TERMS OF REFERENCE
INDEPENDENT DAM SAFETY REVIEW
FOR EXISTING DAMS

Background

The Sava and Drina Rivers Corridors Integrated Development Program (SDIP) Phase I supports integrated water cooperation through investment in infrastructure improvements and complementary measures that take into account the current and expected impacts of climate change. Specifically, the Project intends to address the climate change risk of floods and droughts, thus increasing the resilience of the targeted areas, ensuring economic development. Broadly, SDIP will invest in the following areas:

- Inland waterway transport. (Upgrading of the navigability of the Sava waterway);
- Environmental asset management and development;
- Flood protection. (Investments to increase flood protection and social and economic resilience to extreme weather events linked to climate change);
- Regional cooperation and institutional strengthening.

Objectives of the Project

Wider objective
SDIP's focus on transboundary inland waterway freight transport, flood protection, and river basin management at the regional level addresses complementary dimensions of integration.

PDO Statement
The Program Development Objective (PDO) is to strengthen transboundary water cooperation and improve navigability and flood protection in the Sava and Drina Rivers Corridors. (Phase I of the Program).

This objective will be achieved through the following components:

- Component 1: Integrated Management and Development of the Sava River Corridor
- Component 2: Integrated Management and Development of the Drina River Corridor
- Component 3: Project Preparation and Management
- Component 4: Regional Activities

In accordance with the rules of procedure of the World Bank, and in particular the application of the relevant provisions of the Environmental and Social Framework (ESF), but also with the rules of use in terms of environmental protection and the safety of dams, this project in its preparation phase must be the subject of a study aimed at improving the safety of people, property and the environment downstream of Modrac Dam.

The Bank is therefore seeking the services of a dam safety specialist (hereafter Consultant) to review the existing rehabilitation design documentation and perform an inspection and review the safety of Modrac Dam and its appurtenant structures works in order to meet the requirements of the World Bank in terms of protection of environment and dam safety (reference: Environmental and Social Standard No. 4 (ESS No. 4): Population Health and Safety, and its Annex 1 on Dam Safety). In addition to ESF/ESS4-Annex 1, the Bank's Good Practice Note on dam safety (GPN) should be referred to, which is designed to enhance the quality of practice without creating new requirements for the application of the ESF. Annex 6 of the GPN defines the scope of services and expected results.

Completion of the rehabilitation of the Modrac Dam on the Spreča River is planned as part of the current World Bank funded project, which would complete rehabilitation and finalize the work on

the three previous phases completed so far. Work is planned on the vaults: 5, 4, and 3 (four consoles and three vaults), and with certain beams and aprons associated with the overflow section. Based on the analysis of the data obtained by observing the dam during exploitation, it was determined that remedial measures are necessary for this facility, which would establish a functional facility in terms of its safety, stability, and water sustainability.

Description of Modrac Dam

The Modrac Dam was built in 1964. in the Modrac settlement in the Lukavac municipality, at a distance of about 2.0 km from the Lukavac settlement. The dam facility itself is geographically located at 18o 30' 55'' east longitude (from Greenwich) and 44o 30' 40'' north latitude, at an altitude of 177.50 m.a.s.l. up to 205.00 m.a.s.l. The strait in which the dam is located and the valley of the rivers Spreča and Turija upstream of it form a morphological complex that is extremely favorable for the creation of a large reservoir. Lake Modrac is the largest reservoir in Bosnia and Herzegovina, which contains almost 100 million m3 of water and is located in the northeastern part of Bosnia and Herzegovina.

The priority purposes of Modrac Dam accumulation are as follows:
- drinking water supply for Tuzla Town and the municipality of Lukavac,
- providing technical water for the business operators' capacities in Tuzla and Lukavac,
- providing minimum water quantities (hydrobiology) is being used for dilution of wastewater being discharged to the Spreča River downstream from the dam.

Modrac accumulation inter alia provides as follows:
- Providing flood attenuation by laminating flows in the reservoir thus retention effect and preventing or significant decrease in floods in Spreča River valley downstream from the dam,
- increase in the minimum water flow of the Spreča River downstream from the dam in periods of drought,
- electric power production in a mini hydroelectric power plant Modrac, using the surplus of available quantities in Modrac profile,
- tourism, recreation, water sports, etc., with certain limitations resulting from listed priority purposes.

