaštela*, 1992. (Official Gazette of Kaštela 6/92),
- *Program of Measures for Improvement of Land Use Conditions in the Region of Trogir* (Official Gazette of the Municipality of the Town of Trogir, no 4, July 1995)
- *Regional Plan of the Split-Dalmatia County* (Gazette of Split-Dalmatia County, issue 1, January 2003)
- *Urban Development Plan of the Town of Trogir*, a draft proposal (2001, Croatian Institute of Urban Studies);
- *Urban Development Plan of the Town of Kaštela*, a draft proposal (GIS plan, Split, May 2001),
- *Provisions for Implementation of Regional Plan of the Municipality of Trogir* (March 1993, Urbos d.o.o.)
- *Master Plan of the Town of Trogir* (Gazette of Trogir 1/93)
- *Report on Land Use in the Region of Trogir* (Gazette of Trogir, issue 4, July 1995)
- *Program of Measures for Improvement of Land Use Conditions in the Region of Trogir* (Gazette of Trogir, issue 4, July 1995)

➤ *Master Plan of Kaštela* – in preparation (Gis plan, Split).

In the current regional planning documents and in the master plans and regional plans of the municipalities of Kaštela and Trogir, a corridor for reconstruction of the Solin-Plano section on D-8 has been established with existing junctions taken at grade. In the Regional Plan (RP) of Split-Dalmatia County, the need to construct all junctions as grade separated has been identified. New regional planning documents, currently in preparation, should be harmonized with the RP of Split-Dalmatia County and with the proposed reconstruction design of the critical section. All stages and phases of the improvement should be entered in the above mentioned regional planning documents.

Regarding land use along the road, all zones along the alignment have been described in regional planning documents. From the chainage 0 to interchange 1 (chainage about 319 m), there is a forest zone on the north side of the road, while on the south side there is an industrial/commercial zone. (*and so forth, described in detail for each zone and chainage segment, not included in this translation*).

The developers of the preliminary design (IGH-PC Split, March 2003) defined various elements of the reconstruction of the route, which were approved by the Employer. They are described below:

The reconstruction of the Solin-Plano section of state road no. 8 will be implemented in phases and stages, in accordance with traffic demands, financial resources, and other possibilities. The stages will include segmental reconstruction of the section. The first segment to be reconstructed is Solin-Kaštel Sućurac. An essential criterion is to reconstruct the segments in succession, in such a way that each segment is operable immediately upon completion. The phases will be determined according to the construction designs of intersections and traffic control (signals). In the first phase, described in the EIS (herein and in preliminary design), the intersections will have traffic lights both at grade and grade separated, whereas in the second phase all intersections will be grade separated (in accordance with traffic demands and financial resources).

The total length of the section is 15.3 km. The concept of the construction and traffic design includes compromise solutions, however, in compliance with the following guidelines:

- Intersections with the existing town streets shall be alternatively grade separated and at grade, with traffic lights and without traffic lights, but including right turns in order to enable free flow of through traffic and merging in of local traffic.
- The existing transversal paths shall be grade separated and shall pass under or above the main alignment, wherever possible, with minimal disruption of private property and structures.
- The existing 300 direct access points to the main route shall be reduced to a minimum, and shall preferably be included with additional pedestrian traffic corridors parallel to the main route, while the entry ramps shall be placed at sites which maximize their safety.
- Widening of the road with two additional lanes and a median shall be made on the north side of the existing road.
- The design has allowed for future construction of all junctions as grade separated, which will increase the level of service and design speed.

In the ground plan, the axis of the alignment was placed to follow the axis of the existing carriageway, as much as it was possible. This resulted in minimum requirements for reconstruction of the south carriageway. The main criteria for horizontal elements of alignment was design speed of 80 km/h.

Elements of vertical geometry were set to follow the existing elevation (with an addition of superelevation because of the reconstruction of the existing pavement). The grades were determined by minimum grades required for drainage. Thus the vertical alignment overlaps with the existing carriageway (the south carriageway of the future highway).

Cross section of the highway consists of two carriageways separated by the median (central reserve). The main width of the median is 3.00 m. Each carriageway has 2 lanes, 3.5 m wide each, with marginal strips 0.5 m wide, which makes the total of 8.0 m. Lanes for exit/entry, having a width of 3.5 m was added where necessary. Shoulders/berms are 1.5 m wide. The median and shoulders are higher than the pavement surface (+15 cm). etc.

