

## NON-TECHNICAL SUMMARY

### The strategic aims of building HPP Vranduk

Global task is orientation towards sustainable development and reducing greenhouse gas emissions i.e. pressures on climate change. For decades, especially in the European Union is promoting the orientation towards the usage of renewable energy sources, if their use is a potential for sustainable development, i.e. acceptable economic development in terms of environmental protection and natural resources. Practice has shown that the use of renewable energy sources in developing the electricity sector can have a positive effect on social cohesion and the standard of the local community, including employment, development of small business and recreational sporting activities, contributing to security of electricity supply, etc. At the national and federal level, according to upcoming obligations for accession to the European Union, it is important to ensure appropriate use of hydropower resources in the production of electricity for the needs of internal and external markets. Bosnia and Herzegovina has ratified the Treaty of establishing the Energy Community in 2006., where are established "acquis for renewable energy sources." Each Contracting Party undertakes to make a plan for implementation of Directive 2001/77/EC of the European Parliament and the Council on the promotion of electricity produced from renewable sources. The purpose of this Directive is to increase electricity production from renewable sources in the internal electricity market, with the aim of global reducing CO<sub>2</sub> emissions and pressures on climate change.

Combustion of fossil fuels leads to emissions of pollutants into the air, causing air pollution at the global, regional and local level. The project of construction of HPP Vranduk is based on the use of renewable energy sources, which will contribute to reducing CO<sub>2</sub> emissions and pollutants from the energy sector. Therefore, the implementation of this project is in line with the priority obligations of the energy sector, as well as the structure of executive authorities at local and state level in this context.

The use of hydro potential in production of electric power in Bosnia and Herzegovina is much lower than there are real possibilities. HPP Vranduk by an installed capacity is the project in the category of clean development mechanism (Clean Development Mechanism - CDM) of the Kyoto Protocol, ie the UN Framework Convention on Climate Change. To implement this project can be used favorable financing models, which are designed for developing countries, host countries for implementation of the clean development mechanism projects, and use the certificates obtained as a certificate of reducing greenhouse gas emissions (equivalent CO<sub>2</sub>).

Environmental Strategy of the Federation of BiH, in a part related to the protection of air, was determined an objective to encourage the use of renewable energy sources, with measures for the realization of set objective.

According to the strategic plan and program to develop the energy sector of the Federation of BiH, HPP Vranduk is one of the planned production capacity in the Federation of BiH.

Directive on the use of renewable energy sources and cogeneration is in preparation (in a draft form), which aims to stimulate greater production and consumption of electricity from renewable energy sources in the internal electricity market, particularly in terms of:

- reducing the impact of the use of fossil fuels on the environment,
- long-term provision of energy,
- positive effects on social cohesion and approaching to the Kyoto aims,
- job creation and entrepreneurship development in energy,
- more efficient use of energy,
- encouraging the implementation and development of new technology and the domestic economy as a whole

### Hydropower potentials of the Federation of Bosnia and Herzegovina

The construction of hydropower plants is an important segment of development of electricity industry and the economy in general. One of the characteristics of rivers of Bosnia and Herzegovina is hydropower potential, which has not yet been adequately exploited in the development context.

In accordance with the commitment of JP Elektroprivreda BiH to increase productive hydropower capacities, and providing safe and reliable electricity supply and the Decision of the Government of the Federation of BiH declaring the public interest for the construction of power facilities (Official Gazette of FBiH, No. 60/06) and the Decision to designate the public interest and access and construction of the priority power facilities in the Federation of BiH (Official Gazette of FBiH No. 08/10), were initiated activities on implementation of the Decision and analysis of the possible hydropower exploitation, among other things, of the Bosna River.

Hydropower potential of the Bosna river catchment is 365,78 MW, and the potential annual production is 1593,6 GWh. Thereof, the hydropower potential of the Bosna river in the Federation of BiH is 171,60 MW, i.e. the potential annual production amounts to 993,6 GWh. For now, of the available energy potential of the Bosna river catchment it uses only 2.2%.

### Spatial planning basics

Since the adoption of the current Spatial Plan 1981-2000 on the territory of Bosnia and Herzegovina there was a change in the political map, economic and social conditions, but the facts on the proven and established qualities and assumptions of development in the area largely are valid today.

The Spatial plan of the Federation of BiH is not adopted, and the Spatial Plan of BiH is still valid in the territory of this entity. Under the Spatial Plan on the orientation of the development and arrangement of the economy in space, in a special section on the development of energy production is "to build a new hydroelectric power plants along the

rivers Neretva, Drina, Vrbas, Trebišnjica, Bosna, Una, Sana, i.e. karst fields, therewith it should expect acceleration of the use of available water power and enter into a wider system of construction of new hydropower plants”.

Construction project of HPP Vranduk is, therefore, in accordance with the applicable spatial planning documents of the Federation of BiH and the spatial plan of the Zenica-Doboj Canton (2009. -2029.)

Interventions in space, such as the formation of the storage upstream from the dam, inevitably affect changes of the authentic space. It is significant that such objects are, in most cases, multifunctional. They are primarily built for the purpose of development and satisfaction of civilization needs, prior for water supply and use of water power for electricity production, and the planned hydro storage of HPP Vranduk, in addition to producing the electricity, can be used for irrigation, development of small business and recreational activities.

It is significant to use water resources for energy purposes, but "no" without a selective approach and thorough assessment of the consequences for the environment. A crucial objective of environmental impact assessment is to make a choice of the optimal solution in the context of the construction, operation and maintenance of the hydropower facility, which should have the attributes of environmental and techno-economically acceptable facility. Likewise, it is necessary to identify and estimate some potential impacts of project implementation of construction of the hydropower plant on the quality of ecosystems and the catchment area of the Bosna river, and the environment in the narrow and broad sense.

