ENVIRONMENTAL IMPACT ASSESSMENT STATEMENT

ON THE COMPLETION OF CONSTRUCTION WORKS FOR LUDA YANA DAM

Sofia, November 2008
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I. AUTHOR’S SUMMARY

The Environmental Impact Assessment Statement (EIAS) on the completion of construction works for Luda Yana Dam has been developed following the submission of the comprehensive Environmental Assessment (EA) of 2007 to the World Bank by the Ministry of regional development and public works (MRDPW). It is a part of the documentation for approval of the World Bank assistance requested by the Government of Bulgaria (GoB) for financing of activities meant for municipal infrastructure development through completion of the water supply dam Luda Yana.

The EIAS has been developed to meet the Bank requirements as stated in the ToR and in compliance with the effective environmental legislation in the Republic of Bulgaria (RB). It comprises the following major elaborations and findings.

**Overview of the legislative and political system and organizational diagram referring to the environmental management**

Environmental protection is a country policy priority. Depending on the classification of infrastructure projects they can be either subject to a mandatory EIA or subject to an assessment of the need to have an EIA. Luda Yana dam, which has a total volume of 19,94.10^6 m³ is subject to a mandatory EIA (Appendix 1 to the Environmental Protection Act – EPA).

The EIAS presents the normative documents of the RB that have to be complied with in the course of work, as well as those required by the Bank. The organizational diagram referring to the environmental management is also presented.

**Luda Yana Dam Project**

The construction of Luda Yana dam started in 1986 and the implementation continued throughout the years in compliance with the technical detailed designs (following the design stages effective in those years) until its suspension in 2000. The design has been developed in line with the effective regulations with regard to the security and safety of the dam wall and the facilities thereto.

In 2007, based on a contract with Vodosnabdielen complex OOD, town of Panagurishte, a Comprehensive feasibility study for continuation and completion of construction works for Luda Yana dam - Panagurishte was prepared. This paper secures the implementation of some of the requirements stated in the EA of 2007 for evaluation of the existing situation and the performed construction, updating of hydrological information and the required additional developments for the site.

**Environmental Status**

The status of the environment has been evaluated based on inspection of the territory, field research, review of the available data at bodies with competencies in environmental management – the Regional Inspectorate of Environment and Water (RIEW) in the town of Pazardzhik, literature, survey data etc.

The status of the environment in the area of Luda Yana Dam is impacted by the construction works and is determined as affected by human activities. The construction of the dam wall has been implemented up to elevation 568,25 (height 30 m out of a total of 43,50 m dam wall height, which is about 70%). The construction works for the water intake tower have been performed, 70% of the counter filtration measures and other auxiliary or temporary sub-projects have been implemented, the diversion tunnel has been made, the stone quarry, the clay quarry and the humus quarry have been uncovered, the excavations of the spillway and the chute, the construction site has been shaped. Currently it is being used by Hydrostroy, the contractor of the of the dam wall. The road to the mountain chalet Bunay has been removed but not asphalted. There is no design for the DWTP.

The river eco-system is subject to a considerable adverse anthropogenic impact due to the construction works and the strong fluctuations of the natural river runoff. Since 70% of the dam wall has been constructed the river flow is partially maintained by the diversion tunnel. The river section in the flooding zone dries partially in the period of low summer water. The ichthyofauna is on the verge of survival. A substantial part of the forest tree vegetation has been cut, and a considerable part of the humus layer has
been excavated and disposed of. This accelerated the erosion, especially on the right slope in the period after 2000 (construction suspension). The major impacts on the herpetofauna, the mammals and the ornitofauna result from the strongly eroded terrains, the logging of forest tree vegetation, the excavation of the humus layer and the dewatering of the river.

The suspended construction of Luda Yana Dam leaves unresolved a major social issue – water supply of the town of Panagurishte and settlements in the municipalities of Panagurishte, Pazardzhik and Strelcha. The issue became a major concern for the population during the summer of 2008, when those regions were subjected to the most severe water supply rationing in the country.

Environmental Impacts

The estimated potential impacts upon completion of the construction works and the operation of Luda Yana dam are presented based on applied methodologies approved by the Ministry of Environment and Water (MOEW), experts’ own methodologies, national and international norms and standards.

A substantial part of the adverse environmental impacts resulting from the construction of Luda Yana dam have come to an end due to: uncovering of the quarries for stone embankment, clay and the humus depot, implementation of the construction road network, shaping of the construction site toward the dam wall, implementation of 70% of the construction works on the wall and a majority of the adjacent facilities (construction of the water intake tower, removal of the road to Bunay mountain chalet, the excavations for the spillway and the chute). Wall construction up to elevation 568,25 secures settlement of construction waters during the completion of construction works for Luda Yana Dam without any risk to pollute the river water. The greater part of the forest tree vegetation has been cut, including that in the former agricultural fund, of which only single fruit trees have remained and some lands with limited potential to be used as grazing land.

Due to the degree of construction completeness, the environmental impacts of the finalization works for Luda Yana dam will be limited and will allow for undertaking of measures to reduce, prevent or compensate them.

The major impacts related to Luda Yana dam will be due to the operation of the water supply facility. The river eco system will be transformed into a water reservoir eco system. 142,0 ha will be flooded permanently. The dam wall, classified as ‘big’, and requiring securing of operation safety, will be situated at 2 km above the town of Panagurishte.

At the same time the runoff regime of the Luda Yana river will be stabilized with release of the minimum acceptable runoff in the river (environmental waters), which will overcome the summer drying of the river bed. That will be conducive for the formation of stable ichthyocenosis. The implementation of the counter–erosion design will help stabilize the erosion processes. The impacts on the herpetofauna, the mammals and the ornitofauna will be insignificant. The population of the municipalities will get normal water supplies of potable water at good quality, and this will open opportunities for development of recreation and tourism related to the landmarks of history and archaeology in the area, and the available physical facilities and potential for their development.

Various alternatives have been considered, discussed during the design phase and at present. The normative documents and methodologies used for the EIAS have been applied.

Environmental mitigation plan, environmental management plan and a monitoring plan aimed at reducing the adverse consequences from the construction works and the operation of Luda Yana dam were proposed.

The outcome from the public hearing of the Panagurishte project, the national discussion at MRDPW and the consultations with the administrative and competent authorities have been presented.

The analysis of the project studies performed by the Institute for research and design (IPP) Vodproekt and ENERGOPROEKT – Hydorenergetika OOD, and the meetings held at Panagurishte municipality, underline how important it is to construct Luda Yana dam in order to overcome the adverse consequences on the environment resulting from the suspension of construction works and the social benefit to be brought by the dam. The analyses of the implemented construction works, the evaluations and estimates of the potential impacts of construction and operation of the water supply facility on the environment
prove the capacity to reduce the negative impacts on the environment and for establishing of a healthy 
and comfortable living conditions for the population in the affected municipalities.

II. legislative and political system 
and environmental management organizational diagram

Design and construction of Luda Yana Dam was implemented following a decision of the Council of 
Ministers. In 2000 a decision was taken to suspend dam financing due to economic difficulties of the 
country.

EIAS has been implemented in compliance with the provisions of the Bulgarian regulations and the Bank 
safeguard policies relevant to Luda Yana dam, as follows

1. OP/BP 4.01 Environmental Assessment
2. OP/BP 4.37 Dam Safety
3. OP/BP 4.04 Natural habitats
4. OP/BP 4.36 Forestry
5. Environmental Protection Act (SG No.91/2002 .......... No 94/2008 )

A full list of the laws, regulations and other legislative documents referring to the EIAS is enclosed 
herewith (Appendix: Normative documents).

Control on the implementation of the measures for protection of the environment in the course of 
construction works is exercised by the RIEW in the town of Pazardzhik, and by the Regional Inspectorate 
on Health Safety and Control (RIHSC) in case of signals related to human health risks. The 
environmental expert at Panagurishte municipality performs regular supervision of the implementation 
of measures and the status of the environment and submits reports to RIEW Pazardzhik. In case of failure to 
perform the measures, RIEW Pazardzhik impose sanctions, defines deadlines for implementation of the 
recommendations and, as a last resort, terminates the activity in violation of the recommendations.

The plan for own monitoring during the construction and operation phase is developed at the startup of 
construction and operation and is approved by the Basin Directorate (BD), RIEW and MOEW 
(Environmental Executive Agency – EEA). They are updated and approved annually by the three 
initiations mentioned above. At the end of each year, annual statements are submitted, based on which 
either additional requirements may be included to the monitoring or some requirements may be 
withdrawn. The monitoring period is determined in the EIA. Standing obligations are those of the 
Ministry of Health (MH) to control water quality through its regional unit Regional Inspectorate on 
Health Safety and Control (RIHSC), Water and Sewerage EOOD, Panagurishte and, if needed, or in case 
the dam is included in the National Monitoring Network– of the MOEW (EEA).

Securing of the minimum acceptable runoff (environmental water) is determined in the design during the 
water intake system design phase, and that water shall be provided continuously in the course of 
operation. In case of an undertaking for construction of a Micro hydro power plant (MHPP) for treatment 
of environmental waters, the latter shall be supplied to the plant.

The operation unit shall be responsible for all waters supplied from the dam during the operation phase. 
Control on the quantity of environmental waters shall be exercised by Basin Directorate 
Iztochnobelomorski region - town of Plovdiv.
III. **OVERVIEW OF Luda Yana Dam Project**

Luda Yana Dam is situated at about 2 km northeast from the town of Panagurishte on the Luda Yana River, immediately after the inflow of the Stara reka into the Muleiska reka. The design that was used to startup construction works was prepared by the Institute for research and design (IPP) Vodproekt.

The purpose of the water supply system Luda Yana, town of Panagurishte is to secure steady water supply for the town of Panagurishte and the villages of Oborishte, Poibrene, Popintsi, Banya, Bata, Levski, Elshitsa, mine Radka, the sites of Optikoelektron and Assarel in the municipality of Panagurishte, and five additional settlements in the municipalities of Pazardzhik and Strelcha. It is also technically possible to supply with water Lesichovo municipality. The estimates made cover a period up to 2020 and securing of potable water supplies for 45,000 inhabitants. At present the region is supplied from the terraces of the Maritsa at Zlokuchene village by means of a 45 km water supply pipeline, constructed 20 years ago. The facility is depreciated and the frequent failures create insecurity and water supply rationing. Technical fitness is maintain at the expense of higher operational expenditures, which coupled with the indispensable high power consumption for the five pumping stations form a household water tariff of about 0.70 euro/m³ – one of the highest in the country. In addition to the water intake for the future dam, water catchments and water supply pipeline to the town of Panagurishte have been implemented. The flow of the system is instable and is affected by high water periods when water quality deteriorates. The general condition of water supply sources causes uncertainties in securing the needed water quantities both in low water and high water periods.

The main facilities of the water supply system Luda Yana are: dam wall, water intake tower, diverting tunnel, main water outlet, spillway, Drinking Water Treatment Plant (DWTP).

Construction works for water supply system Luda Yana were implemented in different periods by Assarel Medet and Hydrostroy from 1986 to its suspension in 2000.

Luda Yana Dam is state public property under the Ministry of regional development and public works (MRDPW).

The future dam operator will be “Water supply and Sewerage – P” EOOD (ViK–P EOOD), town of Panagurishte.

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**Dam wall**

The dam wall was designed as an embankment type, constructed of local materials. The watertight element is a central clay core cluster, funded in the central part on the injection gallery, and a concrete foundation slab in the banks. On both sides of the core cluster are the support ballast prisms, connected to the clay by means of transition zones.

The injection gallery is fully excavated in the rock base. The grout curtain is implemented out of it in the central part. A concrete slab has been cast in the banks, at the basic rock, to serve for implementation of the grout curtain and connection with the base of the core cluster.

The major parameters of the dam wall and the water reservoir are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall type</td>
<td>embankment with a clay core cluster</td>
</tr>
<tr>
<td>Maximum height:</td>
<td></td>
</tr>
<tr>
<td>from the natural terrain</td>
<td>43.50 m</td>
</tr>
<tr>
<td>from the base of the core</td>
<td>47.00 m</td>
</tr>
<tr>
<td>from the bottom of the injection gallery</td>
<td>51.00 m</td>
</tr>
<tr>
<td>Crown length</td>
<td>458.00 m</td>
</tr>
<tr>
<td>Crown width</td>
<td>600.00 m</td>
</tr>
<tr>
<td>Total flooded volume:</td>
<td>19.94 x 10⁶ m³</td>
</tr>
<tr>
<td>Lake length</td>
<td>4500 m</td>
</tr>
<tr>
<td>Usable volume</td>
<td>17.74 x 10⁶ m³</td>
</tr>
</tbody>
</table>
Dead volume 2,20.10^6 m^3
Water intake area: 100,40 km^2
Flooded area 142,00 ha
Elevation wall summit (crown) 585,60
Elevation of the highest operational water level (HOWL) 584,00
Elevation of the highest water level (HWL) 585,35
Elevation of the lowest operational water level (LOWL) 563,50
Maximum water quantity for water supply 300 l/s
Total volume for water supply 6,00.10^6 m^3
Watering volume (environmental water) 5,36.10^6 m^3
Dam class II

Water intake tower, spillway and main water outlet

The water intake tower has been designed with several openings at various levels. The spillway is located on the left bank outside of the dam wall with dimensions Q0.1% = 280,00 m^3/s. It has been designed as a front spillway with curvilinear form and a chute with ejector. The main water outlet is a steel pipe Ø1220 mm. It is installed in the diversion tunnel with D = 4.00 m and L = 160 m, and is meant for taking away of the river water amounting to 107,00 m^3/s (Q5%) during the construction phase. To this purpose two parallel chambers have been envisaged at its end with two closing bodies – wedge gate valve for drainage of the lake and a throttle flap valve at the pipeline.

Drinking water treatment plant

No Drinking water treatment plant (DWTP) was designed as of 2007.

Current situation at Luda Yana Dam

During the visual inspection of the dam and the facilities there to in 2007 and 2008 it was established that: the dam wall is constructed 70% up to elevation 569,00 (out of the overall embankment), the excavation of the spillway and the chute is also executed, the construction part of the water intake tower is performed, the bumper on the upstream batter has been partially placed, a part of the SCDA equipment is installed up to the height of the embankment. Fully constructed are the diversion tunnel, the internal technological network, including the removal of the road to Bunay chalet without the asphalt cover, a stone quarry, a ballast quarry and a clay and humus depots were uncovered.

The following construction activities need to be finalized for completion of the dam: on the wall – stone embankment, bumper on the upstream batter, clay core cluster, installation of the entire SCADA system; installation works on the water intake tower and the main water outlet; asphalting the road to Bunay chalet. DWTP has not been designed nor a site for it has been selected as of 2008.

All construction service roads from the stone quarry, clay quarry and the humus depot are in the water reservoir bed. They do not pass across settlements. The by-pass road of the town of Panagurishte will be used for transportation of the equipment for the water intake tower and the main water outlet, and the equipment for the DWTP, once the site for it has been selected. Wastes from the construction site will be transported to the landfill of Panagurishte. The waste quantities and the implementation schedule for construction works are to be estimated during the detailed design phase, and after the design of the DWTP the methods for treatment and discharge of wastewater will be defined. The diversion weir and the wall will secure settling of the construction waters during the construction works on the dam wall. For the
completion of the spillway and the chute, the construction waters will have to be settled in a mechanical settling tank at the end of the chute.

The EA submitted to the Bank in 2007 specifies the activities to be performed prior to commencement of construction works for Luda Yana Dam, as follows:

Prior to the startup of construction works for completion it is necessary to perform the following: review of the as-built drawings of performed construction and installation works on the wall and the facilities, including protocols for hidden works, updating of available designs for the wall and the facilities; re-evaluation of the amount of high waters taking into account the hydrological data in the last 20 years and updating of the elevation of the wall crown in relation with the required freeboard; performance of micro seismic studies to determine the seismic hazards of the site and the dam wall; removal of the upper layer of the clay core cluster, the filters and the ballast embankment to reach the material with design density and water tightness; sampling of the embankment in the core, the filters and ballast prisms and assessment of the technical parameters of the embankment; checking of deposits for embankment materials in the used quarries; updating of the cross-sectional profile of the wall in view of the results from the geotechnical examinations, hydrological and seismic studies; checking of the condition of installed SCADA equipment and updating of the SCADA design; planning and shaping of implemented trenches for a spillway and a chute on the left slope and updating of the spillway design in compliance with the changes that have occurred; evaluation of the condition of the concrete facilities (water intake tower, diverting tunnel, concrete slabs under the clay core cluster on both banks) and rehabilitation of the concrete surfaces; design of DWTP.

In 2008, following a TOR of Vodosnabditele complex OOD Panagurishte, ENERGOPROEKT – Hydroenergetika OOD, developed a Comprehensive feasibility study for continuation and completion of construction works for Luda Yana Dam - Panagurishte, which to a great extent meets the EA requirements for the studies to be performed prior to the beginning of construction.

**Updating of hydrological studies**

Updating of hydrological studies has been performed. Information was used for two base stations in the water intake of the Luda Yana river, with available 52-year series for one of them (until 2006), and a 58-series (until 1999) for the other. The latest 20 years were taken into account for determining of the hydrological parameters of the runoff for the range of Luda Yana Dam. Updating of high waters has been performed. The assessment of the silts quantity made in the study performed by Vodproekt was confirmed.

**Wall Status**

Inspections and a geodetic picture of the wall were made in order to determine the quality and quantity of the performed embankment works, as well as 9 prospecting pits in the body of the wall, from which samples were taken to establish the physical and chemical parameters of the input materials. 21 pocket samples and one shaft sample have been taken, and 12 samples were used to investigate the qualities of the clay core cluster.

The following conclusions have been made of the quality of implementation of embankment works:

1. The results received from the laboratory samples taken during the control engineering and geological studies in 2007 confirm the results of the statistical and grapho-analytical processing of the results of all control samples taken since the startup of construction until the end of 1994.
2. In view of the parameters for water contents and degree of water saturation the built clay core cluster fails to meet the design requirements. The same holds good of the water content indicator for the support prisms. The remaining indicators comply with the design ones.
3. The support prisms materials are of very good granulometric content, high average volume density of the frame and good values of the angle of internal friction and cohesion.
4. For assessment of deformation-strength properties of the core cluster and the material of the support prisms in depth, sampling of these materials shall be envisaged through borehole methods.
**Status of the Facilities**

The status of the facilities as a result of the inspections is:

1. The condition of the diversion tunnel, the water intake tower and the injection heading and the slab providing connection between the clay core cluster and the rock base is good. It is necessary to check the properties of the base concrete slab in the banks.

2. Sample probes by means of water injections shall be made to establish the condition of performed counter seepage works.