Dam Technical Characteristics

Modrac dam is a multi-reinforced concrete arched dam. It has 10 arched sections (including three acting as a spillway section). The maximum height of the dam is quoted as 33.35m, it has a total length of approximately 205m and a total reservoir volume estimated at 103Mm^3 (gross). It is therefore considered a 'large' dam by its technical characteristics and volume, as per the definition of the International Commission on Large Dams (ICOLD).

Multiple arch cylindrical dam consisting of 10 arches – cylindrical shells, 9 buttresses and 2 abutments (concrete gravitational parts) at the left and right riverbank. In the gravitational block at the left bank is the opening with diameter of 5.0 m that is closed with concrete cupola. At the entrance level of opening axis is 195.50 and at the exit 192.50.
Dam has three (3) free spillways (areas 6, 7 and 8), 2 at the level 200.00, and 1 at the 199.90. There are 2 water intakes with diameter of ø1900 in buttress number 2. Intake axis are at the level 190.00 that is 196.50. At the entrance of intake are the auxiliary plate gates. Directly downstream from buttress number 2 there is Howell-Bunger valve operation control facility with a mini power plant of installed power P=1825.00 kW, and installed flow Q=15.0 m3/sec with “net fall” of 14.0 m.

Outlets pass through the buttresses 6, 7, and 8. Diameter of outlet pipes is ø1700 and its axis are at the level 186.50. Auxiliary plate gates are located at the outlet pipe entrance, and the main valves, the Howell-Bunger valves, are located at the end.

Figure 1: Modrac Dam (taken from Google Earth)

TECHNICAL SPECIFICATION

-	dam crown bridge level	205.50 m
-	arch crown and level	205.50 m
-	dam foundation level (min)	177.50 m
-	construction height	27.50 m
-	length in crown	191.00 m
-	buttress axis distance	16.0, 16.60 i 17.00 m
-	buttress diameter in foundation (max)	3.00 m
-	buttress diameter in crown	1.40 m
-	arch shell diameter (up to level 184.00)	0.50 m
-	arch shell diameter (from 184.00 to 205.0)	0.40 m
-	half diameter of arch shell	8.92 m
-	arch central angle	120º
-	accumulation total volume at the level 200.00	100 000 000 m3
-	accumulation total volume at the level 203.00	166 000 000 m3
-	maximum accumulation level	203.00 m
-	accumulation surface at the level 200.00	1700.00 ha
-	accumulation surface at the level 203.00	2250.00 ha
-	spillway level	200.00 (199.90) m
-	spillway capacity at the level 203.00	3 x 100.00 m3/sec
-	outlet capacity for the level 200.00	3 x 25.0 m3/sec

Information available on Modrac Dam

The Modrac Dam was built in the Modrac settlement in the Lukavac municipality, about 2.0 km from the Lukavac settlement. The dam facility itself is geographically located at 18o 30' 55'' east longitude (from Greenwich) and 44o 30' 40'' north latitude, at an altitude of 177.50 m.a.s.l. up to 205.00 m.a.s.l. The strait in which the dam is located and the valley of the rivers Spreča and Turija upstream form a morphological complex that is extremely favorable for the creation of a large reservoir.

In May 2014, Modrac was subject to its largest flood on record, peaking in terms of outflow at approximately 1137 m³/s with a peak inflow of 1602 m³/s, and the highest water level in the dam was identified as 203,42 m above sea level, with water height on the spillway of 3.42 m.

Based on data analysis obtained during observation of dam exploitation in the period 1995-2000, the necessity of rehabilitation measures on this facility was concluded, in such a manner to set up the functional facility in terms of its stability and water sustainability.

In this sense, the solution proposed by the company "Energoinvest" - Sector HIGRA, Sarajevo, proved to be the most rational. The main project was revised in July 2005 by an expert commission, and in February 2008, a decision was obtained - approval for construction.