### **Basis for preparation of the Environmental Impact Study**

Basis for preparation of the Environmental Impact Study of HPP Vranduk (hereafter EIS) is the Conclusion on development of the Environmental Impact Study number UPI-05-23-172/09 from 09.07.2009., issued by the Federal Ministry of Environment and Tourism on basis of the Preliminary Environmental Impact Assessment, pursuant to the article 58. and 59. of the Law on Environment Protection (Official Gazette of FBiH, no. 33/03, 38/09) and the Article 3. and 4. of the Rulebook on plants and facilities for which the Environmental impact assessment is required and facilities and plants that can be built and operated only if they have an environmental permit (Official Gazette of FBiH, no. 19/04). EIS has been prepared in accordance with the provisions of these regulations and the provisions of Directive 97/11/EC on the environmental impact assessment, amending Directive 85/337/EEC on the impact assessment of certain public and private projects on the environment.

The aim of valorisation of potential Project impacts on the environment is identification of some eventual intolerable failures in space, in the context of protection and promotion of cultural-historical and natural values, and the environment in general.

## Project Description

Future HPP Vranduk will be located in the municipality of Zenica, at the location between the city of Zenica and Nemila settlement near the homonymous settlement of Vranduk. The area to be covered by the project extends along the left bank of the Bosna river from the Jelina train station up to the dam profile located about 150 m downstream from the Bosna V bridge on the main road, and then the left bank downstream from the Bosna IV bridge up to the Nemila settlement. Location of HPP Vranduk is good from the aspect of construction organization because the existing road infrastructure allows easy access to all components of the plant. Derivation type of the plant allows that works, without disturbances are carried out on three main buildings: dam, headrace tunnel with a surge shaft and on the power house. Geological conditions are also relatively favourable, and underground works are performed in rocks of medium to low water permeability.

### Energy parameters of HPP Vranduk

		MAIN GENERATING UNITS	SMALL GENERATING UNIT	TOTAL HPP VRANDUK
Installed flow	m <sup>3</sup> /s	100	14 (18)	
Type and number of turbines		2xKAPLAN(„S“)	1xKAPLAN(„S“)	
Elevation of normal backwater	m a.s.l	293,50	293,50	
Elevation of tail water (for Q <sub>i</sub> )	m a.s.l	271,34	284,90	
Maximum gross / net head	m	22,46/20,90	8,45/8,28	
Power	MW	18,24	1,32	19,56
Possible annual production	GWh	86,88	9,50	96,38

## The general concept of solution

The general concept of hydropower use of the Bosna river at the stretch Zenica - Nemila is defined on the basis of basic orientations:

- use, in the most effective way, natural features of the Bosna streams at this relatively short, but typical stretch
- thereby do not affect adversely the main environment values,
- try that existing infrastructure facilities are not affected,

and previous studies, the available backgrounds, realized investigations, boundary conditions and constraints.

Solution with a run-of-river facility is adopted, derivation type, with more or less complex buildings that represent the functional unit, or:

1. The complex of buildings at the location of the dam: dam with four spillway fields located in the central part of the riverbed, gate depot along the left bank, a small

hydropower plant along the right bank and fish path between the small hydropower plant and end spillway field;

2. Intake structure with equipment and facilities;
3. Headrace tunnel with surge shaft;
4. The complex of buildings at the location of the power house: the power house with drainage canals and dug downstream riverbed, the area with pre-turbine gates, the command building, a plateau with transformer and switchgear building;
5. A new road to the Hanovi settlement with a bridge over the railway line, an access road to the weir crest on the left bank and reconstructed existing local roads on the left bank, section Vranduk - Jelina and bridge Bosna IV – Nemila

### Description of the technical solution of facilities

**The dam** is a concrete type, height from the foundations 16 m and length in the weir crest of 110 m, located app. 150 m downstream from the bridge "Bosna V". **The hydro reservoir** is formed upstream of the dam with the elevation of normal (and maximum) backwater of 293,50 m a.s.l. Total storage capacity is  $1,62 \times 10^6 \text{ m}^3$ , length of 5,8 km and area of 42,56 ha. It is important to note that the storage of HPP Vranduk is conditionally the storage, because the parameters and a depth up to 9 m, and generally is formed in the riverbed. It has the characteristics of the storage only during the period, when the inflows of the Bosna river are less than the installed flow of the plant. Then its area is app. 12% higher than the area of the riverbed bottom, while at higher flows and engagements of evacuation organs at the dam it achieves a state similar to natural conditions. **The intake structure** is located on the left bank, approximately 35 m upstream from the bridge "Bosna V" and it is designed on the installed flow of  $100 \text{ m}^3/\text{s}$ . **The headrace tunnel** has a length of 1.476 m and diameter of 6,60 m. The headrace tunnel route passes between tunnels on the main road Dobož – Zenica and railway tunnels. The minimum distance from the existing tunnels is approx. 100 m. **The power house** is located on the left bank, between the bridge after the exit of the railway tunnel. It is to be constructed in a notch, close to the local road.

Digging the downstream riverbed, in order to increase the gradient of the plant and improve energy effects, is running over a length of 2500 m wide of the riverbed of 50,0 m, with the bottom gradient of 0.5 ‰. The adopted width adjusts the natural width of the Bosna riverbed, on this stretch. Cone lowering of the river bottom at the beginning of deepening is maximum 2,91 m.

### Connection to the electric power system (EPS) of BiH

In order to ensure the safe placement of produced electrical energy in the network in all driving situations it was selected a connection to 110 kV network and to the existing 110 kV transmission line Zenica 1 - Zavidovići, which passes near the location of the future plant in the system input-output. The transmission line has been renovated and has sufficient capacity to accept produced energy of the new power plant.