3. Prior to changing the class of the dam wall, additional excavation works after a new design shall be performed for the spillway and the chute.

**Change in the technical solutions**

Due to the amendments to the regulatory framework after 1984 when the majority of the detailed designs for the wall and the facilities had been developed, the following changes occurred:

1. Under the original design the adopted class of the wall was II class. As a result of the amendments in the regulatory documents, the short distance to the town of Panagurishte, it was required to upgrade the dam wall class to class I.

2. The seismic grade of the region according to the map for seismic zones of Bulgaria determines that the site and the facility falls within a zone of seismic grade I = VIII and seismic ratio $K_c = 0.15$.

**Requirement for construction changes in the wall and the water facilities**

**Dam wall**

The change in the class of the dam wall will change the occurrence of the high wave.

In view of that the characteristic features of high walls, retention of the high wall and the crown elevation of the dam wall were checked. The results were $Q_{0.01\%} = 395.00\ m^3/s$ and elevation $HWL_{0.01\%} = 585.80$. The resulting crown elevation is 586.18, and the elevation of the wave reversing railing is 587.20. Because of the small difference, the required excessive design elevation can only be achieved through changes in the construction of the crown.
**Spillway facilities, water intake tower and the main water outlet**

The spillway has been sized for $Q_{0.1\%} = 280,00\ m^3/s$. New hydraulic computations were made for maximum water quantity $395,00\ m^3/s$ and $90\ m$ length of the crest. A new design shall be made for the spillway, including studies of hydraulic patterns.

Water intake tower. The construction part has been implemented. Some reconstruction is needed and most likely the entire water extraction mechanical equipment shall be replaced since the old one was delivered to the warehouse 20 years ago.

The main water outlet has not been designed. A decision shall be made on the necessity to reevaluate the pipe material (whether to replace steel pipes for fiber-glass pipes). That would require a new design for the main water outlet.

**Checking the resistance of the wall batters**

Checking of counter-sliding safety coefficients has been made in compliance with the effective design standards. Computations have been made for the full wall height. The received values meet contemporary requirements in terms of batters safety of earth facilities.

At maximum safety coefficients (Bishop, Morgenstern-Price etc.):

For the downstream batter
- main combination $\text{FS}_{\text{min}} = 1,50$;
- peculiar combination - earthquake $\text{FS}_{\text{min}} = 1,20$;

For the upstream batter
- peculiar combination – fast reduction of the water level $\text{FS}_{\text{min}} = 1,30$,

The results are:

<table>
<thead>
<tr>
<th></th>
<th>Main combination</th>
<th>Peculiar combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downstream batter</td>
<td>1,66</td>
<td>1,41</td>
</tr>
<tr>
<td>Upstream batter</td>
<td>1,52</td>
<td></td>
</tr>
</tbody>
</table>

The estimated maximum daily water consumption by 2025 has been confirmed to be $300\ l/s$.

The existing construction site under the dam wall will be used for completion of the construction works. The time required for site completion is assumed to be within 3 years, as per the preliminary time schedule. The workforce required for the implementation of construction is estimated at about 150 construction workers and mechanical operators. The site operation is to be managed by a maximum staff of 20 (including operation of the DWTP). The operational lifetime of the dam as per the regulatory documents shall be 100 years. The required foreign investment has been estimated at $260\ 000\ 000$.

(Appendix: Diagram of Water supply complex Panagurishte, Luda Yana Dam situation, forest map including Luda Yana Dam, Luda Yana Dam cross sectional diagram, photos)
IV. OVERVIEW OF ENVIRONMENTAL COMPONENTS AND FACTORS

4.1. ATMOSPHERIC AIR

4.1.1 Climate

The climate in the region of Luda Yana Dam is transitory continental with specific peculiarities of the Zad balkanski low-mountain climatic region (Sabev and Stanev). The area features complicated geometry i.e. strongly cut erosive folds that are out of level with the surrounding hills in the period prior to filling of about 170 m. The morphographic peculiarities of the region result in substantial differences in terms of some climatic characteristics of adjacent sections. The dam height above the sea level in case of normal flooding is 584 m.

As a whole the climate here is softer compared to the climate in the Predbalkanski region, where the height above the sea level is similar. In order to get clear idea of the climate in the region different seasons have been considered based on data from the only representative meteorological station of Panagurishte.

Winter. The soft nature of the climate is best exhibited in wintertime. Taking into consideration the comparatively good protection against cold intrusions from northeast, but also from the prevailing western ones, and the specific thermal regime of the upper parts of slopes and heights, the average January temperatures are about -1.5°C. In the deeper depressions, following a more lengthy stay of anticyclone weather in conditions of radiation cooling, minimum temperatures may drop below -19°C.

The winter appears to be the driest season in the year with average seasonal amount of precipitation 104 mm, 50% of which snowfalls. Mild winter conditions are a prerequisite for the relatively short duration of the snow cover. On average it appears in the second ten-days of December and disappears in the first ten-days of March. On average the total number of days with snow cover is 36 days, of which 14 in January. The month with the highest amount of rainfall is December with average monthly precipitation 49.9 mm.

Winter is the windiest season with average monthly wind speed of about 2 m/s in January and February. In 40-50% of the days in the season the weather is gloomy – total cloudiness 8-10 units.

Spring. Springtime here is relatively cool and on average the date when temperature steadily shifts above 5°C is 19 March. The average temperature in the mid-spring month of April is 10.1°C.

Rainfalls increase in springtime to an average amount of 178 mm for the season. The most humid spring month is May with monthly quantity of precipitation 79 mm, which is by 15% above that in July. The maximum daily rainfall in springtime may reach 78 mm (May).

Due to the active atmospheric changes springtime is the windiest season, with average monthly wind speed ranging from 1.8 m/s to 2.2 m/s. The number of gloomy days falls to 30% of the total number of days in the season.

Summer. Considering the height above the sea level, summertime here is relatively cool, featuring an average monthly temperature of 20°C through out the month mid-summer month of July. The average date when temperature steadily shifts above 15°C is in the middle of the first ten-days of June. Seasonal distribution of rainfall exhibits a continental pattern expressed in rainfall winter minimum and summer maximum. Summertime is the season with the most rainfalls featuring an average amount of 195 mm. One of the specific peculiarities of the region is the relatively low (657 mm) annual amount of rainfall compared to the Predbalkanski region, however it is higher than in the Thracian lowland. The transitory nature of the climate is expressed in the moderate seasonal differences in precipitation. Though the rainfall maximum is in summertime, the difference between the summer and the winter rainfall does not exceed 10-12% of the annual amount of rainfall.

Autumn. Late summer and early autumn is the quietest period of the year. The prevailing steady anticyclone weather is the reason for the average monthly speed of 1 to 1.5 m/s. Autumn in the region is
almost completely symmetrical to spring, with an average October temperature of 10.7°C that is nearly the same as that in its spring counterpart of April. The average daily temperature falls steadily below 15°C in late September. In 18-20% of the time weather is bright, and in September and October only in 20% of the days the weather is overcast. Autumn rainfalls amount to 149 mm, but in line with the prevailing bright and quiet autumn weather they are lower than in springtime.

The average annual temperature in the region is about 10°C. To get a more truthful idea of the climatic conditions in the region for the purposes of proper dam management it is necessary to pay special attention to the potential evapo-transpiration and precipitation. The difference between the annual amount of precipitation and evapo-transpiration is insignificant. The annual evapo-transpiration is about 600-700 mm, and the annual amount of precipitation is about 650 mm.

The overview of the climatic background is illustrated and supplemented by the enclosed diagrams, based on data published in the Climate Reference Books of Bulgaria.
Fig. 1 Mean monthly, minimum and absolute minimum temperature - Panagurishte station

Fig. 2 Mean monthly, maximum and absolute maximum temperature - Panagurishte station
Fig. 3 Mean monthly number of bright days by general cloudiness - Panagurishte station

Fig. 4 Mean monthly precipitation quantity — Panagurishte station

Fig. 5 Mean monthly cloudiness — Panagurishte station
Fig. 6 Mean monthly relative air humidity — Panagurisht station

January /calm/ – 67.5%
April /calm/ – 62.3%
July /calm/ – 66.7%
October /calm/ – 72.8%
4.1.2 Quality of atmospheric air

Following the suspension of Luda Yana construction works the air quality in the region regained the indicators it had prior to commencement of the project. Assarel Medet - an enterprise for extraction and processing of copper ore is also located in the region. The strongly disrupted relief in the region prevents transmission of harmful substances, including from the site of Assarel-Medet AD, which is the main reason for the relatively good quality of the air. This has been established through systematic monitoring at 6 points of the air control network for the region (EEA – MOEW).

4.2. WATER

SURFACE WATER

Hydrological Data

There are two hydrometric stations for registration of water quantities in the riverbed of the Luda Yana river – Hydrometric station (HMS) No 336 at the Strelchenska Luda Yana river and HMS No 251 at the Luda Yana river.

HMS No 336 was launched in 1956. It was removed two times – in 1960 and 1970, but the water intake has not been changed substantially – 95.1 km$^2$. It is equipped with a limnograph.

HMS No 251 was launched 1941. In 1950 it was slightly shifted and the water intake, which totals 569.8 km$^2$, did not change significantly. In 1960 it was equipped with a limnograph. In 1999 it was closed down.

HMS No 251 totals the runoff of Strelchenska Luda Yana river and Panagurska Luda Yana river, on which the Luda Yana Dam is constructed, and of the inflow Of Banska Luda Yana river.

The station at the Strelchenska Luda Yana river has a 52-year array of actual monitoring data (until 2006), and that at Luda Yana river – a 58-year array.

Data for the natural runoff at HMS in the upper part of the riverbed of the Topolnitsa river has been used for the update of hydrological data (water intake basin is bordering that of the Panagurska Luda Yana river and the waters of both rivers originate in a common mountain area – Sashtinska Sredna Gora).

The computation period 1950/51-2005/06 comprises a complete cycle, containing the phase of high water (1951/52-1979/80) and the phase of low water (1980/81-2001/02), as well as two additional periods, complementing the cycles.

The updated hydrological parameters at the range of the Luda Yana Dam are:

Hydrological parameters at the range of Luda Yana Dam

---

EEA

Annual /calm-/67.5%

Fig.10 Wind Rose- Panagurishte station
High waters

The data for registered high waters in the bed of the Luda Yana river show that they may occur at any time of the year, but most often the occurrences are in high water periods and in summer months. High waters are due to intensive rainfalls that for significant high waves and in certain conditions, waves of extraordinary order may occur.

Features of estimated high waters at Luda Yana Dam

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<td>102</td>
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<tr>
<td>Volume of the wave W (.10⁶ m³)</td>
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<td>9.16</td>
<td>6.0</td>
<td>3.9</td>
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<tr>
<td>Total duration T (h)</td>
<td>22</td>
<td>26</td>
<td>31</td>
<td>37</td>
</tr>
</tbody>
</table>

Stilt runoff

The update of the stilt runoff does not change the quantity of the stilts defined in the detailed technical design of IPP Vodproekt of 1982. The overall mean annual turbidity of Luda Yana Dam has been defined at 920 g/m³ with floating stilts of 800 g/m³, and bottom stilts 15% of them, or 120 g/m³. The volume weight of deposits has been estimated experimentally at $\gamma_l = 1.45$ t/m³.

The quality of the deposits has not been determined but there are no serious polluters in the water intake of Luda Yana Dam, and particularly in the water reservoir area.

Water Quality

Laboratory analyses have been made of the water quality in the water intake area of the dam. In 1995 at the request of Vodosnabditelen complex OOD in the town of Panagurishte water analysis was performed for the following rivers: the Elashka, Garmi dol, Okoshka and Muleiska, and a study was made of the chemical composition of ground water. Data of former studies, as well as those of 1995 show that river waters meet the requirements of BDS (Bulgarian State Standard) 2823/83 “Drinking Water” (Appendix: Water Analyses Results).

The major physical and chemical indicators from the latest laboratory examinations of mixed water toward Luda Yana Dam (Protocol No 40/25.09.2003.) are:

- pH 7.24
- Color 5-15%
- Turbidity – dry residue 196 mg/l/O₂
- Oxidizability 5.4 mg/equiv./l
- Alkalinity 2.60 mg/l
- Ammonium 0.10 mg/l
- Nitrites 0.02
- Sulphates 33,0 mg/l
- Iron 0,84
- Manganese 0,26
- Microbe number 2 – above 50
- Coli titres 50 above 100
- Phyto plankton random cells
- Seston 33-100 cm$^3$/m$^3$

The results show that water fails to comply with the requirements of BDS 2823/1983 Drinking Water and Ordinance No 9 of the Ministry of Health (approximates the EU directives) for the following indicators:
- oxidizability;
- Manganese;
- turbidity (single cases);
- microbe number;
- Coli titres, seston.

That requires water treatment prior to its supply to consumers and design and construction of a Drinking water treatment plant (DWTP).

The river runoff during summer low water decreases up to semi-drying of the river flows.

The construction of the dam wall has separated the upper river section from the lower sections. The link is via the diversion tunnel. The partial summer drying of watershed rivers is also typical under the dam because the rivers are in the water catchments extracting water for the current water supply of the town of Panagurishte. The waters in them feature not only a fluctuating flow, but are also affected by precipitation.

The region of the dam bed is characterized with active erosion processes.

The elevation to which it has been constructed creates potential hazards for the population of the town of Panagurishte and the settlements under it in times of high water. Any overflow from the implemented embankment might break the embankment and cause severe consequences as a result of the destructive wave. Therefore Vodosnabditelen complex OOD Panagurishte and ViK EOOG Panagurishte perform regular inspections in case of intensive rainfalls.

There is no discharge of street collectors or wastewater treatment systems and collectors in the watershed.

**GROUND WATER**

The groundwater in the dam area is fissure type. The host rocks are heavily fractured and weathered on the surface, and they are an excellent collector of groundwater. From the igneous rocks, the richest in water are the granites, granodiorite, etc. in the high mountain parts. The fractures in the rocks are hydraulically connected. Due to the deep fractures in the rocks, the precipitation waters feed the groundwater with deep circulation. These are usually cold waters with heightened mineralization. The springs fed by these waters have a small flow rate of tens to several hundred grams per second. Their mineralization ranges from 0.6 to 1.6 g/dm$^3$, the water is alkaline and slightly hard. The mode of underground runoff $M_{ur} < 1$ dm$^3$/s.km$^2$ defines the region as low in water capacity.

The fissure water pressure head system of Sredna Gora covers the massif of the Sredna Gora anticlinorium. The groundwater pressure is created in the high parts of the mountain range, and unload takes place on the main longitudinal fault zones – north and south. The springs near Strelcha, Krasnovo, Panagurska Banya spring from the north fault zone in the studied region. Their water is fresh, hydrocarbonate sodium sulfate with temperature from 23 to 55°C.
4.3 GEOLOGICAL ENVIRONMENT

Luda Yana dam is situated in central Sredna Gora. The dam wall is stone embankment. The geological base is from Paleozoic Sredna Gora granitoids, which are part of the South Bulgarian granites.

The magma development of the Sredna Gora granitoids is characterized by several intrusions of granitoid magmas. Three intrusive complexes are differentiated, and the region of Luda Yana dam is part of the First complex and the Smiloven pluton, in particular. It is accommodated among the rocks of the Precambrian metamorphic complex (Ardena group) and occupies an area of about 100 km². It is divided in two by the Strelcha pluton incorporated later from the third intrusive pluton. North of the Panagurishte colonies, it crosses basic bodies from the initial stage and includes xenoliths from them. It is built up of porhyroid granites, granoidiorites, tonalities, interconnected by a gradual passage. The most widespread are porhyroid granites and granodiorites. The pluton is connected with a rich vein phase, represented by various granitoids, many aplites and differentiated pegmatites of varied morphology.

The rocks in their upper part are deeply weathered and fractured, both horizontally and vertically. During their weathering, light loamy sand soils were formed with thickness from 20 to 100 cm, which are easily carried away by the surface runoff water and are a source of flood deposits.

The Quaternary is represented by alluvial, prolluvial and delluvial deposits of Holocenic age. The delluvial deposits are relatively limited in the foot of the mountain slopes. Prolluvial deposits can be found in the form of flood cones in the southern foot of the Panagurishte, Stralcha and Krasnovo hollows. The cone line is predefined to a large degree by the Panagurishte upcast and Krasnovo faults.

The alluvial deposits are concentrated mainly in the river valleys and beds (Luda Yana). They are represented mainly by fine cobble, gravel, unsorted sandy and clay material. There is an emphasized tendency of gradual decrease of the size of the grains along the river flow. In the Panagurishte valley, the alluvium comprises part of the riverbed where the flood terrace is.

The delluvial-prolluvial deposits fill the inter-cone spaces at the foot of the hollow.

The homogeneous Quaternary deposits (delluvial, prolluvial, alluvial) are assumed to be from the Holocene age, and the mixed genetic types – Pleistocene – late Pleistocene.

Tectonics

The crystalline massif of Sredna Gora is a core from a large positive fault structure. In it, the southern limb of the anticlinorium is Panagurishte and Stara Zagora late Cretaceous line, whose Mesozoic mantle was later completely denuded.

In the Panagurishte and Stara Zagora lines south of the crystalline massif there is volcanogenic activity in the late Cretaceous, known only for this region. During the different stages of its development, the crystalline core of the Sredna Gora anticlinorium and maybe parts of its limbs rose up as dry land in the deeply lineamented late Cretaceous geosynclinal area.

To the north, the Sredna Gora horst-anticlinorium is separated from the mountain structures through the zone of the post-Balkan deep fault and to the south, along the South Sredna Gora fault zone, which borders with the Bailovo-Panagurishte syncline. It represents a convergently pressed graben structure, situated between the Sredna Gora (to the north) and Ihtiman (to the south) anticlinorium. Its length is about 80 km and it is from 6 to 12 km wide. In the Alpine magma saturation of the syncline, it played the role of first-class sub-parallel faults, which in their essence are magma-conduction channels.

The block structures played an important role in the formation of the present-day tectonic appearance of the Panagurishte line. The longitudinal segmentation is defined by several faults with orientation 120°–130° (Panagurishte, Krasna, Stefanchovo and Batenski), which form three blocks in the central part of the line.

The dam region falls within 8th seismic zone with seismicity coefficient $K_s = 0.15$. 
**Ores and minerals**

The igneous formation is the main ore-generation factor for the Panagurishte ore region.

The granitoids of Sredna Gora and the plutons of Smiloven and Strelcha, in particular, are bound to pegmatite fields, mainly in the intrusive bodies and more rarely in the host rocks.

A number of ore bodies from the largest industrial deposits of porphyry copper and copper pyrite ore formations are related to the late Cretaceous magmatism.

