GOVERNMENT OF THE KINGDOM OF ESWATINI, MINISTRY OF NATURAL RESOURCES AND ENERGY - DEPARTMENT OF WATER AFFAIRS

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE PROPOSED MBABANE - MANZINI CORRIDOR DAM PROJECT, ESWATINI

ESIA REPORT

23 JUNE 2021 FINAL

VOLUME 1 of 3

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TYPE OF DOCUMENT (VERSION)
FINAL

PROJECT NO.: 41101262
DATE: JUNE 2021

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QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3	REVISION
Remarks	Draft ESIA for Client Review	Draft Final ESIA	Draft Final ESIA	Draft Final ESIA	Draft Final ESIA
Date	January 2020	August 2020	October 2020	March 2021	June 2021
Prepared by	Robert Els	Robert Els	Robert Els	Robert Els	Robert Els
Checked by	Anri Scheepers	Anri Scheepers	Anri Scheepers	Anri Scheepers	Anri Scheepers
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Project number	41101262	41101262	41101262	41101262	41101262
File reference	W:\000 NEW Projects\41101262 - Nondvo Dam ESIA Eswatini\ESIA_Draft				

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This Environmental and Social Impact Assessment Report (Report) has been prepared by WSP Environmental Proprietary Limited (WSP) and Maphanga Mitchell Associates (MMA) and on behalf and at the request of the Government of the Kingdom of Eswatini, Ministry of Natural Resources and Energy - Department of Water Affairs (Client), to provide the Client with an understanding of the environmental impacts associated with the proposed Mbabane – Manzini Dam Project.

Unless otherwise agreed by us in writing, we do not accept responsibility or legal liability to any person other than the Client for the contents of, or any omissions from, this Report.

To prepare this Report, we have reviewed only the documents and information provided to us by the Client or any third parties directed to provide information and documents to us by the Client. We have not reviewed any other documents in relation to this Report, except where otherwise indicated in the Report.

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ACRONYMS

ACRONYM	DESCRIPTION
AC	Alternating Current
AfDB	African Development Bank
AIDS	Acquired Immunodeficiency Syndrome
AIP	Alien Invasive Plant
AoI	Area of Influence
ASPT	Average Score Per Taxon
BoQ	Bill of Quantity
BP	Best Practice
CASP	Comprehensive Agriculture Sector Policy
CCA	Climate Change Assessment
CFR	Concrete Faced Rockfill
CIA	Cumulative Impact Assessment
CL	Crest Length
CMP	Comprehensive Mitigation Plan (used interchangeably with ESMP)
CNHs	Critical Natural Habitats
CPUE	Catch Per Unit Effort
CR	Critically Endangered
CRIDF	Climate Resilient Infrastructure Development Facility
CRR	Comment and Response Register
DCA	Detrended Correspondence Analysis
DSP	Dam Safety Plan
DMU	Discrete Management Unit
DWA	Department of Water Affairs
d/s	Down Stream
EAARR	Environmental Audit, Assessment and Review Regulations (2000)
EA	Environmental Assessment
EAP	Environmental Action Plan
EEA	Eswatini Environment Authority
EEC	Eswatini Electricity Company
EMA	Environmental Management Act, 2002 (Act No. 5 of 2002)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EN	Endangered
ES	Ecosystem Services

ACRONYM	DESCRIPTION
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan (used interchangeably with CMP)
ESMS	Environmental and Social Management System
EPAP	Equator Principles Action Plan
EPFI	Equator Principles Financial Institution
EPs	Equator Principles
ES	Ecosystem Services
EWSC	Eswatini Water Supply Corporation
EWT	Endangered Wildlife Trust
FDI	Foreign Direct Investment
FFR	Final Feasability Report
FL	Flood Level @ $Q_{10,000}$
FME	Fondation Minimum Elevation
FROC	Frequency of Occurrence
FSL	Full Supply Level
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIIP	Good Internatinal Industry Practice
GIS	Geographical Information System
GoE	Government of Eswatini
H	Height
HCR	Habitat Cover Rating
HIV	Human Immunodeficiency Virus
HPP	Hydropower Plant
ICOLD	International Commission on Large Dams
IESIA	Integrated Environmental and Social Assessment
IFC	International Finance Corporation
IHA	International Hydropower Association
IP	Indigenous Peoples
IPCC	International Panel on Climate Change
ISRM	International Society for Rock Mechanics
IUCN	International Union for Conservation of Nature
I&APs	Interested and Affected Parties
JMRBWRS	Joint Maputo River Basin Water Resources Study
KV	Kilovolts
kVA	Kilovolt-ampere
kW	Kilowatt

ACRONYM	DESCRIPTION
LV	Low Voltage
masl	Meters above sea level
Max. OL	Maximum operating level
MAP	Mean Annual Precipitation
Min. OL	Minimum operating level
MIV	Main Inlet Valve
ML	Medium Voltage
MMA	Maphanga Mitchell Associates
MNRE	Ministry of Natural Resources and Energy
MR	Main Road
MSU	Most Sensitive Uses
MTEA	Ministry of Tourism and Environmental Affairs
MW	Megawatt
N/A	Not Applicable
NAMB	National Agricultural Marketing Board
NDS	National Development Strategy
NGOs	Non-Governmental Organisations
NMC	National Maize Coperation
NWA	National Water Authority
NPAES	National Protected Areas Expansion Strategy
OS	Operational Safeguard
PAP	Project Affected People
PCMS	Protection, Control and Monitoring System
PLC	Programmable Logic Controller
PSs	Performance Standards
PVC	Polyvinyl Chloride
QAQC	Quality Assurance and Quality Control
RAP	Resettlement Action Plan
RCC	Roller-Compacted Concrete Dam
RfP	Request for Proposal
SA	Strategic Assessment
SADC	Southern African Development Community
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System version 5
SCC	Species of Conservation Concern
Sds	Downstream Slope
SEP	Stakeholder Engagement Plan

ACRONYM	DESCRIPTION
SGs	Sustainability Guidelines
SQR	Sub Quaternary Reach
STIs	Sexually Transmitted Infections
Studio Pietrangeli	Studio Pietrangeli Consulting Engineers
Sus	Upstream Slope
SWIR	Southwest Indian Ridge
TBC	The Biodiversity Company
ToR	Terms of Reference
TRCM	Trash-rack cleaning machine
TSSR	Technical Scoping Study Report
u/s	Upstream
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VEC	Valued Ecosystem Components
VU	Vulnerable
WB	World Bank
WBG	World Bank Group
WCD	World Commission on Dams
WGS84	World Geodetic System 1984
WHO	World Health Organisation
WMA	Water Management Area
WSP	WSP Environmental (Pty) Ltd
WTP	Water Treatment Plant
VEC	Valued Environmental and Social Components

GLOSSARY

TERM	DESCRIPTION
Biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial and aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.
Catchment	The area from which rainfall flows into a river, lake, or reservoir.
Coffer dam	A temporary structure enclosing all or part of a construction area so the construction can proceed in a dry area. A "diversion coffer dam" diverts a river into a pipe, channel, or tunnel.
Comprehensive Mitigation Plan	A document containing a description of the mitigation measures to be implemented that would prevent, reduce or otherwise manage the environmental impacts of a project and done according to the reporting requirements in the Second Schedule of the Environmental Audit, Assessment and Review Regulations, 2000.
Critical habitat	Areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species; (ii) habitat of significant importance to endemic and / or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and / or unique ecosystems; and/or (v) areas associated with key evolutionary processes (see IFC PS6, Paragraph 16).
Critically Endangered	A taxon is Critically Endangered (CR) when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by IUCN criteria (www.iucnredlist.org).
Cultural heritage	The range of material (tangible) culture, as well as practices, performance, indigenous knowledge, oral traditions / history that is bequeathed from one generation to the next, and which each subsequent generation moulds and adapts.
Dam	A dam is a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply.
Disadvantaged or vulnerable groups	Individuals or groups within the Project are of influence who could experience adverse impacts from the proposed project more severely than others based on their vulnerable or disadvantaged status. This status may stem from an individual's or group's race, colour, sex, language, religion, political, or other opinion, national or social origin, property, birth or other status. In addition, other factors should be considered such as gender, ethnicity, culture, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.
Diversity	An expression of the variety of species that exist in a community.
Economic displacement	Loss of assets or access to assets that leads to loss of income sources or means of livelihood.
Ecosystem services	Defined as the benefits that people obtain from nature. These are typically divided into four categories. — Provisioning services are the goods or products obtained from ecosystems, such as food, timber, medicines, fibre, and freshwater; — Regulating services are the benefits obtained from an ecosystem’s control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards; — Cultural services are the nonmaterial benefits obtained from ecosystems, such as recreation, spiritual values, and aesthetic enjoyment; and — Supporting services are the natural processes that maintain the other ecosystem services, such as nutrient cycling and primary production.

TERM	DESCRIPTION
Endangered	A taxon is classified as Endangered (EN) when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by the IUCN criteria (www.iucnredlist.org) or provisionally assessed by an expert group.
Environment	Means the whole or any component of: — Nature, including air, land, water, soils, minerals, energy other than noise, and living organisms other than humans; — The interaction between the components of nature and between those components and humans; — Physical, aesthetic and cultural qualities or conditions that affect the health and well-being of people.
Environmental Impact	Means any positive or negative impact, on the natural and/or environment, on any form of life, on the social, economic and/or cultural conditions that influence human life, or on any interrelationship between these elements or factors, which is, will be, or may be, directly or indirectly caused by an existing or proposed project, policy, plan or programme.
Environmental Impact Assessment	Means the process of predicting and evaluating the likely environmental impacts of a proposed project where the scale, extent and significance of the environmental impacts cannot be easily determined.
Environmentally Sensitive Area	Means an area which merits a high degree of environmental protection because the environment in that area, or any constituent part of it, is rare, endangered, or sensitive to harm, or has particular environmental, archaeological, social, or cultural significance or value, whether or not the area is legally or administratively protected, and includes areas designated as environmentally sensitive by the Minister.
Erosion	Erosion (geologic). — The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep. Erosion (accelerated). — Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or a catastrophe in nature, such as a fire, that exposes the surface.
Flood plain	The nearly level plain that borders a stream and is subject to flooding unless protected artificially.
Groundwater	Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.
Habitat	The environmental or ecological area in which an animal, plant species or other organism lives.
Homesteads	A homestead is one or more dwellings and adjacent outbuildings.
Infiltration	The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material
Invasive aliens	Species are identified as invasive aliens when (i) they are non-native to an ecosystem, and (ii) their introduction is liable to cause environmental harm, or harm to human health and livelihoods, because they spread rapidly and have negative effects on native species through competition, predation, or disease. Invasive species can be flora, fauna, or other organisms (e.g. microbes) but generally refer to plants.

TERM	DESCRIPTION
Natural Resources	Means any component of nature, capable of being utilised by humans and includes air, land, water, soils, minerals, energy, living organisms other than humans, and genetic resources, and for the purposes of this definition, "genetic resources" means any material of plant, animal, microbial or other origin containing functional units of heredity, of any actual or potential value.
Pollution	Any change in the environment which has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future.
Project	Means an enterprise, undertaking or activity, or a proposal or plan for a new enterprise or activity to significantly change an enterprise, an undertaking or a project, and includes a plan, operation, undertaking, construction, development, change in land use, or alteration which may not be implemented without a permit, license, consent or approval from an authorising agency.
Project Areas of Influence	The Project's Area of Influence includes the primary project site(s) and related facilities that the proponent (including its contractors) develops or controls; associated facilities that are not funded as part of the Project (funding may be provided separately by a proponent or a third party including the government), and whose viability and existence depend exclusively on the Project and whose goods or services are essential for the successful operation of the Project; areas potentially impacted by cumulative impacts from further planned development of the Project; and areas potentially affected by impacts from unplanned but predictable developments caused by the Project that may occur later or at a different location. The Area of Influence (AoI) does not include potential impacts that would occur without the Project or independently of the Project.
Proponent	Means a person responsible for initiating a project and obtaining the appropriate authorization.
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, inform decision making, plan and monitor in terms of a proposed project, programme or development.
Reservoir	A large natural or artificial lake used as a source of water supply.
Resettlement Action Plan	The document in which a project sponsor or the responsible entity specifies the procedures that it will follow and the actions that it will take to mitigate adverse effects, compensate losses, and provide development benefits to persons and communities affected by an investment project.
Runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.
Soil	A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.
Scoping Report	A Scoping Report is a document submitted to the Eswatini Environment Authority (EEA) to demonstrate that the ESIA study for a specific project has been properly planned, and that the key issues to investigate have been identified in consultation with relevant interested and affected parties. The Scoping Report provides the framework, or "Terms of Reference" to guide and direct the ESIA study and is usually prepared by an environmental specialist or consultant employed by the project proponent.

TERM	DESCRIPTION
Vulnerable	A taxon is Vulnerable (VU) when it is not classified CR or EN but is facing a high risk of extinction in the wild in the medium-term future, as defined by the IUCN criteria (www.iucnredlist.org).

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INTRODUCTION AND BACKGROUND

The Kingdom of Eswatini (abbreviated in this document as Eswatini, and previously known as Swaziland) is a small landlocked country in Southern Africa, bordering Mozambique and South Africa.

The nature of the hydrological network of Eswatini, comprising rivers shared between several states upstream and downstream, coupled with highly seasonal patterns with relatively long periods of drought makes the management of the country's surface water resources very difficult and vulnerable to climatic change. Economic and demographic growth of the country as well as changes in the water usage patterns have resulted in a significant increase in the demand for water resources. It has been identified that the size of existing infrastructure and the capacity of equipment will soon be inadequate to satisfy the water demand. Furthermore, in Eswatini, all 'normal flow' in the rivers, most of them being of transboundary type, has been allocated under the arrangements of the international treaties. 'Normal flow' is water that has been calculated as being available 80% of the time during the driest month of the year. Therefore, the only water than can be made available for allocation is surplus flow (during floods and rainy season) through harnessing this flow in large storage reservoirs. This means that currently no water allocation can be made to any new developments as the water demand far exceeds the 'normal flow'. This is a major challenge limiting further social and economic development in the country.

As a response to these constraints the Government of Eswatini, Ministry of Natural Resources and Energy, Department of Water Affairs (DWA) intends to better exploit surface water resources within the Mbabane – Manzini Corridor, by storing surplus water made available during flooding periods, above the allocated abstraction limits established by the Tripartite Agreement signed with South Africa and Mozambique. The stored water is then intended to be released as required for the various downstream usages. The Nondvo Dam will thus serve as an adaptation measure for potential future water requirements and climate change scenarios.

The DWA appointed Studio Pietrangeli Consulting Engineers (Studio Pietrangeli) to undertake the relevant scoping and feasibility studies for the multipurpose project to "*identify and design a project that meets competing water demands up to the Horizon 2050 through optimizing its dimensions and costs and minimizing socio-environmental impacts*". Several project options were studied during the feasibility-Scoping Phase to meet the short- and long-term demands. Based on the results of the feasibility-scoping study the DWA selected the following options, as identified in **Table 0-1**, to be subjected to a detailed feasibility assessment (Studio Pietrangeli, 2019).

Table 0-1: Projects subjected to detailed feasibility assessment

SOLUTION PERIOD	PROJECT
Short Term Solutions (up to 2025)	— Hawane Dam (raising of the by 3.5m) — Luphohlo Dam (raising of the by 5m)
Long Term Solutions (up to 2050)	— Nondvo Dam (construction of new dam)

As per the specified Terms of Reference, this ESIA only deals with the Nondvo Dam project (Long Term Solutions).

The main purpose of Nondvo Dam is the storage of water for the supply of potable water to Mbabane and Manzini, which are currently suffering from intermittent water shortages, and where the anticipated future water demand is deemed to be highest. The additional water supply is also anticipated to facilitate the growth of the population alongside the "Corridor" area connecting these two cities. Possible secondary benefits of the proposed dam are the potential for utilising the Nondvo Dam head for small-scale hydropower generation, as well as utilising the stored water for irrigation of approximately 800 Hectares (ha) of agricultural land in the surrounding region.

PROJECT MOTIVATION

With a Gross Domestic Product (GDP) per capita of approximately US$ 3,500 in 2014, Eswatini is classified as a lower middle-income country by the World Bank Atlas method. In 2015, the global rate of access to potable water supply in Eswatini was identified as 74% of the population and the sanitation coverage rate was 57% (Ministry of Natural Resources and Energy: Department of Water Affairs, 2017). Addressing issues of water resources mobilisation for basic water supply, industrial and agriculture use is clearly a poverty reduction priority for the country. The two main cities of Mbabane and Manzini and the surrounding area host the major part of the population and most of the industrial and productive activities of the country. This concentration is the driver of the country's economic growth and needs to be provided with sustainable public services of high standard.

Water supply for the fast growing population and for sustaining the development of economic activities, is therefore a challenge which needs to be urgently addressed. The mobilisation and better harnessing of surface water resources has become a concern of priority for the government. The challenge is compounded by the additional need of water for implementing the government policy to increase the contribution of agriculture production to the GDP, and to exploit hydropower potential of the national rivers network in order to limit the electricity supply dependency from ESKOM in South Africa.

In Eswatini, agriculture provides a source of sustenance to a majority of households. For that reason, the agricultural sector matters quite significantly. Confounding the situation for rural households and the government in general is that in recent years, particularly in the last 15 years or so, the country has witnessed an increase in drought-like conditions. Making the situation perverse are reports from the IPCC (2007) that suggest that the Southern Africa region will see an increase in the incidence of droughts in the future.

As indicated above, the main objective of the Nondvo Dam is therefore the storage of water in order to provide potable water to Mbabane and Manzini. The stored water could also be used for small-scale hydropower generation and for improving the output of run-of-the-river hydropower plants situated further downstream. In addition, water will be supplied for irrigation.

The project corresponds well to the National Development Plan 2014/15 – 2016/17 in terms of water resource development. The National Development Strategy (NDS) also confirms the government priority to improve storage capacity for renewable water resources through the development of two dams, the Nondvo Dam being one of them. The project is quoted in the Government Programme of Action 2013-2018 and aligns with the Southern African Development Community (SADC) strategies and the principles stated in by the Tripartite Interim Agreement between Eswatini, South Africa and Mozambique, the three riparian countries of the Maputo River Basin.

PROJECT PROPONENT

The Government of Eswatini, Ministry of Natural Resources and Energy, Department of Water Affairs (DWA) is the applicant for the Environmental Authorisation (EA) related to this project. The relevant details of the applicant are provided in **Table 0-2**.

Table 0-2: Details of the Project Applicant

ASPECT	DETAIL
Applicant	Government of Eswatini, Ministry of Natural Resources and Energy - Department of Water Affairs (DWA)
Contact Person	Mr Trevor M. Shongwe (Director - DWA)
Postal Address	P.O. Box 57, Mbabane, Eswatini
Contact Number	+26824049866 / +26876063636
Contact Email	trevorshongwe@gmail.com

ENVIRONMENTAL CONSULTANT

The ESIA process is being undertaken by WSP, in association with Maphanga Mitchell and Associates (MMA), and Knight Piésold.

The environmental consultant's details are provided in **Table 0-3**.

Table 0-3: Environmental Consultant's Contact Details

CONTACT DETAILS	WSP ENVIRONMENTAL (PTY) LTD	MAPHANGA MITCHELL ASSOCIATES	KNIGHT PIÉSOLD
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Contact Email	Anri.Scheepers@wsp.com	mbuso@mapmitch.org	abriel@knightpiesold.com

The Consultant is supported by a number of suitabley qualified and experienced specialists to provide a detailed Environmental and Social Impact Assessment (ESIA).

OBJECTIVES OF THE ESIA

The ESIA Report aims to provide a clear description of the proposed project activities, alternatives considered, affected environment of relevance to the project; assessment of key impacts on environmental and social receptors and appropriate and realistic mitigation measures. Mitigation and monitoring requirements for construction and operation are detailed in the ESMP, which will be implemented by contractors and the DWA respectively.

The ESIA has been prepared to meet the reporting requirements of the Eswatini Environmental Management Act, 2002 (Act No. 5 of 2002) (EMA), as well as complying with Eswatini's National Water Policy, 2018 and Water Act, 2003 which ensures that dams have minimal harmful impact on the environment. Furthermore, it aligns with international safeguards specifically the African Development Bank (AfDB) Integrated Environmental and Social Impact Assessment (IESIA) Guidelines (AfDB 2009; 2015).

LOCATION OF PROJECT

The proposed project site is situated approximately 12 km south of Mbabane and 26 km north-west of Manzini, along the south-eastern boundary of the Hhohho Region, Eswatini. The Nondvo Dam is to be situated on the Lusushwana River, at the following coordinates 26°25'39.04"S and 31°7'0.98"E (UTM, WGS84: 312220E; 7075564S), approximately 7 km downriver of the existing Luphohlo Dam. The figure below indicates the project location in relation to the exitsing Luphohlo Dam and district border.

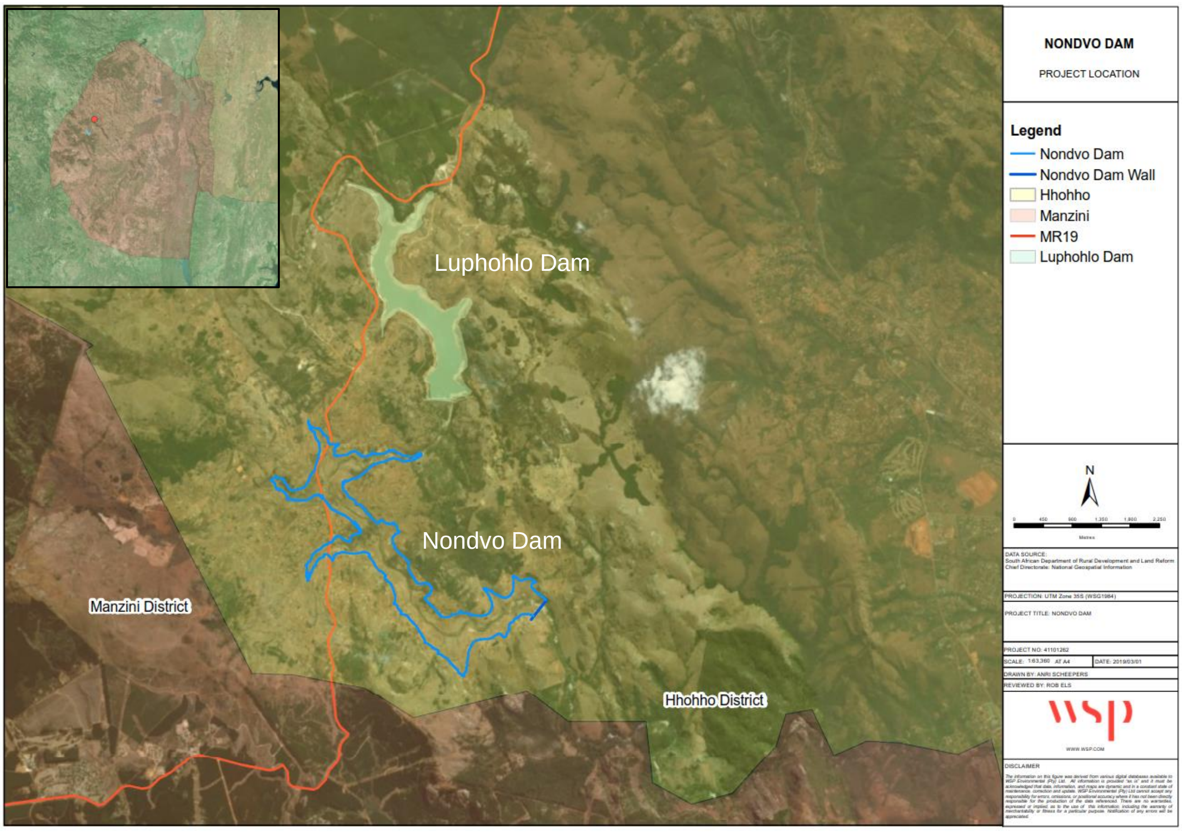


Figure 0-1: Map indicating the Project Location

PROJECT DESCRIPTION

Following the completion of a technical feasibility study, it was determined that the Project would comprise 38.6 m high gravity roller compacted concrete (RCC) Dam and small hydropower plant (HPP) of less than 1 MW. The dam will harvest flows along the Lusushwana River, regulated by the upstream Luphohlo Dam, and associated tributary, the Nondvo River; resulting in a storage reservoir with a total storage capacity of approximately 22 Mm^3, delivering an assured yield of 9.8 Mm^3 per year. The reservoir will cover a surface area of approximately 2.4 km^2 (240 ha) across two Royal Kraal areas, namely Siphocosini and Mantabeni.

The dam will provide water to Mababane, Manzini and the areas between (i.e. Mbabane and Manzini corridor) to meet water demands up to 2050 for the following uses:

— potable, industrial and tourist use;
— irrigation of approximately 800 ha; and
— energy production.

The dam includes an un-gated spillway with two non-overflow sections on either side, an intake and bottom outlet as well as a powerhouse (i.e. small hydropower plant) installed at the foot of the dam. In order to ensure effective construction and operation of the dam, relevant temporary and permanent associated infrastructure is required, including river diversion works, access roads, site establishment (i.e. site camps and offices), and quarry.