## IMPACTS OF HPP VRANDUK ON ENVIRONMENTAL QUALITY

### IMPACTS DURING CONSTRUCTION PERIOD

#### Impact on population

Taking into account the relatively low number of inhabitants in the area of the planned dam and storage, the negative impacts in terms of necessary removal of the population are minimal. Only one house is predicted for demolition i.e. relocation of one household.

Positive impacts on the population are numerous and relate to the increase of economic activities, which follow the construction of such facilities. It creates conditions for employment of a large number of population i.e. employment of some local construction firms and local residents, during the construction of hydropower facilities.

The local community will ensure a fair compensation for some occurred damages and it will be achieved a compromise of interests between the local community and the investors, which implies creating conditions for the multipurpose use of water resources of the Bosna river. In addition to concession fees, duties will be determined in the Investment Program for the local community after the Project support, which should be "friendly" to the population and the environment.

#### Impact on climate

Based on data on the general climatic and morphological characteristics of the narrower and wider area of the Vranduk gorge, it was noted that there will not be significant changes from the microclimate aspects. The most important impacts depending on the size of the project in the area, mainly construction works, can potentially be a temporary impact on the natural ambient condition in a narrower area of the Vranduk gorge.

#### Impact on air quality

During the construction of facilities HPP Vranduk, the air will be affected due to increase of dust, as well as the release of exhaust gases from machines that will be used.

#### Impact on water

During construction of HPP Vranduk it can temporarily occur water turbidity due to excavation works in the riverbed, then during the filling and installation of building materials. Also, during the construction phase can occur leaching of various materials used on the site. It will temporarily come to hydromorphological changes in the natural water regime.

#### Impact on soil

During construction a certain area will be occupied with some auxiliary facilities, construction of site and infrastructure, some temporary places to store construction materials.

### Impact waste generation

During the digging of tunnels and site preparation for future hydro reservoir as well as other construction works it will lead to the accumulation of excavated material. Construction waste materials include earth material, stone, gravel, biomass etc. It is to be continuously collected and removed from the construction site area and directed for use, and the rest of the unused construction debris finally disposed to an established landfill.

Given that it will have to raise the level of the local road up to the level of the railway line near the Hanovi settlement, the major part of the excavated material will be used as an embankment for a new local road.

### Impact on flora and fauna

Construction of hydropower plant – hydro reservoir with a dam leads to changes in the structure of the Bosna river ecosystem. The most significant effects on the environment during the construction phase are manifested during filling a small reservoir, which is reflected in aquatic and semiaquatic flora and fauna. Filling the storage will result in irreversible loss of terrestrial habitat, with simultaneous increasing of border zone between terrestrial and aquatic environment. Water area in relation to the current situation will be only 12% extended. It is possible that there will be eventual degradation of the submerged vegetation and soil, if they are not removed prior to filling the hydro storage.

### Impact on ichthyofauna

Any partitioning of the riverbed and changes of the stream, especially the construction of hydropower plants, will inevitably lead to distortions and changes in the ecosystem

Site preparation, construction works within the river bed, dam building and construction of coastal fortifications, will disturb ecological balance of the stream and affect the ichthyofauna, especially in the vicinity of facilities.

During construction of the hydropower plant, a habitat of indigenous fish species will be disrupted. In the immediate vicinity of the construction site, a river surface will be completely altered or destroyed. In addition to ambient effects, habitat changes have resulted in the destruction of flora and fauna, or interruption of the food chain for a certain period of time.

To avoid possible consequences on the natural balance of the ichthyofauna, it is proposed to ensure migratory routes and construction of a fish path.

### Impact on cultural and historical heritage and landscape

Construction of HPP Vranduk at the proposed location will affect the physical structures of the space of the other protection zone of the Old Town Vranduk i.e. cultural landscape around the Old Town Vranduk which is reflected in the images, structures and shape of the entire area.

Impacts of construction of the planned facility on the cultural and historical heritage can be divided into direct and indirect impacts. Direct impact is considered to be any physical transformation of the site space / facilities within the anticipated impact zones. Direct impact on facilities in the protection zone I has not been determined. Indirect impact represents the violation of integrity of respective surrounding area of cultural heritage, which was established during consideration of impacts of the dam and hydro storage HPP Vranduk on the architectural ensemble of the Old City Vranduk.

During construction works, noise will inevitably increase, which may decrease the number of tourists in the Old Town Vranduk during this period. There will be a modification of space in terms of visual effect.

In the preliminary design it is planned to construct, next to the dam, a road for public communication from the upstream side in the same height level with the access road and dam top elevation. The planned width of the road was about 7 m. Due to the connection with the local road on the left bank, it was intended to build the retaining wall height of 15 m.

Given that from the aspect of protection of cultural and historical heritage it is estimated that a major impact will have the dam, access road and road for public communication next to the dam and hydro storage. It is therefore proposed that the additional load of the space and visual effects should be reduced by giving up of road construction for public communication. The Design Engineer and the Investor supported the proposal and the expert opinion of staff that have made the Impact Assessment of HPP Vranduk on the cultural and historical heritage.

### **Impact on noise level**

The impact that will be caused by the noise in the operation of machinery from the site HPP Vranduk will be acceptable. It is important to emphasize that the first residential buildings are about 250m and the area is already exposed to noise from the frequent traffic of M17 highway and the railway line.

### **Impact on existing infrastructure**

During construction of the facility HPP Vranduk and access road on the left bank, it is expected to impact on traffic. The reason is the reorganization of traffic on local roads, diverting the current to the other alternative routes, and it will come up to the occasional short-term traffic stopping on some shorter sections, especially on a local road to the settlements Hanove and Ljubetovo. It will start the reconstruction of about 1200 m of the local road and build about 500 m of the new local road.