The dam will collect water from the rivers Muleiska, Okoshka, Elashka and their tributaries. They are mountainous in nature and have a large slope of the beds, steep rocky banks and active erosion activity, and consequently, transportation of deposits. It is estimated that an average of 64740 m³ will be deposited in the dam bowl. The dam wall is in an advanced stage of construction. The two slopes to which the wall is bound are built of strong granites. Their weathered part has been removed to the level of fresh rock.

In August 2007 several additional tests were carried out, comprising 9 prospecting pits, 12 samples from the clay core and 1 bank test. The samples taken established that the core and the backfill are well consolidated.

The constructed clay core does not meet the design requirements in terms of the indicators water content and level of water saturation. The same applies to the indicator water content of the support prisms.
Lithology

- Smiloven pluton
- Porfiroide granites and granodoirites
4.4. SOILS

The soils in the region of Luda Yana dam are of the Luvisols class, leached cinnamon forest soils. They are found in the lower vegetation belt and formed under the influence of xerothermic oak vegetation. On the terrains where this vegetation has been destroyed, the soils are subject to anthropogenic impact, which very often (as is the case with the dam area) causes intensive erosion processes.

The soils on the right slope of the dam are severely eroded and in places even the B-horizon is missing. In the dam bowl where the soil was relatively preserved (there was a shallow alluvial horizon), the humus layer was scraped and deposited, in implementation of the planned cleaning of the bed.

On the right slope, the soils are shallow to averagely deep, loamy sand, highly to moderately stony, slightly eroded.

In the river terrace the soils are alluvial, sandy and deep. In many places of the flooded area, there are small sand quarries.

The change in land use of 142 ha was carried out under the respective legal procedure. It included moving the road Panagurishte – Bunay chalet.

The soils in the bed and the dam area are not contaminated with chemical substances, but it is necessary to take measures against contamination with waste from settled areas in sanitary-security zones II and III.

4.5. WASTE

The review of the water supply system did not establish abandoned construction waste or unregulated depots.

4.6. HARMFUL PHYSICAL FACTORS - NOISE

At present, there are no noise sources on the territory of Luda Yana dam, due to the fact that construction has been suspended. The noise background is the natural one of the environment.

When single trucks from the sand quarry pass through (episodically), there is insignificant increase. On the construction site below the wall, due to the working machinery, the noise is higher, but it does not reach the elevation of the constructed part of the wall and the sites of wall construction and facilities for their complete construction.

4.7. FLORA

In compliance with the forestry division of the country, the region of Luda Yana Dam falls into the Thracian forestry district, Gorna Trakia sub-district, lower plain-rolling and rolling-foothill belt of oak forests, sub-belt rolling-foothill mixed deciduous forests (500-700 m above sea level).

The right slope of the flooded volume, as well as the areas above the line of flooding are barren, former agricultural lands – pastures, orchards and fields. The trees remaining in the dam bowl are single fruit trees and some willows along the water flow – Salix alba. The humus layer has been removed. The land is partially used as grazing land and is not cultivated. The left bank of the river that is much steeper is populated by natural broadleaved forest vegetation and some coniferous crops – mainly Scots pine (Pinus silvestris).

The natural vegetation around the dam bowl on the left slope pertains to the mixed mezoxerophyte oak phytocenoses (Querceta mixtum) with sprouting stands comprising: Durmast oak (Quercus dalechampii), Italian oak (Quercus conferta), European hornbeam (Carpinus betulus), cerris oak (Quercus cerris). The stands are not very dense; most of them are not in good health – 30-40% dry tops. Reconstruction has been planned (logging followed by afforestation). Coniferous are comprise mainly Scots pine (Pinus silvestris).
Brush vegetation is represented by whitethorn (Crataegus monogina), hazel (Corylus avelana), dog rose (Rosa canina), traveller’s joy (Clematis vitalba) etc.

Grass synusium is typical for the mixed oak phytocenoses and it does not comprise any species protected by law.

Afforested area affected by the construction of Luda Yana Dam belongs to Forestry Farm of Panagurishte. The areas falling in the bed of the dam have been expropriated in compliance with the legal procedure years ago and have been logged with and exception of a small plot (0,5-0,6 ha) Scot’s pine stand, near the wall.

The natural communities in the dam bowl have been affected by the construction works and the remediation (logging and removal of the humus layer).

The presented data are based on a comprehensive inspection of the territory, examination of the available sources and the consultations given. (Appendix: Forestry map)

**Protected Nature Areas**

There are no protected natural territories on the territory of Luda Yana dam and its vicinity. Protected zone (PZ) “Luda Yana River” with code BG 0000426 Natura 2000 covers Banska Luda Yana and Luda Yana rivers under the town of Panagurishte. Luda Yana dam is outside the borders of PZ BG 0000426 “Luda Yana River” and will not have a direct impact on the subject and preservation goals in it. During dam operation, indirect impact can be expected on the ichthyofauna in the river section covered by the PZ. The expected impact of stabilization of the river runoff will be positive regarding the fish species included in the subject and preservation goals of PZ BG 0000426 “Luda Yana River”.

4.8. **FAUNA**

4.8.1 **Ichthyofauna**

The investigation for the EIA purposes was performed in 2007. The section of the Luda Yana river was visited in the area of the future dam, which included visual inspections and fishing by means of net devices. The analysis made also use of data collected in the fall of 2005 for evaluation of biological diversity in the Environmental Network NATURA 2000 (collected through the same methodology), as well as some survey data on the presence of certain species in the region.

**Current condition of the ichthyofauna**

The upper flow of the Luda Yana river and its tributaries are a trout zone populated mostly by river trout *Salmo trutta fario*. The population is subject to amateur fishing and is maintained mainly through artificial fish stocking. A typical species for the river section below the town of Panagurishte is the Maritsa barbel *Barbus cyclolepis*, however represented by a small population. Other species registered in this section are:

- Common minnow *Phoxinus phoxinus* (in the upper part)
- Chub *Squalius orpheus*
- Gudgeon *Gobio bulgaricus*
- Bitterling *Rhodeus amarus* (in the lower part)
- Common roach *Rutilus rutilus* (in the lower part))
- Golden spiny loach *Sabanejewia balcanica*
- Strumski loach *Cobitis strumicae* (in the lower part)
- Pumpkinseed *Lepomis gibbosus* (in the lower part)

Diversity of ichthyofauna species increases toward the lower part of the river flow, but in general the population density is low. The main factors restricting the development of a steady fish community are...
most of all river pollution with domestic and industrial wastewater, and the strong fluctuations in the river runoff. In the area of the upper flow the integrity of the river continuum is disrupted by the constructed facilities for Luda Yana Dam. The river section in the flooding zone dries partially in the period of low water. Due to the adverse conditions, the ichthyofauna is on the verge of survival. The research made confirms that the Common minnow is practically the only species in this river section.

The composition of the ichthyofauna down the flow in the potentially affected area of the Luda Yana river features four species of conservation significance:

- **Barbus cyclolepis** (Biological Diversity Act (BDA), Appendices 2 and 4; Directive 92/43/EEC, Appendix II (= Barbus plebejus))

- **Rhodeus amarus** (Biological Diversity Act (BDA), Appendix 2; Directive 92/43/EEC, Appendix II; BERN*, Annex III)

- **Sabanejewia balcanica** (Biological Diversity Act (BDA), Appendix 2; Directive 92/43/EEC, Appendix II;

- **Cobitis strumicae** (= Cobitis taenia strumicae) (Biological Diversity Act (BDA), Appendix 2; Directive 92/43/EEC, Appendix II (= Cobitis taenia))

### 4.8.2 Herpetofauna (Amphibians and reptiles)

These data have been obtained as a result of the inspection performed on site and study of various sources on the herpetofauna within the scope of the territory of Luda Yana Dam.

Table I includes the established and likely species in the area of the dam wall and the area planned for flooding, their status in terms of protection, their habitat and source of information. The species proven during the visit in 2007 are marked with 4907, and those taken from available literature with – AL.

The smooth snake is one of the species whose existence in the region of the dam is not certain but is likely. The European pond terrapin and the big warty newt even if not to be found on site now, most likely will come to populate the future water reservoir.

<table>
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<th>IUCN</th>
<th>AL</th>
<th>Dir. 92/43</th>
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<td>European tree frog</td>
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<td>Big water frog</td>
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<td>VK</td>
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*Notes to Table:* BDA – Biological Diversity Act (SG No 77/2002) Appendices No II, III and IV; IUCN – 2002 Red List of Threatened Species; LR – Low Risk; VK Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) Appendices II and III; Dir 92/43 Directive 92/43 of the EEC on the Protection of Natural Habitats of the Wild Flora and Fauna VK – Vasil Kovatchev
The protection status of most species is not high. They are just common animals well represented throughout the country. Out of the 10 listed species seven are closely related with water and the creation of a new water reservoir in on way can be a threat for them. That is exactly the category in which the three species from the Red List of the IUCN fall. The rare wall and green lizards and the smooth snake that would feel uncomfortable on that site will climb up the slopes, which happened when the humus layer was removed and practically their populations in the region will not suffer.

**Number and density of the populations of the species established in the area under consideration**

In the territories to be flooded, nearly all the amphibians and the water snake are to be found in the swampy sections near the river that have originated as a result of the holes left from the excavations for sand and gravel. Comparatively dense is the population only of the big water frog (a dominating species in the region). About 40-50 big and about a hundred small, immature specimens have been established in the river and the swampy areas. However their density compared to other locations in the country is not big.

Of the other 3 frog species 4 specimen were found of the yellow-bellied toad; 2 specimen of the great toad – after recent metamorphosis) and one of specimen of the European tree frog – after recent metamorphosis, and one forest frog – an adult individual). Such density, especially in a season shortly after the metamorphosis, can be described as very low. No doubt that some couples of the species distributed in the region spawn in the swampy areas by the river. One specimen was established form the green lizard and the grass snake. The density of the green lizard in most locations in the country where it is found is very high.

As for the species that have not been established, if any of them were to be found they would be in a very low number (some random or migrating specimen).

### 4.8.3 Mammals

In the area of the municipality of Panagurishte there are big natural forests of oak, hornbeam, durmast oak and Italian oak, and higher in the mountain – high-stemmed beech forests. Forests of Scots’ and Austrian pine, red oak, walnut etc. have replaced forests that were destroyed in the past and lands that are not suitable for cultivation. Grazing lands are set up in all parts of the mountain. In spite of the existing urbanization and the strong anthropogenic impact on the environment, a certain number of animal species have been preserved on the territory of the municipality.

The hunting farm of Panagurishte covers an area of 17 500 ha, where red deer, fallow deer, wild boar, roe deer and mouflon can be found. There has been a recent trend for an increase of predators – wolves, foxes and jackals.

In zoogeographic terms the fauna in the region is of Palaeartic type, i.e. it is represented by species characteristic of temperate geographic zones. Here can be found both species characteristic of forest habitats, but also of open expanses, including agricultural lands. The fauna is represented by species characteristic mainly of Sredna gora region. Information on animal diversity in the region is very limited and scattered, or fully missing for most animal groups. This is most valid for the invertebrate fauna.

The methods used for evaluation of the current status are the route and survey method. Literature sources have been used. Data were collected by different specialists and are pertinent mainly in view of the future operations and planning of additional studies in this sphere.

There are no data whatsoever on bat fauna in the region.

The results of the studies in the region of Srednogorie and the vicinity of Luda Yana Dam show that they are inhabited mainly by Mid-European animal species. The large mammal species here are represented by the roe deer (Capreolus capreolus) and the wild boar (Sus scrofa), and after artificial spreading and successful accommodation, by the red-deer (Cervus elaphus), that is to be found in some regions of Srednogorie. From the predators most often one can come across the fox (Vulpes vulpes), very rarely – the wolf (Canis lupus) and the brown bear (Ursus arctos), included in the Red List for 2000 of IUCN. Relatively more often one can see the hare (Lepus capensis), the beech martens (Martes foina), and the squirrel (Sciurus vulgaris).
The petty mammals are very common in that region: rodents (Rodentia) – various mice species (Apodemus spp. and Mus spp.), voles (Microtus spp.) and insectivorous (Insectivora) – hedgehog (Erinaceus concolor), very low in number are the moles (Talpa europaea) and shrews (Sorex spp., Crocidura spp.). It should be noted that the zoological investigations of the region are extremely scarce.

The mammal species to be found in the central part of Sredna Gora Mountain and the Panagurska pan valley, as well as along the river bed of the Luda Yana river and their nature conservation status are shown in Table 2.

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</thead>
<tbody>
<tr>
<td>Hedgehog <em>Erinaceus europaeus</em></td>
<td>No 3 +</td>
<td></td>
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<tr>
<td>East European hedgehog <em>Erinaceus concolor</em> (Martin)</td>
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<tr>
<td>Common mole <em>Talpa europaea</em></td>
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<tr>
<td>Common shrew <em>Sorex araneus</em></td>
<td>No 3 +</td>
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<tr>
<td>Bicolor white-toothed shrew <em>Crocidura leucodon</em></td>
<td>+</td>
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<tr>
<td>Lesser white-toothed shrew <em>Crocidura suaveolens</em></td>
<td>+</td>
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<tr>
<td>Souslik <em>Spermophilus citellus</em></td>
<td>No 2 +</td>
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<td>+Rez. 6</td>
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<tr>
<td>Red squirrel (<em>Sciurus vulgaris</em>)</td>
<td>No 3</td>
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<tr>
<td>Forest mouse <em>Sylvilagus sylvaticus</em></td>
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<tr>
<td>House mouse <em>Mus domesticus</em></td>
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<tr>
<td>Water vole <em>Arvicola terrestris</em></td>
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<tr>
<td>Norway rat <em>Rattus norvegicus</em></td>
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<tr>
<td>House rat <em>Rattus rattus</em></td>
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<tr>
<td>European hare <em>Lepus capensis</em></td>
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<tr>
<td>Common vole <em>Microtus arvalis</em></td>
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<tr>
<td>Fox <em>Vulpes vulpes</em></td>
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<td>Badger <em>Meles meles</em></td>
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<tr>
<td>Beech marten <em>Martes foina</em></td>
<td>No 3</td>
<td></td>
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<tr>
<td>Marbled polecat <em>Vormela peregusna</em></td>
<td>No 2 3+</td>
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<tr>
<td>Weasel <em>Mustela nivalis</em></td>
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<td>No 3</td>
<td></td>
<td></td>
<td></td>
<td>No 1</td>
<td></td>
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<tr>
<td>Otter</td>
<td>No 2;3+</td>
<td>No 2 +Rez.6</td>
<td>No 1</td>
<td>No 2;4</td>
<td>+</td>
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</tbody>
</table>
### 4.8.4 Ornithofauna

The ornithofauna (Class Aves) in the site area, which is the best studied type of fauna, whose nature conservation status in Bulgaria is also best regulated, comprises species characteristic of broad-leaf forests and forest plantations in the low and middle parts of our low mountains, including Sredna gora, where due to the low height above the sea level and the availability of broad expanses, species characteristic of the lowlands can also be found. From zoogeographic perspective, the ornithofauna is of Palaearctic type, consisting of species dominating in the moderate geographic latitudes, but also some species inhabiting the southern areas of the European sub-continent.

**Status of the ornithofauna in the project area**

The following bird species (Aves) have been registered in the scope of the future water reservoir and the adjacent territories:

#### List 1.

1. Goshawk (Accipiter gentilis (L.))
2. Sparrow hawk (Accipiter nisus (L.))
3. Common buzzard (Buteo buteo (L.))
4. Northern common buzzard (Buteo lagopus (Pontoppidan)) – in fall and winter
5. Golden eagle (*Aquila chrysaetos* (L.)) – migrating and hovering individuals
6. Hen harrier (*Circus cyaneus* (L.)) – in fall and winter
7. Hobby (*Falco subbuteo* L.) – migrating and hovering individuals
8. Merlin (*Falco columbarius* L.) – in fall and winter
9. Kestrel (*Falco tinnunculus* L.)
10. Partridge (*Perdix perdix* (L.))
11. Woodcock (*Scolopax rusticola* (L.)) – during seasonal migration in fall and winter
12. Domestic dove (*Columba livia* (Gmelin) f. domestica)
13. Wood pigeon (*Columba palumbus* L.)
14. Collared dove (*Streptopellia decaocto* (Frivaldski)) – in towns
15. Long-eared owl (*Asio otus* (L.))

