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PROJECT: KARIBA DAM REHABILITATION PROJECT

COUNTRY: MULTINATIONAL – ZAMBIA, ZIMBABWE

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY

Date: October 2015

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

SUMMARY

Project Title: Kariba Dam Rehabilitation Project
Project Number: P-Z1-FA0-075 **Country: Multinational Zambia Zimbabwe**
Department: ONEC **Division: ONEC.2**
Project Category: Category 1

1. INTRODUCTION

The Kariba Dam is a double curvature concrete arch dam located in the Kariba Gorge of the Zambezi River Basin between Zambia and Zimbabwe. The arch dam was constructed between 1956 and 1959 and supplies water to two underground hydropower plants located on the north bank in Zambia and on the south bank in Zimbabwe. Water is released from the reservoir through six sluice gates. In the first 20 years after the dam was constructed there were sustained heavy spillage episodes resulting in erosion of the bedrock to 80 m below the normal water level. This has resulted in instability of the plunge pool making the dam wall unstable and unsafe. Moreover, the six sluice gates that make up the spillway have been distorted over the years due to an advanced alkali-silica reaction in the concrete. Without functional sluices, the reservoir level cannot effectively be maintained to take into account the flood regime of the Zambezi River.

The proposed Project involves rehabilitation work to the plunge pool (anticipated to take 4 years to complete – i.e. 2015 to 2018) and rehabilitation of the six sluice gates (anticipated to take 8 years to complete – i.e. 2015 to 2022).

The Zambezi River Authority (ZRA), a corporation jointly and equally owned by the governments of Zambia and Zimbabwe, is the project proponent for the proposed Kariba Dam Rehabilitation Works. ZRA was formed by the Zambezi River Authority Act of 1987 (Act No. 17 and 19 Zambia and Zimbabwe respectively) and is governed by a Council of Ministers consisting of four members: two are Ministers in the Government of the Republic of Zambia; and two are Ministers in the Government of Zimbabwe. The Ministers are those holding portfolios of Energy and Finance in the respective countries. The functions of ZRA (amongst many others) include operating, monitoring and maintaining the Kariba Complex ("Kariba Complex means: the Kariba Dam and reservoir, all telemetering stations relating to the Kariba Dam, any other installations owned by the Authority").

The ZRA have initiated the Kariba Dam Rehabilitation Project, which is required to rehabilitate the plunge pool and the spill way to allow for safe operation of the dam and avoid possible catastrophic dam failure in the future. Such failure, if it were to occur, would result in a major loss of life (approximately three million people). In addition to human fatality risks, dam failure would result in significant downstream environmental damage and a loss of a main source of power to the SADC region. Therefore, timely rehabilitation is required in order to prevent further degradation of dam safety features.

In light of the above, the Zambezi River Authority (ZRA) proposes to improve the stability of the plunge pool through reshaping its profile. This will limit the preferential erosion towards the foundations of the dam wall along zones of weak rock and allow for the safe operation of the dam and continued generation of electricity from the hydropower plants. The second objective of the project is to rehabilitate the six sluice gates of the spillway, enabling the ongoing use of the spillway function to safely manage the reservoir levels.

As part of the proposed rehabilitation Project, the ZRA have committed to comply with international guidelines and standards, and as such are required to undertake a full Environmental and Social Impact Assessment (ESIA) for the Project. The Kariba Dam Rehabilitation Works Project is not a scheduled activity under the Zambian and Zimbabwean Environmental Legislation (the legislation does list activities associated with the construction of dams; however, not with the rehabilitation/refurbishment of dams). This said, the ESIA will conform and meet the environmental regulatory requirements for both Zambia and Zimbabwe and international standards such as the World Bank and African Development Bank.

In accordance with the Zambian and Zimbabwean Environmental Management Acts, there is a legal requirement for the Project proponent to respectively submit an Environmental Scoping Report and an Environmental Prospectus report as part of the overall ESIA process. As per the agreed outcomes in a meeting held with the Zambian and Zimbabwean Environmental Management Authorities (dated 24 November 2014, held at the ZRA Administrative Block in Kariba), in which the implementation of a harmonized ESIA process was discussed, a joint Scoping/Prospectus Report (this report) was submitted to both Environmental Authorities for review.

This Scoping/Prospectus Report fulfilled the Zambian requirements for a Scoping Report and Zimbabwean requirements for a Prospectus report, and has since been approved by the Zambian Environmental Management Agency (ZEMA) on 27 February 2015 (reference number: ZEMA/INS/101/04/1) and the Zimbabwean Environmental Management Agency (EMA) on 02 March 2015 (reference number: 17/1/1/3A).

The ESIA study has been the second and final phase of the overall ESIA process being undertaken in support of the proposed Project, and forms the basis on which the environmental license/approval is issued. The ESIA process undertaken has identified and assessed a range of potential environmental and social impacts associated with the proposed Kariba Dam Rehabilitation Project and is the subject of this ESIA Summary. The ESIA study proposes that provided that the social and environmental mitigation/management measures provided in the ESIA are implemented, the majority of the impacts identified will be reduced to a minor to negligible level of significance.

2. POLICY LEGAL AND ADMINISTRATIVE FRAMEWORK

The Kariba Dam Rehabilitation Works Project is not a scheduled activity under the Zambian and Zimbabwean Environmental Legislation (the legislation does list activities associated with the construction of dams; however, not with the rehabilitation/refurbishment of dams). That said, the ESIA Report fulfils both the Zambian and Zimbabwean requirements. In addition to Zambian and Zimbabwean legal requirements, the ESIA conforms to international standards and best practices, in particular the requirements of the African Development Bank, the World Bank Group, the International Finance Corporation (IFC) and the Equator Principles. The ESIA also conforms with other international guidelines and standards directly applicable to dam-building and hydropower projects such as the World Commission on Dams (WCD), the International Hydropower Association (IHA) guidelines and the Southern African Power Pool (SAPP) environmental and social impact assessment guidelines.
For Zambia this includes the Environmental Management Act (Act 12 of 2011) and the Environmental Impact Assessment Regulations (No. 28 of 1997), and for Zimbabwe this includes the Environmental Management Act (Chapter 20:27), No. 13 of 2002 and the Environmental Management (Environmental Impact Assessment and Ecosystem Protection) Regulations No. 7 of 2007. As per the

agreed outcomes in a meeting held with the Zambian and Zimbabwean Environmental Management Authorities (dated 24 November 2014, held at the ZRA Administrative Block in Kariba), in which the implementation of a harmonized ESIA process was discussed, a joint ESIA Report must be submitted to both Environmental Authorities for review.

The African Development Bank's Integrated Safeguards System were reviewed. The Dam rehabilitation works are considered high risk activities and the power generation out of the Dam exceeds the Bank threshold of 30MW hence Operational Safeguards (OS) 1 on Environmental Assessment is triggered. OS2 on Involuntary Resettlement is not triggered since the rehabilitation works will not cause resettlement of communities that live within the area. During the rehabilitation of the plunge pool, there is likely to be some disturbance to the aquatic life downstream of the dam hence OS 3 on Biodiversity is triggered. OS 4 on Pollution Prevention and Hazardous Substances is triggered since construction will involve use of fuels and possibly some hazardous materials in the sensitive environment around the dam and the Zambezi River. OS 5 on Labour, Working Conditions, Occupational Health and Safety is triggered since the construction will involve a significant number of construction workers.

On Climate Change, the project was classified as Category 1 according to the Bank's Climate Safeguards System. A review of the Climate Change Scenarios was done by the World Bank and the following conclusion was arrived at. *Climate-change* ***adaptation requires adoption of an iterative approach to water management****. Monitoring and evaluation systems are an essential element of this strategy.* ***The monitoring and evaluation system would help the Zambezi River Basin communities and dam operators to understand clearly whether current water management practices are climate smar****t. Successful adaptation in a highly vulnerable region such as the Zambezi River Basin requires a major shift in thinking, planning and designing water investments for the future. The design and operation of the Batoka Gorge dam now under consideration for the Zambezi illuminate these concerns. An alternative pathway, focused on climate-smart investments that explicitly factor in financial risk and the ecological functions and the values of river systems, is critical*. It was therefore agreed that ZRA shall prepare a Climate Change Action Plan during Project Implementation.

3. PROJECT DESCRIPTION AND JUSTIFICATION

The Kariba arch dam was constructed between 1956 and 1959 across the Zambezi River. It supplies water to two underground hydropower plants located on the north (left) bank in Zambia and on the south (right) bank in Zimbabwe. Both power stations were constructed in 1975 with a combined capacity of 1200 MW later upgraded to 1266 MW and recently increased to 1470 MW.

The Kariba dam evacuates excess water from the lake through its spillway made of 6 sluices located approximately 80 m above the river level downstream of the dam (Figure 1).