## IMPACTS DURING OPERATION PERIOD

### Impact on population

Implementation of the agreed project documentation with environmental protection measures, will ensure that the impacts of built structures of the hydropower plant will be acceptable for the local community.

In the realization of the Improvement Program of outdoor space next to buildings constructed on the dam section, the cohabitation of a new building with the environment will be ensured.

Due to the loss of the authentic condition and loads of the area, the realization of this project is accompanied by various compensations to the society and local community, as well as indemnities for the use of energy resources, pursuant to the applicable legislation in the Federation of BiH, minimum indemnities, under current laws, would amount to:

Indemnities	Municipality (KM)	Canton (KM)	Federation of BiH (KM)
<b>One-off concessions</b>	1,35 mil.	225.000	675.000
<b>Annual indemnities</b>	1,05 mil.	58.000	43.000

### Impact on climate and air

Given that it is about the increase of water mass for only 12%, it can be concluded that there will not be an increase in humidity in the wider area of the storage in the Vranduk gorge, and a local climate with increased air humidity, intensity and frequency of radiation and advection fogs and low air temperature will not be formed.

Since the HPP Vranduk is a project from the scope of the Clean Development Mechanism (CDM) of the Kyoto Protocol, and that is based on the use of renewable energy sources, indirectly impact on reducing CO<sub>2</sub> emissions and pollutants that are emitted into the air from the thermal power sector.

### Impact on water

Construction of the reservoir itself of HPP Vranduk will not lead to additional distortions of flow regime and not expect the impact of oscillations upstream. The project will, in accordance with the Decision of the previous water permit, ensure that the downstream oscillations are minimal. Water quality downstream will be altered due to changes, turbidity and dissolved oxygen concentration, which is not considered a harmful impact, because it helps the development of some organisms. Bearing in mind the current situation regarding

water quality or characteristic parameters of HPP Vranduk and storage, negative impact on water quality is not expected.

### Impact on soil

The impact during the operation of HPP Vranduk on soil is not expected. To achieve the positive effect of cohabitation of new buildings with the natural landscape, it is important to regularly maintain recultivated surfaces according to the Project of external organization of built facilities.

### Impact waste generation

During operation of HPP Vranduk, larger quantities of waste will be created in the overhaul period. Collection, storage and transportation will not present more significant problems and impacts on the environment, because the facility have a Waste Management Plan.

#### External impacts on facilities of HPP Vranduk

Floating waste generated by local communities upstream, and which causes the Bosna river, will be accumulated on the grid and floating dam. The accumulated waste will be disposed by an authorized organization. It should be noted that disposal of this waste is not a legal obligation for HPP Vranduk, but it will be regularly implemented to compensate the community and with the aim of security of facilities, cleanliness, and visual effects of the hydro storage

### Impact on flora and fauna

Formation of the reservoir changes natural conditions and reduces the flooding zone. Many aquatic and semiaquatic species can not adapt to these changes in flow regime and water level. Because of that the ecosystems are subject to change of biodiversity i.e. reduction, because a small number of species can maintain high densities in these areas.

According to the design solution of the storage, water temperature and distribution of dissolved oxygen in water will not be changed in a vertical column, which will not cause the consequences and both qualitative and quantitative changes of aquatic and semiaquatic flora and fauna.

### Impact on ichthyofauna

Construction of the dam structure will change the ecosystem. Formation of reservoir will transform a natural stream to the ecosystem of lake type, where there will be minor or major changes in hydrological and ecological characteristics.

Migration of fish and other aquatic organisms from the lower to the upper river, will be enabled by building fish path under the dam.

### Impact on cultural and historical heritage and landscape

The most significant direct impact of HPP during operation is reflected in the changing cultural landscape / natural environment, characteristics and perceptions of the Vranduk canyon. It can be assumed that the impact will cause a permanent change in the area, as well as in the overall perception of the cultural landscape / natural environment and its impact on the visualization of the Old Town and from the Old Town on the surrounding neighborhood.

### Emission of noise and vibrations

Source of noise and vibration during operation of HPP Vranduk is the turbine, which will be located inside the power house. Equipment in the power house must be modern and meet the technical standards and requirements of local and EU legislation which sets the level of external noise. Significantly higher levels of noise from this source are not expected, especially considering the fact that at the location there are significant sources of traffic noise on the main road M-17 and rail traffic. Nearby the power house, there are no settlements, and the first house from the power house byis located approximately 1,5 to 2 km, so there will not be noise impacts on residents.

### Classification of the estimated potential impacts / effects of the planned HPP Vranduk by importance

After the identification of possible environmental impacts, primarily on the minor part of the Bosna river catchment, some negative and positive impacts of the Project are estimated and environmental protection measures are proposed. Socio - economic and environmental justification for the planned construction of the hydropower facility has been evaluated.

