Mpatamanga Hydropower Project

Environmental & Social Impact Assessment

Volume I – Non-Technical Summary

Prepared for

MHPL

Revision E

31 July 2024

Making Sustainability Happen

Revision Record

Revision	Date	Prepared by:	Checked by:	Description:
A	05 July 2024	M. Bremond D. Buffin J. Hughes Iz. Olivier Cl. Repussard N. Bukowski M. Scott T. Rousseau	D Buffin	First issue for MHPL review (without Alternatives Analysis)
B	18 July 2024			Second Issue for MHPL review
C	19 July 2024			Third Issue for MHPL and PIU review
D	23 July 2024			Fourth issue taking onto account into account comments on Rev B and C received on 22 Jul 2024
E	31 July 2024			Fourth issue taking onto account into account comments on Rev D received on 26 Jul and 30 Jul 2024

Citation: SLR Consulting (2024). Mpatamanga Hydropower Project: Environmental and Social Impact Assessment, Non-technical Summary, Revision E, July 2024.

SLR Consulting France SAS
2 Square Roger Genin, 38000 Grenoble, France
T: +33 6 23 37 14 14
www.slrconsulting.com

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Acronyms

Acronym	Full text
E&S	Environmental & Social
EDF	Electricité de France
EFA	Environmental Flow Assessment
EIA	National Environmental Impact Assessment
ESIA	International Environmental & Social Impact Assessment
ESS	World Bank's Environmental & Social Standards
FSL	Full Supply Level
GBV	Gender Based Violence
GBVH	Gender Based Violence and Harassment
GVGRC	Group Village Grievance Redress Committees
GIP	Good Industry Practices
GoM	Government of Malawi
GRM	Grievance Redress Mechanism
HPP	Hydro Power Project
IBA	Important Bird Area
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
km	kilometre
LC	Least Concern
m. asl	Elevation in meters above sea level
MHPL	Mpatamanga Hydro Power Limited
Mm^3	Million cubic metres
N/A	Not Applicable
NGO	Non-Governmental Organization
NT	Near Threatened
NTS	Non-Technical Summary
PIU	(Government of Malawi) Project Implementation Unit
UNESCO	United Nations Educational, Scientific and Cultural Organization

Preamble

This report is the Non-technical Summary (NTS) for the Mpatamanga Hydro Power Project (Project). It forms Volume 1 of the Environmental and Social Impact Assessment (ESIA) Report. The purpose of the NTS is to convey the key findings of the 2024 ESIA and 2024 Environmental & Social Management and Monitoring Plan (ESMMP) in a clear and concise format to allow the public to understand the Mpatamanga hydropower project development, its likely significant effects, and the planned mitigation and management strategy.

This NTS is currently a draft prior to being made available for public disclosure. Feedback on the ESIA and ESMMP during the public disclosure process could affect the content of the final NTS.

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	• Chapter 1: Introduction • Chapter 2: Project Description • Chapter 3: Methodology • Chapter 4: Legal framework • Chapter 5: Baseline • Chapter 6: Alternatives Analysis • Chapter 7: Stakeholder Engagement • Chapter 8: Impact Assessment • Chapter 9: Eflows Assessment • Chapter 10: Climate Change • Chapter 11: Cumulative Impacts • Chapter 12: Transboundary Impacts	• Chapter 1: Introduction • Chapter 2: E&S Management Approach • Chapter 3: ESIA and E&S Commitments • Chapter 4: ESHS requirements – All EPCs • Chapter 5: ESHS requirements - MHPL • Chapter 6: ESHS requirements - GoM • Chapter 7: Workplan & Budget

1 Project Overview

1.1 Malawi's Energy Context & Need for the Project

The main consumption of energy in Malawi is burning of wood and charcoal for household cooking and heating. Electricity generation accounts for 3% of the country's total energy consumption, of which 72% is hydropower, 18.4% solar and 9.6% thermal. The state-owned Electricity Generation Company (Malawi) Limited (EGENCO) is responsible for the operation, maintenance, and improvement of the power generation facilities owned by the GoM. These include hydroelectric, thermal and solar power plants. Currently, EGENCO operates four hydropower schemes: Nkula, Tedzani, Kapichira and Wovwe. The country's total installed capacity in 2024 is about 550 MW, of which about 400 MW is hydropower.

Malawi is currently experiencing energy shortages and there is frequent load shedding – in part linked to the vulnerability of hydropower assets to periods of reduced flows in the Shire River during drought. Energy demand is forecast to continue to increase, and the GoM has developed a power generation strategy that includes a mix of technologies to reduce vulnerabilities to climate change.

The Mpatamanga Hydro Power Project is a flagship Project of the GoM. It has the potential to contribute to reducing energy shortages and enhancing energy security in Malawi in the short term, which will help bolster the economy and enable renewable energy projects to be developed to meet the mid to long-term energy demands.

1.2 Project's Main Features

The proposed Mpatamanga Hydro Power Project (the Project) is being developed by Mpatamanga Hydro Power Limited (MHPL). The Project is in the Southern Region of Malawi, within the Blantyre and the Neno Districts, on the Shire River, the largest river in Malawi, between the existing Tedzani and Kapichira hydropower schemes (see Figure 4-1). The proposed Main Dam (55 m high) will create a 20 km² reservoir at full supply level, with a total storage volume of 272 million m³. Water from the Main Reservoir will drop by approximately 66 m to a 301 MW powerhouse located 1 km downstream of the Main Dam. The water discharged from the main powerhouse into the Shire River (installed capacity of 550 m³/s) will then flow into a 1.4 km² regulating reservoir (at full supply level) created by a 45 m high regulating dam located 6 km downstream on the Shire River. Water from the Regulating Reservoir will be discharged into the Shire River through a 57.5 MW powerhouse located at the foot of the dam (installed capacity of 388 m³/s). From the upper part of the main reservoir to the Regulating Dam, the Project footprint will extend over 29 km of river length.

No Project facilities directly encroach into existing or planned internationally recognised biodiversity areas. A short distance (< 300 m) downstream of the Regulating Dam, the Shire River will flow through the IUCN Category IV Majete Wildlife Reserve for 11 km before entering the existing Kapichira reservoir.

The Project will have a generation capacity of 358.5 MW, composed of two plants – the 301 MW peaking plant at the Main Dam and the 57.5 MW baseload downstream plant at the Regulating Dam. The Project is expected to contribute to reducing energy shortages and enhancing energy security in Malawi. The 301 MW plant, with its Main Reservoir storage, is designed to provide much-needed energy during peak demand hours of the day and overall grid stability with its ability to ramp up or down production to meet actual demand. The targeted average annual energy production is 1,544 GWh (Main Dam and Regulating Dam combined).

The electricity generated by the Project will be delivered to the grid through two transmission lines: a 63 km long 400 kV transmission line from the main powerhouse to the existing Phombeya sub-station; and a 10.5 km long 132 kV transmission line that will connect to the Regulation Dam powerhouse to the existing Tedzani-Kapichira Transmission Line.

Part of the existing S137 road, which links Blantyre to Mwanza, will be flooded by the future Mpatamanga Main Reservoir. A new by-pass section of the S137 road will be built by the Project, and will pass over the main dam. The future Chileka-Mwanza/M6 to S137 road will be ~50 kms long. Out of these, 11.5 kms will be newly constructed by the Project to bypass the Main Dam and its reservoir, and 34.5 kms will be upgraded on the Blantyre side.

For the operational phase, a permanent operators' village will be built close to the main powerhouse, to accommodate the operators of the two dams. A new 6 km long service road will be built by the Project from the main powerhouse to the regulating dam. During the construction period, the workforce will be accommodated in one construction camp that will be located close to the main Project facilities, away from the Majete Wildlife Reserve.

A 54-month construction schedule has been estimated for the Project, starting in early 2026. The commissioning of the powerhouses is scheduled for mid-2030. Early works (resettlement sites) are planned to be executed from 2025.

1.3 Developer

The Project is to be developed on a build-own-operate-transfer (BOOT) basis by MHPL and the Government of Malawi (GoM), in coordination with the IFC. MHPL is the Project Company. MHPL will be responsible for constructing and operating the Project for a period of 30 years, after which time it will be transferred to GoM for continued operation and maintenance. An Implementation Agreement, which stipulates the responsibilities of MHPL and GoM, will support the BOOT agreement.

The BOOT approach allows GoM to be protected from operating risk, while at the same time allowing it to benefit significantly from a 30% share in the Project through EGENCO. The remaining 70% of MHPL will be owned by EDF (27.5%), Scatec (14%) and its joint venture partners British International Investment (6.75%) and Norfund (6.75%), as well as the IFC (15%).

Finance will be provided by EDF, Scatec, the IFC, and the Government of Malawi, using funds from the World Bank Group, as well as debt from development finance institutions (the Lenders), to be co-ordinated by the IFC.

1.4 ESIA Process and Methodology

1.4.1 ESIA Process

At the time of writing, the Mpatamanga Project was yet to apply for award of an Environmental Permit by the GoM Environmental Authority (MEPA).

The Project initiated the regulatory ESIA process through the submission of a Project Brief in 2020 to the Environmental Affairs Department (EAD, now MEPA). Terms of Reference were then issued by EAD to the Mpatamanga Project in December 2020. The ESIA preparation started in 2021, but the progress was hindered by the global onset of COVID-19. With the arrival of new Project sponsors and the creation of MHPL, the ESIA process resumed in 2022 with a target completion date of end 2024 through the submission of this 2024 ESIA to, and approval by, MEPA.

To ensure compliance with their Environmental and Social (E&S) policies, the Lenders have recommended that supplementary environmental and social studies be undertaken to complement the requirements of the Terms of Reference issued by EAD in 2020.

This Environmental and Social Impact Assessment (ESIA) for the Project has been prepared between May 2023 and July 2024. Its purpose is to present the main aspects of the environmental and social assessment process and define the key management, mitigation and enhancement measures for predicted impacts and risks. The report will be used to facilitate decision making for national regulatory approvals, environmental permitting, international funding and ensuring the sustainable design and management of the project.

1.4.2 ESIA Approach & Methodology

The changes to the physical, biological and human environment resulting from the Project activities were identified and qualitatively and quantitatively assessed on the basis of technical analysis, as well as stakeholder perspectives. The identified area of influence of the Project, which is the geographical scope of the impact assessment, is illustrated on Figure 4-3.

Environmental and social baseline information was collected within the area of influence between May and December 2023. It included field observations and secondary data collection on community health and livelihoods, terrestrial and aquatic ecology, noise levels, water and air quality, landscape and traffic topics.

The identification of impacts requiring detailed analysis and planning (scoping stage) was presented in October 2023 to communities and institutional stakeholders for input and validation.

Detailed analysis of the most significant potential impacts and issues, as well as definition of avoidance, minimisation, and compensation measures for all significant impacts, was undertaken during January 2024 to June 2024. It was based on modelling, expert judgment and stakeholder engagement. Design solutions for potential impacts were integrated into the basic design of the Project within the same time period. The ESIA preparation also used the findings of specialist studies and plans prepared prior to and during 2023 and 2024, including Resettlement Policy Framework (RPF), the habitat analysis and biodiversity action planning (BAP), and cumulative impact assessment at river basin level (CIA).

The outcome of the 2024 ESIA process was presented to and discussed with affected communities and institutional stakeholders in July 2024. Their feedback was incorporated into the 2024 ESIA prior to its initial disclosure in accordance with the United States Government's Pelosi Amendment (1989).

1.5 Applicable Standards

The Project will comply with the existing environmental, social, health and safety laws and regulations in Malawi as well as all international conventions ratified by Malawi and applicable to the Project. This includes conventions related to the protection of the environment (water, air, soil, noise, vegetation, fauna, flora, waste, groundwater) and the protection of people (human rights, labour law, indigenous populations, standards on occupational health and safety and others, including standards of the International Labour Organization (ILO)).

The Project will also comply with the environmental and social policies of the Lenders, including the 2016 World Bank Environmental and Social Framework; the 2012 IFC Performance Standards, and the World Bank Group Environmental, Safety, and Health Guidelines; the 2020 Equator Principles 4; and the relevant EDF and SCATEC corporate requirements.

1.6 Alternatives Analysis

The assessment of alternatives to the proposed Project addresses both (i) the energy production alternatives to the proposed scheme (including both hydro and non-hydro projects, as well as the no-project alternative) and (ii) the alternatives and options that were envisaged and discussed between the technical and environmental and social teams during Project preparation when optimising the location, size, structural design, construction principles and proposed operation of the scheme/ Key points are summarised in the below paragraphs:

- No Project Alternative: If the Project is not implemented, the Project's negative impacts can be avoided, but benefits and positive impacts will not be realised. There would continue to be a gap in Malawi's power production strategy and a lack of access to reliable power supply services which hampers Malawi's economic growth and contributes to poverty, and isolation, of the rural population. Without the Mpatamanga Project, alternative power production projects that are not already included in Malawi's power strategy would need to be developed. This could include expanding the capacity of the planned 300 MW Kam'mwamba coal power plant project. However, this would go against Malawi's commitments related to climate change and GHG emissions. The GoM would have a choice of either facing power shortages or reviewing its commitments about climate change and GHG emissions.
- Alternative Technologies for Power Generation: The GoM's power strategy is to develop a power mix that is resilient to climate change. Alternative technologies to the Mpatamanga Project comprise thermal, geothermal and renewable energy projects. Development of thermal power projects that are in addition to those already envisaged by the GoM would go against Malawi's GHG emission reduction targets and commitments. Development of geothermal and renewable energy projects are planned for the mid-to long-term however, it is not realistic for such projects to be implemented within the required time frame to replace Mpatamanga.
- Alternative Design Options and Design Evolution: The design of the Mpatamanga Project has evolved since the first concept was envisaged in 1998. In 2019, considering concerns previously raised by community and government stakeholders, the project added a regulating dam downstream of the main dam, as a key component to mitigate major flow fluctuations which would have led to significant downstream effects and to provide more energy generation. Since then, Project design features that have been the subject of design and optimisation studies include type of dam structure, dam height, headrace tunnels, bottom outlet, reservoir water level, environmental flow, general layout, transmission line routing, access road routing, fish pass, substation design, alternatives to avoid resettlement, and review of potential impacts on biodiversity. The Basic Design finalised in 2024 is the Reference Design for the 2024 ESIA.
- Alternative Modes of Operation: Aspects of alternative modes of operation that have been assessed prior to finalisation of the 2024 Basic Deign comprise: Alternative flow rates and optimisation of the environmental flow, run-of-river mode of operation, and operation of the regulating dam without turbining the discharge.

2 Environmental and Social Assessment

2.1 Hydrology, River Geomorphology and Water Quality

2.1.1 Changes in Hydrology

The flow in the Shire River is heavily dependent on the outflow of Lake Malawi which, since 1965, has been regulated by the presence of the Kamuzu Barrage, located 73 km downstream of the lake. The operation of Kamuzu Barrage at Liwonde acts to both control water levels upstream in Lake Malawi and to manage downstream flows into the Shire River such that the adverse impacts in the Shire River that are associated with droughts and floods are reduced.

The proposed Main Dam is located 116 kms downstream of the Kamuzu Barrage. Under typical flow conditions, the outflow of Lake Malawi contributes almost 85% of the flow at Mpatamanga Gorge, with the remainder of the flow being generated in the 'intervening catchments' between the Kamuzu Barrage and the Mpatamanga dam wall, such as the Rivi Rivi and Lisungwe catchments. Flow generated in the 'intervening catchments' varies markedly throughout the year, with a clear seasonal pattern of higher flows between January and March, after which time these gradually fall to a minimum in November. In contrast, although longer term variations do exist, the outflow from Lake Malawi regulated by Kamuzu Barrage remains relatively constant, with slightly higher flows experienced during the period April to June. Overall, the current average flow at Mpatamanga Gorge is 265 m^3/s.

The flow in the Shire River gradually increases as the river travels downstream of the main dam. The Mkulumadzi tributary joins the Shire River in the north-eastern corner of the Majete Wildlife Reserve, the Likhabula tributary joins immediately upstream of Chikwawa Bridge, and the Mwanza tributary joins a further 26 km downstream, in the northern part of Elephant Marsh. At this location, the river has begun to meander from side to side and is bordered by a wide floodplain that supports a wide range of terrestrial and aquatic habitats and human activities. At this point the average flow in the Shire River has increased to approximately 300 m^3/s.

Flow in the Shire River is also affected by human activity, particularly by the existing hydropower plants at Nkula, Tedzani, and Kapichira. The dam walls at each of these hydropower plants create small upstream reservoirs, and flow is diverted through intake turbines and / or spilt over the dam walls. Electricity production at these hydropower plants also significantly affects the variation in river flow throughout the day, as water is stored in the upstream reservoirs and released through the power turbines during periods of peak electricity demand. Water levels at the Mpatamanga Gorge have been recorded in 2023 and 2024 as changing multiple times during the day by between 0.57 m and 1.32 m. Further downstream near the Majete Wildlife Reserve, larger daily variations in water level of between 0.72 m and 2.37 m have been recorded. During these periods, the Shire River almost doubled / halved in flow, often over the duration of just a couple of hours.

Extreme weather events are also an important feature in the Shire Valley, particularly with regards to flooding and associated damage. Notable major events occurred in 1946 (Cyclone Edith), leading to large scale changes in lakes and wetlands in the southern part of Elephant Marsh and in 2015 (Tropical Storm Chedza) leading to the realignment of the Ruo River and a change in the morphology of the southern Elephant Marsh. More recently, in 2022 (Cyclone Ana), lead to extensive damage at the Kapichira dam and significant power outage, impacts on infrastructure, and environmental degradation.

During construction, the Project is expected to not have a significant impact on the hydrology of the Shire River as river diversions will ensure that downstream flow is neither interrupted nor significantly reduced for the whole period of construction. The diversion tunnel for the Main Dam will be operational for between 2 and 3 years. It will convey a flow of 529 m^3/s. During any periods when flow in the Shire River is greater than the capacity of the diversion tunnel, water will

continue to flow down the main river channel. The river diversion for the Regulating Dam involves diverting the flow of the Shire River towards the Blantyre side of the river, then towards the Neno side, then back again towards the Blantyre side, as dam wall construction progressively takes place behind temporary cofferdams.

During the first filling of the Main Reservoir, 90% of the flow in the Shire River will be released downstream, firstly though use of the diversion tunnel, and then, as water levels begin to rise in the Main Reservoir, progressively through the spillway. Assuming typical flow conditions during reservoir filling, it is expected to take 3 to 4 months to fill the Main Reservoir.

During operation, the functioning of the Project will cause significant changes to the hydrology of the Shire River, between the existing Tedzani hydropower plant and the Kapichira reservoir. The principal change will be the conversion of 29 km of fast flowing river into: (i) 22 km of deep, relatively still water in the Main Reservoir, (ii) 0.85 to 2.5 km of dewatered reach between the two reservoirs, and (iii) 4 to 6 km of relatively shallow, depth varying lake-like conditions in the Regulating Reservoir. Loss of river water due to evaporation from the two proposed Mpatamanga reservoirs will be negligible.

During normal operating conditions:

- The water level in the Mpatamanga reservoirs could typically vary:
  - Within 0.5 metres of the full supply level in the Main Reservoir;
  - Between 6 and 8 metres in the Regulating Reservoir, throughout the day.

- The Shire River flow between the Main Dam and the Regulating Reservoir will be:
  - 2 m^3/s between the Main Dam and the Main powerhouse, except during spillage: This minimum flow release will be discharged into the dewatered reach by a jet valve. When there is no spilling over the main dam wall, this minimum flow is not expected to result in a continual flow of visible river, but rather is expected to flow between the cobbles and boulders of the riverbed and result in small local pools of water. The quantity of water spilled over the dam into the dewatered reach wall can vary considerably. It will depend on the amount of water flowing into the Main Reservoir but also on any deviations from the expected Main Reservoir power production schedule. Spilling of about 120 m^3/s may occur for over 200 days per year on average, or as infrequently as less than two weeks per year on average if power production is maximised.
  - 550 m^3/s during periods of peak power production from the Main Powerhouse into the Regulating Reservoir, typically for 9 hours per day distributed over two to three hydropeaking periods. For the remaining 15 hours of the day, typically no power or constant low-level power will be produced, and hence there will be no or low flow from the main powerhouse into the Regulating Reservoir. River flow conditions in the reach between the Main Powerhouse outlet and the Regulating Reservoir will vary markedly throughout the day: the width, depth, and speed of water will change quite dramatically depending on whether or not the main powerhouse is producing electricity.

- The Shire River flow from the Regulating Dam down to the Kapichira Reservoir will be within a range of plus or minus 10% of the previous day's inflow into the Main Reservoir.
- Downstream of the Kapichira Reservoir, any flow variations will be attributed to the operation of the Kapichira HPP, not to the Mpatamanga Regulating Reservoir operation.

Outside of normal operating conditions, when the amount of water flowing into the Main Reservoir is greater than 550 m^3/s:

- the Main Reservoir ceases to operate as a 'hydropeaking' plant. Under such 'high flow' conditions, the Project is operated such that flows passed downstream will not be higher than the flow that would have occurred if the Project did not exist.

- there will be no noticeable flood attenuation effects associated with the Main Reservoir and Regulating Reservoir due to the low storage volumes associated with the operational range of the two reservoirs.

The changes to hydrology as a result of the Project have consequences on other aspects of the social and natural environment. These are addressed in the next sections of this summary.

The inclusion of a Regulating Reservoir in 2019 within the design of the Project was a significant step in minimising a general change in the hydrological conditions of the Shire River. Additional mitigation measures to further minimise adverse effects on downstream social and environmental reliance are planned as follows:

- During filling of the Main Reservoir, although 90% of the river flow will be released downstream, a 10% reduction of flow in the Shire River may affect downstream environmental and social use, for example, for hydropower production and irrigation water supply at Kapichira Reservoir. To minimise any such downstream impacts for the duration of reservoir filling and depending on the flow conditions in the Shire River at the time of reservoir filling, an additional release of water from Kamuzu Barrage may be required.
- During normal operation of the Project, when power production at the main powerhouse varies throughout the day and flow into the Regulating Reservoir varies accordingly, the flow out of the Regulating Reservoir can vary by +/-10% (otherwise expressed as 20% overall). To ensure that any such variation does not take place too quickly and cause danger to communities, animals or ecological health, including when the Shire River runs through the Majete Wildlife Reserve, the maximum rate-of-rise and rate-of-fall of river water levels have been defined as 1 cm per minute.

Additional mitigation measures have been defined to both ensure that the Project does not contribute to an increase in downstream flood risk and to assess any incremental upstream flood risk, for example at the M6 road bridge over the Lisungwe tributary and at Tedzani hydropower plant, that may be caused by the presence of the Main Reservoir.

2.1.2 Changes in Sediment Transport and River Geomorphology

Sediment transport and river geomorphology is dependent on both the physical geography characteristics, the amount of sediment that is eroded in the watershed and is transported to the Shire River, and the erosional and depositional processes that take place within the Shire River itself. The estimated average annual soil erosion rate over the watershed is predicated to be 711 tonnes per km^2. However, soil erosion rates vary widely and are typically higher in steep areas with no vegetation cover: Areas with extreme average annual erosion rates of more than 10,000 tonnes per km^2 occupy less than 1% of the catchment area but contribute one quarter of the total amount of soil erosion. High erosion rates are associated with the Ruo River in the Shire which flows into the southern part of Elephant Marsh (6.1 million tonnes per year), and the Lisungwe tributary which flows into the proposed Project Main Reservoir (1.8 million tonnes per year).

