TERMS OF REFERENCE

Consultancy for Design of an Early Warning System (EWS) for the Kariba Dam and its downstream extending to border with Mozambique AND Supervision for the EWS Equipment Supply, Customization, Installation, Training and Commissioning.

10th March 2023

Background of the Kariba Dam

The Kariba Dam is a double curvature concrete arch dam located at 16°31′18″S 28°45′41″E in the Kariba Gorge of the Zambezi River Basin between Zambia and Zimbabwe, with a maximum height of 128m and a crest length of 617m. The dam was constructed across the Zambezi River between 1956 and 1959 and is the second largest hydro-electric scheme by installed capacity on the Zambezi River Basin, after the Cahora Bassa complex situated downstream in Mozambique. The dam forms Lake Kariba, which extends for about 280 kilometres and holds 181 billion cubic metres of water at full capacity. The following figure shows a layout of the Kariba Dam and Lake Kariba.

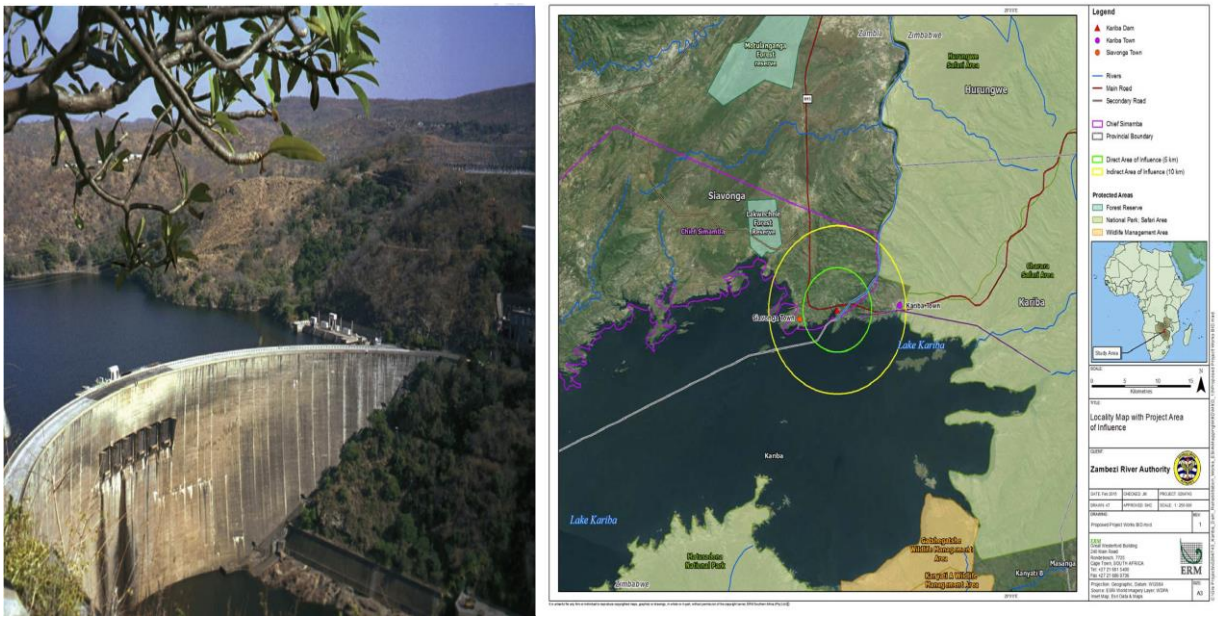

Figure 1.1 Kariba Dam and Lake Kariba

The minimum operating level of the reservoir for electricity generation is +475.5m. The spillway comprises six submerged flood sluices located on the central part of the dam wall, with a lower level of +455.37m above sea level. The maximum discharge capacity of the dam's spillway is approximately 9,000 m^3/s. The highest recorded discharge through the dam was 7,300m^3/s in 1978 with a combined outflow through the spillway (four gates open) and power stations. The active storage up to the Full Supply Level of +488.5m is 64.5 km^3. This includes 23.2 km^3 of flood control capacity that must be made available at the beginning of each flood season (during the months of February to April) to assist with flood attenuation.

The Zambezi River is Southern Africa's longest trans-boundary river, the Zambezi, rises at 1,585 metres above sea level in north-western Zambia. The river flows for some 2,700km through plains, gorges, rapids and cataracts before spreading out as it enters the Indian Ocean in the East Coast of Mozambique. The river carries more than 75% of the mean annual runoff of the region's interior and drains more than 40% of the landmass. It is the fourth largest river basin of Africa, after the Congo, the Nile and the Niger basins. The basin covers some 1.3 million square kilometres spread over eight countries, namely Zambia (40.7%), Angola (18.2%), Zimbabwe (18.0%), Mozambique (11.4%), Malawi (7.7%), Botswana (2.8%), Tanzania (2.0%) and Namibia (1.2%). Almost 33% of the total population of the riparian countries lives in the basin. The Zambezi catchment lies in a tropical region with three distinct seasons. The normal hot and wet season starts in November and ends in April. After April, dwindling amounts of rainfall soon translates into a cool and dry season, which persists until July. The third season is the dry and hot period between August and October.