Figure 1: Photo of Kariba dam showing 1 of the 6 sluices spilling

The Zambezi River Authority (ZRA) intends to carry out the rehabilitation of the Spillway (the six sluice gates) and the reshaping of the Plunge Pool. The proposed rehabilitation which require works in situ on existing infrastructure will be done to avoid potential catastrophic failure of the dam and secure operations in accordance with international dam safety standards.

Spillway Rehabilitation:

The spillway is located in the arch dam. It is made of six sluices equipped with downstream gates yielding a total capacity of 9000 m3/s. A reservoir rule curve is imposed to create a buffer volume of 23.2 km3 in order to safely pass the 10 000 year return period flood.

To date, the sluices can be inspected or repaired in the dry when closed by a set of stop beams in still water (downstream gates closed). Considering the distorting effects of the concrete swelling on the geometry of the spillway (Alkali-Aggregate Reaction) and the ageing of the hydro-mechanical equipment (now operated for 50 years), planned and unplanned maintenance operations in the dry should become more frequent if no rehabilitation is undertaken. In addition the upstream grooves are in poor condition and need refurbishing.

To address the need for maintenance and to be able to close the sluices in any circumstance (including cases where a downstream gate is jammed partially or fully opened), the ZRA plans to equip the spillway with an emergency gate. This new gate will be operated by a new gantry and will slide into the rehabilitated upstream grooves.

The new emergency gate shall close by its own weight against full water flow if one of the downstream floodgate is jammed in a semi-opened position. It is handled by a gantry and lowered or lifted as a whole. It slides into the refurbished upstream grooves.

The new gantry located on the dam crest will be able to lift or to lower the gate as a whole. It is mounted on rails and transfers the emergency gate from one sluice to another (Figure 2). Installing the new emergency gate involves rebuilding the grooves, the sills, the lintels, the surrounding concrete and partly the top of piers. The refurbishment works within the sluices (grooves, sill, and lintel) will be done after dewatering the sluices to perform the works in dry condition. A specially designed

temporary cofferdam facility will be built for this operation. It will be placed on the upstream face of the spillway in front of one sluice before dewatering it.

The works involve a significant amount of underwater works consisting in grouting of construction joints and cracks, anchoring of rebars, control by divers during cofferdam installation and un-installation.

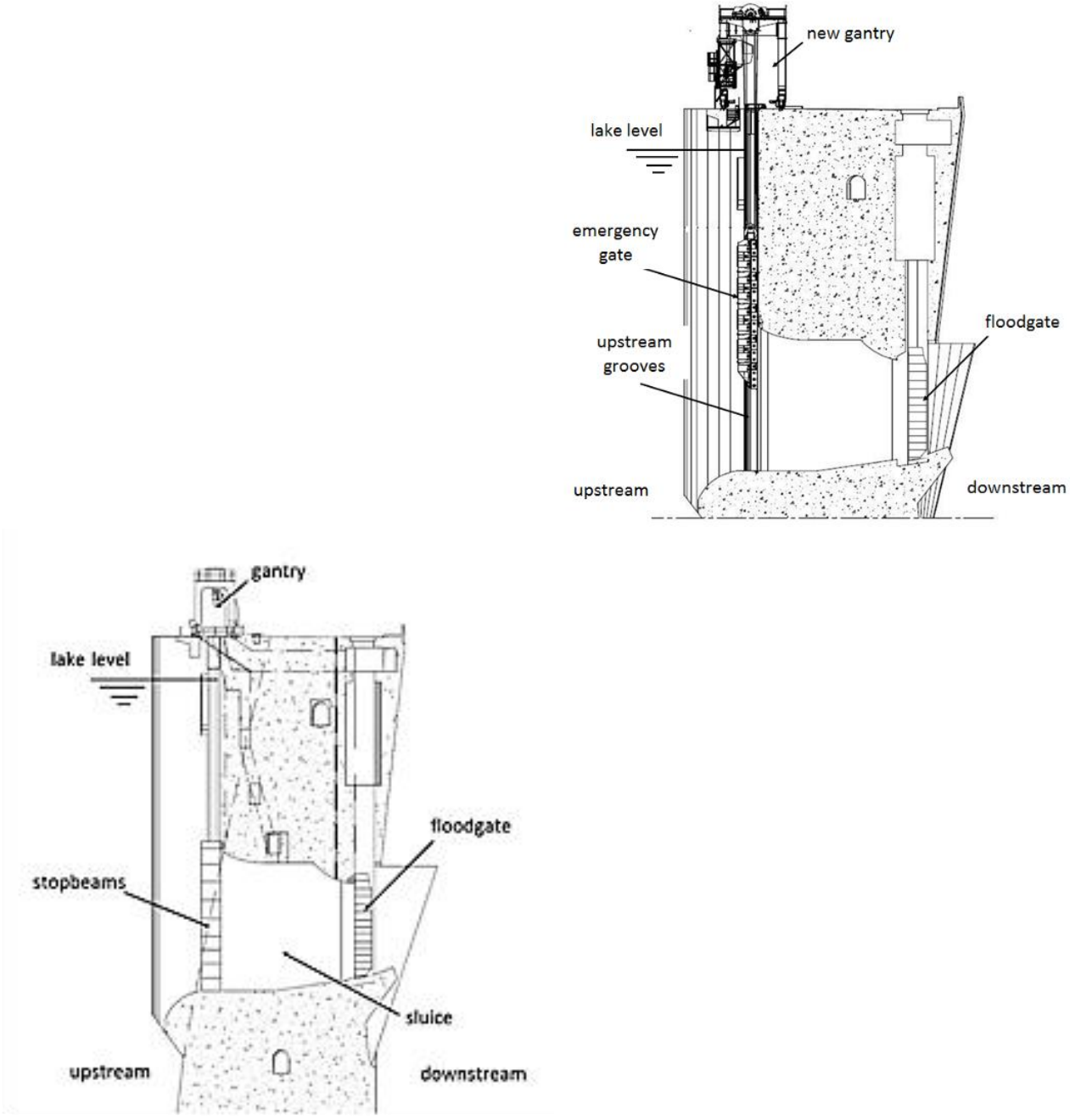

Figure 2: Vertical cross section of the spillway (left = before the works, right = after the works)

These works will take place after the Plunge Pool reshaping works in order to spill through possibly adjacent gates without deepening further the existing Plunge Pool.

The main works regarding the spillway refurbishment includes the assemblage and transport of a floating cofferdam for the dewatering of sluice gates 1 and 3 to 6. The existing stopbeams will be used to create a cofferdam for sluice gate 2, due to the different geometry associated with its waste disposal function.

For sluice gate rehabilitation, built-in-parts within the sluices need to be replaced and refurbished. The outer layer of concrete will be removed, after which the new stainless steel sills and lintels will be installed, and established with new high strength concrete. Grooves need to be rebuilt to adapt to the new emergency gate. New concrete will be anchored and reinforced on the old concrete to resist the load of new built-in-parts, and control cracking.

Plunge Pool Reshaping:

In the course of the first 20 years of sustained heavy spillage episodes, the river bedrock was scoured down to 80 m below the normal water level and resulted in what is now known as the "Plunge Pool". There is a major concern over its natural development in the future, if an intense spillage episode were to occur in case of exceptional Zambezi floods.

In order to control its future development and avoid dam toe weakening, the studies came to the conclusion that the best solution would consist in an enlargement of the plunge pool, mainly downstream but also on both banks. This reshaping should indeed facilitate the evacuation of spillage flows downstream, and avoid the concentration of turbulence in a restricted and confined area.

The primary aim of reshaping the plunge pool profile is to improve the stability of the plunge pool, limiting preferential erosion towards the foundations of the dam, along zones of weak rock. In order to arrive at the solutions described below the engineering team undertook; Multi-beam Bathymetric Survey of the Pool; Plunge Pool Geotechnical Investigations; and Plunge Pool Hydraulic Modeling.

Generally, the rehabilitation of the plunge pool will include a number of activities: (i) The construction of a cofferdam just downstream of the plunge pool, which will block off the plunge pool from the downstream river. (ii) The pumping/dewatering of the plunge pool. (iii) The excavation of the plunge pool. (iv) The deposition of excavated rock material in the existing quarry on the north bank. (v) The reshaping of the excavated plunge pool into terraced steps.

Excavation and pumping will be carried out simultaneously. While excavations are being carried out on one of the plunge pool steps, the pumps will keep lowering the water level underneath. The objective is to be able to excavate continuously even when switching from one step to the next one situated below it. An estimated 295,000 m^3 of rock will be carefully excavated due to the excavation depth below the current Tail Water Level (TWL). The reshaping of the plunge pool into terraced steps will reduce dynamic pressures in the pool and reduce flow recirculation towards dam toe. As a result, it is estimated that the power density will be reduced from 25 kW/m3 to 7.5 kW/m3. Trial blasts will be carried out, whereby increasing charges of explosives will be fired and the impacts of the vibrations on the surrounding sensitive structures will be measured.