Not all the soil that is eroded from the watershed finds its way into the Shire River as, depending on the shape and overall slope of the contributing catchments, some of it remains in tributary rivers. Additionally, erosion from the tributaries and river channels is another source of sediment input into the Shire River. The amount of sediment that reaches the Shire River upstream of the proposed Mpatamanga Main Reservoir is estimated to be 2 million tonnes per year, of which 55% is sand and 45% is fine material. Approximately half of this is from the Shire River upstream of Tedzani, and the majority of the remainder is from the Lisungwe tributary. Downstream of the Main Reservoir, an additional 1.5 million tonnes per year of sediment is delivered to the Shire River upstream of the lower extent of Elephant Marsh. At the downstream extent of Elephant Marsh, an additional 1.1 million tonnes is delivered by the Ruo River. Other main sources of sediment include the Likhabula tributary, the Mkulumadzi tributary and the Mwanza tributary.

During construction, no significant sediment transport or river geomorphology impacts are predicted to occur.

During operation, the Project will result in significant changes on the sediment transport and river geomorphology of the Shire River, primarily due to the trapping of sediment in the proposed Main Reservoir. The Main Reservoir will trap 100% of incoming coarse sediment (sand) and a large majority (~90%) of incoming fine sediment (silt & clay). Because of sediment trapping, there will be:

- Sediment deposition at the upper limit of the reservoir, potentially affecting the M6 road bridge over the Lisungwe tributary and operation of the Tedzani hydropower plant, after 30 years of operation.
- Reduction in the amount of sediment that is transported through the Majete Wildlife Reserve by the Shire River and further downstream of Kapichira, and:
  - Resultant lowering of riverbed levels and bank erosion;
  - Reduction in floodplain groundwater levels; and
  - Reduction in the frequency, duration, and extent of flooding in the Shire floodplain downstream of Kapichira.

There are uncertainties in the prediction of the timing, location, and magnitude of impacts on downstream river geomorphology during operation. This is due to predictive models' limitations for sediment transport and erosion, and because downstream of Kapichira the depth of the bedrock in the Shire riverbed is not known.

Downstream riverbed erosion and bank erosion in the Shire River will occur at different rates and to different depths between the Regulating Reservoir and the confluence with the Mwanza tributary. A precautionary approach has been adopted and conservative assumptions regarding riverbed erodibility were included in the modeling studies. Given the lack of available information on riverbed erodibility, two different 'scenarios' have been considered: i) 'Without a Non-erodible Sub-Layer' – where the depth of unconsolidated sand may extend to up to 20 m; and ii) 'With a Non-erodible Sub-Layer' – where the depth of unconsolidated sand is limited to typically 5 m.[1] Within this scenario-based approach, the predictions, illustrated on Figure 4-4 with reference to the 'without project' predicted conditions, are as follows:

- Between the Regulating Reservoir and Kapichira Reservoir, the depth of riverbed erosion is limited by the presence of hard bedrock. Sandbars present in this reach are likely to be washed away.
- Riverbed lowering is likely to be constrained to that part of the Lower Shire between Kapichira and 11 km downstream of Chikwawa Bridge, with the most lowering restricted to taking place upstream Chikwawa Bridge:
  - From the Kapichira Reservoir to 10 km downstream, the potential effects on riverbed incision and bank erosion would be the most severe, if and when they occur. Without a non-erodible sub-layer, the depth of riverbed erosion could be up to in the order of 6 m after 30 years of Project operation, increasing up to 17 m after 90 years of Project operation. If there is a non-erodible sub-layer below the current riverbed, maximum erosion depths of 8 m are predicted to occur 4 km downstream of Kapichira after 30 years.
  - From 8 km upstream of Chikwawa Bridge to the bridge itself, in the short-term, erosion is predicted to be limited but, without a non-erodible sub-layer, after 30 years of Project operation, the riverbed could lower by up to 2 m and after 70 years of Project operation by more than 4 m. If there is a non-erodible sub-layer below the current riverbed, the riverbed levels are expected to rise within the first 10 years of Project operation, thereafter, eroding away to between 2 m and 5 m below current levels after 50 years of Project operation.
  - From Chikwawa Bridge to 11 km downstream, the predicted lowering of riverbed levels becomes less pronounced. Without a non-erodible sub-layer, no general lowering of the riverbed is predicted in the first 30 years of Project operation. Localised bed

[1] The depth of the non-erodible sub-layer varies spatially: within this scenario it is assumed to be at a depth of 1 m in the reach from Mkulumadzi to Kapichira, then 5 m thereafter, except for a short 1.5 km reach downstream Kapichira in which – due to recent deposition associated with Tropical Storm Ana – it is assumed to be at 8 m.

lowering of up to 1 m is predicted after 50 years of Project operation, increasing to 2 m of lowering after 70 years and 3 m of lowering after 90 years. If there is a non-erodible sub-layer below the current riverbed, this would only tend to limit the predicted riverbed lowering after 90 years of operation and would not constrain earlier predicted lowering.

- From 10 km upstream the Mwanza tributary confluence to the confluence itself, lowering of bed levels only occurs after 70 years of Project operation, and in the first 4 to 5 km downstream of Chikwawa Bridge. More generally, an increase in riverbed levels of 1 m, increasing to 2 m at the Mwanza tributary confluence, are predicted, irrespective of the presence or absence of a lower non-erodible layer.
- Downstream the Mwanza tributary confluence, a short 1 to 2 km reach of river is predicted to be prone to riverbed lowering of up to 0.5 m depth, otherwise, a general increase in riverbed levels of approximately 0.5 m are predicted to gradually take place over 70 to 90 years of Project operation. Overall, the impacts from the project operation on the Elephant Marsh geomorphology are predicted to be negligeable.

The adopted mitigation strategy for the Project does not include measures to reduce soil erosion or sediment yield from the watershed as these have been assessed as operationally complex and requiring the long-term engagement and commitment from multiple stakeholders not under the control of MHPL.

For upstream effects, seasonal drawdown of the Main Reservoir water level could be required after 30 years of Project operation to minimise the impacts associated with sediment deposition at the upper limit of the Main Reservoir. This measure would wash deposited sediment further into the Main Reservoir where no further sediment management would be required because there is no impact on the live storage of the main reservoir. If and when required, seasonal drawdown could be complemented with localized dredging at the Tedzani HPP outlet or close to the M6 bridge in the Lisungwe branch of the main reservoir.

The downstream impacts on river geomorphology due to sediment trapping in the Main Reservoir cannot be directly mitigated. Sediment flushing options to restore part of the downstream sediment transport were discarded as not efficient enough given the size and the shape of the Main Reservoir. Rather, the Project will seek to monitor and mitigate the ecological and social consequences of downstream riverbed and bank erosion, if and when they occur as a result of the Project operation. These 'consequence' impact mitigation measures are discussed, where applicable, in relevant other sections of this document.

2.1.3 Changes in Groundwater Availability

In the project area only two types of aquifers are present: (i) a Quaternary shallow alluvial aquifer, and (ii) a deeper-lying Archaean fractured basement aquifer. Groundwater boreholes inspected during the baseline survey abstract groundwater from the deeper-lying fractured basement aquifer. Close to the Shire River, particularly in the Lower Shire River floodplain where alluvial thickness is less than 5 m, the local population abstract water from the shallow alluvial aquifer through hand dug wells. Groundwater is the most dominant water supply source for the rural areas in the Shire River watershed where, in the deeper-lying fractured basement aquifer, average yields vary between 1 and 2 litres per second. Close to the proposed Main Reservoir, the yields are usually lower, and boreholes are exclusively installed with hand pumps. In the alluvial aquifers of the Upper and Lower Shire Valley, groundwater yields of greater than 20 litres per second have been obtained. However, localised water quality problems associated with high alkalinity, taste, and pollution by faecal contamination have been experienced in some parts of the Lower Shire Valley.

During construction, no significant groundwater availability impacts are predicted to occur.

During operation, the Project is predicted to:

- Raise groundwater levels around the Main Reservoir and Regulating Reservoir. No impacts on groundwater availability associated with raised groundwater levels around the Project

reservoirs were predicted. Potential risks on groundwater quality are discussed in Section 2.1.4.

- Lower groundwater levels downstream of the Regulating Reservoir, associated with predicted lowering of the riverbed. Consequential impacts on ecosystem services (soil moisture and local irrigation of farmland, fisheries) and terrestrial (birds) and aquatic (wetland) habitats are described in Section 2.11, together with the planned mitigation measures.

2.1.4 Changes in Water Quality

2.1.4.1 Surface Water Quality

The key baseline surface water quality characteristics are as follows:

- The river and its main tributaries are characterised by high levels of nitrogen and phosphorus, thought to originate from discharge of sewage and/or the extensive use of fertilizers in the catchment. There are no major industries or large-scale production facilities in the watershed and consequently there is no chemical pollution in the river.
- Dissolved Oxygen levels are mostly near saturation levels and typical of rivers not subject to eutrophication. However, some areas have dissolved oxygen concentrations that are at 70% saturation or less.
- The river waters are widely contaminated with faecal coliforms and faecal streptococcus. The contamination is due to the absence of sanitary wastewater treatment facilities throughout the catchment area.

During construction, without mitigation measures, the impacts on the Shire River water quality would be as follows:

- Water quality of the Shire River at the Project site and downstream is potentially altered by (i) runoff from worksites polluted from accidental leaks and spills of hazardous substances, and (ii) domestic and sanitary waste. These potential impacts will be significantly mitigated by implementing Good International Industry Practices (GIIP) pollution prevention and protection measures.
- Construction works will include in-channel river works which are expected to cause a localised increase in turbidity and sediment load in the river downstream. The magnitude of the impact will be reduced by implementing protection measures to control erosion, stabilise slopes and riverbanks, minimise in-channel works, and rehabilitate disturbed areas at the end of the construction period. Because the river naturally has a high sediment load, the increase in sediment and turbidity caused by the Project is expected to be minor.
- Reservoir impoundment will flood vegetation and cause the reservoir waters to have a higher level of suspended solids, and vegetation debris (leaves, twigs, branches and logs) will float on the surface of the reservoir and carried downstream with the river water released from the reservoir. The duration of the reservoir filling is constrained by a legal requirement to release 90% of the inflow downstream and retain 10% of the inflow to fill the reservoir, and consequently the residence time of the impounded water is expected to be between 6 and 20 days. Because of the release of 90% of the inflow, short residence time and relatively small amounts of flooded biomass, it is expected that levels of suspended solids and floating vegetation in the downstream river will not exceed typical levels that occur during interannual flood events. Consequently, alteration to river water quality is therefore expected to be within the limits of naturally occurring variations.

During operation, the unmitigated potential impacts on the Shire River water quality would be as follows:

- Reservoir thermal stratification is expected, with the thermocline at a depth of between 6 to 12 m below the surface. Destratification is expected each year for a duration of 1 to 4 months. Minor alteration to downstream water temperature is expected because the power waterway intake is at an elevation below the thermocline and water abstracted from the reservoir is taken from the cooler lower layer. The downstream water temperature is

predicted to be generally increased by ~1°C and under infrequent flow conditions can be increased by 2-3°C. No mitigation measures are planned. However, monitoring will be performed.

- Nutrient concentrations in the Project reservoir waters and released downstream are expected be in general slightly higher than the inflowing water. This is because in addition to the nutrients that enter the reservoir water with the inflow, there will be the input of nutrients from flooded soils and biodegradation of flooded biomass. However, the degree of alteration is expected to be within the range of natural interannual variations. Exceedance of annual variations may occur during periods of exceptionally heavy rain when runoff from the intermediary catchment brings to the reservoir additional nitrogen and phosphorous (originating from fertilizers) that are leached by the rain from the soils in the catchment.
- Accumulation of sediment in the Project main reservoir reduces the quantity of nutrients transported downstream with the sediment. However, this is assessed to be non-significant, because the river water has high nutrient levels, and the reduction in sediment/nutrients attenuates the increase that has occurred over the last 50 years caused by land use/cover changes which has increased the input into the river of sediment and nutrients from the catchment.
- Alteration to Dissolved Oxygen concentrations in the Project reservoirs and in the waters discharged from the reservoirs is assessed to be minor. Waters at the bottom of the reservoir have lower Dissolved Oxygen concentration, but the waters at the elevation of the power water intake have concentrations that are only marginally different from the inflowing river, and which are above the threshold concentrations for fish mortality.
- The intermittent operation of the regulating dam spillway may cause a phenomenon known as Total Dissolved Gases (TDG) supersaturation to occur on an intermittent basis, and this can have negative effects on fish. Spillway operation causes air and water to be mixed and carried to substantial depths in the plunge pool where the hydrostatic pressure is sufficient to greatly increase the solubilities of atmospheric gases. The air thus passes into solution in sufficient amounts to produce supersaturation with respect to surface or atmospheric pressure. The reach of the river potentially affected by TDG supersaturation is the reach extending downstream from the regulating reservoir. Worst case levels reported in literature for supersaturation caused by hydropower projects' spillway operation is 140% TDG. The actual level of supersaturation from operation of the Mpatamanga spillway may be lower and will depend on the spillway and plunge pool design, but the ESIA has taken a precautionary approach and assumed that 140% TDG supersaturation could potentially occur. However, it is noteworthy that the spilled water is commingled with non-supersaturated waters from the powerhouse, which reduces the level of supersaturation by dilution. The worst- case levels of supersaturation in the waters discharged from the regulating reservoir could be in the order of 115-130% during January-June of a year with very high seasonal high flows. However, this would be infrequent, and most years the levels will be in the range of 100%-112%. The natural degassing of the river waters to lower the levels of TDG supersaturation is a slow process and the extent of measurable increase in TDG levels may extend many kilometres downstream. To minimise TDG supersaturation in the waters discharged from the regulating dam spillway, the risk of TDG supersaturation in the regulating dam plunge pool will be assessed in more detail during the detailed design stage, and if necessary, deflectors will be included in the design of the spillway. The residual impact is expected to be minor.
- From analogy with sediment quality that has accumulated in the existing reservoirs on the Shire River, it is expected that traces of heavy metals, in particular nickel, iron and chromium will be present in the sediment that accumulates in the Project main reservoir. Nickel, iron and chromium are naturally present in the catchment soils. Because the Project is not planning on sediment flushing operations, the presence of heavy metals in the sediment has not been identified as a risk.
- The predicted levels of nitrogen and phosphorus in the Project reservoirs is typical of lakes and reservoirs with hyper-eutrophication. However, it is assessed that it is unlikely that phytoplankton will be able to develop in the reservoir because of the short residence time

of impounded water (6-20 days). Consequently, development of algal blooms which can cause eutrophication is unlikely.

- It is assessed that there is the possibility that water hyacinth (an invasive species) may develop in the Project's reservoirs. This is because water hyacinth is present in the waters upstream from the Kamuzu Barrage. Water hyacinth forms floating mats on the surface of the water along the reservoir shoreline and in where the reservoir shore meets the dam structure. The water hyacinth may block the dam spillway gates and represents a community health risk as it hosts the bilharzia vector. It may also create a nuisance for future reservoir fisheries. In the case of the Mpatamanga Project, the presence of the water hyacinth is not expected to influence levels of DO in the reservoir waters because the DO originates from the inflowing waters and not from phytoplankton or aquatic plants and consumption of DO by the development of the water hyacinth would be balanced by the inflow of oxygenated river waters.

2.1.4.2 Groundwater Quality

Groundwater quality in the area around the proposed reservoirs is good and fit for human consumption, and there is no evidence of anthropogenic pollution. However, localised water quality problems associated with the presence of salts, traces of heavy metals (such as chromium), taste and pollution by faecal contamination have been experienced in some parts of the Lower Shire Valley and the groundwater is generally not fit for human consumption.

During construction, localised pollution of groundwater could occur in the event of accidental leaks and spills of hazardous substances at construction sites. The extent of the pollution would depend in the size of the spill. In general spills may occur frequently and large spills are rare events. The Project construction does not require large quantities of hazardous substances to be stored and handled. The largest inventory would probably be storage of fuel for the construction camp and fuel for vehicles, and this is not expected to exceed 30,000 litres. Impacts on groundwater from accidental spills and leaks at worksites will be prevented by implementing GIIP measures for protection, pollution prevention and spill clean-up. Residual impacts are expected to be localised and minor.

During operation, the potential risks on groundwater quality would be as follows:

- Reservoir Area: Groundwater quality along a fracture zone extending in an east-west direction from the reservoir may be altered by the ingress of reservoir water into the basin rock underlying the reservoir. Most of the water impounded in the reservoir has only a low degree of alteration compared to baseline river water conditions, and so alteration to groundwater is expected to be negligible. However, the bottom layers of reservoir water are expected to have low DO concentrations and there is accumulation of sediment with the presence of metals including nickel, chromium, iron. There is a risk that if anoxic conditions occurred, these conditions may be favourable for chemical processes that increases the solubility of metal ions present in the sediments and also creating other toxic compounds. In this case there may be increased heavy metal concentrations in the groundwater along a fracture zone extending in an east-west direction from the reservoir – potentially affecting boreholes in villages in this area. Monitoring will be performed, and a contingency plan will be prepared to supply potable water to any households affected by degraded groundwater quality as a result of the Project.
- Downstream Area: The trapping of sediment in the Project main reservoir is expected to result in reduced sediment load in the Shire River downstream, that is expected to cause vertical and lateral erosion of the Shire River channel at certain locations downstream from the Project, and this may cause changes to groundwater flow dynamics. However, because the project is expected to cause only negligible alteration to the water quality of the Shire River downstream from the Project, no noticeable alteration to groundwater quality in downstream areas is expected.

2.2 Climate Change

2.2.1 Climate Resilience

The Mpatamanga Climate Resilience Assessment was conducted in 2023-2024, derived from the Mpatamanga Climate Change Risk Assessment (EDF, 2024b), which followed the 2019 International Hydropower Association (IHA) "Hydropower Sector Climate Resilience Guide" guidelines.

The Shire River outflow represents approximately 20% of Lake Malawi outflow, while evaporation accounts for 80%. Additionally, the area where Lake Malawi flows into the Shire River is very flat, creating a natural control section (Elevation 471.5) below which no flow exits into the Shire River. The intermediate catchment basin contributing to the Mpatamanga Main Reservoir represents approximately 15% of the annual mean incoming flow, making Mpatamanga HPP highly dependent on the flow received from Lake Malawi. A key focus for the Climate Change Risk Assessment is understanding the evolution of the lake water balance and outflow changes under climate change conditions.

The selected IPCC scenarios for the study were SSP2-4.5 (intermediate GHG emissions scenario) and SSP3-7.0 (high emission scenario). The 11 chosen models show homogeneous rising trends in temperatures and heterogeneous trends in precipitation. The modelling is characterised by significant uncertainties inherent to climate change science and the limited availability of observed data. Additionally, biases in Lake Malawi's module were identified and need correction before drawing quantitative conclusions, especially since the lake balance is sensitive to evaporation.

Regarding the estimation of Mpatamanga HPP power generation evolution with future climate change, three qualitative trajectories appear possible:

- Stable energy generation over time.
- Progressive and moderate decrease of energy generation.
- Earlier and significant energy generation decrease.

The reduction of Shire River inflow would impact Mpatamanga HPP baseload production but will not prevent peaking production, at least in the near future (next 30 years).

The Project risk analysis identified climate-change-related risks. The main risks include:

- Potential reduced mean inflow of the Shire River due to higher air temperatures and reduced rainfall.
- Increased sediment loads due to more frequent extreme meteorological events,
- Higher incision rates downstream of Mpatamanga (Chikwawa plain) due to increased frequency of extreme meteorological events causing more frequent extreme floods that drive geomorphic processes.

Additional recommendations emerged from the Climate Resilience Assessment, as well as the following main recommendations:

- Foster research programs to better understand the Lake Malawi-Shire River system water balance and the evolution of extreme events.
- Gather additional data and access more relevant climate models to reduce hydrological modelling uncertainties.
- Design housing and working areas related to the project to be as resilient as possible to heatwaves.
- Propose sustainable access to water and provide training/support for sustainable agricultural practices to resettlement village inhabitants.

2.2.2 Greenhouse Gas Emissions

Project construction Greenhouse Gas (GHG) emissions represent 488 800 tCO_2 of equivalent carbon dioxide (CO2e), an additional 8% (40 100 tCO_2) cover the operation and maintenance emissions over a 100-year period. Both reservoirs' emissions, without vegetation clearing before reservoir filling, represent 1,639,500 tCO_2, the main reservoir accounting for more than 90% of the emissions. The emissions induced by other land use changes (e.g., deforestation) can be totalled at 120 .000 tCO_2 over 30 years.

The combined construction, reservoir, and land use changes emissions (over 100 years) amount to 2.3 $MtCO_2$ equivalent – or 23,000 tCO_2 per year over 100 years. Those are typical values for hydropower projects, according to the Intergovernmental Panel on Climate Change.

GHG emissions avoided by the implementation of the Project have been estimated by comparing the Project's GHG emissions with emissions from generating the equivalent of the Project's power generation capacity with Malawi's current power mix. Generating 1,544 GWh of power with Malawi's current power mix (107 gCO2e/kWh – source: IRENA) over 100 years would generate 16.5MtCO2e/year. Consequently, the Mpatamanga Project would reduce GHG emissions by 14.2 $MtCO_2$ over a 100-year period, or 142,000 tCO_2 per year.

2.3 Project-Induced In-Migration

The population density is low within the project footprint area, with higher densities noted within Blantyre District, especially moving along the S137 toward Blantyre City. Most people living in the project area work in the informal economy and charcoal industry and have high levels of income insecurity. Access to community infrastructure and services is challenging in these rural areas but become more accessible around urban areas.

Large-scale projects attract new in-migrants, and it is predicted that the Mpatamanga Project will attract newcomers. The potential for project-induced in-migration will be increased by the upgrade of the S137 road, the development of the private service road between the Main Dam and the Regulating Dam, and the construction and maintenance of the access track along the proposed 132kV transmission line. Based on IFC recommended methodology, it is estimated that up to 4,000 to 7,500 persons could migrate towards the Project area during construction. This influx would represent a significant increase in the existing population of the villages that could potentially accommodate the migrants located along the S137 and in the Project area, i.e. areas under Group Village Head (GVH) Kaliati, GVH Feremu, GVH Gwadani, GVH Kunthembwe and GVH Kadikira (see Figure 4-5). As the Project progresses to operations, the reduced personnel needs and the limited need for unskilled positions are unlikely to attract a significant influx of migrants. However, the new reservoir, the newly accessible areas and the improved livelihoods may attract newcomers, including fishers and non-local charcoal makers or poachers.

Project-induced in-migration has the potential to bring beneficial impact on local communities. However, in the absence of pro-active management involving the participation of local and regional stakeholders, rapid increase in population will also result in adverse environmental and social impacts: additional pressure on the natural environment, ecosystem services, social dynamics and existing infrastructure, services, and utilities that cannot meet the new demands. Such influx may also induce risks of anti-social behaviour, deterioration in law and order, increase in sexually transmitted diseases, gender-based violence, sexual exploitation and abuse, and local inflation.