NEGATIVE IMPACTS /EFFECTS ON ENVIRONMENT	POSITIVE IMPACTS /EFFECTS ON ENVIRONMENT
<p>Possible estimated negative impacts / effects of the construction of the HPP Vranduk are:</p> <ul style="list-style-type: none"><li>• Transformation of the ecosystem of stream to the ecosystem of lake type, a length of 5,8 km,</li><li>• changes in the landscape / natural environment in the II zone of protection of national cultural monuments "Architectural ensemble of the Vranduk Old Town,</li><li>• characteristics and perceptions of the Vranduk gorge, views from "Architectural ensemble of the Vranduk Old Town",</li><li>• relocation of a household - 1 house to be demolished</li><li>• loss of land area - the total land area to be bought off is 84. 434 m<sup>2</sup>,</li><li>• loss of indigenous habitats of flora and fauna in</li></ul>	<p>In addition to development - economic significance, and possible typical positive impacts / effects will follow the construction of HPP Vranduk:</p> <ul style="list-style-type: none"><li>• production of hydro – energy, i.e. „green energy“ in the territory of Zenica – Dobož Canton, as well as reducing pollutant emissions in electricity production,</li><li>• construction of facilities within the clean development mechanism - "Green kWh", or contribution to reducing greenhouse gas emissions, approximately 70.000 t CO<sub>2</sub>/year,</li><li>• physical integrity and safety of facilities in the I protection zone "Architectural ensemble of the Vranduk Old Town" will be preserved</li><li>• implementation of the Planning Programme and additional presentations of the National</li></ul>

NEGATIVE IMPACTS /EFFECTS ON ENVIRONMENT	POSITIVE IMPACTS /EFFECTS ON ENVIRONMENT
<p>the zone of the storage and colonization of new species,</p> <ul style="list-style-type: none"> <li>• disruption of ecological balance, the number of species and the natural migration routes for aquatic and semiaquatic organisms, on the part of the Bosna river catchment where the dam and hydro storage of HPP Vranduk are situated,</li> <li>• disruption of the self-cleaning mechanism – the self-cleaning mechanism will be disrupted in the hydro storage area, while it will be increased in the downstream part,</li> <li>• there will be minimal oscillations downstream of the hydropower plant,</li> <li>• impact on quality of air, water and soil during construction of facilities, which is temporary,</li> <li>• changes in the natural riverbed below, with the planned deepening of the maximum length of 2,5 km conic from the power house, where is the initial depth of 2,91 m,</li> <li>• regulation of sediments and deposition of sediments in the storage zone,</li> <li>• eventual occurrence of erosive processes, which beforehand with certainty can not be assessed,</li> <li>• relocation of the local road and making a new road in a length of 600 m,</li> <li>• flow in this part of the river will be regulated by environmentally acceptable flow, which will guarantee the maintenance of ecological balance of the downstream part of the Bosna river.</li> </ul>	<p>Monuments</p> <ul style="list-style-type: none"> <li>• cohabitation of the new building with landscape characteristics of the II protection zone of "Architectural ensemble of the Vranduk Old Town",</li> <li>• the hydro storage is formed in the riverbed, with expansion of only 12%,</li> <li>• construction of a fish path, which will mitigate the disruption of ecological balance and ensure the migration of aquatic and semiaquatic organisms,</li> <li>• fair compensations for the submersion of material goods, removal of only one family, or demolition of 1 house,</li> <li>• submersion of only 0,20 ha arable lans,</li> <li>• collection and cleaning of the Bosna river from floating waste, which will be accumulated in front of the dam and water intake grilles. It is evident that the Bosna river is burdened with the waste that people throw around the entire basin,</li> <li>• the possibility of water supply for irrigation in the region,</li> <li>• chosen location of the plant is good for the organization of construction works, transport and installation of equipment,</li> <li>• tourism development and several forms of recreation and sports activities in the area of the planned hydro storage, eg, recreational sailing, fishing, etc.,</li> <li>• minimal changes in microclimatic conditions, may be suitable for the development of some plant and animal communities,</li> <li>• local economic importance and the establishment of small business activities,</li> <li>• employment of local people, if some domicile firms and labor would be preferred,</li> <li>• increased value of property in the immediate vicinity of the hydro storage,</li> <li>• in addition to the above, some other measures to compensate the community because of losse of the authentic condition at this part of the Bosna river catchment,</li> <li>• programs to improve the area affected by the Project - Investments in consultation with local</li> </ul>

NEGATIVE IMPACTS /EFFECTS ON ENVIRONMENT	POSITIVE IMPACTS /EFFECTS ON ENVIRONMENT
	community. • reconstruction of some local roads

## DESCRIPTION OF MEASURES FOR MITIGATION OF NEGATIVE EFFECTS ON ENVIRONMENT

### Mitigation measures during construction

#### Population

For all construction machinery and vehicles used in construction of the hydropower plant, there should be a sound protection / isolation of the engine and other components, which produce or contribute to the development of noise. In the case of use of blasting for excavations in rock massifs, select the type of explosive that has the least harmful impacts on environment.

Within the Study on land acquisition to determine the real facts and investment program for fair compensation. Before performing works, within the Projects of construction organization to plan the construction, maintenance of alternative crossings / passages for the local population.

#### Air - Climate

Basic measures to mitigate and potentially prevent negative impacts of construction works during construction of the HPP Vranduk facilities are relating to mitigation of dust emissions using modern construction techniques and devices to control emissions from fuel combustion, the performance of construction works in the site zone and avoid the devastation of the environment, vegetation and soil, outside that zone. Avoiding, wherever possible, the use of explosives. It should be noted that the production of concrete will be done in the area out of the site location of the hydropower plant, especially the location of the dam which is near the Architectural ensemble of the Vranduk Old Town.

#### Water – Ecosystem of the Bosna river

At all stages of works to ensure a continuous water flow by the Bosna river, and migration of aquatic and semiaquatic organisms. Also, during the construction works, it is necessary to take measures concerning the possible blasting, temporary disposal of waste, and after destruction of the cofferdam, all remnants of construction materials to be cleaned up to the bottom of the river bed and etc.

Within the Programme of Site Organization it is important to prevent spreading the riverbed with any waste material, and ensure waste management in accordance with the Plan of waste management during construction. Collect and manage all wastewater from the site in accordance with the Programme of Site Organization.

Also, take other measures as specified in the Resolution on the previous water permit.