The condition of pavement structure is mostly poor, satisfactory only in small segments. The shoulders along the entire length are in poor condition/nonexistent. The preparation of the reconstruction project should include detailed inspection of the pavement structure. According to the results, it will be necessary to determine rehabilitation of the south pavement, or removal of the existing and construction of the new pavement.

There will be 11 junctions on the section. The criteria for selection of a junction type were as follows:

- in order to enable undisturbed traffic flows; the length of entry-exit ramps, which are integral parts of at grade junctions, was the main reference used to determine minimum distance of junctions with traffic lights (signals). On parts of alignment where the required length of entry-exit ramps could not be applied, grade separated junctions were placed, or junctions with right turns only.
- land acquisition issues and availability of land. Grade separated junctions require areas of large size, and entail issues of land acquisition.
- financial resources are not sufficient for construction of all junctions as grade separated (this refers to the first phase of construction).

Based on the mentioned criteria, the 11 junctions will be designed as follows:

- two grade separated junctions of the diamond type – intersections 3 and 9
- two junctions with right turns only – intersection 5 and 8
- all remaining are junctions at grade, with traffic lights.

Junctions at grade include lanes for left and right turns in order to relieve traffic and thus improve traffic flow capacity. Pedestrian islands with elevated curbs (+15 cm) shall be constructed for improved safety of pedestrians. Ramps will be installed at the zebra crossings to accommodate the disabled. In subsequent phases of design development traffic signals will be synchronized in order to achieve effect of "green wave" in the main traffic streams.

In addition to reconstruction of state road D8 on the section Solin-Plano, the Preliminary Design (prepared by IGH, Branch Office Split, 2003) included reconstruction of segments of local road network, to connect traffic transverse to the main route. Currently, the local roads have access to the main route at junctions without proper traffic control, which is risky. Alternative roads and access roads will be used temporarily before construction of network of streets to be finally connected to D8 through grade separated junctions with entry ramps or junctions at grade with right turns. The plan includes 24 axes of alternative network, having length of 10,533.20 m.

24 axes are described in detail in the text that follows (*detailed description not included in this translation*).

Engineering solutions of civil engineering structures on the section Solin-Plano of the road D-8 were selected according to efficiency and aesthetic values. Common solutions of span structure were selected (prefabricated reinforced concrete supports with reinforced concrete slab).

The viaduct will enable for crossing of the new north carriageway of the section Solin-Plano (road D8) over the existing railway lines and the valley on both sides of the railway. The length of the viaduct is 135.4 m. In selection of spans and position of pier, the most important criteria was the required distance from the axis of the railroad (the second field) to viaduct piers, and the possibility of extension of the railroad with one new track (the third field). Vertical clearance from the rails to the span structure of new viaduct is 5.6 m (identical with vertical clearance of the existing viaduct). The inspection of the condition of the existing viaduct structure has revealed damages on span structures. In further design rehabilitation of the viaduct shall be proposed. Total width of the structure (old and new viaduct) is 12.5 m.

Alternative road network (axis 3, axis 12, 15, 21 and 23) will cross the state road D-8 on the section Solin-Plano through five overpasses. Depending on the local conditions of the soil and visibility, standard designs of overpasses were planned (*detailed description follows (not included in this translation)*).

Alternative roads axis 5, 9 and 14 will cross the state road through underpasses.  
Alternative roads axis 6 and 8 will cross the state road D8 through passages (clearance 4.5 m).  
Pedestrians will cross the state road D8 on the section Solin-Plano, at the chainage 2+870, 823 through underpasses, while at the chainage 5+820,30 overpasses will be constructed. The north carriageway of the new designed state road D8, section Solin-Plano over the stream will cross over the bridge.

Drainage system will be closed system for the Solin-Plano section segment which crosses the zone III of sanitary protection of water source Pantan and for alternative road axis 26 in the part which crosses the same zone.

This system will prevent spilling of effluents and precipitation water from the road and over the adjacent land into the ground. Collected runoff and effluent will be purified in grease traps and sand traps before they are discharged into a receptacle which will be located out of the zone III of sanitary protection of water source Pantan. The sediments from the grease and sand traps must be collected by an agency authorized for collection of hazardous waste.