To minimize the adverse effects associated with project-induced in-migration resulting from the Mpatamanga Project activities, the Project will:

- Develop a Multi-Stakeholder Forum at District, TA, and GVH levels to (i) raise awareness about the likelihood of influx and the associated potential adverse effects on Community Health, safety and security, access, biodiversity and land issues, including around Majete (ii) share information on project activities and results of influx monitoring; (iii) discuss and decide how MHPL could best support initiatives to discourage and control influx; (iv) coordinate and collaborate on planning, design and delivery of the selected control and

development initiatives to minimize project influx, and (v) coordinate induced access and biodiversity issues, and provide support to law enforcement to monitor and check road users

- Raise awareness of the community leaders in villages around the reservoirs and along the S137 road before construction starts on the risks associated with the Project's 'Local First' Employment Policy, employment opportunities, and conflict arising from the distribution of the Project benefits. It will continue throughout the Project;
- Ban recruitment at the construction camp, or any of the construction or work sites, including along the road and transmission line corridors. Regional employment centres will be established at a distance from the work sites;
- Design the construction camp to accommodate all non-local workers, including employees of sub-contractors working on site. Local workers not accommodated in the construction camp will be transported from/to collecting points;
- Support for the preparation and implementation of Village Level Action Plan for GVH Kaliati and GVH Feremu that consider (i) the resettlement and relocation requirements due to the land take process, and (ii) the likely influx during construction and operation, to anticipate and plan the incremental demand on services (health, education, water and sanitation);
- Assist in installing and maintaining control of access roads with checkpoints at selected key locations to discourage poaching and illegal logging;
- Work with local authorities to advance the competitive abilities of communities living around the main reservoir with regards to reservoir fisheries during operation.

2.4 Air Quality, Noise Levels, Waste, Landscape and Visual Amenities

2.4.1 Air Quality & Dust

The local air quality has been assessed as not degraded. Background air pollutants levels are well below the World Health Organization standards for nitrogen dioxide (NO_2) and dust levels, fine particulate matter of less than 10 µm diameter (PM_{10}). Fine particulate matter ($PM_{2,5}$) concentrations are slightly above guidelines because of the regional semi-arid condition.

During construction, the Project is not expected to cause significant alteration to air quality, except for areas in the immediate vicinity of worksites, or along the S137 road and the new service road between the Main Dam and Regulating Dam. Chaswanthaka village, located at the junction between the S137 road and the new service road, as well as Mpindo village located along the proposed service road, would be particularly exposed to dust generated by construction traffic. The detailed design of the new service road between the Main Dam and Regulating Dam, planned to be undertaken in 2025, will avoid settlements as much as possible. However, households in too close proximity to the worksites, and settlements located within 200m of the selected service road route will be exposed to air and noise nuisances, as well as road safety issues: they will be relocated, as part of the Project's resettlement process. Good industry practices will be implemented to minimize air and dust emissions.

During operation, villages along the S137 road are not predicted to be significantly exposed to dust from traffic given the expected low public traffic. The road will be paved in the most densely populated areas. Emission of malodours due decomposition of flooded biomass under anaerobic conditions from the main reservoir and the regulating reservoir is not predicted to be a significant risk.

2.4.2 Noise

The Project area is situated within a quiet rural area with a typically rural noise climate, and very limited anthropogenic influences. Noise from traffic and human activities has been mainly

observed along the S137 road from Blantyre up to Chikuli. As the distance from the urban area increases (beyond Chikuli towards the proposed main dam), these noise sources are rapidly replaced by natural sounds. Similarly, the soundscape in the Majete Wildlife Reserve is categorised with sources of noise from the natural environment. At night, the Project area has the potential to be very tranquil and steady in nature and the soundscape is dominated with natural sounds (i.e. noise source from water movement from rivers and insects).

During construction, households close to the access roads and construction sites could be affected by noise nuisance, resulting from traffic and construction activities (e.g. crushing plant, blasting, movement of excavators and dumpers), as illustrated on Figure 4-7:

- Along access roads, main receptors affected by traffic noise are the same as those exposed to dust emissions, i.e. settlements within 200 m from the junction of the S137 with the service road, and along the service road. Without mitigation measure, these households could be significantly affected by noise from daytime and nighttime traffic.
- Houses located close to the worksite would be exposed to significant noise nuisance, if and when construction activities are undertaken at night.

Most of households living in Chaswanthaka, Kambalame and Mpindo, close to the construction sites and along the new service road between the Main Dam and Regulating Dam will be relocated before construction starts, either because they reside in the reservoir area, or because they are too close and exposed to air, noise and safety hazard. A limited number of households, living between the main dam and the regulating dam would still be affected by nighttime noise, should construction activities be undertaken at night. Likewise, while no noise impacts are expected at the lodges in the Majete Wildlife Reserve, increased level of noise (> 45dB) is predicted to occur at the northern boundary of Majete Wildlife Reserve, extending up to 1,500 m into the Reserve, because of the works at the Regulating Dam, depending on wind direction. To mitigate noise impact at night, significantly noisy construction activities will be restricted to daytime hours.

During operation, there are no predicted noise impacts, either from traffic or the operation of facilities. However, corona noise from the 400 kV Transmission Line could be perceived by residents located close to the wayleave (less than 200 m) during low and medium rainfall. The transmission line will be designed to ensure that noise emissions comply with WHO noise guidelines and Malawi noise level regulations.

2.4.3 Waste

The Blantyre City Council (BCC) is responsible for solid waste management in Blantyre. There is only one dumping site for the whole city, the Mzedi Dumpsite. It is located approximately 12 km northeast of central Blantyre. It was created in 1990s with minimal engineering, no fencing and with an initial expected lifespan of 20 years. The site is in operation but does not have the capacity to accommodate additional waste and is not fully operated as per good international practices.

During construction, the Project activities will produce inert spoils (e.g. tunnelling spoil), hazardous and non-hazardous waste. Existing municipal landfill and waste facilities in Blantyre are not suitable to manage qualitatively and quantitatively the waste generated. A landfill will be established on site as per good international practice, for the management of non-hazardous waste. Hazardous waste will be collected, transported and treated in Malawi or abroad by a licensed company that has been verified to meet GIIP.

During operation, the quantities of waste generated by the Project will be significantly less than during construction, and limited to those generated by the operators' village, the two powerhouses and the floating debris transported by the Shire River and accumulating in the Main Reservoir. Those will be managed as per good international practice. A portion of the construction phase landfill will remain in operation to manage this waste.

2.4.4 Landscape and Visual Amenities

The landscape of the Project area is formed by the Great Rift Valley as it passes through southeastern Africa. This creates a wide, flat-bottomed trench through which the Shire River runs.

The edges of the trench are formed by mountainous upland areas of fractured rock with the base of the trench a mixed valley landform of undulating and flat topography. Historically woodland covered the lower valley landscape, but conversion to farmland and widespread resourcing of firewood and charcoal, has degraded the nature habitat. Most intact woodland survives in protected areas. The main such area is the Majete Wildlife Reserve. The proposed Main Dam is located where the Shire River has eroded a narrow path through a local ridge line within the valley lowland. The Mpatamanga Ridge and Gorge provides a spectacular setting for the Shire River creating rapids and white water. The ecological value of the Majete Wildlife Reserve extends out into the area adjacent to the dams. Both aspects make the Mpatamanga gorge, and the Shire River associated with the Majete Wildlife Reserve an area with high scenic quality.

Settlements are present and generally tend to be located within cleared areas of woodland/scrub and therefore have limited views out. However, some of the settlements to the Blantyre side of the Shire River have more elevated positions, looking east across the rift valley landscape and have potential for visibility of the Main Dam. Visitors to the Majete Wildlife Reserve tend to be concentrated along the Shire River, touring the reserve on games drives, or experiencing nighttime activities on highpoints within Majete Wildlife Reserve. Recent construction work at the Kapichira Dam have created sky glow effects perceived from these high points, which may also be impacted by the skyglow effect of the Regulating Dam.

The landform of the Shire River valley formed by mountainous upland areas will regulate visibility along a north-south corridor. There are places where the landscape is more open, like at the Main Reservoir area to the north of the Main Dam, improving the possibility of seeing the Main Dam. Towards the south and Majete, potential visibility is more restricted to elevated areas on the valley sides, where views of the Shire River may be seen. Local permanent residents of settlements and land users, road users along the M6/M1 and S137 and visitors and residents of the Majete Wildlife Reserve concentrated along the Shire River or at viewpoint location will be the main visual receptors.

The large geographical extent and scale of the project and its components inevitably leads to several landscape and visual effects.

During construction, and then operation, the main landscape and visual impacts will be caused by the introduction of the Project infrastructure and reservoirs into the natural environment. The Project components would become part of the wider landscape, affecting the level of development perceived and resultant aesthetic change to landscape character. These changes would be concentrated in the centre of the study area affecting the Mpatamanga Ridge and Gorge, the Southern Shire River valley and the Mpatamanga Convergence (area of main reservoir). The proposed 400 kV and 132 kV transmission lines would have fewer impacts due to their lighter footprint, when compared to dams and reservoirs. However, several settlements would be visually affected by the close passage of the transmission lines. Tourists and visitors to the Majete Wildlife Reserve would have very limited exposure to visual effects due to the location of the nearest components in the base of the Shire River valley, vegetation and topography. No significant day-time visual effects are predicted. Sky glow effects from construction worksites and the future Project infrastructure could affect dark skies at night and direct lighting may be visible from highest viewpoints in the northeastern section of the MWR.

Mitigation of visual and landscape impacts is often not practical for such large structures. Appropriate mitigation would reduce the prominence of the proposed development but would not prevent the fundamental changes to the valley that would occur due to the construction of the dams and creation of the reservoirs. Where feasible, the powerhouse and switchyards will be painted with colours that reflect and blend with the colours of the surrounding landscape. During construction, strict control of vegetation clearance and construction method will be undertaken to minimize visual impacts from landscape scarring. All disturbed construction areas will be revegetated to reduce the potential effects of these elements on the landscape. The Project will mitigate night light impacts through use of low intensity lighting, directional and shielded lighting to avoid light spill towards Majete Wildlife Reserve.

2.5 Loss of Land & Restrictions on Land Use

The land requirements for the Project include the areas needed for all permanent facilities, the areas needed for temporary facilities during construction, and the areas where restriction of use will be established, either for operational reasons or for safety reasons.

Land is required in seven main areas: (i) the Main Reservoir, (ii) the 'Main Works' area covering the main works for the Main Dam and the Regulating Dam and Regulating Reservoir, as well as the associated construction facilities, the service roads and the operator's village, (iii) the areas required for the refurbishment of the S137 road, (iv) the areas for the 400 kV transmission line, (v) the areas for the 132 kV transmission line, (vi) the Resettlement Sites and (vii) the biodiversity conservancy area proposed in Section 2.6 below. The land requirements are summarised in Table 2-1 below.

Table 2-1: Project's Land Requirements

Project Facilities	Total Area	Description
Main reservoir	2,045 ha	The whole area is a permanent land requirement. The entire Main Reservoir area will be acquired permanently. Access to the shore of the main reservoir will not be permitted in the 500m area immediately upstream of the main dam and the 500m stretch downstream of the end of the tail or the main reservoir, from Tedzani HPP tailrace.
Main Works	794 ha	The main works area includes the footprint of the construction and operation facilities. At the Basic Design stage, the Project Technical team identified a general area to be allocated to the EPC contractor to establish the permanent (operation) and temporary (construction) facilities. This entire Main Works area will be acquired permanently. It has been assumed that there will not be any land handed back to the local communities after construction. Access to the Regulating reservoir will be allowed on the Blantyre side, except between the main powerhouse outlet and the upper part of the Regulating Reservoir.
S137 Access Road	106 ha	For the Sections of the S137 which will be upgraded, the Ministry of Transports and Public Work already owns the road and the land of the existing road reserve (18 metres from each side of the centre of the road). For these existing sections to be upgraded, the lands requirements will be limited to the areas needed for the road upgrade. This includes the road platform itself, the road banks and drainage channels along the road. The upgraded road width will be 9.2m, except when crossing the Chikuli market, where it will be 12.2m[2]. For the new section to be constructed, the entire road reserve (18m of each side of the central line of the road) will be acquired.
400kV Transmission Line	345 ha	Only the pylon footprints will be acquired permanently, but houses and trees will not be permitted in the wayleave. Temporary land requirements (access tracks, construction camp(s), laydown areas) will be defined at the Detailed design stage.
132kV Transmission Line	38 ha	Only the pylon footprints will be acquired permanently, but houses and trees will not be permitted in the wayleave. Temporary land requirements (access tracks, construction camp(s), laydown areas) will be defined at the Detailed design stage.
Resettlement Sites	387 ha	Temporary land requirement: The Project will acquire the land to develop the resettlement sites, but as they are an in-kind compensation option, the land plots allocated to affected households and communities on these resettlement sites will be transferred to them after their relocation.
Biodiversity Conservancy Area	1,910 ha	To offset the Project biodiversity impacts, a conservancy area will be acquired and fenced before the start of construction, and maintained throughout operation.
Total	5,625 ha	

The households affected by the footprint of the Main Reservoir and the Main Works have been surveyed in 2023. In the Main Reservoir and Main Work area, small scale subsistence farming is the main agricultural activity, with maize as the main staple crop. The general standards of living and levels of income can be considered low for most of the affected households surveyed in 2023, with most of them experiencing food security issues at some point in the year. Rain-fed agriculture is the main form of crop farming, but some fields along the riverbanks are cultivated all year long with small-scale manual irrigation. The main sources of cash income are charcoal making (although it is done illegally), selling crops and piece work. Cows and goats graze along

[2] (GIBB 2024)

the riverbanks as well as lands close to villages or in the hills surrounding the villages. More than 70% of the interviewed households declared they take their livestock to the Shire River to water them. Other rivers or tributaries to the Shire are also used.

Based on the importance of land-based subsistence activities amongst the affected households, and their use of the Shire River, the communities affected by the Project land requirements in the Main Reservoir and Main Works area can be considered highly sensitive. The households affected by the other project components (Transmission Lines and S137 road work) have not yet been identified and have not been surveyed. Their sensitivity is considered similar to the communities in the Main Reservoir and Main Works areas with the exception of those close to urban centres, such as Blantyre and Zalewa where there is easier access to markets and other services.

Prior to and during construction, households living in the project footprint and within 200m of the new service road will be physically displaced. Landowners and land users will lose land or access to lands located in the project footprint (i.e. affected by economic displacement). Table 2-2 (physical displacement) and Table 2-3 (economic displacement) provide the estimated number of households affected by involuntary resettlement as a result of the project activities.

Figure 4-6 distributes this estimate by project components. Overall, between 150 and 220 households may be physically displaced. In addition, between 1,600 to 2,100 households could be economically affected by the project's land take process. These figures are not definitive. During the detailed design stage, additional investigations will be undertaken to minimize involuntary resettlement.

During operation:

- The Project land take process will reduce the areas available to produce charcoal. This will increase pressure on terrestrial natural resources outside of the Project footprint, in addition to the incremental pressure resulting from project-induced in-migration (described in Section 2.3) and the presence of a large workforce.
- Access will be restricted to the Main Reservoir within 500 m from the main dam and 500m from the Tedzani HPP outlet. Four villages (Chaswanthaka, Kambalame, Mzingala, and Mwazilingua) could be affected by this restriction of access.
- Access to the right bank of the Regulating Reservoir will no longer be possible for Nkwhali village, because of the creation of a new conservancy along the Regulating Reservoir on Neno side (See Section 2.6). Associated river water uses (e.g. cattle watering, domestic water, farming) would be impaired.
- Land use within the transmission line easements will be restricted to avoid activities incompatible with Transmission Line operations and to allow for maintenance activities.

The Project involuntary resettlement impacts will be managed and mitigated through the implementation of a phased land acquisition, compensation and resettlement process compliant with the requirements of the standards set out in WB ESS5 and IFC PS5. As the Project is large and complex the land acquisition, compensation and resettlement process will be phased as follows:

- Acquisition of, and compensation for (i) the S137 road upgrade works in Blantyre District, and (ii) the Chaswanthaka and Mpindo resettlement sites;
- Acquisition of, and compensation for (i) all areas covering all the Project main facilities, as well as construction facilities, and the Regulating Reservoir area, (ii) the S137 road upgrade works in Neno District, (iii) the Kambalame Resettlement site and (iv) the proposed biodiversity conservancy area;
- Acquisition of, and compensation for the Transmission Lines pylons footprint and access restriction to the right-of-way for the Project's two transmission lines;
- Acquisition of, and compensation for the Main Reservoir.

The phasing could be modified and some of these phases could be done concurrently, depending on the construction activities schedule.

Table 2-2 Estimated Number of Households Potentially Affected by Physical Displacement

District	Traditional Authority	Group Village	Village	Main works Area[a]	Main Reservoir Area[a]	S137 Works[b]	400kV TL[c]	132kV TL[c]	Proposed Biodiversity Conservancy Area	Resettlement Sites	Total
Blantyre District	TA Kuntaja	GVH Nkata and GVH Solomoni		-	-	2	-	-	-	-	2
	TA Kunthembwe	GVH Mbanda, GVH Chikumbu, GVH Kadikira, GVH Makunje, GVH Kunthembwe, GVH Gwadani		-	-	18	-	-	-	-	18
		GVH Kaliati	Kaliati	-	-	13	-	-	-	-	13
			Inosi/Chilaulo	-	-	1	-	-	-		1
			Chaswanthaka	29	3	2	-	-	-	-	34
			Lisangwi	-	6	6	-	-	-	-	12
			Mbwinja	3	-	-	-	-	-	-	3
			Mpindo	25	-	-	-	-	-	-	25
		GVH Dzikupi	Dzikunika	-	-	-	-	from 0 to 2	-	-	from 0 to 2
		GVH Namputu	Chikira	-	1	-	-	-	-	-	1
			Chinkwinya	-	3	-	-	-	-	-	3
Neno District	TA Mlauli	GVH Feremu	Feremu / Andivuta	-	-	from 0 to 4	from 2 to 5	-	-	-	from 2 to 9
			Kambalame	1	25	from 0 to 5	-	-	-	-	from 26 to 31
			Nkhwali	-	-	-	-	-	from 5 to 10	-	from 5 to 10
		GVH Nsalawatha	Petulo	-	2	-	-	-	-	-	2
			Ntingala	-	-	-	from 1 to 2	-	-	-	from 1 to 2
	TA Symon	GVH Ngwenyama	Liyenda	-	1	-	from 5 to 10	-	-	-	from 6 to 11
		GVH SomiSomi		-	-	-	from 10 to 15	-	-	-	from 10 to 15
Total				58	41	42 to 51	18 to 32	0 to 2	5 to 10	-	~160 to ~200

[a] *Estimate based on SLR surveys in Nov-Dec. 2023, based on land requirements available at the time of writing.*
[b] *Estimate based on SLR direct observation on site in Nov- Dec. 2023 and interpretation of aerial imagery. This estimate should be minimised by optimisation during the Detailed Design*
[c] *Estimate based on SLR direct observation on site in Nov-Dec. 2023 and interpretation of aerial imagery, the number of buildings in the TL wayleaves is used as a proxy.*

Table 2-3: Estimated Number of Households Affected by Economic Displacement Only

Number of households affected	RAP Areas							Grand Total[d e]
	Main Works Area[a]	Main Reservoir[a]	S137[b]	400kV TL[c]	132 kV TL[c]	Proposed Biodiversity Conservancy Area[d]	Resettlement sites[e]	
Blantyre District	47	358	600 to 1,000	--	70 to 80		3 to 5[d]	~1,100 to ~1,450
Neno District	7	113	50 to 100	370 to 400	--	30 to 80	3 to 5[d]	~500 to ~700
Balaka District	-	-	-	30 to 50	-		-	~ 30 to 50
Total	54	471	650 to 1,100	400 to 450	70 to 80		6 to 10[e]	~1,600 to ~2,200

[a] *Estimate based on SLR surveys Nov. Dec. 2023, based on land requirements available at the time of writing.*
[b] *Estimate based on SLR direct observation on site in Nov. Dec. 2023 and interpretation of aerial imagery.*
[c] *Estimate based on the extrapolation of the MOMA RAP information. For the MOMA project, there was an average number of 7 Project Affected Persons with land plots affected by the transmission line wayleave per linear kilometre. This ratio is applied to the 62 km of the 400kv transmission line and the 11 km of the 132KV transmission line*
[d] *The households economically displaced by the Regulating Reservoir on the Neno side of the Main Works are also affected by the proposed biodiversity conservancy area.*
[e] *The households economically displaced by the resettlement sites are also displaced by the Main Works or the Main Reservoir*

2.6 Ecology

The closest protected and internationally recognised biodiversity areas are (i) the Majete Wildlife Reserve located 300 m from the regulating dam, one of the flagship reserves in Malawi containing priority species fauna such as Black rhinoceros and African elephant and (ii) the Elephant Marsh Ramsar Site located 60 km downstream of the Regulating Dam, important for its floodplain habitats supporting numerous waterbirds and essential ecosystems services e.g. fisheries.

2.6.1 Vegetation

Much of the project area comprises modified habitat in the form of low, degraded shrublands, cultivated fields and villages, which have low ecological importance. Patches of natural habitat remain, comprising undifferentiated woodland, miombo woodland and patches of riparian woodland, all assessed as having medium ecological importance (see Figure 4-8). Most of the remaining important patches are located on the west bank (Neno side) of the Regulating Reservoir. Downstream of Chikwawa, riparian woodland habitat transitions to riparian wetland habitat on seasonally flooded soils comprising reeds and hydrophytic grasses, which is more typical of Elephant Marsh. Undifferentiated woodland and riparian woodland along the Shire River in Majete Wildlife Reserve have been identified as critical habitat for black rhino, African wild dog, and cheetah.

No globally threatened or restricted-range plant species have been recorded in the Project area. One near-threatened species, *Dalbergia melanoxylon*, is relatively common through the Project area, including in modified habitat, and is also a protected species. Alien invasive species are widespread across most of the Project area, especially in the modified and degraded habitats, road verges and along riverbanks, including in Majete Wildlife Reserve.

Regulating and supporting ecosystem services provided by the natural vegetation types in the Project area include attenuating stream flow and runoff, bank stabilisation, reduction in erosion and soil loss, and water quality purification. However, these functions have been significantly impacted by the extent of woodland degradation for charcoal production and clearance for agriculture and settlement. The actual benefits of natural ecosystems to support these regulating and supporting services are therefore much diminished in the project area and mainly limited to portions of more intact woodland.

During construction, the Project will result in loss of vegetation during the construction phase through clearing of vegetation for infrastructure footprints and reservoir filling. Approximately 2,710 ha of modified and 1,000 ha of natural habitat are likely to be lost. Loss of natural habitat will also mean some loss of regulating and supporting ecosystem services, particularly riparian woodland thicket which provide services such as riverbank stabilisation and flood attenuation. Increased ground disturbance in and adjacent to construction areas is likely to cause increased spread of invasive alien plants, many of which are already present in the project area. Despite the largely degraded habitats in the project footprint, the extent of habitat loss is considered significant given the size of area affected with loss of natural habitat requiring no net loss. The influx of jobseekers and presence of construction staff during construction and extending into operation is expected to cause additional loss of woodland (for timber and charcoal production) in the wider area, especially on the western side of the regulating dam, possibly with increased encroachment into Majete Wildlife Reserve. This impact is considered potentially significant without adequate mitigation.