### Protection of structures against external impacts

In accordance with the fact that the Bosna river is loaded with municipal and other waste, it is necessary to install a floating barrier which would collect the waste accumulated by river flow. It is therefore necessary to set a grille in front of the water intake.

### Soil – Waste

Within the Environmental Impact Study it has been made a general Waste management plan during construction and during operation of HPP Vranduk. The Plan should be updated after the start and during construction in accordance with some objective indicators of the possible and the generated waste. During works, records and periodic reports on waste management should be taken.

### Flora and fauna

During construction of the HPP Vranduk, It is necessary to remove existing vegetation from the site of the facilities. Prior to the formation and filling of the reservoir, cleaning of vegetation should be made, because it is essential to avoid decay and loss of oxygen in the future storage.

### Ichthyofauna

Proper management of the site can greatly reduce harmful impact on the ichthyofauna during construction and at its completion.

The basic measures would be the following:

- maximum remove the site facilities from the riverbed,
- depots of construction material and waste,
- prevent the same to reach into the river .

Before construction of the HPP facilities in order to reduce damage to fish stocks it is necessary to catch fish in a length of 1 km downstream from the site and to place evenly the entire population at various locations upstream from the site. Build a fish path and ensure the protection of fish stocks and fish migration. Install some devices on the water intake to prevent fish entering the tunnel (adequate grid), and in case of damage to fish stocks it should make the Program of rehabilitation and equitable compensation to the user of fishing rights.

### Cultural and historical heritage and landscape

It is necessary to take measures to protect cultural and historic heritage and archaeological sites, or any new findings, which implies:

- Compulsory termination of all works and information of the authorized services for the protection of heritage, if any archaeological sites or artifacts are found during the execution of works, which have not known or explored;
- In case of discovery of archaeological finds it is necessary that the competent services for protection of cultural-historical heritage manages or under its supervision, carries out the process of researches and documentation of the site. Depending on the nature of findings, possibilities and methods for its protection and preservation will be determined by applying the following measures:
  - conservation of the findings by re-backfilling,
  - relocation of findings,
  - relocation of a part of findings with conservation of the remaining part of the site by re-backfilling.
- Applying a quality site organization, with the systematic waste disposal, using modern construction technology and machinery, with preventative measures and good construction practices, the overall negative impacts on cultural and historical heritage and the landscape can be mitigated during construction of the facilities.
- Already in the Preliminary design it should take into account the possibilities of construction of related structures of HPP Vranduk, which includes: access roads, the proposed road for public communication over the dam, any parking, etc.
- Also, it is necessary to take into account the visual communications (signposting and information signs) and the illumination of the dam and roads, to ensure proper presentation of heritage, visual compatibility of structures with surrounding cultural landscape
- If possible to avoid the construction of communication over the dam, this will contribute to mitigation of negative visual effects and reducing the traffic load over the area of the Architectural ensemble of the Vranduk Old Town.
- During the construction and use of the access road (road on the left bank of the river is necessary for the construction of the dam) it should strictly take into account to avoid irreversible changes to the existing slope (inclination changes, an extension that would later be impossible to completely repair, etc) and damages to the existing road for the settlement.
- During preparation of the Landscape design it should pay special attention to the proper presentation of the heritage, visual conformity of newly built structures with

the surrounding cultural landscape, as well as ensuring safety belt - plantations or protective structures by which vibrations of the soil will be reduced and possible changes in groundwater flows, which may indirectly have an impact on the monument.

- Reducing the negative impact of construction of HPP Vranduk on heritage should be provided in accordance with the Landscape design. It should be noted that the Landscape design of outer space must be an integral part of the Main design of HPP Vranduk.

Recommendations for preparation of the Landscape design of HPP Vranduk area:

- Measures to protect landscapes (reconstruction, rehabilitation, restoration, etc.) should be chosen in a way that will not undermine the basic character of the cultural and historical heritage and the associated landscape, and they should be elaborated in details within the Landscape design. Having in mind that the direct impacts and results of building such a plant in a given area are significant and irreversible, it is recommended that after the construction of the dam, the access road on the left bank used during the construction of the dam, tries to fully repair i.e. adjust the space as much as possible to the surrounding environment.
- Visual treatment of the built structures through the possible change of materialization and the possibility of greening the area of retaining wall, access sequences to the facilities, colourful treatment of built structures and similar are measures to mitigate negative effects, but not complete reduction in this context. When selecting the approach to the final materialization of visible dam structures, it is necessary to strictly take into account the use of colors and elements in a given area, and try to bring the entire area treated by construction to a state similar to the natural ambient condition.
- Greening of the dam structures is recommended if it provides the functionality of the facility (support structures, parts of the dam along the bank);
- A dominant use of stone lining is not recommended for the structures along the bank or those lying on the slopes, since they are, in nature, covered with vegetation, with or without a small quantity, of the visible stone parts of the micro locations of the dam;
- To finish the dam, it is recommended to leave a visible concrete, due to the dam represents a contemporary intervention in the area, and the stone lining, as a dominant final materialization, is not the material that predominates in a natural ambient, and it could degrade the structure of the Old Town;
- For the materialization of fences on the dam it is recommended to use some transparent materials, to mitigate the negative visual impact, and as much as possible, enable the views to the Old Town.



It is recommended that the investor when making the necessary project documentation for building permits for the preparatory work, in accordance with Article 47 and 48, paragraph 6 of the Law on spatial planning and land use of the Federation of BiH (Official Gazette of FBiH no. 2 / 06) engages an engineering company certified by the Federal Ministry for Physical Planning to work on buildings and heritage sites, which will make the documentation - Study on the protection of heritage. When creating documents – Study, it will be taken into account the current state of the Old Town, all the possible physical impacts on it (possible movement of groundwater, the stability of the massif which the Old Town is located on, etc.) as well as planned facilities (access road, a possible road for public communication, dam) and the possibility of their placement on the predicted location. This will be possible to give detailed and specific recommendations for the architectural design of HPP Vranduk, with the aim of its better integration into the existing environment of the National Monuments.