In case of accident of freight trucks and tank trucks, effluent spilled over the road should be collected through the above mentioned closed drainage system and stored in impermeable concrete receptacle, which will be emptied by emergency services. Alternative solution is a receptacle with biological separator.

The problem of torrential streams in the period of heavy rainfall in the Kaštela valley should be solved by adequate control system. Culverts with adequate vertical clearance shall be included on ditches. The main principle in drainage is that the direct and shortest drainage path shall be chosen. On the section there are already culverts for torrential streams, therefore the minimum requirement for the culverts is that wherever possible, the culverts of reconstructed sections should be at the same place and of the same dimensions. However, it is recommended that the culverts are constructed to prevent obstruction. This means that they must be at least 4 m wide, and at least 2.5 m high.

#### CLARIFICATION

The phase of preparation of the design which is called Preliminary design, includes construction design of reconstruction of the road D8 on the section Solin-Plano and alternative roads with structures (a viaduct, overpasses, underpasses, passages), but it does not include measures of protections (dimensions, locations at the highway).

The design engineer who prepared Preliminary design planned some measures of protection and included them in the project cost estimates (Section A.5 herein), in order to adhere to Laws and Regulations in the field of construction, regional planning and environmental protection. In addition, the design engineer considered that the environment has limited possibilities to receive pollution. Therefore adverse impacts of the project must be reduced by mitigation measures.

For that reason the Project is acceptable for the environment only if mitigation measures are implemented.

Optimal location/position of individual elements of protection on the road (such as the position of noise screens or the position of runoff collectors) as well as dimensions of protection elements and their visual fitting into environment, will be described in detail in the subsequent phase of design development.

Environmental mitigation measures, described under heading 3 herein, are given to serve as guidelines to design engineer in subsequent development of designs, and can be useful for selection of location and dimensions of individual elements of protection.

## **2. POSSIBLE ENVIRONMENTAL IMPACT OF THE PROPOSED ALTERNATIVE**

### **Water**

Regarding hydrogeological features, the project area of the Solin Plano section of road D8, and its network of alternate roads, has permeable layers in the small segment of the section, while in the larger segment there are impermeable layers. The main alignment of the length of about 1.3 km passes through the zone III of the sanitarily protected area of the Pantana water source and by its larger part through a torrential basin in the Kaštela area. Axis 26 of the network of alternate roads passes through zone III of the sanitary protection of the Pantana water source, while other axes pass through the torrential basin in the Kaštela area.

During road construction, many impacts occur which may be detrimental to water quality. These impacts include cutting torrential streams, reducing the thickness of cover, opening topsoil layers, opening borrow pits, pollution of water by construction material, emission of sewage water and polluted runoff from the construction site and fluids from construction machinery (fuels, lubricants).

During the operation and maintenance of roads, pollution is generated by runoff that rinses away pollution particles from the road surface – tire marks, wear of brakes, surface pavement layers, fuel combustion products, leaking of fuel and lubricants, de-icing chemicals, and cleansing agents for vehicles. In principle, the runoff from rainfall carries away solid particles and unevaporated components of fluid on pavement. This pollution is spread in the roadside area over a distance of about 10 m. According to research, the highest concentration has been recorded in embankment toes.

Hydrogeological features of flysch layers and the climate and weather in the region of Kaštela do not enable the formation of permanent surface streams but only minor temporary torrential streams in the heavy rainfall period. Road reconstruction in this area will lead to disruption of surface runoff on the alignment segment where the road is placed in cuts and on the embankment. This will result in a higher concentration of inflows on upstream ravines. However, provided that the project includes structures for free discharge of temporary streams on water-worn ravines and an adequate control system for torrential streams, changes in the runoff rate of surface water (torrents) will be kept to a minimum.

### **Pollution of the Air**

Pollution particles can be found in exhaust gases from construction machinery (construction phase) and road vehicles (operation phase). Permanent air pollution occurs in the operation phase. The noxious constituents of exhaust gases are: carbon dioxide, carbon monoxide, hydrocarbons, sulfur dioxide, nitrogen oxides, lead and lead compounds, soot, and smoke.