During operation, the main reservoir shorelines will be vulnerable to establishment of invasive alien plants which could then spread downstream exacerbating alien spread in Majete Wildlife Reserve. Invasive species are also likely to spread along road verges and transmission line wayleaves and can be controlled. Downstream of the regulating dam, the progressive riverbank erosion may result in limited incremental reduction of riparian vegetation over decades. This is particularly likely to occur in the immediate reaches downstream of the regulating dam to Mkulumadzi tributary and downstream of the Kapichira dam to Chikwawa.

The planned mitigation strategy for vegetation is as follows:

- Wherever possible, construction footprints will be prioritized in disturbed habitat and will be clearly demarcated to limit access to areas of natural habitat. Site clearance will take place in a manner that allows retention of trees where possible, and construction disturbed areas will be re-vegetated. In addition, resettlement areas will be planned in such a way that land uses for resettled communities optimise retention of woodland patches and encourage community protection.
- Strict rules and control measures will be applied and enforced to minimise risks of construction staff harvesting woody vegetation for firewood, construction, or medicinal plants or engaging in charcoal production, transport or selling.
- In addition, the Project will implement influx control measures as described in Section 2.3.
- Alien plant species around construction sites, transmission line and reservoir margins will be monitored and removed.
- No ecology-specific mitigation is considered feasible to manage potential long-term and incremental loss of downstream riparian floodplain vegetation during operation.

These mitigation measures will reduce most impacts to a non-significant level if successfully implemented. However, the residual impact of habitat loss through inundation of the main and regulating reservoirs remains significant as mitigation measures cannot adequately minimise the permanent loss of natural habitat with relatively high plant diversity. This impact will need to be offset (Section 2.6.4).

2.6.2 Terrestrial Fauna

Bird diversity is high in the Project area, with a total of 309 species recorded (including the Elephant Marsh). These include six threatened and eight near threatened species, of which the most significant are three Critically Endangered species (white-backed vulture, hooded vulture, and white-headed vulture) and two Endangered species (martial eagle and bateleur). These species primarily occur in Majete Wildlife Reserve, but vultures move between Majete and other protected areas while eagles forage in adjacent community lands. From Kapichira dam to the Elephant Marsh (Lower Shire), wetland birds are more diverse than upstream of the main dam, as a result of more extensive and a greater variety of wetland habitats. Species along this reach include globally significant numbers of African skimmer and African openbill, which (together with the Zambezi flapshell turtle) qualify the Elephant Marsh for critical habitat.

Mammal diversity is relatively low in the Project area, except in Majete Wildlife Reserve where most of the larger threatened and near-threatened mammals are confined, which and unlikely to occur outside of the reserve. These include African savanna elephant, lion, black rhinoceros, giraffe, cheetah, leopard, African wild dog, African buffalo, and plains zebra. Two threatened mammals that occur outside of Majete Wildlife Reserve are hippo and Temminck's ground pangolin. Two near threatened species associated with aquatic habitats in the Shire River and its tributaries may occur across the project area, namely African clawless and spotted-necked otters.

Reptile and amphibian diversity is particularly diverse in the lower reaches of the Shire River, particularly Elephant Marsh, where 25 frogs and 21 reptile species have been recorded. Diversity of frogs in the rest of the Project area is much lower, while reptile diversity is moderate. None of the herpetofauna recorded in the Project Area are classified as restricted-range and no threatened or near threatened species have been recorded. Nile crocodile is the main herpetofauna species of interest found in the proposed reservoir areas and the Majete Wildlife Reserve.

During construction, loss of faunal habitat primarily from reservoir filling will be one of the main impacts on fauna, although most is modified and unlikely to support high faunal diversity. Vegetation clearance for road construction and clearing of the transmission line wayleaves will cause habitat fragmentation and degradation, particularly on the Neno side closer to Mpatamanga. Construction activities, blasting and heavy vehicle movement for the regulating dam will cause noise disturbance impacts on fauna in the northern part of Majete Wildlife

Reserve, possibly displacing some larger, more mobile species, disrupting bird breeding, and altering predator-prey dynamics. The noise-induced displacement of fauna away from the northern reserve boundary may reduce the risk of poaching. Noise impacts on wildlife is not considered a significant impact because of the short-term and intermittent nature of noise sources and the noisiest construction activities will be restricted to daytime. Similarly, increased construction phase lighting may result in minor adverse impacts on sensitive fauna in the northeastern portion of the Majete Wildlife Reserve.

Reservoir filling may result in stranding of mammal and reptile fauna on opposite sides of the reservoirs. The regulating reservoir, in particular, will fill relatively rapidly and there is a risk of mortality of indigenous fauna such as slower moving reptiles (tortoises) or burrowing fauna (rodents, moles) from stranding or drowning.

The only potentially significant impact on fauna during construction is increased harvesting of natural resources such as bushmeat or animal body parts for traditional medicine by project-induced in-migration and construction staff. Of particular concern is the risk of increased poaching pressure resulting from human influx into the Project area on Majete Wildlife Reserve, particularly along the eastern and northern boundaries closest to the regulating dam. This could potentially result in an increased risk of poaching of target species such as highly threatened elephant, rhino, lion or other species. The risk of encroachment into Majete is likely to continue into the operation phase depending on the extent of human influx that remain in the area post-construction.

During operation, the dams will pose a partial barrier to movement of some fauna, such as hippos and crocodiles, moving up from downstream reaches in Majete WR, particularly from fencing of the operation areas for human safety. The main reservoir may, in fact, create new aquatic habitat for fauna, especially hippos and crocodiles, that can potentially move down from upstream reaches, e.g. Liwonde National Park and Lake Malombe. Any establishment of hippo and crocodile populations in the reservoirs would bring them into conflict with residents, local fishermen, reservoir users, and livestock herders. This may cause human or wildlife mortality and displacement of wildlife from the area, especially from the main reservoir. Sub-daily fluctuation of water level in the regulating reservoir of 6-8 m could potentially result in stranding or drowning of wildlife that are drinking or grazing along the edge. This risk is assessed as low, because of the gradual rate of water level rise and fall in the accessible part of the regulating reservoir, and the low abundance of wildlife in the regulating reservoir area.

Along the downstream reaches of the Shire River, sediment reduction is predicted to cause lateral erosion of riverbanks, and loss of sandbanks and reedbed habitat within Majete Wildlife Reserve (see Section 2.1.2). Sandbanks are primary nesting habitat of Nile crocodile, and possibly African skimmer, which may be displaced from preferred breeding areas. However, new sandbanks are predicted to form at the top end of Kapichira reservoir which would provide additional habitats for hippos, crocodiles and water birds.

Predicted incremental riverbed incision downstream of the Kapichira dam to Chikwawa bridge, with potential knock-on effects on floodplain wetlands are predicted to have a low impact on biodiversity in this reach due to relatively low abundance of water-dependent bird species and low effects on hippo and crocodile habitats. Downstream of the Chikwawa bridge, at the northern boundary of the Elephant Marsh, riverbed incision is predicted to not commence for several decades. In addition, the Shire floodplain has less wetland habitat and is more degraded in this reach compared to central and southern portions of the marsh. The two notable lakes (Gumbwa, upstream of the Chikwawa Bridge, and Lisuli downstream of the bridge) provide water bird habitat including species that may qualify the Elephant Marsh for Critical Habitat (i.e. African skimmer and African openbill) but are likely to occur in low numbers compared to the southern portion of the marsh. Overall, it is predicted that the Project would not adversely affect the terrestrial fauna of the Elephant Marsh.

The new 400kV and 132kV transmission lines could increase the risk of mortality through collisions and electrocutions. The consequences of mortalities of avifauna will be highest for threatened species such as vultures and other large birds of prey, confirmed present in the Project Area. Data from GPS-tagged vultures in Majete indicate regular movements over the 132kV line route, in particular. The risk of increased bird collision and electrocution can be a

significant impact for threatened bird species if transmission lines are not bird-friendly. However, installation of anti-electrocution and bird diverters on the 132kV and 400kV line will reduce this risk to an acceptable level.

Although there is minimal mitigation that can significantly reduce terrestrial habitat loss during construction and reservoir filling, the Project will ensure that construction site boundaries are clearly demarcated and cordoned off, implement a 50 m buffer along streams and river courses for exclusion of infrastructure, and wherever possible retain trees with >30 cm diameter at breast height. Construction noise and night light impacts, especially for the regulating dam located at a few hundred meters from the Majete Wildlife Reserve, will be mitigated as described in Section 2.4.

The potentially significant impacts of influx of construction staff and job-seekers will be managed by the Project through implementing a suite of influx control measures as described in Section 2.3. The Project will also support strengthening of improved security surveillance on the northern boundary of Majete Wildlife Reserve. This will be done through establishing a northern ranger camp, providing equipment and resources to Majete security staff, facilitating road access across the Regulating Dam to access both sides of the river, restricting public use of project roads, and supporting law enforcement to monitor and check road users. The creation of a fenced conservancy on the western bank of the Regulating Dam (see Section 2.6.4) would also serve to restrict access and influx impacts on woodland habitat and fauna and offset project terrestrial habitat losses.

Mitigation for potential drowning or stranding of wildlife during the 3-5-day period of Regulating Reservoir filling will be focused on areas with more intact woodland portions on the Neno side of the reservoir. During operation, the water level rate of rise and fall in the Regulating Reservoir is expected to remain within the moderate risk category of between 1 and 5 cm rate of rise per minute for fauna along the edge of the reservoir. Since there is still a risk that there could be some stranding of fauna, the Project will implement measures to monitor and rescue / relocate stranded animals during reservoir filling and early operation phase, and to inform and manage potential increased risk of human conflicts with snakes that may enter settlements. There are limited opportunities to sufficiently mitigate the risk of interactions with wildlife such as hippos and crocs that could establish themselves in either or both reservoirs, although the Project will create awareness of risks of dangerous wildlife interactions through educational awareness, signage and brochures.

Mitigation measures that will be implemented by the Project to reduce risk of avifauna mortalities on Transmission Lines will include installation of bird flight diverters and elevated perching devices along the entire 132kV line and the southern 30 km of the 400 kV line. The Project will mitigate risks of collisions with wildlife along public and access roads by implementing traffic speed control measures and signage warning road users of wildlife presence (e.g. hippo).

The above mitigation measures will ensure that the residual impact is non-significant for almost all project-related impacts. The risks to wildlife in Majete WR from human in-migration and increased poaching could have potentially significant residual impacts if priority species are hunted. The mitigation and offsetting measures proposed are expected to significantly reduce this risk and severity of this impact to a negligible level, although there is still likely to be some increased loss of faunal habitat and hunting in the Project Area. Additional offset actions would be implemented should negative impacts on priority wildlife species be recorded.

The loss of natural terrestrial habitat is to be offset through the creation of a conservancy area on the Neno side of the Regulating Reservoir with the aim of achieving no net loss. Additional supporting conservation actions for vultures, black rhino, and possibly pangolin, will aim to achieve a net (qualitative) gain. These measures are summarised in Section 2.6.4.

2.6.3 Aquatic Habitats and Biodiversity

Aquatic habitats from the Tedzani Dam to the Kapichira Dam, comprises mostly rocky bedrock with fast-flowing water. The diversity and abundance of aquatic macroinvertebrates and fish in this reach is low. The ecological conditions are degraded mainly because of (i) intra-day

fluctuations in water level from upstream hydropower plants; (ii) the abrasive action of mobile sands due to widespread catchment degradation; (iii) general absence of marginal vegetation; and (iv) increased magnitude of flood events because of deforestation. Benthic algae and diatoms recorded in September 2023 indicated biological water quality to be eutrophic, exhibited by floating mats of a cyanobacterium on river margins, and filamentous green algae on rocks. The aquatic biota recorded are tolerant of degraded conditions and are adapted to living in both flowing and standing water, with only a few sensitive species (e.g. mayflies, caddisflies) recorded.

Fish species diversity in the Middle Shire (Kamuzu Barrage at Liwonde to Kapichira Dam) is significantly reduced compared to previous records in the 1970s due to sedimentation, which has filled pools and abraded benthic substrates, and loss of overhanging riparian vegetation which provided fish refugia. Fish species mainly comprise common and widely distributed taxa, dominated by rheophilic species such as *Labeobarbus johnstoni*. Two alien fish species are reported in the Middle Shire so far (the Mozambique tilapia (*Oreochromis mossambicus*) and guppy (*Poecilia reticulata*)). There is a risk that two invasive species (tigerfish and Australian red claw crayfish) may invade in future, where they may pose a risk to the indigenous cichlids of Lake Malawi. However, the additional Mpatamanga dam barriers may further limit this risk. Tiger fish are indigenous to the lower Shire (downstream of Kapichira) and the crayfish has invaded the Zambezi River, further downstream of the Shire confluence. Fish migration in this reach is of minor relevance because of the downstream Kapichira falls (and dam) and Mpatamanga falls/gorge (separated by 18 km) that constitutes natural barriers to fish migration, except for the common and widely distributed eel, *Anguilla labiata*. Furthermore, none of the fish species in this reach are obligatory migrators, although some, such as *L. johnstoni* may conduct short migrations within specific reaches. No fish or aquatic invertebrates of conservation concern were recorded or expected to occur.

Floating water weeds of water hyacinth and water lettuce were not recorded at the proposed dam sites due to the fast-flowing water. However, patches of floating weed occur in Tedzani Reservoir where it provides habitat for snails, and extensive floating mats occur in the upstream Kamuzu barrage.

Hillslope seepage wetlands in the Middle Shire comprised small areas (<1 ha) with permanent pools and seepage areas fed by springs. The ecological conditions in the springs are degraded mainly because of charcoal harvesting. Although these wetlands support a greater variety of wetland biota, most notably dragonfly and damselfly larvae than the mainstem Shire River, they are small and of relatively low importance in the context of the Project Area.

Downstream of Kapichira, the Shire River comprises mostly medium to fast-flowing channels with sandy substrate, pools, riparian vegetation dominated by Phragmites reeds, and seasonally inundated floodplains. Some off-channel lagoons and cut-off oxbow lakes are present. The ecological condition in this reach is degraded mainly from deposition of sand and subsistence cultivation. However, the diversity and abundance of aquatic macroinvertebrates and fish in the northern Elephant Marsh is higher than upstream due to more diverse habitats, and characteristic of the lower Zambezi River. Fish species are dominated by minnows and barbs (Cyprinidae), followed by cichlids, mormyrids, catfish and others. Many migrate laterally into floodplains to breed in the rainy season. The Mozambique tilapia (*Oreochromis mossambicus)* is more abundant in lagoons and marshes (although less so than historic levels) and is a key component of subsistence fisheries.

The aquatic habitats have been classified as “degraded natural habitat” in terms of IFC PS6 based on Index of Habitat Integrity scores in the 2024 ESIA; the Middle Shire (Kamuzu barrage to Kapichira) was categorised as largely degraded, and the Lower Shire (Downstream of Kapichira Dam) as largely to seriously degraded. In terms of IFC definitions, modified aquatic habitats comprised the reservoir impoundments of Tedzani and Nkula (upstream of the Project) and Kapichira (downstream).

During construction, impacts on aquatic biodiversity can be mitigated to non-significant levels through (i) maintaining environmental flows requirements (see Section 2.12), and (ii) standard good practice relating to sediment and water quality control.

During reservoir filling and operation, the main impact of the Project is the unavoidable inundation of ~29 km of the Shire River converting the rapid flowing river into a reservoir and dewatering a short reach (see Section 2.1) between the Main Dam and powerhouse. Most fish are adaptable to living in lentic (standing water habitats) and reservoir creation will still maintain an array of aquatic fauna, as observed in Tedzani and Nkula Reservoirs. Although the river is already ecologically degraded (due to hydropeaking and sedimentation and does not support any aquatic species of conservation concern), the impact is considered significant because of the size and scale of the river alteration. No mitigation is feasible to mitigate the alteration of aquatic habitat in the Middle Shire from inundation of the two reservoirs for which the residual impact is assessed as significant. Options to offset the unavoidable loss of aquatic habitat are being planned through the implementation of a Biodiversity Action Plan (see Section 3.4). This includes options for potential increased protection measures for the Elephant Marsh through expansion of community conservation areas.

During operation:

- The two new dams will not create additional barriers to fish migration because of existing Kapichira falls and Mpatamanga falls. In fact, the Project may reduce the risk of alien tiger fish and Australian redclaw crayfish reaching the Shire River upstream of the Regulating Dam and potentially threatening indigenous fish in Lake Malawi. Potential attempts to develop aquaculture in the Main Reservoir could result in deliberate or accidental introduction of alien fish and crayfish species, with possible significant impacts on indigenous species. The new aquatic habitat in the Main Reservoir is likely to have a small positive impact on fisheries, estimated at less than 40 tonnes per annum. Water hyacinth and possibly other floating plants are likely to proliferate in some areas in the Main Reservoir. In addition to potential operational issues, these plants could provide habitat for pest aquatic species, such as bilharzia snails and malaria mosquitoes.
- For the short, dewatered reach, which will become largely dry when the dam is not spilling, the Project will provide a minimum release of 2 m^3/s which will create some limited refugia for aquatic biota. Macroinvertebrates and fish in this reach are hardy tolerant species with low diversity and abundance and the impact on aquatic biota of this minimum flow is of minor significance.
- The regulating dam operation will reduce intra-day fluctuations in water level in the 11 km Shire River reach between the regulating dam and the Kapichira reservoir, which is expected to improve the ecological conditions. Predicted increased riverbed incision and bank erosion from the regulating dam down to the Kapichira reservoir is likely to be low because the riverbed is mostly made of rocky bedrock. The progressive removal of accumulated sediment in the form of sandbars in that reach is assessed as positive for improvement of aquatic habitats and biota. Downstream of the Kapichira reservoir, the predicted geomorphological and associate floodplain hydrological changes are predicted to result in minor impacts on riverine aquatic habitats and the absence of confirmed threatened aquatic species in the more degraded northern portion of the Elephant Marsh.

During operation, the main mitigation for impacts on aquatic impacts of sub-daily flow variation associated with the regulating dam operation is the operation constraint imposed on rate and range of changes (see Section 2.12). As per Section 2.1.4, the risk of dissolved gas supersaturation in the plunge pool will be assessed in more detail during the detailed design stage, and if significant risk to fish is identified, deflectors will be included in the design of the spillway.

The intake structures and spillways are not currently designed with fish screens, bypass channels, bubble curtains, or other fish passage structures to divert fish away, as these are considered neither effective nor appropriate. Likewise, the adoption of fish friendly turbines to minimise fish mortality in turbines was considered and assessed as not technically feasible due to the 55 m head of the dam (15 m higher than the maximum 40 m head design for these turbines). The impact of the dam design and operation on fish is nonetheless assessed as minor significance as fish diversity and abundance in the reservoir is expected to be low and turbines will be below the preferred depth for fish.

Aquatic species of medical and veterinary importance, such as malaria mosquitoes, bilharzia snails, and blackflies, will be monitored as part of an aquatic biomonitoring programme.

Corrective action will be taken, if required, which could include habitat alteration to reduce prevalence of disease hosts, e.g. aquatic weed removal, and community health interventions.

To minimise risks of alien invasive aquatic fauna introduction, the Project will monitor invasive fish in the Mpatamanga reservoirs and downstream of Kapichira, assess the risks of their spread and identify potential actions to be taken.

2.6.4 Critical Habitat Assessment

2.6.4.1 Natural Habitat

Terrestrial natural habitats comprise patches of woodland types that occur as relatively discrete and fragmented patches, mostly in the less accessible portions of the Project area, particularly in private land on the western side of the Regulating Dam. No threatened flora was confirmed in these habitats, although some protected trees species occur. The undifferentiated woodland and deciduous forest and thicket ecosystem types are assessed as Endangered at a national scale in a draft ecosystem redlisting process, although are relatively widespread. These habitats in the Project Area contain a low diversity and abundance of fauna with no threatened species, except possibly Temminck's pangolin, and include a relatively high bird diversity with some priority raptor species.

Aquatic habitats in the Project area of influence comprise the 29 km reach of the Shire River within the project footprint (comprising 128 ha of open water and 99 ha of bare rock in channels). The Shire River from Tedzani to Kapichira is highly degraded by catchment sedimentation and hydropeaking by upstream hydropower plants. The aquatic river system is evaluated as 'degraded' natural habitats. This is because although macroinvertebrate and fish diversity and abundance has been significantly reduced by catchment changes, it still hosts a predominantly native community of biota with few alien species. It also hosts hippos and crocs which are considered species of stakeholder concern although adaptable to modified habitats such as reservoirs. No aquatic species of conservation concern were recorded in the Shire River between Tedzani and Kapichira, or which qualify for critical habitat. Fish diversity and abundance is significantly reduced compared to historic records. Most species recorded are common, widely distributed, indigenous fish, and only two alien fish species were confirmed. No fish are considered obligatory migrators and migration corridor in the main Shire River is already restricted by the Kapichira Falls and hydropower plant, and Mpatamanga Falls which limits this reach to approximately 18 km.

Impacts on terrestrial natural habitat are the same as those described in Sections 2.6.1 and 2.6.2. These include: (i) loss of discrete and fragmented woodland habitats (totalling approximately 932 ha), with no confirmed threatened plant species, a few protected trees, low faunal abundance but higher bird diversity; (ii) spread of alien invasive plants into woodland habitats and along the Shire River in Majete Wildlife Reserve; (iii) increased noise and light disturbance to fauna in and outside Majete; (iv) increased hunting and harvesting in woodlands outside and possibly within Majete Wildlife Reserve; (v) barrier or interference with movement of hippo and crocodiles (vi) incremental loss of sandbanks for wildlife in the Shire River reach inside Majete Wildlife Reserve; vii) bird mortality (eagles, vultures) from collision and electrocution on transmission lines; (viii) wildlife stranding/drowning in reservoirs, and (ix) stabilisation of sub-daily flow variations and reduced risk of animal stranding in the Majete reach (positive impact).

Impacts on aquatic natural habitat are described in Section 2.6.3. These include: (i) increased sedimentation and water turbidity from construction; (ii) permanent loss and alteration of degraded aquatic habitats from reservoir filling (transforming a 29 km reach of running river (lotic) to a still water (lentic) water body); (iii) improved flow stability (reduced sub-daily variation) and reduced sediment transport in the 11 km reach of the Shire River in Majete Wildlife Reserve (positive impact), which will reduce turbidity of the water column, improve aquatic plant and algae growth, scour out sedimented pools and create improved habitat conditions for aquatic biota; (iv) incremental loss of wetland floodplain habitat downstream of Kapichira from potential water level lowering of off-channel floodplain lagoons upstream of Chikwawa. This is expected to have non-significant impacts on aquatic biota but with low confidence given uncertainties in the predictions and functioning of the floodplain system.

Mitigation measures for natural terrestrial habitats are covered under Sections 2.6.1. The residual impact of the Project on natural habitat is approximately 1,000 ha (comprising a mix of miombo, undifferentiated and riparian woodland types). To offset the loss of terrestrial habitat it is proposed that a conservancy along the Regulating Reservoir on Neno side be established and managed by a competent conservation entity with sufficient funding allocated (see Figure 4-9).

Mitigation measures for degraded natural aquatic habitats are covered under Section 2.6.2. Residual impacts on the Shire River are assessed as significant due to transformation of 29 km of the Middle Shire River into lake habitat. To compensate for the loss of aquatic river habitats, an offset to improve protection of the Elephant Marsh Ramsar site is proposed (trade-up offset). The Project through implementation of the Regulating Dam will stabilise the existing fluctuating hydropeaking flows from Tedzani and the future Mpatamanga Main Dam. and is predicted to have a net improvement on the 11-km river reach through Majete WR.