The hydrometric network used for the control of the day-to-day operations of the Kariba reservoir comprise of thirteen stations where water levels are monitored daily by the Zambezi River Authority (ZRA). Flow measurements are carried out at eight of these stations which include the Victoria Falls, one of the key stations on the Zambezi River. Coincidentally, the maximum flow recorded at Victoria Falls was during the early construction phase of Kariba Dam in March 1958 at 10,000 cubic metres per second. The lowest flows recorded to date at Victoria Falls were during the 1995/96 season which had an annual mean flow of 390 cubic metres per second, whereas the long term mean annual flow at Victoria Falls is 1,100 cubic metres per second.

Regarding risk assessment for the Kariba Dam, a Potential Failure Mode and Effect Analysis (PFMEA) was revised in January 2021 by ZRA with the assistance of Tractebel Engineering consulting firm with further support from various stakeholders that included the KDRP appointed Dam Safety Panel of Experts (DSPoE) and Experts from KDRP Financiers. The assessment identified and ranked potential modes through which the Kariba Dam could fail to effectively retain water resulting in uncontrolled water release downstream. The controls in place as well as adequacy and effectiveness of prevailing controls were considered during the PFMEA. Key potential failure modes that ranked high

include jamming of the gate (opening or closing) during maintenance operations, loss of abutment support for the arch dam on the south bank, extreme flood larger than expected leading to dam overtopping and failure to adhere to the Rule Curve among others. These failure modes could result in excessive uncontrolled water release resulting in corresponding degrees of inundation downstream. The EWS is thus key a precautionary approach to save lives and to mitigate on the potential socio-economic and environmental impact should such potential events occur.

Since the construction of Kariba Dam, controlled release of water by opening gates has over the years resulted in scouring of the plunge pool. The Plunge Pool has been gradually eroded towards the foundation of the Dam wall and if it remains unchecked, it could, with time, compromise the integrity of the foundation of the dam wall. This with the need to rehabilitate the spillway gates triggered the current Kariba Dam Rehabilitation Project (KDRP) whose objective is to ensure the long-term safety and reliability of the Dam and subsequently continued hydro power generation.

The Zambezi River Authority, with support from Mott McDonald Consulting firm of the United Kingdom, in 2020 completed the Dam Break Analysis study which identified communities and infrastructure at risk should there be a dam breach in any of the three basin categories as defined in the Dam Break Analysis report. The outcomes of this study together with the PFMEA results are key and should also be used to inform the design of the EWS.

1. Objective of the Early Warning System assignment

A scenario where the dam wall fails will release a flood event that is catastrophic resulting in a major loss of lives and adversely affecting approximately three million people; loss of livelihoods (socio-economic activities); damage to key infrastructure, environmental degradation; and a loss of main source of power to the region. Nonetheless, in the event of uncontrolled release of water from the Kariba dam, including a dam breach scenario, there is great potential of making a lifesaving difference for the people living, working or exposed to the immediate vicinity of the dam and more importantly the downstream communities. This life saving opportunity lies in the establishment of an Early Warning System (EWS) in line with the Authority's mandate and

values including the value on safety. An effective EWS enhances people's chances of evacuation in good time and shall, besides uncontrolled water release, also scope for controlled water release from spill gates opening, turbined water from the Power Stations at Kariba dam and catchment inflows into the Zambezi River downstream of the Kariba dam. Furthermore, in implementing the KDRP, development and implementation of the Emergency Preparedness Plan (EPP) has been one of the four (4) dam safety plans that the Project Implementing Agent was required to prepare in line with the World Bank Safeguard Policy on Safety of Dams (OP/BP 4.37) and one of the anticipated outputs of the Results Based Logical Frameworks of the Project Appraisal (AFDB).