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</thead>
<tbody>
<tr>
<td><em>Lutra lutra</em></td>
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<tr>
<td><em>Wild cat</em> <em>Felis sylvestris</em></td>
<td>No 3 +</td>
<td>No 2 +</td>
<td>No 2 +</td>
<td>No 4</td>
<td>+</td>
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<tr>
<td><em>Wild boar</em> <em>Sus scrofa</em></td>
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<tr>
<td><em>Wolf</em> <em>Canis lupus</em></td>
<td>No 2;4+</td>
<td>+</td>
<td>No 2 +</td>
<td>Rez.6</td>
<td>No 2 +</td>
<td>No 4 +</td>
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<tr>
<td><em>Bear</em> <em>Ursus arctos</em></td>
<td>No 2;3+</td>
<td>+</td>
<td>No 2 +</td>
<td>Rez.6</td>
<td>No 2 +</td>
<td>No 2;4 +</td>
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<tr>
<td><em>Jackal</em> <em>Canis aureus</em></td>
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<tr>
<td><em>Roe deer</em> <em>Capreolus capreolus</em></td>
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<tr>
<td><em>Red deer</em> <em>Cervus elaphus</em></td>
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<tr>
<td><em>Mouflon</em> <em>Ovis musimon</em></td>
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</table>
16. Northern common buzzard (Buteo lagopus (Pontoppidan)) – in fall and winter
17. Tawny owl (Strix aluco L.)
18. Little owl (Athene noctua (Scopoli)) – mainly in towns
19. Swift (Apus apus (L.)) – when hunting
20. Pallid swift (Apus pallidus (Shelley)) – when hunting – nesting in towns and in the
   “Assarel Medet” complex
21. Bee eater (Merops apiaster L.) – during seasonal migrations
22. Hoopoe (Upupa epus L.)
23. Green woodpecker (Picus viridis L.)
24. Greater spotted woodpecker (Dendrocopos major (L.) incl. in town
25. Syrian woodpecker (Dendrocopos syriacus (Ehr.)) – incl. in town
26. Lesser spotted woodpecker (Dendrocopos minor (L.))
27. Crested lark (Galerida cristata (L.))
28. Wood lark (Lullula arborea (L.))
29. Sky lark (Alauda arvensis L.)
30. Swallow (Hirundo rustica L.)
31. Red-rumped swallow (Hirundo dahirica L.)
32. House martin (Delichon urbica (L.))
33. Crag martin (Ptyonoprogne rupestris (Scopoli))
34. Tree pipit (Anthus trivialis (L.)) – during seasonal migrations
35. Black-headed wagtail (Motachilla flava feldeggii Mihaeles)
36. White wagtail (Motacilla alba L.)
37. Grey wagtail (Motacilla cinerea Tunstall)
38. Wren (Trogolodytes troglodytes (L.))
39. Marsh tit (Parus palustris L.)
40. Sombre tit (Parus lugubris Temminck) - rare
41. Black tit (Parus ater L.) – in fall and winter
42. Blue tit (Parus caeruleus L.)
43. Great tit (Parus major L.)
44. Nuthatch (Sitta europaea L.)
45. Tree creeper (Certhia familiaris L.)
46. Wheatear (Oenanthe oenanthe (L.))
47. Black redstart (Phronicus ochrurus (Gmelin)) – in town
48. Whinchat (Saxicola rubetra (L.))
49. Nightingale (Luscinia megarhynchos C. L. Brehm) – including in town
50. Robin (Erithacus rubecula (L.))
51. Blackbird (Turdus merula L.)
52. Song thrush (Turdus philomelos C. L. Brehm)
53. Mistle thrush (Turdus viscivorus L.)
54. Fieldfare (Turdus pilaris L.) – in fall and winter
55. Great reed warbler (Acrocephalus arundinaceus (L.)) – in a small swamp with dense
cattail by the right bank of the Luda Yana river
56. Blackcap (Sylvia atricapilla (L.))
57. Whitethroat (Silvia communis Latham)
58. Lesser whitethroat (Sylvia curruca L.)
59. Chiffchaff (Phylloscopus collybita (Vieillot))
60. Wood warbler (Phylloscopus sibilatrix (Bechstein))
61. Willow warbler (Phylloscopus trochilus (L.)) – during seasonal migrations
62. Forest dunnock (Prunella modularis (L.)) – rare
63. Spotted flycatcher (Musciropa striata (Pallas)) – more abundant during seasonal
   migrations
64. Raven (Corvus corax L.) – single migrating specimen


65. Hooded crow (Corvus corax L.) – single migrating specimen
66. Jackdaw (Corvus monedula L.) – in town
67. Jay (Garrulus glandarius (L.))
68. Oriole (Oriolus oriolus (L.))
69. Red-backed shrike (Lanius collurio L.)
70. Starling (Sturnus vulgaris L.) incl. in town
71. Tree sparrow (Passer montanus (L.)) – in town
72. House sparrow (Passer domesticus (L.) – in town
73. Green-finch (Carduelis chloris (L.)) – in the low parts of the region – incl. in town
74. Goldfinch (Carduelis carduelis (L.)) – in the low parts of the region – incl. in town
75. Siskin (Carduelis spinus (L.)) – in fall and winter, incl. in town
76. Common redpoll (Acanthis cannabina (L.))
77. Chaffinch (Fringilla coelebs L.)
78. Brambling (Fringilla montifringilla L.) – in fall and winter
79. Serin (Serinus serinus (L.)) incl. in town during the nesting period
80. bullfinch (Pyrrhula pyrrhula (L.))
81. Hawkfinch (Coccothraustes coccothraustes (L.))
82. Corn bunting (Emberiza calandra L.)
83. Yellow bunting (Emberiza citrinella L.)
84. Cirl bunting (Emberiza cirlus L.)
85. Rock bunting (Emberiza cia L.)

That composition of species characteristic of the small project site and the adjacent lands can be evaluated as rich and due to the diverse habitats.

The most numerous out of the species nesting in the forest in the region are the chaffinch and the robin, significant are also the number, respectively the pairs of the dipper, the chifchaff, the blackcap and the great tit. The most numerous of the swallows is the red-rumped swallow, followed by the swallow. In the open grass territories with small quantity of sparse wood vegetation the highest number of nesting pairs is represented by the sky lark, the corn bunting, the red-backed shrike, and close to the town – also the crested lark. Most numerous in the urban areas are the house sparrow and the house martin; significant in number are also the domestic dove, the starling, the swallow, the tree sparrow (in urban outskirts) etc.

The species in List 1, specified in Annex 2 (of plant and animal species threatened by extinction, whose conservation is a priority) in the Biological Diversity Act (SG No 77, Section II – Protected zones, Art. 6, item 4 (2) and (3)) are presented in List 2:

List 2.

1. Golden eagle (Aquila chrysaetos (L.)) – migrating and hovering individuals
2. Hen harrier (Circus cyaneus (L.)) – in fall and winter
3. Merlin (Falco columbarius L.) – in fall and winter
4. Northern common buzzard (Buteo lagopus (Pontoppidan)) – in fall and winter
5. Bee eater (Merops apiaster L.) – during seasonal migrations
6. Syrian woodpecker (Dendrocopos syriacus (Ehr.)) – incl. in town
7. Wood lark (Lullula arborea (L.))
8. Red-backed shrike (Lanius collurio L.)

8 of the species in List 1 fall within the Annex 2 of the BDA. No one of them is related to river habitats.
Of the first two species here – golden eagle and hen harrier – only over flying and hovering specimen have been registered, i.e. the site and the adjacent territories are not among their reproduction habitats.

Specimen of the next two species – the merlin and the short-eared owl spend only the winter period in the region i.e. they are present here only in fall and winter. High flying and hovering flocks of the bee eater are registered most often during seasonal migrations, but the territory to be covered by the future water reservoir does not feature steep and high banks suitable for nesting.

Not only present but also nesting wood larks have been registered in the area of Assarel-Medet complex that is located in the adjacent area, to the west of the site, however no nesting pairs have been spotted in the scope of the adjoining river banks that will be covered by the site. The species features a significant number in various parts of the country, including in the region of Panagurishte.

The remaining two species in the list – the Syrian woodpecker and the red-backed shrike are quite numerous throughout the country, as well as in the project site. The Syrian woodpecker is the most popular woodpecker in urban areas and in the lowland rural areas in the country, an in this region it has been registered also as a nesting species in the area of Assarel Medet and in the town of Panagurishte. The Red-backed shrike dwells and nests in the low forest vegetation in open expanses or in the edges or thinned forest sections, including urban areas. This species is quite numerous in the country.

4.9. LANDSCAPE

To a great extent changes have already occurred in the landscape and environment in the area under consideration. The dam wall of Luda Yana has been constructed to elevation 30 m, nearly the entire forest vegetation has been logged, the humus layer on the right bank has been removed. The stone quarry, and the sand and clay quarries have been developed and a construction site has been set up to the dam wall.

Suspension of construction works has a negative effect on the landscape because of the active development of erosion and as a consequence of the unfinished activities for remediation of areas disrupted by construction and the incomplete implementation of facilities.

4.10. SOCIAL AND CULTURAL ENVIRONMENT, HEALTH FACTORS

The population of Panagurishte municipality, on whose territory Luda Yana Dam is situated amounts to 27156 inhabitants. The municipality has potential for economic development due to the availability of significant industrial enterprises in the municipality or very close to it. Assarel Medet - one of the leading mining companies for extraction and processing of copper ore is located in the region. There are some more hi-tech enterprises in the sphere of optics, optical equipment, and textiles in Panagurishte. There are good conditions for agriculture and stockbreeding.

The town of Panagurishte and the municipality are rich in archaeological, historical and architectural landmarks, they offer recreation facilities, which may be conducive to development of active tourism in the region. The economic downturn in the country has affected the municipality, but now the existing base is to be expanded to serve for development of recreation and tourism in relation to the historical and archaeological heritage.

The Luda Yana river does not provide conditions for fishing neither above nor below the town of Panagurishte.

Transport infrastructure is good. There is a railway line from Plovdiv to the town of Panagurishte. Road infrastructure in the region is being improved. The town is connected by road to the whole country.

Nevertheless the population is decreasing, and the negative growth is higher than the average value for the country (Table 3).

<table>
<thead>
<tr>
<th>Urban centre</th>
<th>Population (number)</th>
<th>Births (per 1000)</th>
<th>Deaths (per 1000)</th>
<th>Growth (per 1000)</th>
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</thead>
<tbody>
<tr>
<td>Assarel Medet</td>
<td>27156</td>
<td></td>
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</tbody>
</table>

Table 3.
Leading among death causes are blood circulation diseases – myocardial infarction, brain-vascular diseases, hyper tension. Second come malignant diseases and diseases of the respiratory system.

Contagious diseases that can be spread via water in the region of Pazardzhik vary in terms of: dysentheria (shigelosis) from 9.4 to 11.8 per 100 000 for 2005-2006; Hepatitis A virus - from 65.0 to 166.0 for the same period. These values do not differ from the mean values for the country. There are no data on the link between these diseases and water quality. Hazardous infections disseminated via the water tract, such as cholera and abdominal typhoid, have not been established in the country for over 40 years.

4.11. CULTURAL AND HISTORICAL HERITAGE

There are no data of any historical, archaeological or architectural finds on the territory of the dam. None of the above has been registered during the construction of the Luda Yana dam. Should any finds be uncovered on site in the course of dam completion and lake remediation, the procedures envisaged in the Law on Monuments of Culture shall be undertaken by the Institute of Archaeology and the Archaeological museum.

V. Evaluation of the expected environmental and social impacts related to the implementation of Luda Yana dam

5.1. ATMOSPHERIC AIR

5.1.1 Climate

Dam construction will inevitably result in changes in the thermo-physical properties of the base surface, and hence of the microclimate in the area surrounding the dam. The impact of artificial water reservoirs on the environment has been a subject of long-standing examinations in Bulgaria. A methodology has been developed for evaluation of microclimate features in areas surrounding dams. According to the preliminary studies in Bulgaria, that change affects only the area of the dam since the gradient of the meteorological elements is great and that may have only a favorable impact on the unaffected flora and fauna. The availability of a huge water volume will cause a reduction in daily temperature differences, as well as to improved conditions for humidification. At the same time, the availability of an artificial water reservoir of the size of Luda Yana Dam (lake area of 142 ha and length 4500 m) will not change the climate in the relevant climatic region.

The recent decades feature significant climate fluctuations exhibited in alteration of dry and wet years, as well greater frequency of extreme phenomena such as long periods of high temperatures, lengthy draughts and heavy rains. Numerous examinations of climatic changes in Bulgaria exhibit significant statistic trends toward decrease of rainfalls and increase of temperatures, which results in reduced humidity.

Luda Yana Dam will not affect adversely local climatic conditions in the region. The plan for water reserves management and the recommendations and measures will secure normal conditions for operation of Luda Yana Dam.
5.1.2 Quality of atmospheric air

Determining the type and quantity of air pollution emissions related to completion of Luda Yana Dam

During construction works

The completion of Luda Yana Dam is related to the application of technologies that are the main source of the considerable dust emissions (incl. of fine particulate matter, FPM). These will occur during excavation of earth and its loading, transportation and disposal, as well as during extraction and transportation of rock and other construction materials, necessary for completion of the site and the accompanying transportation and logistic infrastructure.

Emissions will also occur when using on site powerful construction equipment mainly with diesel traction. The latter will emit in air various harmful substances, whose quantities will be proportionate to the power and time of operation of the equipment.

The same emissions will occur when technology transportation is used for supply of raw materials and materials needed for the overall dam completion. In this case the type and quantity of emissions will be proportionate to the volume of the required loads and length of the roads along which they are to be supplied.

All three-emission factors may generate quantities that may cause negative impacts on the environment during the construction works.

The availability of rock quarry materials in the flooded area of the future dam means that the application of detonation technologies will be a significant factor for air pollution during the construction phase. The extraction will satisfy the requirements to form the crest and the lagging for completion of the dam.

The type and quantity of harmful substances due to extraction and transportation of construction materials (incl. detonation technologies) may reach tens of milligrams per cubic meter of air and will depend strongly on the manner of extraction, physical and chemical properties of materials (e.g. humidity) and type of detonation substances.

According to data received from Ministry of Health laboratory, referring to a similar site, air dust may reach 10 mg/m³.

As long as these facts refer not only to protection of the environment, but also to health protection of workers – an efficient system for measurement shall be applied in order to overcome harmful impacts.

Emissions from construction machinery

The machine fleet of construction machinery shall include:

- Excavators for excavation works
- Bulldozers for shoveling of earth;
- Vybro rollers – for compaction of the embankments;
- Fadroma – for rehabilitation of construction roads;
- Compressors – for local energy operations.

The total installed capacity of the enumerated machines is estimated at 1000 kW.

The estimated quantities of gas emissions are made based on expert estimates of mean values:

- Of the time in operation of the machine fleet within the planned construction period;
- Ratio for intense utilization of working time (per shift)

The data obtained as a result of the above conditions are specified in Table 4.
Table 4

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<tr>
<td>2808</td>
<td>3400</td>
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<tr>
<td>Per shift</td>
<td>Kg/10h</td>
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<td>3.3</td>
<td>40</td>
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</tbody>
</table>

Thus capacity in operation is reduced substantially. The data computed in Table 4 is based on 235 kW and specific fuel consumption from 0.25 to 0.30 kg/kWth. Soot from the incomplete burning of the fuel has been added to them. They are of high physiological activity as a result of the sorption processes of oxides on the surface.

The emissions due to site transportation (Table 5) have been computed for one vehicle with diesel traction and maximum 10-km mileage for transportation of materials.

Table 5

<table>
<thead>
<tr>
<th>Emissions</th>
<th>SO₂</th>
<th>NO₂</th>
<th>VOS</th>
<th>CH₄</th>
<th>CO</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 km</td>
<td>10</td>
<td>109</td>
<td>21</td>
<td>0.6</td>
<td>90</td>
<td>7900</td>
</tr>
<tr>
<td>Linear emission</td>
<td>1</td>
<td>11</td>
<td>2.08</td>
<td>0.06</td>
<td>8.7</td>
<td>800</td>
</tr>
</tbody>
</table>

Based on the data in table 5 the emissions of the listed harmful substances produced by one or two trucks for the following distances can be computed:

1. Rock quarry – the dam wall 500 m;
2. Ballast quarries – the wall three ballast quarries at a distance of 4 km
3. Clay – the dam wall up to 5 km

They will be in operation only until the project completion.

The nature of the relief – openness to the waterside of the water reservoir bed, to a great extent is conducive to quick reduction of the pollutants density and prevents their accumulation.

_During the operation phase_

There will be no emissions of harmful substances in the atmospheric air during the operation phase of Luda Yana Dam.

_Defining the strength of impact on atmospheric air_

_During construction works_

The construction of Luda Yana Dam will be accompanied by emissions of hard particulate matter and harmful air gases, both from operation of machinery and of the technological transport. In the first case,
the total quantity of harmful gasses will exceed 126 kg per shift, and in case there is no natural ventilation (no wind) that may cause concentrations in ambient air on site that would exceed the admissible air values. If no measures are taken, there will be direct impacts on the environment, including a cumulative effect due to the synergy of the simultaneous presence of dust and sulphur oxides.

This impact will be temporary, and only during the construction phase, if the recommended measures are not implemented.

The distance from Luda Yana Dam to the closest settlement the town of Panagurishte, is 2 km considering the available natural shielding provided by the rolling relief. Immediately after the dam wall the river goes round an afforested hill on the left bank, which serves as a natural barrier to the town. There will be no need to pass through settlements for the transportation of construction materials for the dam wall. The gravel, sand and clay quarry are in the bed of the lake and they can be reached by the road to Bunay chalet. The only transportation vehicles that will pass through the town of Panagurishte will be carrying equipment, cement and additional materials for the concrete farm and will follow routes approved in advance by the municipality.

The strongly disrupted relief in the region prevents transmission of harmful substances, including from the site of Assarel Medet, established through systematic monitoring at 6 points of the air control network for the region. The same geographic factors will contribute also against transmission of pollutants from the construction site to the town of Panagurishte.

During the construction of Luda Yana Dam no change will occur in air quality in Panagurishte and the rest of the settlements around due to their remoteness from shielding of the site.

**During the operation phase**

There will be no harmful impacts on the population and the environment due to absence of emissions of harmful substances in the atmospheric air during the operation phase.
5.2. WATER

SURFACE WATER

During construction works

The water quantities required for construction needs and the respective water sources have been defined. They will provide for the site until the year 2000 and can supply it until its complete construction. The problems of domestic wastewater from the construction site (canteen, kitchen, bathrooms) currently used by “Hydrostroy” have been solved. A temporary settlement for the construction workers is not to be built. The organization of construction works is preserved from the time of implementation of the constructed part of the wall, during which the construction workers were recruited from the nearby settlements and spent the night in their homes.

The excavation works on the dam wall have been carried out and the construction of the dam wall to a height of 30 m ensures preservation of the water quality of the river during the further construction of Luda Yana dam. During the construction of the front spillway and chute in the stilling pool, it is necessary to construct a mechanical settling tank, where the construction waters will settle.

The movement of construction machinery and transportation vehicles should be strictly limited on the territory of the construction site. Transport routes should be marked. The technical condition of the machines must be inspected before each shift and those in faulty technical condition should not be operated. In case of potential emergency oil leakage, it is necessary to carry out an immediate deactivation of the soil through mechanical removal against contamination of surface and groundwater and soils. The use of the equipped and operated machinery on the Hydrostroy construction site provides the possibility for servicing the machinery park of the site.

A potential outside pollutant is the Assarel mine, especially in the event of intensive rainfall, due to which the design envisages special measures for their drainage outside the watershed of the dam. According to data from Assarel-Medet AD, the planned measures have been implemented and the water is discharged outside the watershed of the dam.

Chemical toilets are placed on the construction sites of the quarries and the dam wall and a contract is signed with a company to service them.

During construction, safe operation is provided of the water catchments and the water supply network in the lakebed for water supply of the town of Panagurishte.

During operation

Changes in the condition of the Luda Yana riverbed

The completion of Luda Yana dam forms an artificial lake with a volume of 19.94.10^6 m^3. The water level will rise to an elevation of 584,00 (the highest working water level – HWWL). A dam is created with a slowed water exchange despite the continuous supply of water quantities for water supply. At the same time, the dam will stop the erosion processes in the bed. It will stop the drying up of the river section after the dam during the summer period.

Water contamination

The data from the analysis of the water quality of the tributaries and the total runoff indicate that a DWTP should be constructed. Its design and allocation of the site are pending. The DWTP will be designed, constructed and the control on the quality of the water supplied after it will be in compliance with contemporary conditions and legal requirements.
In order to ensure the purity of the dam water, the following is planned: cleaning the bowl of the lake and
design of sanitary security zones (SSZ) I, II and III. The design and allocation of the zones is under
Ordinance No. 3 on the conditions for analysis, design, approval and operation of SSZ around water
sources and facilities for domestic drinking water supply.

The initial designation of the zones was carried out in the preliminary developments from 2007. The
precise planning of the cleaning of the lake bowl and the zones will be carried out in the technical
working design following the geodesic survey.