In the period from 2009 to 2011, Energoinvest-Energoinženjering Higra Sarajevo carried out the "Executive project for the rehabilitation of the dam "Modrac". The rehabilitation project of the "Modrac" dam envisages the creation of reinforced concrete vaults from the inside of the existing vaults. A plastic foil (geomembrane) is placed between the new and existing vaults. The new vaults rest on corbels that are added to the existing buttresses. The chosen rehabilitation method keeps the "acquired" structural system elastic. Also, the rehabilitation method allows rehabilitation to be carried out in several stages and without special conditions. The rehabilitation is done from the outside of the dam (toward the river Spreča), and it is not necessary to empty the Modrac reservoir.

In line with the main design, rehabilitation will be conducted in 4 phases. The following works have been completed to the present:

Phase I (arches 1 and 2 and a portion of arch 3 – works completed in 2009);
Phase II (arches 10 and 9 and a portion of arch 8 – works completed in 2011), and
Phase III (arches 6, 7, and 8 - works completed in 2015);
The designer defines the arches rehabilitation sequence.

The project proposed Phase IV, which would complete the rehabilitation of the dam. Works on arches 5, 4, and 3 have been planned (4 consoles and 3 arches).

The rehabilitation of the "Modrac" dam began in April 2008 and was stopped at the end of 2015 due to a lack of financial resources. Three phases of rehabilitation have been completed so far, and the fourth phase consiting of three arches and associated cross beams will be implemented once the financial structure is finalized.

In addition, there are also planned works to improve the existing beams located underneath the spillway apron slab.

Drawings

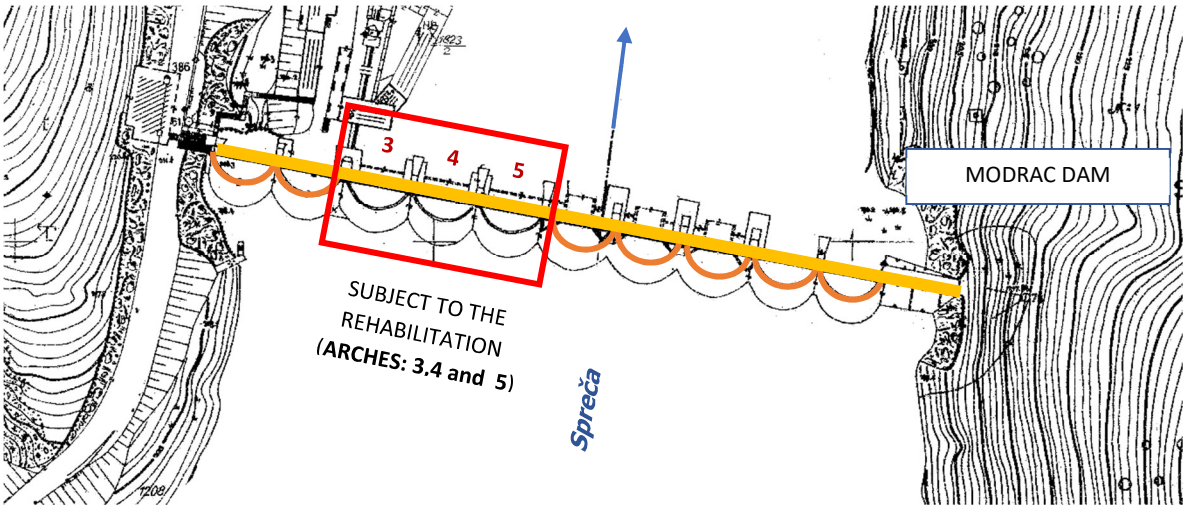

Figure 2: Modrac Dam Rehabilitation (Ground Plan/Situation)