Certain existing infrastructure will be affected by the dam reservoir that will require realignment/ relocation. These include the main road (MR19) and smaller informal roads, railway line, electricity / communications lines, as well as private structures (i.e. dwellings, small businesses and religious and education facilities).

Table 0-4 provides a breakdown of the identified aspects assessed within the ESIA.

Table 0-4: Nondvo Dam Aspects

ASPECT	COMPONENTS	DESCRIPTION
River Diversion Works	Canal and coffer dams	210 m long excavated canal between a temporary upstream and a downstream cofferdam
Dam and Auxiliary Works	Dam (Non-overflow Sections - Left and Right Dam)	38.6 m high RCC dam with a crest length of ~300 m
	Spillway	130 m wide un-controlled overflow crest with a stepped chute and Type III stilling basin
	Intake	Two intake pipes, of 600 mm diameter, at 955.0 and 945.0 masl respectively,
	Powerhouse	Surface powerhouse of 93.6 m^2 with an installed capacity of 135 kW.
	Bottom Outlet	Single pipe, of 1000 mm diameter, at 938 masl designed to release up to 9.22 m^3/s.
Associated Infrastructure	Quarry	100 m upstream of the Dam on the left bank
	Site Camps and Offices	Temporary and permanent support infrastructure on the right bank of the dam close to the dam site.
	Power evacuation and distribution	123 m overline heading northwards; 347 m insulated cable line (trenched) heading southwards; both connecting into new low voltage cabins.
Reservoir	Inundation area	2.4 m^2 at the Full Supply Level (FSL) / Maximum operating level (Max. OL), which is 960.0 meters above sea level (masl). The flood demarcation level (FL) is 963.1 masl, which is the FL at 10,000 years, and covers approximately 2.9 km^2
Re-alignment of existing linear infrastructure	Railway infrastructure	6.25km railway aligment (discussed railway line from Ngwenya Iron Ore mine)
Re-alignment of MR 19	Road infrastructure	6km of road realignment

The resettlement process required to facilitate the development of the Project, which has implications for this ESIA in terms of loss of housing, land, crops and social facilities, has been assessed and detailed within a Resettlement Action Plan (RAP).

The following aspects have been excluded from the current ESIA:

— Water distribution infrastructure (i.e. pipeline network connecting dam to end users).
— Realignment of the inundated internal access roads.
— Host community impacts has only been included at a high-level.

Figure 0-2 provides an overview of the Project.

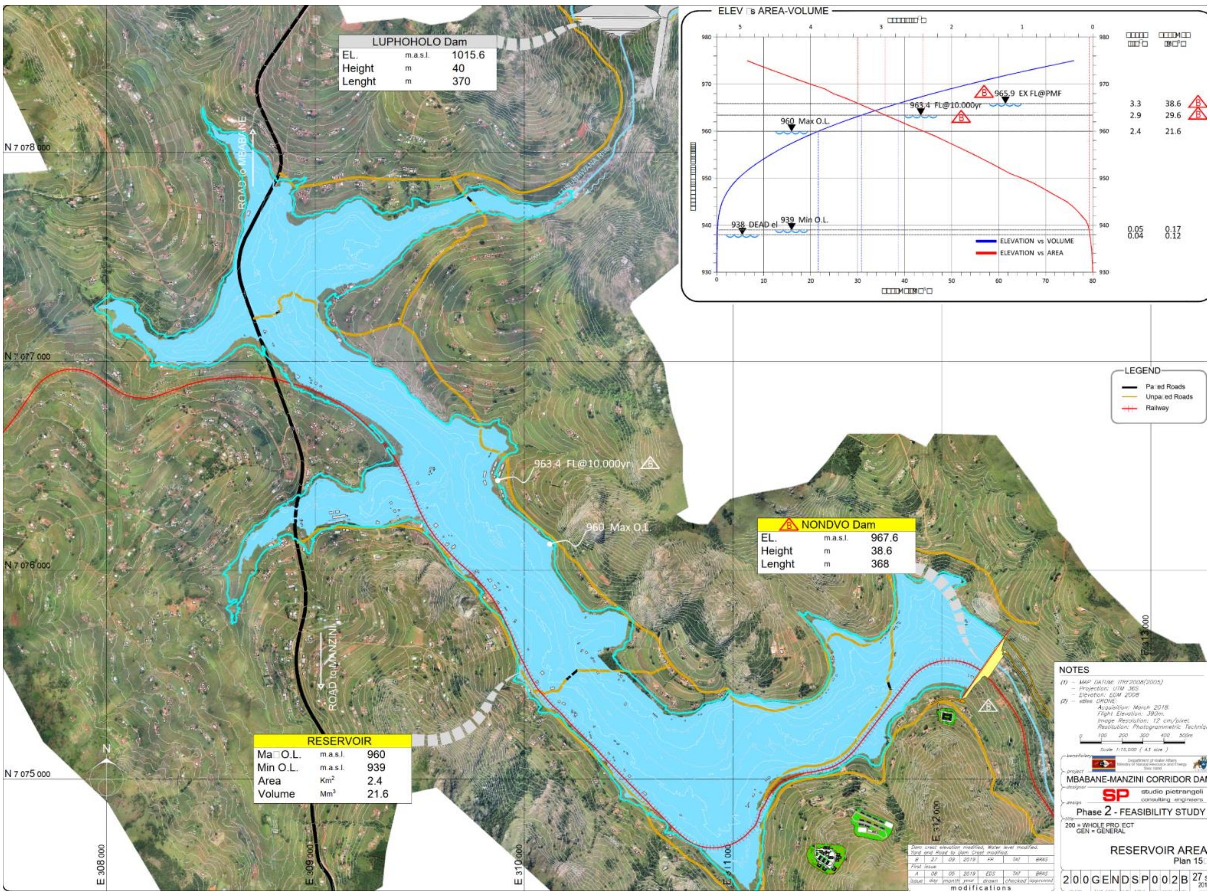


Figure 0-2: Nondvo Dam Layout – Design Drawing (Studio Pietrangeli, 2019)

PROJECT ALTERNATIVES

In the present evaluation, several alternative scenarios were assessed by considering a list of suitable options for:

— Dam location;

- Three alternatives have been studied for the Nondvo Dam axis location. Alternatives 1 and 2 are located approximately 500 m and 800 m downstream from the preferred Alternative.

— Dam height;

- The investigated reservoir elevations ranged for the three locations:
  - Dam Alt Preferred from 950 to 975 masl, at 10 m step intervals;
  - Dam Alt.1 from 940 to 980 masl, at 10 m step intervals; and
  - Dam Alt.2 from 930 to 980 masl, at 10 m step intervals.

— Dam type.

- Two types of the dam were studied; Gravity dam (i.e. Roller Compacted Concrete (RCC) dam) and deformable dam (i.e. Concrete Faced Rockfill (CFR) dam). The gravity dam solution was selected as the prefered option for development based on the dam safety; and reduction of maintenance costs.

The "no-go" alternative was not assessed as this will result in insufficient storage capacity of water to supply potable water to Mbabane and Manzini. In addition, there will not be the possible secondary benefit of utilising the proposed Nondvo Dam for small scale hydropower generation.

PUBLIC CONSULTATION

The first step included the drafting of a Stakeholder Engagement Plan (SEP) that defined all of the proposed stakeholder engagement activities, throughout the ESIA process.

An initial stakeholder database was compiled based on: the project characteristics, the socio-economic profile of the project area, similar studies developed in the region, the analysis of existing databases, knowledge of the team; and consultations with different government institutions.

During the Scoping Phase separate meetings were held with the Mantabeni and Sipocosini inner councils and communities. In addition to the Scoping meetings, additional meetings were held with the Hhohho and Manzini Regional Administrators, and associated chiefs, in order to disseminate project information to all the potentially affected communities. Issues and concerns raised during the scoping consultation were included and addressed within the ESIA.

During the ESIA Phase separate meetings were held with the Mantabeni and Sipocosini inner councils and communities and Inkundla. In addition, a public meeting was held in Mbabane.

The main issues raised during consultation include:

— Whether PAPs must continue with improvements to their homesteads and cultivation plans.
— Whether proposed community development programmes should continue.
— Concerned about where the PAPs will be relocated to.
— Resettlement by the railway line and main road realignment.
— Accessibility between the community and across the dam.
— Relocation of community services, such as schools.
— Socio-economic benefits of proposed dam to the affected community.
— Potential impacts on cultivated lands
— Potential risk with living in close proximity to two dams.
— Inadequate information on supporting infrastructure.
— Estimated commencement date of implementation.

Public Consultation will continue during the ESIA Phase Public Disclosure Process as well as the project implementation, as part of the requirements set out within the RAP. Comments received have been collated and a full Issues and Concerns Register Register is included in the SEP.

POTENTIAL IMPACTS

During the Scoping Phase the main issues and potential impacts associated with the proposed project were determined at both a desktop level based on existing information as well as field work and specialist input. These potential impacts were used to inform the scope of the data gathering and field surveys required to supplement the data as the basis for the assessment of impacts.

The ESIA evaluated the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

Based on the impact assessment methodology used the significance score can range from 3 (minimum) to 100 (Maximum). The significance weightings are defined as Low, Medium and High, as such the scoring system has been allocated accordingly to define the significance weighting, as identified in **Table 0-5**.

Table 0-5: Significance Weightings of an Impact

OVERALL SCORE	SIGNIFICANCE RATING (NEGATIVE)	SIGNIFICANCE RATING (POSITIVE)	DESCRIPTION
≤ 30 points	**Low**	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31 - 60 points	**Medium**	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
≥ 61 points	**High**	**High**	where the impact must have an influence on the decision process to develop in the area

The residual impacts (positive and negative) that were assessed as medium or high are discussed in **Table 11-1** and **Table 11-2**. There are three residual impacts with a high negative sensitivity.

Table 0-6: Residual Medium and High Impacts - Construction Phase

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
Geology and Topography	Blasting and large foundations constructed into the underlying geology and establishment of a quarry to extract material will remove soil cover and expose underlying rock.	High
Soil, Land Use and Land capability	Trapping of sediment will prevent the normal sediment load distribution downstream potentially resulting in a deeper and narrower channel and other related morphological impacts. Clear water has the capacity to carry more sediment than turbid water. The release of clear water is therefore likely to increase erosion and collapse of river banks downstream of the dam.	Medium
Hydrology and Hydrogeology	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Medium
	Rainfall on eroded / unconsolidated sediment has the potential to result in an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems functioning may occur.	Medium
Riverine Ecology	Construction activities instream will present an immediate migration barrier with potential to fragment the populations of biota in the watercourse.	Medium
	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	High
Terrestrial Ecology	Destruction, further loss and fragmentation of the vegetation community.	Medium

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
Climate Change and Green House Gases	The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others.	Medium
	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink.	High
Disturbance and Loss of Social and Economic Activities	The Project will result in physical displacement and relocation of approximately 210 households in Mantabeni and Siphocosini.	Medium
	Loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will affect PAPs ability to produce food and cash crops/ produce.	Medium
Employment Creation, economic Opportunities and Diversification	Generation of employment (formal and informal) and other income generation opportunities in the Nondvo Dam Project area and the surrounding area	Medium
Introduction and Movement of Workers into / Out of Local Communities	Expectations regarding possible employment opportunities may result in the area surrounding the site experiencing an influx of job seekers. Migrants will bring with them differing cultures, religious beliefs, norms and values; they influence young people to change in a manner that may not be accepted by the more conservative/ traditional sector of the population. Resulting increased prevalence of STI's and HIV/AIDS as well as crime.	Medium
	The Project area has one clinic, primary school and high school and is regarded as semi-rural. The possible influx of work seekers and additional contractor's workforce may add more stress on the existing resources.	Medium
Disruption to Family and Community Structures	Employment opportunities may inadvertently cause a shortage of available farming skills and family support networks during the construction phase. Additionally people employed in the construction work may aim to secure further work in the construction sector with their newly acquired skills and experience, leading to a longer term disruption to social and economic networks.	Medium
Increased safety risks to people and animals	Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.	Medium

Table 0-7: Residual Medium and High Impacts - Operational Phase

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
Soil, Land Use and Land Capability	During the operational phase water for irrigation of 800 ha of agricultural land will be made available.	Medium
	Sediment trapping will prevent normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower.	Medium
Hydrology and Hydrogeology	Operation of the Nondvo Dam will result in changes to the river flow regime and ecosystems: — Seasonal variation impacting aquatic and riparian systems downstream. — Loss of turbulent flow reducing dissolved oxygen concentrations; — Increase of turbulent flow resulting in oxygen super-saturation; — Increased water loss rate due to increased evaporation; — Increased recharge of the underlying aquifer through infiltration; and Changes in velocity and volumes of flow resulting in changes to natural shape of the streams.	Medium
	Initial inundation of the reservoir will increase in concentrations of nutrients and organic matter due to decomposition of inundated vegetation and possible mobilisation of nutrients from previous agricultural activities. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation).	Medium
	Dam inundation alters the amount of sediment production, retention and transportation in the system.	Medium
	Change in flow (reduced quantity) downstream of the dam affecting downstream ecological functioning and disruption of supply to users.	Medium
Riverine Ecology	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	High
	Alteration of downstream flow regime can impact on the relative volume of water discharge, permanence of low flows as well as the frequency and magnitude of flood peaks leading to reduced frequency of overbank flooding and negative impacts on the breeding cues of local fish communities.	Medium

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
	Alteration of migratory patterns for the observed Eel species (*Anguilla mossambica*) due to migratory habitats upstream of the dam being inaccessible.	Medium
Terrestrial Ecology	Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances	High
	Continued habitat degradation (litter, fire and alien vegetation encroachment)	Medium
	Loss in genetic diversity, habitat fragmentation and disruption of habitat corridors	Medium
	Introduction of new waterborne diseases	Medium
	Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter and feral species such as cats and dogs	Medium
Ecosystem Services	The inundation of the reservoir area will result in an alteration of ecosystem services	Medium
	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	High
Climate Change	The operation of the dam will result in the dam basin area filling to capacity which will result in the inundation of vegetation. There are potential carbon emissions that will be released by the decomposing of woody vegetation	Medium
Ease of Shortage of Water in Manzini and Mbabane, Irrigation of agricultural land and Promotion of Social and Economic Growth	The completion of the Nondvo Dam Project water infrastructure will ensure reliable water supply in Manzini, Mbabane and surrounding areas as well as water supply for irrigation of 800 ha of agricultural land in the project area. The availability of reliable infrastructure assets can increase returns and levels of investment and therefore accelerate economic growth.	High
Employment Creation, economic Opportunities and Diversification	The number of direct Project employment and procurement requirements will be dramatically reduced during operation (no accurate figures are currently available); however, as a result of the Project, the area will be more accessible, and the reservoir will potentially be seen as an attraction resulting in increased number of tourists visiting the area. Additionally, some of the workers and migrant work- seekers will remain following construction; thus, the population is likely to increase as compared to the current baseline. The economy, which is almost exclusively focused on agriculture, is likely	Medium

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
	to become more diversified through an influx of people with a greater variety of skills and offerings.	
Downstream Economic Activities	Disruption of downstream economic activities as a result of reduced flow.	Medium
Introduction and Movement of Workers into / Out of Local Communities	The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available.	Medium
	It would be recommended that the Nondvo Dam serve multi purposes. This strategy would increase the footprint of tourist and contribute to the income generation of the local area. Aggressive marketing well ahead of construction, including promotion of the nearby nature reserve, would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be developed at the site. Growth of the tourism sector will also facilitate creation of induced employment for local people, especially the youth.	Medium
	Establishment of the Nondvo Dam would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be permitted at the site. This would increase the footprint of tourist and contribute to the income generation of the local area. Construction of tourism facilities by local entrepreneurial and partnerships in the area may increase. Growth of the tourism sector will also facilitate creation of induced employment for local people, especially the youth	Medium
	As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo Project Area.	Medium
Demand on local utilities - Energy	The energy generated by the Project is to be utilised for operational purposes of the dam as well as distribution of electricity to the local population near the reservoir and thus thereby increasing their quality of life.	Medium
Change in sense of place	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and distrubed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape. The impact is considered positive as the	Medium

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE
	reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	
Visual Impacts	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and distrubed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape. The impact is considered positive as the reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	Medium
Downstream Tourism Potential	The reduced flow may result in a reduction of downstream tourism potential.	Medium

CUMULATIVE IMPACTS

The cumulative impact assessment (CIA) process analysed the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen valued environmental and social components (VEC) over time.

During the ESIA regional projects were identified through discussions in stakeholder workshops and literature review. Potential projects included Raising of the Luphohlo Dam Wall; Raising of the Hawane Dam Wall; Construction of the Ethemba Dam and Construction of a 132 KV powerline. Information on the likelihood of the projects proceeding and the implementation timeframes was generally limited or unavailable.

In terms of biophysical cumulative impacts, the potential cumulative impacts associated with the Project include Water quality and quantity impacts on the Lusushwana River; Augmentation of urban water supplies to the urban areas of Mbabane and Manzini (current: 8.4 Mm^3/a in 2005 to 10.4 Mm^3/a in 2030); Development of largescale irrigation agriculture near Malkrerns; and Proposed dams in the Usuthu River catchment (JMRBWRS, 2008). Should the proposed Nondvo Dam project proceed, water quality (increased salinity) impacts in Lusushwana River near Manzini can be anticipated as a result of potentially reduced flows, particularly during the operation and initial flooding of the reservoir. This would likely be compounded through increased water demand in the urban areas of Mbabane and Manzini.Should the proposed Nondvo Dam and the proposed irrigation projects near Malkerns proceed, water quality deterioration in the Lusushwana River would be anticipated as a result of the loss of dilution capacity and influx of irrigation return flows. Should the development of impoundments in the Usuthu / Maputo Rivers proceed, it is likely that there will be an impact to floodplains within the lower reaches of the watercourse. This will likely result in the further alteration of hydrology, sediment loads and local ecology in the Phongola River floodplains and Makatini Flats in proximity to the Ndumo Game Reserve in South Africa.

The construction of the Nondvo Dam, in addition to the other regional projects will result in a cumulative impact that will change the socio-economics of the area. It is anticipated that that for all the projects there will be livelihoods lost and displacement and resettlement will occur. The 132 KV powerline has already received authorisation to proceed and the resettlement and compensation process has commenced. The 132 KV powerline is proposed in the same location as the Nondvo Dam and the two projects will not be able to co-exist in the manner they are currently proposed. As such the powerline will have to be realigned in order for the Nondvo Dam to be feasible. It is thus anticipated that additional housholds will need to be relocated for the realignment of the powerline.

Even though there are negative socio-economic impacts there will also be the cumulative positive socio-enomic impacts associated with water supply for domestic, industrial and irrigation purposes. In addition, there will be temporary employment opportunities for each of the projects. These impacts have a significant influence on the economics of Eswatini.

PROPOSED MITIGATION MEASURES

An Environmental and Social Management Plan (ESMP) has been developed (**Appendix B**). The ESMP represents the Project's commitment to address and manage the potential negative and enhance the positive impacts associated with the bulk water supply infrastructure. The key intent of the ESMP is to ensure that the environmental and social objectives of the Project are met, and it is based on the various components of the Project throughout design, construction and operational phases.

The ESMP makes recommendation for capacity building and assigns responsibilities for the implementation of enhancement and mitigation measures as well as the completion of the monitoring programs.

It is expected that should the ESMP be executed effectively, the proposed project will not result in significant impacts (moderate significance post mitigation). For this to be achieved, the ESMP will be integrated into the Project's overall planning, design, budget, and implementation. The ESMP provides the required level of detail for mitigation and monitoring measures and its assignment of institutional responsibilities, and cost requirements.

A Resettlement Action Plan (RAP) has been developed as part of the Project, which focuses on physical and economic displacement issues in more detail.

CONCLUSIONS AND RECOMENDATIONS

The main purpose of Nondvo Dam is the storage of water for the supply of potable water to Mbabane and Manzini, which are currently suffering from intermittent water shortages, and where the anticipated future water demand is deemed to be highest. The additional water supply is also anticipated to facilitate the growth of the population alongside the "Corridor" area connecting these two cities. Possible secondary benefits of the proposed dam are the potential for utilising the Nondvo Dam head for small-scale hydropower generation, as well as utilising the stored water for irrigation of approximately 800 Hectares (ha) of agricultural land in the surrounding region.

The ESIA has identified various project impacts (both positive and negative) which may be incurred by the dam construction and operation. The high impacts (positive and negative) identified in the ESIA include the following:

— The permanency of the impact to geology by the quarry and dam wall construction.
— The inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat, which cannot be mitigated.
— The alteration of the flow regime of the river due to the construction of the dam wall.
— Benefit of water supply to Mbabane and Manzini, and the corridor inbetween.
— Irrigation of 800 ha of agricultural areas.

An ESMP has been developed which represents the commitments to address and manage the potential negative and enhance the positive impacts associated with the Nondvo Dam. The key intent of the ESMP is to ensure that the environmental and social objectives of the Project are met, and it is based on the various components of the Project throughout design, construction and operational phases.

The ESIA has not identified any fatal flaws that would restrict the development of the proposed Nondvo Dam. With effective implementation of the mitigation measures detailed within the ESMP and associated management plans, identified negative impacts can be reduced to acceptable levels while the positive impacts can be maximised to provide significant benefits to the region.

The proposed Nondvo Dam should be approved for development with the following key recommendations:

— The ESIA is limited to the project description as contained in this report. Should the Project be implemented, any changes in the project description that have potential to materially affect the findings of the ESIA should be evaluated.
— The ESIA has been undertaken on the feasibility designs as per the Final Feasability Report (FFR), dated October 2019, undertaken by Studio Pietrangeli (Studio Pietrangeli, 2019). Due to the Project being in the feasibility stage and not yet the final design stage there may be a need to revisit the findings of this ESIA and the management measures contained in the ESMP to ensure the findings and mitigation are still relevant.

- Amendments of the EMPs may be required should any design changes or updated construction information have environmental or social implications that are different to the findings of this ESIA Report.
- A detailed assessment of the project components below potentially needs to be undertaken prior to the Project being implemented:
  - Water distribution infrastructure (i.e pipeline network connecting dam to end users):
  - Realignment of the inundated internal access roads; and
  - Identfiifcation of host community(ies) and assessment of impacts.
- Implement the recommendations outlined in the Dam Safety Plan (DSP) (Knights Piesold, 2019).
- An Ecological Flow Requirement (EFR) release of 4 Mm^3/year is recommended (JMRBWRS, 2008) however a PROBFLO assessment to determine and assess the current EFR is to be undertaken as part of the detailed design.
- Implement the ESMP (**Appendix B**).
- Implementation of the RAP (in accordance with international lender requirements).
- The ESIA recommendations and ESMP are critical environmental management tools to be implemented during the construction phase; however, their effectiveness is underpinned by the level of adoption by the construction contractor. To this end, these documents should be made available to the contractor for inclusion in its own environmental and social management system.

In summary, the positive benefits of the proposed water supply to Mbabane and Manzini far outweigh the negative impacts and the proposed Nondvo Dam is recommended for development.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Kingdom of Eswatini (abbreviated in this document as Eswatini, and previously known as Swaziland) is a small landlocked country in Southern Africa, bordering Mozambique and South Africa. It covers an area of 17,360 km^2 and has a population of 1.39 million (mid 2012). The country is largely mountainous with 75.8% of the population living in rural areas with livelihoods predominantly dependent on subsistence agriculture. Eswatini has relatively well-developed infrastructure in comparison to other Sub-Saharan African countries, but there are a number of critical areas that require further improvement.

The nature of the hydrological network of Eswatini, comprising rivers shared between several states upstream and downstream, coupled with highly seasonal patterns with relatively long periods of drought makes the management of the country's surface water resources very difficult and vulnerable to climatic change. Economic and demographic growth of the country as well as changes in the water usage patterns have resulted in a significant increase in the demand for water resources. It has been identified that the size of the existing infrastructure and the capacity of equipment will soon be inadequate to satisfy the water demand. Furthermore, in Eswatini, all 'normal flow' in the rivers, most of them being of transboundary type, has been allocated under the arrangements of the international treaties. 'Normal flow' is water that has been calculated as being available 80% of the time during the driest month of the year. Therefore, the only water that can be made available for allocation is surplus flow (during floods and rainy season) through harnessing this flow in large storage reservoirs. This means that currently no water allocation can be made to any new developments as the water demand far exceeds the 'normal flow'. This is a major challenge limiting further social and economic development in the country.

As a response to these constraints the Government of Eswatini, Ministry of Natural Resources and Energy, DWA intends to better exploit surface water resources within the Mbabane – Manzini Corridor, by storing surplus water made available during flooding periods, above the allocated abstraction limits established by the Tripartite Agreement signed with South Africa and Mozambique. The stored water is then intended to be released as required for the various downstream usages. The Nondvo Dam will thus serve as an adaptation measure for potential future water requirements and climate change scenarios.

A Joint Maputo River Basin Water Resources Study (JMRBWRS) was jointly undertaken by the Kingdom of Eswatini, the Republic of South Africa and the Republic of Mozambique (Skoy Plancenter Ltd, 2008). During this study, a multi-criteria selection process was developed and applied to a number of proposed water supply projects in order to identify the most promising options for further investigation.