The two abandoned buildings mentioned in the EA of 2007 are to be demolished. The remains of the
buildings will be deposited in a depot pointed out by the mayor of Panagurishte municipality. The terrain
under the buildings will be removed to a certain depth, which will guarantee the purity of the earth
foundation.

In zones I, II and III, there is strict regulation of the prohibition and restrictive activities, the observation
of which is controlled by the Ministry of Healthcare (MH) through its units – the Regional for Protection
and Control of Public Health (RIPCPH).

Deposit runoff

The design of IPP “Vodproekt” and the updated hydrological data of “Energoproekt – Hydroenergetika”
OOD do not distinguish the defined deposits, and the dead volume is preserved to the amount of
2,2.10^6 m³. There are no data on the quality of the deposit runoff of Luda Yana river. After cleaning of
the lakebed and the constructed SSZ I, II and III, there is no danger of contamination of the deposits. In
these conditions, the existing and future land use in the watershed does not change the operation and
operation life cycle of the dam.

The management plan of Luda Yana dam will include the possibility for cleaning the lake from deposits
when the main water outlet is put in operation in the event of high water when the turbidity in the river
increases naturally.

In order to reduce the size of deposits coming into the dam as a result of erosion, during construction and
operation a “Technical plan for erosion containment” should be implemented, developed by the planning
organization “Agrolesproekt” EOOD.

Defining the flooding water quantity

The construction of Luda Yana dam disturbs the regime of the natural river runoff of Luda Yana river.
The amount of the remaining minimum admissible runoff (ecological waters) is important.

In order to preserve the river ecosystem of Luda Yana river in the construction of the water supply
system, the design envisages the discharge of ecological water quantity to the amount of 0.170 m³/s.

An additional model analysis was carried out to specify the ecological runoff under a methodology
developed in the Republic of Bulgaria.

A mathematical model is used, based on the dependency of the total number of the zoobenthos on the
runoff. The change of the total number is viewed as a probability process. In order to determine the model
parameters, data are necessary on corresponding values of the total number and the average monthly
water quantity, covering an overall vegetation period. To this end, summarized data were used from long-
term nature monitoring for the whole territory of Bulgaria. The Fisher criterion and the change of the
zoobenthos cenosis in different regimes of the ecological runoff are used. A program has been developed,
with the help of which the calculations were made.

The regime of the ecological runoff is determined under the following scheme:

- Modeling the development of the zoobenthos in natural runoff regime.
- Modeling the disturbed runoff regime after the dam, under a balanced method in different
  ecological runoff regimes.
- Modeling the development of the zoobenthos in the obtained different regimes of disturbed
  runoff.
• Comparison of the obtained rows of average monthly values of the total number of zoobenthos in a disturbed regime with that obtained in a natural one, in order to select a suitable ecological runoff regime.

The runoff norm for the dam range was defined by the designer in the amount of 0.79 m$^3$/s. To obtain the monthly values, HMS No. 71 250 on Strelcha Luda Yana river was used as analogue. A hydrological row of monthly values for the period 1955 – 2006 was calculated. Figure 11 shows the hydrograph of the average annual runoff for the period in question. Figure 12 shows the average annual hydrograph.

Figure 12 compares the average annual hydrographs of the runoff in a natural and in a disturbed regime.

The ecological runoff proposed in the design amounting to 0.170 m$^3$/s has been defined in compliance with the conditions created in the river following a number of anthropogenic impacts in the region. The analysis of the results from the model study shows that the proposed ecological runoff will maintain a stable ecosystem in the river after the dam wall (figure 14).

To the present moment, due to the activities of “Assarel-Medet” and the presence of a number of economic water consumers, the water balance of Luda Yana river is disturbed. A runoff of 0.170 m$^3$/s will maintain Luda Yana River in good ecological condition after the dam wall – of the river and forest ecosystems and natural areas downstream. The ecological runoff will actually preserve the river during the period of low water levels, when it almost dries up in the section under review, and will ensure its good sanitary condition within the town of Panagurishte.

The thus defined ecological runoff is in compliance with § 125 of the Transitory and Final Provisions of the Law for Amendment and Supplement of the Water Act: “Until the methodology under article 135, item 1 is issued, the minimum admissible runoff in rivers is defined as 10% of the average multi-year water quantity, but not less than the minimum average monthly water quantity with availability 95% to the point of each facility for runoff regulation or water intake.”
Figure 12

Figure 13
The problems of minimum admissible runoff in river flows after hydrotechnical facilities in the country have been considered since 1987. In the last 10 years, different possibilities have been studied for discharge of these waters from the dams. In Luda Yana dam, this will take place from the water intake tower to a depth of 10m from the water level of the lake. In the established drying up of the river in natural conditions of low water level, these will be provided by the planned ecological runoff amounting to 0.170 m³/s.

**Transmission of high waters**

The transmission of high waters is carried out through the spillway to the wall. The updated hydrological information indicates the need of a new design of the spillway, chute and stilling pool.

**Transformation of the river ecosystem**

The construction of Luda Yana dam and the formation of a water reservoir will have both a negative and a positive impact on the river inhabitants and the transformation of the river ecosystem into the system of a water reservoir (still water). Gradually, the formation of a habitat typical of still water reservoirs will take place.

The negative impact comprises:

- Significant reduction of the reobionte (river species), and respectively, the species, biocenotic and functional diversity due to the decrease of the flow speed.
- Changes of the nature of the ground under the dam.
- Possibility of appearance of eutrophication.

Positive impact comprises:

- Settling of the suspended insoluble matter.
- Large-scale development of limnophila species, which will to a large extent compensate the reduction in reophil species and, consequently, the species, cenotic and functional diversity.
- Increase in the trophic resources and, respectively, productivity of the ecosystem.

No studies have been carried out in Luda Yana River in terms of the macro-zoobenthos.
The studies in Austria and Bulgaria of Zhrebchevo dam show that under the dam walls, the river condition is at least one saprobe degree better than that of the respective dam lake (Prof. B. Russev, Institute of Zoology to the Bulgarian Academy of Sciences).

If the management plan of Luda Yana dam is observed and taking into account the environmental factors (eutrophication, environmental runoff, deposits, etc.), there will be no deterioration of the water quality and biological value of the river ecosystem under the dam, and if the measures prescribed in the EIA report are applied, an improvement of the overall ecological condition of Luda Yana river can be achieved.

**Cumulative effect**

In the vicinity of the Luda Yana water supply system there are no constructed or planned for construction other hydro-technical facilities to contribute to a cumulative effect from its completion.

The construction of Luda Yana dam ensures adequate water supply for the population in the municipalities Panagurishte, Pazardzhik and Strelcha, creates the possibility for achieving a “good” ecological condition of Luda Yana river, containment of the erosion in the zone of impact of the water supply system, development of certain recreation activities, and as a whole contributes to the economic development of the town of Panagurishte, including as a tourist destination.

**GROUNDWATER**

Control is necessary on water infiltration through, under and along the wall, and especially of the watersfiltrating through the wall, for presence of suffusion.

**5.3. GEOLOGICAL ENVIRONMENT**

**During construction**

Despite the good results from the engineering-geological and hydrological surveys (in the design and in 2007), it is recommended that three test drills be made through the whole core trunk and test filtration studies be made in them. For the stability calculations of the dam wall, it is necessary to obtain strength deformation parameters for the clay core and the material from the support prisms in depth. To this end, it is necessary to plan sample taking from these material with drill developments.

The study of the quarries in 2007 proved the availability of the necessary quantity and quality of the material to be put in the wall.

During construction, no domestic and construction waste, fuel and oil materials, or other pollutants are to be disposed.

**During operation**

Regular monitoring should be carried out of the regime of inflow in the dam bowl and runoff from it, in order to prevent emergency situations during heavy rainfall and intensive snow thaw.

The inbuilt in the wall control and measurement equipment should monitor the wall behavior. This comprises deformations in the wall and base, state of the diaphragms, sinking and shift of the crown, berms and geological base.

Contingency plans should be developed to guarantee dam security in the event of emergencies. The dam is located in a seismicity zone of 8th degree.

**5.4. SOILS**
During construction

The change in land use was carried out under the respective procedure. Expropriation of the terrains was completed in compliance with the active normative base (State Forestry “Panagurishte”).

Active erosion in the lake bed and adjacent territory imposes that the implementation of the “Technical Plan for Erosion Containment” developed by Agrolesproekt EOOD should begin together with dam construction.

The impact of completion of Luda Yana dam on soils is related to the fact that the water supply system will be constructed on terrains under severe anthropogenic impact.

The forest tree vegetation has been felled and a large part of the humus layer has been removed and deposited in the humus depots. The depots are for temporary storage of humus until it is used under the reclamation plan. The height of the humus depots must not exceed 10m. It is obligatory that no contamination or destruction of the humus layer be allowed. The total volume of removed humus layer is estimated at about 22,000 m$^3$.

A new construction site is not planned. The “Hydrostroy” site will be used.

The soil contamination on adjacent lands with dust, gas fumes and detonation works during construction is insignificant.

The removal of the remaining part of the humus in the lake should be in accordance with the schedule for commissioning the dam and the threat of activating erosion.

During operation

The total flood territory amounts to 142 ha, which under the forest development plan of SF “Panagurishte” of 2002 are part of it, but have been excluded for dam construction. The expropriated agricultural lands are abandoned and are not used.

5.5. WASTE

Type, character and quantity of generated waste

The forecast assessment of the type and character of generated waste in dam completion is related to the constructed completed to present date and the need for activities to be carried out during implementation of construction works for site completion.

Generated waste resulting from implementation of the construction and mounting works in dam completion can be viewed in two stages:

1. During the construction of the remaining part of the site.
2. During site operation.

During construction domestic and construction waste is generated. No new site is planned for storage of daily formwork, fittings and construction machinery. The “Hydrostroy” site will be used for this purpose.

During dam operation mainly domestic waste and waste from repair works will be generated. Their collection, storage and transportation should also be in compliance with the Waste Management Act.

In the completion of Luda Yana dam, waste will be generated which could be divided into:

- **Domestic waste.** generated by the construction workers and staff involved in site operation.
- **Construction waste.** These will be generated during excavation, embankment, formwork, strengthening, concrete and formwork works on the site. These comprise mainly:

  1. Soil and rock masses during excavation works in construction of the spillway and chute on the left slope of the dam.
Waste from rock material in the removal of the upper layer from the filters and the ballast embankment until a material of design thickness is reached.

Clay waste during removal of the upper layer from the clay core until a material of suitable water tightness is achieved.

Waste from rock materials necessary for the construction of the stone embankment on the wall and plate on the upstream batter.

Waste from clay necessary for the construction of the remaining part of the clay core of the dam wall.

Waste from rock and earth masses potentially resulting from works on re-commissioning of the stone quarry, clay pit and humus depot.

Waste from the settling of construction waters obtained in mechanical settling tank at the end of the chute.

Waste from concrete used for rehabilitation of the concrete surfaces and potential additional concrete works, if necessary.

Waste from concrete used in the construction of the spillway and chute.

Waste from asphalt concrete necessary for the construction of the pavement on the road to Bunay hut.

Metal waste from equipment.

Waste from metals (mainly steel) used for implementation of the formwork and fittings and other metal constructions and details, planned in the site completion.

Waste wood from wooden packaging and pellets for transportation of packaged materials delivered to the site.

Waste from wood material used in construction, mainly for formwork.

Waste from bricks, tiles, faience and ceramic ware obtained as waste during the completion works on the site.

Plaster-based waste, obtained during the completion works on the administrative building of the dam.

Waste from packaging of polymeric materials used in the delivery of materials for the site.

Waste from paper packaging used in the delivery of materials for the site.

Waste from hydro insulation materials used in the process of site completion.

Waste from insulation materials used in the heat insulation works planned in site completion.

Waste from cables and other connecting equipment in the mounting of the control measurement devices (CMD).

Waste from forestry. These result from the felling of the remaining forest vegetation (Scots pine culture) on a small remaining area of about 0.5-0.6 ha and from completion of the cleaning of the lake on an area of 142 ha. The amount of this type of waste will be small.

Hazardous waste

This type of waste is generated both in the implementation of the investment proposal and during its operation. It comprises as follows:

Laminated boxes from paint and polish.

Packaging containing remains of hazardous substances or contaminated with such.

Glue packaging.
- Spent engine oil from construction machinery.
- Waste from oil and liquid fuel.
- Mixed packaging from raw materials and materials.
- Luminescent lamps.

The individual types of waste with their codes, under Ordinance No. 3 of MEW and MH of 2004 on waste classification (SG, v. 44/25.05.2004), generated during the implementation of the investment proposal and operation of Luda Yana dam are shown in table 6.

### Waste classification

<table>
<thead>
<tr>
<th>No</th>
<th>Type of waste</th>
<th>Code under Ordinance No. 3 of 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td><strong>During construction</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Waste from mining of non-metal ores and minerals</td>
<td>01.01.02</td>
</tr>
<tr>
<td>2.</td>
<td>Waste fine rubble/ ballast and rubble rock materials, different from those listed in 01.04.07</td>
<td>01.04.08</td>
</tr>
<tr>
<td>3.</td>
<td>Waste sand and clay</td>
<td>01.04.09</td>
</tr>
<tr>
<td>4.</td>
<td>Waste from forestry – felling of tree vegetation (Scots pine culture) on a small remaining area and from completion of cleaning of the lake</td>
<td>02.01.07</td>
</tr>
<tr>
<td>5.</td>
<td>Waste from liquid fuel – other fuels (including mixtures)</td>
<td>13.05.08*</td>
</tr>
<tr>
<td>6.</td>
<td>Spent engine oil from construction machinery</td>
<td>13.08.99*</td>
</tr>
<tr>
<td>7.</td>
<td>Paper and cardboard packaging</td>
<td>15.01.01</td>
</tr>
<tr>
<td>8.</td>
<td>Plastic packaging</td>
<td>15.01.02</td>
</tr>
<tr>
<td>9.</td>
<td>Packaging from wood materials</td>
<td>15.01.03</td>
</tr>
<tr>
<td>10.</td>
<td>Metal packaging</td>
<td>15.01.04</td>
</tr>
<tr>
<td>11.</td>
<td>Composite/multi-layer packaging</td>
<td>15.01.05</td>
</tr>
<tr>
<td>12.</td>
<td>Mixed packaging</td>
<td>15.01.06</td>
</tr>
<tr>
<td>13.</td>
<td>Glass packaging</td>
<td>15.01.07</td>
</tr>
<tr>
<td>14.</td>
<td>Packaging containing residues from hazardous substances or contaminated with such</td>
<td>15.01.10*</td>
</tr>
<tr>
<td>15.</td>
<td>Concrete waste</td>
<td>17.01.01</td>
</tr>
<tr>
<td>16.</td>
<td>Waste from tiles, plates, faience and ceramic</td>
<td>17.01.03</td>
</tr>
<tr>
<td>17.</td>
<td>Wood material used in construction</td>
<td>17.02.01</td>
</tr>
<tr>
<td>18.</td>
<td>Plastic used in construction</td>
<td>17.02.03</td>
</tr>
<tr>
<td>19.</td>
<td>Asphalt mixtures containing coal tar</td>
<td>17.03.01*</td>
</tr>
<tr>
<td>20.</td>
<td>Asphalt mixtures containing other substances different from those listed in 17.03.01*</td>
<td>17.03.02</td>
</tr>
<tr>
<td>No</td>
<td>Type of waste</td>
<td>Code under Ordinance No. 3 of 2004</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>21</td>
<td>Mixed metal waste</td>
<td>17.04.07</td>
</tr>
<tr>
<td>22</td>
<td>Cables different from those listed in code 17.04.10</td>
<td>17.04.11</td>
</tr>
<tr>
<td>23</td>
<td>Soil and stones different from those listed in code 17.05.03</td>
<td>17.05.04</td>
</tr>
<tr>
<td>24</td>
<td>Excavated land masses different from those listed in code 17.05.05</td>
<td>17.05.06</td>
</tr>
<tr>
<td>25</td>
<td>Insulation materials different from those listed in codes 17.06.01 and 17.06.03</td>
<td>17.06.04</td>
</tr>
<tr>
<td>26</td>
<td>Construction plaster-based materials different from those listed in code 17.08.01*</td>
<td>17.08.02</td>
</tr>
<tr>
<td>27</td>
<td>Mixed waste from construction and demolition different from those mentioned in 17.09.01, 17.09.02 and 17.09.03*</td>
<td>17.09.04</td>
</tr>
<tr>
<td>28</td>
<td>Paint, ink, glue/ adhesives and resins containing hazardous substances</td>
<td>20.01.27*</td>
</tr>
<tr>
<td>29</td>
<td>Paint, ink, glue/ adhesives and resins different from those listed in code 20.01.27</td>
<td>20.01.28</td>
</tr>
<tr>
<td>30</td>
<td>Mixed domestic waste</td>
<td>20.03.01</td>
</tr>
<tr>
<td>31</td>
<td>Domestic waste not mentioned elsewhere</td>
<td>20.03.99</td>
</tr>
</tbody>
</table>

**II. During operation**

<table>
<thead>
<tr>
<th>No</th>
<th>Type of waste</th>
<th>Code under Ordinance No. 3 of 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>Mixed metal waste – from repair works</td>
<td>17.04.07</td>
</tr>
<tr>
<td>33</td>
<td>Cables different from those listed in code 17.04.10 – from repair works</td>
<td>17.04.11</td>
</tr>
<tr>
<td>34</td>
<td>Insulation materials different from those listed in codes 17.06.01 and 17.06.03 – from repair works</td>
<td>17.06.04</td>
</tr>
<tr>
<td>35</td>
<td>Paper and cardboard</td>
<td>20.01.01</td>
</tr>
<tr>
<td>36</td>
<td>Fluorescent pipes and other waste containing mercury</td>
<td>20.01.21*</td>
</tr>
<tr>
<td>37</td>
<td>Paint, inks, glue/ adhesives and resins containing hazardous substances from repair works and maintenance</td>
<td>20.01.27*</td>
</tr>
<tr>
<td>38</td>
<td>Paint, ink, glue/ adhesives and resins different from those listed in code 20.01.27* from repair works and maintenance</td>
<td>20.01.28</td>
</tr>
<tr>
<td>39</td>
<td>Plastic</td>
<td>20.01.39</td>
</tr>
<tr>
<td>40</td>
<td>Metals</td>
<td>20.01.40</td>
</tr>
<tr>
<td>41</td>
<td>Mixed domestic waste</td>
<td>20.03.01</td>
</tr>
<tr>
<td>42</td>
<td>Domestic waste not mentioned elsewhere</td>
<td>20.03.99</td>
</tr>
</tbody>
</table>

**Collection, transportation, storage, detoxification, treatment and recycling methods**

**During construction**

Under the Waste Management Act, waste generated during construction should be collected and stored temporarily on the territory of the construction site up to their transportation in suitable containers,
depending on their type. It is necessary to ensure their separate collection and submittal for recycling or re-use. The organization of the collection, storage and transportation is at the expense of the owner of the generated waste.