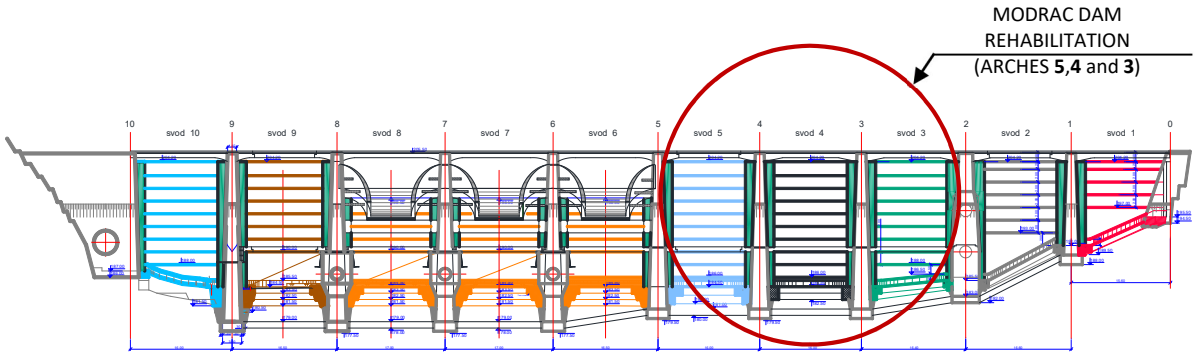

Figure 3: Modrac Dam Rehabilitation (downstream view)

Legislative context:

1. Dam operator: Public Company JP Spreča d.d Tuzla, Alije Izetbegovića 29/VII, Tuzla;
2. The operator JP Spreča currently arranges for the independent inspection/ monitoring of the dam on a six-month basis, with an initial high-level report and a more detailed annual report. These include some suggestions that the operator should follow in order to get their water license every five years. Reports are provided to the Canton.

Project documentation/project information:

a) Recent documents:

- Environment and social management plan (ESMP) - for sub-project Renovation of Modrac Dam - phase IV, February, 2025;
- Modrac Dam Safety Report, September 2023, (JP "Spreča", d.d. Tuzla);

b) Technical information & Design:

- Rehabilitation of the Modrac Dam, Book 4. Actualization of rehabilitation, amended implementation project, Volume 4.4. Rehabilitation (strengthening) of beams under overflow fields 6, 7, and 8, June 2023.
- Revised and amended Executive Project for the rehabilitation of the Modrac Dam, - Rehabilitation of vaults 5,4 and 3 (Book 4, Volume: 4.1, 4.2, 4.3), Energoinvest - Energoinženjering / HIGRA, Sarajevo, December 2021;

- Renovation of the Modrac Dam, revised executive project, Volume 4.1. Formwork and reinforcement plans, Energoinvest - Energoinženjering, December 2021.
- Independent Design Review (with technical monitoring method), Energoinvest - Energoinženjering / HIGRA, Sarajevo, April 2008;

Recent documents about the Modrac Dam's rehabilitation are mentioned in the text above. Annex B contains a comprehensive list of all available legal and technical documents as well as relevant studies.

List of relevant and available documentation – Annex B

Objective of the mission

The objective of the mission is twofold:

Firstly, to perform an inspection and assess the safety condition of Modrac dam and its appurtenant structures (spillway, outlet works, monitoring system, ...) in order to ensure their good operating conditions, their long-term integrity and safety and, where applicable, to estimate the need for additional studies or remedial safety measures necessary to upgrade the dam to an acceptable standard of safety, considering the potential risk of the dam and urgency of interventions.

Secondly, the Consultant shall provide comments, if any, on the proposed rehabilitation work. The review shall include both the arch rehabilitation elements and the overflow section beam repairs.

Specifically, the Consultant shall:

a) Review proposed design for rehabilitation works, as well other relevant technical document and reports, including geological reports, design or as-built drawings, and, if available, construction records, materials strength parameters and stability analysis.

b) Assess the safety condition of the dam and associated structures as well as their operational status / procedure in accordance with the national standards and international guidelines and practices;

c) Assess the overall risk of the dam and required remedial works, considering potential failure modes, consequences, and urgency of implementation; and

d) Prepare a dam safety assessment report, including any safety issues, potential risks, and recommendations for remedial works and safety improvement measures, covering both structural and nonstructural elements along with their conceptual design and preliminary cost and time estimates.

e) Provide comments if any, on the proposed rehabilitation works. It is noted that the original overall design concept was subject to an independent review in 2008, the Consultant shall familiarize themselves with this independent review, the original dam stability analysis and key design documents as part of the review.

f) Draw up technical specifications for the additional studies and investigations required to improve knowledge of the dam's current safety conditions.