The DWA appointed Studio Pietrangeli Consulting Engineers (Studio Pietrangeli) to undertake the relevant scoping and feasibility studies for the multipurpose project to "*identify and design a project that meets competing water demands up to the Horizon 2050 through optimizing its dimensions and costs and minimizing socio-environmental impacts*". Several project options were studied during the feasibility-Scoping Phase to meet the short- and long-term demands. Based on the results of the feasibility-scoping study the DWA selected the following options, as identified in **Table 1-1**, to be subjected to a detailed feasibility assessment (Studio Pietrangeli, 2019).

Table 1-1: Projects Subjected to Detailed Feasibility Assessment

SOLUTION PERIOD	PROJECT
Short Term Solutions (up to 2025)	– Hawane Dam (raising of the by 3.5m) – Luphohlo Dam (raising of the by 5m)
Long Term Solutions (up to 2050)	– Nondvo Dam (construction of new dam)

As per the specified Terms of Reference (**Section 1.2**), this ESIA only deals with the Nondvo Dam project. Although the Luphohlo Dam raising is not assessed in this ESIA the dimensioning of Nondvo Dam, as defined within the final feasibility study undertaken by Studio Pietrangeli, takes into account the benefit of the presence of the raised Luphohlo Dam.

The main purpose of Nondvo Dam is the storage of water for the supply of potable water to Mbabane and Manzini, which are currently suffering from intermittent water shortages, and where the anticipated future water demand is deemed to be highest. The additional water supply is also anticipated to facilitate the growth of the population alongside the "Corridor" area connecting these two cities. Possible secondary benefits of the proposed dam are the potential for utilising the Nondvo Dam head for small-scale hydropower generation, as well as utilising the stored water for irrigation of approximately 800 Hectares (ha) of agricultural land in the surrounding region.

Two terms have been utilised in identification of the proposed dam, namely the 'Mbabane – Manzini Corridor Dam' and the 'Nondvo Dam'. The Mbabane – Manzini Corridor Dam is reference to the geographical area that will be served by the dam, whilst the term "Nondvo Dam" is the official shortened version of the project title in reference to the dam's location whereupon it will harvest surface flows along the Lusushwana River and its tributary, the Nondvo River. The terms "Mbabane – Manzini Corridor Dam" and "Nondvo Dam" are therefore used interchangeably throughout the Project's study documentation.

1.1.1 PROJECT COMPONENTS

The Nondvo Dam ESIA include and assessed the components listed below:

- River diversion works;
- Nondvo Dam and auxiliary works;
  - Dam wall;
  - Spillway;
  - Intake;
  - Powerhouse (i.e hydropower plant); and
  - Bottom outlet.
- Quarry;
- Site camps and offices;
- Electrical distribution system, connection to the existing low voltage electricity distribution scheme;
- Temporary access roads;
- Realignment of MR19[1]; and
- Railway line realignment.

The following components are excluded from the ESIA:

- Water distribution infrastructure (i.e pipeline network connecting dam to end users):
  Excluded due to not being included in the Technical Feasibility Study (Studio Pietrangeli, 2019).
- Realignment of the inundated internal access roads:
  Excluded due to not being included in the Technical Feasibility Study (Studio Pietrangeli, 2019).
- Host community impacts has only been included at a high-level:

Four potential host sites were identified, the viability assessed and associated host impacts assessed at a high-level, as the actual amount of land required for resettlement will only be confirmed following acceptance of compensation packages during the RAP implementation phase.

At the time of writing the ESIA Report (this report), the details for the excluded components had not been identified or assessed within the feasibility studies (Studio Pietrangeli, 2019). A detailed assessment would have to be undertaken prior to Project being implemented.

[1] The realignment of the MR 19 was only provided in the Draft Technical Designs by Studio Pietrangeli (2020). The specialist studies and site investigations were already concluded, however due to the proximity to the site it is not anticipated that significant additional impacts will arise.

1.2 TERMS OF REFERENCE

The DWA has applied a portion of the funds for the appointment of consultants to carry out the Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for the Nondvo Dam Project. The tender to perform the ESIA and RAP was awarded to WSP Environmental (Pty) Ltd. (WSP) in association with Maphanga Mitchell Associates (MMA) and Knight Piésold, collectively referred to in the ESIA as "the Consultant".

The Consultant understands the overall objectives of the appointment are to:

- Undertake an ESIA and prepare the associated Environmental and Social Management Plan (ESMP) to inform all stakeholders of the potential environmental and social risks associated with the Project, and inform the detailed design based on findings of the study.
- Prepare a RAP in order to identify activities that require physical (i.e. resettlement) and / or economic displacement and provide a detailed action plan for compensation of the affected populations.

1.3 REQUIREMENT FOR AN ESIA

The Eswatini environmental legislation, principally the Environment Management Act (2002) and the Environmental Audit, Assessment and Review Regulations (2000) (EAARR), lists three categories that the authorising agency can assign to a proposed project (Category 1, 2, and 3), which dictates the level of environmental assessment required.

Under the First Schedule of the EAAR, the proposed Project is categorised as a Category 3 project requiring a full Environmental (and Social) Impact Assessment (EIA/ ESIA[2]) study to be undertaken and submitted to the Eswatini Environmental Authority (EEA) for consideration prior to project implementation. The EEA confirmed the categorisation in correspondence received, dated 21 December 2018 (**Appendix D**).

This is in line with Operation Safeguard (OS) 1 of the African Development Bank Group's (AfDB) Integrated SafeguardsSystem Category1 Project (i.e. Bank operations likely to cause significant environmental and social impacts). Catergory 1 investment projects require an ESIA, leading to the preparation of an ESMP.

In terms of other international standards, this is in line with Category A Projects of the World Bank's environmental and social safeguard policy categorisation, which is required to conform to the norms and standards of the World Bank's safeguard system. As well as the International Finance Corporation (IFC) Performance Standard (PS) 1: Assessment and Management of Environmental and Social Risks and Impacts, focusing on the significant environmental and social issues of a project.

Prior to proceeding to the ESIA Phase a scoping assessment was undertaken (WSP, 2019) to determine the practicality of the proposed project, identify potential risks and benefits (i.e. negative and positive impacts), and identify the preferred alternative proposed for development. The Scoping Phase was approved by the EEA in July 2019 (**Appendix E**).

This report constitutes the Draft ESIA Report for the proposed Nondvo Dam Project, as defined in **Section 5** (Project Description) fulfilling the first objective as per **Section 1.2** above.

1.4 PROJECT MOTIVATION

With a Gross Domestic Product (GDP) per capita of approximately US$ 3,500 in 2014, Eswatini is classified as a lower-middle-income country by the World Bank Atlas method. In 2015, the global rate of access to potable water supply in Eswatini was identified as 74% of the population and the sanitation coverage rate was 57%

[2] The Environment Management Act speaks of an Environmental Impact Assessment (EIA). However, in line with the Contract Terms of Reference, the current process is being referred to as an ESIA with the resultant report being referred to as an ESIA Report.

(Ministry of Natural Resources and Energy: Department of Water Affairs, 2017). Addressing issues of water resources mobilisation for basic water supply, industrial and agriculture use is clearly a poverty reduction priority for the country. The two main cities of Mbabane and Manzini and the surrounding area host the major part of the population and most of the industrial and productive activities of the country. This concentration is the driver of the country's economic growth and needs to be provided with sustainable public services of a high standard.

The economy of the country depends on key sectors namely, construction, tourism, mining and financial services, and rain-fed agriculture, and therefore remains vulnerable to exogenous global and regional shocks and climate-related risks affecting water availability. The main objective of the Nondvo Dam is the storage of water in order to provide potable water to Mbabane and Manzini. The requirement for Nondvo Dam is based on a demographic assessment along with a future water demand assessment.

1.4.1 DEMOGRAPHIC ASSESSMENT

The last demographical census of 2007 and the Eswatini population projections 2007-2030 study by the Central Statistical Office have been used as a baseline for the demographic study. According to the data of the Central Statistical Office the Eswatini population increased from 1997 to 2007 per district (Studio Pietrangeli, 2019). Refer to **Table 1-2** and **Figure 1-1** for the population data.

Table 1-2: Population Data in 1997 and 2007 (Studio Pietrangeli, 2019)

REGION	1997	2007	GROWTH % 1997 - 2007
Eswatini	965'859	1'018'449	5
Hhohho	262'203	282'734	8
Manzini	287'949	319'530	11
Shiselweni	217'598	208'454	-4
Lubombo	198'109	207'731	5

The country's population increased on average 5 % in 10 years, but with different distributions within the districts. The Manzini districts registered the maximum growth, on the contrary of the Shiselweni district registered a reduction of the population.

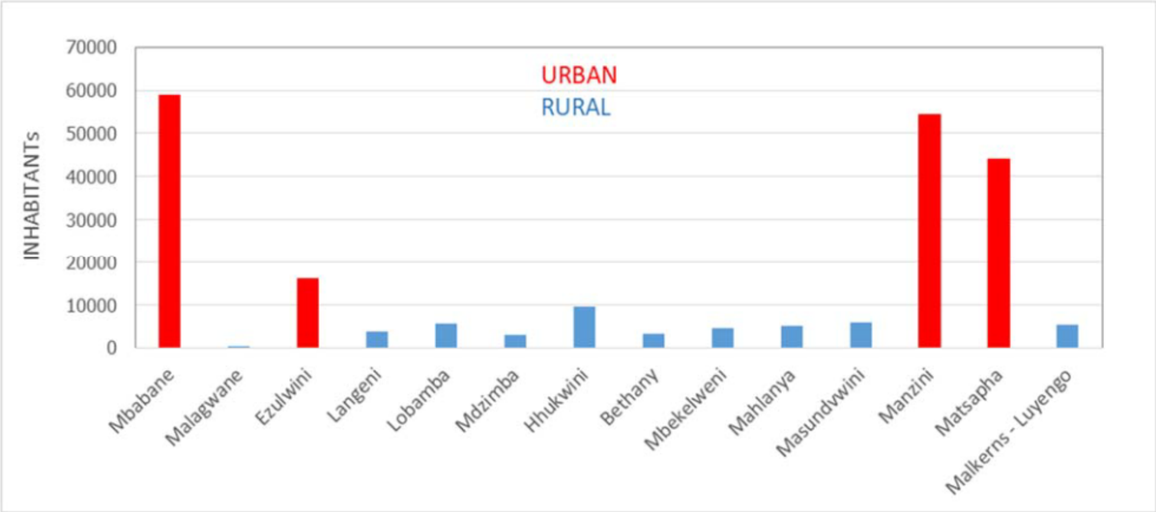


Figure 1-1: Mbabane-Manzini Corridor Population Data in 2007 (Studio Pietrangeli, 2019)

A study about population projections for the period 2007-2030 was carried out by the Central Statistical Office of Eswatini, involving calculations of future population size and their characteristics based on assumptions about the future trends in fertility, mortality, and migration.

The cohort–component method was used in preparing the population projections. Using the initial population distributed by five-year age groups and sex, the method projects the population by updating the population of each age- and sex-specific group according to assumptions about three components of population change: fertility, mortality, and migration. The projected size and age structure of the population at any point in the future depends entirely on the size and age structure at the beginning of the period and the age-specific fertility, mortality, and migration rates over the projection period. The results are summarised in **Figure 1-2**.

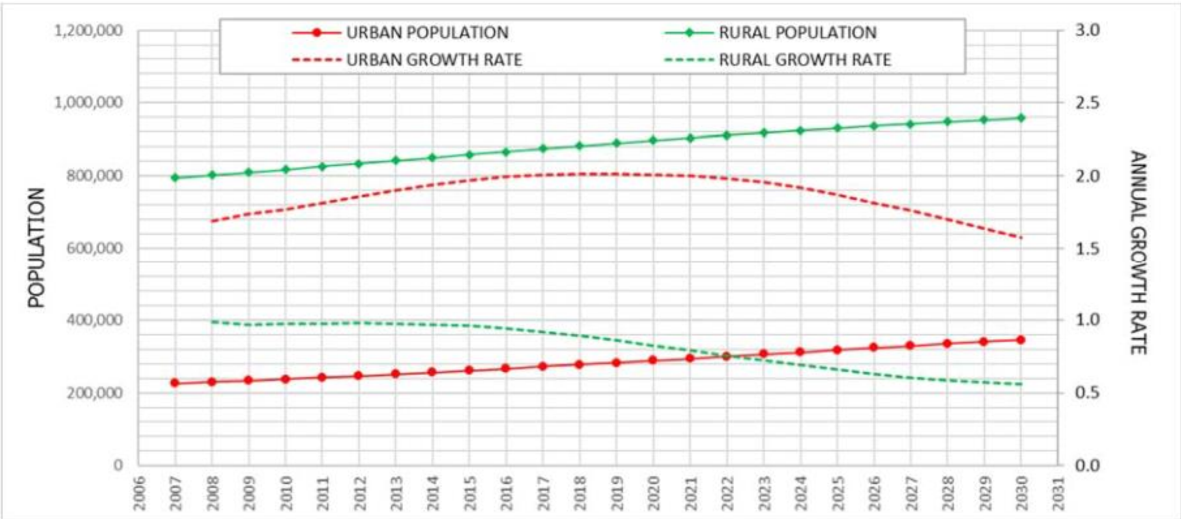


Figure 1-2: Eswatini Urban and Rural Population Projections 2007-2030 (Studio Pietrangeli, 2019)

The population growth trend suggests a variable annual growth for both rural and urban areas. The urban population growth rate increased within the decade 2008-2018, reaching a peak growth rate of 2%, and then decreases after 2020, down to a rate of 1.6% in 2030.

The rural population growth rate always decreased since 2008, first gently, and after 2016 with a major slope. According to the population projection model, the rural population growth rate in 2026 will start to decrease gently in time.

In order to forecast the population in 2050, the trend of growth rate for both rural and urban areas has been extended up to 2050. The population trend in the period 2030-2050 has been considered varying according to a linear law similar to the trend of the last 3-5 years.

The results are summarized in **Figure 1-3**, showing both the population and the growth rate estimates up to 2050.

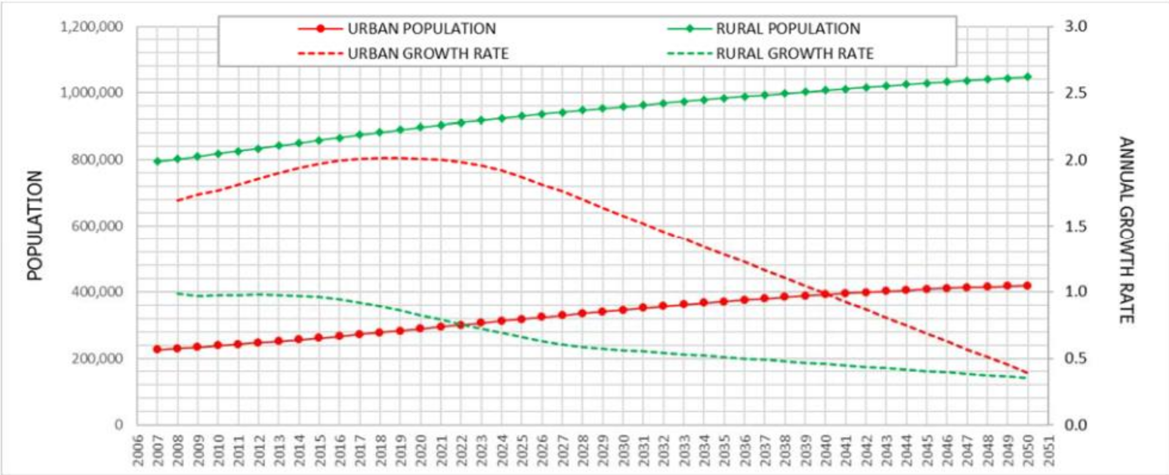


Figure 1-3: Eswatini Urban and Rural Population Projectsions 2007-2050 (Studio Pietrangeli, 2019)

The above growth rates have been applied to estimate the population in the Mbabane-Manzini corridor up to 2050. The results are summarized in **Figure 5-2**.

Table 1-3: Mbabane-Manzini Corridor Urban and Rural Population Projections (Studio Pietrangeli, 2019)

	SHORT-TERM HORIZON 2025			LONG-TERM HORIZON 2050		
AREAS	**Urban**	**Rural**	**Total**	**Urban**	**Rural**	**Total**
Mbabane	83 142	7 823	90 965	109 327	8 804	118 131
Ezulwini + Lobamba	22 845	17 895	40 760	30 029	10 154	50 183
Matsapha + Manzini	138 715	28 077	166 792	182 410	31 631	214 041

1.4.2 CURRENT WATER SUPPLY

The supplied monthly volumes in the period 2008 – 2016, with some gap, have been collected for the Mbabane-Manzini corridor Water Treatment Plants (WTP), except data relevant to the most recent WTP suppling Ezulwini and the Malkerns WTP. Furthermore, the amount of water supplied by the latter two cited WTPs is practical nil if compared to the others and will be neglected conservatively. The monthly abstraction volumes are provided in **Figure 1-4**.

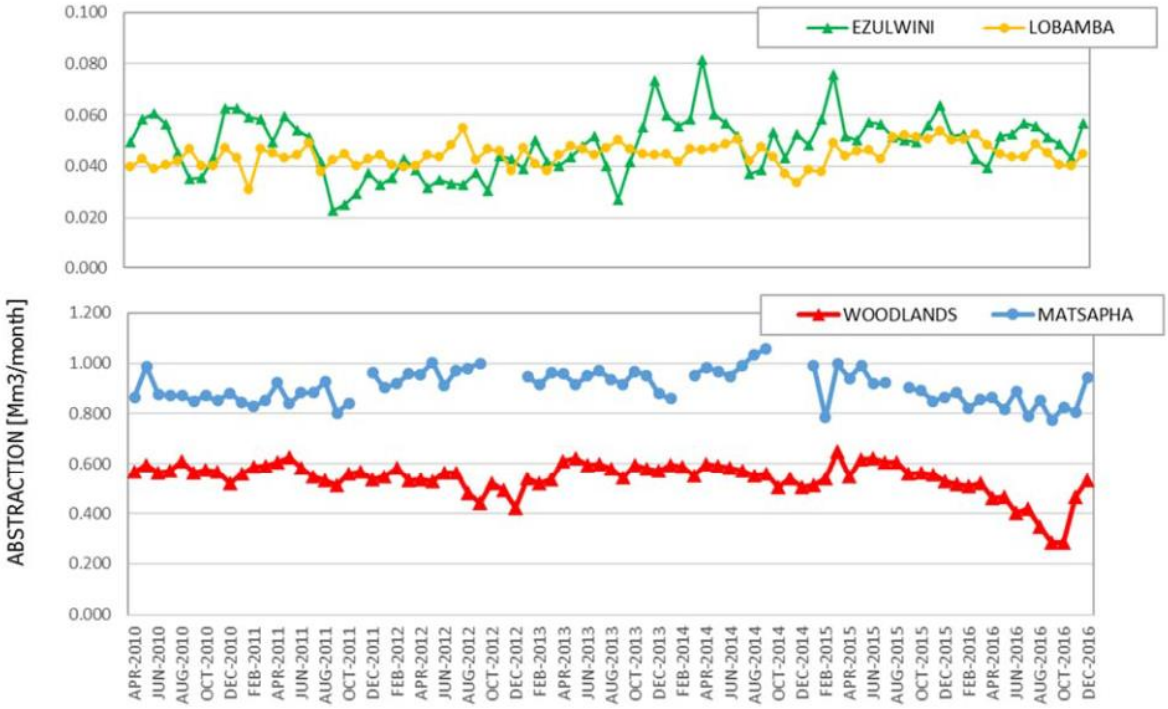
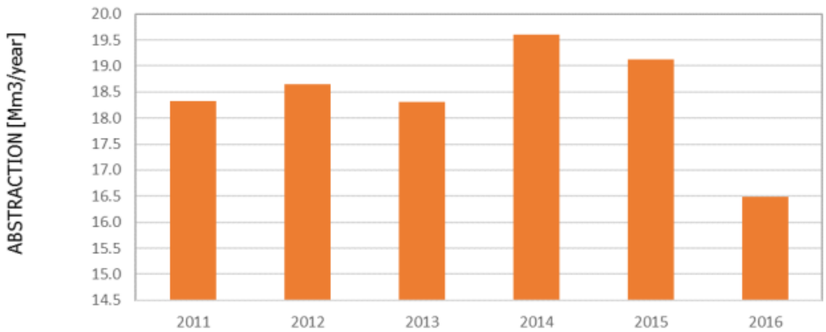


Figure 1-4: WTP Monthly Abstraction Volume Trends 2010-2016 (Studio Pietrangeli, 2019)

According to the data, it is evident that the existing WTPs currently work almost at the full capacity.

The worst consequences to the drought of 2016 have been experienced in Mbabane, where the Woodlands WTP registered a significant reduction in the supplied volume.

The estimate of the total annual volume supplied by the water treatment plants is provided in **Figure 1-5**.



YEAR	Mm3/year
2011	18.3
2012	18.6
2013	18.3
2014	19.6
2015	19.1
2016	16.5

Figure 1-5: WTP Annual Supplied Volumes Trend 2011-2016 (Studio Pietrangeli, 2019)

1.4.3 FUTURE WATER DEMANDS

The future water demand projections was estimated based onthe projected population and the per capita water use. The per capita water demand differs from urban and rural areas as follows:

– Urban- 250 l/inhabitant/day; and
– Rural - 100 l/inhabitant/day.

The projected water demands for areas are provided in **Table 1-4** and **Figure 1-6**.

Table 1-4: Mbabane-manzini Corridor Projected Water Demands (Studio Pietrangeli, 2019)

AREAS	SHORT-TERM HORIZON 2025			LONG-TERM HORIZON 2050		
	Urban	Rural	Total	Urban	Rural	Total
Mbabane	7.6	0.3	7.9	10	0.3	10.3
Ezulwini + Lobamba	2.1	0.7	2.7	2.7	0.7	3.5
Matsapha + Manzini	12.7	1.0	13.7	16.6	1.2	17.8

According to the reservoir routing, Hawane dam can supply a yield with 1 to 20 years assurance of 6.8 Mm^3 per year. Therefore, the gap demand to be supplied in the future can be estimated as the total demand minus 6.8 Mm^3/year.

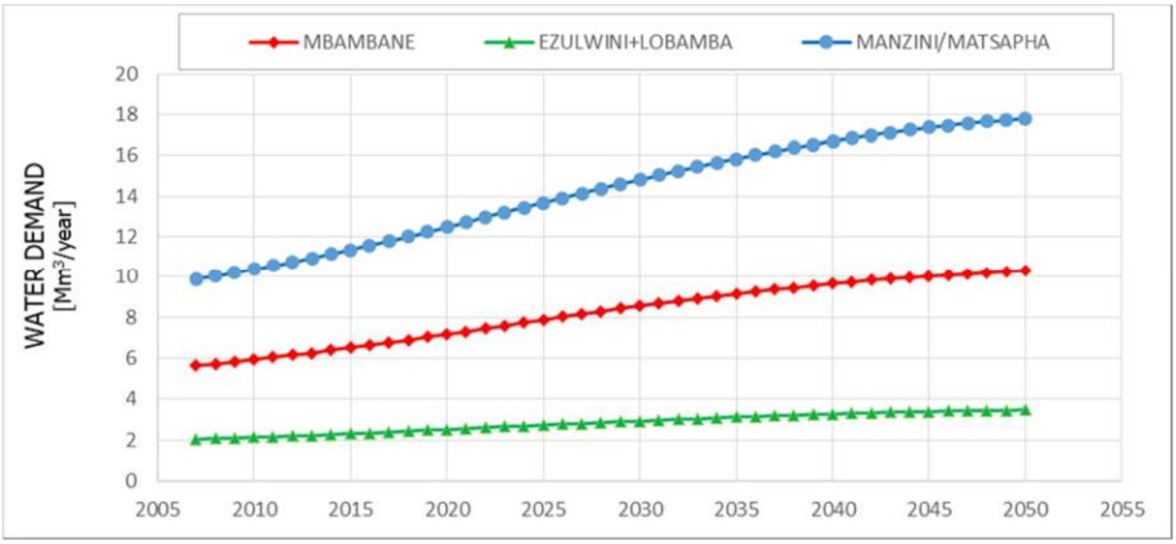


Figure 1-6: Projected Water Demands (Studio Pietrangeli, 2019)

According to the reservoir routing, Hawane dam can supply a yield with 1 to 20 years assurance of 6.8 Mm^3 per year. Therefore, the gap demand to be supplied in the future can be estimated as the total demand minus 6.8 Mm^3/year.

For the other areas, for sake of safety, it has been considered, as current water supply, the minimum amount supplied in the period 2009-2016. Furthermore, it has been accepted an interruption of service twice in 53 years. The future water demands to be supplied to meet the gap per area are indicated in **Table 5-4**.

Table 1-5: Mean Net Future Water Demands

WATER DEMAND (MM^3/YEAR)	SHORT-TERM	LONG-TERM
Mbabane	1.1	3.5
Ezulwini + Lobamba	1.7	2.5
Matsapha + Manzini	3.6	7.7

WATER DEMAND (MM^3/YEAR)	SHORT-TERM	LONG-TERM
Total	6.4	13.6

Water supply for the fast-growing population and for sustaining the development of economic activities is, therefore, a challenge thatneeds to be urgently addressed. The mobilisation and better harnessing of surface water resources have become a concern of priority for the government. The challenge is compounded by the additional need of water for implementing the government policy to increase the contribution of agriculture production to the GDP, and to exploit the hydropower potential of the national rivers network in order to limit the electricity supply dependency from ESKOM in South Africa.