The other three (3) plans (not for this consultancy but to be aligned with) include: (i) Plan for Construction Supervision and Quality Assurance, (ii) Instrumentation Plan, and (iii) Operation and Maintenance Plan. Zambezi River Authority intends to enhance and operationalize the EPP by having an Early Warning System installed so that in the event of high volumes of water released from the dam, whether controlled or uncontrolled, affected downstream communities would be timely alerted for action including evacuation as may be necessary. The EWS should completely cover community settlements and activity areas downstream of the Dam along and either side of the Zambezi River (in Zambia and Zimbabwe) to the border with Mozambique. The Consultant shall adopt results of the Dam Break Analysis study that are available with ZRA to adequately cover all communities that will be potentially impacted, activity areas and inundation areas. The water release scenarios other than the total dam breach scenario, though important and more relevant given their probabilities of occurrence, are not fully assessed. These include power generation discharge form the Power Stations at Kariba Dam and the discharge of the Spillway gates when opened to manage the reservoir levels as well as catchment inflows into the Zambezi River downstream of the Kariba dam. As such, corresponding inundation maps for these controlled scenarios are required for the downstream communities.

2. Scope of work

Establishment of the Early Warning System will be carried out in two stages: (i) Design of the EWS, followed by (ii) Installation and commissioning of the EWS. The scope of work under this Consultancy covers the design of the EWS and supervision of the installation works. Specifically, the scope is as follows:

i. Design the system and prepare detailed description with defined number, type, location, characteristics and operating requirements of the system's different components, and budget estimates to put the system in place.
ii. Propose appropriate procurement method and type of contract for the second phase with argumentation of pros and cons (For example, Goods /Non consulting services or IT Single Stage/One Envelope or IT Two Stage).
iii. Based on the decision regarding procurement method, prepare tender documents for procurement of equipment and software (with customization as may be required), including specifications and bill of quantities.
iv. Assist the Client (ZRA) in contracting out and negotiating the second contract for "Supply, Customization, Installation, Training and Commissioning of the Early Warning System". The scope includes assistance during evaluation and all associated tender process. Zambezi River Authority will however remain fully responsible for the procurement process.
v. Carryout supervision of installation works up to EWS commissioning stage.

All communities exposed under both uncontrolled and controlled release of water shall be effectively covered. On the Zambia side, the downstream communities to be covered by the EWS include, but are not limited to: Namomba, Chalokwa, Manyepa, Pambazana, Chirundu border post, Chiawa, Chitende, Hanunka and communities around Luangwa including Amoro, Chidada township, Ludaka, Kavalamanja. On the Zimbabwe side, the downstream communities include, but are not limited to Kariba, Chirundu, Mana Pools and Kanyemba. The tourism activities and settlements downstream including hotels and lodges, safari areas and wildlife authority camps shall also be covered by the EWS design downstream from Kariba Dam extending to the border with Mozambique on either side of the Zambezi River. The Consultant is required to conduct a verification exercise to confirm all communities, tourism activities, Safari areas and wildlife authorities' camps among other settlements and activities downstream are scoped and covered by the EWS installations for effective alerting during a flood related emergency.

The EWS design should incorporate the parameters outlined in the section that follows.

i. The EWS design should incorporate local alert systems using locally available resources and corresponding evacuation plans revised or established for each of the afore mentioned communities that fall within the geographical scope of the assignment.

ii. The EWS design shall cover communities on both sides of the Zambezi River downstream in Zambia and Zimbabwe. All communities with inundation risk in the event of flooding shall be scoped in the design to ensure the EWS provides for all the communities with inundation risk.

iii. The EWS design should consider all possible flow release scenarios covering maximum generation of the two power plants, minimum to maximum spilling through sluice gates and possible rapid fluctuations and other confluence-induced high flows downstream of the dam.

iv. The system should be robust enough to manage the worst-case scenario in terms of uncontrolled water release, which scenario is the total breach/break of the Kariba dam and the respective exposure and timing downstream. The total dam breach scenario along with controlled water release scenarios will guide the EWS design in the level of effort required for the work as well as the cost estimate for the design stage.

v. The Early Warning System design shall provide for the interaction with the Kariba Dam Operations and therefore, the Consultant must start with a review of salient features of Kariba Dam (including power stations) and existing dam safety monitoring systems/instruments to guarantee respective alignment of the design. The Consultant shall familiarise with the Kariba Dam, operations, dam surveillance, monitoring and the current rehabilitation works (KDRP) in progress to ensure alignment of the design of EWS with the Kariba dam facility.

vi. The Consultant shall carry out field surveys across the entire extent of the intended EWS coverage to come up with detailed design of the EWS complete with all specifications for instruments to be procured, customised and installed for the EWS. The EWS design shall be informed by the existing systems, always prioritising on enhancing the current alert systems by including local resources and networks (e.g. mobile phones, drones, megaphone mounted vehicles/cycles, etc). alert systems

and evacuation plans being used by downstream users shall be considered and where possible integrated in the EWS technology and features.