- **Domestic waste**

The amount of generated domestic waste during construction depends on the number of workers and the time of site implementation. It is necessary to provide suitable containers for storage of this waste and to coordinate a schedule for their transportation to a regulated depot for domestic waste in the town of Panagurishte.

- **Redundant soil and rock masses**

The excavated unfit for construction rock masses are deposited temporarily on a depot. From the depot they are used for reclamtion and construction of the road to Bunay hut.

- **Construction waste**

The construction waste, which is not categorized as “hazardous”, should be collected in containers for construction waste. Some of these containers should be used for separate collection of waste, which can be recycled or re-used. It is necessary to provide for the submittal of the separately collected waste to a company for follow-up treatment. The construction waste which are not fit for re-use should be deposited in a negotiated cell in the depot in the town of Panagurishte.

- **Hazardous waste**

A suitable site with security should be designated for the storage of liquid fuel and oils in order to avoid leakages and, consequently, contamination of soil, surface and groundwater. It is recommended that the change of spent engine oils in construction machinery take place outside the territory of the site, at the designated places – gas stations. 

Sites with security should be allocated for temporary storage of waste classified as “hazardous”, or reliable containers (according to their type) for their storage up to their submittal to licensed companies for hazardous waste detoxification, following a contract signed to this end.

Packaging containing residues from hazardous substances or contaminated with hazardous substances should be collected in plastic containers and their treatment should be carried out in compliance with the Ordinance on packaging and packaging waste (SG, v. 19 of 2004, amended v. 56 of 2004, amended and supplemented v. 104 of 2004, amended and supplemented v. 58 of 2005).

**During operation**

During operation domestic waste and waste resulting from repair works will be generated. The amount of the two types of waste will be insignificant and their collection, storage and transportation for follow-up detoxification will not differ from that applied during construction.

The collection of domestic waste and that close in composition to domestic waste and not classified as “hazardous” shall be implemented in compliance with the system for waste collection and transportation approved in the municipality of Panagurishte. Due to the insignificant amount of generated domestic waste, it is necessary to coordinate a schedule for their transportation with a company, with which a contract will be signed for the implementation of this activity.

In the event of needed repair works, the respective waste will be collected and transported in containers of suitable volume, under advance request by the Investor.

The waste obtained from the DWTP after its design shall be treated in the same way, under the Waste Management Act.
Registered previous contaminations with waste and unregulated landfills situated on the territory covering the region of the investment proposal implementation

On the territory of the water supply system and its vicinity there are no registered previous contaminations with waste and unregulated landfills.

Description, analysis and assessment of the supposed significant impact on the population and environment, resulting from waste generation and creation of discomfort

During the completion of Luda Yana dam, there is a risk that the waste generated during site construction and operation will have an impact on the individual components of the environment (ambient air, landscape, surface and groundwater, soils, wildlife) and human health, if the measures for their reliable management under the normative framework (the Waste Management Act) are not implemented.

Possible impact during construction

During construction, generated construction waste has a priority in quantity compared to the domestic waste and that close in composition to domestic waste. This waste should be treated in compliance with the normative waste management framework adopted in the country. Possible impact can be summarized as follows:

Atmospheric air

Harmful impact on the air could be generated by potential unregulated incineration of some types of construction waste instead of their separate collection and storage, transportation and detoxification in an environmental way. Their incineration could result in harmful emissions, which will contaminate in an uncontrolled way the air in the site region for a certain period of time. This type of waste includes packaging from polyethylene, wood materials, composite multi-layer packaging, mixed packaging from raw materials and materials, residue from paint, inks, glues, adhesives and resins containing hazardous substances, wood material from construction, paper and cardboard packaging, packaging containing residue from hazardous substances or contaminated with hazardous substances.

Landscape

In the event of uncontrolled disposal of construction waste, the surrounding landscape will be disturbed on adjacent terrains as a result of the anthropogenic impact of this waste on it. A result of dissemination by the wind of small fractions of this waste at large distances and their detention in shrubs and trees, a negative visual effect will be observed. The predominant part of this scattered waste is hardly degradable in the course of many years and will result in sustainable damage of the landscape.

Water

There is a risk of water contamination in the event that during construction generated waste is not collected, stored, transported and deposited in the depot in the town of Panagurishte. First, the ambient water running along the slopes of the waste stored on site and not transported will be contaminated. It, in turn, can contaminate the surface water, in this case – the water in Luda Yana river – or some of it can infiltrate down to the subsurface aquifers and cause significant and sustainable contamination in some aquifers.

Soil

Some of the waste generated during construction is classified as hazardous. If irresponsible and uncontrolled disposal (storage) of this waste is allowed on site territory, as a result of the flow of ambient water down the slopes or their infiltration through the waste, the underlying soil will be contaminated.

Wildlife

The uncontrolled disposal (storage) of waste allows free access of animals and birds to it. This free access to illegally deposited waste, the use of the surrounding vegetation and the waste itself for food can lead to the spread of diseases at undetermined distances, as well as the death of some animals and birds. In this way, the biodiversity in the region will be disturbed.

Human health
Harmful impact on the individual components of the environment will inevitably have an impact on the health of the construction workers, local population and, possibly, tourists visiting the region.

Possible impact during operation
During operation, mainly waste from required repair works would form. Taking into account, however, the fact that repair works will be required rarely, it can be said that their formation will be one-time, they will be small in quantity and the collection, storage and transportation for detoxification will not pose a problem. As for domestic waste – during operation this will be insignificant in quantity. It is necessary to place suitable containers for their collection and storage and organize their transportation to the waste depot in the town of Panagurishte.

Cumulative impact
If the prescriptions and conditions in the normative framework for waste management are observed, the impact of the waste generated on site territory on the individual components of the environment will be insignificant and without cumulative impact.

5.6. HARMFUL PHYSICAL FACTORS

Noise

During construction

The sources of noise in the environment are most types of works related to the completion of the water supply system (excavation, embankment, concrete, formwork, mounting, drill and detonation, transport). The levels of noise emitted by the main used machines and equipment are: excavator – 80÷91 dBA; bulldozer – 97÷105 dBA; motor-crane – 92÷98 dBA; asphalt mixer – 84 dBA; concrete mixer – 88÷93 dBA; roller – 87 dBA; vibromass – 98÷106 dBA; stone grinding installation – 88÷96 dBA; drill hammers – 105÷120 dBA; heavy automobiles heavy-weight automobiles – 85÷90 dBA; compressors – 86÷99 dBA. During detonation works, impulse noise is emitted with levels depending on the detonation system. Construction equipment is concentrated on specially designated territories and sites: terrain for construction of the main site – dam wall, the DWTP, auxiliary and production facilities – stone quarry, ballast quarries, clay pit, concrete facility. The expected equivalent levels of noise on the individual construction sites in the immediate vicinity of the groups of operating machinery and facilities are around, and sometimes above, 90 dBA.

The technological road network for the transport vehicles servicing the construction has been completed. The heavy-duty vehicles, depending on the intensity of traffic, will generate noise with an equivalent level of about 60-61 dBA, at a distance of 7.5 m from the axis of traffic.

The limit values of the noise level for the different territories and zones regulated in Ordinance No. 6 on the indicators for noise in the environment (MH, MEW, 2006) are: for residential territories: day – 55 dBA, evening – 50 dBA, night – 45 dBA; for production and storage zones: day, evening and night – 70 dBA.

The nearest settlement – the town of Panagurishte – is about 2 km away from the site of the future dam. Due to the sufficient distance of the town, the construction activity on the site will not be a source of noise for it.

The transport servicing the construction will move only from the lakebed to the wall and will not pass through settled areas. The freight vehicles delivering equipment, cement, fittings and transporting waste will pass through approved routes in the town of Panagurishte and will not have an impact on the noise regime on its territory.

During operation
During site operation, a source of noise will be the equipment of the future DWTP (pumps, mixers, blowfans, hydrophore, etc.). According to their technical characteristics, the levels of emitted noise are within the range of 70-75 dBA. The equipment will be placed in a massive building with concrete construction, with expected sound insulation of the façade walls not lower than 35 dBA. Noise levels outside the building higher than 45 dBA are not expected, which is quite below the hygiene norm of 70 dBA. The DWTP and the two possible sites are at a distance sufficiently away from the town of Panagurishte.
5.7. PLANTS

During the construction period

During the construction of the Luda Yana dam felling of the remaining small area (0.5-0.6 ha) of Scots pine plantation near the dam and the rehabilitation of the lake with an area of 142 ha must be completed. No impacts on the forest tree, grass and brush vegetation (outside the floodplain) are expected during the construction period.

The particular vegetation on the DWTP site that will be affected will be known after the project is developed.

During the operation

The project requires flooding of 142 ha toward the Panagurishte State Forestry Board (the lake is designated in white color on the map), and this area has been excluded from the state forestry board area for the construction of the water reservoir.

The felling of the forest tree vegetation (except for the Scots pine plantation), the removal of the top-soil in much of the lake, has been established after the walk around the entire future lake in September 2007 that there are no rare or endangered species among the plant species, in accordance with the regulations.

The ensuring of a minimum admissible flow in the Luda Yana river during the summer-time low levels of the water in the river and the improved water balance during the remainder of the year will create better conditions in the river downstream of the dam and will, therefore, allow for the establishing of a good status of the river within the town of Panagurishte.

There is no forest tree and brush vegetation in the river bed and up until a certain height above the river bed as far as the town of Panagurishte, that will be affected by the reduced water flow of the river during the spring time high-water levels. The securing of the minimum admissible flow of 170 l/s during low-water periods will be conducive to the development of typical riverside vegetation.

The increasing of the relative air humidity around the lake will have a favorable effect on the vegetation.

5.8. ANIMALS

The forecasts for the impact of the Luda Yana dam on the animals was based on the assessment of the status made in item 4.8 in consideration of the significant anthropogenic activities in the area and in the Luda Yana river itself. The drastic reduction of the flow and the drying of the river during a part of the low-water period have led to the destruction of the river biota and to gradual distancing of amphibians, reptiles, mammals and birds from the river in search of more suitable habitats.

5.8.1. Ichthyofauna

Assessment of the impact on the ichthyofauna

The construction of the future Luda Yana dam located along the upper stretch of the same river is in an advanced phase. The dam has been constructed to a large extent, and the integrity of the river continuum is maintained partially, only via the constructed main outlet.

Expected impact on the river ichthyofauna

1. The no-action case (with the current situation remaining unchanged) means that it cannot be expected that the river continuum will be restored and the fish life stabilized in the affected section of the Luda Yana river and in the entire middle stretch of the river.
2. No direct impacts on the ichthyofauna along the middle stretch of the river is expected during the construction works for completion of the dam.

3. The commissioning of the Luda Yana dam will be conducive to the stabilizing of the flow regime along the middle stretch of the Luda Yana river by means of controlled releasing of the ecological flow and will, therefore, have a positive effect on the entire complex of ichthyofauna in this area. The expected improvement of the population of Maritsa barbell is particularly important because this species is indicative of the ecological status of the water body.

4. The filling of the reservoir will enable the creation in the bowl and in the upper stretches of the river of a stable fish community based on a brook trout population with its attendant species. The brook trout population may be established naturally by the entry of the fish from the upper stretch of the river, and by artificial stocking.

**Potential threats**

Although the riparian biota along the middle stretch of the Luda Yana river is subject to significant negative anthropogenic impacts, there are two specific forms of potential negative impacts from the management of the future water reservoir:

- Insufficient water in the river bed;
- Releasing of water from the lower layers of the water reservoir with constantly lower temperature and increased concentrations of nutrients.

The prevention of the potential negative effects and the improvement of the ecological status of the affected river stretch require measures for the achieving of good ecological status of the surface water bodies:

- Ensuring of sufficient water in the riverbed downstream of the reservoir (179 l/s during the low-water periods).
- Location of the water extraction facilities at a depth of no less than 10 m in order to ensure the ecological minimum.
- Development of a management plan of the water in the Luda Yana river basin inclusive of measures for restoration and conservation of the biological potential of the river (waste water treatment, restoration of the habitats of fish, amphibians and invertebrates, prevention of flood events causing destruction of benthic habitats and flood plains, etc.).

The above potential impacts on the ichthyofauna may be prevented completely by the implementation of the proposed measures.

5.8.2. **Herpetofauna**  
*(Amphibians and reptiles)*

**Assessment of the impact on the amphibians and reptiles**

Most of the species are not of a high nature conservation status. These are common animals widespread in Bulgaria. Of 10 listed species seven are closely related to water and will not be threatened by the creation of a new water impoundment. This category includes also the three species from the Red List of the International Union for Nature Conservation (IUCN). The rare wall and green lizards, and the smooth snake, whose occurrence in this area is uncertain, will climb higher along the slopes and their populations in the region will sustain virtually no damage.

Observations of other water impoundments with the characteristics and regime of the one under constriction show that the prevalent “thriving” species is the large water frog. This species may become abundant in several years from the damming of the reservoir. The remaining amphibian species will use this water impoundment for spawning and development of larvae. It is likely that grass snakes and
tortoises will exist in low numbers in the less accessible areas. No substantial change of the populations of the 3 species of terrestrial reptiles will occur.

According to research data, approximately 70% of the species on the Luda Yana dam area inhabit the riverside sections of small water reservoirs (Institute of Zoology at the Bulgarian Academy of Sciences).

The assessment of the current status of the reservoir area with regard to herpetofauna is negative, and is particularly so around the dam. The completion of the water reservoir, the rehabilitation and self-restoration of the vegetation around the lake will make this territory a more suitable and more acceptable herpetofauna habitat. It is particularly important to guarantee the envisaged flow downstream of the dam during low water periods.

The construction and operation of the Luda Yana dam will have no negative effects on the populations of amphibians and reptiles in the floodplains and near-by areas. Seven of the 10 established and most likely species are related to water; among those are the three species included in the IUCN Red List. No special measures for protection and subsequent monitoring are required for those species.

5.8.3. Mammal Fauna

Assessment of the impact on the mammal fauna

The study has shown that there will be no negative effects on the fauna, which is relatively mobile and would move up to higher altitudes as early as the construction phase. No substantial loss of habitats is expected since the main flooded area is unfavourable to most of the species. No overpopulation or excessive numbers of species in the unaffected areas is expected due to their extremely small density within the flooded area.

Generally, the effect of the flooded area and of the dam will have no negative effect on the existing mammal fauna. The comparatively limited period left for the construction works, of which approximately 70% are complete, means that the works will have no effect on the trophic base and on the habitats of individual mammal species’ populations and will not affect their numbers. The completion of the Luda Yana dam will have a favourable effect on biodiversity in the area. Predominantly heavily eroded areas will be flooded.

5.8.4. Ornithofauna

Assessment of the impact on the ornithofauna

The construction of the dam and of adjoining facilities has already affected the land surface and the covering vegetation, as well as the habitats of a certain number of individuals of the inhabiting bird species. In this case there is a positive circumstance – the flooded area is rather small in comparison to the region in which the water reservoir is located.

Of the species listed in Annex 2 of the Biodiversity Act (BA), only the red-backed shrike and, to a much lesser degree, the Syrian woodpecker habitats will be affected by the construction works and flooding of the site, however, these species are much more abundant in other parts of the country, and in this area too. The pairs whose nesting areas will be affected will occupy new such areas adjacent to the future water reservoir where there are adequate nesting areas for such species. Regarding the remaining species listed in Annex 2, the flooded area comprises a negligibly small part of their trophic base and its destruction would not impact their existence in this part of the country to a significant extent.

A year-round releasing of the minimum admissible water quantity of 170 l/s required for the normal functioning of the river ecosystem is envisaged. Therefore, the completion of the site will not affect any animal species inhabiting the river downstream of the reservoir as well as the species using the river water for drinking and bathing, including some bird species foraging along the banks and in the shallows of the river, such as the white wagtail and gray wagtail. There are no areas within the dam system with regular (annual or seasonal) concentration of large numbers of certain bird species.

The damming may be followed by the appearance and subsequent increase of fish species that are typical of standing or slowly flowing water, which will result in an increased trophic base of certain bird species diving for fish, such as grebes (Podicipedidae), cormorants (Phalacrocoracidae), smews (Mergus albellus L.), red-crested pochards (Netta rufina (Pallas), Aythya sp. etc.) etc. The lake may attract
individuals of certain other water bird species – ducks (*Anas sp.*), storks (*Ciconia sp.*), herons (*Ardeidae*) etc., to establish nests in the vicinity. This would be a significant increase in the ornithofauna in this part of Bulgaria, especially during the autumn and winter, which would be a positive development.

With its parameters (142 ha in area and 4.5 km in length), the reservoir is incapable of having any detrimental effect on the migrating birds in this part of Bulgaria, and once its fish stock increases, can only be conducive to the migration and wintering of piscivorous species.

This assessment means that no negative changes of the state of the species of significance for conservation and of their habitats can be expected as a result of the water reservoir. The area used for the lake is of insignificant size and will not cause any significant reduction in the trophic base of the bird species inhabiting the area, and will even increase the trophic base of a certain numbers of water fowl and piscivorous species.

5.9. LANDSCAPE

The appropriate architectural design, site reclamation and dam flooding will create the new landscape.

The evaluation of the self-cleaning potential and recovery of landscape in the region in question underlines its substantial capacity for inclusion and harmonization of the water supply system of Luda Yana within the nature environment. Lakes are no foreign element to mountains and the newly created artificial lake will match the nature landscape.

5.10. HEALTH FACTOR AND SOCIAL SIGNIFICANCE

*During construction works*

*Concerning the population*

There are no inhabited places in the vicinity of the site where the Luda Yana dam is being constructed. So non-organized noise sources from construction and transportation machinery, dust and exhaust gas emissions will have no negative impact on the population’s health.

*Concerning the construction workers*

During the works negative health impacts could be produced by a number of factors, occurring in the working environment during the construction process, namely:

*Non-favorable microclimate.* Work will be going on in all four seasons in the open, in both excessive heat and cold. Excessive heat could be a risk factor for incidents such as heat and/or sunstroke. If prolonged, such conditions could lead to dehydration, loss of salts and microelements and heat exhaustion. Excessive cold contributes to increased incidence of colds, muscular and bone complaints and disturbances of the peripheral nervous system.

*Noise.* Drivers of heavy machinery and excavator operators will be exposed to excessive noise level to the tune of 80 - 90 to 100 dB/A. This could have negative consequences for the central nervous system, sleep disturbances, neurosis-type complaints and is a risk factor for arterial hypertension as well.