In Eswatini, agriculture provides a source of sustenance to a majority of households. For that reason, the agricultural sector matters quite significantly. Confounding the situation for rural households and the government, in general, is that in recent years, particularly in the last 15 years or so, the country has witnessed an increase in drought-like conditions. Making the situation perverse are reports from the International Panel on Climate Change (IPCC) (2007) that suggest that the Southern Africa region will see an increase in the incidence of droughts in the future.

As indicated above, the main objective of the Nondvo Dam is therefore the storage of water in order to provide potable water to Mbabane and Manzini. The stored water could also be used for small-scale hydropower generation and for improving the output of run-of-the-river hydropower plants situated further downstream. In addition, water will be supplied for irrigation.

The project corresponds well to the National Development Plan 2014/15 – 2016/17 in terms of water resource development. The National Development Strategy (NDS) also confirms the government's priority to improve storage capacity for renewable water resources through the development of two dams, the Nondvo Dam being one of them. The project is quoted in the Government Programme of Action 2013-2018 and aligns with the Southern African Development Community (SADC) strategies and the principles stated in the Tripartite Interim Agreement between Eswatini, South Africa, and Mozambique, the three riparian countries of the Maputo River Basin.

2. ORGANISATION OF THE ESIA STUDY

2.1 APPLICANT DETAILS

The Government of Eswatini, Ministry of Natural Resources and Energy, DWA is the applicant for the Environmental Authorisation related to this project. The relevant details of the applicant are provided in **Table 2-1**.

Table 2-1: Details of the Project Applicant

ASPECT	DETAIL
Applicant	Government of Eswatini, Ministry of Natural Resources and Energy - DWA
Contact Person	Mr Trevor M. Shongwe (Director - DWA)
Postal Address	P.O. Box 57, Mbabane, Eswatini
Contact Number	+26824049866 / +26876063636
Contact Email	trevorshongwe@gmail.com

2.2 DETAILS OF THE ENVIRONMENTAL CONSULTANTS

The ESIA process is being undertaken by WSP, in association with Maphanga Mitchell and Associates (MMA), and Knight Piésold.

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, architects, planners, surveyors, and environmental specialists, as well as other design, program, and construction management professionals. We design lasting solutions in the Transportation & Infrastructure, Property & Buildings, Environment, Industry, Resources (including Mining and Oil & Gas), and Energy sectors, as well as offering project and program delivery and advisory services. With approximately 48,000 talented people in 550 offices across 40 countries, we engineer projects that will help societies grow for lifetimes to come.

In Africa, WSP, Environment, is a leading environmental consultancy with a broad range of expertise and over 23 years' experience in the regional market. As part of a global business, we provide the marketplace with a dynamic blend of local knowledge and global expertise.

We offer independent, insightful and professional advice to our clients to achieve a balance between environmental protection, social desirability and economic development. We have a reputation for delivery and excellence and provide a diverse range of integrated and innovative solutions to both public and private sector clients across the industrial, mining, infrastructure and financial sectors.

The team is principally be led by Environmentalist Amelia Briel (Knight Piésold). Amelia's role is to provide strategic guidance on the Project and undertake progressive Quality Assurance and Quality Control (QAQC) on all deliverables. Her advice is based on her vast experience as ESIA Lead in water infrastructure and bankable projects in Africa – allowing her an understanding of a broad range of specialist considerations, thereby enhancing the expertise within the broader team.

Anri Scheepers, Support Environmentalist (International) (WSP) is responsible for the day-to-day management of the Project and overall coordination of the project team activities and inputs. She plays the role of key client contact, communicates across disciplines to ensure the scope of works are aligned and timeframes adhered to.

Mbuso Kingsley (MMA) undertakes the role of Support Environmentalist (Local) and coordinates and manages all aspects of the national regulatory ESIA application process and engage with key local authorities throughout the ESIA, he is primarily responsible for the submission of documents to the EEA and assists in transboundary liaison.

The environmental consultant's details are provided in **Table 2-2**.

Table 2-2: Environmental Consultant's Contact Details

CONTACT DETAILS	WSP ENVIRONMENTAL (PTY) LTD	MAPHANGA MITCHELL ASSOCIATES	KNIGHT PIÉSOLD
Contact Person	Ms Anri Scheepers	Mr Mbuso Kingsley	Ms Amelia Briel
Address	Building C, Knightsbridge, 33 Sloane Street, Bryanston, South Africa, 2191	P.O. Box 8, Veni, Mbabane, Eswatini, H103	4 De la Rey Road, Rivonia, Gauteng, South Africa, 2128
Telephone Number	(+27) 11 300 6089	(+268) 2424 3044 / (+268) 2404 6139	(+27) 11 806 7111
Contact Email	Anri.Scheepers@wsp.com	mbuso@mapmitch.org	abriel@knightpiesold.com

2.3 ESIA PROJECT TEAM

The various roles and members of the ESIA project team involved in the ESIA are listed in **Table 2-3**. A detailed table including relevant qualifications, experience and specialism for the assigned roles is included in **Appendix A**. The structure of the ESIA project team is illustrated in **Figure 2-1**.

Table 2-3: ESIA Project Team

ROLE	NAME	ORGANISATION	QUALIFICATIONS
Project Team			
International Advisor	Jean Marc Evenat	WSP	Bachelor of Science, Major in Geography Master's Degree, Major in Environmental Sciences
Environmentalist	Amelia Briel	Knight Piésold	BSc Biological Science BSc (Hons) Zoology MSc Environmental Toxicology
Expert Participative Approach and Consultation	Antoine Moreau	WSP	BSc Sociology MSc Sociology Ph.D. Public Participation in Environmental Management
Project Manager / Support Environmentalist (International)	Anri Scheepers	WSP	BA Geography BA(Hons) Geography

ROLE	NAME	ORGANISATION	QUALIFICATIONS
Support Environmentalist (International)	Robert Els	WSP	BSc Environmental Sciences BSc (Hons) Geography
Support Environmentalist (Local)	Mbuso Kingsley	MMA	BSc (Hons) Environmental Science
Environmental Specialist Team			
River Morpho–dynamic Specialist	Karen King	WSP	MSc Hydrology BSc (Hons) Hydrology BSc Hydrology and Soil Science
Basin Protection Specialist	Greg Mathews / Hassen Khan	WSP	BSc Hydrology, Geography and Geology BSc (Hons) Hydrology
Ecologist	Andrew Husted	The Biodiversity Company	BSc Zoology and Botany BSc (Hons) Aquatic Health MSc Aquatic Health
Aquatic Surveyor	Gordon O'Brien	The Biodiversity Company	BSc Zoology and Botany BSc (Hons) Aquatic Health MSc Aquatic Health Ph. D Aquatic Health
Herpetofauna Surveyor	Luke Verburgt	The Biodiversity Company	BSc Zoology BSc (Hons) Zoology MSc Zoology / African Mammalogy
Botanical Surveyor	Llewelyn Coertzen	The Biodiversity Company	BSc Animal Science BSc (Hons) Wildlife Management
Invertebrates and Avifauna Surveyor	Lukas Niemand	The Biodiversity Company	BSc Zoology and Entemology BSc (Hons) Entemology MSc Restoration Ecology/Zoology
Mammal Surveyor	Samuel Laurence	The Biodiversity Company	BSc Conservation Biology and Marine Biology BSc (Hons) Wildlife Management MSc Wildlife Management
Dam Safety Specialist	Campbell Abrahamson	Knight Piésold	BSc Civil Engineering
Social Specialist Team			
Local Stakeholder Engagement Advisor	Mthokozisi Sibeko	MMA	BA Social Science (major in Geography, Environmental Science and Planning and Public Administration)
Social Survey Specialist / RAP	Marie Andree' Burelle Richard Ramoeletsi	WSP SI Futures	MSc Anthropology MSc Rural Resource Management, BSc (Hon.) Forestry

ROLE	NAME	ORGANISATION	QUALIFICATIONS
Socio-Economic Survey Supervisor	Tjengisa Dlamini	MMA	Diploma Sustainable Rural Development Diploma Social Studies
	Zodwa Dlamini	SI Futures	Phd Social Foundations, University of Iowa, USA
Socio-Economic Database Specialist	Phakisa Mokheni	SI Futures	BSc Computer Science and Physics BCom (Hons) Business Information Systems
Cultural Heritage Specialist	Bob Forrester	MMA	BA Archaeology and Anthropology

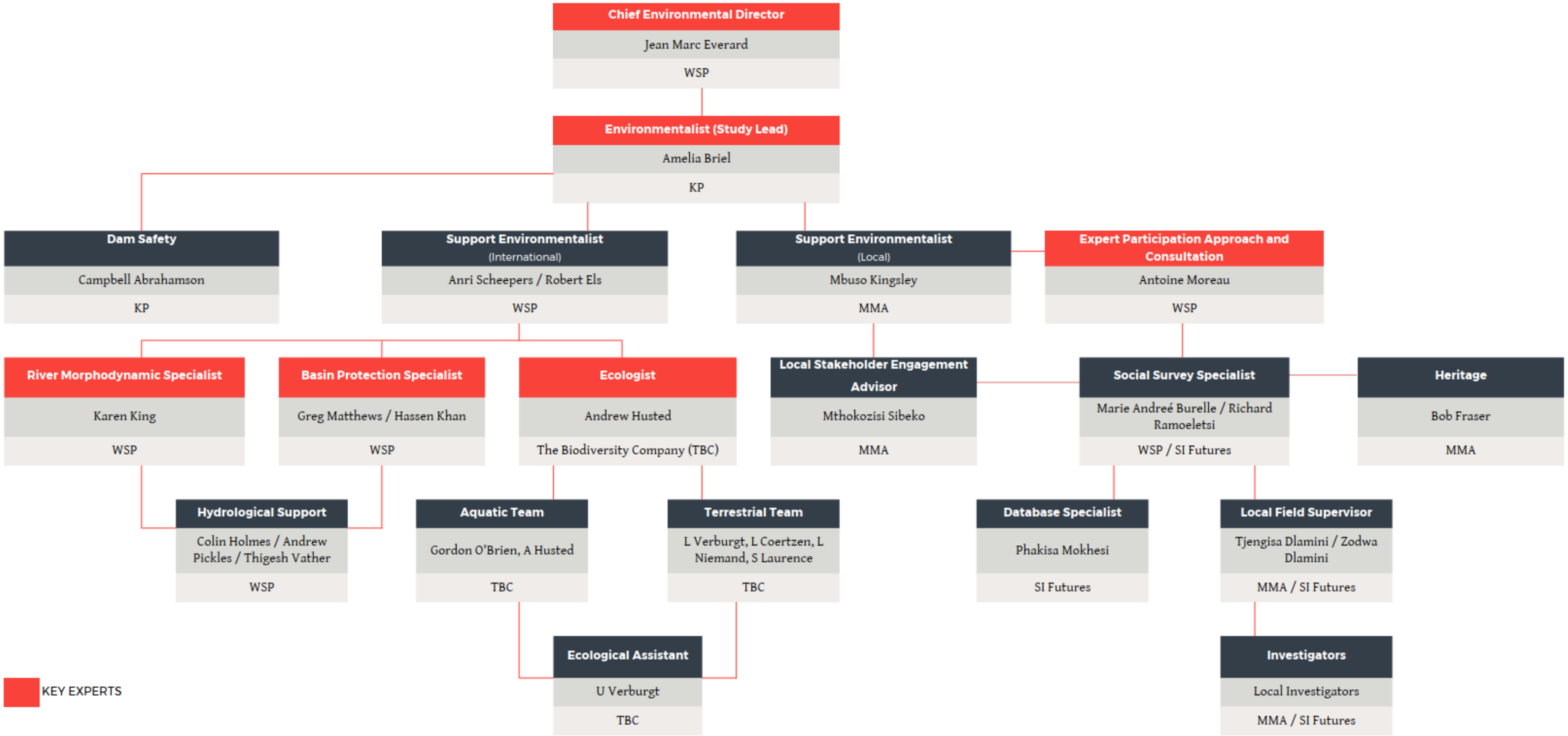


Figure 2-1: ESIA Project Team Structure

2.4 PURPOSE THIS REPORT

This report presents the ESIA findings for the proposed construction and operation of the Nondvo Dam and support infrastructure (hereinafter referred to as 'the Project'). The report aims to demonstrate that the key environmental and social issues have been properly assessed in consultation with relevant stakeholders. The report will be presented to Interested and Affected Parties (I&APs) as part of the stakeholder engagement process and submitted to the EEA for adjudication.

To reach the above objectives, the ESIA Report aims to accomplish the following tasks:

- Provide a description of the Project;
- Justify the need and desirability of the Project;
- Provide the institutional, legal and regulatory framework (both local and international) relevant to the Project;
- Evaluate project alternatives;
- Provide a description of the biophysical and socio-economic baseline environment;
- Identify and assess the Project's main environmental and social impacts and evaluate the significance of these;
- Propose relevant mitigation or enhancement measures to decrease the negative impacts and enhance positive impacts associated with the Project;
- Conduct public consultations with all interested and affected stakeholders;
- Address stakeholder concerns and comments raised during public consultation for the Project;
- Prepare an ESIA compliant to the relevant authorities and Good International Industry Practice (GIIP); and
- Prepare an ESMP that details mitigation measures, the monitoring process, training support and institutional structure required for implementation.

2.5 ESIA REPORT STRUCTURE

The structure of the ESIA Report is summarised in **Table 2-4**.

Table 2-4: Structure of the ESIA Report

CHAPTER	DESCRIPTION
ESIA REPORT	
	Non-technical Summary
Chapter 1	**Introduction** Provides a background to the Project and terms of reference and requirements for an ESIA as well as motivation for the Project and its advantages.
Chapter 2	**Organisation of the ESIA Study** Provides details of the Project Applicant, the Environmental Consultants, ESIA Project Team and the main objectives and structure of the report.
Chapter 3	**ESIA Approach and Methodology** Provides details of the overall approach, ESIA process and the different assessment phases thereof, as well as defining the impact assessment methodology and the mitigation and management approach utilised in the ESIA This chapter also presents the assumptions and limitations under which the ESIA was conducted.

CHAPTER	DESCRIPTION
Chapter 4	**Administrative and Legal Framework Analysis** Outlines the legal framework within which the ESIA has been undertaken and identifies international environmental and social legislation, standards and guidelines applicable to the Project.
Chapter 5	**Project Description** Provides a description of the various components of the Project, including location; general layout; size, capacity, etc.
Chapter 6	**Analysis of Alternatives** Describes alternatives examined in the course of developing the proposed Project, including the 'No-Go Alternative'.
Chapter 7	**Description of the Environment** Presents the biophysical and socio-economic baseline for the Project area of influence.
Chapter 8	**Stakeholder Engagement** Describes the public consultation process that was undertaken and how comments and issues raised are addressed.
Chapter 9	**Impact Assessment** Identifies and evaluates the likely extent and significance of the potential environmental (including physical and biological receptors) and social impacts on identified receptors and resources against defined assessment criteria (semi-quantitative approach) during the construction, operation and maintenance phases of the Project. Key mitigation measures are identified along with any residual negative impacts that cannot be mitigated (fuller mitigation information is presented in the accompanying CMP / ESMP[3]).
Chapter 10	**Cumulative Impacts** Analysis of potential impacts and risks of proposed developments together with current impact assessment based on chosen valued environmental and social components (VEC).
Chapter 11	**Impact Statement** Provides a summary discussion of the anticipated impacts and significance levels thereof.
Chapter 12	**Conclusions and Recommendations** Specifies the environmental and social acceptability of the project, taking into account the impacts and measures identified during the assessment process.
Chapter 13	**References** Lists references cited in the report.
APPENDICES	
A	ESIA Team Roles and Responsibilities
B	ESMP
C	Specialist Studies
D	Project Categorisation
E	Scoping Report and Terms of Reference Acceptance

[3] The Environment Management Act speaks of a Comprehensive Mitigation Plan (CMP). However, in line with the Contract Terms of Reference, the ESIA refers to an Environmental and Social Management Plan (ESMP).

CHAPTER	DESCRIPTION
F	Stakeholder Engagement Plan
G	Applicable Legislation and Policies
H	Impact Assessment
I	Resettlement Action Plan
J	Enlarged Maps

3. ESIA APPROACH AND METHODOLOGY

3.1 OVERVIEW AND OBJECTIVES OF THE ESIA

The ESIA Report aims to provide a clear description of the proposed project activities, alternatives considered, affected environment of relevance to the Project; assessment of key impacts on environmental and social receptors and appropriate and realistic mitigation measures, which are defined within the ESMP / CMP. Mitigation and monitoring requirements for construction and operation are detailed in the ESMP / CMP, which will be implemented by contractors and the DWA respectively (refer to **Appendix B**).

The Scope of Work, as described in **Section 3.2**, has been prepared to meet the reporting requirements of the Eswatini EMA, as well as align with international safeguards specifically the AfDB Integrated Environmental and Social Impact Assessment (IESIA) Guidelines (AfDB, 2015). The ESIA also broadly considers additional international standards and good practice guidelines, such as those of the World Bank Group (WBG), the IFC (2012) and Equator Principles. In the case of requirements that conflict with the AfDB IESIA Guidelines (AfDB, 2015), the latter will take precedence.

The ESIA has been designed to meet the needs of decision-makers to provide an informed and balanced presentation of findings, and be easily understood by stakeholders. The ESIA has also taken other relevant norms, standards and legislation into account (refer to **Section 4**).

The ESIA process includes the definition of the Area of Influence (AoI), the legal process followed, a summary of the methodologies of the specialist studies (full details are provided in the Specialist Reports attached as **Appendices C1 to C5**), summary of the stakeholder engagement process and the Impact Assessment methodology. The process also involved the collation and integration of the specialist studies and other data, including coordination with the RAP process, to provide a full ESIA Report.

The ESIA should not be viewed as an isolated process and therefore, a further objective was to inform the designs, construction specifications and environmental and social monitoring requirements related to the Project.

3.2 SCOPE OF WORKS

The generation of this ESIA was initiated by a literature review of available existing project information to provide background information and identify key socio-economic and environmental aspects and impacts for consideration. The following key stages have applied through the generation of the ESIA[4] (**Figure 3-1**):

— Task 1: Inception Phase (**Section 3.2.1**)
— Task 2: Scoping Phase (**Section 3.2.2**)
— Task 3: Specialist Studies (**Section 3.2.3**)
— Task 4: ESIA (**Section 3.2.4**)

[4] Survey and assessment methodologies associated with specialist studies are presented within the relevant appended reports.

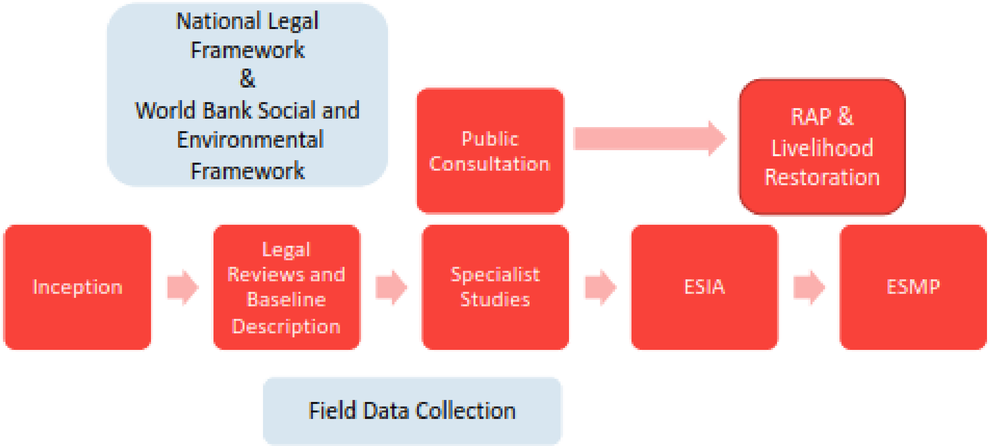


Figure 3-1: Summary of the ESIA Process Followed

The purpose of the Inception Phase (Task 1) was to refine the methodology based on a review of the available information, the team's knowledge of the area, site visit and discussions with the Client's Project Manager. This resulted in the confirmation of the required scope of works, the extent of the proposed project and overarching approach to be undertaken for the required assessment.

The Scoping Process (Task 2) resulted in the identification of gaps in the data which were further considered in order to understand the extent (and significance) of impacts arising from the Project. The Scoping Process culminated in a Scoping Report (including terms of reference (ToR) for the specialist studies and ESIA) compiled in line with the general requirements of the EAARR (2000) and international performance standards and guidelines.

The Specialist Studies (Task 3) were aimed at additional baseline data collection, to supplement the available desktop data, to an appropriate level to inform the ESIA (Task 4). The Specialist Reports have synthesised existing data with new data collected during fieldwork to develop the physical and social baseline for the Project. The Specialists compiled an Impact Assessment based on WSP's ESIA methodology. The Specialists also provided mitigation measures for each significant impact.

3.2.1 INCEPTION PHASE

The approach to the Inception Phase was to gain a thorough understanding of the available information; to start compiling a project description to inform the ESIA and specialist studies; and, to confirm the proposed approach and methodology for the ESIA and specialist studies. The approach was based on receiving information from the Client; collating additional data from other public sources; holding initial meetings with key stakeholders (government and traditional leaders), and familiarising the team with site conditions. The Inception Phase culminated in the submission of an Inception Report detailing the proposed project team, ToR for the assessment and associated Work Programme to carry out the ESIA.

At the outset of the regulatory ESIA procedure, a project brief was prepared which contained a description of the proposed project, including the project scale, location and proximity to environmentally and socially sensitive areas. This was submitted to the EEA to confirm the determination of the project category and confirmation of the authorisation process to be followed. As per correspondence received from the EEA, dated 21 December 2018 (**Appendix D**), the Project has been categorised as a Category 3 project requiring an Environmental Impact Assessment and formulation of a Comprehensive Mitigation Plan (CMP).

3.2.2 SCOPING PHASE

The Scoping Phase resulted in a Scoping Report being compiled, in the format required by the EAARR (2000), containing additional information as required to address the key requirements of the international performance standards. Fundamentally, the scoping report addressed the following:

- Description of the project justification and rationale.
- Detailed technical description of the Project.
- Elaboration of the environmental and social aspects associated with the Project.
- Definition of the project study area including the AoI (direct and indirect).
- Identification and description of the alternatives including site alternatives, technology alternatives and the no-go option and provide justification of the preferred alternatives to be assessed in the ESIA.
- Identify the local environmental and social laws, regulations and policies; as well as international performance standards, and their relevance to the Project.
- Descriptions of the receiving social and biophysical environment (including maps) based on the qualitative and quantitative assessments carried out in the Scoping Phase.
- Preliminary identification of potential environmental and social impacts, their significance, and requirements for further investigation in the ESIA.
- Preliminary identification of mitigation measures.
- Summary of the stakeholder engagement undertaken as part of Scoping Phase including the manner in which key issues and concerns raised during this process will be addressed.
- Terms of reference for the ESIA including:
  - Details of the experts to do the proposed ESIA Study and study schedules.
  - Proposed assessment methodologies.
  - Details of the total project implementation costs.
  - Outline modalities for environmental audit and monitoring.
  - Identification of sources of baseline information and any information gaps.

The Scoping process (as discussed above) included the commencement of the critical Scoping Phase specialist work, the findings of the verification site visits, as well as stakeholder engagement process undertaken. The Scoping Report, which included the ToR / Plan of Study for the ESIA Phase, was structured in order to comply with the general requirements of the Environment Management Act (2002) and international performance standards and guidelines.

The Final Scoping Report was submitted to EEA for approval on 04 July 2019. As per correspondence received from the EEA, dated 29 July 2019 (**Appendix E**), the ToR / Plan of Study for the ESIA wasapproved.

3.2.3 SPECIALIST STUDIES: APPROACH AND METHODOLOGIES

Specialist studies have been undertaken to review and ascertain existing environmental and socio-economic conditions relevant to the project area and its surroundings, identify receptors and resources sensitive to potential impacts. Baseline conditions and specialist findings are discussed in **Chapter 7: Description of the Environment.**

The aim of the specialist studies is to provide a baseline against which the impacts arising from the development of the Project can be identified and assessed. Based on the initial information/ data review the need for the following studies to be completed in support of the Scoping Assessment and ESIA were identified.

- Morpho-dynamic Assessment;
- Basin Protection Assessment;
- Ecological Assessment (terrestrial and aquatic);
- Socio-Economic Assessment; and
- Cultural Heritage Assessment.

The approach and methodology of the specialist studies are described in detail in each Specialist Report (included as **Appendix C1 to C5** of this Report). In general, however, all the specialist studies involved:

- Desktop assessment:
  - The specialists assembled and reviewed available data for the project area to identify and confirm survey focus areas.