2.6.4.2 Critical Habitat

No species qualifying for critical habitat were confirmed in the Project footprint. Critical habitat has been identified for six fauna species outside the Project footprint. These species are located primarily in either Majete Wildlife Reserve or Elephant Marsh, both downstream of the Project sites. They include black rhinoceros restricted to Majete Wildlife Reserve; white-backed and white-headed vulture ranging between Majete Wildlife Reserve, Lengwe and Liwonde National Park; and two waterbirds (African openbill and African skimmer) and a reptile (Zambezi flapshell turtle (provisional)) in the Elephant Marsh. Some vultures and other threatened raptors will pass through the Project Area. Twelve additional species of stakeholder concern due to international/national stakeholder interest include: hippopotamus, Temminck's pangolin, martial eagle, bateleur, hooded vulture, lappet-faced vulture (all known to occur in the Project Area), and five restricted to protected areas; cheetah, giraffe, African savannah elephant, African wild dog, lion, and leopard.

In addition to the Majete Wildlife Reserve (Wildlife Reserve, IUCN Cat. IV) and the Elephant Marsh (Ramsar site), there are also the Lengwe National Park and Liwonde National Park around the Project area. All four of these sites are critical habitat due to the presence of critical habitat-qualifying species. Potential impacts of the Project on the Majete Wildlife Reserve and the Elephant Marsh are of primary concern to the Project.

Potential pre-mitigation impacts on the six above-described critical habitat qualifying species are predicted to arise from (i) increased influx and associated poaching pressures on Majete Wildlife Reserve which could target black rhinoceros; (ii) collision and electrocution of white-backed and white-headed vultures on transmission lines, primarily the 132kV line, and (iii) possible long term and incremental reduction and degradation of sandbanks and wetland habitats in the river reach from Kapichira to Chikwawa at the northernmost portion of the Elephant Marsh, with minor effects on African skimmer, African openbill and Zambezi flapshell turtle (if present).

The Project aims to achieve net gain for critical habitat qualifying biodiversity and no net loss for natural habitat and species of stakeholder concern.

For the five above-mentioned critical habitat qualifying species, mitigation measures are planned to meet net gain for potential project-related losses to these species:

- To improve rhino protection, the Project will provide additional support to Majete Wildlife Reserve for increased security surveillance (ranger camp, better roads and bridges, training and equipping of staff and firebreak management) and support with education and training to surrounding communities to improve benefits and relations. With the planned mitigation measure the residual impact of the Project on black rhinos is assessed as unlikely and of low significance. A contingency plan for black rhino protection will also be prepared.
- For vulture protection, the Project will place anti-bird collision and electrocution devices on the project transmission lines and undertake fatality and carcass monitoring (mitigation); develop a vulture contingency plan and provide support for additional vulture conservation and research (supporting conservation actions). These actions are anticipated to reduce the potential impact to vultures to an acceptable level with further adaptive management as required.

- Although no project impacts on African skimmer, African open bill and Zambezi flapshell turtle are predicted, there are no viable or warranted mitigation measures to reduce the potential future effect of the Project on floodplain habitats from sediment retention in the dams. However, the reach of river and floodplain between Kapichira and the northern Elephant Marsh is a narrower strip than the central and southern portions and exhibits a higher degree of human disturbance and habitat degradation. The northern area is not considered primary habitat for these species, and the two wetland birds are expected to occur in higher abundance in the areas further downstream of any areas of potential project impact. Therefore, it is unlikely there would be a residual impact of the Project on these three species and their wetland habitats in the Elephant Marsh, and it is assessed as non-significant. In the southern portions of the Elephant Marsh (south of Mwanza River) the reduction in sediment load via the Shire River may lead to improved aquatic habitat.

For species of stakeholder concern, the influx of people to the area and increased hunting pressure may have residual impacts on Temminck's pangolin, outside and possibly inside the Majete Wildlife Reserve. Since there is no population data available and the Project impact on pangolin is uncertain, the Project's aim of achieving a no net loss of woodland habitat through creation of a conservancy areas will also serve as a surrogate for increased pangolin protection. The conservancy can also assist with potentially providing additional habitat for release of any captured pangolins. For hippopotamus, although the Project will cause displacement and barriers to movement of hippo and possibly increase wildlife conflicts, the reservoirs may create new habitat for them if there is sufficient grazing and acceptable levels of human disturbance. Whether or not hippopotamus (and crocodiles) adapt to the reservoirs or remain more confined to Majete WR, the residual impact on these species is of minor significance.

In summary, offset options for loss of natural and terrestrial habitats and critical habitat qualifying species are being further developed under the BAP. These include protection of a conservancy on the north side of Majete WR (Neno side of Regulating Reservoir); improved protection measures in the Elephant Marsh, and species-level targeted additional conservation actions for black rhinoceros and vultures.

2.7 Community Health, Safety & Security

2.7.1 Health

Community health within the area of influence for the Project is affected by poor socio-economic circumstances, an inefficient public health system and poor access to basic services in most rural communities creating an environment where health concerns are widespread and cross cutting. These challenges have been exacerbated by recent tropical storms and a delayed return to normal following the disruption brought by these environmental disasters. The burden of disease is primarily due to communicable diseases, i.e., malaria, acute respiratory infections (including TB), schistosomiasis and sexually transmitted infections (including HIV), and complicated further by high rates of malnutrition, inappropriate hygiene practices and poor health seeking behaviour. In addition to this, the incidence of non-communicable diseases is increasing but remains under-diagnosed and treated due to limited diagnostic and treatment capacity, especially in peripheral health facilities.

During construction, the incoming construction workforce may contribute to the transmission of communicable diseases through a variety of impact pathways but with a particular concern regarding HIV transmission. This will depend on the management of their deployment and how workforce members are allowed to interact with local residents. Project-induced in-migration into the area of influence will result in population densification in hotspot areas and influence transmission of communicable diseases, ranging from communicable diseases related to the living environment to water and sanitation related diseases and including sexually transmitted infections. The resettlement process may also hold significant risk for adverse impacts on human health of affected households if not executed effectively and without consideration being given to sustainable livelihood restoration.

During operation, the Project may affect community health primarily because of the creation of the reservoir/s, significantly increasing vector breeding sites, vector densities and, subsequently, potentially increasing the already substantial burden attributed to vector related diseases (malaria, onchocerciasis and schistosomiasis). An entomological and cross-sectional health survey will be conducted to determine a robust baseline as a point of departure. These surveys will be undertaken prior to the start of construction. The Project will then use the result of these surveys to plan and support the following mitigation measures:

- Health System Strengthening: (i) support of District Health Management Teams on public outbreak preparedness and response capabilities, ii) support local health facilities in improved diagnostic and disease surveillance capabilities, ii) support of community health worker/ health surveillance agents programmes in association with local health development partners and the GoM, and (iv) establishing a private / public health committee to address cumulative impacts across the broader project area.
- Resettlement sites planning and replacement housing for physically displaced households that will include elements for communicable disease: housing design and provision of basic services with some consideration for potential influx, to prevent adverse impacts in the resettled population.
- During construction, (i) Planning and development of appropriate procedures to manage the incoming workforce, their accommodation in the construction camp and their interaction and behaviour toward potentially vulnerable community members, and (ii) implementation of workforce health management facilities and services with sufficient resources and capacity in place to not add to the overburdening of the public health system.
- Community health indicators monitoring implemented throughout project construction and operation to assess the performance and report on effective consideration of environmental health in the initiatives supported by the Project

In addition, management actions to limit influx will help minimise impact on community health exacerbated by population densification (see Section 2.3).

2.7.2 Safety & Security

During construction, most of the potential impacts on community safety and security are those that are common to all major infrastructure construction projects: i.e. project traffic on public roads, general hazards from construction worksites and increased insecurity due to project-induced in-migration.

The main access to the Main Dam is through the existing S137 road from Blantyre. The baseline traffic volumes on the S137 are in general low, and predominantly made up of motorcycles, bicycles and pedestrians. At night, the traffic volumes drop significantly to reach almost zero. There is currently little provision in terms of road safety along the S137 road. The Project will upgrade the S137 road on the Blantyre side. Once built, the Main dam will be used as a bridge, ensuring permanent access to crossing of the Shire River via the S137.

During construction, most of the project-traffic will be on-site, between the various construction sites, the quarries and the disposal areas. However, part of the project trucks will use the S137 road and the new Service Road linking the Main Dam to the regulating Dam, where public and project traffics will cumulate. Project vehicles will use the S137 road (i) from Blantyre to the dam site for delivery of equipment and movement of staff, (ii) from the Shire bridge to the new service road for material and staff transport. On these S137 road sections, project traffic will represent an incremental road safety hazard and risk of accidents, especially where villages are crossed. Along the new private service road linking the two dam sites, the Project traffic could be as much as one truck every two minutes at peak, exposing adjacent settlements to safety risks. As per Section 2.5, settlements that could not be avoided and that are located within 200m of the Service Road route will therefore be relocated prior to construction. During construction, the service road will also be used by communities residing south of the construction camp area. Robust road safety management will be implemented to ensure safe coexistence of the project

and public traffic. Planned traffic management measures will be prepared, discussed and disclosed locally. Awareness campaigns will be organised to ensure that local communities are aware of the risks associated with project traffic and the road safety devices installed by the Project.

Construction sites are hazardous for any non-workers and animal herds. In particular, several areas may present safety risks for communities, including the Main Dam construction site and quarries that are located close to the Chaswanthaka and Kambalame settlements and accessible from the S137 road. The new Service Road serving southern communities will cross the construction area comprising the Operators Village and the Construction Camp. Mitigation has been planned to reduce these risks. Check points will be installed and operated on strategic points across the construction sites. Fences along public roads around dam sites, powerhouse sites and quarries will be installed where there is a safety hazard (e.g. fall-out, collision, projection). Flag men will be mobilized in sensitive areas along public roads used by project trucks (e.g. close to quarry area, close to schools). MHPL will also engage with cattle herders and identify acceptable corridors for herds through the project area which can be made safe during the construction.

The influx of jobseekers and the presence of a large workforce could affect the social fabric of local communities and result in increased conflicts and criminality. The Project will also generate significant local employment and business opportunities during construction. Although this can be considered as a positive impact, this may result in socio-economic inequalities that could lead to social tensions and increased social ills. Additionally, theft of materials and/or vandalism in construction sites could lead to potential violence and expose communities and workers to incremental safety hazards (e.g. electrocution, falling structures). These impacts are likely to occur throughout the Project construction and operation periods. Security issues in general will be mitigated by implementing on site awareness-raising campaigns and establishing cooperation with a local police station that will be opened for the project. The strengthening of the police force in the area, implemented at the construction stage, will continue throughout the operational life of the project.

During operation, the two main safety concerns resulting from the Project activities are (i) hydraulic safety (risk of drowning) associated with the reservoirs' operations and (ii) road safety along the upgraded S137 road.

The Project will not change the frequency or magnitude of natural floods. No flood attenuation is predicted from the presence or operation of the two reservoirs. However, the Main Powerhouse will be operated as a peaking plant. The river reach between the Main Dam and the Regulating Reservoir will be exposed to sudden and rapid variations of river water level and velocity. The operation of the Main Reservoir will induce rapid variations of downstream flow (i) on a routine basis through sub-daily peaking power releases, (ii) in the case of occasional events (e.g. turbine shut down), and (iii) in relation to flood or emergency management (spillway opening or closing). The magnitude of the sudden variations of river water level and velocity will be significantly higher than that currently experienced due to the operation of the existing hydropower schemes on the Shire River. Change in flows will be of the order of five times those currently experienced on that reach. The river reach between the Main Dam and the upper part of the Regulating Reservoir could pose a significant safety risk to the public. The Project will therefore fence and patrol this area. Complementary measures such as regular community awareness campaigns will be undertaken. Safe viewpoints from the S137 road will be installed.

As per Section 2.5, provided it does not interfere with the dams' operation, most of the Main Reservoir will be accessible for local communities, apart from the two exclusive zones (500m from the Main Dam facilities, 500m from the Tedzani tailrace). These two exclusive zones will not be safe. Boats could be exposed to higher flow velocities and rotating currents with the risks of being capsized or sucked up. Likewise, no activity will be authorized in the Regulating Reservoir, apart from cattle watering and domestic water use. Warning signs will be installed, and an extensive public awareness campaign undertaken.

As per Section 2.6, the main reservoir will create new aquatic habitat for fauna, especially hippos and crocodiles. This could increase conflicts between wildlife and local farmers related to crop damage and risk of attack from wildlife to people or cattle accessing the reservoir banks. In

complement to the organization of awareness raising campaigns, the Project will assist in the construction of safe accesses to the reservoir bank for communities and livestock.

Flood control structures have been designed to withstand a 1,000-year return flood. During operation, the stability of the dam walls will be assessed with monitoring devices and regular visual inspections will also be carried out. A dam break analysis was undertaken as part of the 2024 ESIA and shows flooding maps in case of a very unlikely dam break. The Project's Emergency Preparedness Plan will include procedures and early warning system for dam emergency situations, including downstream emergency releases. Dam operation safety awareness campaigns will be conducted amongst the local communities throughout operation.

The Blantyre-Mwanza traffic diverted from M1/M6 via the upgraded S137 road, is expected to be low given the longer journey and the road condition on the Neno side. During operation, the vehicles used by the Project will not significantly increase the traffic along the improved S137 road. However, increased accidents could result from higher vehicle speed allowed by the improved road conditions on the Blantyre side and poor responsible driving. The S137 road upgrade detailed design will include road safety arrangements (e.g. speed bumps, separate lanes for pedestrian). In addition, the Project will support awareness-raising campaigns on road safety and responsible driving.

2.8 Gender-related risks

Gender-based violence[3] (GBV) is common in Malawi and throughout the Project area. According to the 2023 socioeconomic investigations undertaken as part of this ESIA preparation, cash earnings are usually managed jointly or by the person earning the money, with women often excluded from a role in managing cash income spend. Many men prioritise financial resources for their personal use, such as alcohol, while women typically prioritise spending on the household and children needs. Control over finances also leads to disputes and gender-based violence when surplus cash is available. The local gender-based violence context is considered very sensitive.

During construction, a number of risks or changes linked with the Project may affect women more than men due to:

- Gender bias with women less likely to benefit from local employment opportunities during construction,
- Shifting power balance and role and position of women in local communities if women are employed by the Project, potentially leading to some resentment, conflict or even violence from their husbands or other men.
- Increased burden of domestic and agricultural work on women if the contractor hires a number of men in a local community, leaving women and children having to compensate for the labour support in the family.
- Women also face additional risks induced by project workers, such as harassment and gender-based violence.

The Project land acquisition and compensation process will create the following gender-related risks for some households:

- Exacerbation of intra-household dispute over cash spending if men try to take control or manipulate the compensation process and spend the compensation payment for their own purposes without prioritising household benefit or livelihood restoration. This is a high

[3] As per the International Labour Organisation (ILO, 2019) the term "gender-based violence and harassment" means violence and harassment directed at persons because of their sex or gender, or affecting persons of a particular sex or gender disproportionately, and includes sexual harassment.
According to the world Bank (World Bank, 2018), Gender-Based Violence (GBV) is an umbrella term for any harmful act that is perpetrated against a person's will and that is based on socially ascribed gender differences. The term GBV stems from the 1993 United Nations Declaration on the Elimination of Violence against Women, which defined violence against women as 'any act of gender-based violence that results in, or is likely to result in, physical, sexual or psychological harm or suffering to women'. While GBV disproportionately affects women and girls across the globe, men and boys can also experience GBV and these acts are highly stigmatized and often stay hidden and unreported.

risk as compensation payments will represent a large amount of money for the affected households.

- Potential for land rights or ownership changes or imbalances to occur within families if both spouses are not included in the census and land survey process as men are generally considered the head of households even if most groups in the Project affected area are matrilinear societies. In such cases, men could try to be recorded as landowners of affected parcels at the expenses of their wives. There is also the risk that uncles or brothers may be allocated land from their nieces or sisters.

During the land acquisition, compensation, resettlement and livelihood restoration processes, gender-specific measures will be implemented by the Project, such as female-led and women only focus groups and consultations. To ensure women participate in the compensation process and are aware of the compensation provided to the households, the individual disclosure of the compensation packages will be done during one meeting with both spouses and all adults members of the households (including daughters and sons). The Project will ensure that both spouses are informed of the household's entitlements, compensation amount and payment process during individual meetings.

During construction, to reduce GBV risks and mitigate potential impacts, MHPL will recruit a Gender-Based Violence Harassment (GBVH) service provider to avoid and minimise GBVH, manage potential cases of GBVH, and provide support to survivors. The GBVH service provider will mobilise staff on-site during the duration of the construction activities and introduce these staff members to the local communities at the start of construction. MHPL will implement a Community Outreach Programme on GBVH which will disclose the Project's GBVH protocols and reporting processes. The Community Grievance Mechanism will channel all GBVH complaints and store them on a dedicated database. MHPL's Service Provider will be responsible for handling and solving these complaints and those collected by the EPC Contractors. MHPL will capacitate local women into social groupings to address GBV, work with local authorities to find preventative solutions and remedies for GBV, and support the creation of 'safe-houses' where victims of domestic abuse can be cared for, with links to the public health services so survivors can receive the necessary medical support.

During operation, the systems defined by the GBVH service provider will continue to be applied.

2.9 Labour and Working Conditions

The Project's workers may be exposed to occupational health and safety risks, which are typical of large construction sites. These include a range of hazards from exposure to hazardous materials, noise, dust and vibrations, blasting activities, and to traffic and vehicle movements.

During construction, most of the workforce will be recruited and managed by the EPC Contractors and their sub-contractors. About 2,500 workers (at peak) will be mobilised, including 50% of unskilled workers. The EPC Contractors will aim at recruiting Malawian citizens for 100% of the unskilled personnel, with priority to local residents, especially in Project Affected Communities. All non-local workers will be housed within the accommodation camp. The Project's human resources policy and labour management principles will include provisions related to transparency, non-discrimination, fair treatment and equal opportunity. The EPC Contractors will train all employees on their work environment and associated risks and will develop and implement Occupational Health and Safety management plans aligned with ISO 45001:2018 to ensure that workers have limited and/or controlled exposure to these risks. MHPL will monitor the EPC Contractors health and safety performance.

During operation, employees will be recruited and managed by MHPL. MHPL will recruit up to 120 persons to maintain and operate the Mpatamanga HPP facilities. They will be accommodated in the operators' village. MHPL will develop and implement an Occupational Health and Safety Plan covering the health and safety hazards at the worksite, many of which will be similar to the construction hazards. MHPL will undertake regular health and safety risk assessments, monitor the implementation of the Operational Health and Safety Plan and provide health and safety training to its employees during operation.

2.10 Cultural Heritage

Malawi has two official UNESCO World Heritage sites (i.e. Lake Malawi and Chongoni Rock Art Area), both located far from the Project area. Likewise, the six sites listed on the UNESCO World Heritage tentative list are located far from Project. The Tangible Cultural Heritage elements potentially affected are churches or mosques, cemeteries or graves, or sacred sites located inside or close to the Project footprints. These Cultural Heritage elements are 'living' cultural heritage elements i.e. they are used by the local communities nowadays. One sacred site (a baobab tree where ceremonies are practiced) has been identified in the main reservoir area. The Department of Museums and Monuments identified 43 archaeological artefacts or potential archaeological sites or remains and 6 graveyards in the Main Reservoir and Main Works footprint. At the time of writing, the S137 road works areas, the 400 kV and the 132 kV transmission lines' wayleave, and the Main Works area (operator's village and construction camp), were yet to be surveyed. The Department of Museums and Monuments will undertake the required investigations to identify cultural heritage impacts in the areas not yet surveyed.

During the ESIA social surveys in 2023, it was reported that cultural practices, such as initiation ceremonies and baptisms are practised on the banks of rivers. These practices/events are organised on the riverbanks by some villages because of the proximity to water, but they are not linked to one specific place. In addition, none of the informants reported a perception of the Shire River as holding a particular aesthetic, spiritual, religious or cultural value for the population. No mention of cultural elements or cultural practices on the banks of the Shire River inside the Project land requirements was reported, except for the sacred tree and cemeteries previously mentioned.

During construction and reservoir filing, the 43 archaeological sites, the six graveyards and one sacred site will be flooded by the Main Reservoir. One church is located in the 400 kV line wayleave. Additionally, pending the final S137 design, two graveyards, one church and one mosque could be affected.

The sacred site, cemeteries and graves are highly sensitive: they are very important for the local communities. Appropriate ceremonies will therefore be performed at the sacred site with the local communities before the main reservoir flooding. The sacred site will then be displaced and re-established outside of the impacted area by the local communities. The Department of Museums and Monuments will prepare and implement a Graveyards Impact Assessment and Relocation Plan, to identify appropriate replacement sites for cemeteries, establish the new cemeteries and displaced the affected graves. It will be done through a participatory process with the affected communities. Any affected churches and mosques will be relocated. A Chance Find Procedure has been developed to manage potential chance finds during earthworks and construction activities.

During operation, no further loss of cultural heritage elements and no impaired access or restriction of access to cemeteries, religious buildings or sacred site is anticipated. Although access to part of the Regulating Reservoir, and to some areas of the Main Reservoir banks, will be restricted, cultural or religious activities practiced on the Shire riverbanks will not be affected as they are not linked to a specific place.

2.11 Ecosystem Services

Ecosystem services encompass the various benefits that local communities derive from healthy ecosystems. Biodiversity is central to the production of ecosystem services; it is the direct source of services, such as food and fibre, fisheries, and underpins others, such as clean water and air, through the role of organisms in energy and material cycles. Non-material benefits can be also obtained from ecosystem through aesthetic, sense of place and spiritual experiences.

The project land take will reduce areas available for communities for crop cultivation, livestock farming or collection of natural resources such as medicinal herbs, firewood, timber, clay soils and sand. One of the main sources of income in the impacted area is the production of charcoal, which already suffers from limited supply of woodland resources. Losing areas for timber

collection and charcoal production and putting more strain on other surrounding natural habitats will worsen the situation. The creation of the two reservoirs will also flood a spiritual value element and will lead to the direct loss of landscape features through removal of vegetation and changes to the landform. Access to water will be restricted for safety reasons in some parts of the reservoirs. The Main Reservoir may create an opportunity to replace the already limited river-based fishing with reservoir fishing.

Rivers and associated habitats outside the project land take is also used for irrigation, wood collection, limited fishing, drinking water, transportation, recreational purposes or various economic activities. Downstream of the Kapichira Dam, as per Section 2.1.2, the progressive riverbed erosion and bank erosion may result over decades to a reduction of land and water used in the floodplain.

These impacts and associated mitigation measures are addressed in the previous sections of this Non-Technical Summary.

2.12 Environmental Flows Assessment

The Environmental Flows Assessment sets out the requirements for defining the quantity and quality of water and sediment flows needed to sustain the Project affected freshwater ecosystems and human livelihoods and well-being that depend on these ecosystems. Within the 2024 ESIA, particular consideration was given to potential impacts within the Majete Wildlife Reserve, in the Lower Shire floodplain and in Elephant Marsh.