The choice of explosives to be used will be considered very carefully. While ammo-nitrate fuel oil (ANFO) is commonly used as it is inexpensive and has sufficient strength, its water sensitivity is high. It is therefore recommended that surface bulk emulsions are used. Blasting will take place for approximately six months.

The Project Documents states that after 50 years of operation serving the southern African region, the Kariba Dam now requires a series of rehabilitation works for its continued safe operation. A failure to invest in the timely rehabilitation of the dam will result in the gradual degradation of key safety features associated with the structure to a level that is not acceptable in accordance to international standards.

The rehabilitation on the Spillway will be financed by the African Development Bank and the World Bank and includes: i) the design, fabrication and installation of emergency gates and a new gantry to prevent uncontrolled loss of water in the event of floodgate failure; ii) refurbishment of the upstream stop-beam guides and replacement of secondary concrete to prevent failure during operation of stop-beams. Failure of both of the above operations would result in water levels dropping below the minimum operational levels and interrupting power production. The spillway comprises six sluices on the dam wall as illustrated in Figure 3.

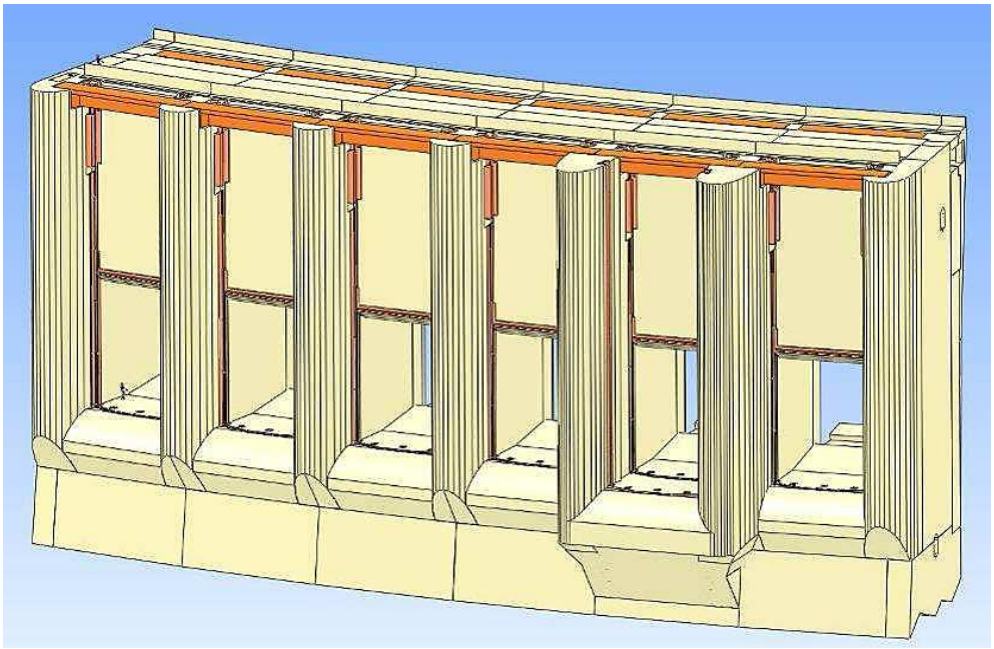

Figure 3: Upstream view of the spillway (arch not shown)

The rehabilitation on the Plunge Pool will be financed by the EU and includes i) reshaping of the plunge pool to limit erosion and wearing away of the pool which has a current depth of 80 meters below the river bed. Further scouring of the pool could undermine the dam foundations, leading to dam failure with catastrophic results. The plunge pool is located approximately 50 m downstream of the dam wall, in the Zambezi riverbed, and some 50 m upstream of the two powerhouses' outlets as shown in Figure 4.

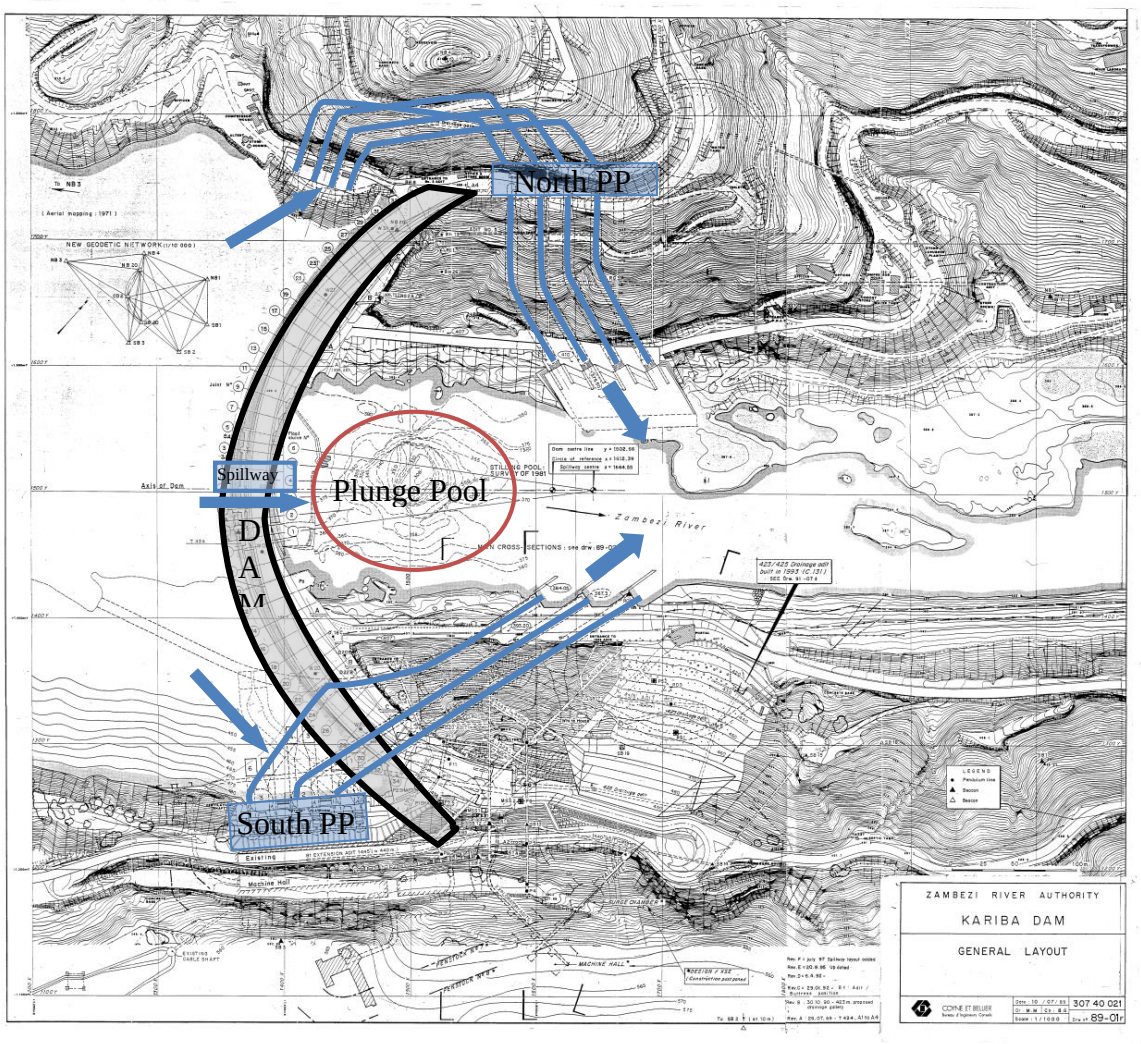

Figure 4: Layout of the Kariba dam

Justification of the Project:

Failure to implement remedial measures to the plunge pool will result in the failure to operate the reservoir as expected (i.e. at a reduced capacity) or required under extreme flood events, and an increase in the risk of dam wall failure. A scenario where the dam wall fails will release a flood event of a total 273 km³ resulting in: (i) Major loss of life as the flood plain is home to approximately three million people; (ii) Loss of livelihoods (socio-economic activities); (iii) Environmental degradation; and (iv) A loss of main source of power to the SADC region.

Catastrophic dam failure of the Kariba Dam would result in significant downstream environmental damage reaching into the Mozambique delta. However, arguably the most important motivating factor of the proposed Kariba Dam Rehabilitation Works is the potential resultant human fatality risks that would result from a catastrophic dam failure event. There are an estimated three million people who live downstream of the Kariba Dam that may be impacted should the dam fail. Therefore, it is imperative that the Kariba Dam is maintained in safe working condition.

Moreover, the Kariba Dam Hydro-Electric Scheme significantly contributes to the security of energy supply to the SADC region and specifically to Zambia and Zimbabwe over the last 50 years. This region has an increasing demand for energy supply, placing even greater significance to the existing energy supply by the Kariba Dam Hydro-Electric Scheme. Loss of this supply as a result of dam failure would significantly adversely impact the socio-economic status of the region. Therefore, timely rehabilitation is required in order to prevent further degradation of dam safety features, and to uphold Kariba Dam's status of functioning to meet international standards.