Detailed Scope of the Assignment

The mission of the Consultant will consist in verifying the conformity of Modrac Dam with ESS4-Annex 1, which deals with the safety of dams but also in compliance with Annex 6 of the GPN and will include, but not limited to the following tasks (Tier 1):

a) Meet with the representatives and technical staff of the dam owner or operator to discuss the safety condition and the operation and maintenance (O&M) status or plan, including surveillance, monitoring, and contingency procedures.

b) Review the dam safety inspection and periodic safety review reports performed by the dam owner or other entities, if any, and check the quality of the reports based on the expert's own site visit and field inspection.

c) Review available design reports, design or as-built drawings, and, if available, construction records, including geological reports, foundation investigations, materials testing, materials strength parameters, and stability analysis.

d) Review recent O&M records and instrumentation monitoring records, such as reservoir level, inflow and outflow volume, spillway discharge volume, seepage volume, settlement, and so on.

e) Review available data and records of surveillance and monitoring instruments and analytical results of monitoring data, if any, and check their quality, trends, and anomalies.

f) If major deficiencies arise regarding basic surveillance measures, issue an interim report to highlight the issues and indicate urgent remedial actions. This should be done on priority basis, before undertaking further assessments or in parallel with those, depending on the expert's judgment.

g) Review the criteria, methodology, and determination of the design flood, flood routing studies, and spillway sizing; check the spillway operation records; and evaluate the adequacy of the spillway capacity considering current and future conditions.

h) Conduct field inspection of the dam and associated structures, such as spillway, outlet structures, and gates or valves; water intake; saddle dam; control and monitoring instruments; and so on.

i) Apply checklists to appraise the safety condition of the dam and associated structures. Annexes A and B of Annex 6 of GPN provide examples of checklists that can be used as broad guidance which should be adapted to the specific case with due consideration to proportionality principles. The condition of each element on the checklist should be noted and categorized according to one of the following: satisfactory, fair, poor, or unsatisfactory. Additional explanations should be provided for categories that are poor or unsatisfactory, including general recommendations of required remedial and upgrading measures with preliminary cost estimates.

j) Assess the current operational procedures and conditions, including the Operation and Maintenance Plan (O&MP) or O&M Manual (including regular surveillance, instrumentation monitoring and data analysis, periodic inspection, flood forecasting, reservoir operation, sediment management, downstream warning, and so on) and Emergency Preparedness Plan, if available.

k) Assess the number, types, and functionality of monitoring equipment and needs for replacement and upgrading, including data acquisition, storage system, and procedures.

l) Assess the capacity of the dam owners and operators in terms of organizational structure, staffing, skills, budget, equipment, and facilities needed to operate and maintain the dam in a safe and sustainable manner.

m) Assess conditions of the catchment area, reservoir rim slope, and downstream areas, and provide expert opinion on potential effects on safety of dam and downstream communities.

n) Provide key findings of the overall safety condition of the dam and recommendations of required structural and nonstructural remedial measures. Prioritize the urgency based on the dam's potential risk, along with time and cost estimates.

o) Develop technical specifications for the additional studies and investigations needed to enhance understanding of the dam's current safety conditions. *(only if the need arises for these specifications).

Methodology

The Consultant is expected to apply best practice procedures in assessing the dam safety, including but not limited to: review of the existing documents, interviews with the staff in charge of O&M activities, direct observation of the dam and its appurtenance structures through field visits, and production of his report.

Duration and workload

The duration of the mission is set at two (**2**) months from the date of notification of the service order to start the mission.

The estimated workload is **25** man-days.

Organization

The consultant is expected to work in a highly interactive fashion with the team of Modrac Dam Operator, as well as other consultants and development partners. The Consultant's contract, reporting, and invoicing arrangement will be directly with the Federal Ministry of Agriculture, Water Management and Forestry - Project Implementation Team (PIT). The person of contact is Zoran Mićević (Email: info@piusum.ba).

The implementing agency of the project is the Project Implementation Team (PIT), which will ensure the strategic coordination of the Consultant's mission in close collaboration with the World Bank as part of the preparation of the Project. In this context, PIT is responsible for validating the deliverables. PIT will be the Consultant's interlocutor for all technical questions relating to the performance of the Consultant's services. He will ensure the conformity of the services provided by the Consultant with the terms of reference and will organize the process of validation of the deliverables in liaison with the World Bank.