The Project has included in-built design features to address these environmental flows requirements, principally, incorporating a downstream Regulating Reservoir into the Project Design to minimise the impacts on flow alteration due to sub-daily variations in outflow from the Main Powerhouse associated with peak period power production.

Additional impact mitigation measures and monitoring commitments are incorporated into the Project to further minimise the predicted aquatic ecosystem and social reliance impacts associated with flow alteration, sediment management, and water quality management, both during the construction phase and during the operational phase of the Project:

Residual flow alteration impacts in the reach between the Regulating Reservoir and Kapichira Reservoir are predicted to be satisfactorily mitigated by ensuring that sub-daily flow in this reach does not vary by more than +/-10% with respect to the daily average incoming flow upstream of the main reservoir. Additionally, the flow variation of +/-10% is constrained by limits on rate-of-change such that water levels will not vary by more than 1 cm per minute. Water levels through the Majete Wildlife Reserve are predicted to therefore vary slowly over an approximate range of 50 cm maximum, representing a significant improvement with respect to conditions that are currently experienced (0.8 m to 2.4 m as measured in the Shire River in 2023 at the proposed Regulating Dam location). Potential water quality impacts are also predicted to be limited. Commitments are made to further assess the potential risk of supersaturation and fish mortality downstream of the Regulating Reservoir and to incorporate additional design features (spillway deflectors) as necessary.

Certain potential impacts related to environmental flows are either not able to be mitigated or indeed are beneficial:

- Passing downstream any sediment trapped in the Main Reservoir: Mitigation strategies considered are either not technically feasibly (e.g. sediment flushing) or are associated with significant additional environmental or social impacts and costs (e.g. downstream reinjection of sediment dredged in the main reservoir).
- Downstream riverbed incision and bank erosion is predicted to occur due to sediment trapping in the Main Reservoir, but the scale, location, and timing of such impacts remains highly uncertain. A “Downstream Management Plan” has been defined in the 2024 ESSMP to address these potential impacts.
- The Project has not included specific design features such as fish-friendly turbines or fish ladders to ensure ecological connectivity as the aquatic habitat assessment has identified

that these are not required due to the small home ranges of the fishes present. Indeed, the Main Reservoir and Regulating Reservoir dams are considered beneficial obstacles to limit the potential spread of alien invasive fishes such as the tigerfish and Australian redclaw crayfish.

Underlying the EFlow assessment is a comprehensive monitoring program associated with flow alteration, sediment management, and water quality management. Commitments to an adaptive management approach have been made such that when any significant negative impacts are confirmed, management systems are in place to further minimise and/or mitigate these impacts.

2.13 Cumulative Impact Assessment

2.13.1 Approach

The 2024 Cumulative Impact Assessment (CIA) for the Mpatamanga HPP on the Shire River Basin has been undertaken concurrently with the 2024 ESIA. The CIA is conducted for the Shire River Basin from downstream of Lake Malawi to the confluence with the Zambezi River, with focus areas from Kamuzu Barrage to the border with Mozambique.

Unlike the 2024 ESIA, the 2024 CIA process is a Value-Centred Environmental and Social Component approach that assesses the basin's past, present, and future developments through a selected set of scenarios. A Valued Environmental Component (VEC) refers to fundamental elements of the physical, biological, or socioeconomic environment that are considered important by stakeholders. These components can include resources, ecosystems, and human communities. Basin stakeholders and MHPL have identified and prioritised both the VECs and the scenarios in a participatory approach in 2023.

Cumulative impacts on the selected VECs have been modelled and studied for ten scenarios that fall into four main scenario groups, namely:

- Near natural (early 1900) and trended past (1992-2022) scenarios.
- Baseline scenarios, e.g. current/2023 and 2030 with and without Mpatamanga HPP.
- Near Future scenarios (2035); e.g. business as usual (BAU), BAU + joint dams operation (JDO), BAU + JDO + climate change (CC) and BAU + JDO + CC + sustainable pathway (SP).
- Distant Future scenarios (2070); e.g. BAU + CC and BAU + CC + SP (as of 2035 but with continued catchment restoration).

The prioritised VECs studied for all scenarios, through a cause-and-effect impact pathway, from drivers/causes via stressors/primary impacts and secondary impacts, include the following main VEC groups (each supported by a set of indicators):

- Reliant water availability and quality (WAQ);
- Biodiversity and habitats for wildlife, birds and aquatic life (VEC species and habitats, VEC-SH);
- Ecosystem services for livelihoods (ESL);
- Productive land/soil for agriculture (PLA);
- Historical, cultural and religious sites (HCR); and
- Tourism and social services (TSS).

2.13.2 Findings

The main scenario results are as follows:

- Near natural (Early 1900): Characterised by a largely pristine, and unmodified Shire River Basin with largely intact forest, terrestrial and riverine ecosystems. Impacts on VECs minor or absent.

- Trended past Pre 1992: Stark population increase in this period and infrastructure development in the basin, including HPPs/dams. Agricultural expansion. Deforestation occurs, especially in the second half of the period. Impact on VECs increases to moderate impacts on (i) biodiversity and habitats for wildlife, birds and aquatic life and (ii) ecosystem services for livelihood, whilst the four other VECs are in the low impact range. Between 1992-2002 and 2002-2022 population increases considerably. There is widespread deforestation and land use change in the basin, the leading cause being charcoal/fire wood extraction and agricultural expansion. Due to climate change, more extreme weather events occurred in the second half of the 2002-2022 period. More infrastructure comes online, including HPPs, transmission lines, roads, etc. Bigger pressure is imposed. The cumulative impact on the VECs rises considerably over both periods, and we see high impacts on WAQ, VEC-SH, and ESL as well as moderate impacts on PLA and TSS in 2022.
- Baseline 1 (2023): Same as the end of 2002-2023 period.
- Baseline 2 (with and without Mpatamanga HPP, 2030):
  - Population increases, and agricultural expansion/deforestation continues. Deforestation and extreme weather events remain the most prominent stressors to the basin.
  - Adding Mpatamanga has more local than basin-wide effects on the VECs, with its resulting influx of people being assessed to be the most prominent basin-related stressor.
  - Both with and without Mpatamanga, the impacts on the VECs rise to severe for VEC-SH and ESL and WAQ to high. There is just a slight increase in impact on all VECs at the basin scale with Mpatamanga in place.

- Near Future Scenarios 1, 2 and 3 (2035): This set constitutes the BAU, BAU + JDO and BAU + JDO + CC.
  - Basin degradation continues, and the impact profile in the impact pathway towards the VECs is quite similar, especially between Near Future 1 and 2 (only a slight decrease in VEC impacts due to JDO, but with an increase again when adding climate change.
  - Impacts on the three VEC groups WAQ, VEC-SH and are estimated to become severe, while PLA is high and the two last to be moderate.

- Near Future 4 – Sustainable Pathway (2035): This is the recommended basin development scenario, and what constitutes the measures is summarized in footnote 2.
  - With these catchment scale measures in place, the 2024 CIA estimates a reduction in the magnitude of the impacts from especially (i) charcoal/firewood production and encroachment into forested areas and (ii) agricultural and industrial practices have knock-on effects on many of the stressors/primary impact and secondary impacts, leading to reduction of impacts on all VEC groups compared to Near Future 1, 2 and 3 Scenarios.
  - Impacts are lowered to moderate (four VEC groups) or low (two VEC groups).

- Distant Future (2070): This scenario set constitutes the BAU for 2070 (Distant Future 1), which is similar to Near Future 1 (2035) but with further basin degradation and more extreme weather events due to climate change, and the Sustainable Pathway Scenario for 2070 (Distant Future 2) with continued basin restoration and reforestation as of Near Future 4 scenario. For the Near Future 1 scenario, the magnitude of almost all impact pathways becomes more prominent, eventually leading to severe impact scores on all VEC groups. Hence, we will probably witness a basin collapse or transition into a completely different state if no large-scale restoration, reforestation, and other mitigation measures are implemented. On the contrary, if the steps in the sustainable pathways are continued to be implemented up to 2070, the basin's health and impacts on the VECs will be considerably reduced. Only continued climate change remains somehow prominent. Impacts on all VEC groups are considerably lowered and are even lower than for Near Future 4 due to the continued restoration, reforestation and other mitigation measures.

Three VEC groups are in the moderate impact range, and the remaining three are in the low impact range.

2.13.3 Recommendations

The recommendations from the 2024 CIA for further basin development and management of the Shire Basin are largely embedded in the sustainable pathway scenarios and those measures. A set of catchment scale mitigation measures has been developed. Most of these go beyond the responsibility of MHPL and are rather the main responsibility of GoM like for example: (i) catchment rehabilitation that includes rehabilitation/reforestation of targeted erosion hot-spot areas, (ii) enhancing tourism and protected areas management and (iii) Sustainable land use enhancement and energy source transition.

The measures specifically relevant for Mpatamanga HPP/MHPL are (i) implementing/enhancing the joint operation of Shire River dams, (II) implementing a Co-Management Platform for Shire (especially for the water users), and (iii) payment for ecosystem services (PES) for the rehabilitation/reforestation of erosion hotspots in the Lisungwe catchment (that drains into the main reservoir).

2.14 Transboundary Impact Assessment

The Shire River is a tributary to the Zambezi River, and thus part of the Zambezi River Basin which is shared by eight countries: Angola, Namibia, Botswana, Zambia, Zimbabwe, Tanzania, Malawi, and Mozambique. Upstream of the Mpatamanga Project, Tanzania, Mozambique, together with Malawi, have tributaries joining Lake Malawi, which outflow create the Shire River. The Shire River enters Mozambique and joins the Zambezi, downstream of the Cahora Bassa Dam, and close to the Zambezi delta before it reaches the Indian Ocean. Through the design of the Mpatamanga Project it has negligible impact on neighbouring countries. One of the pre-requisites for design of the Mpatamanga Project has been that downstream flows should not be altered within the Majete Wildlife Reserve, and thus there are no impacts on flows at the point where Shire enters Mozambique. Through the reservoir created by the main dam (20 km²) there is theoretically an impact of evaporation creating a net loss and a hindrance of sediment transport. The loss of evaporation is approximately 1.1 m3/s, which is 0.03% of the outflow in Zambezi delta of 4,134 m^3/s. Sediment outflow from Shire River is mainly governed by the Elephant Marsh, which is downstream of the Mpatamanga Project, and therefore also the impact of sediment transport on the basin scale is negligible.

Following the procedures for the Zambezi Watercourse Commission (ZAMCOM), Malawi sent a preliminary notification to ZAMCOM on June 30, 2023, including an overview of the Mpatamanga Project. As of June 2024, no responses had been received from any of the riparian countries through ZAMCOM based on this notification. The Technical Notification to ZAMCOM, including the technical design and the 2024 ESIA, will be submitted to ZAMCOM in September 2024 as per procedures. In addition, GoM has agreed to send bi-lateral notifications to the seven riparian countries to meet the World Bank OP7.50 requirements. Notifications are planned to be sent out in mid-2024 with a 30-days response time for the riparian countries to responds with any objections. A legal covenant will ensure that the ZAMCOM procedure is fulfilled, should there be any responses on the Technical Notification, before start of main works planned for November 2025.

3 Environmental and Social Monitoring and Management

3.1 Responsibilities

MHPL will take the full responsibility of the Environmental and Social management of the construction and operation of the Project. Responsibilities for the preparation and implementation of the Resettlement Action Plans are distributed between the Government of Malawi and MHPL. MHPL will also take the full responsibility of the Environmental and Social management of the proposed S137 road upgrade works and the construction of the 400 kV and 132 kV transmission lines. At the end of the construction phase, the transmission lines and the associated responsibilities, will be handed over to ESCOM. The upgraded S137 road will be managed by the Department of Roads.

Although MHPL takes the overall responsibility for the implementation of E&S mitigation and compensation measures of the Project, MHPL will delegate to several EPC Contractors the implementation of the E&S measures relating to the construction methods. This delegation is ruled by the environmental and social specifications that form part of the EPC contract and that establish the objectives in terms of E&S performance for the construction methods. Some environmental and social actions that do not relate to the construction methods will be initiated during the construction period. These actions result from the mitigation strategy of the long-term effects identified by the 2024 ESIA. Their implementation will be under the responsibility of MHPL.

MHPL will contribute to the coordination among hydropower operators of the Shire River. Sediment flushing, continuity of ecological flow, emergency preparedness planning are activities which require coordination at the watershed or river level.

3.2 Construction Methods

Detailed environmental and social obligations have been included into the EPC Contracts to ensure that construction methods do not incur adverse or non-compensated effects on communities, vegetation, soils, groundwater, biodiversity, natural drainage and water quality in areas adjacent to worksites for the entire duration of the works. It includes the performance requirements of the Lenders' Environmental and Social policies. These specifications include the preparation and implementation of several construction management plans, such as waste management, erosion control, site rehabilitation, chance finds procedure, spoil disposal and quarry management.

Strict environmental and social surveillance of construction works will be undertaken to ensure compliance with GoM, MHPL and Lenders environmental and social requirements. Design adjustments decided during the construction stage will be strictly managed within the 2024 ESMMP framework.

3.3 Land Acquisition & Involuntary Resettlement

The construction and operation of the Project will require resettlement, land acquisition and restriction of land use. These resettlement, land acquisition and restriction of use could induce adverse impacts for the affected households. A Resettlement Policy Framework (RPF) has been prepared as part of the 2024 ESIA. The 2024 RPF sets out a framework by which the impacts will be mitigated and how compensation will be made. Responsibilities for the preparation and implementation of the phased Resettlement Action Plan (RAP) are distributed between the GoM and MHPL.

As per Section 2.5, as the Project is large and complex the land acquisition, compensation and resettlement process will be phased. A Resettlement Action Plan will be prepared and executed for each of these four phases: 1) S137 road upgrade works in Blantyre District, and Chaswanthaka and Mpindo resettlement sites; 2) Main facilities and S137 road upgrade works in Neno District and Kambalame Resettlement site; 3) Transmission Lines pylons footprint and access restriction to the line right-of-way; and 4) Main Reservoir.

The 2024 RPF defines the principles and implementation arrangements to be applied for each phased RAP, in compliance with the Malawi legal land acquisition process, and the requirements of World Bank Environmental and Social Standard 5 and IFC Performance Standard 5.

A cut-off date for determining eligibility for compensation or other assistance will be established for each of the four phased RAPs. This cut-off date will be the date of the end of the census of affected persons and the inventory of their affected land plots and assets. It will be communicated, documented, and disseminated, including by providing clear demarcation of areas to be acquired for the Project. Individuals taking up residence in, or use of, the project area after the cut-off date are not eligible for compensation or resettlement assistance.

During the preparation of each phased RAP, all affected households and businesses will be identified. Compensation for the loss of assets and lands will be offered, according to the full replacement cost principle.

For physically displaced households, the Project will offer a choice between (i) resettlement on one of the resettlements sites in Chaswanthaka, Mpindo and Kambalame village or assisted self-relocation in the same village or GVH with replacement housing constructed by the Project for households physically displaced in other villages, and (ii) cash replacement at full replacement cost. The Project will identify replacement lands to offer a choice between in-kind and cash compensation to the persons losing land. It must be noted that replacement lands may be limited or not available in some villages. The assessment of the feasibility of this approach will be done village by village through a participatory process.

Assistance to resettlement will be provided through in-kind replacement land and housing to the affected households choosing in-kind compensation over cash compensation, (i) on the 3 resettlement sites for physically displaced households of Chaswanthaka, Mpindo and Kambalame villages or (ii) through assisted self-relocation for other physically displaced households and economically displaced households losing farmlands they are cultivating. Psychological support to the displaced household to help them adjust to the resettlement process. In kind assistance will also be provided to vulnerable households physically displaced to move their belongings during their relocation.

A livelihood restoration programme will be implemented for all affected households for each phased RAP. Individual (household-level) livelihood restoration support will include (i) support to open a bank account, (ii) training for sustainable management of compensation, (iii) transitional support as staple food basket provided in-kind during 6 months, (iv) in-kind provision of agricultural inputs to restore crop production, (v) provision of one bicycle per affected household, (vi) support to development of off-farm economic activities and (vii) preferential hiring and skills training.

Collective (village-level) livelihood restoration support will include (i) farmer field schools, trainings on improved fallow and demonstration plots, (ii) Support to development of small agro-processing units, (iii) support to development of micro-businesses producing agricultural inputs, (iv) support to sustainable and green charcoal production, (v) restoration of access to water for domestic and drinking purposes, (vi) restoration of livestock access to water, (vii) support to develop small scale irrigation, (viii) support to fisheries activities for affected communities around the Main Reservoir.

Livelihood restoration measures for vulnerable households include (i) assistance to land-clearing and/or preparation of agricultural fields, (ii) provision of small livestock (goat or sheep), and (iii) support to develop beekeeping.

3.4 Environmental and Social Management

Through the 2024 ESIA, a number of mitigation and compensation measures have been identified to reduce or compensate the predicted adverse E&S effects resulting from the Project construction and operation. They are based on embedded mitigation involving site and technology choice, application of good international industry practice and enhancement measures that distribute benefits more equitably. These measures constitute the Project's E&S commitments. They are approved by MHPL and will be implemented during the construction and operations of the Project. Through its 2024 ESMMP, MHPL describes the management actions necessary to implement these commitments and mitigation strategy, including the manner in which they will be executed, the timetable, the resources and the performance indicators. Management actions include the following:

- Resettlement Action Plans, as described above, will be prepared to guide the land take process and to ensure that all individuals affected by land acquisition for the Project are compensated for their land and assets, which will enable them to attain a standard of living similar to and, if possible, better than the existing one.
- A Local Area Development Plan sourced by MHPL during the construction period and the operation phase will be managed to financially support local initiatives which sustainably address educational, economic and social needs of communities in the TA Kunthembwe and TA Kuntaja in Blantyre District, TA Mlauli and TA Symon in Neno District, TA Phalula in Balaka District, and TA Kasisi and TA Mlilima in Chikwawa District.
- To mitigate the adverse effects on community health resulting from project-induced in-migration and increased burden attributed to vector related diseases because of the reservoir presence, a Community Health Management Plan will be prepared and implemented to support and strengthen health authorities and local health facilities in (i) their diagnostic and disease surveillance capabilities (ii) Treatment initiation and retention and follow-up of patients, (ii) Supply chain management related to medication, consumables as well as waste management, (iii) Outreach activities, and (iv) Vector control.
- A Community Health Management Plan will be prepared and developed to strengthen health system in the project area. Based on capacity needs assessment of the local health facilities and conclusions on gaps against Project requirements for community health management, actions for supporting training, logistical support, and communicable disease, HIV and malnutrition management will be developed and implemented throughout the construction period and operation, and adjusted based on monitoring outcomes, as necessary.
- A Community Safety Plan will be prepared and implemented to (i) raise awareness on increased risks of traffic accidents on the upgraded 137 road, and (ii) respond to rapid variations of downstream river water level due to reservoir operation. Emergency Planning will also be prepared, tested and resourced to respond to sudden river flow in the Shire valley, including interface with local authorities and emergency services, in case of dam failure hazard, downstream release hazard or circumstances that potentially indicates an increase in the likelihood of a dam failure hazard or downstream release hazard happening.
- A Biodiversity Action Plan has been prepared and will be implemented for an agreed set of conservation actions that covers i) mitigation measures for off-site risks to critical habitat qualifying species including protection measures for potential project-related risks for black rhino in Majete and vulture collision on powerlines, ii) offset measures to mitigate impacts and achieve no net loss for residual impacts on natural terrestrial and aquatic habitats prioritising woodland protection on the Neno side of the regulating dam and conservation activities in the Elephant Marsh, and iii) supporting conservation actions to provide additional protection for vultures, pangolins and rhinos, including support for post graduate research.
- A Reservoir Management Plan will be prepared and implemented in order to (i) optimise benefits to community livelihoods without compromising dam operations and health and safety, (ii) make provision for sufficient water source allocation to communities to

maintain and improve existing livelihoods, and (iii) restrict and manage alien invasive fish & aquatic weed in the Main Reservoir.

- An Influx Management Plan will be developed and implemented to manage risks associated with project induced in-migration, involving a combination of interventions seeking to (i) minimise the in-migration phenomenon, (ii) influence its physical expression within the project's areas of influence, and (iii) mitigate the most significant potential adverse impacts.
- A Downstream Floodplain Management Plan, including the preparation and execution of a monitoring and mitigation strategy to be developed during construction to minimize the potential adverse effects of progressive and long-term riverbed incision and riverbank erosion downstream of the Kapichira dam on floodplain farming and fisheries, based on (i) geotechnical, groundwater, ecology and socio-economic surveys and baseline monitoring, (ii) detailed hydraulic modeling, (iii) meaningful and transparent stakeholder engagement, (iv) comprehensive monitoring of land use, river and floodplain geomorphology and hydrology, and (v) management and response plan for affected areas.
- A Stakeholder Engagement Plan has been prepared to summarize the public consultation process carried so far and program the future engagement initiatives during the construction and the operation periods. See Section 3.6 below.

3.5 Environmental and Social Monitoring

The Project has made assumptions on the prediction of adverse and positive effects during the construction and the operation phase, as well as on the efficiency of its mitigation and compensation strategy. These assumptions, as well as the performance of the E&S management plan implementation will be monitored.

The environmental monitoring will be implemented to detect changes in the key environmental quality parameters, which can be attributed to the Project to plan the necessary corrective measures. It will target the following indicators: (i) river hydrology; reservoir, river and groundwater water quality; reservoir erosion and river geomorphology; (ii) terrestrial wildlife stranding at reservoirs; (iii) terrestrial alien plants; (iv) aquatic biomonitoring (fish, aquatic invertebrates, instream vegetation, diatoms, waterborne disease hosts, and alien aquatic species, and (iii) land use and revegetation progress on areas disturbed by the Project during construction.

The socio-economic monitoring will include (i) household surveys to evaluate the effects of the Project on the community health and ensure no degradation of local livelihood; ii) high level market survey to assess the extent of the potential local price inflation, and (iii) data collection on migration phenomena in the project area.

3.6 Stakeholder Engagement

Between 2015 and 2022, date of MHPL creation, stakeholder meetings were undertaken during the pre-feasibility and feasibility studies, the framework Biodiversity Action Plan, and the 2021 ESIA, BAP and RAP through different consultants, such as AGRI-PRO Ambiente, Multiconsult, TBC, Mott MacDonald and C12.

From 2022, MHPL has conducted a number of stakeholder engagement activities: i) Monthly community meetings, ii) Quarterly stakeholder meetings, iii) Newsletters, and iv) 2024 ESIA process meetings, including ESIA, Cumulative Impact Assessment (CIA) and BAP Scoping Meetings in 2023, (v) focus groups, key informant interviews and households interviews as part of the 2023 socioeconomic surveys, and (vi) Public Consultation Meetings on the Draft ESIA in July 2024 to discuss the findings of the 2024 ESIA and the proposed mitigation measures. These activities have been done prior to the disclosure of the 2024 ESIA.

3.7 Grievance Redress Mechanism

The Project has defined and implemented a Grievance Redress Mechanism. The objective is to help third parties to avoid resorting to the judicial system for as many grievances as possible. This mechanism includes three successive tiers of extra-judicial amicable grievance review and resolution: (i) the first is the Village Grievance Redress Committee, (ii) the second being the Project Grievance Redress Committee and (iii) the third is a Grievance Review Board. Complainants can resort to judiciary channels at any time. The three-tier process does not deter them from doing so.