4. DESCRIPTION OF THE PROJECT ENVIRONMENT

Physical Environment

Hydrology: The existing flows on the Zambezi River reflect a large digression from reference flow conditions, and remain the major driver of the altered habitat and cover units for instream aquatic communities noted. Similarly, channel widening has laterally impacted on the riparian zones, downslope floodplains and swamp areas, causing a loss of these habitats due to loss of inundation in these zones.

Water Quality: Water quality fell within threshold values for sustaining aquatic ecosystems. Results from both the September 2014 (low flow) and February 2015 (high flow) field assessments were consistent with the water quality data provided by the Zambezi River Authority. Water from this reach was characterised by circumneutral pH values and relatively low electrical conductivities. Conversely, water sampled within the old disused Sinohydro Quarry Site (the preferred site for the waste rock dump) reflected a high alkalinity and salt loads. This water is contaminated and should remain isolated from aquatic environments.

River Erosion and Sedimentation: The Zambezi River channel bed has lowered since the construction of Kariba Dam and the channel has widened in places downstream of the gorge. The rate of channel widening has decreased in subsequent years, inferring stable condition under current bed load capacity. This along with the altered flow regime and the dam obstruction resulted in sediment and nutrient deprivation. The gorge itself is well armoured by basement rock and unlikely to be affected by erosion although additional sediment inputs may result in changes in water quality and the existing habitat template.

Biophysical Environment

Aquatic Environment: Sites on the Kariba Dam and the Zambezi River downstream of the dam were in a good and moderate ecological state according to the diatom community. The community at sites reflected slightly alkaline, fresh-brackish, oxygenated waters with moderate pollution. The macroinvertebrate assemblage is considered largely modified due to a knock-on effect from flow regulation from the dam on habitat, connectivity and water quality. A decrease in diversity and a large loss of macroinvertebrate families with requirements for various flow conditions were noted. Although all metrics show a change from reference conditions, the major driver of change in the system is hydrology, which has a subsequent impact on habitat, connectivity and water quality.

Baseline fish assemblages reflected a moderate to large variation from reference assemblages. The most notable cause for this change is alteration in the natural flow regime and a change in velocity depth constituents from the reference conditions. A longitudinal improvement in fish assemblage was noted.

Terrestrial Habitat: The broad habitats on the Zimbabwean side of the border are largely natural, whereas modified habitats are widespread on the Zambian side. The natural habitats of the valley floor are widespread and do not support many endemic or threatened species. The Kariba Gorge has been classified as a Critical Habitat however the upper extent in the vicinity of the dam is heavily impacted by previous construction works and long term operation of the Kariba Hydropower Scheme. The project site is located within the Lower Zambezi Transfrontier Conservation Area (TFCA), which qualifies as a protected area. This protected area extends over both sides of the border incorporating parts of Zambia and Zimbabwe.

Waste materials from excavation of the plunge pool will be dumped into an existing quarry site on the north bank (Zambian side) which qualifies as a modified habitat of little known ecological value. The slipway that will be used to assemble and launch the floating cofferdam within Lake Kariba is already used as a boat jetty, while the shores of Lake Kariba have not developed a riparian fringe and have a low biodiversity value.

Terrestrial Species of Conservation Concern: The baseline assessment states that *Cyclantheropsis parviflora* (a Vulnerable plant species) occurs in the Kariba Gorge. Various threatened mammal species may occur in the greater area such as Endangered Wild Dogs and other predators, but these species are mobile and typically avoid active work zones. A large elephant population occurs within the Zimbabwean side of the Ecological Area of Influence but are not expected within the Kariba Gorge, the slipway or quarry sites.

Bird species of concern include Southern Carmine Bee-eater (*Merops nubicoides*), African Skimmer (*Rhynchops flavirostris*) and Rock Pratincole (*Glareola nuchalis*). The latter species is a migrant that depends on emergent rocks within fast-flowing rivers and is expected to occur within the downstream reaches of the Zambezi River during the low flow season. These birds may be displaced by rehabilitation activities within the plunge pool, but the area of displacement represents a small area of their available habitat.

Large colonies of Southern Carmine Bee-eaters (not threatened) exist in the exposed sandbanks and are vulnerable to disturbance. Large crocodiles occur in Lake Kariba many individuals were observed downstream of the wall during aquatic studies in Sept 2014. Some individuals may be displaced, however the crocodile population in the area has grown substantially over the past three decades and this species is not considered to be at risk.

Protected Areas: The area downstream of the dam up to the Mozambique border consists of National Parks and extensive transfrontier conservation areas, including the Lower Zambezi TFCA. The Mana Pools National Park and adjacent conservation areas are recognised as a UNESCO World Heritage Site and the Zimbabwean side of the lower Zambezi River is also recognised as an Important Bird Area. The wildlife areas on both sides of the river are popular tourist destinations.

Flow releases from the Kariba Dam are controlled and the regular flooding of the downstream habitats no longer occurs. Extensive riparian habitats on the downstream floodplain have been affected, and germination recruitment of the dominant canopy trees is inhibited. These conservation areas are important tourist destinations with international recognition but the habitats
are in a gradual state of decline.

Social Environment

Tourism: An unintended consequence of the construction of the Kariba Dam has been the emergence of a thriving tourism industry, especially at the wall. Visitors are attracted to the water body and the surrounding rural/natural environment. A variety of activities such as safaris, boating, fishing, sunset cruises, canoeing, water sports, bird watching, cultural village tours and visiting look-out points are sought after. The tourism industry also supports a large informal trade sector whose customers are mainly tourists.

The majority of the mentioned activities happen upstream from the dam and adjacent to the lake on both sides of the river/lake. The wall itself was constructed in a narrow gorge and thus blends in well with the landscape. Downstream of the wall, there are two look-out points facing the wall which are popular tourist stops (i.e. at the Zimbabwean Tourism Authority Offices (ZTA) and at the wall itself).

Fisheries-Based Livelihoods: Commercial and artisanal fishing occurs on Lake Kariba and in the river, downstream of the dam. Commercial fishing activities are mainly focussed upstream of the wall and limited artisanal fishing upstream and downstream of the wall. Fishing methods (lake and river) include gillnets, dip nets (especially for kapenta) and lines and hooks. On both sides of the river, a significant number of people derive their livelihoods from fishing. People from other parts of Zimbabwe and Zambia migrate to the Kariba and Siavonga districts to pursue fishing as a means to make a living. The presence of tourism operators and activities in the AoI plays a big role in supporting the survival of the fishing industry.

Sexually Transmitted Infection including HIV/AIDs: The prevalence of HIV/Aids is slightly lower in Zambia compared to Zimbabwe at 13 percent and 15 percent respectively. It is reported that condom use as a means of HIV/Aids prevention as well as comprehensive knowledge of HIV/Aids is lower in Zambia than in Zimbabwe. In the Mashonaland Province of Zimbabwe, the top five causes of mortality (amongst others) is HIV/AIDS. In the Southern Province of Zambia, HIV/Aids infection rate is estimated at 14.5 percent. Of those with HIV/Aids, 17.4 percent receive antiretroviral treatment. The population between 15 and 24 years remains at a higher risk than other age groups to be infected with HIV/AIDs.

5. PROJECT ALTERNATIVES

The No-Go Alternative: The No-Go Alternative is the option of not undertaking the Kariba Dam Rehabilitation Works Project. As described, water is released from the reservoir through six sluice gates. In the first 20 years after the dam was constructed there were sustained heavy spillage episodes resulting in erosion of the bedrock to 80 m below the normal water level. This area is known as the 'Plunge Pool'. The plunge pool represents a risk to the stability of the dam wall and therefore risk of a flood event and reduced operating capacity of the dam.

Furthermore, there is also a need to rehabilitate the six sluice gates that make up the spillway. The work needed within the sluices is associated with the refurbishment of the concrete surface of all sluices which have been distorted over the years due to an advanced alkali-silica reaction. Without functional sluices the reservoir level cannot effectively be maintained to take into account the flood regime of the Zambezi River. Without the ability to release water from the reservoir, there is a danger of the reservoir being too full prior to a flood event, and the subsequent flood event causing over topping of the dam wall which could lead to dam failure.

Failure to implement remedial measures to the plunge pool and spillway will result in the failure to operate the reservoir as expected (i.e. at a reduced capacity) and an increase in the risk of dam wall

failure. A scenario where the dam wall fails will release a flood event of a total 273 km3 resulting in a major loss of life as the flood plain is home to approximately three million people; loss of livelihoods (socio-economic activities); environmental degradation; and a loss of main source of power to the region. Therefore, the No-Go alternative is not a reasonable alternative and it is necessary to implement the remedial action to avoid such an event.