vii. The Authority (ZRA) shall provide the Consultant, for review, with available information including the last four (4) Kariba Dam 5-yearly inspection reports, the Kariba Dam Standard Operating Procedure (SOP), the ZRA Dam Break Analysis report, the Kariba Dam Monitoring Plan, the Dam's existing Emergency Response Plan / Emergency Preparedness Plan and the Kariba dam report on Potential Failure modes and Effects Analysis (PFMEA).

viii. The design shall include a review of existing flood routing and river hydrodynamic models. This is crucial in assessing the adequacy of the hydrometric system and identifying the critical location for any additional stations and parameters if required.

ix. The design shall specify points of EWS components' installation particularly targeting the communities likely to be inundated by flooding in case of dam breach and indeed any other flow release scenarios as per outputs of the Dam Break Analysis and Consultant's assessment following a site visit to physically appreciate the downstream stretch from Kariba dam to border with Mozambique where the EWS is to be installed.

x. An establishment of the correct tower location points along the river zone needs to be done by the Consultant along with installation specifications as informed by the established soil type, geology, terrain, wildlife and corridors among other parameters. This shall require a physical survey of the area. The design shall be reviewed against meeting the requirements of these ToRs, statutory requirements, ZRA Dam Safety plans and SOP, Risk Management and Mitigation principles as well as Good Industry International Practice.

xi. The design shall be reviewed by ZRA and its Cooperating Partners including the World Bank, AfDB and the Dam Safety Panel of Experts appointed under the Kariba Dam Rehabilitation Project. The design shall be accepted only after it meets the requirements and review comments by the reviewer parties. The provision for manual activation of the EWS shall be key in the design.

xii. The EWS functionality shall cover full geographical scope in a timely manner in the context of an emergency when the electricity supply grid is not available or is

disrupted (Battery system and/or Solar mechanisms among other options as may be acceptable to the ZRA on reliability and robustness basis)

xiii. The EWS electronic sirens shall be mounted on robust concrete anchored towers that can withstand potential impacts of storms, weather, wildlife, and other possible exposures. In respect of installations, the design shall be informed by geology, soil type, slope gradient, wildlife corridors and by community feedback in terms of materials with less exposure to vandalism and pilferage.

xiv. Electronic sirens to be placed at intervals that ensure all target audience (exposed communities) is covered on either side of the Zambezi River where communities and livelihood activities exist.

xv. The design should provide for installation of an EWS with a robust security system to prevent vandalism, interference, and theft. Protection of installations against wildlife shall also be ensured.

xvi. The design to ensure an EWS that gives the right mass notification, that commands audience to react according to the situation.

xvii. The installations and siren system should be corrosion protected, inherently and by means of canisters for the latter as applicable while maintenance, safety and accessibly should be enhanced.

xviii. Design to factor for robustness and redundancy to make the system highly reliable.

xix. Design should make monitoring data useful and intuitive, but data to be analysed and interpreted before an alarm is manually triggered. It should have proper and effective notifications and alarms including life voices.

xx. The design to incorporate the latest EWS technology including ICT technology that will allow for remote access, coordination, and monitoring of the EWS from all the Zambezi River Authority and Kariba Power utilities through smart gadgets.

xxi. The Consultant shall carry out all further analysis needed for controlled release of water incorporating power plant turbine release and spillway gates operations. All hydraulic simulations shall be carried with input data from the power plant operators and the ZRA for turbines discharge and spill gates operation respectively.

xxii. The Consultant shall identify and train on all necessary trainings to selected ZRA staff for effective long-term use and management of the EWS. The respective

training scope and plan shall form part of the offer and reviewed and agreed with ZRA during negotiations.

3.1 Review and updating of the available information.

The Consultant shall carryout a detailed review of the available information in terms of the previous dam break analysis and other project information which will be made available by the Authority. The Consultants will also assess the adequacy of existing hydrometric network used for the control of the day-to-day operations of the Kariba reservoir and propose the need for additional stations as may be necessary. All further studies deemed necessary for the sound design of the EWS shall be carried out by the Consultant. The EWS design shall require inundation maps, as informed by the water release simulation the Consultant shall undertake. The design shall require flood hazard/inundation mapping and safe zones to be established for each scenario as follows:

- Scenario for dam failure as contained in the Dam Break Report (to be provided by the ZRA))
- Scenario for power generation, gates opening, and catchment inflows all combined.
- Separate scenarios for power generation, gates opening and catchment inflows (given these may occur independently)

3.2 Assess the existing/establish Community emergency alert systems and evacuation plans.

The Consultant shall carry out a field based in-depth assessment of the various alert systems and evacuation plans currently existing in the communities. Where such is disintegrated or does not exist, the design shall incorporate these for integration with the EWS. Relevant disaster management agencies, community leaders and the selected community groups shall be interviewed to understand the current methods being used, preferences, existing gaps and proposed areas of enhancements. The assessment should also obtain feedback from the communities in terms of early warning components and alert systems that can be less exposed to community-based vandalism. This would greatly inform the design of the system that would stand a test of time.