The air pollution possible has been estimated for peak hour traffic (8%), the maximum values of individual compounds in the typical chemical composition of exhaust gases of a vehicle with the engine in neutral. The results obtained were compared with the recommended levels (RL) of pollution, as established in the Directive on Recommended Values of Air Quality (NN 101/969).

The pollutant levels from vehicle exhaust gases was estimated for the peak traffic hour as follows:

- AADT 2001 - 17774 vehicles/day, 2007 – 20900 vehicles/day
- ASDT 2001 – 23661 vehicles/day, 2007 – 27600 vehicles/day
- the crossing with the heaviest traffic, Kaštel Sućurac: AADT 2001 – 22100 vehicles/day, 2007 – 25987 vehicles/day.

The estimates have shown that pollutants will stay on the level recorded for the Solin Plano section of road D8 and that their levels will not exceed the recommended values set by the Decree on Recommended Values of Air Quality (NN 101/96).

For the Solin-Plano section of road D8, a traffic study has not been made to give suggestions on the redistribution of traffic loading. However, it can be assumed that AADT and ASDT taken at the existing eight intersections will be redistributed over 11 new intersections. As a result, future traffic loads on the section will not exceed current maximum loads.

At the moment of opening the road or a section of it for traffic, a comparison will be made with the AADT and ASDT projections for the intersection with the highest traffic volumes.

Because the estimated quantity of pollutants does not exceed the recommended values (Decree NN 101/96) on the intersection in Kaštel Sućurac, with the highest traffic loads, it is not expected that the quantity of pollutants generated in the year 2007 by traffic on the alternative network of roads will exceed the RL stipulated by the Decree (NN 101/96).

### **Soil and Agriculture**

The construction and maintenance of the future road will result in a loss of arable land. The use of arable land for agriculture in the protective zone-belt of 25 m from the edge of the road (both sides) will be restricted.

Road traffic emits exhaust gases and disperses fugitive road particles through the air or by water. Pollutants are partly dispersed into the atmosphere but are also spread through the air and deposited on soil and plants, while some pollutants are carried by surface waters and discharged into the sea. Pollution of exhaust gases has a direct adverse impact on the soil, crops, and forests. Noxious substances, such as heavy metals, are transmitted through the soil to plants, where they accumulate. The accumulation of heavy metals depends on the types of heavy metal and plant species. Concentrations of heavy metals in plants are significantly higher in the area along the road. Heavy metal pollution which accumulates in plants has an adverse impact on their biochemistry and physiology and thereby adversely affects their growth. The chain of impacts of such pollution, for example from adding lead to gasoline, are well established and widely known facts. The ultimate impact on humans (who directly or indirectly eat these polluted plants) are cardiovascular diseases, premature death, growth and behavior problems in children, etc.

Data on the contents of heavy metal in the soil and in the plants of the Kaštela bay and on their disposition in the area can be found in the works: Miloš, B. 1989; 1992 and Miloš, B. et al 1993. The highest content of lead is in the eastern part of the bay (industrial plants), in the west around the airport and along the roads in the area. Furthermore, the research has shown that the total content of lead in soil is rapidly reduced with the distance from the road and is usually deposited at the distance of less than 25 m. In relation to natural conditions of soil, the content of pollutants in the soil has been increased, but it does not exceed permitted threshold limits for the use of soils for agriculture.

According to estimates made in Chapter B.1.2, Impact of the Project on the Pollution of Air, it is evident that in the year 2007 imission of pollutants generated by traffic on the road D8 and on the intersection Kaštel Sućurac, will remain at the level of the highway and will be below recommended values of pollution of air stipulated in Decree (NN 101/96). The distribution of traffic flows on alternative roads will result in pollution levels staying on the level of the roads and will not exceed recommended values (Decree 101/96).

If the pollution generated by traffic on the highway exceeds recommended values (as set in the Decree published in NN 101/96), mitigation measures shall be implemented to protect field crops.

### **Vegetation and Wildlife**

Road construction encroaches into or destroys the habitats of various plant and animal species. It can be assumed that the road construction will lead to the devastation of present plant habitats and that the largest impacts will be on flora. Animal species may migrate to adjacent areas, so it can be assumed that they will flee to areas outside the reach of construction work in the project area. However, some animal populations will perish at the construction site. If these are insects, which are numerous in nature, it can be assumed that some members of the species will survive and move to other habitats.