### Noise and vibrations

In the case of the blasting process for excavations in rock massif, it should engage an authorized organization that will provide protection for the cultural-historical heritage, acceptable noise and vibrations for residents, wildlife and the environment in general. If possible, use excavation technique using hydraulic hammers or mechanical excavation with milling machines, "moles" and the like. Machinery to be used for construction and equipment that will be installed in facilities of HPP Vranduk should be in accordance with the technical standards for protection against noise and vibrations.

### Infrastructure

In places of collision with the existing roads of higher rank: main roads and railroad to perform the necessary temporary protective structures that will separate the roads from the zone of works; apply all the required traffic signalization and if necessary to ensure traffic police patrols. Finding an alternative route or road construction, it is necessary to provide a unobstructed communication to the residents of surrounding settlements. If there is a collision with the existing installations of electricity (power lines) in the previous works to displace lines; or by technical measures it should separate / protect / isolate the lines. These measures taken in accordance with the sector permits.

## MITIGATION MEASURES DURING OPERATION PERIOD

### Population

Taking into account that the impacts during operation of HPP Vranduk are positive on population, it is not necessary to take measures to mitigate impacts.

### Climate

Concerning the meteorological impacts that the accumulation provides during the phases of its operation, taking into account the fact that it is a power plant of run-of-river type and with increasing the area of water mass for only 12% (42ha) in relation to the current state (36.7 ha), it can be concluded that there are no significant impacts that may arise during the exploitation of the accumulation.

However, it would be particularly significant that, in the period of exploitation, some significant technogenic changes are not made in the environment. It would be suitable to bring the entire direct area around the hydro reservoir in the state with similar ambient conditions as before construction of the accumulation, which would reduce its potential negative impacts to a minimum.

### Water - The Bosna river

In order to reduce the accumulation of waste in front of the floating dam and the grille on the water intake in the hydro reservoir, it should engage an authorized firm that will collect the same, if necessary, transported and properly disposed of it. In accordance with the Regulations on the minimum content of general act on the maintenance, use and monitoring of water facilities it should make the general act, which is the basis for Water Licence. The realization of water protection measures and Operational Plan for exceptional pollution in waters and bank water soil regularly to implement and update. Some potential and other measures to protect water and ecosystem of the Bosna river should be carried out in accordance with the Water Licence for HPP Vranduk.

### Flora and fauna

Mitigation of negative effects that may arise as a result of sedimentation in the accumulation, and a possible reduction in the capacity of water storing, is including the maintenance of newly created environmental balance of the hydro storage. If there is an increased phytoplankton and zooplankton to take measures to remove it. Measures to mitigate the proliferation of aquatic weed species in the storage area should be applied, because they can pose a significant problem. The measures include the removal of woody vegetation from the storage and bank area, which will contribute to the reduction of nutrients.

### Ichthyofauna

Built-in devices to prevent entry of fish on the water intake, are to be regularly maintained. Regularly maintain the fish path being passable and clean. In the case of emergency situations related to HPP Vranduk, measures should be taken to evaluate and repair the damage caused to fish stocks.

### Cultural and historical heritage and landscape

Measures to mitigate effects during operation of the plant include:

- establish the necessary (minimum) lighting of the access road, possibly built road for public communication, the dam and other facilities of HPP Vranduk;

- Ensuring some adequate presentations of the individual site of the Old Town or the entire cultural landscape, which, until now, has not been done or has not been provided by existing development projects.

The investor, as compensation to the community, could during operation period, and in a manner determined by the institutions responsible for implementing the Decisions of the Commission for Preservation of National Monuments, participate in the effort to protect the Architectural ensemble of Vranduk established by the Decision of the Commission to designate the Architectural ensemble Vranduk as a national monument, No. 05/02-2-274/04-4 of 25 of January 2005., published in the „Official Gazette of BiH 16/06”.

Accordingly, during the operation of the plant it should foresee the development and implementation of the Illumination Design and the Design of regular maintenance of the Vranduk Old Town. The design of regular maintenance of the Old Town Vranduk should be made by an authorized design engineer. The design, among other things, should include regular cleaning of the town structures from sediments of contaminated air particles, and regular monitoring and timely repair of any cracks in the town structures and/or replacement of the connective or structural elements (the period in which it is necessary to perform regular cleaning and monitoring will be defined by the design). Both of these designs must be approved by the competent institutions for heritage protection. All works can also be performed under regular supervision of the institutions responsible for heritage protection.

## MONITORING SYSTEM

### Water monitoring

Water monitoring of The Bosna river should be established and enforced in accordance with Prior Water Approval, or Water Licence in the future. In accordance with the provisions of the Law on waters, the water monitoring should include:

- monitoring of surface regimes and impacts on groundwater, according to the established backwater elevation 293,50 m a.s.l. (piezometers on the dam profile). Monitoring of the groundwater regime is also important for the safety of the area of the national monument - "the Architectural ensemble of the Vranduk Old Town",
- monitoring of continuous discharge of environmentally acceptable flow downstream from the dam, to avoid drying up of the Bosna river bed, on the stretch from the dam to the power house,
- control of oscillations defined by the design downstream from the dam, and the protection of flora and fauna in the Bosna river,
- monitoring the volume of sediment in the storage,
- monitoring of changes in the rate of erosion in the catchment, in the storage area downstream from the power house.

During the construction works and operation of the hydropower plant (with gauges) to monitor the water level, the registration of the flows at the entrance and exit of the hydrostorage.