3.3 Interfacing of the EWS with existing Dam Safety Monitoring system

To bolster the Safety and Security of the Dam through harnessing digital possibilities, the design of the EWS shall provide for:

- Interface the EWS with the existing dam monitoring system at the Kariba Dam.
- Ensure the system interacts with the status/behaviour of the dam, providing instant warning indoor, outdoor, and digitally informing all key staff and designated stakeholders. The alerted officials will be able to verify immediately and decide to manually trigger EWS to alert the downstream communities for action.
- Automation of the EWS to the existing dam monitoring system is required and monitoring data should be analyzed, interpreted and confirmed before manually triggering any alarm.
- Integrate life voice messages and pre-programmed tones for the better understanding of the situation before, during and after an emergency (inside, upstream or downstream of the dam). The pre-programmed messages shall be triggered manually following an alert and verification. The warning should break through potential roaring noise such as severe flooding, high wind and severe storm. Flashing lights synchronised with wailing siren is key and required.
- The design to provide for alternative manual activation of the EWS if a relevant emergency level is established.

3. Supervision for Supply, Customization, Installation, Training and Commissioning of the Equipment for the Early Warning System.

In close collaboration with ZRA, the Consultant shall supervise the overall implementation of the equipment supply, customization, installation, training and commissioning) of the EWS in accordance with the signed contract agreements. The duration of the second phase (implementation) of the contract will be determined at a later stage. ZRA will write to the Consultant, informing on the commencement date of the second phase of the contract. The services to be provided shall include but not necessarily limited to the following:

i. Advise and prepare documents relevant to the contract with the contractors (the Contract), including letter of acceptance for carrying out the Contract or part thereof.

ii. Examine and approve the Contractors' (design) proposals and (shop) drawings for compliance with the Contract (specifications). Also attend factory acceptance tests/ pre-shipment inspection for major equipment as may be required.

iii. Issue pre-shipment inspection certificate for major equipment.

iv. Undertake site supervision of Equipment customization, installation, training, testing and commissioning of the EWS project components.

v. Undertake site supervision of excavation and blasting works as may be required,

vi. Prepare detailed site reports, certified by the site Engineer, during the continuation of the Contract. The reports shall include on site/off site activities, weather conditions, ground and traffic conditions, number of staff on site, records of visitors to the site, construction materials delivered, plants or equipment used or idling at site, daily works recording, quality inspections, encumbrances causing delays, photographic and video recording of important activities at factory and or site, etc.

vii. Monitor the progress and prepare monthly progress reports both on site and off site on progress made and take necessary actions to ensure that the Contactor adheres to the construction program.

viii. In collaboration with ZRA's Manager Environment, Health and Safety; supervise environmental and social matters in accordance with these ToRs and the stipulations of the KDRP ESMP. Any additional and unexpected environmental and social aspects should be noted, and necessary adjustments recommended and amended accordingly.

ix. Assess and incorporate confidential delay contingencies, should delays become unavoidable and advise ZRA about the target practical completion dates for the Project components.

x. Ensure that proper quality and quantity control is maintained, Consultant shall monitor the quality and quantity of the works and the performance management of the Contractor.

xi. Undertake cost management for ZRA. The Consultant shall follow a number of criteria in monitoring the cost such as details of breakdown of work items as in the Contract, variation and escalation contingencies within the budget, status of sub-packages (let/ unlet), anticipated variations, running forecast cost at completion from each item.

xii. Prepare actual and forecast monthly cash flows to assist ZRA's cash flow management.

xiii. Check contractor's invoice and issue progress payment certificates.

xiv. Check and make recommendation for any variation orders if required.

xv. Check and recommend any extension of time required to be given to the contractor.

xvi. Recommend substantial completion certificate to the contractor for each contract.

xvii. Recommend final acceptance certificate for each contractor after expiration of defect liability period.

xviii. Ensure that conditions/ recommendations made by all statutory and approval authorities are met without incurring loss of time and money on the Project.

xix. Provide comprehensive monthly reports to ZRA which includes the current expected completion date, the current forecast and cost, achievements during the month, status against program, current expenditures against expected cash flow, an analysis of any cost changes or variations, report on any significant problem areas and the action being undertaken to resolve them. The reports shall include a summary program showing the status, together with the trend graphs of key activities and a photographic & video record of work on site. The reports shall incorporate individual reports prepared by others as required.

xx. Supervise the Project during Defect Liability Period stipulated in the Contract.