Since 2023, the Mpatamanga HPP has established five Group Village Grievance Redress Committees (GVGRCs) and two GVGRC Sub-committees in Blantyre and Neno Districts:

- In Blantyre District:
  - GVGRC GVH Kaliati: Mpindo, Inosi, Chaswanthaka, Lisangwi, Chilaulo villages; and GVH Kaliati sub-committee: Mbwinja, Divala villages;
  - GVGRC GVH Namputu: Chinkwinya, Chimpanda, Namputu, Chikira, Mwazilinga villages.

- In Neno District:
  - GVGRC GVH Feremu: Feremu, July, Kambalame villages, and GVGRC GVH Feremu subcommittee: Nkhwali village;
  - GVGRC GVH Nsalawatha: Nsalawatha, Chikaya, Liyenda, Joathan, Liwonde villages;
  - GVGRC GVH Ngwenyama: Mbemba, Nkoka, Joseph (1 and 2) villages.

Additional GVGRCs will be established if or when needed.

To provide feedback or to raise questions or concerns about the Mpatamanga HPP, the affected persons or the general public can contact MHPL or the Government of Malawi using the following contact details:

MHPL Contact Details:	Government of Malawi Contact Details:
• Mobile/WhatsApp: ▪ Toll free code: 4265 ▪ Airtel: +265 986 643 212 ▪ TNM: +265 886 595 369 • E-mail: info@mpatamangahydro.com • Mail: P.O. Box 886 Blantyre, Malawi • Office: 16, 17 and 18 on First Floor, Almira Complex at Plot Number BC1114, Mandala, Blantyre • Website: www.mpatamangahydro.com	• Mobile/WhatsApp: ▪ Airtel: +265 999 138 270 ▪ or +265 999 922 356 • E-mail: info@energy.gov.mw; austin.theu@energy.gov.mw; khumbolungu@gmail.com • Mail: P/Bag 309 Lilongwe 3, Malawi • Office: Second Floor, Capital House, Robert Mugabe Crescent, City Centre, Lilongwe • Website: www.energy.gov.mw

3.8 ESMMP Budget

The estimated cost of the ESMMP measures under the responsibility of MHPL is provided in Table 3-1. It is a preliminary budget that would need to be updated as long as the Project's activities progress and that the need for mitigation materializes. It is made of:

- Budget during the construction period (54 months): USD 62,628,174
- Annual budget for the operation phase, during the first three years: USD 8,120,382
- Annual budget for the operation phase, after the first three years: USD 2,368,867

The budget required for the implementation of the measures under the responsibility of the EPC Contractor is included in the EPC Contracts. Therefore, these costs are not included in Table 3-1.

Table 3-1: Summary Preliminary Budget for the ESMMP Measures under the Responsibility of MHPL

Sub-Plan	Construction (54 months)	Operation, per year	
		First 3 years	4-10 years
Environmental & Social Management System	$1,370,000	$25,000	$-
Management of Change Procedure [a]	$-	$-	$-
Environmental Surveillance of Construction works [a]	$-	$-	$-
Resettlement [b]	$40,878,194	$2,854,188	$-
Environmental Flow Management [c]	$-	$-	$-
Influx	$2,700,000	$1,100,000	$125,000
Downstream Floodplain Erosion & Groundwater	$2,175,000	$425,000	$425,000
Community Health	$3,397,000	$635,000	$331,450
Community Safety & Security	$1,400,000	$210,000	$60,000
Gender Action Plan	$1,000,000	$90,000	$20,000
Habitat and Biodiversity	$ 4,507,980	$ 691,193	$ 617,417
Local Area Development (Community Investment)	$1,950,000	$850,000	$200,000
Reservoir Management	$1,450,000	$250,000	$150,000
Stakeholder Engagement	$500,000	$200,000	$25,000
E&S Monitoring	$1,200,000	$725,000	$350,000
Cumulative Impacts	$100,000	$65,000	$65,000
TOTAL	$ 62,628,174	$ 8,120,382	$ 2,368,867

[a] Included in construction costs
[b] Responsibilities and funding for the preparation and implementation of the Resettlement Action Plans are distributed between the Government of Malawi (66% - Compensations and Resettlement assistance) and MHPL (33% - Livelihood restoration and monitoring).
[c] Included in construction and operation costs

4 Maps and Illustrations

Figure 4-1: Project Location

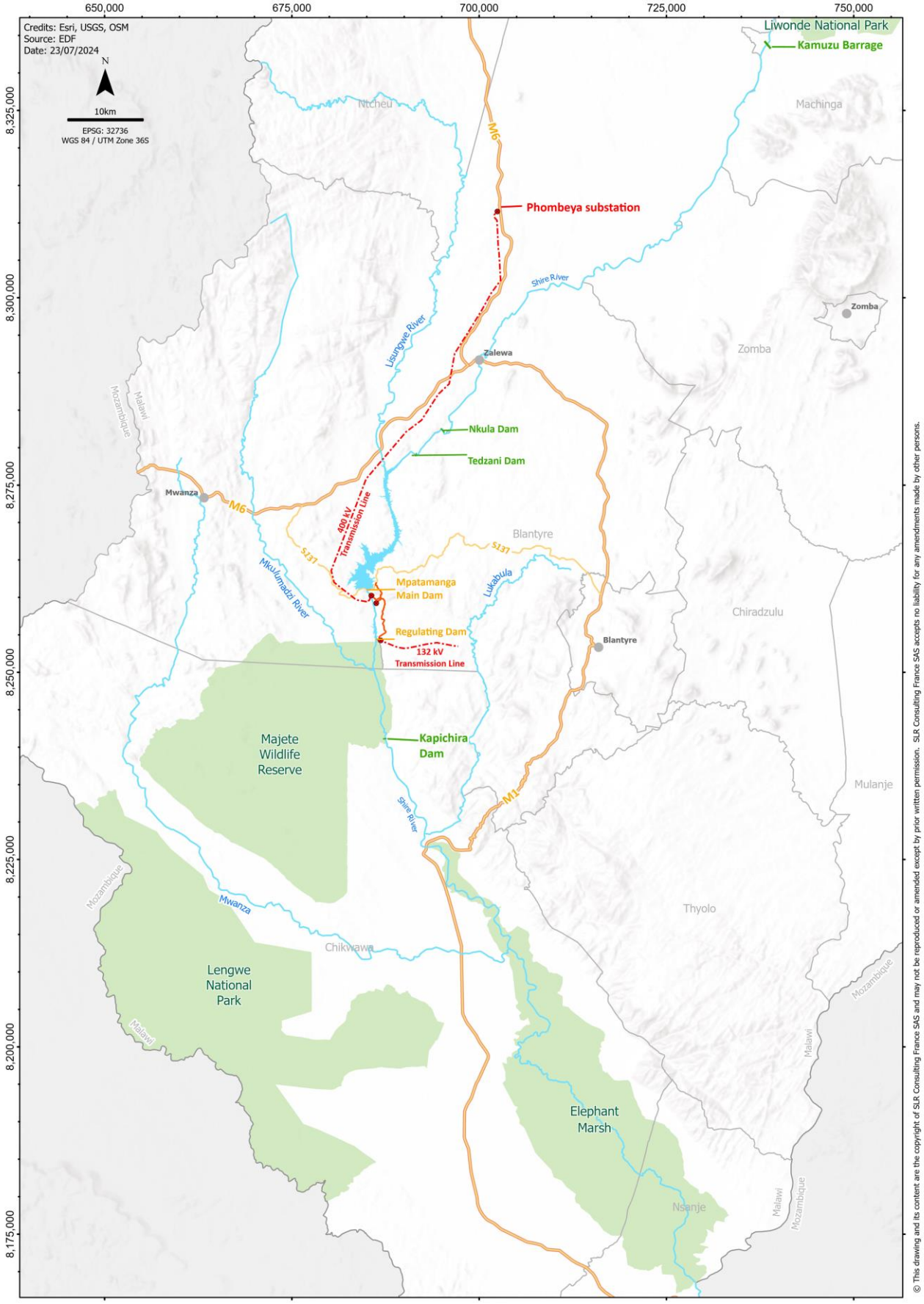


Figure 4-2: Layout of Project's Facilities

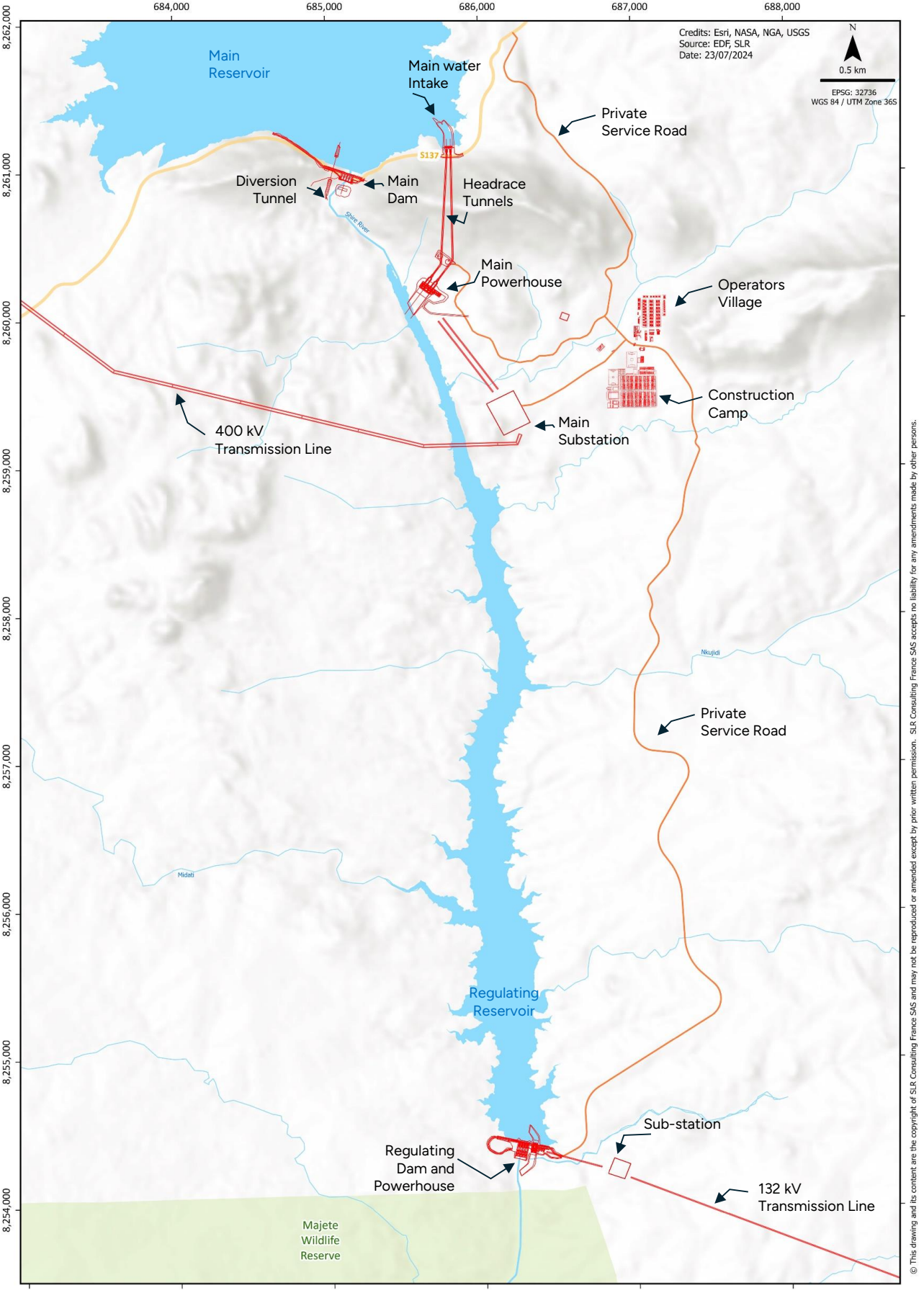


Figure 4-3: Project's Area of Influence

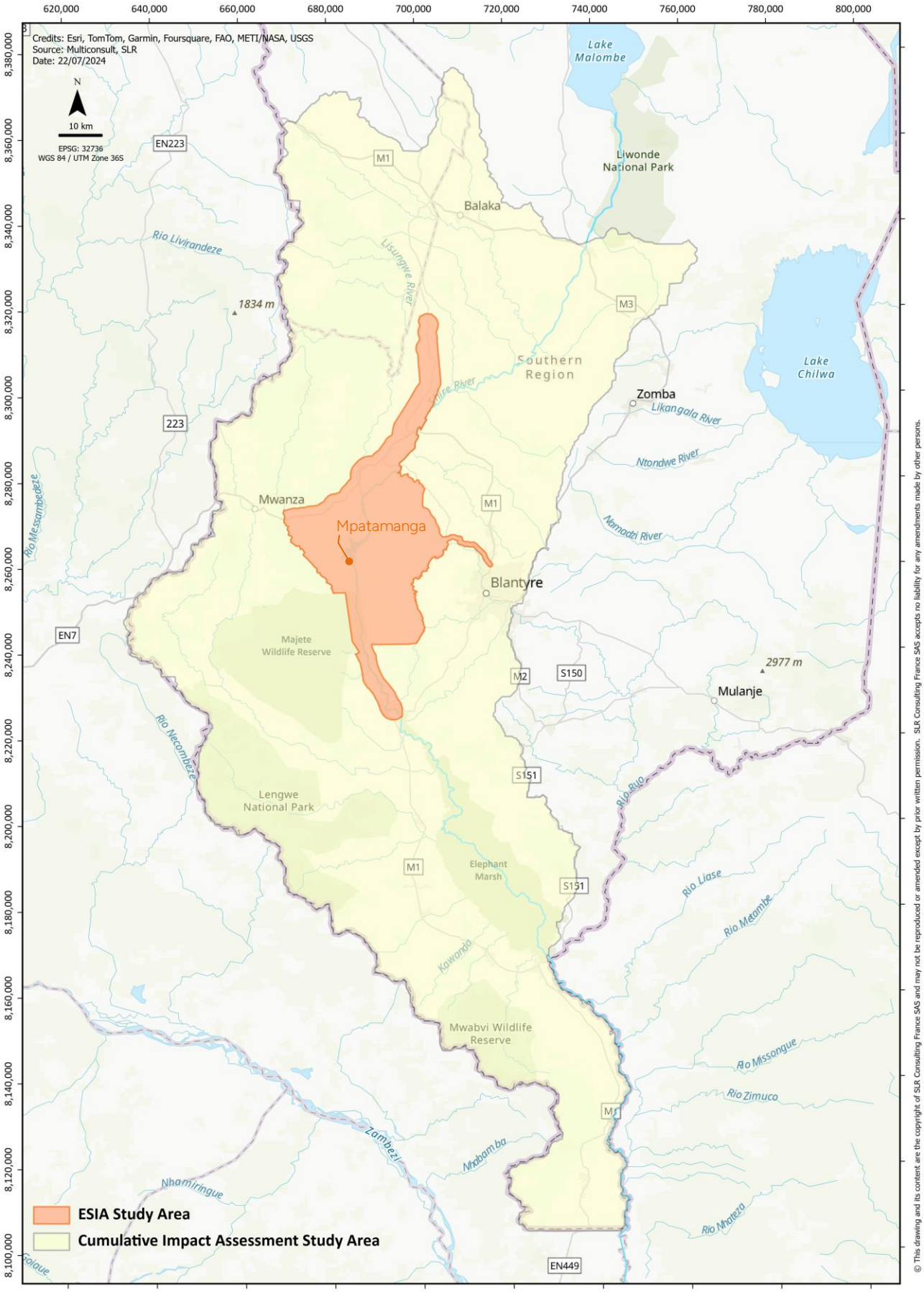
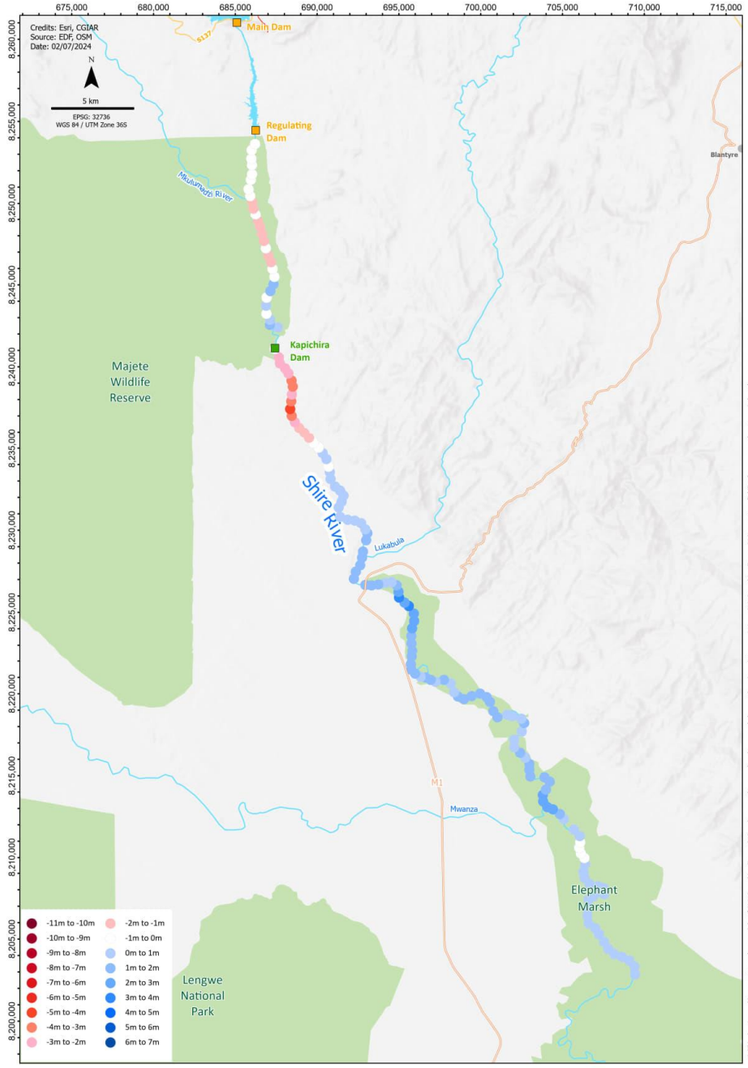
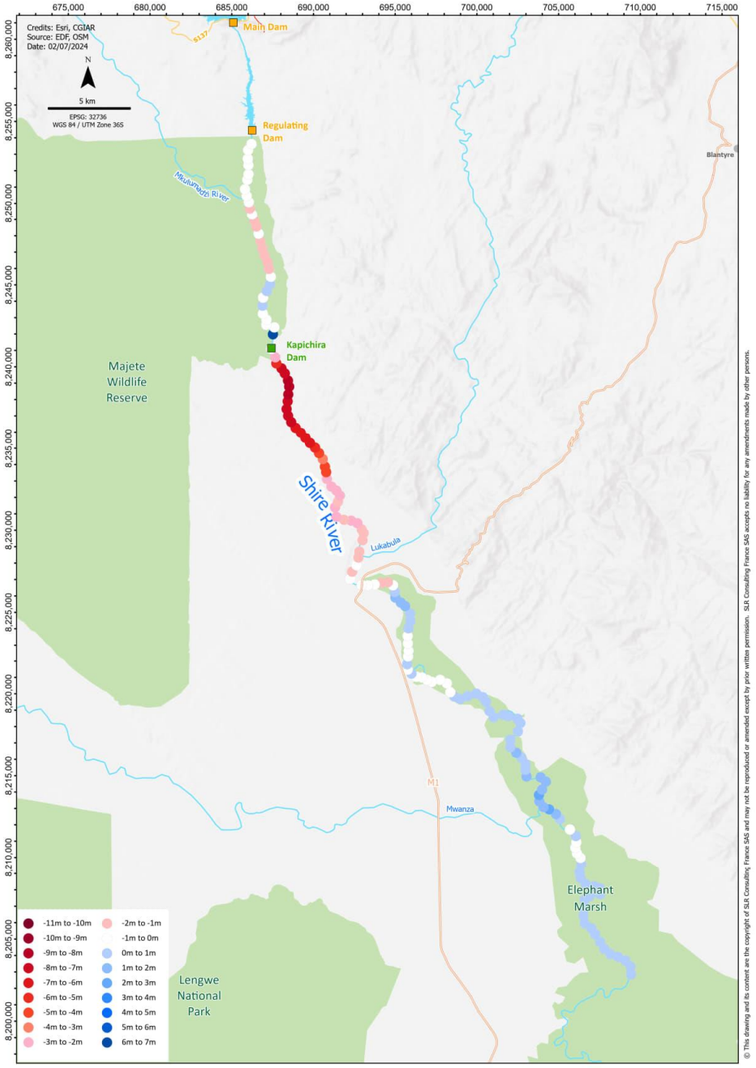


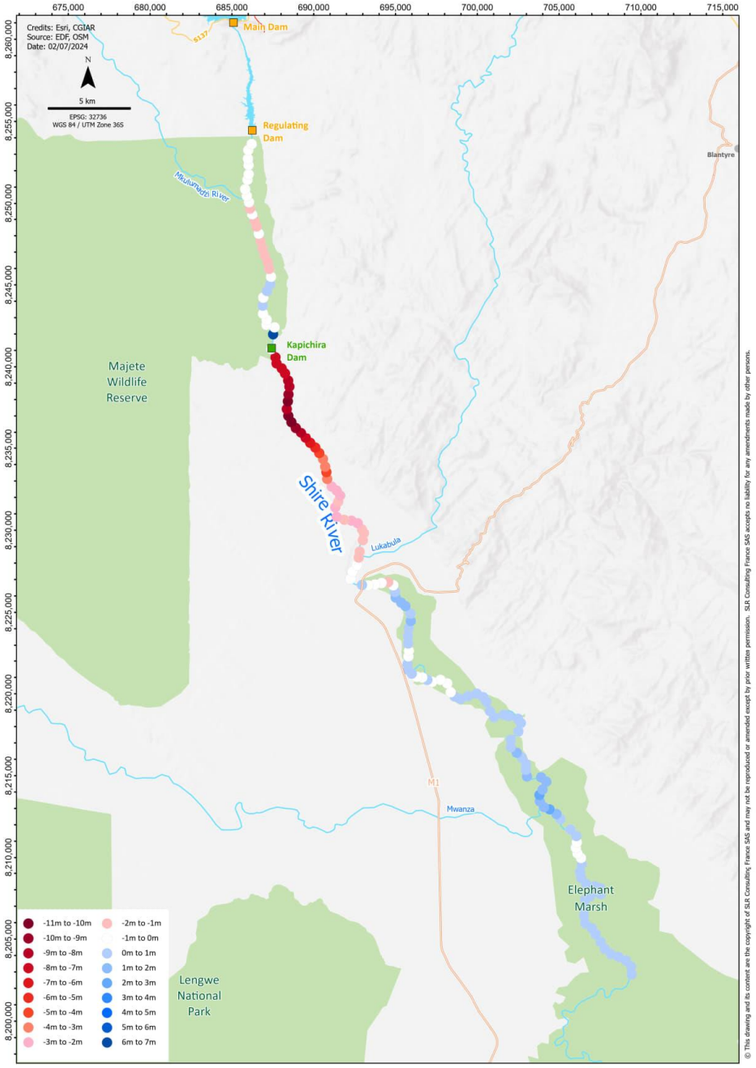
Figure 4-4: Downstream Riverbed Erosion Predicted After 30 Years of Operation