Waste Rock Dump Site Alternatives: Four alternatives for disposal of waste rock were considered and analysed. Accordingly the preferred order of the alternatives assessed is, from most preferred to least preferred, as follows: Alternative 1: Old Disused Sinohydro Quarry Site; Alternative 3: Old ZRA Quarry Site; Alternative 4: Area East of the Sinohydro Quarry Site and Alternative 2: Site on Northern River Bank. Alternative 1 is the preferred alternative as the Sinohydro quarry is the most suitable site for dumped waste rock (it will have the least visual and terrestrial ecology impacts). Moreover, the site is in close proximity to the plunge pool.

Slipway Site Alternatives: The slipway will allow assembly of the floating cofferdam on the reservoir bank above water level and launching of the floating cofferdam onto the reservoir. During feasibility studies, the possibility was examined to use a dry-dock instead of a slipway. However, due to the reservoir level fluctuation range, this solution was found not feasible. Two engineering site visits were undertaken in December 2011 and April 2012, resulting in the identification of three possible sites for the construction of a slipway.

Accordingly, the preferred order of the alternatives assessed is as follows: Alternative 1: DDF – most preferred; Alternative 2: Wild Site – next most preferred (based on its proximity to the spillway [~1.2km]); Alternative 3: ZPC Sports and Social Club – least preferred (based on the fact that the slipway site would be situated ~6.8km from the spillway).

The preferred slipway site (Alternative 1: DDF Site) is located about 2.0 km south west from the Kariba Dam wall, and is currently owned and operated by the Zimbabwean District Development Fund (DDF). This site has been selected as the preferred site for the following reasons: (i) The site has an existing slipway which can be upgraded; (ii) The site is flat and large enough to cater for the construction of the floating cofferdam; (iii) There is an existing road to the site; and (iv) The site is a short boat distance (2.0km) to the spillway.

Plunge Pool Coffer Dam Alternatives: Alternative 1 – a cofferdam built from one bank to the other, i.e., continuous, built at the start of the works and demolished at the end. However, removal at the end of the works is costly and time-consuming. Alternative 2 - Installing a sheet pile cellular cofferdam at the beginning of the works and removed at the end of each dry season. This is however not a possible option as the removal and reconstruction time is too long before and after each spillage episode. Alternative 3, the preferred alternative would consist of the establishment of a cofferdam at the beginning of the works, removed at the end of the dry season and then reinstalled at the beginning of the following dry season. This cofferdam design allows for easier mobilization and demobilization between potential flood events, and allows for a three phase work program. The cofferdam will comprise of 10 piers spaced 13 m apart, with nine stoplogs in between. Alternative 3 is the preferred alternative as the cofferdam can be quickly mobilised and de-mobilised once constructed.

Reservoir Management Alternatives: As the rehabilitation works associated with the plunge pool are located right under the spillway gates, the reshaping works can only be done during a period that will not require spillage, i.e. a "non-spillage period". Normal spillage usually occurs from January to the end of August, leaving a reduced time window for works (i.e. September through to December). The non-spillage period can be increased by lowering the reservoir level and creating a storage volume that

will be used as a buffer volume against a flood. This volume allows storing of the flood inflows while the reservoir level is rising. Simulations were undertaken by Tractebel (2012) to find an optimised scenario that increases the non-spillage period, and limits consequences on energy production and water availability during and after works.

Three alternative scenarios, based on a series of assumptions, have been retained depending of the duration made available for works: Alternative Scenario 1: Allows 16 months for works, and the cofferdam and the excavation works can be done in the same non-spillage period. Alternative Scenario 2: Allows 11 months for works, and the cofferdam can be partly constructed in advance, and completed just before the excavation works. Alternative Scenario 3: Allows 7 months for works, and the cofferdam will be rapidly mobilized and demobilized to leave enough time for excavation works.

The preferred alternative is Alternative Scenario 3, where the works can be carried out in the plunge pool for 7 months, after which time all materials and equipment will have to be dismantled to allow for the 5 months spillage period, before the works can be resumed for another 7 months. The results of the Reservoir Management Scenario Modeling indicate that Alternative Scenario 1 would result in a significant loss of power generation during rehabilitation works (22.2 km3 of water would not run through the turbines). Alternative Scenario 3 (preferred alternative) would require the lowest maximum reservoir level drawdown (1.9m), which is beneficial to the hydropower facility for future power generation.

Alternative Rock Blasting Technologies: A critical aspect that needed to be considered as part of the Project design is the explosive material to be used. Generally, for rock extraction inside large open pits, bulk explosive ANFO (ammo-nitrate fuel oil) is used because it is a cost effective option and has sufficient blasting strength. Nevertheless, the water sensitivity of ANFO is very high, which ultimately means that the risk of frequent misfires, as a result of predictable water seepages are during works, is large. As a result, a more effective solution is using modern adequate explosives materials (such as surface bulk emulsions) was deemed as the preferred blasting technique. These explosives have a good water resistance and have a velocity of detonation (strength) better than that of ANFO.

6. POTENTIAL IMPACTS

Creation of Employment Opportunities: Rehabilitation activities associated with the plunge pool and spillway will create an as yet unknown number of employment opportunities, which will be distributed over the duration of approximately 7 years. Rehabilitation activities of the plunge pool is planned for during dry seasons (7 months per year) over an estimated four year period and the spillway for a period of approximately 8 years.

There are 2 factors that will influence the actual number of employment opportunities that will realistically be available to prospective employees in the AoI, namely skills levels and structuring of employment contracts by the Contractor. It is foreseen that due to the highly specialised nature of the rehabilitation works; a large number of the opportunities will be for highly skilled and skilled persons e.g. engineers, shutterhands, drillers and blasters, steel fixers, machine operators, concrete hands and drivers while a relatively small number of opportunities will be available for unskilled labour such as for security, housekeeping and catering staff. It is anticipated that the impact on employment creation on those seeking employment will be a Positive Impact pre-mitigation.

Impacts on Hydrology: The rehabilitation of the dam, specifically referring to any of the three scenarios, can be considered to have little to no impact on the hydrology of the downstream river reach

when compared to the present state of the system, if the hydropower releases are made throughout the project duration. However, there is a low probability that these releases may not be possible due to a lack of inflows to the dam after the dam water level has been lowered (i.e. if reservoir management results in a sustained non-spillage of 16 or 11 months alternative scenario 1 and 2, which would have significant negative impacts on the downstream hydrological system in terms of flow volume for downstream users and for the downstream receiving environment. Decreasing flows below the Environmental Flow Requirements (EFRs) will have a Major Negative Impact pre-mitigation.

Impact on Water Quality: An impact on water quality is considered the most likely of the potential impacts identified. Potential sources of impacts on water quality have been identified as: (i) dewatering of the plunge pool, (ii) the installation of the cofferdam and dewatering of the associated work area, (iii) dredging of the slipway, (iv) blasting activities and (v) construction and use of associated access roads. The perceived impacts are mainly related to rehabilitation where the deterioration of water quality will most likely be attributed to increased sediment loads (e.g. earth and rock moving activities), construction material (e.g. cement), hydrocarbons (e.g. oil and diesel), solvents and other hazardous substances via accidental spillage/leakage from construction machinery and equipment. The impact on water quality will be a Moderate Negative Impact pre-mitigation on the water quality of the receiving environment. The plunge pool reshaping and spillway dredging activities will require instream actions such as dewatering, blasting and sediment removal, which are likely to result in water contamination.

Impacts of erosion and sedimentation: During rehabilitation works, the removal and disturbance of vegetation and soil as well as blasting activities poses a risk for erosion and sedimentation related impacts. Potential sources of impact related to sediment loads have been identified during: (i) the construction and operation of the temporary access roads, (ii) discharge from the plunge pool, (iii), blasting and rock removal activities, (iv) construction of the downstream cofferdam and (v) dredging of the slipway site. It is anticipated that the impact of erosion and sedimentation on the water quality and habitat template of the receiving environment will be a Minor Negative Impact pre-mitigation.

Impacts on Aquatic Environment: Rehabilitation activities relating to dredging, blasting and dewatering are likely to result in direct fish mortalities due to the proximity of these activities to the instream environment. It is anticipated that the impact of blasting, dewatering and other instream activities on the instream aquatic community of the receiving environment will be a Moderate Negative Impact pre-mitigation.

Impacts on Terrestrial Habitat: Areas impacted by rehabilitation works activities will extend over both Zambia and Zimbabwe and will include a general construction site on the Zambian side of the river; widening and upgrading of existing access roads; the construction of an access road into the plunge pool below the dam; construction of the cofferdam; the deposition of waste rock in the existing disused Sinohydro Quarry Site in Zambia; access to the waste rock dumpsite and access to and the existing slipway in Zimbabwe.

An area of direct terrestrial ecological influence has been defined as the general construction site on the Zambian side of the river, the temporary access road into the plunge pool area, the access road to the waste rock dumpsite, the dumpsite itself, access to the spillway on the Zimbabwean side of the river and the slipway area itself. It is anticipated that the impact on terrestrial habitat loss will be a Negligible Negative Impact pre-mitigation.