Deliverables

The Consultant will prepare and submit the reports listed below in hard and electronic versions, in English.

No.	Report	Deadline	Number of copies
1	Draft Dam Safety Review Report (see sample table of contents in Appendix A)	**35** days from the date of signing the contract	electronic version
2	Final Dam Safety Review Report	**60** days from the date of signing the contract	4

All reports will be submitted to PIT, which will disseminate them to the relevant stakeholders. Comments will be provided within three **(3)** weeks of receipt of the draft report. A restitution workshop/video conference will be organized for the presentation of the draft report in the presence of PIT and Modrac Dam operator representatives.

Qualifications of the Consultant

The Consultant must hold a university degree in a relevant discipline (Civil, Hydraulic Engineering, or equivalent) and present a general experience of at least **20** years in the design, construction, and review of the safety of large dams.

His/Her specific experience should include:

a) Participation in the design and construction of at least three (**03**) large dams (height greater than 15 m);

b) The conduct of at least two (**02**) inspections and reviews of the safety of large dams;

c) Demonstrated experience in the design, construction or safety review of arch concrete dams and/or buttress dams.

d) Detailed design and/or construction supervision experience in reinforced concrete.

e) Familiarity with internationally accepted dam safety guidelines, such as the International Commission on Large Dams (ICOLD) and so on.

f) Ability to communicate at a good level of proficiency in English;

g) The ability to read and communicate in local (Bosnian) would be desirable, as many of the existing documents are in the local language and untranslated.

Documents to be consulted

- Environmental and Social Framework (ESF): https://www.worldbank.org/en/projects-operations/environmental-and-social-framework,

- Good Practice Note on dam safety (GPN)
https://openknowledge.worldbank.org/handle/10986/35484

ANNEX A

Independent dam safety inspection and assessment report - A sample Table of contents

In order to follow para 8 of Annex 1 of ESF/ESS4, the GPN on Dam Safety has provided sample TORs for independent safety assessment of existing dams in Appendix 6. In particular, the Appendix includes the report template as: i) Annex A: Sample Sheet for Dam Safety Data and Items, and ii) Annex B: Dam Safety Inspection Form. These should be the basis for the dam safety inspection/assessment required by OP4.37 and ESF/ESS4/Annex 1, which may be tailored to each country / project / dam context.

The following is a sample table of contents, representing the essential elements of a comprehensive dam safety assessment. Contents may be more extensive, depending on complexity and level of risk of the project.

1. Executive summary
2. Context and objectives of the dam safety inspection and assessment
3. Description of the project structures
   - 3.1. Location and purpose
   - 3.2. Description of the dam and appurtenances
   - 3.3. Summary of operations (normal reservoir operations, flood operations, reservoir sedimentation and sediment management)
   - 3.4. Hydrology
   - 3.5. Geology and geotechnical aspects
   - 3.6. Seismic hazards
   - 3.7. Hydraulic structures and O&M status (including electro-mechanical equipment)
   - 3.8. Dam risk classification (likelihood of failure and consequence)
4. Reference material
   - 4.1. Legislation, regulation, standard and national/international practice
   - 4.2. Design and construction documents, geotechnical investigation report/data, as-built drawings
   - 4.3. O&M records
   - 4.4. Instrumentation arrangement and monitoring records
   - 4.5. Special rehabilitation /refurbishment records / reports
   - 4.6. Dam safety inspection and periodic safety review reports
   - 4.7. Dam safety plans availability and application
5. Review of prior reports
   - 5.1. Review and evaluation of design basis and construction
   - 5.2. Review and evaluation of previous analyses
   - 5.3. Review and evaluation of instrumentation data and surveillance reports
   - 5.4. Review and evaluation of the dam safety inspection and periodic safety review reports

5.5. Review and evaluation of the dam safety plans

5.6. Conclusion

6. Inspection and assessment of the dam and appurtenances

6.1. General

6.2. Field inspection observations

6.3. Evaluation of the dam /appurtenant structures behavior and performance

6.4. Consideration to potential failure modes

6.5. Conclusion

7. Findings and recommendations

7.1. Review and evaluation of prior reports and analyses

7.2. General conditions and evaluation of the performance of the dam and appurtenances

7.3. Review and evaluation of the dam safety plans

7.4. Assessment of the capacity of the dam owner to operate and maintain the dam

7.5. Conclusion and Recommendations - required remedial measures with their priorities and needs for additional investigation, study, etc. if any, incl. preliminary time and cost estimates.