— Field/ Data Gathering Surveys:
  - The Morphodynamic Assessment did not include a specific requirement for fieldwork, but rather a reconnaissance of the dam area was undertaken to determine the present geomorphological state of the environment based on the disturbances identified on-site, and identification of areas morphologically sensitive to the proposed development.
  - The Basin Catchment Assessment included the identification of potential impacts associated with soil erosion and sedimentation, veld degradation, discharges and runoff that may affect water quality. Baseline water samples were taken for analyses against relevant regulations/ standards.
  - An IFC compliant dual-season terrestrial and aquatic ecology study was undertaken with fieldwork being undertaken in summer (wet season) and winter (dry season) to collect field data (including data from ad hoc interviews with people residing in the area) and make site observations within the identified AoI. The ecological field surveys were coordinated such that the specialists were in the field simultaneously and able to share information and observations with each other on a daily basis. The ecological assessment included aquatic, botanical, mammal, avifauna, herpetofauna and invertebrates. Additionally, a Wetland Assessment and Environmental Water Requirements assessment, including ecosystem services, was undertaken as part of the Biodiversity Assessment.
  - The socio-economic impacts, compensation and relocation needs have been based on a detailed census and socioeconomic survey of Project Affected People (PAP) and affected communities, which was undertaken over a period of 8 weeks. The aim of the survey was to establish a portrait of the socio-economic conditions of the households and communities and to evaluate the nature and extent of the impacted elements (cultivated and other lands, structures, etc.).
  - The cultural heritage study was carried out simultaneously with the stakeholder engagement process over a four-week period.
  - A summary of the scope of the field surveys is contained in **Table 3-1**.

— Data analysis and Reporting:
  - Data analysis included the assembly and mapping of field data / observations. Field data comprising sampling areas and key findings were collated, mapped in a Geographical Information System (GIS), and photographs documented;
  - Baseline data from the desktop review and field surveys were collated into each Specialist Report and used as the basis for the identification and assessment of impacts; the formulation of management (mitigation and monitoring) measures of the construction and operational phases of the Nondvo Dam, and identification of additional recommendations.

Table 3-1: Summary of Specialist Fieldwork

SPECIALIST STUDY	SCOPE OF SURVEYS	SURVEY PERIOD
Morpho-dynamic	— Visual survey	13 to 14 February 2019
Basin Protection	— Soil sampling. — Water quality sampling. — Water quality screening.	13 to 14 February 2019 4 to 10 March 2019 (wet season) 21 to 30 May 2019 (dry season)
Ecological (terrestrial and aquatic)	— An assessment of all the vegetation units and habitat types. — Floristic sampling. — Faunal survey with sampling. — Herpetological survey with sampling. — In situ water quality assessment. — Habitat assessment. — Ichthyofaunal sampling.	4 to 10 March 2019 (wet season) 21 to 30 May 2019 (dry season)

SPECIALIST STUDY	SCOPE OF SURVEYS	SURVEY PERIOD
Socio-Economic	— Detailed socio-economic surveys, by means of questionnairesand interviews. — Census and detailed asset inventory. — Focus group meetings	29 July to 17 August 2019
Cultural Heritage	— Foot searches and GPS records and photographs of cultural heritage features. — Focus Group Discussions with community members on cultural heritage features.	June 2019

The Specialist Reports have synthesised existing data with new data collected during fieldwork to develop the ecological and social baseline for the Project. The Specialists compiled an Impact Assessment based on WSP's ESIA methodology. The Specialists also provided mitigation measures for each significant impact. The outcomes of these studies were used to inform the development of this ESIA Report as well as the development of the ESMPs.

3.2.4 ESIA PHASE

The ESIA task involved the collation and integration of the specialist studies and other data to develop a full ESIA Report (this report). The key activities involved in this stage are summarised as follows:

— Assessment of alternatives

- ▪ The assessment of alternatives is a key element to the ESIA and includes an assessment not only of site alternatives (e.g. quarries and borrow pits, project housing, laydown areas, etc.) but also of alternative technologies considered in the design of the various elements (where this is feasible). Alternative layouts have also been considered where possible. Alternatives considered and evaluated in ESIA are outlined in **Chapter 6: Analysis of Alternatives**.

— Identification and assessment of impacts and mitigation measures

- ▪ The interrelationship between project elements and impacts needs to be understood in the context of impact assessment as there are a number of factors which will impact on various environmental aspects (i.e. ecology, health and socio-economic). The impacts and their interrelatedness were assessed so that the full significance of the impact could be determined and appropriate mitigation measures developed.
- ▪ The impact assessment stage comprises a number of steps that collectively assess the manner in which the proposed Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors, and the effects of the environment on the proposed activities. The Impact Assessment methodology utilised within the ESIA is described in Section 3.3 and the findings are detailed in **Chapter 9: Impact Assessment**.

— Cumulative Impact Assessment

- ▪ Cumulative Impacts identified and assessed relate to projects or actions planned within or in close proximity to the study area. The Cumulative Impact Assessment (CIA) process analyses the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen valued environmental and social components (VEC) over time and proposing sound measures to avoid, reduce or mitigate the impacts as far as possible. The methodology and findings are detailed in **Chapter 10: Cumulative Impact Assessment**.

— Stakeholder Engagement

- ▪ Stakeholder consultation is understood to be a series of inclusive and culturally appropriate interactions aimed at providing stakeholders with opportunities to participate effectively in the Scoping and ESIA process and identify any additional issues and concerns associated with the proposed project so that these can be considered and incorporated into the ESIA decision-making process. Stakeholder engagement has been a continuous process undertaken throughout the ESIA. The stakeholder engagement process undertaken is outlined in **Chapter 8: Stakeholder Engagement**. A Stakeholder Engagement Plan (SEP) is a live document thatincludes an overview of the ESIA Phase public consultation process and its findings (stakeholder database, community concerns, etc); and is developed further for implementation during the construction and operations phase in conjunction with the Proponent. The SEP is attached hereto as **Appendix F**.

The ESIA should not be viewed as an isolated process and therefore, a further objective was to inform the designs, construction specifications and environmental and social monitoring requirements related to the Project.

Upon completion, the ESIA Report will be submitted to the EEA (i.e. the regulatory authority) for review. Upon completion of the initial review by the EEA, the EEA will issue the Proponent with the comments to be addressed. The Consultant will address comments received from the EEA by amending the ESIA Report and CMP accordingly, in consultation with the Proponent. The amended ESIA Report will be resubmitted to the EEA for approval prior to issuing for Public Review. The EEA will then issue its final decision on whether or not the proposed project is authorised to proceed (i.e. issue an Environmental Compliance Certificate). Where the proposed project is authorised by the EEA to proceed, the EEA will specify the conditions of authorisation as well as any additional requirements for compliance monitoring (i.e. the frequency at which Project Compliance Reports shall be submitted to the EEA).

3.3 IMPACT ASSESSMENT METHODOLOGY

The ESIA utilises a methodological framework developed by WSP to meet the combined requirements of international best practice and the relevant EIA Regulations. The determination and assessment of impacts arebased on the following criteria:

— Nature of the Impact;
— Significance of the Impact;
— Extent of the impact;
— Magnitude of the impact;
— Duration of the Impact;
— Probability if the impact;
— Degree to which the impact:
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be avoided, managed or mitigated.

It should be noted that the definitions given are for guidance only, and not all the definitions will apply to all of the environmental receptors and resources being assessed. Impact significance will be assessed with and without mitigation measures in place. Impacts are assessed in terms of the following criteria:

a) The **nature**; a description of what causes the effect, what will be affected and how it will be affected.

Table 3-2: Nature or Type of Impact

NATURE OR TYPE OF IMPACT	DEFINITION
Beneficial / Positive (+)	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative (-)	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of the Project).

NATURE OR TYPE OF IMPACT	DEFINITION
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

b) The **physical extent**.

Table 3-3: Physical Extent Rating of Impact

SCORE	DESCRIPTION
1	the impact will be limited to the site;
2	the impact will be limited to the local area;
3	the impact will be limited to the region;
4	the impact will be national; or
5	the impact will be international;

c) The **duration**, wherein it is indicated whether the lifetime of the impact will be:

Table 3-4: Duration Rating of Impact

SCORE	DESCRIPTION
1	of a very short duration (0 to 1 year)
2	of a short duration (2 to 5 years)
3	Medium-term (5–15 years)
4	Long-term (> 15 years)
5	permanent

d) **Reversibility:** An impact is either reversible or irreversible. The level of reversibility is the ability of an environmental receptor to rehabilitate or restore itself after the activity has caused environmental change (i.e. how long before impacts on receptors cease to be evident).

Table 3-5: Reversibility of an Impact

SCORE	DESCRIPTION
1	The impact is immediately reversible.
3	The impact is reversible within 2 years after the cause of stress is removed; or
5	The activity will lead to an impact that is in all practical terms permanent.

e) The **magnitude** of impact on ecological processes, quantified on a scale from 0-5, where a score is assigned.

Table 3-6: Magnitude Rating of Impact

SCORE	DESCRIPTION
0	small and will have no effect on the environment.

SCORE	DESCRIPTION
1	minor and will not result in an impact on processes.
2	low and will cause a slight impact on processes.
3	moderate and will result in processes continuing but in a modified way.
4	high (processes are altered to the extent that they temporarily cease).
5	very high and results in the complete destruction of patterns and permanent cessation of processes.

f) The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale where:

Table 3-7: Probability Rating of Impact

SCORE	DESCRIPTION
1	very improbable (probably will not happen).
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).
4	highly probable (most likely).
5	definite (impact will occur regardless of any prevention measures).

g) The **significance**, which is determined through a synthesis of the characteristics described above (refer to the formula below) can be assessed as low, medium or high.

The significance is determined by combining the above criteria in the following formula:

$$Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$$

$$[S = (E + D + R + M) \times P]$$

Where the symbols are as follows:

SYMBOL	CRITERIA	DESCRIPTION
S	Significance Weighting	Refer to **Table 3-8**:Significance Weightings of an Impact
E	Extent	Refer to **Table 3-3**:Physical Extent Rating of Impact
D	Duration	Refer to **Table 3-4**:Duration Rating of Impact
R	Reversibility	Refer to **Table 3-5**:Reversibility of an Impact
M	Magnitude	Refer to **Table 3-6**:Magnitude Rating of Impact
P	Probability	Refer to **Table 3-7**:Probability Rating of Impact

The significance score can therefore range from 3 (minimum) to 100 (Maximum). The significance weightings are defined as Low, Medium and High, as such the scoring system has been allocated accordingly to define the significance weighting, as identified in **Table 3-8**.

Table 3-8: Significance Weightings of an Impact

OVERALL SCORE	SIGNIFICANCE RATING (NEGATIVE)	SIGNIFICANCE RATING (POSITIVE)	DESCRIPTION
≤ 30 points	**Low**	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31 - 60 points	**Medium**	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
≥ 61 points	**High**	**High**	where the impact must have an influence on the decision process to develop in the area

The impact significance without mitigation measures hasbeen assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of the impact, and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures, and is thus the final level of the impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in the ESIA.

3.4 IMPACT MITIGATION AND MANAGEMENT

3.4.1 MITIGATION APPROACH

The Mitigation Hierarchy (**Figure 3-2**) has been applied when proposing prevention, compensation, and mitigation measures within the accompanying ESMP:

- **Avoid / Prevent**: Avoidance or prevention refers to the consideration of options in the project location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services, and people. This is referred to as 'the best option', but it is acknowledged that avoidance or prevention is not always possible.
- **Minimise**: Minimisation refers to the consideration of alternatives in the project location, siting, scale, layout, technology and phasing that would minimise impacts on biodiversity, ecosystem services and people. As defined in IFC PS1; "acceptable options to minimise will vary and include: abate, rectify, repair, and/or restore impacts, as appropriate".
- **Rehabilitate / Restore**: Rehabilitation refers to the consideration of the rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to a near-natural state or an agreed land use.
- **Offset**: Offsetting refers to the consideration of measures over and above rehabilitation to compensate for the residual negative effects on biodiversity ecosystem services and people, after every effort has been made to minimise and then rehabilitate impacts.

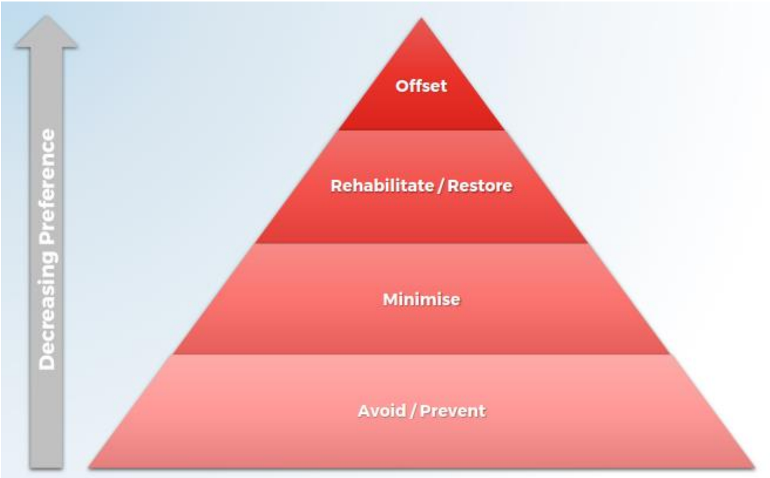


Figure 3-2: Impact Assessment Mitigation Hierarchy

3.4.2 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The identified mitigation measures are integrated into a suite of customised management programs. The ESMP / CMP[5] is developed to guide environmental and social management throughout the Project's life cycle. This is the mechanism whereby mitigation and monitoring of environmental impacts (as defined in the ESIA Report) are integrated with project implementation. The ESMP / CMP is attached as **Appendix B**.

3.5 ASSUMPTIONS, LIMITATIONS AND EXCLUSIONS

Assumptions and limitations under which the ESIA was conducted are described below, together with their implications for the findings of the ESIA Report. Most of these relate to limitations in the scope of work and the studies undertaken for the ESIA, or the available baseline data on environmental parameters of the catchment, or to the level of design detail that may have restricted the identification and assessment of Project impacts. More detailed assumptions, limitations and exclusions relevant to each specialist study are described in the individual Specialist Reports in **Appendix C1 to C5**.

3.5.1 GENERAL ASSUMPTIONS

General assumptions and limitations relating to the ESIA study are listed below:

- The consultant hereby confirms that they have undertaken to obtain project information from the proponent that is deemed to be accurate and representative of the Project;
- An initial site visit was undertaken to better understand the Project and ensure that the information provided by the proponent is correct, based on site conditions observed;
- It is assumed that all third-party information obtained (e.g. spatial data) and discussed is correct at the time of writing this report;
- The accuracy of the GPS' used for this assessment are likely to incur an error of between 2-8m, which will, in turn, have an effect on the accuracy of habitat delineations;
- The consultant hereby confirms their independence and understands the responsibility they hold in ensuring all comments received are accurately replicated and responded to within the ESIA documentation;

[5] The Environment Management Act speaks of a Comprehensive Mitigation Plan (CMP). However, in line with the Contract Terms of Reference, the management plan is being referred to as an ESMP

- The comments received in response to stakeholder engagement, are representative of comments from the broader community; and
- The following disclaimers are relevant to all maps and figures included in this ESIA Report:
  - The information has been derived from various digital databases available to WSP;
  - All information is provided "as is" and it must be acknowledged that data, information, and maps are dynamic and in a constant state of maintenance, correction and update;
  - WSP cannot accept any responsibility for errors, omissions, or positional accuracy where it has not been directly responsible for the production of the data referenced; and
  - There are no warranties, expressed or implied, as to the use of this information, including the warranty of merchantability or fitness for a particular purpose.

3.5.2 SCOPE OF WORK FOR ESIA

Based on the information provided in the Request for Proposal (RfP) and ToR, WSP's proposal included the need for a number of specialist studies (as defined in **Section 3.2.3**) to be completed. Given the feasibility studies already completed by Studio Pietrangeli and an initial risk assessment, the following studies were not commissioned as part of the ESIA:

- Traffic;
- Greenhouse gas inventory/ emissions;
- Seismic and dam break assessment; and
- Tourism.

3.5.3 SEPARATION OF PROJECT COMPONENTS

The Project comprises a number of different project components, not all of which have been assessed in this ESIA. The Scope of Work for this ESIA was limited to the construction and operation of the Nondvo dam. Due to the lack of detail information host community impacts have been identified and assessed at a high-level, while the following components have not been assessed are excluded from this ESIA.

- Water distribution infrastructure.
- Realignment of internal road networks.

Environmental assessment and development of CMPs for these latter components have not yet been commissioned and are expected to be done soon for separate authorisation.

The splitting of the different project components across separate assessments and CMPs may result in confusion to stakeholders and the decision-making authorities who will need to understand how all the different Project elements fit together and the overall environmental implications.

In general, individual components (e.g. road upgrades) can be adequately assessed and managed under separate CMPs as the environmental and social impacts of each are considered to be relatively minor. However, the routing for the water supply pipelines and power evacuation transmission lines will require a separate assessment to fully understand the environmental and social impacts of each.

The different components highlighted above will therefore fall under separate approval processes.

3.5.4 AVAILABLE INFORMATION

Engineering Design Detail

Detailed engineering designs have not yet been undertaken. In the absence of such information, the project description, alternatives assessed and the impact assessment were therefore developed on the basis of the information available in the Feasibility Study (Studio Pietrangeli, 2019).

Despite the limitations related to the Nondvo Dam, it is assumed that the footprint will be based on the preferred option identified in the feasibility report. It is possible that minor adjustments will be made to the design and operational specifications by the engineering Consultant during the detailed design phase, but it is assumed that these will not be material to the findings of this ESIA.

It is therefore recommended that once detailed dam design and operation is confirmed a comparison is made between the feasibility study design and the final design and operational parameters to assess whether any changes may have environmental implications, and how these may differ from those on which this ESIA is based or the findings derived therefrom. Any differences in design and operation, and their environmental implications should be captured in the Construction and Operational ESMPs (as appropriate) and the amended plans submitted to the EEA for approval.

Additional Construction and Works Areas

Should the need arise for additional supporting components (e.g. borrow pits for gravel or haul roads) to be developed in new works areas, the impacts of these components should be captured in a method statement submitted to the Resident Engineer and their Environmental Manager for approval. As the project area exhibits a high level of land use transformation and degradation, it is unlikely that any additional areas will be of significant importance for biodiversity, although some may have social implications in terms of land use or proximity to settlement. Based on the currently known footprint of the Project, it is believed that the information obtained to date for the dam basin, through the surveys for this ESIA, is a robust reflection of the environmental conditions in the project area.

4. POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

4.1 INTRODUCTION

This chapter sets out the relevant legal and policy standards applicable to the proposed Project. Specifically, this chapter summarises the following:

- The relevant institutional framework in Eswatini involved in the regulation of this Project;
- Relevant Eswatini environmental and social laws and Regulations that are applicable to the Project;
- International treaties, conventions and protocols relevant to the Project and to which Eswatini is a signatory;
- Environmental and social guidelines and standards developed by international organisations to which the Project will need to comply; and
- Other international guidelines and standards directly applicable to dam-building and hydropower projects, which are considered good international industry practice.

Refer to **Appendix G** for a detailed list of applicable legislation and policies.

4.2 ADMINISTRATIVE AND INSTITUTIONAL FRAMEWORK

4.2.1 GOVERNMENT

The Kingdom of Eswatini is a Monarchy whose current Head of State is His Majesty King Mswati III, who ascended to the throne on 25 April 1986. Both the country’s political and legal system can be described as dual in that they feature the simultaneous operation of traditional institutions and western methods of modern governance and Roman-Dutch common law. Eswatini practices a Tinkhundla–based electoral system of government. The Tinkhundla system is a democratic participatory system that emphasizes devolution of power from central government to Tinkhundla (constituencies) areas and individual merit as a basis for election or appointment to public office.

The Constitution of EswatiniAct No.001/2005 came into force on 26 July 2005. The Constitution is the supreme law of the land and provides for three organs or arms of government; namely, the Executive, a bicameral Legislature and the Judiciary. Each of these organs is independent from other arms.

The primary function of the Executive arm of government is to execute the decisions of the judiciary, to implement the laws made by the Legislature and see to the overall administration of the country. Furthermore, it is the Executive’s role to defend the Constitution of the country. The Executive authority of Eswatini vests in the King as the Head of State. The King may exercise the executive authority either directly or through the Cabinet or a Minister. In His capacity as the Head of State, the King has authority to sign and assent to Bills, summon and dissolve Parliament, receive foreign envoys, reprieve or commute sentences, declare State of emergency, confer honors, establish any commission and order a referendum. The Executive arm consists of the Cabinet and civil servants. The Cabinet is made up of the Prime Minister, the Deputy Prime Minister and 18 Ministers. They are responsible for policymaking, administration and executing the functions of government. The Prime Minister is the Chairman of the Cabinet and the leader of Government in business. He is appointed by the King with the recommendation of the Kings Advisory Council (Liqoqo) from the House of Assembly. The King appoints Ministers from both chambers of Parliament and on the recommendation of the Prime Minister. At least half of the Ministers are appointed among the elected members of the House.

The main function of the Judiciary is to adjudicate and interpret Acts of Parliament and the common law. Additionally, the Judiciary has the power to issue out orders or directions as may be necessary to ensure law, peace and order are maintained. The Judiciary is independent and subject only to the Constitution. The country's judiciary comprises of the Courts of general jurisdiction, the Supreme Court, High Court and Magistrate Courts and other specialized courts, such as Swazi or Customary Courts. In addition, there is the Industrial Court and the Industrial Court of Appeal which are specialist tribunals whose jurisdiction is confined to Labour disputes. The judges of the superior courts (Supreme and High Courts) and the specialist tribunals are appointed by the King on the advice of the Judicial Service Commission (JSC) and Magistrates are appointed by the JSC. Officers (President) of the Swazi Courts which administer Swazi law and custom are appointed by the King independently of the Judicial Service Commission.

The main function of the Legislature is to make laws for the peace, order and good governance of Eswatini. The power of the King and Parliament to make laws is exercised through bills. A bill may be introduced into either chamber for debate or passage into law except for a financial bill, which must only be introduced in the House of Assembly before it proceeds to the Senate. The Parliament of Eswatini is a bipartite chamber consisting of the Senate and the House of Assembly. Section 94 (1) of the Constitution states that the Senate shall consist of not more than 31 members. Currently, the Senate consists of 30 members. Ten (10) Senators, at least half of whom must be female, are elected by members of the House of Assembly to represent a cross-section of society. Twenty (20) Senators, at least eight of whom must be female are appointed by the King acting in His discretion after consultation with such bodies as He may deem appropriate.

In terms of section 95 (1) of the Constitution, the House of Assembly shall consist of a maximum of 76 members. The House currently consists of 66 members, 55 of whom were elected from Tinkhundla areas serving as constituencies and 10 members were nominated by the King, as provided for by the Constitution. The 66th member is the Speaker of the House who was elected from outside the House as sanctioned by section 102 of the Constitution (The Government of the Kindom of Eswatini, 2019).

Local government is administered on a regional level. An administrator appointed by the king heads each of the country's four regions (Hhohho, Lubombo, Manzini, and Shiselweni).

4.2.2 MINISTRIES AND DEPARTMENTS

The national government, represented by various Ministries and their associated Departments, is responsible for the development and administration of the laws of Eswatini. Various Ministries and Departments, their areas of responsibility and relevance to the Project are outlined in **Table 4-1**. This list is not exhaustive but highlights the main units that play a role in either the ESIA or other activities associated with the rollout of the Project.