Impacts on Terrestrial Species of Conservation Concern: Many of the rehabilitation activities are located within a protected area and there is a high likelihood that animals may become trapped or

unexpectedly cornered. Many animals can be dangerous when trapped or cornered (including snakes, carnivores, horned antelope, porcupines and others) and adequate training should be undertaken to handle a range of potential wildlife interactions. It is anticipated that the significance of the impact on species of conservation concern will be a Minor Negative Impact pre-mitigation.

Impacts on Protected Areas: The Project is located within the Lower Zambezi TFCA. In Zambia this TFCA includes the Open Area around Siavonga down to Chirundu, Chiawa Game Management Area and Lower Zambezi National Park. In Zimbabwe the TFCA includes the Charara, Urungwe and Rifa Safari Areas between Kariba and Chirundu, Mana Pools National Park, Sapi and Chewore Safari Areas down to Kanyemba. It is anticipated that the significance of the impact to protected areas will be a Moderate Negative Impact pre-mitigation.

Impacts on Tourism: Rehabilitation activities with the most likely impact on tourism are probably associated with blasting for rehabilitation of the plunge pool. It is anticipated that blasting activities will take place over a six month period. Depending on the safety risk linked to the blasting, it is possible that there will be temporary access restrictions to the wall when blasting occurs. It is, therefore, possible that rehabilitation activities may result in a slight disturbance to tourism activities in the area. It is anticipated that the impact on tourism will be a Negligible Negative Impact pre-mitigation.

Impacts on Fisheries-Based Livelihoods: Sensitivity in this case relates to fragile livelihood strategies, income instability, lack of food security and poverty. The most sensitive receptors are downstream fishers who may lose an important source of nutrition and income if activities associated with the rehabilitation works change the water quality to such an extent that it negatively affects the fish population. It is unlikely that the fishers will be able to find an alternative source of nutrition and income easily. it is anticipated that the impact on fisheries-based livelihoods will be a Negligible to Moderate Negative Impact pre-mitigation

Impacts of STIs and HIV/AIDs: The proposed Project has the potential to increase the transmission of HIV and other STIs in the social AOI due to the following: (i) Transport drivers, who may typically have higher rates of HIV or STIs than the general population, may engage in casual sexual activity at their end destination, acting as a vector for the disease. (ii) A mainly male workforce with a comparatively larger disposable income may engage in sexual activities in local communities, acting as a vector for the disease. (iii) Existing stigma and taboos around STIs and HIV will make it challenging to negotiate safe sex practices such as the use of condoms (including the use of female condoms).

Any increase in the prevalence of HIV or STIs in the SSA is a business risk for the proposed Project and may affect the health of the workforce and therefore their ability to do their job. There is little access to treatment for STIs in the social AOI; as such, these could also impact the long term health of those who suffer infections. The stigma and taboos around STIs may also affect people accessing treatment in a timely manner which may affect health outcomes.

Women, young children, the elderly, those infected with sexually transmitted infections and their carers will be most vulnerable to increased transmission of HIV or STIs. The vulnerability in women will be linked to the potential of being infected by their partners and potentially passing the diseases onto their young children (especially HIV) and/ or having to care for the ill for long time. In turn, the elderly may end up having to care for the young children in case of the parents' severe illnesses and deaths. Those infected by HIV or STIs are likely to endure long term stigmatisation by their peers. This impact has been assessed as a Major Negative Impact prior to mitigation.

Dam Safety:

Given that Lake Kariba is the largest man-made reservoir in the world (at 181 x 109 m3), and has a spill capacity of 9,000m3/s, this Project constitutes a high risk to both downstream inhabitants and the environment in the event of dam failure. The downstream flood plain is currently home to more than 3 million people so potential loss of life could be catastrophic. Other impacts from a dam failure would include loss of livelihoods and loss of power, which will also negatively affect the economies of the region. Kariba Dam and Cahora Bassa Dam account for 40% of the South African Power Pool (SAPP) generation capacity (excluding South Africa).

Impacts from Climate Change:

When Kariba Dam was designed, the possibility of climate change was not considered and the reliability of this scheme was therefore assumed to be stationary. Studies have since shown that the climate is likely to change, which will cause a change in the reliability of the reservoir. If information about climate change was available during the design of Kariba Dam, it is likely that a larger safety factor could have been adopted when selecting the reservoir capacity. A larger capacity of the reservoir could have been selected in order to ensure that a high reliability level is maintained even under climate change conditions.

Over the next century, climate change is expected to increase this variability, and the vulnerability of the basin –and its hydropower dams – to these changes. Results (World Bank, 2014) show that under the driest scenarios (see figure below) hydropower generation could decline by more than 60%, and unmet irrigation demand could decline by more than 25% in the Zambezi basin. The benefits of wetter scenarios in the Zambezi basin, in the upper right corner, suggest an increase of up to 25% in hydropower production and a few percent in irrigation water provision. The results vary dramatically by basin, but show overall climate change could be an important factor in water and power infrastructure performance in the Zambezi in particular.

7. MITIGATION MEASURES AND COMPLIMENTARY INITIATIVES

Mitigation Measures

Enhancement Measures for Employment: The following management measures are proposed to enhance this impact: (i) The development of Project specific Recruitment Policies by the Project Proponent, the Engineer as well as the Contractor. (ii) The setting of targets to maximise the number of Zambian and Zimbabwean nationals, to consider the gender balance for available local jobs. Consideration of targets for disabled, unskilled, skilled and highly skilled employees from the AoI. (iii) Targets to become part of Conditions of Contract with Engineer and Contractor. (iv) Preparation of monthly and cumulative employment statistics reports for submission to Project Proponent. (iv) Conduct an annual audit of employment statistics based on which an incentive for achieving employment targets can be considered. (v) Public advertising of employment opportunities in all newspapers, public libraries, the District Office and in all relevant languages. (vi) The establishment of a Recruitment Office by the Contractor with the purpose of keeping a record of available prospective employees, their skills levels and contact details. Registration of job seekers with the Recruitment Office will be free of charge.

Mitigation and Management for Impacts on Hydrology: The implementation of the preferred reservoir management scenario, and the use of a cofferdam structure that can allow for spill events as, and when they are required, are the main mitigations for impacts pertaining to hydrology. Although it is recognised that any spill is likely to have a positive effect on the downstream ecology and channel processes, the risks associated with not enough discharge, for any period of time, are greater.

Mitigation for Impacts on Water Quality: Water quality monitoring during rehabilitation works should monitor pH, EC, TDS, temperature, turbidity and dissolved oxygen on a weekly basis. For the rehabilitation of the plunge pool, these measurements can be taken from the river bank at 200m, 500m and 1km intervals downstream from the instream activities. Measurements at the 1km monitoring point should remain below threshold values as provided in the water quality monitoring plan. Hydrocarbons, major ions (Sulphates, Chlorides, Calcium, Magnesium, Sodium, Carbonates/ Bicarbonates) and nutrients (total Nitrogen and total Phosphates) should be monitored in line with the water quality monitoring plan.

Other mitigation measures include; (i) No dumping of any building rubble, soil, litter, organic matter or chemical substances should occur within watercourses; (ii) As dewatering takes place the water quality within the plunge pool may deteriorate further at greater depths. (iii) The dewatering systems should be designed to accommodate as much sediment trapping as possible. (iv) The total suspended solid levels downstream of the dewatering point should not vary with more than 15% that of background levels. (v) A detailed course of action for accidental spills or surface water contamination should be provided for all sites where such contaminates are stored/used. (vi) Construction equipment should not be serviced or refuelled near the river or dam. In cases where there is no option but to refuel near the water, suitable preventative and responsive actions should be taken.

Mitigation for erosion and sedimentation: Erosion and silt control mechanisms should be in place prior to the onset of rehabilitation within any watercourse. This includes (i) the elimination of surface flow through the active work site. (ii) Silt fences or hay bales need to be placed near the base of an exposed slope in order to limit the amount of sediment entering the watercourse. (iii) Depending on the silt load suspension within the plunge pool, it may be necessary to delay dewatering until sediment has settled or until turbidity levels downstream of the discharge point do not vary with more than 10-15% to that of background values. (iv) The erection of silt barriers along all affected drainage lines should be undertaken to curb any sediment and silt run-off in the preparation of rehabilitation activities. (v) Ideally, the amount of land that will be disturbed should be kept to an absolute minimal.

Mitigation on Aquatic Environment: Most impacts expected to affect aquatic biota have been discussed under previous sections. Implementing recommendation and mitigation measures for impacts related to water quality, hydrology, erosion and sedimentation, will also mitigate most expected impacts on aquatic biota. Aquatic biota may further be impacted by mortalities directly associated to instream activities such as blasting and dewatering. Local literature on mitigating blasting impacts on instream biota is limited, but international literature suggests that blasting induced over pressure should not exceed a 100 kPa and peak particle velocity should not exceed 13mm/s.