Construction work on the section will destroy olive groves, orchards, and vineyards on valuable arable land. Arable land needs to be developed over hundreds of years. It is unacceptable to cover the humus layer with asphalt or to remove it and dispose it at dump sites. Plots of land along the alignment of D8 are partly used for agriculture. On the south side, rezoning has resulted in a loss of agricultural land for construction of buildings with industrial, commercial or residential purposes. On the north side, the plots are mainly cultivated, but there are also plots of untended arable land.

Vegetation is very sensitive to air pollution. Drastic impacts can be seen as the withering of some plant species, while chronic impacts can be seen as changes in the leaf color.

It has been estimated that in the year 2007 traffic volumes on the road D8 and the intersection Kaštel Sućurac will not exceed the recommended values of pollution of air stipulated by Decree (NN 101/96). The distribution of traffic flows on alternative roads will result in pollution levels staying on the level of the roads and will not exceed recommended values (Decree 101/96).

In the list of currently known species of invertebrate and vertebrates, there are not sensitive, endangered or protected animal species in the project area. Because the project area is placed partly in the industrial zone, and partly in built-up urban area where construction is permitted, the existing habitats with their wildlife will be destroyed in the project area. However, these types have wide ecological valence and will migrate to adjacent regions which are less exposed to negative effects of the highway construction.

### **Noise Levels**

During construction noise is generated by construction machinery. This noise cannot be avoided, but it is temporary.

The highest permitted level of noise in open spaces, thus also along the section Solin-Plano on the road D8, are set by the Regulations (NN issue 37/90), for day it is 65 dB(A), for night 50 dB(A).

The increase in noise levels has been calculated to obtain distance from the edge of pavement at which the noise levels are within permitted levels for day and night according to the Regulations (NN 37/90).

The calculations have shown that the emitted noise levels generated by traffic exceeded the permitted levels for day and night already in 2001, and that all noise exposed structures were placed within 25 m from the edge of pavement. The exposed area is three times larger by night than by day, which is the result of lower permitted levels at night.

From the above mentioned it is evident that on the reconstructed section Solin-Plano for the road D8 noise abatement measures will have to be implemented. These measures will serve also for prevention of pollution of air from highway pollution (in compliance with the Law on the Protection of Air Quality, NN 48/95).

### **Population and Human Settlement Patterns**

The most evident impact of polluted air on human health are diseases of respiratory organs. Pre-school children are very sensitive, and persons with chronic diseases. Noxious gases such as SO<sub>2</sub>, NO<sub>2</sub>, NO, CO, ethylene, lead and soot in certain quantities cause negative impacts on human health in direct or indirect ways.

Noise above tolerable level has negative impact on human health. The opening of reconstructed section of the road Solin-Plano for traffic, the levels of noise generated by traffic will exceed permitted levels set in the Regulations NN 37/90.

### **Utilities**

Reconstruction of state road D8 on the section Solin-Plano will include reconstruction or construction of new local network roads. All existing connections to the main route (section Solin-Plano) on the road D8, were channeled into junctions, on connections with right entries to main flow and alternate roads. Designed alternate roads and connections will be temporarily used, while in final stage a street network will be constructed and connected to D8 through grade separated junctions with access ramps and junctions at grade with right turn options. The length of each road in alternative road network, which will be named according to its axis, and be included in the

project presented in this Study, has been described in detail in under heading A.3.1 Description of the project.

Because of reconstruction of state road D8, relocation of underground power lines and water mains will be required, with approvals to be obtained from the power and water management authorities /HEP, Hrvatske vode) on procedures of relocation of utility lines.

#### **Architectural and Natural Heritage**

The research carried out so far has given evidence on continuity of settlements in the area. There are traces of civilization and culture in the project area dating to as early as the prehistoric period (prehistoric tumuli and ruins, ancient Greek and Roman structures and necropolises, early Christianity and Medieval churches and cemeteries, to citadels and fortresses.

For this Environmental Impact Study, the preservationists have made a survey report on architectural and historical heritage. It shows that in the project area the entire length of the road D8 on the section Solin-Plano and the network of alternate roads is located in the area rich with archeological and historical heritage.