Table 4-1: Key Ministries and Departments and their Areas of Responsibility Relating to the Project

INSTITUTIONS	RESPONSIBILITIES
Ministry of Tourism and Environmental Affairs (MTEA)	Their mission is to promote and support the tourism industry, wildlife conservation within an environmental framework that enhances amenities, conserves culture, sustains forest management, embraces meteorology and addresses climate change challenges to contribute towards sustainable socio-economic development. Core objectives: — provide strategic leadership and strategic corporate services; — develop and promote the tourism sector to contribute to the economic growth of the country; — promote and conserve the natural and cultural heritage of the Kingdom; — protect, conserve, restore and enhance the environment; — safeguard and develop the forestry sector for the benefit of the Eswatini nation; and — observe weather and climate and monitor climate change in order to provide consistent and reliable data information.
Eswatini Environment Authority (under MTEA)	To provide for and promote the protection, conservation and enhancement of the environment and the sustainable management of natural resources, the functions of EEA (as stipulated in the Environment Management Act 2002 (S12)) include, but are not limited to, the following:

INSTITUTIONS	RESPONSIBILITIES
	— to institute measures for the implementation of this Act both alone and in co-operation with other public bodies, organs of government, non-governmental organisations, private sector organisations, and members of the public; — to monitor the implementation of the Act and assess its effectiveness in improving the level of protection, conservation and enhancement of the environment and the sustainable management of natural resources, and to advise the Minister on ways of giving effect to the purpose of the Act more effectively; — to assist the Minister in formulating policies relating to the environment and the sustainable management of natural resources; — to advise and to make recommendations to the Minister and the Government either upon request or on its own initiative, on matters relating to the protection, conservation and enhancement of the environment and the sustainable management of natural resources; — to develop in cooperation with other organs of Government, as appropriate, economic measures that encourage the sustainable management and use of natural resources and the enhancement, protection and conservation of the environment; — to administer licenses issued under the Act in accordance with the provisions of this Act; — to prepare a national waste strategy; — to give directions to local authorities regarding their functions relating to the collection and disposal of waste in urban areas, and to perform the waste management functions listed in section 44; — to give general and/or specific directions to local authorities, in order to promote the protection, conservation and enhancement of the environment and the sustainable management of natural resources; — to liaise with bodies concerned with matters relating to the protection, conservation and enhancement of the environment and the sustainable management of natural resources; — to monitor trends in the state of the environment and to prepare reports on the state of the environment for consideration and approval by the Minister; — to prepare National Environmental Action Plans for consideration and approval by the Minister and to promote their implementation; — to review environmental impact assessment reports and strategic environmental assessments reports; — to undertake and promote research into matters relevant to the protection, conservation and enhancement of the environment and the sustainable management of natural resources; — to promote, in collaboration with other appropriate bodies and organisations, training, education and public awareness programmes relating to the protection, conservation and enhancement of the environment and the sustainable management of natural resources; — to disseminate and facilitate public access to information on the environment including creating and maintaining an environmental information registry in accordance with section 50; — to facilitate public involvement in decision making concerning the environment including establishing procedures to facilitate the submission of comments on license applications under this Act; — to recommend environmental standards, codes of practice, guidelines and legislation to the Minister and the Government; — to publish guidelines, codes of practice and other information relating to the protection and conservation of the environment and the sustainable management of natural resources; — to conduct inspections and take other measures to monitor compliance with this Act and to conduct investigations into alleged contraventions of this Act;

INSTITUTIONS	RESPONSIBILITIES
	— to take all reasonably practical measures, to enforce this Act and other environmental protection legislation either alone or in co-operation with relevant bodies and police forces, including issuing and enforcing orders and prosecuting offences; and — to perform other functions incidental or conducive to the exercise by the Authority of any of the above functions or which are assigned to it by the Minister in order to further the purpose of this Act.
Ministry of Natural Resources and Energy (MNRE)	Their mission is to ensure the sustainable development, use and management of natural resources by providing adequate services in water, minerals, energy, surveying, mapping, conveyancing, registration of real rights in land and valuation to the public and private sector in a transparent manner for the socio-economic benefit of the Kingdom of Eswatini. The following strategic objectives are elucidated for the provision and management of resources for ensuring the optimal land use, mineral exploration, adequate water and energy to meet national aspirations: — To set goals and strategies to facilitate the coordination and implementation of Government priorities and other national priorities within the Ministry's portfolio; — To develop, review and operationalise relevant policies ensuring optimal utilization of natural resources; — To provide general management of land, minerals, water and energy resources; — To provide surveying, mapping, land and real rights registration and valuation services for Government and other public entities; — To provide facilities for ensuring access to sustainable energy and security of energy supply; — To ensure optimal development, management and supply of adequate water resources in a sustainable manner; — To explore and identify mineral targets with economic potential; — To ensure extraction and value addition to mineral resources for sustainable development and; and — To develop relative policies, collect and maintain an up-to-date database on land and natural resources.

Environmental and social issues cut across a wide variety of sectors and there are a number of government institutions and agencies which are involved in environmental and social management. Some of the ministries, sectoral agencies and authorities that may also need to be consulted as part of the Project include:

— Deputy Prime Minister's Office;
— Ministry of Finance;
— Ministry of Economic Planning and Development;
— Ministry of Agriculture;
— Ministry of Commerce, Industry and Trade;
— Ministry of Education and Training;
— Ministry of Health;
— Ministry of Housing and Urban Development;
— Ministry of Information, Communication and Technology;
— Ministry of Labour & Social Security;
— Ministry of Public Service;
— Ministry of Public Works and Transport;
— Ministry of Tinkhundla Administration and Development; and
— Ministry of Tourism and Environmental Affairs.

4.3 LEGAL CONTEXT FOR THIS ESIA

As the proposed Project is situated within Eswatini, the Project is subject to the Eswatini regulatory framework and development policies, as well as international treaties, conventions and protocols to which Eswatini is a signatory. Relevant Eswatini environmental and social laws and Regulations that are applicable to the Project are described in **Section 4.4.1**, relevant development policies are described in **Section 4.4.2**, and relevant international treaties, conventions and protocols described in **Section 0**

Furthermore, project funding is to be provided by the AfDB, therefore in addition to the national environmental and social standards and regulations, the reference framework for the ESIA includes the AfDB Integrated Environmental and Social Assessment (IESIA) Guidelines (AfDB, 2015). The applicable Operational Safeguards, WBG EHS Guidelines and international commissions/ associations relating to the construction of large dams / hydropower plants are described in **Section 4.5**.

Where relevant, the ESIA also broadly considers additional international standards and good practice guidelines, including the following:

- The IFC performance standards;
- World Bank Safeguard Policies; and
- Equator Principles.

4.4 ENVIRONMENTAL AND SOCIAL LEGISLATION

4.4.1 ESWATINI REGULATORY FRAMEWORK

The Eswatini regulatory framework establishes well-defined requirements and standards for environmental and social management of infrastructure developments. Legislation and national plans, policies and strategies of specific relevance to the environmental and social environment in **Table 4-2**. The table highlights some of the important legislation and plans of relevance to the Project and is not to be considered a complete legal register. Such a register should be compiled by DWA.

Table 4-2: Eswatini Environmental and Social Legislation

LEGISLATION	DESCRIPTION AND RELEVANCE
Environmental Management Act 2002 (Act No. 5 of 2002) (EMA)	The EMA provides for environmental management principles and the establishment of regulations with regard to the conduct of environmental assessments. Sections of the Act relevant to this project are: — Section 5 outlines the Environmental Principles of preventing and minimizing adverse environmental effects, the polluter pays principle, the prudent use of non-renewable resources, the sustainable use of renewable resources; — Sections 34-36 on Pollution Control which prohibit the discharge of contaminants into the environment; and — Section 41 on Waste Management, which prohibits the collection, transport, sorting, recovery, treatment, storage and disposal of waste in such a manner that causes adverse environmental impacts.
Environmental Audit, Assessment and Review Regulations, 2000 (EAAR)	These Regulations control the environmental assessment process and stipulate requirements on the structure of reports and reporting procedures. The Regulations are applicable to the environmental assessment of the proposed project. The Regulations further provide for the public consultation process with respect to proposed projects. For example, the ESIA Report is required to demonstrate that the views, queries and concerns of interested and affected parties have been taken into

LEGISLATION	DESCRIPTION AND RELEVANCE
	consideration during the evaluation of the potential environmental and social impacts of a proposed project. The Regulations require the measures for mitigating the potential adverse and enhancing the potential positive impacts to be documented in a CMP, which includes allocation of responsibilities. Where a proposed project is authorised to proceed, the adherence to the CMP is required to be monitored and documented in a Project Compliance Report, which is submitted to the EEA for review. Any matters arising, including impacts that were unforeseen during the time of undertaking the ESIA are required to be reported by the project proponent to the EEA immediately they become apparent to the project proponent, who shall advise the EEA of the subsequent corrective and preventive action taken.

Environmental issues cut across a wide variety of sectors, as such, there are numerous pieces of legislation in Eswatini which have bearing on the environment and should be considered in the decision-making process.

A summary of the most relevant national legislation that may be applicable to the Project is presented in **Table 4-3** and a detailed breakdown of the applicability is provided in **Appendix G**.

Table 4-3: Other Applicable Environmental and Social Legislation

ISSUE / COMPONENT	APPLICABLE LEGISLATION
Natural Resources and Heritage Management	
Water Resources	— Water Act, 2003 — Integrated Water Resources Master Plan, 2016 (Draft) — Water Pollution Control Regulations, 2010 — National Water Policy, 2018
Wildlife, Natural Resources and Heritage	— National Trust Commission Act, 1972 — Flora Protection Act, 2001 — Plant Control Act, 1981 — Wild Birds Protection Act, 1914 — Mines and Minerals Act, 2011 — Natural Resources Act of 1951 — Natural Resources (Public Stream Banks) Regulations, 1951 — The Protection of Fresh Water Fish Act, 1937
Waste Management	— Waste Regulations, 2000 — Litter Regulations, 2011
Air	— Air Pollution Control Regulations, 2010 — Ozone Depleting Substances Regulations, 2003
Socio-economic, Archaeology and Cultural Heritage	
Human Resettlement, Compensation and Rehabilitation	— Building Act, 1968 — Resettlement Policy Framework, 2007 — Human Settlement Authority Act of 1988 — Swati Graves Act of 1909 — Land Survey Act of 1961 — Sub-division of Land Act of 1957 — Vesting of Land in King Order 1973 — Immovable Property (Race Discrimination) Act 1963

ISSUE / COMPONENT	APPLICABLE LEGISLATION
	— Persons with Disabilities Act, 2018 — Sexual Offences and Domestic Violence Act, 2018
Archaeological, Historical and Cultural	— National Trust Commission Act, 1972
Construction	— Construction Industry Council Act, 2013 — Water Services Corporation Act, 1992 — Employment Act, 1980 — Workmen's Compensation Act, 1983 — Workmen's Compensation Regulations, 1983 — Building Operations Regulations, 1969
Health and Safety	— Occupational Safety and Health Act, 2001 — Explosives Act, 1961 — Explosives Regulations, 1961 — Factories, Machinery and Construction Works Act, 1972 — Factories, Machinery and Construction Works Regulations, 1974 — Public Health Act, 1969 — Road Traffic Act, 2007 — Children's Protection and Welfare Act, 2012
Energy	
Energy	— Electricity Act, 2007 — Energy Regulatory Authority Act, 2007 — National Energy Policy, 2018

4.4.2 ESWATINI DEVELOPMENT POLICIES

The development policies for Eswatini at a national level that are of applicability to this Project are listed in **Table 4-4** and a detailed breakdown of the applicability is provided in **Appendix G**.

Table 4-4: Eswatini Development Policies

ISSUE / COMPONENT	APPLICABLE POLICY
Water Resources	— National Water Policy, 2009
Agriculture	— National Food Security Policy, 2005
Land Use Management	— Rural Resettlement Policy, 2003
Energy	— National Energy Policy, 2018

4.4.3 INTERNATIONAL CONVENTIONS, PROTOCOLS AND AGREEMENTS

In addition to national policies and laws, there are also statutory provisions with broad requirements for conservation and protection of certain species and habitats and prevention of pollution emanating from international conventions and agreements. Eswatini is a signatory to a number of international conventions on environmental protection and conservation. **Table 4-5** lists the relevant international conventions and protocols to which Eswatini is a signatory and a detailed breakdown of the applicability is provided in **Appendix G**.

Table 4-5: International, Conventions, Protocols and Agreements

TYPE	NAME
Agreements	— Tripartite Interim Agreement between the Republic of Mozambique and the Republic of South Africa and the Kingdom of Eswatini for Co-operation on the protection and sustainable utilisation of the water resources of the Incomati and Maputo Watercourses, 2002 — Joint Water Commission Treaty (Eswatini and South Africa), 1992
Protocols	— Protocol on Shared Watercourses in the Southern Africa Development Community (SADC), 1995 — Kyoto Protocol, 1997 — Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 — The Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, 2003
Conventions	— African Convention on the Conservation of Nature and Natural Resources, 1968 — Bamako Convention on the Ban of Import of Hazardous Wastes into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, 1991 — Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989 — Convention on Biological Diversity, 1992 — Convention to Combat Desertification, 1994 — Convention on the International Trade on Endangered Species (CITES), 1973 — Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979 — Convention on the Protection and Promotion of the Diversity of Cultural Expressions, 2005 — Ramsar Convention — Convention for the Safeguarding of the Intangible Cultural Heritage, 2003 — United Nations Convention on Biological Diversity, 1992 — United Nations Framework Convention on Climate Change, 1992 — Vienna Convention for the Protection of the Ozone Layer, 1985

4.5 INTERNATIONAL GUIDELINES AND STANDARDS

4.5.1 AFRICAN DEVELOPMENT BANK INTEGRATED SAFEGUARDS

The ESIA was required primarily to meet the requirements of the EMA and other national legislation, however on the basis that Project funding is to be provided by the AfDB, the reference framework for the ESIA principally comprises the national environmental and social standards and regulations and the AfDB IESIA Guidelines (AfDB 2009; 2015).

Table 4-6 provides a brief summary of the key international guidelines and standards applicability to this Project.

Table 4-6: AfDB IESIA Guidelines

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION
PROJECT CATEGORISATION	
AfDB Integrated Environmental and Social Assessment (IESIA) Guidelines (AfDB 2009; 2015)	The AfDB guidelines require Project screening. Projects that are directly funded by the AfDB are classified into three categories, depending on the expected severity of the Project's potential beneficial and adverse impacts: — Category 1 projects require a full ESIA, including the preparation of an ESMP. These projects are likely to induce important adverse environmental and/or social impacts that are irreversible, or to significantly affect environmental or social components considered sensitive by the Bank or the borrowing country; — Category 2 projects require the development of an ESMP. These projects are likely to have detrimental and site-specific environmental and/or social impacts that are less adverse than those of Category 1 projects and that can be minimised by the application of mitigation measures or the incorporation of internationally recognised design criteria and standards — Category 3 projects require no impact assessment. These projects shall involve no adverse physical intervention in the environment and induce no adverse environmental or social impact. This project is considered to be classified as a Category 1 project.
PUBLIC PARTICIPATION	
AfDB - Stakeholder Consultation and Participation Guidelines	For Category 1 projects, the AfDB guidelines require meaningful consultations during the ESIA. Consultations are required with relevant stakeholders, including potential beneficiaries, affected groups, civil society organisations and local authorities, with the objective of discussing the Project's environmental and social aspects as well as taking public views into account. The guidelines indicate that these consultations should be done in compliance with national legal requirements, as long as they meet AfDB minimum requirements for public consultation, which are summarised below:

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION
	— Consultation should be done as early as possible; — Project and ESIA information should be disclosed in a timely manner and in a form and language accessible to the groups being consulted; — Relevant stakeholders should be consulted during both the Scoping Phase and the EIS Phase; — Contributions from stakeholders should be integrated into the ESIA Report and reflected in the proposed mitigation, if applicable; and — Stakeholder consultation should be extended from the ESIA into the construction and operational phases.
RESETTLEMENT	
AfDB's Involuntary Resettlement Policy	The AfDB's Involuntary Resettlement Policy has been developed to cover involuntary displacement and resettlement of people caused by an AfDB financed project and it applies when a project results in relocation or loss of shelter by the persons residing in the project area, assets being lost or livelihoods being affected.
	The overall goal of the policy is to ensure that when people must be displaced they are treated equitably, and that they share in the benefits of the Project that involves their resettlement.
	The policy has the following key objectives: — To avoid involuntary resettlement where feasible, or minimize resettlement impacts where population displacement is unavoidable, exploring all viable project designs. Particular attention must be given to socio-cultural considerations, such as the cultural or religious significance of land, the vulnerability of the affected population, or the availability of in-kind replacement for assets, especially when they have important intangible implications. When a large number of people or a significant portion of the affected population would be subject to relocation or would suffer from impacts that are difficult to quantify and to compensate, the alternative of not going ahead with the Project should be given serious consideration; — To ensure that displaced people receive resettlement assistance, preferably under the Project, so that their standards of living, income earning capacity, and production levels are improved; — To provide explicit guidance to AfDB staff and the borrowers on the conditions that need to be met regarding involuntary resettlement issues in AfDB operations in order to mitigate the negative impacts of displacement and resettlement and establish a sustainable economy and society; and — To set up a mechanism for monitoring the performance of involuntary resettlement programs in AfDB operations and remedying problems as they arise so as to safeguard against ill-prepared and poorly implemented resettlement plans.

4.5.2 INTERNATIONAL STANDARDS AND GOOD PRACTICE GUIDELINES

Where relevant that ESIA also broadly considers additional international standards and good practice guidelines, including the following:

- The IFC performance standards;
- World Bank Safeguard Policies; and
- Equator Principles.

A brief summary of the key international guidelines and standards applicability to this Project are provided in **Appendix G**. In the case of requirements that conflict with the AfDB IESIA Guidelines (AfDB, 2015), the latter will take precedence. **Table 4-7** provides an outline of the alignment of this ESIA to International Standards.

Table 4-7: Alignment of ESIA to International Standards

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
PROJECT CATEGORISATION		
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.01 Environmental Assessment	The purpose of OP 4.01 is to ensure that projects funded by the World Bank (WB) are environmentally feasible and viable and that the decision-making is improved through the appropriate analysis of actions and their probable environmental impacts (OP 4.01, par. 1). This policy is triggered if a project is likely to have potential (negative) environmental risks and impacts in its zone of influence. The WB undertakes environmental screening to determine the appropriate extent and type of environmental assessment to be conducted. It classifies the proposed projects into categories, depending on the type, location, sensitivity, scale of the projects and the nature and magnitude of their potential environmental impacts. This project is considered to be classified as a Category A project. When considered as Category A, projects have potentially adverse environmental impacts that could be significant on human populations or environmentally important areas. These impacts may affect an area broader than the sites or facilities subject to physical works. The environmental assessment will examine the project's potential negative and positive environmental impacts and recommend any measures needed to prevent, minimise, mitigate, or compensate for any adverse impacts and improve its environmental performance.	Under the First Schedule of the EAAR, the proposed Project is categorised as a Category 3 project requiring a full Environmental (and Social) Impact Assessment (EIA/ ESIA) study to be undertaken and submitted to the Eswatini Environmental Authority (EEA) for consideration prior to project implementation. The EEA confirmed the categorisation in correspondence received, dated 21 December 2018 (**Appendix D**).
Equator Principles - Principle 1: Review and Categorisation	When a project is proposed for financing, the Equator Principles Financial Institution (EPFI) will, as part of its internal social and environmental review and due diligence, categorise such project based on the magnitude of its potential impacts and risks in accordance with the environmental and social screening criteria of the IFC. Using categorisation, the EPFI's environmental and social due diligence is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts. The categories are:	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
	— Category A – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented; — Category B – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and — Category C – Projects with minimal or no adverse environmental and social risks and/or impacts. This project is considered to be classified as a category A project.	
ENVIRONMENTAL AND SOCIAL ASSESSMENT AND MANAGEMENT		
IFC Performance Standards (PS) (IFC, 2012) - PS1 - Assessment and Management of Environmental and Social Risks and Impacts	PS1 underscores the importance of managing environmental and social performance throughout the life of a project. PS1 requires the proponent to conduct a process of environmental and social assessment, including stakeholder consultation, and to establish and maintain an Environmental and Social Management System (ESMS), appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts.	The EAAR states that a proponent in respect of a project classified under category 3 shall prepare an EIA report and a CMP in accordance with the requirements set out in the Second Schedule. From this assessment a CMP/ESMP results, which can be further developed by the Proponent into an ESMS. The national regulations are thus in line with international best practices. Refer to **Appendix B** for the CMP/ESMP.
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.02 Environmental Action Plans	This OP aims at encouraging and supporting the efforts of borrowing governments to prepare and implement an appropriate Environmental Action Plan (EAP) and to revise it periodically as necessary. Although the Bank may provide advice, responsibility for preparing and implementing the EAPs rests with the government	
Equator Principles - Principle 2: Environmental and Social Assessment	For all Category A and Category B Projects, the EPFI will require the proponent to conduct an Assessment process to address, to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed project (which may include the illustrative list of issues found in Exhibit II). The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed project. The Assessment Documentation will be an adequate, accurate and objective evaluation and presentation of the environmental and social risks and impacts, whether prepared by the proponent, consultants or external experts. For Category A, and as appropriate, Category B Projects, the Assessment Documentation includes an ESIA. One or more specialised studies may also need to be undertaken. The ESIA must include a comprehensive assessment of the key environmental and social impacts and must comply with national requirements. In addition, an EMP will be compiled to outline relevant mitigation and management measures required to minimise the impacts identified.	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
Equator Principles - Principle 3: Applicable Environmental and Social Standards	The Assessment process should, in the first instance, address compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues. For Projects located in Non-Designated Countries, the Assessment process evaluates compliance with the then applicable IFC PS and WBG EHS Guidelines. As Eswatini is designated as a non-designated country the reference framework for environmental and social assessment is based on the IFC PS.	
Equator Principles - Principle 4: Environmental and Social Management System and Equator Principles Action Plan	For all Category A and Category B Projects, the EPFI will require the proponent to develop or maintain an ESMS. Further, an ESMP will be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards. Where the applicable standards are not met to the EPFI's satisfaction, the proponent and the EPFI will agree to an Equator Principles Action Plan (EPAP). The Equator Principles AP is intended to outline gaps and commitments to meet EPFI requirements in line with the applicable standards. The development of the ESMS is not included in the scope of the ESIA. A formal ESMS will need to be implemented by the DWA.	
PUBLIC PARTICIPATION		
World Bank's Environmental and Social Safeguard Policies - BP 17.50 Disclosure Policy	This best practice (BP) supports the decision-making of the WB by allowing the public access to information on the environmental and social aspects of projects. It is a mandatory safeguard policy that has specific requirements for disclosure. It requires that during the project's design phase, the Project Affected People (PAPs), affected groups and local Non-Government Organisations (NGOs) will be consulted and that the environmental and social aspects of the project will be presented. Also, consultations must be undertaken throughout the approval process of the project. The policy also requires that relevant documents be disclosed to PAPs, such as the EIS and Resettlement Action Plan (RAP) and kept in places where individuals can gain access easily.	The EAAR fully complies with these international guidelines and policies' requirements for stakeholder consultation. A proponent in respect of a project classified under category 3 shall effect a consultation process to involve or include concerned or affected Government agencies, local authorities, non-governmental organizations and any other interested and affected persons to help determine the scope and effect of the project or work to be carried out. The ESIA process included an extensive stakeholder engagement process thatcomplied with the EEAR. The process includes consultations with local communities and a range of government sector stakeholders. The stakeholder engagement process solicited interest from potentially interested parties through newspaper advertisements, radio advertisements and public meetings (see section 8 and **Appendix F** for additional details).
Equator Principles - Principle 5: Stakeholder Engagement	The EPFI will require the proponent to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with Affected Communities and, where relevant, Other Stakeholders. For Projects with potentially significant adverse impacts on Affected Communities, the proponent will conduct an Informed Consultation and Participation process. In order to accomplish this, the appropriate assessment documentation, or non-technical summaries thereof, will be made available to the public by the borrower for a reasonable minimum period in the relevant local language and in a culturally	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
	appropriate manner. The borrower will take account of and document the process and results of the consultation, including any actions agreed resulting from the consultation. For projects with adverse social or environmental impacts, disclosure should occur early in the Assessment process and in any event before the project construction commences, and on an ongoing basis.	
RESETTLEMENT		
IFC Performance Standards (IFC, 2012) - PS5 – Land Acquisition and Involuntary Resettlement	PS5 recognises that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons who use this land. PS5 aims to: avoid or at least minimise involuntary resettlement wherever feasible by exploring alternative project designs; mitigate adverse social and economic impacts from land acquisition by (i) providing compensation for loss of assets and (ii) ensuring that resettlement activities are implemented with appropriate consultation and disclosure; and improve or at least restore the livelihoods, standards of living and living conditions of displaced persons.	The National Rural Resettlement Policy (2003) provide a practical framework for the planning of resettlement activities and the sustainable management of land in rural Eswatini. The Ministry of Housing and Urban Development Resettlement Policy and Guidelines (1994) lay a foundation through which resettlement can be carried out. The national resettlement regulations are in line with international best practices, having the goals to minimize resettlement when possible and to restore and enhance the standards of living for resettled people, when resettlement is unavoidable. A RAP has been compiled as part of the ESIA and is aligned to the Policies, refer to **Appendix I**.
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.12 Involuntary Resettlement	The main objectives of the WB Resettlement Policy (OP 4.12) are to: — Avoid or minimise involuntary resettlement, whenever feasible; — Develop resettlement activities as sustainable development programs, providing sufficient investment resources to enable the displaced persons' share in project benefits; — Meaningfully consult displaced persons and give them opportunities to participate in the planning and implementation of the resettlement programs; and — Assist displaced persons in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of the project's implementation, whichever is higher This policy is usually applied toprojects that require international financing. Annex A (Paragraphs 17 31), describes the scope (level of detail) and the elements that a resettlement plan should include. These include objectives, potential impacts, socioeconomic studies, legal and institutional framework, eligibility, valuation and compensation of losses, resettlement measures, relocation planning, community participation, grievance management procedures, implementation schedule, costs and budgets, and monitoring and evaluation. WB OP 4.12 (6a) requires that the resettlement plan include measures to ensure that displaced persons are (i) informed about their options and rights, (ii) consulted and	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
	offered choices among technically and economically feasible resettlement alternatives, and (iii) provided prompt and effective compensation of full resettlement costs. WB OP 4.12 (8) requires that particular attention should be placed on the needs of vulnerable groups among those displaced such as those below the poverty line, landless, elderly, women and children, indigenous populations and ethnic minorities. WB OP 4.12 (13a) stipulates that any displaced persons and their communities and any host communities receiving them should be provided with timely and relevant information. They also should be consulted on resettlement options and offered opportunities to participate in planning, implementing and monitoring of the resettlement. WB OP 4.12 (12a) states that payment of cash compensation for lost assets may be appropriate where livelihoods are land-based but only when the land taken for the project is a small fraction (less than 20%) of the affected asset and the residual is economically viable. WB OP 4.12 (6b&c) state that in case of physical relocation, displaced persons should be (i) provided assistance (such as moving allowances) during relocation; and (ii) provided with residential housing, or housing sites, and, if required, agricultural sites for which a combination of productive potential, locational advantages, and other factors is at least equivalent to the advantages of the old site. In addition, displaced persons should be offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living. This development assistance comes in addition to compensation measures such as land preparation, credit facilities, training, or job opportunities. WB OP 4.12 (13a) requires that appropriate and accessible grievance mechanisms be established to sort out any issues arising.	
	POLLUTION PREVENTION	
IFC Performance Standards (IFC, 2012) - PS3 – Resource	PS3 recognises that economic activity and urbanisation often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. PS3 aims	The EAAR include provisions for a CMP (ESMP) that needs to provide mitigation measures to be implemented that would prevent, reduce or otherwise manage the environmental impacts of a project