*Vibrations.* The drivers of the heavy trucks will be exposed to general and local vibrations. Given the new technology to be used, those vibrations maybe will not exceed the admissible levels. The use of some, mostly outdated machinery may cause excessive levels of vibration, and hence damages to the vestibular system, the locomotory system and the parenchyma; also the s. c. “vibration disease” may occur, which is a common occupational disease in this field of work.

*Air pollution.* Drivers of heavy machinery and excavator operators will be exposed to exhaust gasses emissions. No harmful health effects are expected in this case, as they work in the open air. Furthermore, excavation works will be limited in volume.
Dust. Construction workers are exposed to non-organized dust emissions. Large dust particles can only have an irritation effect on the upper respiratory system.

Exposure to metal aerosols and noxious gasses. During welding operations various quantities of carbon oxide, carbon dioxide, nitric gases and metal aerosols (manganese, lead, iron or others, depending on the type of welding material) are emitted. If welding is performed in closed premises or inside large pipes those emissions can cause chronic occupational disturbances of the lungs (chronic bronchitis, pneumoconiosis of the siderosis type).

Traumas. Construction workers suffer from the highest incidence of occupational traumas during excavation and assembly works.

Heavy labor. Notwithstanding the fact that a large part of the construction operations are performed by machinery, still heavy physical labor is required in a number of operations, including the lifting and carrying of excessive weights. Another unfavorable aspect of construction work is that a lot of the operations are performed in a difficult position, requiring considerably tension of muscles and limbs. This leads to micro-traumas, diseases of the locomotory system, the nervous system and the muscles.

Conclusion The site is located away from inhabited places and no unfavorable health effects on the population can be expected during its construction. The working environment will exert certain impact on the health of the construction workers during construction works, of a temporary nature. It can be minimized by taking adequate health and safety protection measures.

During operation

No changes in air humidity or the climate or expected during the operation of the dam. It is expected to have a favorable impact for the population as new jobs will be created and new recreational spots will be set up in its vicinity. Improved water supply will guarantee the elimination of epidemic via water contamination. The fact that the population will make use of drinking water, which meets Bulgarian and European standards of quality, will have an indirect positive health impact for the population.

5.11. Safety of the Luda Yana dam

The safety of the dam walls is of considerable economic, social and ecological significance.

Safety of large dams, such as Luda Yana is a consideration embedded back in the very investment proposal for the dam.

In designing dam walls in Bulgaria the design norms for embankment walls, published in 1986, in the Architecture and Construction Bulletin, vol. 1 and 6; the fundaments of design norms for hydro-engineering facilities, guidelines by the Ministry of Construction and Public Works and the Ministry of Power Generation, (Architecture and Construction Bulletin, vol. 11/1985.), norms for load and impact of waves, ice and navigation for hydro-engineering facilities (1988), design norms for buildings and facilities in earthquake zones (Architecture and Construction Bulletin, vol. 1/1989 ). As the above-listed regulations are not recent, and given the lack of an EC code on hydro-engineering facilities design, internationally recognized standards are also used, such as those of the Fepartment of the Army US Army Corps of Engineers, German standards and others. Also followed are Bulgarian regulatory documents and standards for construction design, which are described in the design Contract. Various risks are being considered in the process of design, such as the hydrological risk of high waters, with the respective precautions envisaged and seismic risk from an earthquake of a given intensity. The designs comprise a section on a control and measurement system (CMS). Upon commissioning the site, the designs feature also a Program of Surveillance and Measurements by means of a CMC, Operations Guidelines and Emergency Action Plan (Crises Management Plan) for the duration of construction works and subsequent operation of the site. The Luda Yana dam wall is category I, hence the high safety requirements.
When the State Approval Committee checks the site to be approved for operation, it also checks whether all normative requirements have been met (Ordinance № 2/2003 on commissioning construction sites in Bulgaria and minimum warranty terms on approval of construction and assembly works (State Gazette 72/2003). The operational staff is employed at the beginning of construction and the specific teams are defined as the site is being commissioned. The duration for dams being operable is deemed to be 100 years (the time for the established volume to be filled by deposits).

To ensure safety of dam facilities, Ordinance № 13/29.01.2004 on the conditions and procedures for technical operation of dam walls and related facilities is to be followed. At each stage of the operation the Surveillance and Measurement Program is being updated. On the basis of the measurements the security of construction and engineering works is being assessed, as well as the impact of the dam wall on the environment (degree of danger to the natural and material goods and human health and life). Safety is assessed for normal operational mode, for work under extreme conditions and for emergencies. Two times per year the operational teams perform a visual check on the wall, the water area and the related facilities and issue a protocol with respective recommendations. The engineering analysis of the wall status is performed by a person responsible for the technical operation of the site and is based on the results of the engineering checks and measurement and control for a period of three years at most, and is approved at an expert engineering board, appointed by the owner. Inspections to evaluate the safety of the dam walls and related facilities are carried out by experts, which are not on the payroll of the person, responsible for the site’s technical operation. The first inspection is to be carried out before flooding, then at the end of the first operational period, not later than the 5th year of regular operation, and later on – by decision of an expert engineering board, appointed by the owner.

In case of high waters of a level close or equal to the highest water level (hydrological risk), and if an earthquake of a magnitude above VI by the SK-64 scale (seismic risk), inspections are to be carried out and full measurements taken by all measurement and Control System tools for all facilities, in accordance with the Program on Status Analysis and Registration.

In extreme and emergency conditions the Crises Management Plan is to be implemented, which formulates all tasks, relationships and responsibilities of the institutions, whose responsibility it is to react in times of crises under the Crises Management Act.

Responsible for the safety of the dam wall are the technical operation team, the managers of the operational unit and the company, which ensures the dam’s operation (ViK P Ltd, Panagurishte), as well as the respective state authority (the Ministry of Regional Development and Public Works).

Risk

The risk is a possibility of certain damages occurring during an event of a probable nature.

In terms of operating the Luda Yana dam, the following need to be considered:

- Hydrological risk;
- Seismic risk;
- Ecological risk.

Hydrological risk

The hydrological risk is the probability of certain damages caused by high water of a highest occurrence. To prevent it, the following is needed:

- The expected high water should be reliably defined and taken into account in calculating the type and category of the facility to be constructed (calculations provided in the updated hydrological description).
- The dimensions need to be established of the facilities needed to carry over safely the high water described above (the spillway and the chute need to be designed anew).
• Emergency rules and action plan need to be formulated (Operational Guidelines, Crises Management Plan).

Seismic risk

The seismic risk is defined as the probability of certain damages occurring if earthquakes of a given magnitude take place. To prevent, to the maximum extent possible, the damages from occurring, the following should be done:

• A micro-seismic study of the river area where the Luda Yana dam is envisaged to be built is a must;
• The geological survey for the sites, including the updated geological report should include an assessment of possible consequences for the geological bed in the event of a heavy earthquake;
• Facilities should be designed and built in such a way as to provide for a safe outcome in the event of a rated seismic impact;
• Rules and action plan in case of heavy earthquake during operation need to be formulated (Operational Guidelines, Crises Management Plan).

The assessment of the possible negative impacts that the existing environment can have on the investment proposal should feature both in the micro-seismic study and when the hydrologic parameters are being determined, taking into account meteorological factors and climate characteristics (provided in the updated hydrology study).

Environmental risk

The environmental risk for the dam wall and related facilities is linked to the risk of changes in the quality of the environmental components, as discussed in the EIAS. The environmental risk for the Luda Yana dam is assessed in the Risk Assessment Table on the basis of prognostication.
### Table on the environmental risk ensuing from the construction and operation of the Luda Yana dam

<table>
<thead>
<tr>
<th>Impact sources</th>
<th>Component</th>
<th>Notes</th>
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<tbody>
<tr>
<td></td>
<td>Atmospheric air</td>
<td>Water</td>
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<tr>
<td>In the course of construction</td>
<td>+</td>
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<tr>
<td>Dam wall and Luda Yana water reservoir</td>
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<tr>
<td>Transport routes, water supply system</td>
<td>+</td>
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<tr>
<td>During operation</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Dam wall and Luda Yana water reservoir</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+  low level expected  
++ medium level expected

*The indicated “low level” of risk is based on the overall information, presented in the Environmental analysis section and on the conclusions that have been drawn and prognoses formulated thereon.*
5.12. **Transborder effect**

The Luda Yana dam is located at 2 km above the town of Panagurishte, district of Pazardzhik.

*In the course of construction* no transborder effect will occur, as the site is located in the interior of the country.

*During operation* a transborder effect is the volume of the waters from the Maritsa river boundary flow, which has been withheld in the country. The boundary flow has been calculated in the General Scheme on water use for the regions of the water basin management for the Republic of Bulgaria (Bulgarian Academy of Sciences – Institute on Soils and Waters 2000) to amount to 3403.4.10^6 m^3/yr. In the water collection area of the Maritsa river some 500 smaller or bigger dams have been constructed (the largest reservoirs are the Vucha dam, volume 226.10^6 m^3, Belmeken - volume 144.04.10^6 m^3, and Batak - volume 305.830.10^6 m^3).

The Luda Yana dam is proposed to cover the needs for water supply, and the volume of the dam to be used to this purposes id calculated by the designer to be 6.0.10^6 m^3/yr. Of all the water fed to the water supply system some 80% are restorable – water that is fed back into the rivers through the sewerage systems. The water contained in the territory amounts to 1,20.10^6 m^3/yr, or 0,035% of the Maritsa river boundary flow.

5.13. **Social impact**

The construction of the Luda Yana dam will solve a major social problem in the municipality of Panagurishte by providing regular water supply for the population. Opportunities will be created for economic development, reduction of unemployment, and increased incomes through tourism. The municipality of Panagurishte can become an attractive cultural tourism centre with its archaeological and historic monuments and its links to the major future tourist destination “the Valley of the Thracian Kings”. Eco-tourism is also a major prospect for development of the region.

The project has the following advantages: no migration of the population is needed, no loss of agricultural lands or pastures (those have already been expropriated when construction had begun). Forests in the area have also been expropriated and felled (with the exception of a 0,5-0,6 ha pine grove). The humus layer has been taken away, to a large extent. The anthropogenic impact within the vicinity of the dam wall and the reservoir has mostly been exerted already.

No infrastructure sites are to be affected. The road to the Bunay chalet (an interesting tourist itinerary) has been re-routed. In the course of the construction works compulsory requirements will be met concerning the normal operation of the water supply network from the dam to the town of Panagurishte. No road infrastructure is affected, and the bridges along the national road network and sound enough to permit the heavy traffic, carrying machinery and building materials. The same bridges have been used in the first stages of construction. No waste depots, irrigation or drainage systems exist on the site’s territory.

The insignificant impact on the flora and fauna has been considered in the EIAS.

The Luda Yana dam has a positive impact on the river eco-system under the wall by providing ample water. Favorable conditions are created for the fish population both in the reservoir and below it. The minimum flow ensured under the wall creates gradually opportunities for habitats to be created, enriching the fauna of amphibians and reptiles, mammals and birds along the river. The sanitary status of the Luda Yana river within the town of Panagurishte will be considerably improved.

VI. **ANALYSIS OF ALTERNATIVES**

All possible alternatives for the Luda Yana dam have been considered in the EA of 2007.

The studies on the possible alternatives for the Luda Yana dam date back to the 1980-ies. The following alternatives have been considered:
In terms of location: Several ranges have been studied; the possibility of building the dam on another river; to upgrade an existing dam or to build several smaller dams. The range of the Luda Yana River proved most acceptable from an economic and an ecological point of view, and also because of the developed road network in the area. Two sites have been discussed for the Drinking Water Treatment Plant – below the dam wall or at the site of the existing DWTP servicing the town of Panagurishte. The location of the DWTP will be decided during the design process.

The alternative that is closer to the town of Panagurishte is the preferred one, because it is by far the more efficient solution as compared to the existing 45 km water supply pipeline from the Maritsa river. The location of the Luda Yana Dam even back in the 80-ies provided for improving the ecological status of the Luda Yana river, which suffers considerable anthropogenic pressures as a result of the economic activities in the region and the needs for water supply, met by drawing water from the river. The future lake will be situated in a territory, which does not affect any rare or endangered flora and fauna species. No sites from the National Ecology Network are affected, either.

Feasibility studies for the DWTP have been made back in 1989, but those have not been considered, as no final decision has been taken about the location and respectively, the type of the site (the choice being between a site that necessitates the water to be pumped from the dam to the DWTP and a site with gravity water supply to the network, or gravity water supply to the DWTP and pumping the water to the supply network).

In 1980 no procedure for EIA existed in Bulgaria, so environmental issues were not discussed at that time; an EIA was only made in 2000.

In terms of quantity of water to be fed to the water supply system. Various development prospects have been considered for the regions of the towns of Panagurishte, Pazardzhik and Strelcha, as well as possibilities to provide water supply for other inhabited places (Lesichkovo). The adopted alternative for \( Q_w = 300 \text{ l/s} \) corresponds to the economic and demographic projections for the development of the municipalities by 2025 (in has been confirmed in the updated hydrologic data).

In terms of type of dam wall and related facilities. The type of dam wall has been chosen following an analysis of the economic and operational safety indicators of a several wall types for a seismic magnitude VIII and a category II facility. The selection of the related facilities (intake water tower, front spillway with chute) was determined by the terrain and the parameters of the spillway. The updated hydrological information, the geological report and the proximity of the dam to the town of Panagurishte have changed the category of the dam wall to category I, hence the need for a new design for the spillway and the chute, and a change in the wall crown, dictated by the modified upper limit for the highest water level.

A zero option has also been considered but has been rejected, as it has been proven that the Luda Yana dam is the only possible water supply source in the regions under consideration.

The scarcity of water in 2008 and the strictest water supply rationing for almost 2 months proved that the zero option is not possible, and the only possibility for the region to have regular water supply is to finish the construction of the dam.

Currently the dam wall has reached a height of 30 m, and construction works have been halted for 7 years.

Possible new alternatives: preserving the status quo, partial finishing, demolishing the dam wall, rehabilitation of the water supply pipeline from the Maritsa rive terrace

The need to have Luda Yana dam built

All data, collected by the team, the update of the project, where the needs till 2025 have been formulated, the public discussion in the town of Panagurishte and the prognostication designs of ViK – P Ltd, Panagurishte indicate that there is still need for water to be supplied to the above-mentioned towns. ViK – P Ltd, Panagurishte had daily problems with breakdowns along the water supply pipeline from the Maritsa rive (it has been used for 20 years now, and has 5 pumping levels) The 45 km of pipeline incurs high operational costs, as it needs constantly to be controlled and consumes energy. The water from the catchment areas within the location of the future dam lake has no constant flow, is of low rate or, in high water periods, of bad quality. The town of Panagurishte and the villages in the district have great potential
for cultural and ecotourism to be developed, as there are considerable archeological and historical monuments in the area, so a regular good quality water supply is indispensable. The population considers the Luda Yana dam to be the only possibility to provide the water needed and none of the project versions included the possibility of abandoning the construction works. The only reason for them to be halted was the lack of finance, although at certain periods investments have been made on the part of the Assarel – Medet company. Other alternatives will cause new water supply sources to be sought, but prospecting in the region for over 25 years has shown that no such sources exist there.

Environmental impacts

Preserving the status quo. In this case an update needs to be made of the wall status (2/3 of the site has been finished), and it should be conserved with adequate safety measures, hence – costs. A spillway needs to be constructed (the existing one is not usable), and a possibility should be provided for high water to be fed to the lower sections of the river, by building a power stifling pool and correction. Operational staff needs to be available to control the wall status via an updated MCS. Re-cultivation needs to be done of the quarry and the depots. A plan should be drawn up to mitigate the visual impact from the stone embankment. Other remaining issues are the dewatering of the section below the wall, the critical conditions of the ichthyofauna, progressing erosion, negative environmental impacts on the river ecosystem below the wall and the sanitary conditions of the river flowing through the town of Panagurishte.

This option will definitely have only negative environmental impacts, given that dewatering of the river after the dam is thus continued, including when it flows into the town of Panagurishte, will all the respective consequences for the sails, water, flora, and fauna, and for the town as a whole.

Partial completion. A partial completion would mean to find an additional water source, which has been proven to be lacking. This the main social issue – water supply – remains open. And as with the option described above, the additional engineering works will need to be done, at respective costs; the wall design will need to be updated in conformity with existing regulations. This option is no less investment-intensive, as new mitigation facilities will need to be built. Operational costs will be almost the same without the benefit of providing water for the three municipalities. It is not possible to compare the environmental impacts, as it is not clear what the wall height will be if it is decided to be partially completed. The same negative environmental impacts will occur as the ones described for option I.

Should an additional water supply source be sought (no such source has been proven to exist in the vicinity), new negative ecological impacts will be caused on another territory.

Demolishing the dam wall. Demolishing the dam wall will have environmental consequences which are hard to predict, because a natural passage way will have to be provided for the high waters, and some 430 000 m$^3$ of embankment will have to be taken away and stored somewhere. Concrete structures will have to be demolished and the territory will have to be re-cultivated. New operational guidelines and a Crisis Management Plan will have to be formulated for the duration of the works. The bad ecological status of the Luda Yana river below the dam wall will be perpetuated (dewatered section), with all the respective consequences for the flora, fauna and for the town of Panagurishte. Anti-erosion measures will have to be implemented on a much larger scale.

Rehabilitation of the water pipeline coming from the Maritsa river terrace. The water pipeline has been used for 20 years, it is 45 km long, passing through relatively difficult terrain, and has 5 pump stations. Frequent breakdowns cause often interruptions in water supply. According to ViK – P Ltd, it is not economically efficient to rehabilitate it, because, among others, energy will be used for the pumping stations, which causes the price of water to rise; even now the water price in the region is one of the highest in the country. The pipeline broke down also in 2008, and its operational limits have almost been exhausted, given its current status.

To combine the rehabilitation of the existing 45 km of water pipeline and one of the three options as proposed will not solve the problems of water supply in the region, because surface sources (components of the water supply system) have variable flow rate and do not contribute to improving the ecological status of the Luda Yana river. The river dewatering remains below the dam wall range, hence the negative impacts on the flora and fauna. Rehabilitation of the water pipeline requires a major overhaul and
reconstruction, which is extremely expensive and will cause the town to suffer water scarcity and a regime of lowered water supply for a long time, without providing guaranteed for its future operation.

The four options considered here are not justified and are not acceptable for Bulgaria, both in social and ecological terms. To develop the project on finishing the dam wall, which is subject to the EIAs, would mean to approve and implement all environmental impact mitigation measures.