Polluted air has adverse impacts also on objects and structures, because pollutants get settled on the surface of structures. There, the humidity, temperature changes and sun rays cause chemical reactions which have aggressive impacts on the surface of structures.

#### **Environmental Accidents and Risks**

Extraordinary events or environmental accidents which might be dangerous to health and life of people, and which may damage the environment and cause material damage, may happen in cases of truck tanks transporting fuel for gas stations along the section and in accidents involving freight vehicles transporting noxious and hazardous substances (in construction and operation).

In storage of oil derivatives there is a danger of explosion of stored hazardous substance. Tank trucks with fuel might be a risk because the contents might be spilled or explosion of the substance might happen. Such accidents might have disastrous consequences for people, and the environment. The probability of occurrence is once in a thousand years, but such accidents have disastrous impact on the environment (UNEP, 1992).

As a rule, accidents happen during bad weather and are unpredictable, and as such are the major risk. It is critical to enable collection of pollution generated by such accidents and their storage in receptacle before the arrival of emergency services.

### **3. ENVIRONMENTAL MITIGATION MEASURES**

#### **3.1 Mitigation Measures During Project Development**

All the components on the road which enable safe traffic should be included and planned in the design phase. These should be in compliance with all the regulations and legislation related to the construction of roads and to environmental protection in the road area. These regulations and legislation are as follows:

- A closed drainage systems is the engineering measure to be taken in the road segment which passes through zone III of the sanitary protection of the well (approx. 1.3 km of the main alignment, axis 26 from the alternate roads network), in order to prevent adverse impacts from the road on the Pantana water source. The collected runoff and effluents will be purified in grease and sand separators before they are discharged into the receptacle, which must be located outside of the zone III of sanitary protection of the Pantana water source. The measures for protecting the waters from road surface pollution will also protect the soil, and therefore indirectly the vegetation and wildlife, since runoff from the road which reaches the soil is detrimental to the flora and fauna too.

- In the case of accidents of heavy freight trucks or road tankers, any effluents spilled onto the road surface shall be collected through a closed drainage system and discharged into an impermeable concrete receptacle, which will be emptied by an emergency service team. The location and capacity of the impermeable concrete receptacle shall be determined in a separate study. (Any pollutant spilled onto the road surface during an accident may be collected in a receptacle with a biological separator which must be located in the most convenient site between the road and the receptacle.
- Adequate openings of proper size and vertical clearance should be planned above the ditches. They will be integrated into the system of streams and channels for the regulation of torrential streams. The openings shall be at least 4 m wide, and at least 2.5 m high.
- The regulation system for torrents (to be determined by the Croatian Water Management Authority, Hrvatske vode), should be open in the upper stream (above the Solin-Plano section of road D8), whereas a closed system should be designed in the lower stream (south from the section). Transition structures will be placed between the open and the closed control systems.
- The use of any road elements, furniture, or equipment which might confuse and disturb the concentration of drivers shall be avoided.
- The area along the road shall be revegetated by indigenous plants – a mixture of evergreen and deciduous bushes – in order to reduce the emission of pollutants. In order to be able to absorb 60% of the pollution, the planted vegetation must have a width of 10 m. Since it will not be possible to put such plantings along the full length of the section, they will be placed only on locations with enough space.
- Any vegetation planted to protect agricultural land shall be placed on the side of the alignment bordering such zones. Purposeful revegetation and maintenance of trees and shrubs enables purification-filtering of emission particles.
- Noise screens may be used for protection from noise, but also for the reduction of air pollution (and thereby also soil pollution and impacts on the vegetation and wildlife). Through an optimal combination of screen heights and their distance from the pavement edges, a significant reduction of the pollutants generated by traffic can be achieved behind the screen. A detailed calculation of the required noise abatement measures and the selection of the screen types and location will be determined in a separate study in the subsequent phases of the development of the design documents for the reconstruction of state road D8, section Solin-Plano.
- Green wave on intersections with traffic signals and the construction of all intersections in the Solin-Plano section of road D8 as grade separated will increase the capacity of the main traffic stream and thus reduce air pollution (and thereby also soil pollution and impacts on the vegetation and wildlife).
- It is not permitted to plant trees, shrubs, or any high field-crops which might obstruct visibility in close vicinity of intersections on the road D8 that are at grade or on insides of curves.
- Remediation of heavy-metal polluted agricultural soils shall be conducted in order to reduce the mobility of heavy metals and to facilitate their bonding. This refers primarily to calcification and coating with humic substances. The application of substances for the bonding of heavy metals in the soil to make them into less accessible forms may be used instead of calcification.
- Special measures shall be taken if organic agriculture is planned in the vicinity of the road. Farms or land plots may be classified for organic food production if located at a distance of at least 50 m from any road with peak traffic volumes of more than 100 vehicles/hour or 10 vehicles in a minute. Alternatively, the minimal distance from the road may be reduced to 20 m if the land and road are separated by hedges or barriers having a height of at least 1.5 m. The content of heavy metals in the soil on the border of such land must first be determined. Borders can be moved only if complying with the permitted contents in the soil.