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
Efficiency and Pollution Prevention	to: avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities; promote more sustainable use of resources including energy and water; and reduce project-related emissions that contribute to climate change.	and done according to the reporting requirements in the Second Schedule. Refer to **Appendix B** for the CMP/ESMP.
IFC Environmental, Health and Safety (EHS) Guidelines	The EHS Guidelines are technical reference documents that address the IFC's expectations regarding the industrial pollution management performance of its projects. They are designed to assist managers and decision-makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimising, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC PSs, particularly in those aspects related to PS3, as well as certain aspects of occupational and community health and safety. When host country (Eswatini) regulations differ from the levels and measures presented in the EHS Guidelines, projects will be expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is required. There are no industry-specific guidelines for Dam or Hydropower Projects, although guidelines do exist for electrical power transmission and generation. General EHS Guidelines also exist which contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors.	
BIODIVERSITY		
IFC Performance Standards (IFC, 2012) - PS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources	PS6 encourages sustainable development while recognising that the protection and conservation of biodiversity and sustainably managing living natural resources are fundamental to sustainable development. PS6 aims to: protect and conserve biodiversity; maintain the benefits from ecosystem services; and promote the sustainable management and use of natural resources through practices that integrate conservation and development.	A biodiversity specialist study has been developed, taking into consideration both national requirements and international best practices (see **Appendix C-4** for additional details).
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.04 Natural Habitats	OP 4.04 is a conservation policy designed to protect natural habitats and their biodiversity and to ensure the sustainability of services and products that natural habitats supply to human societies. In principle, the WB will refuse to finance projects that may be perceived as causing significant damages in Critical Natural Habitats (CNHs). Its objective is to circumvent the conversion or degradation of non-critical natural habitats, as much as possible. These impacts should be avoided by reconfiguring the project, even in its size or its extension, and/or by implementing	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
	acceptable mitigation measures, such as the establishment of protected areas or the strengthening of effective protection of CNHs. Should the project involve the significant conversion or degradation of natural habitats that are not considered as critical, and if there are no alternative solutions for the project and its location, and if the complete analysis clearly shows that the project's overall benefits are significantly higher than the environmental costs, then the WB can finance the project if the project includes appropriate mitigation measures. The WB defines natural habitats as land or water zones where biological communities sheltered by ecosystems are in majority made of indigenous plant and animal species, and where human activity has not fundamentally modified its zone's main ecological functions. CNHs are defined as: – existing protected areas and areas officially proposed by governments to be classified amongst 'protected areas' e.g. reserves that meet the criteria of the International Union for Conservation of Nature (IUCN) classifications; – areas recognised as protected by traditional local communities; and – sites maintaining vital conditions for the viability of such protected areas. The WB expects the borrower to take into account the views, roles, and rights of groups, including local non-governmental organizations and local communities, affected by any project involving natural habitats, and to involve such people in planning, designing, implementing, monitoring, and evaluating such projects. Involvement may include identifying appropriate conservation measures, managing protected areas and other natural habitats, and monitoring and evaluating specific projects.	
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.36 Forests	OP 4.36 is about forest protection. The major objectives of the policy are: — sustainable management of forests; — conservation of wet forest zones; and — communities' rights are respected in their traditional use of forest zones in a sustainable manner. The WB does not finance projects that would involve significant conversion or degradation of critical sections of forests or essential (critical) natural habitats attached to them. Should the project involve the significant conversion or degradation of natural	

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
	forests or associated natural habitats that are not considered as critical, and if there are no alternative solutions for the project and its location, and if the complete analysis clearly shows that the project's overall benefits are significantly higher than the environmental costs, then the WB can finance the project on condition that it includes appropriate mitigation measures. OP 4.36 is triggered by the project as some forest habitats are located along the projected transmission line route	
SOCIO-ECONOMIC		
IFC Performance Standards (IFC, 2012) - PS2 - Labour and Working Conditions	PS2 recognises that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. PS2 aims to: establish, maintain and improve the worker-management relationship; promote the equal opportunity of workers, and compliance with national labour and employment laws; protect the workforce by addressing child labour and forced labour; protect vulnerable workers; and, promote safe and healthy working conditions and the health of workers.	The protection of the fundamental rights of workers is fully encoded in Eswatini law, through the Employment Act (1980) and Workmen's Compensation Act (1983) (see the analysis of the legal framework in **Appendix G** for more information).
IFC Performance Standards (IFC, 2012) - PS4 – Community Health, Safety and Security	PS4 recognises that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. PS4 aims to: anticipate and avoid adverse impacts on the health and safety of the affected community during the project life cycle; and ensure that the safeguarding of personnel and property avoids or minimises risks to the community's safety and security.	The Public Health Act (1969) quires prevention of nuisances and public health hazards such as standing water, pollution of potable water and the disposal of waste water. It also provides for the control of unsanitary and unsafe buildings. The requirement to protect community health and ensure community safety and security can be derived from the overall national legal framework.
IFC Performance Standards (IFC, 2012) - PS7 - Indigenous Peoples	PS7 aims to: ensure that the development process fosters full respect for Indigenous Peoples; anticipate and avoid, minimise or compensate adverse impacts of projects on Indigenous Peoples and provide opportunities for development benefits; establish and maintain an ongoing relationship with affected Indigenous Peoples throughout the life of the project; ensure free, prior and informed consent of Indigenous Peoples; and respect and preserve their culture, knowledge and practices.	PS7 is not applicable to the Project. There are no Indigenous Peoples in the project area, as defined in PS7.
IFC Performance Standards (IFC, 2012) - PS8 - Cultural Heritage	PS8 recognises the importance of cultural heritage for current and future generations. PS8 aims to: protect cultural heritage from the adverse impacts of project activities; support its preservation; and promote equitable sharing of benefits from cultural heritage.	The Eswatini National Trust Commission Act (1972) provides for the management of cultural institutions, declared national parks, nature reserves, monuments, relics and antiques through the Eswatini National Trust Commission (ENTC) which is a body corporate established under the same Act.

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
		A Heritage Assessment was undertaken as part of the ESIA (refer to **Appendix C-5** for further detail)
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.11 Physical Cultural Resources	This policy assists in preserving physical cultural resources (PCRs) and helps reduce chances of their destruction and/or damage. The policy considers PCRs to be resources of archaeological, paleontological, historical, architectural, religious (including graveyards and burial sites), aesthetic or other cultural significance. According to this policy, an investigation and inventory of PCRs likely to be affected by the project have to be conducted. The investigation should document the significance of such PCRs and assess the nature and extent of potential impacts on them. Since many cultural resources are generally not well documented or protected by law, public consultations are an important means of identifying PCRs. Such consultations include meetings with project-affected groups, relevant government and non-governmental organizations. If PCRs are found during an inventory, a management plan must be prepared. This management plan must include measures to avoid or mitigate any adverse impacts on PCRs, provisions for managing chance findings, any necessary measures for strengthening institutional capacity for the management of PCRs and monitoring systems to track the progress of these activities. Finally, whether or not a PCR is found at the inventory phase, provisions for managing chance finds must be implemented to ensure that PCRs that may be discovered be properly handled.	The Eswatini National Trust Commission Act (1972) provides for the management of cultural institutions, declared national parks, nature reserves, monuments, relics and antiques through the Eswatini National Trust Commission (ENTC) which is a body corporate established under the same Act. A Heritage Assessment was undertaken as part of the ESIA (refer to **Appendix C-5** for further detail)
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.20 Gender and Development	The objective of the WB's gender and development policy is to reduce poverty and enhance economic growth, human well-being, and development effectiveness by addressing the gender disparities and inequalities that are barriers to development, and by formulating and implementing gender and development goals.	The Employment Act (1980) provides for the improvement of the status of employees in Eswatini. Sections of the Act applicable to gender issues are: – Section 29, under Part IV, which prohibits the discrimination against employees on the grounds of sex (and other personal attributes such as marital status, race, colour, religion, etc.); – Section 96, under Part X, which provides for equal pay for equal work between male and female employees; – Sections 102 and 103, under Part X, which provide for entitlement to maternity leave by female employees;

INTERNATIONAL STANDARD / GUIDELINE	DESCRIPTION	REQUIREMENT IN TERMS OF NATIONAL LEGISLATION AND ESIA ALIGNMENT
		– Section 105, under Part X, which prohibits termination of employment of female employees arising from or relating to the granting of maternity leave; – Section 106, under Part X, protects the seniority and/ or remuneration and any other conditions of employment of female employees subsequent to returning from maternity leave.
Equator Principles - Principle 6: Grievance Mechanism	The borrower will inform the Affected Communities about the mechanism in the course of its community engagement process and ensure that the mechanism addresses concerns promptly and transparently, in a culturally appropriate manner, and is readily accessible to all segments of the affected communities.	The ESMP and RAP include a Draft Grievance Mechanism. This procedure allows for external communications with members of the public to be undertaken in a transparent and structured manner. Refer to **Appendix B** for the CMP/ESMP and **Appendix I** for the RAP.
SAFETY OF DAMS		
World Bank's Environmental and Social Safeguard Policies - OP/BP 4.37 Safety on Dams	The WB requires that experienced and competent professionals design and supervise construction, and that the borrower adopts and implements dam safety measures through the project cycle. The policy also applies to existing dams where they influence the performance of a project. In this case, a dam safety assessment should be carried out and necessary additional dam safety measures implemented.	A Dam Safety Plan has been compiled by Knights Piesold (2019) and safety measures have also been included in the final feasibility report undertaken by Studio Pietrangeli Consulting Engineers dated August 2020 (Studio Pietrangeli, 2020).

4.5.3 INTERNATIONAL COMMISSIONS AND ASSOCIATIONS

In addition to the above, the World Commission on Dams (WCD) and the International Hydropower Association (IHA) have developed key strategic priorities and sustainability guidelines relevant to dams and hydropower projects. These are briefly identified below.

WORLD COMMISSION ON DAMS

The WCD was established in May 1998 in response to the escalating local and international controversies over large dams, with the mandate to:

- review the development effectiveness of large dams and assess alternatives for water resources and energy development; and
- develop internationally acceptable criteria, guidelines and standards for the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams.

The WCD framework puts forward seven strategic priorities, each based on a set of policy principles, which are widely acknowledged as a framework for dialogue. A set of 26 guidelines for good practice lay out specific actions for complying with the strategic priorities at five key stages of the project development process. The Strategic Priorities are as follows:

1. Gaining public acceptance
2. Comprehensive Options Assessment
3. Addressing existing dams
4. Sustaining rivers and livelihoods
5. Recognizing entitlements and sharing benefits
6. Ensuring compliance
7. Sharing rivers for peace, development and security

The WCD dissolved in 2001 having undertaken its assigned activities. However, the WCD framework has become a key benchmark in international dam building.

INTERNATIONAL COMMISSION ON LARGE DAMS

The International Commission on Large Dams (ICOLD) is a non-governmental International Organisation, which provides a forum for the exchange of knowledge and experience in dam engineering.

The Organisation leads the profession in ensuring that dams are built safely, efficiently, economically, and without detrimental effects on the environment. Its original aim was to encourage advances in the planning, design, construction, operation, and maintenance of large dams and their associated civil works, by collecting and disseminating relevant information and by studying related technical questions.

The mission of ICOLD is to:

- Lead the profession in setting standards and guidelines to ensure that dams are built and operated safely, efficiently, economically, and are environmentally sustainable and socially equitable;
- Be the world's leading professional organisation, dedicated to advancing the art and science of dam engineering and promoting the wise and sustainable development and management of the world's water and hydropower resources; and
- Assisting nations to prepare to meet the challenges of the 21st century in the development and management of the world's water and hydropower resources.

INTERNATIONAL HYDROPOWER ASSOCIATION (IHA) SUSTAINABILITY GUIDELINES

The International Hydropower Association (IHA) Sustainability Guidelines (SGs) were published in February 2004, with the aim to promote greater consideration of environmental, social, and economic sustainability in the assessment of:

- new energy projects;
- new hydro projects; and
- the management and operation of existing hydropower facilities.

The principles set out in the SGs encompass a number of elements; these include:

- The role of governments;
- The decision-making processes;
- Hydropower - environmental aspects of sustainability;
- Hydropower - social aspects of sustainability; and
- Hydropower - economic aspects of sustainability.

The IHA has put forward policy and sustainability criteria thatencourage good governance within each country and collaboration between governments at an international level to ensure sustainable hydropower development prerequisites are met. According to the IHA, it is the responsibility of governments to:

- Have in place national and/or regional energy policies, which should:
  - clearly set out energy development strategies.
  - include a Strategic Assessment (SA) process that involves an assessment of cumulative impacts, determination of land use and environmental priorities, as well as goals for poverty alleviation and economic growth.
  - be framed in the context of the global need to reduce greenhouse emissions.
  - incorporate the three elements of sustainability: economic, social and environmental in energy planning.
  - be a participatory, streamlined process, focused on major issues, using common sense and readily available information, and with short and definite time limits for its completion.
- Evaluate alternative energy options using key sustainability criteria, prescribed by the IHA; and
- Evaluate hydropower project alternatives using key sustainability criteria, prescribed by the IHA.

In order to facilitate decision-making and to ensure the sustainability of hydropower projects, the IHA's policy position is that Environmental Assessments (EAs) should be applied at the project level from the pre-feasibility stage to the post-construction auditing stage. The IHA encourages governments and project proponents, through the use of key criteria, to ensure appropriate management of environmental and social issues throughout the life of the Project by adopting strategies to maximise positive outcomes and reduce the severity or avoidance of negative social, economic and environmental impacts.

To support the IHA SGs, the IHA has also developed the Hydropower Sustainability Assessment Protocol, which was released in 2006 and updated in November 2010, to assist in assessing performance against the criteria set out in the IHA SGs. The Protocol is a sustainability assessment framework for hydropower development and operation. The intention of the Protocol is to enable the production of a sustainability profile for hydropower projects through the assessment of performance against sustainability topics. The sustainability of a hydropower project is assessed through the use of assessment tools.

5. PROJECT DESCRIPTION

5.1 OVERVIEW

Following the completion of a technical feasibility study, it was determined that the Project would comprise a 38.6 m high gravity roller compacted concrete (RCC) Dam and a small hydropower plant (HPP) of less than 1 MW. The dam will harvest flows along the Lusushwana River, regulated by the upstream Luphohlo Dam, and associated tributary, the Nondvo River; resulting in a storage reservoir with a total storage capacity of approximately 22 Mm^3, delivering an assured yield of 9.8 Mm^3 per year. The reservoir will cover a surface area of approximately 2.4 km^2 (240 ha) across two Royal Kraal areas, namely Siphocosini and Mantabeni.

The dam will provide water to Mbabane, Manzini and the areas between (i.e. Mbabane and Manzini corridor) to meet water demands up to 2050, for the following uses:

- potable, industrial and tourist use;
- irrigation of approximately 800 ha; and
- energy production.

The dam includes an un-gated spillway with two non-overflow sections on either side, an intake and bottom outlet as well as a powerhouse (i.e. small hydropower plant) installed at the foot of the dam. In order to ensure effective construction and operation of the dam, relevant temporary and permanent associated infrastructure is required, including river diversion works, access roads, site establishment (i.e. site camps and offices) and.

Certain existing infrastructure will be affected by the dam reservoir that will require realignment/ relocation. These include the main road (MR19) and smaller informal roads, railway lines, electricity / communications lines, as well as private structures (i.e. dwellings, small businesses and religious and education facilities).

The resettlement process required to facilitate the development of the Project, which has implications for this ESIA in terms of loss of housing, land, assets and social facilities, has been assessed and detailed within a RAP.

This chapter provides details relating to the identification and description of the proposed dam and auxiliary works as well as associated infrastructure, existing infrastructure affected by the reservoir and the resettlement process required to facilitate the development and operation of the proposed dam, including small HPP. **Table 5-1** provides a breakdown of the identified aspects and the relevant sections in which they are discussed.

The technical information contained in this Section was obtained from the final feasibility report undertaken by Studio Pietrangeli Consulting Engineers dated October 2019 (Studio Pietrangeli, 2019).

Table 5-1: Identification of Aspects Constituting the Project

ASPECT	COMPONENTS	SECTION IN REPORT
River Diversion Works	Canal and coffer dams	5.5
Dam and Auxiliary Works	Dam (Non-overflow Sections - Left and Right Dam)	5.6.3
	Spillway	5.6.4
	Intake	5.6.5
	Powerhouse	5.6.6
	Bottom Outlet	5.6.7
Associated Infrastructure	Construction Material	5.7.1
	Site Camps and Offices	5.7.2

ASPECT	COMPONENTS	SECTION IN REPORT
	Power evacuation and distribution	5.7.3
Reservoir	Inundation area	5.8
Re-alignment of existing linear infrastructure	Railway infrastructure	5.9.1
Land acquisition, resettlement and compensation	Resettlement Action Plan	Stand Alone Report

The focus of this ESIA Report is the Nondvo Dam and support infrastructure. A detailed description of the Project is presented in the following sections, which, in summary, includes the following key components:

— Nondvo Dam: 38.6 m high RCC dam with spillway, located downstream of the Luphohlo Dam on the Lusushwana River.
— Nondvo Reservoir: The reservoir will inundate an area of approximately 2.4 m^2 upstream of the Dam at the Maximum operating level (Max. OL), which is 960.0 meters above sea level (masl). The flood demarcation level (FL) is 963.1 masl, which is the FL at 10,000 years, and covers approximately 2.9 km^2.
— Quarry: Material for the RCC and associated works will be obtained from a quarry located approximately 100 m upstream of the Dam on the left bank of the Lusushwana River.
— Site Camps including offices, workers camp and management camp.

The following aspects have been excluded from the current ESIA:

— Water distribution infrastructure (i.e. pipeline network connecting dam to end-users).
— Realignment of the inundated internal access roads.

Whereas host community impacts have been identified and assessed at a high-level only due to the high potential for variability based on PAPs selection of compensation package.

5.2 WATER DEMAND ASSESSMENT

The Technical Scoping Study Report (TSSR) (Studio Pietrangeli, 2018) undertook a water demand assessment, based on the main objective to increase the water availability for supplying water for the cities of Mbabane and Manzini and the relevant corridor.

As a first step, the demographic study has been carried out in order to estimate the growth projections up to the selected design horizons within the Mbabane-Manzini corridor areas.

The water demands to be met in 2025 and 2050, both urban and rural, divided per allocation areas havebeen further identified on the basis of the population projections and on the currently available resource. The last demographical census of 2007 and the Eswatinipopulation projections 2007-2030 study by the Central Statistical Office have been used as a baseline for the demographic study.

On the basis of the geomorphology of the territory, together with the spatial distribution of the main water allocations (at this stage only the existing Water Treatment Plants are considered as sources), the population of the Mbabane-Manzini corridor has been divided into sub-groups.

A study about population projections for the period 2007-2030 has been carried out by the Central Statistical Office of Eswatini, involving calculations of future population size and their characteristics based on assumptions about the future trends in fertility, mortality and migration. On the basis of the above population projections, the projection of the population in the Mbabane-Manzini corridor up to 2050 has been carried out. The results are summarized in **Table 5-2**.

Table 5-2: Mbabane-Manzini Corridor Urban and Rural Population Projections

AREAS	SHORT-TERM HORIZON 2025 Urban	Rural	Total	LONG-TERM HORIZON 2050 Urban	Rural	Total
Mbabane	83 142	7 823	90 965	109 327	8 804	118 131
Ezulwini + Lobamba	22 845	17 895	40 760	30 029	10 154	50 183
Matsapha + Manzini	138 715	28 077	166 792	182 410	31 631	214 041

By considering the following per capita water demand:

- Urban- 250 l/inhabitant/day; and
- Rural - 100 l/inhabitant/day.

The projected water demands for areas are listed in **Table 5-3**.

Table 5-3: Mbabane-manzini Corridor Projected Water Demands

AREAS	SHORT-TERM HORIZON 2025 Urban	Rural	Total	LONG-TERM HORIZON 2050 Urban	Rural	Total
Mbabane	7.6	0.3	7.9	10	0.3	10.3
Ezulwini + Lobamba	2.1	0.7	2.7	2.7	0.7	3.5
Matsapha + Manzini	12.7	1.0	13.7	16.6	1.2	17.8

According to the reservoir routing, Hawane dam can supply a yield with 1 to 20 years assurance of 6.8 Mm^3 per year. Therefore, the gap demand to be supplied in the future can be estimated as the total demand minus 6.8 Mm^3/year.

For the other areas, for sake of safety, it has been considered, as current water supply, the minimum amount supplied in the period 2009-2016. Furthermore, it has been accepted an interruption of service twice in 53 years. The future water demands to be supplied to meet the gap per area are indicated in **Table 5-4**.

Table 5-4: Mean Net Future Water Demands

WATER DEMAND (MM^3/YEAR)	SHORT-TERM	LONG-TERM
Mbabane	1.1	3.5
Ezulwini + Lobamba	1.7	2.5
Matsapha + Manzini	3.6	7.7
Total	6.4	13.6

5.2.1 IRRIGATION

In Eswatini, agriculture provides a source of sustenance to a majority of households. For that reason, the agricultural sector matters quite significantly. Confounding the situation for rural households and the government, in general, is that in recent years, particularly in the last 15 years or so, the country has witnessed an increase in drought-like conditions. Making the situation perverse are reports from the IPCC (2007) that suggest that the Southern Africa region will see an increase in the incidence of droughts in the future.

The Comprehensive Agriculture Sector Policy (CASP), (GoS, 2005) recognises that there are spatial differences in agricultural production in Eswatini that draw primarily from variability in climatic conditions, intra and inter regions. For high rainfall zones, the policy encourages the use of sustainable crop management practices and adaptation of appropriate technologies. It also provides for the commercialisation of the operations of small (subsistence) and medium producers in Eswatini, and pledges support to farmers who want to improve the conditions of their soils, including building the capacity of agricultural producers to manage their soils. For drylands, it recognises the effects of droughts in Eswatini and calls for the use of drought adaptation strategies, drought-tolerant crops, and the sustainable exploitation of forestry ecosystems.

The CASP, therefore, calls for the prioritisation of dam and irrigation development and sees food security as inextricably linked to the expansion of irrigated agriculture in Eswatini.

The Technical Scoping Study Report (Studio Pietrangeli, 2018) identified some areas of 800 ha of arable land which is in line with the provisions of the Tripartite Interim Agreement between South Africa, Mozambique, and Eswatini. According to the information available on soils and land capability, and the topography (slope map), the identification of the areas eligible for the development of an irrigation scheme has been carried out excluding the peri-urban areas and the areas already irrigated. Using the above-mentioned criteria, three areas of about 800 ha have been selected:

- Area A – south-west of Lomamba (838 ha, altitude from 780 to 670 masl).
- Area B – north-east of Lomamba (842 ha, altitude from 690 to 640 masl).
- Area C – about 7 km south-east of Malkerns (1.165 ha, altitude from 690 to 615 masl).

The estimated irrigation water requirement is 4.9Mm^3/800ha (6,125m^3/ha).

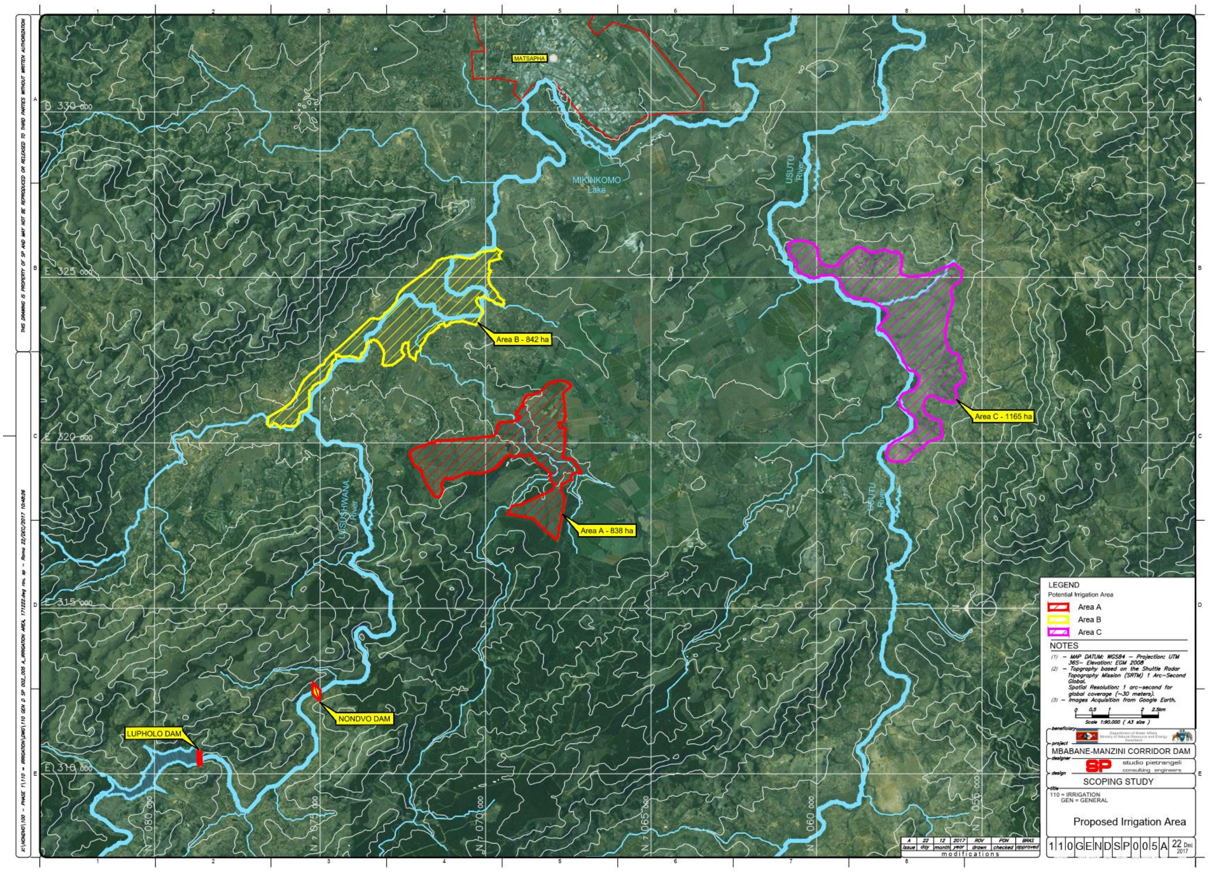


Figure 5-1: Proposed Irrigation Areas (Studio Pietrangeli, 2017)

5.3 CLIMATE CHANGE

The Climate Resilient Infrastructure Development Facility (CRIDF) underook a Climate Change Assessment (CCA) of Nondvo Dam in 2016.