xxi. Prepare a comprehensive final Project Completion Report (PCR) at the end of the assignment. This report must be submitted immediately after completion of contracts and shall summarize the methods of construction, construction supervision performed and recommendations for future projects of similar nature to be undertaken by the Employer. The report should also contain summary of all reports in terms of Project implementation, targets versus achievements, lessons and experience gained in Project implementation, problems encountered and resolved, environmental issues, synopsis of short study etc. (if undertaken), both tangible and in-tangible accomplishment of Project objectives, all such are presented in tables, charts and graphs; Before complete handover, the consultant will make an assessment and evaluation of the capacity and ability of the ZRA staff proposed for the operation and maintenance of the EWS. Recommendations shall

be made on what needs to be done to ensure sustainability of the installed systems in all the three project areas.

The consultant will be advised in writing when the supervision phase will commence.

4. As-installed and built Drawings

The consultant shall be responsible for ensuring that the supply and installation contractor maintains at the site a complete set of 'as-installed or built' drawings for the contract as the work proceeds. To this end the contractor shall maintain a continuous reproducible 'as-built' record of the actual alignments, levels, dimensions etc. to which the works have been constructed.

On completion of the construction of each structure, transfer all records changes to a CAD file (original CAD files to be supplied by the Consultant), or prepare new CAD drawings as required.

5. Operation and Maintenance Manual

The consultant shall review any detailed Operation and Maintenance manuals prepared by the contractor and shall be responsible for finalizing the manuals as appropriate and submitting to ZRA.

The O&M manuals shall include at least-

i. Reference to all relevant design and other reports, specifications etc. to provide a complete bibliography on the structures and plant such that the operation and maintenance staff can understand the basis of their functions.

ii. Details of any problems encountered during construction which may have a bearing on the future safe operation and decommissioning of the facilities.

iii. Full operating instructions for all systems; drawings, diagrams, charts, notices etc. to facilitate understanding of safe operation and maintenance including trouble shooting guide of electro-mechanical equipment.

iv. A maintenance schedule and consumables required to give reliable operation of the system.

The consultant shall prepare formats for reporting and record keeping of O&M activities.

6. Quality Assurance and Coordination

The ZRA with the Owner's Engineer will jointly supervise the EWS design. The Consultant shall constantly coordinate with the ZRA and Owner's Engineer for quality assurance and the Consultant shall ensure the following:

i. A site visit by the Consultant's authorised representatives to appreciate and understand the physical scope, community settlements and other geographical factors.

ii. With the facilitation of ZRA, jointly engage with Cahora Bassa Dam owner and operator as well as with respective key stakeholders to ensure support related to EWS design particularly synchronisation, appreciation, maintenance arrangement and other aspects as may be applicable.

iii. Arrange and have a benchmark visit conducted by ZRA and Owner's Engineer representatives to similar (Large Dam EWS). EWS for design appreciation. The benchmark visit shall constitute at least five (5) Client's staff and two (2) Owner's Engineer staff. The visit to have at least three days of EWS appreciation excluding travelling days. The cost (flights/transport and per diem) for this requirement shall be part of the bid. An option of three options shall be provided for client to select the option for benchmark visit.

iv. The EWS should provide distinct advantage on maintenance, safety, and accessibility.

v. Robustness and redundancy are crucial to make the system highly reliable.

vi. The equipment and supplies for the EWS must be of specifications suitable and/approved for southern Africa. Successful and durable installations of such approved equipment and supplies in Southern Africa (and subsequent durability) in previous projects is a distinct consideration.

7. Deliverables – List of reports, schedule of deliverables and period of performance

The duration of the design phase shall be sixteen weeks from effectiveness of the contract. For the design phase, the following constitute the deliverables

ID.	Deliverable	Timeline
1	**Inception report** including Program of works.	Two weeks from effective date.
2	**EWS design baseline assessment report**: The report shall highlight, based on physical surveys and community feedback the existing alert systems and evacuation plans, gaps and proposed enhancement measures. It shall also highlight a summary assessment of flow release scenarios, gaps and proposed additional analysis. The report shall incorporate specifications of components and installations as informed by physical established parameters of the specific areas including geology, soil type, slope, etc. A physical presentation shall be made to the Client following submission of the report. Recommendations/comments shall then be integrated into the overall design.	Four weeks from effectiveness date
3	Benchmarking visit	Five weeks from effective date.
4	Complete physical surveys of the EWS geographical areas to ensure adequate design of the EWS and prepare detailed description with defined number, type, location characteristics and operating requirements of systems different components and budget estimates to put the system in place.	Nine weeks from effective date.