- The land in the project area will be divided by the future reconstructed road, which will be much wider than the current road. For this reason, crossings shall be placed in the road formation in order to enable the migration of animals such as amphibians, reptiles, and mammals. The minimum number of such passages shall be calculated according to the quantity of intersections. Preferably, there shall be twice as many passages as there are intersections.
- Fences shall be placed along the alignment to prevent mammals the size of hedgehogs or larger from crossing the road.
- A number of grade separated passages for farming vehicles shall be included in the alignment; (such vehicles are prohibited from state roads. Pedestrian crossings shall also be provided in order that the shortest and the safest approach to farming facilities and agricultural land is placed at both sides (south and north) of the reconstructed section. Crossings for farming vehicles and pedestrians shall be placed at 1 km intervals.
- In the current regional planning documents, master plans, and regional plans of municipalities of Kaštela and Trogir, a corridor for the reconstruction of the Solin-Plano section of D-8 has been set with the existing junctions taken at grade. In the RP of Split-Dalmatia County, the need to construct all junctions as grade separated has been identified. New regional planning documents, currently in preparation, should be harmonized with the regional plan of Split-Dalmatia County and the proposed design of reconstruction of the critical section. All stages and phases of the improvement should be entered into the above mentioned regional planning documents.
- For alternative roads, revisions and amendments shall be entered into urban planning documents (current plans and plans in preparation). The design engineer has taken into account the present status of the area (the existing residential buildings) and adjusted the position of some alternative roads, thus causing noncompliance with current urban development documents.
- In order to incorporate some alternative roads ("blind alleys") into the traffic system, it will be necessary to construct links within urban street network. The project will be implemented in stages, therefore the authorities financing the construction of required segments within the network of streets, will have to adjust the construction of these roads with the reconstruction of D-8.
- The road on axis 3 is essential for the project. The responsible authorities should therefore find financing for it. On the segment from Solin to Kaštel Sućurac, uncoordinated schedules of construction will result in the availability of an overpass only on axis 3, without an alternative road along the same axis. It is necessary to construct the road on axis 3, in order to avoid the unsightly view of an overpass and in order to prevent deterioration of the structure.
- In order to preserve historical and cultural sites in conformance with the rules and criteria of preservation, it is necessary for the institution in charge of the area to prepare a study on the protection of architectural heritage. The project area must be investigated in detail, and the borders of possible archeological sites must be identified and determined with precision. The study will result in requirements to be taken into account in the further development of the design documents.
- In order to adhere to the Law on the Protection of Nature, it will be required to continue with systematic care and protection of nature in the project area. The local authorities will have to prepare regulations on the use of land for economic activities for any sites of special value which will not be classified within the protection categories.

### **3.2. Mitigation Measures During Construction**

- The sites of the provisional structures (workshops, storage of fuel and lubricants for the construction machinery, staff barracks, etc.), which will be located on the flysch layers, shall

be determined in accordance with the water protection terms to be established by a competent authority. This needs to be done in the later stages of the design development.