ANNEX B
List of relevant and available documentation

a) Legislative documents:

1. Decision on the declaration of the reservoir "Modrac" as a public good (Official Gazette of the Tuzla Canton, number: 09/03);
2. The concession agreement for the use of water from the hydro accumulation "Modrac" concluded on: March 30, 2006;
3. Decision on urban planning approval No.: 12-04/04-23568/06, October 9, 2007;
4. Plot data and land registry extract for the subject plot: J-I, October 18, 2007;
5. Decision on water management consent for rehabilitation works at the Modrac Dam facility, October 29, 2007;
6. A decision regarding approval for construction - execution of rehabilitation works for the Modrac dam facility, No: 12-04-/1-23-30/08, February 28, 2008;

b) Design and technical documentation:

1. Main Design for rehabilitation of Modrac Dam (complete dam facility), 2005, Energonivest - Energoinženjering / HIGRA, Sarajevo;
   Book 1- Bill of quantities, August 2003,
   Book 2 - Formwork Plans, August 2003
   Book 3 - Reinforcement Plans, December 2005,
   Book 4 - Project of technical monitoring of the Modrac dam, May 2006
2. Minutes of the commission for the revision of the project documentation for the repaired condition, May 25, 2006;
3. Report on the revision of project documentation for the Main Modrac Dam rehabilitation project, April 12, 2006;
4. Expert opinion on the geological characteristics of the terrain, and general geological conditions for the rehabilitation of the Modrac Dam, May 2007, "EARTH" d.o.o., Tuzla;
5. Independent Design Review (with technical monitoring method), Energoinvest - Energoinženjering / HIGRA, Sarajevo, April 2008;
6. Revised and amended Executive Project for the rehabilitation of the Modrac dam, - Rehabilitation of vaults 5,4 and 3 (Book 4, Volume: 4.1, 4.2, 4.3), Energoinvest – Energoinženjering / HIGRA, Sarajevo, December 2021;
7. Renovation of the Modrac Dam, Revised Executive Project, Volume 4.1. Formwork and reinforcement plans, Energoinvest - Energoinženjering/ HIGRA, December 2021.
8. Minutes with comments after the visit and inspection of the Modrac dam, March 23, 2023 / designer: Mirza Pašić;
9. Actualization of rehabilitation/Amended Executive project for the rehabilitation of the Modrac Dam / Energoinvest - Energoinženjering (Book 4. volume 4.4 Rehabilitation/strengthening of beams under overflow fields 6,7 and 8), June 2023;

c) Documentation related to the Dam safety assessment:

1. Stability Control Calculation of the Modrac Dam with 3D finite element model (for the entire dam); Energoinvest – Energoinženjering / HIGRA, Sarajevo, February 2000;
2. Operation and Maintenance Plan of the Modrac Dam & reservoir, JP Spreča, November 2023;
3. Rulebook on maintenance, use, and monitoring of facilities & equipment of the multipurpose water management system "Modrac", JP Spreča, January 2022;
4. Protection and Rescue plan from natural and other disasters;
5. Emergency Preparedness Plan that includes:
   5.1 Regulations on Fire Protection,

5.2. Fire Protection Plan,
5.3. Regulations on occupational safety,
5.4. Evacuation plan,

6. Monitoring;
   6.1. Technical Observation Project, 2022/2023;
   6.2. Project task (TOR) - technical inspection of the dam;
7. Modrac Dam safety report, September 2023, (JP “Spreča“, d.d. Tuzla);

- All the above-mentioned documents are available for inspection at the operator of the Modrac Dam (JP Spreča), as well as other relevant documentation that is deemed necessary for the completion of this task.