5	**Draft EWS design package** - The draft design report shall be reviewed by the Client, owners Engineers, Project Co-financiers and the Panel of Experts appointed under KDRP. It is after all the joint review input and comments are incorporated to the satisfaction of the Client that the final design report may be accepted, and the acceptance shall be in writing. Requisite training by the Consultant to be conducted to ZRA staff. The training plan and scope shall be presented to ZRA for acceptance.	Twelve weeks from effective date.
6	**Final EWS design package submission**	Fifteen weeks from effectiveness date.
7	**Complete and accepted (by Client) tender package documents for the Equipment supply, customization, installation, training, and commissioning of EWS –** The tender package to be submitted in Hard Copy (06 No.) and soft copy. The package to include all necessary training to be received the supplier in the bidding documents for the contractors to quote accordingly.	sixteen weeks from effectiveness date

All the reports shall be submitted in soft copy (pdf) while the final EWS design shall be submitted both in soft copy-pdf and hard copy (03 No.).

For the supervision phase, the following will be the deliverables.

No.	Description	Timing
1	Progress Reports	Monthly
2	Operation and Maintenance Manuals	1 month after project completion

3	As-Installed / Built Drawings	1 month after project completion
4	Environmental and Social Reports	As and when required
5	Final Construction Report	1 month after project completion and at end of Defects Liability Period
6	Special reports	As an when required. These will also include any design modifications that might be required.

Final Reports will be submitted in five (5) copies to the PMU as per TORs. Soft copies of all deliverables shall also be submitted at the same time as the hard copies.

8. Data, Local Services, Personnel and Facilities to be provided by the Client.

a) Personnel

The Client will designate representative/s to assist the Consultant's personnel where necessary in activities regarding performing inspections at site, downstream of the dam and assistance in the consultations with local and national authorities and utilities. From a technical standpoint, the Dam Safety Panel of Experts and Financiers' specialists shall review the Consultant's proposal and inception report among other submissions to the Client in respect of this assignment.

b) Facilities

During the design phase, the EWS Consultant shall secure suitable offices and accommodation where interfacing with Client representatives is enhanced. The Consultant is expected to be fully self-sufficient in all respects for undertaking the assignment including in the areas of accommodation, office space, equipment (including for surveying, navigation and routing) and supplies, meetings with stakeholders, communication and transportation. Reimbursables for these (where applicable) shall be included in the Consultant's financial proposal.

During the supervision phase, the contractor will provide the following facilities, which should form part of the tender documents:

a) Five (5) x 4x4, vehicles robust enough for the terrain (detailed specs to be agreed at a later stage) for use by the client and the Consultant.
b) Site offices to accommodate all client and Consultant staff. These should be complete with good internet connection.
c) The consultant staff shall seek own accommodation near site preferably in Kariba (Zimbabwe side). Consultant may reside in Siavonga (Zambia side) if cleared by Client in writing.
d) Suitable printing facilities associated consumables and maintenance thereof.

9. Institutional and Organizational Arrangements for carrying out the assignment

The Consultant shall report all progress related to the EWS design assignment to the client (ZRA) through the Client and Owner's Engineer designated persons. The Client representative will disseminate information accordingly to respective parties for prompt reviews and feedback. The Consultant has the ultimate responsibility to deliver the assignment and the EWS design should align with the EPP and compliant with Zambia and Zimbabwe regulations as well as with Good Industry International Practice (GIIP). The Consultant shall be solely responsible for organising and coordinating the stakeholders and third parties for all activities as required. The Client shall play a role to facilitate and assist.

10. Required Minimum Qualification and Experience of the firm and its key experts to undertake the Assignment.

a) Firm experience and requirements

The consulting firm is required to meet the following minimum requirements:

a. Capability through proven record/s of having carried out similar assignments (Early Warning System design) for at least three (03) similar/closely related projects in the last fifteen (15) years. Similar or closely related projects/scenarios include EWSs for dam failure flooding, EWS for flooding due

to Tsunamis on Islands and oceanic shore areas and EWS for Nuclear Power Plants among others.

b. At least Ten (10) years specific experience in the subject assignment of design of EWS
c. Must be able to deploy all required experts to the Project site.
d. Experience in designing the EWS installed for Sub Saharan Africa is a distinct advantage.

b) Firm's experts for the assignment

For the design phase, the required Team Composition and Minimum Qualification and Experience of the key experts of the firm to undertake the assignment are as follows:

i. Project Manager

The Project manager must have fifteen (15) years' experience in similar/related projects, ten (10) of which should be specific to this assignment. Bachelor's degree in relevant discipline such as Civil/Structural Engineering or Project Management with demonstrated knowledge of the assignment and capability to coordinate and lead the team. Experience working in Sub-Saharan Africa is required.