- In the zone III of sanitary protection of the Pantan water source, by virtue of Article 24 of the Regulations on the Determination of Water Source Sanitary Protection Zones (NN 55/02), any disposal of oil and petroleum products is prohibited. For this reason, it is not recommended to place temporary storage of fuel and lubricants for the construction machinery in the mentioned area.
- Any excess excavated soil shall be dumped on sites selected for such use by the local authorities.
- Topsoil removed during the road construction (a thickness of about 50-60 cm, or more in some places) shall be separated and transported to another location (determined in advance), in order to conserve valuable soil and safeguard its primary function – the production of biomass. Thus it will be possible to preserve about 100,000-150,000 m<sup>3</sup> of soil, which may be used to improve areas where ground cover is scarce.
- The operation of construction machinery and the transport of materials shall be scheduled to avoid the disturbance of people living in the area of the towns, Kaštela and Trogir.
- During the construction of the road, care shall be taken to preserve as much as possible the natural herbaceous cover in the area surrounding the alignment. Every group of trees or solitary trees which do not grow directly on the alignment shall be protected to enable their continued growth.
- If construction in the zone of agricultural plots causes damage to crops in the vicinity of the alignment, such as fruit trees or grape vines, all damaged plants should be replaced.
- During construction, care shall be taken to keep any possible damage (direct or indirect) to wildlife to a minimum. Special care should be taken with regard to possible indirect impacts to domestic animals; therefore, all possible measures for the prevention of adverse indirect impacts shall be applied.
- During earthworks, open access to the site shall be granted to the preservation authorities who will conduct a reconnaissance survey.
- At expected archeological sites, archeological probing and surveying shall be carried out first, before any discussion on the possible purposes of the sites. All schedules, construction designs, and landscaping shall be subordinated to the conservation project and the presentation of any findings. Any artifacts discovered during excavation works must be reported to the National Authority for the Protection of Cultural and Natural Heritage.
- All protected and environmentally valuable areas are subject to compliance with all provisions, directives, and guidelines contained in *National Strategy and Action Plan for the Protection of Biological and Landscape Diversity*.

### **3.3. Post Construction Mitigation Measures**

- A book of rules for the scope and periods of inspection, cleaning, and repair of highway drainage structures shall be prepared.
- Routine inspection and maintenance of the road and traffic signs shall be established.
- A supervision service to report on any accidents or any extraordinary events on the highway or road structures shall be established.

- An operative plan of procedures in the case of accidents shall be prepared, and relevant emergency services shall be established in municipalities or counties.

#### **4. ENVIRONMENTAL MITIGATION MONITORING PLAN**

The environmental protection requires continuous monitoring of environmental conditions in order to identify probable adverse impacts of the highway on the environment (noise levels, pollution of air, water, soil) and in order to determine mitigation measures. Environmental mitigation monitoring plan shall be an integral part of base documents of the project, and shall be continually implemented by authorized institutions and persons. Special mitigation measures will be mandatory in cases when, in the monitoring, values are identified which are above the permitted levels, stipulated in the environmental laws and regulations of the Republic of Croatia.

The following environmental monitoring plan is proposed for the project:

##### **Monitoring of noise levels**

Control noise measurements will be conducted biannually in the conditions of the highest and the lowest traffic loading and during the changes of traffic rates. Measures will be conducted by an authorized institution according to legislative in force: The Law on the Protection from Noise (NN 20/03); Regulations on the Highest Permitted Noise Levels in Human Environment (NN 37/90). Noise measurement shall be conducted in places with least distance from structures where people live and work.

##### **Monitoring of air quality**

In order to determine air quality in areas exposed to air pollution, air pollutants shall be measured, and recorded. Polluted air shall be measured at the peak hour of traffic loads at the speeds of wind below 3m/sec.

##### **Monitoring of water quality**

Testing of runoff water quality: based on the samples taken from the settling tanks twice a year in the rainy (fall) and dry (summer) periods it will be necessary to analyse chemical and bacteriological conditions of water. This will be done to check the quality of water discharged into the environment (Decree on Maximum Permitted Concentration of Hazardous Matter in Waters and Coastal Sea, NN 78/98; National plan for protection of waters, NN 8/99).

Monitoring of water quality of the water source Pantan: according to the Rules on Determination of zones of Sanitary Protection (NN 55/02), it will be required to take samples of water from the well twice a year (rainy and dry periods), and to analyse bacteriological and chemical conditions of water.

##### **Monitoring of soils**

Monitoring sites will be established in the observed area where soils samples will be taken to identify features which regulate chemical and physical processes in the soil (pH in H<sub>2</sub>O, humus content, content of lead (Pb), polycyclic aromatic hydrocarbons (PAH), and textural composition). Tests will be conducted once a year.