Thus the only option is to finish the construction of the Luda Yana dam, which does not necessitate a change in the methodology, the calculations for investments (including foreign), the operational costs, the measurement and control system (the monitoring facilities) as a whole, and the benefits and costs analysis. All of those already feature in the project of finishing the construction of the Luda Yana dam in the version proposed by the Bulgarian side.

VII. Environmental Impact REMEDIATION PLAN

A substantial part of the impacts on the environment as a result of the construction of the dam wall of Luda Yana Dam to a height of 30 m have already occurred.

70% of the construction works for the dam wall were completed by 2000: excavation works, embankment of 30 m, diverting weir, diverting tunnel, approach galleries on both slopes; construction part of the water intake tower, switchgear; 70% of the counter seepage measures and other auxiliary or temporary subsites; the trench for the spillway and the chute was made; the rock, sand and clay quarries and the humus depot were uncovered; the road to Bunay chalet was removed. Road network has been implemented 100%. The remaining works comprise: the dam wall up to crown elevation, spillway and chute to the wall, installation works on the machinery and equipment of the facilities.

The construction of the dam wall to a height of 30 m will prevent the waters of Luda Yana river from pollution during completion of the dam wall. During the construction of the spillway, at the end of the energy stifling pool, it will be necessary to construct a mechanical settling tank for setting of construction waters.

The remaining construction works require compliance with the technology for consequential implementation of the dam wall and quality control. These are dam activities in which the construction companies in the country have the required experience (in the country there are 16 big rock fill walls – Belmeke Dam – 98 m, and 98 big earth fill walls – Ogosta Dam – 59 m).

This is the background for proposal of the Environmental impact remediation plan. It includes the required measures both during the construction phase and during the operation phase of Luda Yana water supply system.

ATMOSPHERIC AIR

7.1. Restriction of the impacted area within the construction period, sprinkling.

7.2. Use of mobile sprinklers to suppress dust emission along temporary construction roads and routs through residential areas, construction sites and quarries for extraction of inert materials and rock fill.

7.3. Regular adjustment of diesel and petrol aggregates during the time of use of construction machinery and vehicles; compliance with the daily construction schedules in view of maximum compaction of the operational regime; limiting to a minimum the so-called „idle motion“ of machines.

7.4. Checking of the technical condition of the construction equipment and vehicles for eventual failures, or leakages at each shift. Deactivation of pollutants in case of emergency.

Water

7.5. Construction of water measuring point in the tail of the dam pond for measuring of received water quantities.

7.6. Construction of measuring profile in a suitable place below the dam, after discharge of environmental waters to control the size of environmental water quantity.
7.7. Marking of zone I in the design of sanitary protection zones I, II and III around the dam.

7.8. Remediation of the dam bed – felling of the remaining tree vegetation and removing of the humus.

7.9. Securing the supply of environmental water quantity amounting to 0.170 m\(^3\)/s from the level of the water intake tower at an appropriate depth (up to 10 m from the lake surface).

7.10. Provision of chemical toilets during the construction phase, and consider a solution combined with a treatment module for the operation phase.

7.11. To maintain water supply from the lake bed during the construction phase, and disconnect the system at the appropriate stage of commissioning in operation.

7.12. Construct a mechanical settling tank for setting of construction waters prior to their discharge in the Luda Yana river during the construction of the energy stifling pool.

**Geology**

7.13. Drive three research probes through the stem of the core and carry out trial filtration tests in them.

7.14. Envisage sampling of the clay core cluster and the material of the support prisms with boreholes for acquisition of their deformation-strength properties in view of the computations of the dam wall robustness.

**Soils**

7.15. Perform deactivation of pollutants in case of emergency spillages and leakages from mechanical equipment and vehicles to prevent soil pollution.

7.16. Compliance with the requirements for waste management in order to avoid soil pollution in adjoining areas.

7.17. Perform regular supervision of the water area of the lake for establishing of any land erosion or collapse during operation.

7.18. Remove the humus layer and dispose it to the two depots.

7.19. At the beginning of construction works a Technical design for erosion control shall be launched.

**Harmful physical factors – noise**

7.20. Heavy transportation vehicles used for construction shall comply with the admissible speed limit on passing through residential areas and the speed on the roads shall be coordinated with the municipalities.

7.21. Construction equipment and the activities shall be focused on the main construction sites.

**Wastes**

7.22. The provisions of the Waste Management Act shall be complied with during construction and operation.

7.23. Construction works shall be launched on the site after the Employer’s submission of a contract with a licensed company for transportation and disposal of hazardous and non-hazardous wastes that will be generated during the construction and operation.

7.24. Creation of a system for separate collection of wastes, securing of sufficient number of vessels for collection of domestic wastes or wastes similar to domestic wastes in terms of contents and exercising of strict control on the activities for collection and transportation of wastes to the place of disposal performed by the contracted licensed company.

7.25. Collection and proper storage of any generated wastes in the course of construction works.

7.26. Transportation of domestic wastes, and after special agreement of the construction wastes to the landfill of Panagurishte.

7.27. The generated “hazardous” wastes shall be collected, stored in environmentally friendly manner and submitted for disposal by licensed companies.

7.28. Unregulated burning of flammable construction wastes shall not be allowed.
7.29. Transportation of domestic wastes generated in the course of dam operations to the landfill in Panagurishte.

Flora
7.30. Detonation works at the stone quarry shall be performed following a ‘no debris’ technology.

7.31. Species appropriate for the climatic conditions in the region and with the relevant landscaping qualities shall be used for the biological remediation envisaged for the areas impacted by construction works.

Fauna
7.32. Detonation works at the stone quarry shall not coincide with the reproduction period of fauna (end of April and May).

7.33. Secure the supply of environmental water quantity from an appropriate height of the water tower (not more than 10 m).

Landscape
7.34. Design and implement a landscaping spatial plan for the territory.

7.35. Perform at the end of the construction works remediation of the impacted areas beyond the facilities.

7.36. The building of the DWTP and the administrative building at the crest of the wall shall have a proper architectural solution and shall be painted in a proper color.

7.37. At the end of construction works the impacted section of the national road network shall be repaired.

Health
7.38. Proper bath, toilet and kitchen facilities, working outfit, personal protection kits and work and rest balance shall be secured for the workers and drivers at the dam wall. The operational personnel at the DWTP shall be equipped with the necessary protection means, including in case of emergency.

The Emergency Action Plan shall be developed at the beginning of the construction works – for the construction period, and as of the commissioning in operation – for the operation period. It comprises all actions and situation related to industrial emergencies and natural disasters – high water, earthquakes etc.

VIII. ENVIRONMENTAL Monitoring Plan
Prior to construction and operation the Contractor, the Implementation Unit and the Owner shall develop a their own monitoring plan that shall comply with the requirements in the regulatory base specified in chapter 2.

The Monitoring plan is presented in Annex 3.

The Monitoring Plan shall be developed, implemented, reported and controlled in compliance with chapter 2. The Project control unit established with the MRDPW shall receive all the documentation related to environmental management. The regular reports will be forwarded to the World Bank every six months.
### Institutional responsibilities for application of the impact mitigation measures and environmental monitoring for Luda Yana Dam

**During construction works**

<table>
<thead>
<tr>
<th>Responsibilities for impact mitigation and implementation of monitoring</th>
<th>Reporting (accountable person – accounting person – frequency)</th>
<th>Taking of decisions on monitoring implementation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRDPW (Employer) RIEW Pazardzhik REGIONAL INSPECTORATE ON HEALTH SAFETY AND CONTROL (RIHSC) MOEW (EEA) If needed – from the accredited laboratory</td>
<td>The construction supervision and RIEW, RIHSC (as per the Monitoring Plan) Construction supervision of MRDPW PIU with MRDPW to the Bank (every six months)</td>
<td>Implementation of measures for impact mitigation and implementation of monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contractor Construction supervision Employer (MRDPW) RIEW; RIHSC BD Iztochnobilomorski Region, Plovdiv</td>
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</table>
Institutional responsibilities for application of the impact mitigation measures and environmental monitoring for Luda Yana Dam

During the operation phase

<table>
<thead>
<tr>
<th>Responsibilities for impact mitigation and implementation of monitoring</th>
<th>Reporting (accountable person to accounting person – frequency)</th>
<th>Taking of decisions on monitoring implementation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIK-P EOOD Panagurishte RIEW Pazardzhik BD Iztokhobelomorski Region, Plovdiv</td>
<td>VIK-P EOOD Panagurishte RIEW Pazardzhik BD Iztokhobelomorski Region, Plovdiv as per the monitoring plan</td>
<td>Implementation of measures for impact mitigation and implementation of monitoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VIK-P EOOD Panagurishte RIEW Pazardzhik RIHSC BD Iztokhobelomorski Region, Plovdiv</td>
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</table>

Environmental management is performed by the competent institutions, i.e. MOEW, BD, and EEA to MOEW, RIEW, and RIHSC. The procedure for development, evaluation and acceptance of EIA, as well as control on the implementation of adopted decisions in Bulgaria are regulated by law and are observed strictly. They are harmonized with the European directives. The MOEW comprises a Directorate on “Prevention Activities” and a line deputy minister, while RIEW comprise departments on “Prevention Activities”. The authority of the above-mentioned bodies, and their actual activities show their professional competence. There have been many cases in which they have rejected EIAs or have returned them for a rework, they have imposed sanctions, suspended construction works and operation of sites because of failure to implement their decisions, and they have withdrawn rights under EIA in case of failed deadlines. Competent authorities cooperate actively with the municipalities, and through them with the population and the NGOs. The mayors of municipalities affected by the investment proposal and representatives of NGOs are members of the Expert environmental councils for consideration of EIA.

Control on use of water and water facilities, as per the decision for water intake and use of a water facility, is under the competences of the BD.

Competent bodies have difficulties in securing personnel due to their difficulties to secure the relevant payment.

At local level recruitment of personnel for implementation of the Environmental Management Plans and Monitoring Plans is competitive. All employees within the system are subject to annual training at national or local level. Once per year the knowledge and skills of the operational personnel is checked and they get ‘no objection’ to proceed with the implementation of their tasks at work. At local level there are also certain problems with payments to direct contractors. Staff responsible for environmental operation of dams and other facilities gradually makes their way into the management of water supply systems.

Thanks to state financing and support under EU programs, EEA and RIEW have been equipped with modern devices for laboratory control on the status of environmental components and factors. EEA with MOEW has been accredited for performance of environmental monitoring at national level. An annual Bulletin is issued on the condition of all components.

IX. PUBLIC HEARINGS

Public hearings were carried out at the time of EA development. Namely: A public hearing was carried out on 18.10.2007 in the town of Panagurishte on the Municipal Infrastructure Development Project, including the Environmental Assessment for implementation of the requirements for to this procedure (public notification was posted at the town hall and in the local medial). The attendants raised the following issues: eventual climatic changes, operational safety of the water supply system, risk of water level reduction in the water supply boreholes of Optikoelektron. The team provided answers to all questions asked.
The public supports the construction of Luda Yana Dam because of the urgent need to secure normal water supply in the municipalities of Panagurishte, Pazardzhik and Strelcha. During summer low water period the municipalities are on water supply rationing, and during spring and autumn high water the water is of poor quality. The water pumped from the terrace of the Maritsa river comes from a system that has been in operation for 20 years and features frequent bursts and high water cost. The town has potential for development of recreational and traditional tourism, however that is not possible without a steady quantity of drinking and sanitation water.

Consultations have been made with the administrative and competent authorities:

1. RIEW – Pazardzhik.
2. Municipality of Panagurishte – meeting with Georgi Gerginekov, mayor of Panagurishte who on behalf of the municipality expressed the support of the population for the completion of the dam and its foremost importance for the water supply of the municipality and its economic development. (Appendix: Opinion).
3. VIK –P EOOD Panagurishte – At a meeting with the manager eng. G.Lulchev it was established that in 2000 an EIAS was developed for Luda Yana and a public hearing was carried out in the town of Panagurishte where no objections had been raised by the public. After its submission to the MOEW it was returned to be included in a Report for the DWTP that was not designed. No final decision has been issued by a competent authority. (Appendix: Opinion of VIK –P EOOD – Panagurishte.

The Environmental Assessment of 2007 was submitted to Panagurishte municipality for a detailed presentation to the community. Board notifications and announcements in the local media secured access to the document. VIK- P EOOD - Panagurishte, in their capacity of a future operator, have published it on their web site.

A national public hearing on the project, including the Environmental Assessment, attended by media and NGOs took place on December 12, 2007 at the MRDPW. There have been no comments and recommendations to the Environmental Assessment that has been published on the web site of MRDPW within the deadline stipulated by law.

The recommendations made during the consultations and hearings have been reflected in the EIAS.

As a result of the status evaluation and the envisaged insignificant environmental impact during the construction completion phase and future operation of Luda Yana Dam, in view of the social significance and improvement of the health and sanitary conditions in the maunicipality of Panagurishte, it is considered that the completion of Luda Yana Dam is imperative.
### Abbreviations used

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<tbody>
<tr>
<td>1.</td>
<td>AIM</td>
<td>Archaeological Institute and Museum</td>
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<td>2.</td>
<td>BAN</td>
<td>Bulgarian Academy of Sciences</td>
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<tr>
<td>3.</td>
<td>BD</td>
<td>Basin Directorate</td>
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<td>4.</td>
<td>VIK</td>
<td>Water supply and sewerage company</td>
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<td>5.</td>
<td>EU</td>
<td>European Union</td>
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<tr>
<td>6.</td>
<td>EEC</td>
<td>Expert Environmental Council</td>
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<td>7.</td>
<td>EPA</td>
<td>Environmental Protection Act</td>
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<tr>
<td>8.</td>
<td>EEA</td>
<td>Environmental Executive Agency</td>
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<td>9.</td>
<td>IWI</td>
<td>Institute on Water Issues</td>
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<td>10.</td>
<td>IPP</td>
<td>Institute for research and design</td>
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<tr>
<td>11.</td>
<td>MRDPW</td>
<td>Ministry of Regional Development and Public Works</td>
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<td>12.</td>
<td>MOEW</td>
<td>Ministry of Environment and Water</td>
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<td>13.</td>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>14.</td>
<td>NGO</td>
<td>Non Government Organizations</td>
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<td>15.</td>
<td>ALV</td>
<td>Admissible limit values</td>
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<td>16.</td>
<td>DWTP</td>
<td>Drinking water treatment plant</td>
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<tr>
<td>17.</td>
<td>RIEW</td>
<td>Regional Inspectorate of Environment and Water</td>
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<td>18.</td>
<td>RIHSC</td>
<td>Regional Inspectorate on Health Safety and Control</td>
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<td>19.</td>
<td>WSS</td>
<td>Water supply system</td>
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<td>20.</td>
<td>CMS</td>
<td>Central measuring station</td>
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<td>21.</td>
<td>KOPS</td>
<td>Committee for Environmental Protection</td>
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<td>22.</td>
<td>BCA</td>
<td>Bulletin for Construction and Architecture</td>
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<td>23.</td>
<td>UF</td>
<td>University of Forestry</td>
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<td>24.</td>
<td>UASG</td>
<td>University of Construction, Architecture and Geodesy</td>
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## Methodologies and Sources Used in the Environment Impact Assessment Statement

<table>
<thead>
<tr>
<th></th>
<th>Methodology or Source</th>
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<tr>
<td>3</td>
<td>Methodology for balance computation of pollutants released in the atmosphere, 2000</td>
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<td>6</td>
<td>Euro-3 EU standards for emissions of harmful substances emitted by motor transports</td>
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<td>7</td>
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<td>Anna Tzenkova, Meteorological investigation around the mountain reservoir. 24&quot; International Conference on Alpine Meteorology (ICAM 1996), Bled, Slovenia, 9-13 September 1996</td>
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<td>13</td>
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<td>14</td>
<td>Beshkov V. 1972 Item III Examinations on ecology and distribution XXXVI 125-136</td>
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<td>17.</td>
<td>Beshkov B., K.Nanev 2002 Amphibians and reptiles in Bulgaria, Pensoft cc 1-120</td>
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<td>25.</td>
<td>National plan for protection of bio diversity, 2000, MOEW.</td>
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### Regulations

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<td>2.</td>
<td>Water Act (SG No.67/01.09.1999 – amended and supplemented as of 70/20087)</td>
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<td>3.</td>
<td>Biological Diversity Act (SG No.77/09.08.2002 amended and supplemented as of No.94/2007)</td>
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<td>9.</td>
<td>Act on the Cleanliness of Ambient Air (SG No 45/1996…..No 105/2006);</td>
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<td>12.</td>
<td>Order No RD-272/03.05.2001 for classification of surface waters in water sites or parts thereof – MOEW.</td>
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<td>13.</td>
<td>CoM Decision 122 of 02.03.2007 for acceptance of a list of protected areas for wild bird conservation and list of protected areas for conservation of nature habitats of wild flora and fauna.</td>
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<td>15.</td>
<td>Ordinance No 13/2004 on the terms and conditions for technical operation of dam walls and accompanying facilities thereto – MOEW, MH, MRDPW.</td>
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<td>17.</td>
<td>Ordinance No 3/16.10.2000 of MOEW, MH and MRDPW on the terms and conditions for investigation, design, approval and operation of sanitary protection zones around water reservoirs and facilities for drinking water supply and around mineral water sources used for medicinal, prophylactic, drinking and sanitation purposes.</td>
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<td>18.</td>
<td>Ordinance No 5/08.11.2000 of MOEW on the terms and conditions for creation and functioning of the National system for water monitoring</td>
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<td>19.</td>
<td>Ordinance No 10/03.07.2001 of MOEW for issuance of permits for discharge of wastewater in water bodies and determination of individual emission limits at point sources of pollution.</td>
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<td>Ordinance No26/01.10.1996 (amended and supplemented as of 2007) for remediation of impaired areas, upgrading of low productivity lands and utilization of the humus layer.</td>
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<td>25.</td>
<td>Standards for sizing of embankment dam walls 1986, BSA books 1 and 6</td>
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<td>Standards for loading and impacts of hydrotechnical facilities due to waves, ice and vessels (1988)</td>
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10. Opinions and minutes of meetings held in Panagurishte municipality, and VIK EOOD Panagurishte
LUDA YANA DAM DESIGNS

1. **Feasibility studies** – Institute for Research and Design (IPP) VODPROEKT SOFIA – 1982 – in 3 volumes

2. **Design for Luda Yana Dam** – IPP VODPROEKT SOFIA – 1984 – in 16 volumes


4. **Final EIA Statement on Luda Yana Dam** – 2000, without implementation of the procedure;

5. **Results from water sample analysis performed by independent experts on request of VodosnabditeLEN complex OOD PANAGURISHTE**

6. **Comprehensive feasibility study on continuation and completion of construction works for Luda Yana Dam town of Panagurishte** – 7 volumes, February 2007 - ENERGOPROEKT– HYDROENERGETIKA OOD, SOFIA