ii. EWS Designs Engineer

The designs Engineer for the EWS shall have advanced knowledge and direct experience in designing Early Warning Systems for similar/closely related projects such as large dams, floods or oceanic coastal areas. Bachelor of Science or Engineering in relevant discipline such as Hydraulic Engineering, Applied Environmental Engineering, Hydrology, Civil Engineering or related discipline, with minimum of fifteen (15) years of experience. Relevant on the job training and qualification is key. The expert should have experience in team coordination and delivery of guidelines, analysis reports. Strong communications skills and experience working with binational institutions and co-funded projects is key.

iii. Surveyor

Minimum twelve (12) years' experience and minimum of a Diploma in the relevant field. Experience working is similar assignments required. The surveyor is expected to

efficiently and effectively undertake land surveying to inform EWS installations as well as surveying related to flood mapping for establishing safe zones. Training and requisite experience in Geographical Information System (GIS) is key.

iv. Environmental Expert

Minimum twelve (12) years' experience and Master's in Environmental sciences, Environmental Management/Studies, Environmental Engineering. Knowledge on Environmental and Social safeguards is a distinct advantage. Experience in similar or related assignment/s required.

v. Hydrologist/Hydraulic Expert

Minimum twelve (12) years' experience and Masters in hydrology, hydraulics or related discipline. Experience and capability to interpreting flood maps and floods digital elevation modelling. Flood simulation experience is required. Experience in similar or related assignment/s required.

vi. Social expert

Minimum twelve (12) years' experience in community and stakeholder engagement. Masters in Sociology/Social work/economics, or related discipline. The Social experts should have qualifications and experience in economic assessment for projects that interface with communities. Must be able to actively engage with communities at risk and facilitate public education and awareness on risk.

During the EWS Equipment Supply / installation / construction phase, the following staff will be required:

vii. Resident Engineer

The Resident Engineer must have fifteen (15) years' experience in similar/related projects, ten (10) of which should be specific to supervision of civil and structural works. Bachelor's degree in civil/Structural Engineering. He/she should have supervised at least 3 similar projects in terms of nature and complexity. He should have good communication skills

(written and oral in English) and demonstrated capability to coordinate and lead the team. Experience working in Sub-Saharan Africa is required.

In addition to the above, Consultants shall propose additional non key staff that may include the following:

a) Clerks of works (x 2)

b) Social officers (x 2)

c) Environmental officer (x1)

d) Project assistant (1)

The CVs of the non key staff shall be provided prior to engagement and the staff shall at least have 3 years' experience and possess at least a Diploma in related fields relevant to the assignment. The staff should have worked on at least one project similar in nature and complexity with the assignment at hand.

11. Contract Type

The design phase shall be governed by the lumpsum contract, and all payments will be based on deliverables acceptable and approved by the Client. The Construction supervision phase will be Governed by a Time-Based contract where all payments will be backed by approved time sheets and associated monthly reports.

12. Payment schedule

The payment schedule for the assignment shall be as follows:

ID.	Deliverable	Disbursement
1	**Advance payment.** The advance payment will be recovered in two equal amounts in the two subsequent invoices.	10% of the Lumpsum contract amount (against a Bank guarantee).

2	**Approved Inception Report.** The inception report should include the program of works.	15% of the Lumpsum contract Price
3	**EWS design baseline assessment report after physical surveys and community engagement**: The report shall highlight, based on physical surveys and community feedback, the existing alert systems and evacuation plans, gaps and proposed enhancement measures. It shall also highlight a summary assessment of flow release scenarios, gaps and proposed additional analysis. The report shall incorporate specifications of components and installations as informed by physically established parameters of the specific areas including geology, soil type, slope, etc. The EWS design baseline report shall also indicate detailed description with defined number, type, location characteristics and operating requirements of system's different components and budget estimates to put the system in place. A physical presentation shall be made to the Client following submission of the report. Recommendations/comments shall then be integrated into the overall design.	25% of the Lumpsum contract Price
4	Benchmarking visit report	10% of the Lumpsum contract Price
5	**Draft EWS design report** - The draft design report shall be reviewed by the Client, owners Engineers, Project Co-financiers and the Panel of Experts appointed under KDRP. It is after all the joint review input and comments are incorporated to the satisfaction of the Client that the final design report may be accepted, and the acceptance shall be in writing. Requisite training by the Consultant to be done to ZRA staff.	30% of Lumpsum contract Price

6	**Submission of acceptable final EWS design package and Tender Package for the supply, customization, installation, training and commissioning of the EWS**	20% of Contract Price

For supervision phase, payments will be made monthly upon submission and approval of the time sheets accompanied by monthly reports.

…THE END…