In addition to blasting, fish may become isolated and trapped within the plunge pool area during dewatering activities. This may provide a good opportunity to further the taxonomic resolution of fishes of the middle Zambezi River. Fish trapped within the dewatered area can be removed via gill and seine netting. The latter is the preferred method and released within the downstream area. A representative sample of the fish community may be preserved appropriately and provided to local and international institutions for curation. A bio monitoring regime, before during and after rehabilitation should be instated.

Mitigation for Impacts on Terrestrial Habitat: (i) Appoint and Authorise an Environmental Officer – a qualified and competent Environmental Officer should be appointed with sufficient authorisation to ensure protection of the environment is prioritised. (ii) Incorporate Ecological Awareness into Induction Programmes – induction programmes for staff, contractors and site visitors should emphasise that many of the active work areas are inside protected areas and should include the importance of minimising the disturbance to the environment. (iii) Avoid Footprint Creep – measures should be taken at the planning stage to determine the minimum required area for all rehabilitation works, equipment laydown sites, construction vehicle parking, erection of staff toilet facilities, construction viewing sites and other activities.

Mitigation for Terrestrial Species of Conservation Concern: Implement an Animal Rescue Plan – Wildlife authorities are present in both Zambia and Zimbabwe and private veterinary skills are available. Arrangements should be put in place with relevant persons of authority or with appropriate capacities to be on call and able to react. Their contact details should be appropriately circulated amongst rehabilitation work teams and included in induction programmes for use in the event of an incident involving a dangerous or potentially dangerous animal.

Recognise Threatened and Protected Species and Translocate Appropriately – various threatened and protected species of plants and animals are present in the Project AOI and surrounds. An Environmental Officer, or a member of his/her staff should be able to recognise these species and scan areas prior to the start of rehabilitation activities to determine if present or potentially present (in the case of animals), and take appropriate steps based on the species involved.

Mitigation for Impacts on Protected Areas: Maintain Dialogue and Collaboration with Protected Area Authorities – an open communication should be maintained with conservation authorities to ensure that they are familiar with future plans, activities taking place and are provided with opportunity to advise on day-to-day measures to minimise possible impacts. Their advice and support should be considered regarding an animal rescue plan and translocation of species. Responsibilities should be delegated (e.g. to the Environmental Officer) for ensuring regular communication occurs with conservation authorities.

Mitigation for Impacts on Tourism: The following mitigation and management measures are proposed: (i) Installation of project information boards, which provide a brief description of rehabilitation works, Project timeframes as well as the blasting schedule. (ii) Sharing of Project description and rehabilitation schedule with tourism operators. (iii) Implementation of noise and dust abatement measures as required.

Mitigation of Impacts on Fisheries-Based Livelihoods: The management of water quality during the drawing down of the plunge pool and subsequent rehabilitation activities will be challenging. The following mitigation and management measures are proposed regarding the down-stream fishers: An aquatic monitoring program should be implemented that will enable
an early identification of a decline in fish numbers and associated fish catches downstream. If changes are observed, the ZRA should working with NGOs and Government to develop a mitigation and compensation plan.

Mitigation for Impacts of STIs and HIV/AIDs: As a means to mitigate impacts related to the increased incidences of HIV/AIDS and other STIs: (i) In partnership with local health officials and relevant NGOs, Contractors should undertake information, education and communication campaigns around safe sexual practices and transmission of STIs and HIV/AIDS. (ii) Contractors should engage with an

independent entity such as an NGO to develop and implement an HIV/AIDS Prevention Programmes for its workforce. The NGOs mandate shall cover the workers and communities in the Project Area. (iii) ZRA should develop and implement a Workforce Code of Conduct for appointed Contractors. The key health and safety elements of the code should include: Zero tolerance of illegal activities by all personnel; Forbidding the use of prostitution; Forbidding the illegal sale or purchase of alcohol; Forbidding the sale, purchase or consumption of drugs; and Forbidding gambling and fighting. (iv) The Workforce Code of Conduct should be adhered to by all Contractors. Any Contractor found in violation of the Code should face disciplinary hearing which should potentially result in dismissal. (v) Contractors should ensure that they have sufficient capacity and capability to care and treat any HIV-positive employees. (vi) Contractors should ensure there is access to free condoms (including female condoms) at the worker camp to promote safe sexual practices.

Mitigation for Dam Safety:

ZRA have an existing Emergency Preparedness Plan: Kariba Dam and Reservoir Standing Operations Procedure dated Jan 2013. Apart from this Dam Safety Inspection Reports are periodically compiled on. The overall rehabilitation of the Kariba Dam plunge pool and sluices is inherently a dam safety issue that needs to be carefully considered as part of the overall Kariba Dam Emergency Preparedness Plan (included in the ZRA Kariba Dam and Reservoir Standing Operations Procedure dated Jan 2013).

The updating the preparedness plan will be the highest priority. The key to such an update is a well-developed communication plan that has been thoroughly vetted and tested. In addition to the above, the ZRA will ensure that the updating of the existing Kariba Dam Emergency Preparedness Plan be done in a way that – (i) The plan is updated in consultation with the relevant stakeholders (stakeholder mapping and identification to be done as part of the updating process). (ii) The contact details of those individuals included in the chain of command and communication procedure should be provided in the plan and kept up to date. (iii) Downstream communities affected by such an emergency should be identified and contact details for applicable community heads should be provided and kept up to date. (iv) Clarifies the need to put a national disaster response mechanism in place for downstream reaches in the event of a catastrophic incident.

Moreover, copies of the final amended Kariba Dam Emergency Preparedness Plan should be made available to – The Offices of the President; The Disaster Management and Mitigation Unit; The Civil Protection Unit. Periodically undertake Kariba Dam emergency preparedness drills to test the emergency plan.

Mitigation for Climate Change Impacts:

Currently there are several hydrological and climate change and climate variability studies being undertaken on the Zambezi River Basin. The studies results shall be used by ZRA to develop a Climate Change Action Plan for the management of Kariba Dam.

8. CUMULATIVE IMPACTS AND ENVIRONMENTAL HAZARD MANAGEMENT

The cumulative impacts that would result from a combination of the proposed Kariba Dam Rehabilitation Project and other developments in the broader Project Area include: (i) Impacts on Surface Water Hydrology and Aquatic Environment; (ii) Employment; (iii) Increased Risk of Road Accidents; and (iv) General Construction Impacts (dust and noise emissions). Each of these potential cumulative impacts is described below.

Impacts on Surface Water Hydrology and Aquatic Environment: Cumulative impacts affecting the aquatic integrity of the Kariba gorge include the historic construction of the Kariba dam and the associated hydroelectric power stations, both current and proposed, all of which have irreversibly altered the hydrological regime operational within the gorge. Current downstream activities involving the deposition of large volumes of coarse aggregate, resulting in steep unstable slopes which are vulnerable to erosion and threaten the current water qualities through increased turbidity, are likely to further add to the cumulative impacts affecting the receiving aquatic environment. Subsequently, proposed activities directly downstream of the dam involving localized decanting, blasting and potential short-term alteration of existing flow regime, are unlikely to add significantly to the overall cumulative impact affecting the aquatic system downstream of the dam.

*Employmen*t: Although development in the AOI provides employment opportunities and contributes to households having more disposable income to contribute to improved livelihoods, it also has the potential to result in unfair and unsafe working conditions. During in-field engagement with local stakeholders, concerns related to labour and conditions of employment for existing/previous projects (viz. the North and South Bank Kariba Power Station extensions) were raised. It was reported that contractors associated with such projects do not adhere to basic conditions of employment as set out in the countries' legislation. Such conditions include low remuneration packages, poor treatment, long working hours, poor workforce accommodation and poor health and safety standards. Should mitigation/management measures included be implemented, it is unlikely that the proposed Kariba Dam Rehabilitation Project will add to negative impacts around inadequate labour and poor employment conditions.

Increased Risk of Road Accidents: Baseline vehicle traffic volumes are low in the Project AOI. Existing upgrade works at the Kariba South Bank Power Station and the proposed Kariba Dam Rehabilitation Project will increase light and heavy vehicles using the local roads throughout the duration of works. The combined volumes of road traffic will place both human and livestock in danger of being injured or killed throughout the life of these projects. Close communication and coordination between both project teams and effective signage and traffic management will be required to avoid significant cumulative impacts.

General Construction Impacts (Dust and Noise)

Dust Emissions: Rehabilitation activities associated with the proposed Kariba Dam Rehabilitation Project together with construction activities from other developments have the potential to create negative cumulative impacts associated with the generation of total dust, PM0 and PM2.5. The magnitude of these potential impacts may be minor, moderate or major, depending upon how the impacts from other projects will combine with impacts arising from the proposed Kariba Dam Rehabilitation Project and the respective timing of each project. There will be some overlap of rehabilitation/construction works between the proposed Project and works associated with the upgrading of the Kariba South Bank Power Station, which may result in additional dust generation. This may be worsened by elevated wind speeds, increasing the potential for cumulative impacts during periods of adverse weather. Implementation of dust management actions by both construction projects will be required.