A. Without the Project
without a non-erodible layer downstream of Kapichira



B. With the Project
With a Non-erodible Sub-layer (at 5 meters)



C. With the Project
Without a Non-Erodible Sub-layer downstream of Kapichira

Figure 4-5: Potential Areas Targeted by Project-Induced In-Migration

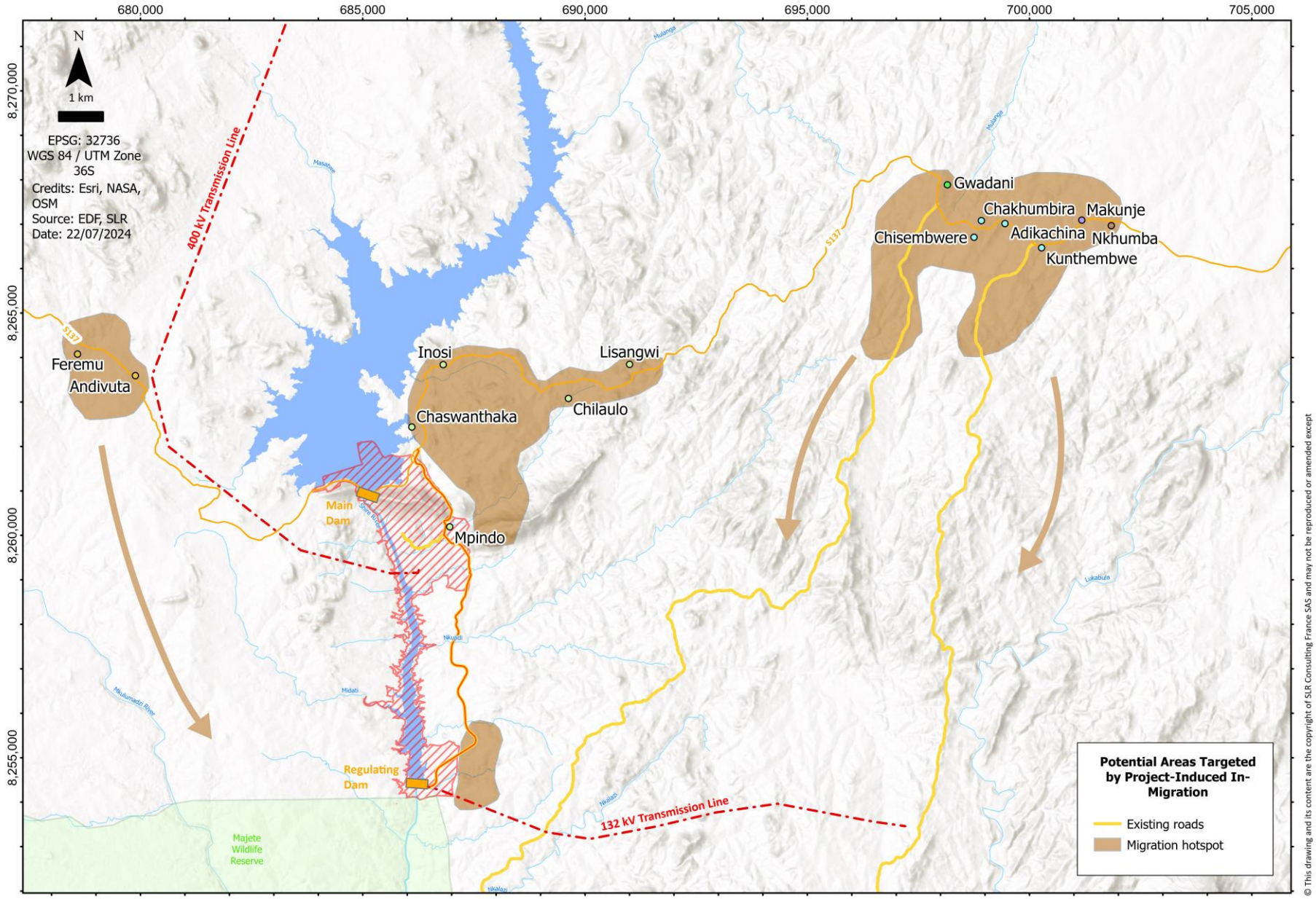


Figure 4-6: Overview of Estimated Potential Involuntary Resettlement Impacts

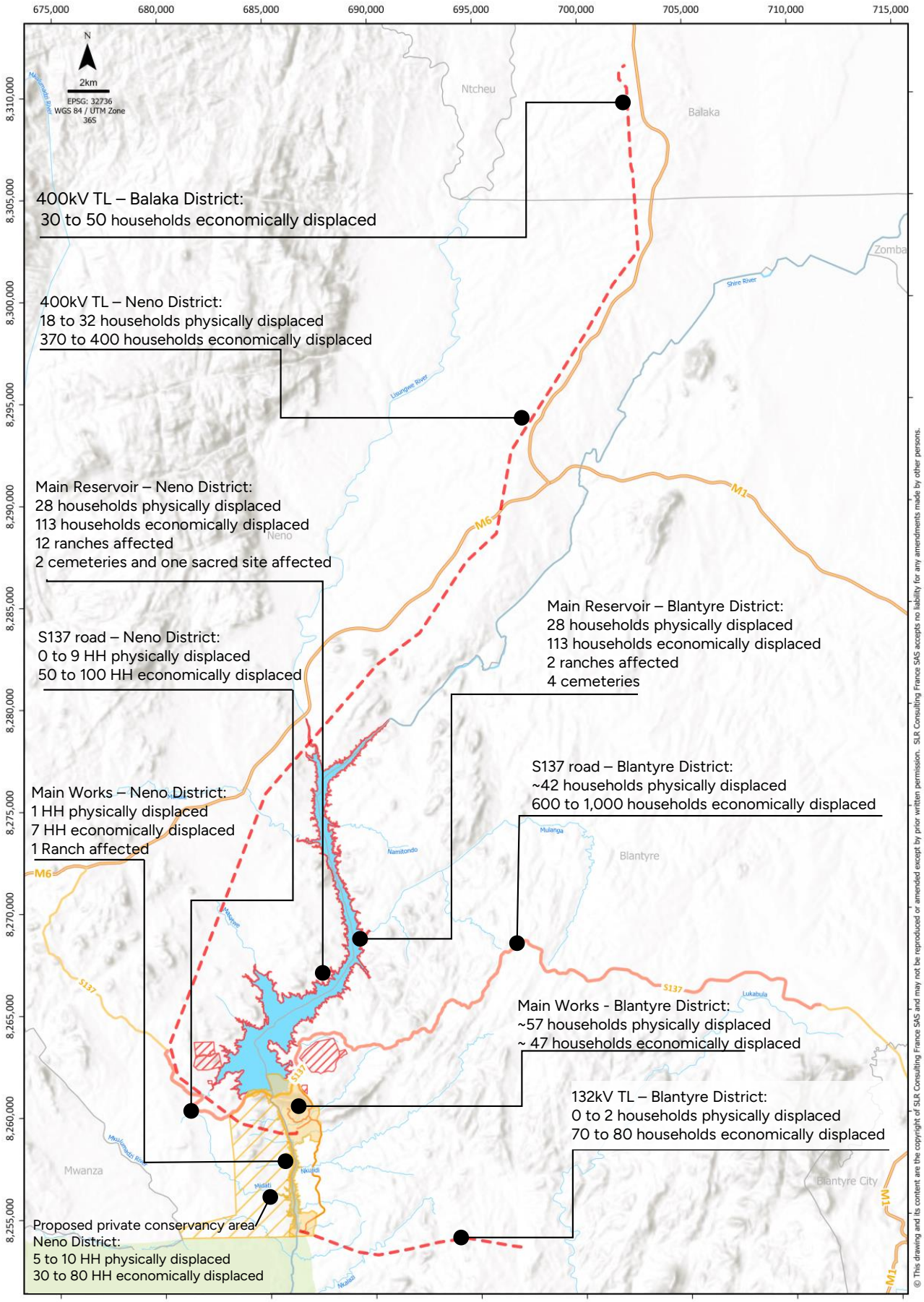


Figure 4-7: Predicted Noise Levels during Construction

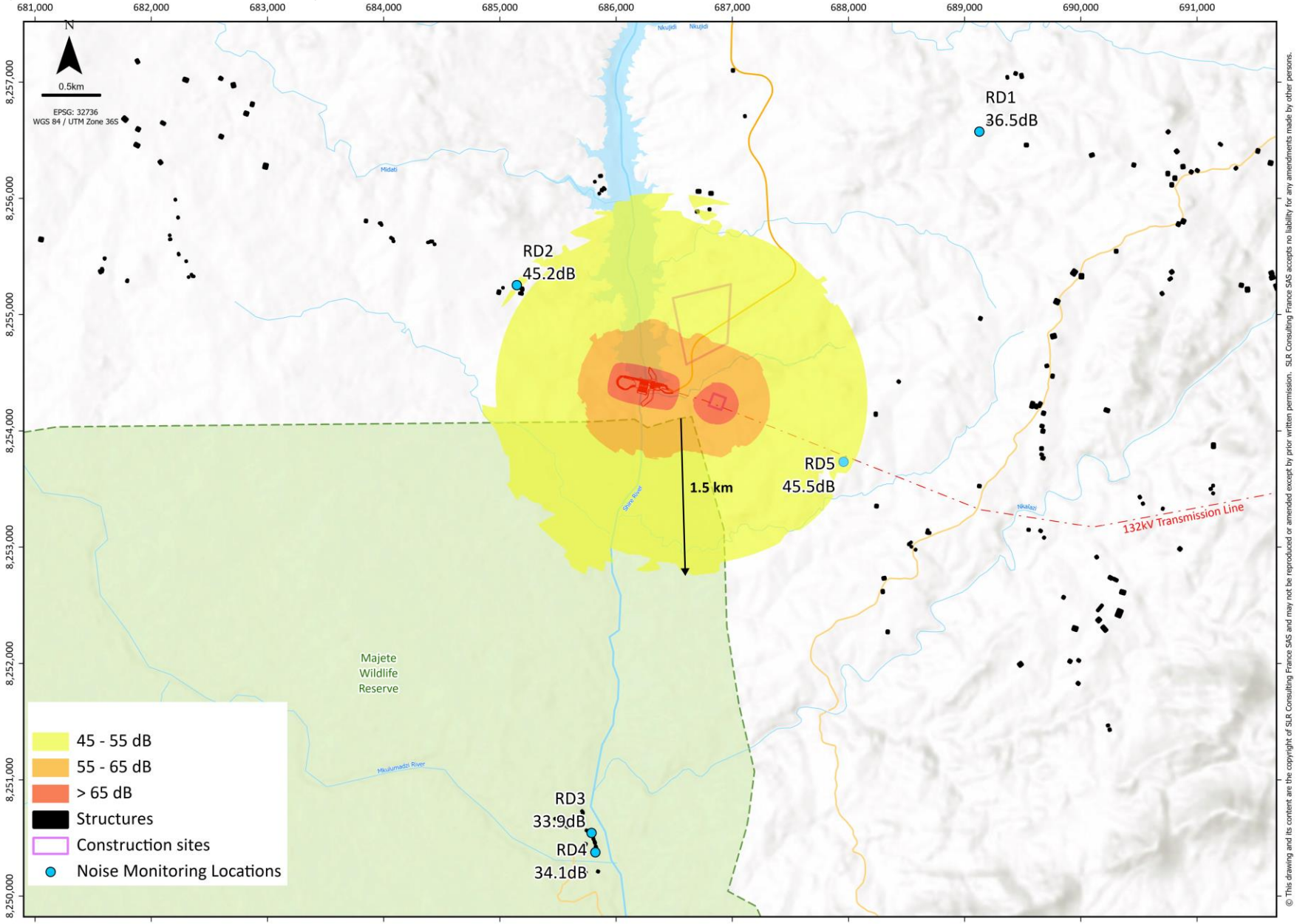


Figure 4-8: Habitat Mapping

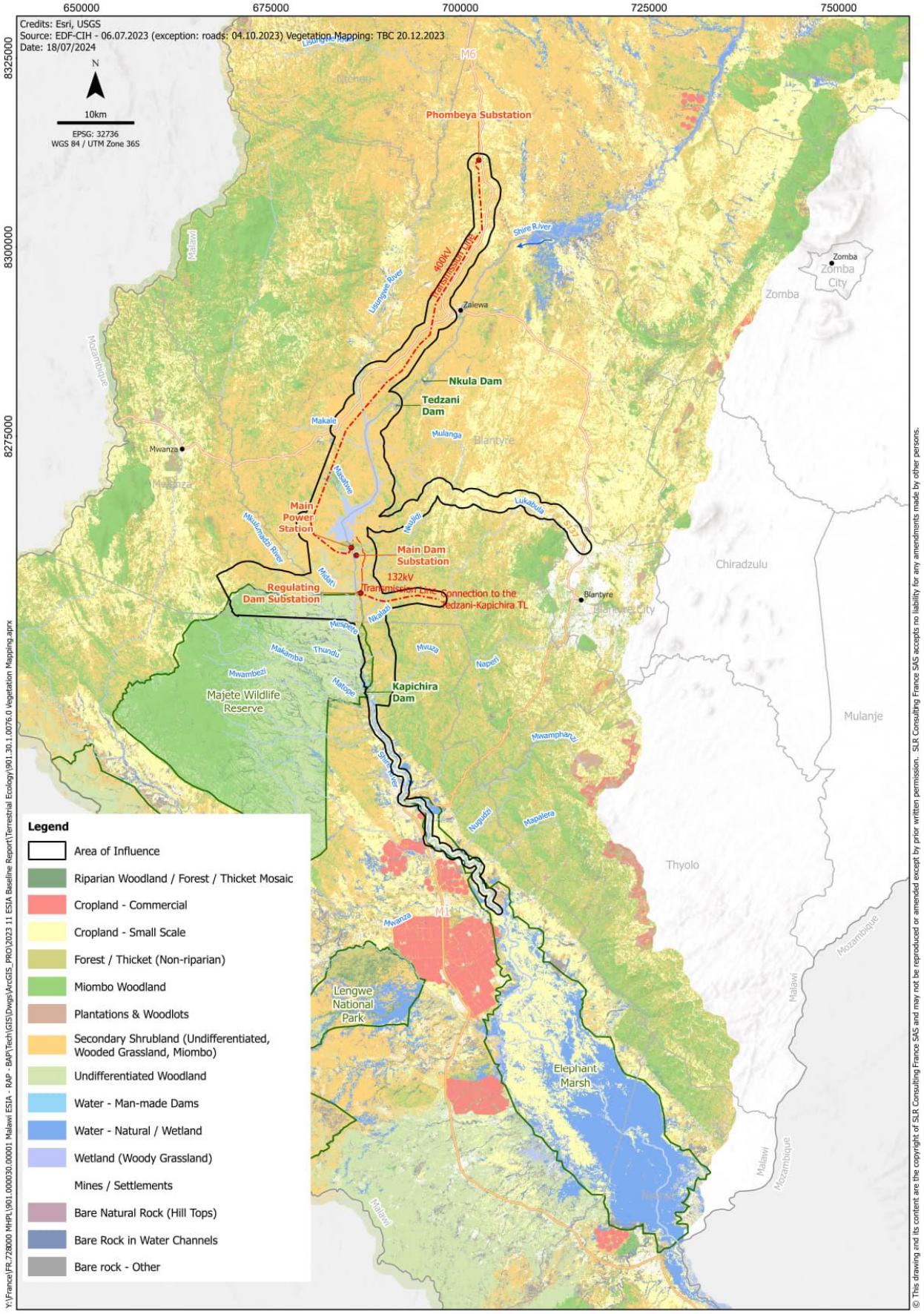
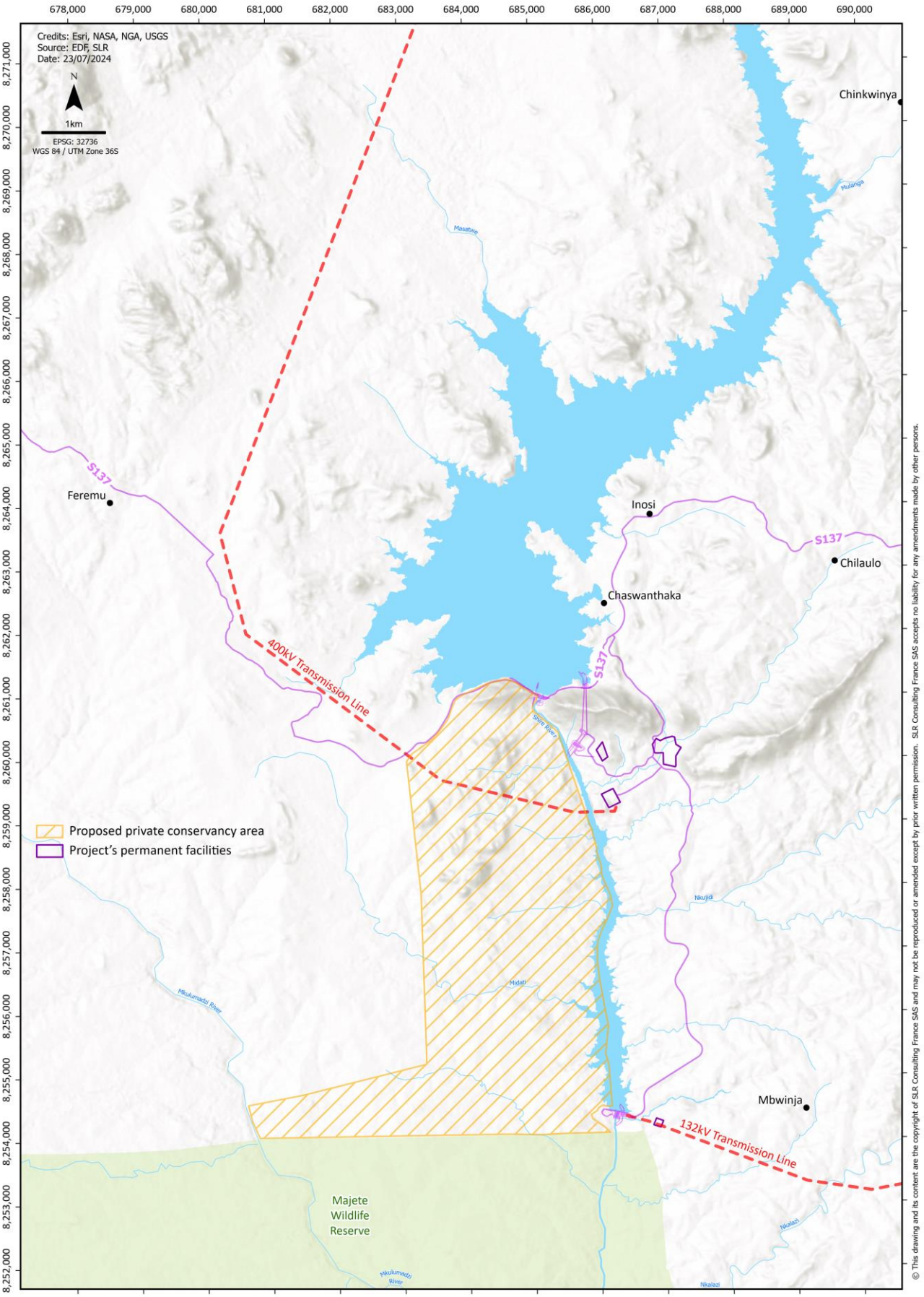
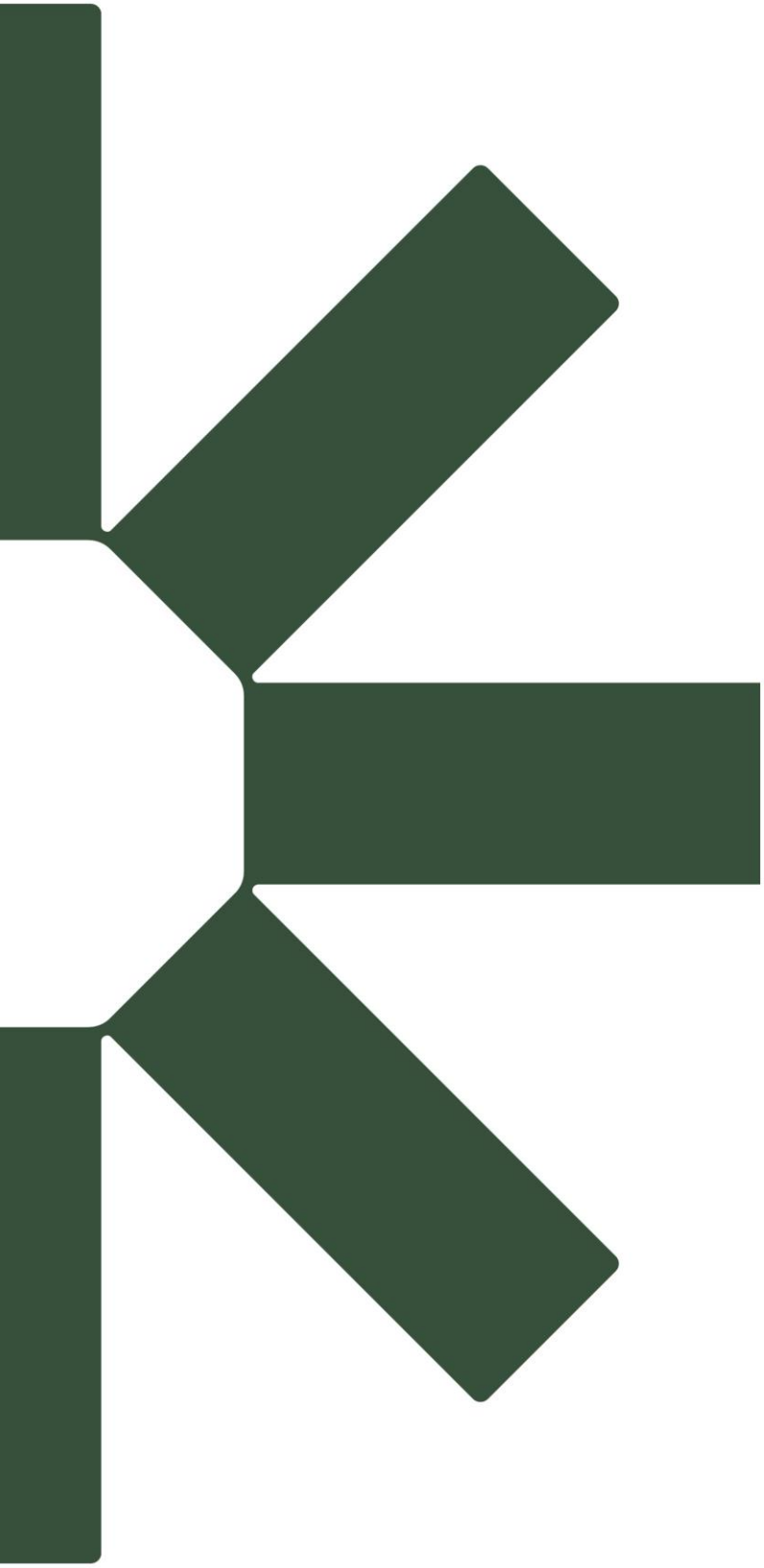


Figure 4-9: Proposed Neno Conservancy Area





Making Sustainability Happen