It is also necessary to regularly control the accumulation of waste in the storage zone, on the grid of the intake structure and floating dam.

In some emergency – incident situations in the contents of the General Act - Plan for maintenance and use of HPP Vranduk facilities, it is also required to determine the protection measures, the notification and alert system in case of a possible threat of the areas downstream of HPP Vranduk, which also includes monitoring of water quality, bank soil, etc.

These monitoring should agree with any special requests of the public enterprise „Agency for the water area of the Sava River Basin "of Sarajevo and the Hydrometeorological Institute of the Federation of BiH.

### Cultural and historical heritage and landscape

The monitoring system of impacts during construction and operation of HPP Vranduk on the national monument, "The architectural ensemble of the Vranduk Old Town" should be carried out in accordance with applicable legislation from the respective areas: the Law on implementation of the decisions of the Commission for Preservation of National Monuments, established pursuant to Annex 8 of the General Framework Agreement for Peace in Bosnia and Herzegovina (Official Gazette of FBiH, no. 2/02, 27/02, 6/04 and 51/07); Law on spatial planning and land use at the Federation of Bosnia and Herzegovina (Official Gazette of the Federation BiH, no. 2/06, 72/07 and 32/08), the Law on Environmental Protection (Official Gazette of the Federation of BiH, no. 33/03); and the Decision of the Commission for Preservation of National Monuments to designate the Architectural ensemble of the Vranduk Old Town in Vranduk as a national monument of Bosnia and Herzegovina, the number of 05.2-2-274/04-4 of 25 of January 2005 published in the Official Gazette of BiH 16/06. Monitoring under the jurisdiction, will be done by competent and authorized institutions for the protection of cultural and historical heritage.

### Monitoring system during construction

Monitoring during the construction phase covers the period from planning and site preparation to completion of construction of facilities. Monitoring includes monitoring of the impacts during preparation of site, materials, delivery of materials and hiring of machinery and the construction itself (impacts of work and servicing of machinery, etc.).

Before construction works it is necessary that representatives of relevant institutions for the protection of heritage made recording (or completion of the existing record) of the Vranduk Old Town, with an emphasis on the recording of existing damages to the Town structure. It is also necessary to make recognition of site - hills through which the headrace tunnel will pass, and in order to identify potential archaeological findings.

It takes the regular presence of an archaeologist during earthworks.

Regular and continuous conservation monitoring of state of the Old Town (any changes on existing cracks, formation of new cracks, the increased deposition of dust and soot particles, the changes in the structure of materials and fixings, etc.), by the competent services for protection of cultural and historical heritage.

In the phase of the plant construction, this supervision will include monitoring of state and changes that are reflected through:

- the occurrence of any cracks or expansion of the existing cracks in structures of the Old Town Vranduk,
- changes in rapidity and amount of sedimentation of soot and dust particles, and changes in the connective elements of the structures of the Old Town Vranduk,
- changes (cracking, moving, crumbling of earth, etc.) on possibly recognized archaeological heritage at the site,
- erosion due to removal of vegetation and soil cuts,
- construction of facilities for the site (parking's, warehouse and storage areas, etc.)
- raising the depot for the disposal of the removed layer of fertile soil,
- providing a borrow area of material for backfilling and similar, which must be outside the construction zone of HPP Vranduk

### Monitoring system during operation

In addition to the mandatory monitoring of impacts of HPP Vranduk on buildings of national monument, "The architectural ensemble of the Vranduk Old Town" it would be also needed to monitor some changes of the socio-economic indicators, which relate to a broader area of Vranduk. It would be supervised the change in population, urban development, implementation of development-self sustainable projects, development of cultural tourism, etc. It would be carried out by relevant institutions, and the user HPP Vranduk would possibly be involved in these activities, according to objective and economic opportunities.

### Flora and fauna

Decomposition of organic material leads to the nutrient enrichment of the storage, which stimulates the growth and development of aquatic plants (algae and macrophytes) and leads to undesirable imbalance of organisms present in water, and water quality. In order to prevent this, it is necessary to continuously monitor: water quality at the discharge from the storage and at different points on the Bosna River (pH, temperature, electrical conductivity, turbidity, dissolved oxygen, suspended particles, phosphates, nitrates), as well as elements of biodiversity (phytobentos and phytoplankton, zoobenthos, ihtuiofauna, macrophytes), and occasionally and if necessary if the changes are observed.

### Ichthyofauna

Before starting the construction of the dam it is necessary to make a study of the zero state of flora and fauna in the Bosna river, on the micro-location of Vranduk. These studies are needed to better anticipate the future consequences of dam impacts on wildlife of the Bosna River.

As part of the Fishermen basis for a fishing area, where HPP Vranduk will be located (which is to be made most every 10 years), it is desirable to do a segment of the impact assessment of the hydropower plant on ichthyofauna and other aquatic organisms.

It is necessary to perform a visual control of the waste accumulation, which is caused by the Bosna river to the fish path and perform routine maintenance of its passage.

**After evaluating the positive and negative effects, or real losses and benefits of the Project, taking into account the indicators of listed fees and compensations to the local community, which the implementation of the project provides, according to the applicable regulations of the Federation of BiH, it can be concluded that the planned projects in the Bosna river catchment is environmentally acceptable and socially justified.**

**With the application of measures for the protection and realization of the Project to improve the condition and presentation of the national cultural and historical monument "The architectural ensemble of the Vranduk Old Town", it should accept cohabitation of a new building with a cultural landscape.**

**Objective measures for protection of the values of material goods are essential to assess the project as a techno-economically and environmentally justified, because during the construction works and during operation of the planned power facility the principles of sustainable development will meet, and the project will have attributes of friendly development project.**