Noise Emissions: As is mentioned previously, there will be some overlap of rehabilitation/construction works between the proposed Project and works associated with the upgrading of the Kariba South Bank Power Station. As such, it is possible that the cumulative noise impact of activities carried for these two projects may result in a nuisance to noise sensitive receptors in the vicinity of the Kariba

Dam. This is however dependent on how the impacts from the other development combine with the impacts from the proposed Project, and the respective timing of these impacts.

Blasting Activities and Related Dam Safety: Both the Kariba Dam Rehabilitation Project and the Kariba South Bank Power Station construction activities involve blasting. At this stage it is uncertain if these activities will overlap. If they do, it is possible that the combination of blasting activities from both projects could result in a cumulative impact on dam safety. The Kariba Dam Rehabilitation Project will be carried out in compliance with the OP/BP 4.37 with the project aimed at ensuring appropriate measures are implemented and sufficient resources provided to ensure the continued safety of the dam. As per OP/BP 4.37 an independent Panel of Experts will be appointed to review the investigations, design, and implementation of the rehabilitation works. The Panel should consider the possible cumulative impacts of blasting.

9. PUBLIC CONSULTATION AND DISCLOSURE

The key principle of consultation is to ensure that the views of stakeholders are taken into account and reported throughout the ESIA process. The objective is to ensure the assessment is robust, transparent and has considered the full range of issues or perceptions, and to an appropriate level of detail. Detailed public participation started during the scoping phase and continued throughout the assessment ensuring that legislative requirements and Project standards were met, that stakeholder concerns were addressed in the assessment and that sources of existing information and expertise were identified.

The overall public participation process was designed to slot in with typical ESIA Phases; namely Scoping, draft ESIA and announcement of ZEMA and EMA's approval or rejection (i.e., Environmental Authorization) regarding the Project.

Stakeholder identification took place through a social scan followed by stakeholder recording and categorization. During the stakeholder identification, individuals, groups and local communities that may be interested and affected by the Project, as well as the broader stakeholders who may be able to influence the outcome of the Project, were identified. Elected and non-elected community representatives and leaders were also identified.

Care was taken to consult with vulnerable groups such as the elderly and women during this process. The ESIA stakeholder database consists of approximately 600 stakeholders representing the different sectors of society. The stakeholder contact details were captured on an electronic database and categorized. Each stakeholder's attendance of consultation activities were recorded.

During the Scoping Phase, stakeholder consultations were focused on achieving the following outcomes: (i) To meet key stakeholders and introduce them to the Project and ESIA process; (ii) To identify the issues, needs and expectations of the interested and affected stakeholders; (iii) To provide opportunity for stakeholders to contribute to the debate with their local knowledge and experience; (iv) To refine the terms of reference of specialist work on the basis of stakeholder comment received; (v) To gather issues of concern and through this identify a list of potential impacts; (vi) To gather primary data informing the social impact assessment; (vii) To verify that stakeholders' issues and concerns have been captured; and (viii) To assist ZRA in strengthening its relationships with existing and future stakeholders.

The ESIA public participation team announced the opportunity to participate in the Project widely and via a range of communication methods such as site notices, radio communication, print media,

dedicated webpage, social media distribution of Background Information Documents (BIDs) in the three languages. Communication with stakeholders (including consultation materials) were usually undertaken in three languages, namely English, Shona (Zimbabwe), and Tonga (and sometimes in Bemba or Nyanja) in Zambia. Local facilitators were used during all community meetings.

A total of 1,500 BIDs were distributed (of which 1,000 in English, 250 in Shona and 250 in Tonga). During the Scoping Phase, the meeting Attendance Registers show that 580 people attended the public meetings. This number does not account for engagements through ad hoc face-to-face meetings, focus group discussions and people who took BIDs without completing the attendance register. Various size site notices were posted in public places in Zambia and Zimbabwe.

The issues and concerns raised by stakeholders were captured in the Issues Log. The Issues Log is used to inform the social baseline study, as well as the impact identification and assessment process. An analysis of the Issues Log indicates that issues and concerns related to employment opportunities and working conditions dominated the consultation process (25 percent). This was followed by concerns related to the plunge pool rehabilitation works at 20 percent. Health and safety concerns linked to the alleged potential collapse of the Kariba Dam wall and enquiries linked to the availability of the emergency response procedures for the downstream users follows with 16 percent of the captured issues.

The ESIA stakeholder engagement process was undertaking during the week starting the 2nd March 2015. The objective of this phase of engagement was to: (i) Present the key social and environmental impacts identified in the ESIA report, and proposed mitigation; (ii) Involve stakeholders in assessing the efficacy and appropriateness of the proposed mitigation measures; (iii) Capture stakeholder concerns and opinions on the identified impacts; and (iv) Identify revisions or additions to the ESIA report where necessary. The ESIA engagement process targeted the following stakeholders: National, Provincial, and District level government officials; Local Communities (within sub-basin 5); and Other Interest groups/ or parities.

The ESIA engagement and disclosure process involved: Public meetings (for the local communities, general public as well as interest groups/ or people); Workshops with the national, provincial and district level government officials; Formal Ms PowerPoint Presentation (that were presented to stakeholders at the meetings); Updating of the existing Issues and Concerns Log (to capture and respond to stakeholder issues and comments); and The use of an ESIA Non-Technical Summary (NTS) in English, Shona and Tonga.

10. ESMP

The ESMP for Kariba Rehabilitation Project has been compiled as Volume III of the ESIA. The ESMP consists of a series of plans and components outlining management measures to address different impacts throughout the life of the Project. Each individual Management Plan outlines proposed mitigation measures in accordance with proposed performance criteria for specified acceptable levels of environmental and social performance. The Management Plans identify: (i) Environmental and social objectives that the management plan aims to achieve; (ii) Person responsible for implementation; (iii) Performance criteria; (iv) Mitigation strategies; (v) Relevant monitoring requirements; and (vi) Reporting and corrective action requirements.

The Management Plans included in the overall ESMP include: (a) Noise and Vibration Management Plan; (b) Air Quality and Dust Management Plan; (c) Soil Erosion and Sediment Control Management

Plan; (d) Waste Management Plan; (e) Dangerous Goods and Hazardous Substances Management Plan (Including Storage of Explosives); (f) Surface Water Quality Management Plan; (g) Aquatic Ecology Management Plan; (h) Terrestrial Ecology Management Plan; (i) Revegetation and Rehabilitation Management Plan; (j) Social Values Management Plan; (k) Procurement of Goods and Services Management Plan; (l) Road Safety Management Plan; (m) Social Infrastructure Management Plan; (n) Community Health and Safety Management Plan; (o) Traffic and Transport Management Plan; (p) Worker Health and Safety Management Plan; (q) Employment and Training Management Plan; (r) Tourism Management Plan; (s) Cultural Heritage Management Plan; (t) Grievance Management and Incident Reporting Plan; (t) Environmental Induction and Training Management Plan; (u) Blasting Management Plan; (v) Emergency Preparedness Plan; (w) Dam Safety Plan.

The key role-players during the rehabilitation works, for the purposes of environmental and social management on the site, include but are not limited to: (i) The Developer (ZRA); (ii) The Engineer; (iii) The main Contractors (direct appointments including civil works contractor, building contractor, landscape contractor etc.); (iv) The Environmental Control Officer (ECO); (v) Representatives of the relevant Zambian and Zimbabwean Authorities; and (vi) Any lenders the provide funding for the Project.

The total estimated cost for implementation of environmental and social management commitments (including monitoring) is estimated at US$ 2,225,000.00.

11. CONCLUSION

The Kariba Dam Rehabilitation Works Project is not a scheduled activity under the Zambian and Zimbabwean Environmental Legislation (1); however, the ZRA has committed to comply with international guidelines and standards, and as such were required to undertake a full ESIA for the Project. In addition to international guidelines and standards, the ESIA has conformed and met the environmental regulatory requirements for both Zambia and Zimbabwe.

The ESIA report is the second and final phase of the overall ESIA process being undertaken in support of the proposed Project, and forms the basis on which the environmental license/approval is issued. The purpose of the ESIA report is to: (i) Present a detailed baseline review of the physical, biophysical and social characteristics of the Project Area of Influence and surrounds; (ii) Assess the impacts (including cumulative impacts) of the physical, biophysical and social environments related with the different phases of the proposed Project; and (iii) Provide mitigation measures and an associated environmental and social management plan that aims to avoid /minimise/manage the severity of identified impacts.

The ESIA process undertaken has identified and assessed a range of potential environmental and social impacts associated with the proposed Kariba Dam Rehabilitation Project; however, provided that the environmental and social mitigation/management measures provided in the ESIA and associated environmental and social management plan are implemented, the majority of the impacts will be reduced to a minor to negligible level of significance.

Provided that all the mitigation/management commitments provided in the environmental and social management plan are implemented, it was the opinion of ERM that there are no environmental or social fatal flaws which inhibit authorization of the proposed Kariba Dam Rehabilitation Project.