Based on the assessment Eswatini will warm by at least 1.25°C in 2055 and by up to 1.75°C by the end of the century, based on an ensemble of global climate models and greenhouse gas emissions scenarios. At the same time, the frequency of extreme temperatures will continue to rise. Also, a general increase in hot days, by 40%-50% is expected, and in the length of warm spells, while the length of cold spells reduces considerably.

In terms of rainfall, there is conflicting evidence from climate models. Some models project an increase in annual rainfall, perhaps up to +10%, whilst another set project a decrease at about the same level (i.e. 5 to 10%). It is conceivable that water stress might increase even under an increased rainfall scenario when there is increased evaporation when temperature increase is taken into consideration.

On extreme rainfall events. One set of models projects that rainfall on the typical heavier rainfall day might decrease, while others increase. Given the similarity of likelihoods, it follows that changes in extreme events in either direction are roughly also equally likely.

In addition, the National Climate Change Policy (Ministry of Tourism and Environmental Affairs, 2016) identified that climate change will affect the water availability and use of water resources in Eswatini due to changes in precipitation and run-off patterns. The stream-flow of rivers in the country is projected to decrease by 40% by 2050. With an increasing demand for water and areas under water stress projected to increase affecting hundreds and thousands of the rural poor, this will pose a challenge to the country's attainment of sustainable growth. The country, therefore, faces the challenge of how best to manage its water resources to ensure future water demand can be met as water stress or shortage and the decline in agricultural production would pose a serious threat to the country's food security and to lives and livelihoods especially of the rural poor. Consequently, improvement in water infrastructure and management especially watershed management can potentially mitigate the adverse effects of climate change.

5.3.1 OPTIONS REVIEW

In order to address potential climate change, the dam options below were identified (CRIDF, 2016):

1. Large dam: the largest possible dam design for the location of the dam site (to be confirmed by the technical feasibility study). In this case, for illustrative purposes for our assessment, we are using a dam with a storage capacity of 94 M m^3 and takes up an area of 6.4 km^2.
2. Small dam: designed to store 54 Mm^3 and takes up an area of 3.8 km^2.
3. Flexible dam: consists of building a small dam the size of Option 2, but with foundations that would allow extending the dam to the size of Option 1, should the need arise.

The three preliminary project options, present different abilities to manage risks and opportunities, depending on the particular scenario. A small dam can present cost savings and might be better suited in a scenario dominated by less water and demand (i.e. Yellow Scenario) where there is a risk for the dam to never fill up or the demand being lower than expected. In such a scenario an oversized large dam could become unnecessary. A small dam with flexibility might present a better option in a scenario with high population growth and lots of water (Blue Scenario) where the resettlement impacts would be better managed in steps and should the need arise the dam could be expanded. Finally, in a water-constrained world (Red Scenario) a larger dam would give more ‘cushion’, a kind of a safety buffer, and also might be in a better position to fulfill a multi-purpose role and the scenario’s high water demand.

According to the overall results, the large dam option (Option 1) is the preferred option across scenarios.

It is worth noting that while the large dam was the best option overall by the stakeholders, in certain scenarios, it can become the worst option particularly in the scenarios that come with a decrease in rainfall (see **Figure 5-2**). On the other hand, the small dam with flexibility shows less performance variability. It might not be the best overall, but it presents good enough, satisficing performance across all scenarios.

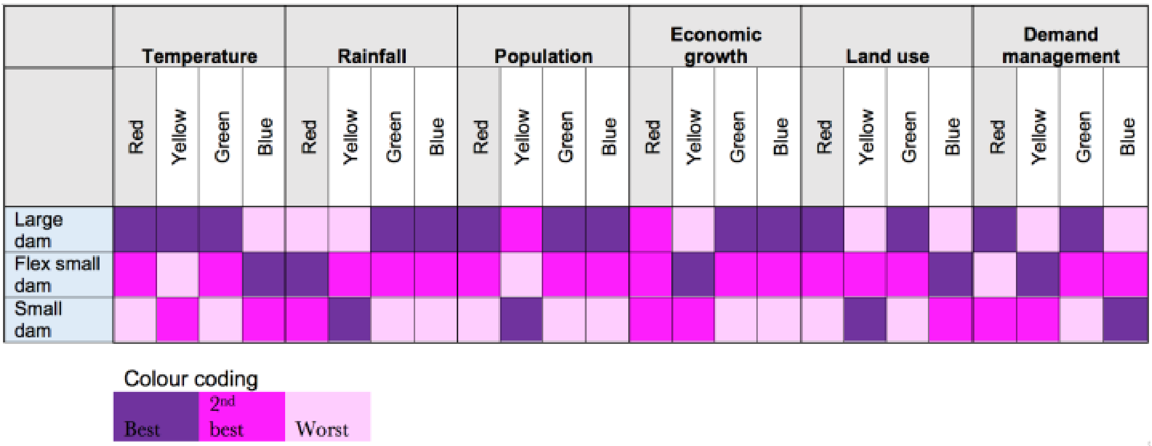


Figure 5-2: Preferred Climate Change Adaptation Measure (CRIDF, 2016)

5.4 PROJECT LOCATION

The proposed project site is situated approximately 12 km south of Mbabane and 26 km north-west of Manzini, along the south-eastern boundary of the Hhohho Region, Eswatini (**Figure 5-3**). The proposed Nondvo Dam is to be situated on the Lusushwana River, at the following coordinates 26°25'39.04"S and 31°7'0.98"E (UTM, WGS84: 312220E; 7075564S), approximately 7 km downriver of the existing Luphohlo Dam.

Figure 5-4 indicates the proposed locality of the Nondvo Dam and extent of the inundation area.

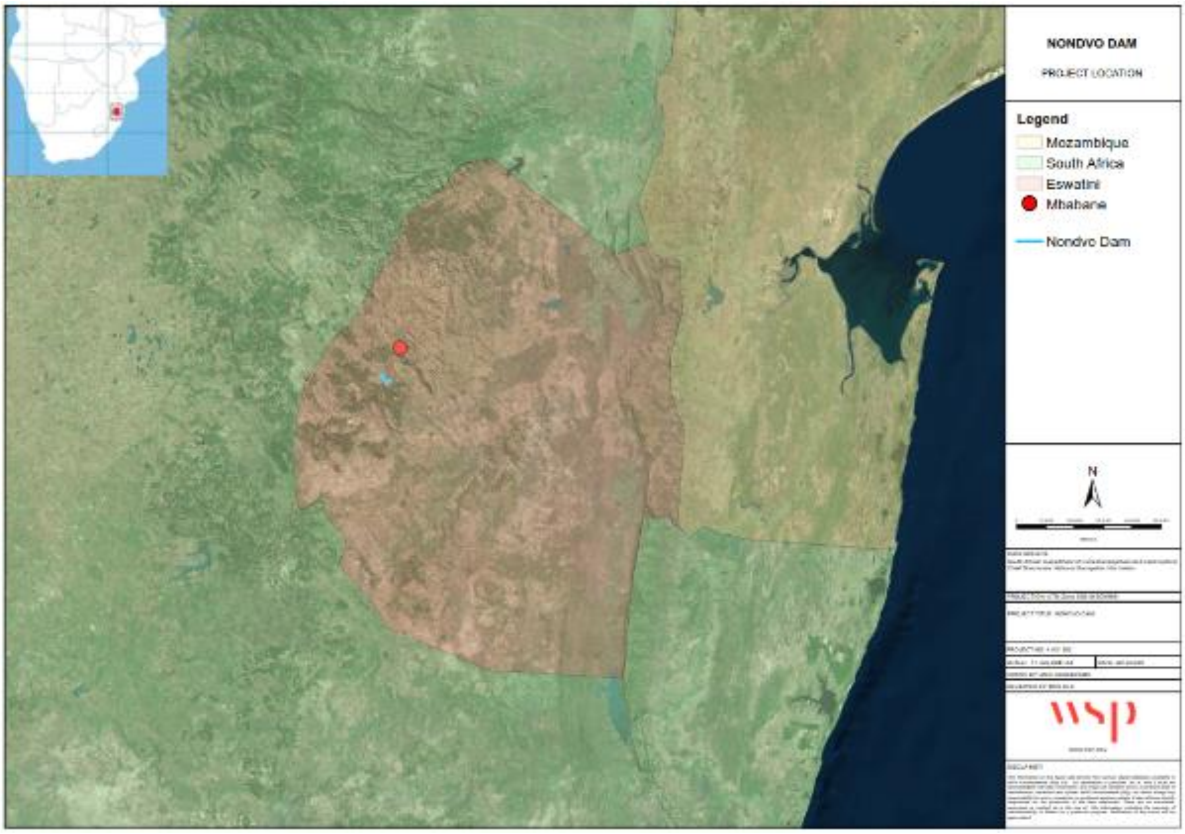


Figure 5-3: Map Indicating the Project Location

Figure 5-4: Proposed Nondvo Dam

Figure 5-5 provides an aerial photo, taken by drone of the dam site, showing the rocky outcrops on both the left and right banks as well as on the river bed.

Figure 5-5: Aerial Photo of the Dam Site

5.5 RIVER DIVERSION WORKS

Temporary river diversion works shall provide protection against flooding for the area where permanent works are constructed. A hydraulic analysis has been carried out to verify the hydraulic performance of the diversion for a design flood of 320 m^3/s, corresponding to a return period of 20 years.

The river diversion consists of an approximately 210 m long excavated canal, located on the left bank of the natural river, aimed at diverting water from the river bed in the stretch comprised between the temporary upstream (u/s) and downstream (d/s) cofferdams. In order to avoid the inundation of the dam area, the right side of the channel consists of a vertical wall of variable height while the left side of the canal is excavated in the rock.

The u/s cofferdam and d/s cofferdam are foreseen in the form of a rock-filled embankment with its crest at an elevation of respectively 938.8 and 928 masl and a length of about 90 m (both). The embankment body will be built with material from the quarry. The cofferdams will be made watertight by an upstream-facing PVC membrane.

According to the results of the hydraulic analysis, the water surface level at the u/s section of the canal is 938.0 masl, corresponding to a freeboard of 0.5 m in relation to the cofferdam elevation. The water surface elevation d/s at the diversion canal is 927 masl, lower than the d/s cofferdam elevation. Additionally, the maximum velocity of 11.8 m/s is to occur in the channel reach d/s of the dam block, which is within the acceptable design range for a concrete channel.

Figure 5-6 and **Figure 5-7** provide a plan and profile layout, respectively, of the river diversion works. **Figure 5-8** provides typical cross-sections of the river diversion canal as well as the u/s and d/s cofferdams.

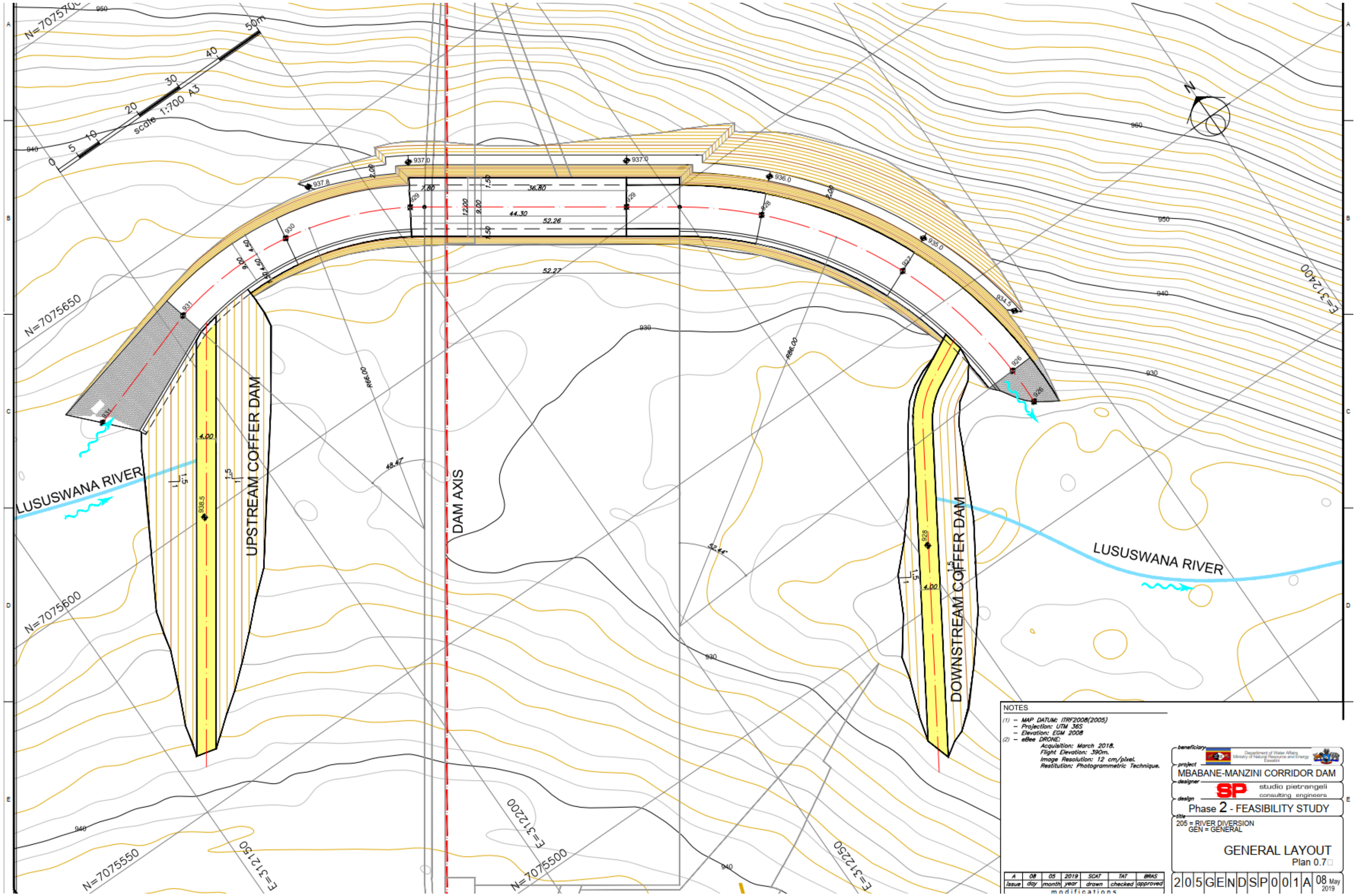


Figure 5-6: Layout of the Diversion Works (Studio Pietrangeli, 2019)

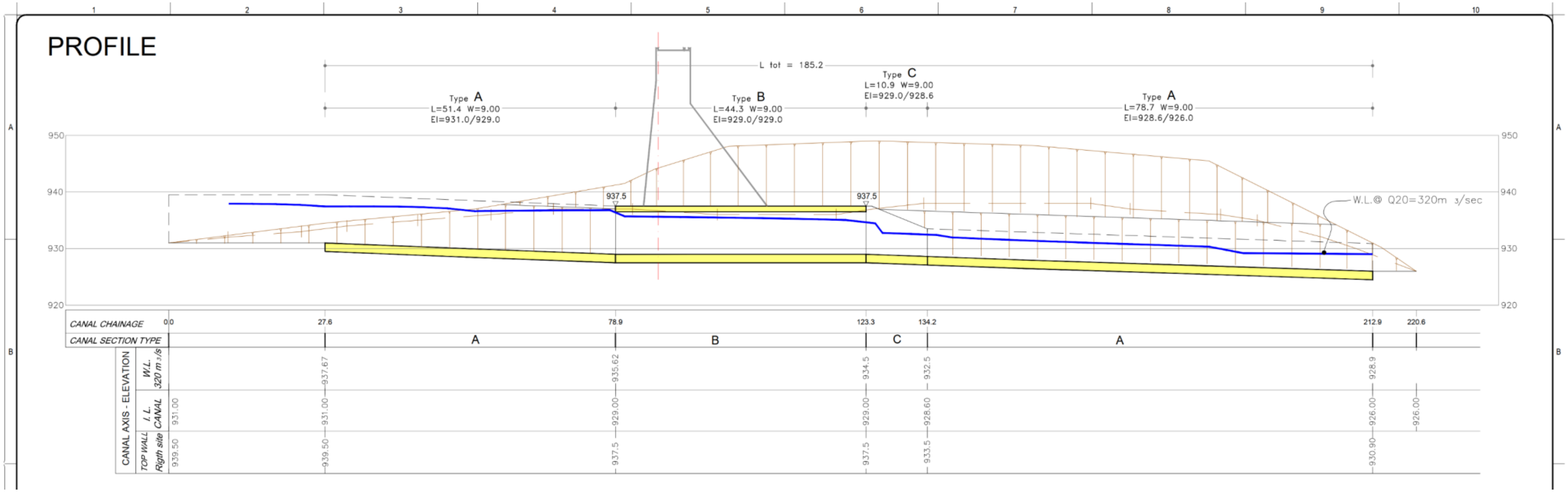


Figure 5-7: Layout Showing the Profile View of the River Diversion (Studio Pietrangeli, 2019)

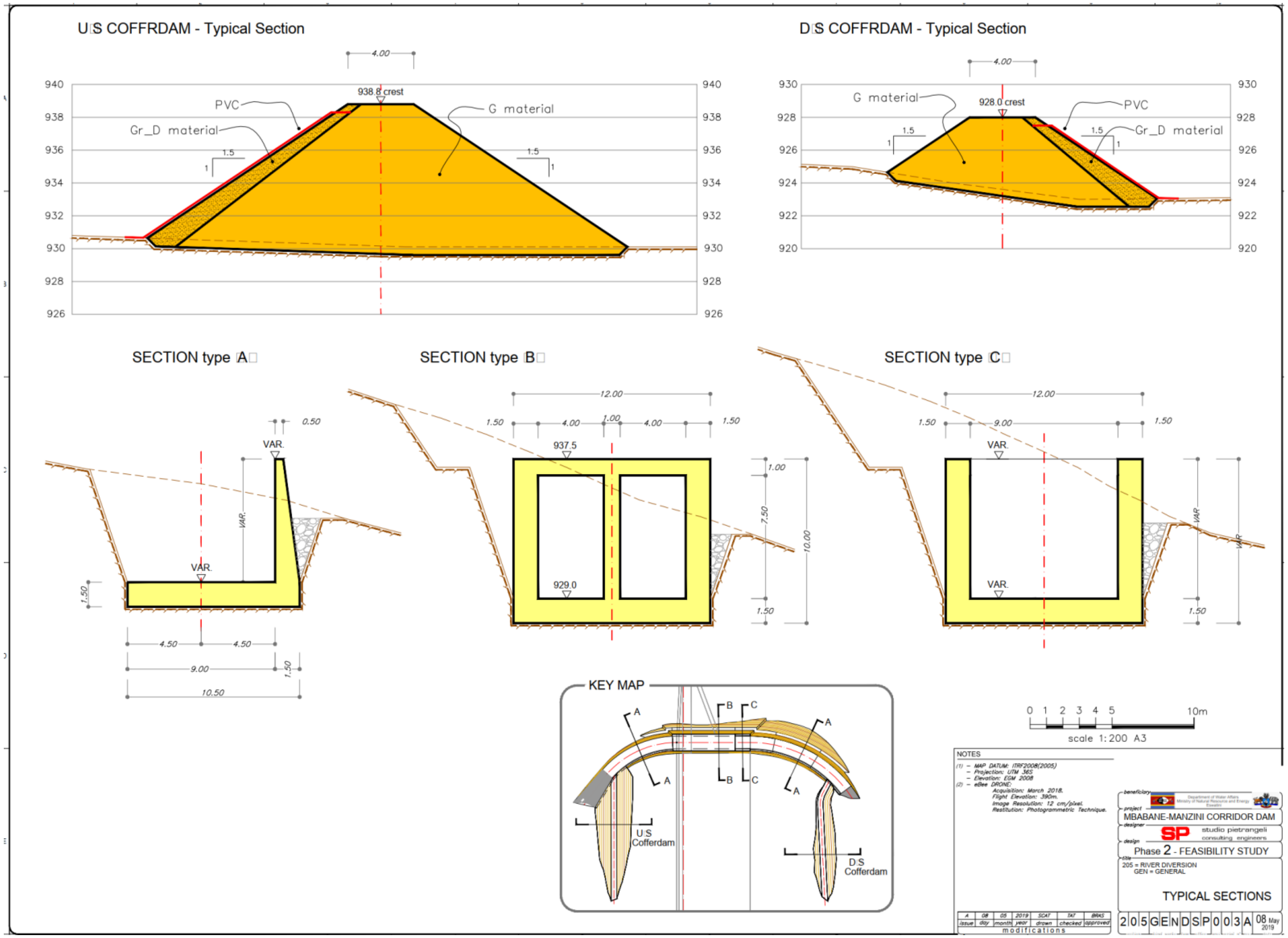


Figure 5-8: Layout Showing Typical Cross Sections of the River Diversion Works (Studio Pietrangeli, 2019)

5.6 NONDVO DAM AND AUXILIARY WORKS

The type of dam proposed for the Nondvo project is a RCC gravity dam. The design decision to adopt a non-deformable type of dam was based on the type of foundation materials encountered on site. The investigation identified that the project area is characterised by granitic bedrock. Mass granite rock outcrops are present for the majority of the foundation area, with superficial soil deposits only present at the left and right abutments (refer to **Figure 5-5** and **Section 7.1.4**: Geology).

Generally, an RCC dam is preferable, foundation permitting, because it is more secure than an earth-fill or rock fill embankment dam and the construction time is much shorter. Furthermore, an RCC dam can overflow without jeopardizing the stability of the dam. The main characteristics of Nondvo Dam are provided in **Table 5-5**.

Table 5-5: Main Characteristics of the Dam

CHARACTERISTIC	TYPE / VALUE	UNIT
Type	Gravity (RCC)	-
Max. height above foundation (H)	38.6	m
Crest length (CL)	~300	m
Crest elevation (Cel)	967.6	masl
Foundation minimum elevation (FME)	929.0	masl
Max OL	960.0	masl
Upstream slope (Sus)	1/0.10	h/v
Downstream slope (Sds)	1/0.75	h/v

5.6.1 EFFECTIVE FETCH AND WAVE HEIGHT

The length of fetch (the surface lapped by wind in a given direction) on inland reservoirs is calculated based on the distances from a given point of the dam to the nearest opposite shore. The maximum effective fecth in correspondence with the dam is approximately 765 m. According to the United States Bureau of Reclamation (USBR) manual “Design of Small Dams” indicates that for the considered effective fetch and a wind speed of ~120 km/hr (conservative value) will result in a wave height of ~0.7 M (equal to 2.4 ft.) and therefore a half-wave height (i.e. the maximum increase in water level) of 35 cm.

5.6.2 FREEBOARD

The normal freeboard is calculated as a difference in elevation between the dam crest (967.6 masl) and normal reservoir water level, which is the Max OL (960.0 masl), by considering the half wave-height. The minimum freeboard is calculated as a difference in elevation between the dam crest and the reservoir water level when the inflow design flood occurs, which is the Flood Level @ 10,000 yrs (963.4 masl), by considering the half-wave height. Therefore, the normal freeboard and the minimum freeboard are 7.2 m and 3.8 m respectively.

The USBR manual shows that for an effective fetch of less than < 1.6 km (i.e. 1 mile) the recommended normal and minimum freeboards are 1.2 m and 0.9m. The relevant freeboards for the dam, therefore, comply with the recommendations for dams suggested by USBR.

The general layout of the dam and auxiliary works is shown in **Figure 5-9**. While **Figure 5-10** provides a profile view of the dam, as well as the foundation line and overburden required to be removed, along the dam axis.

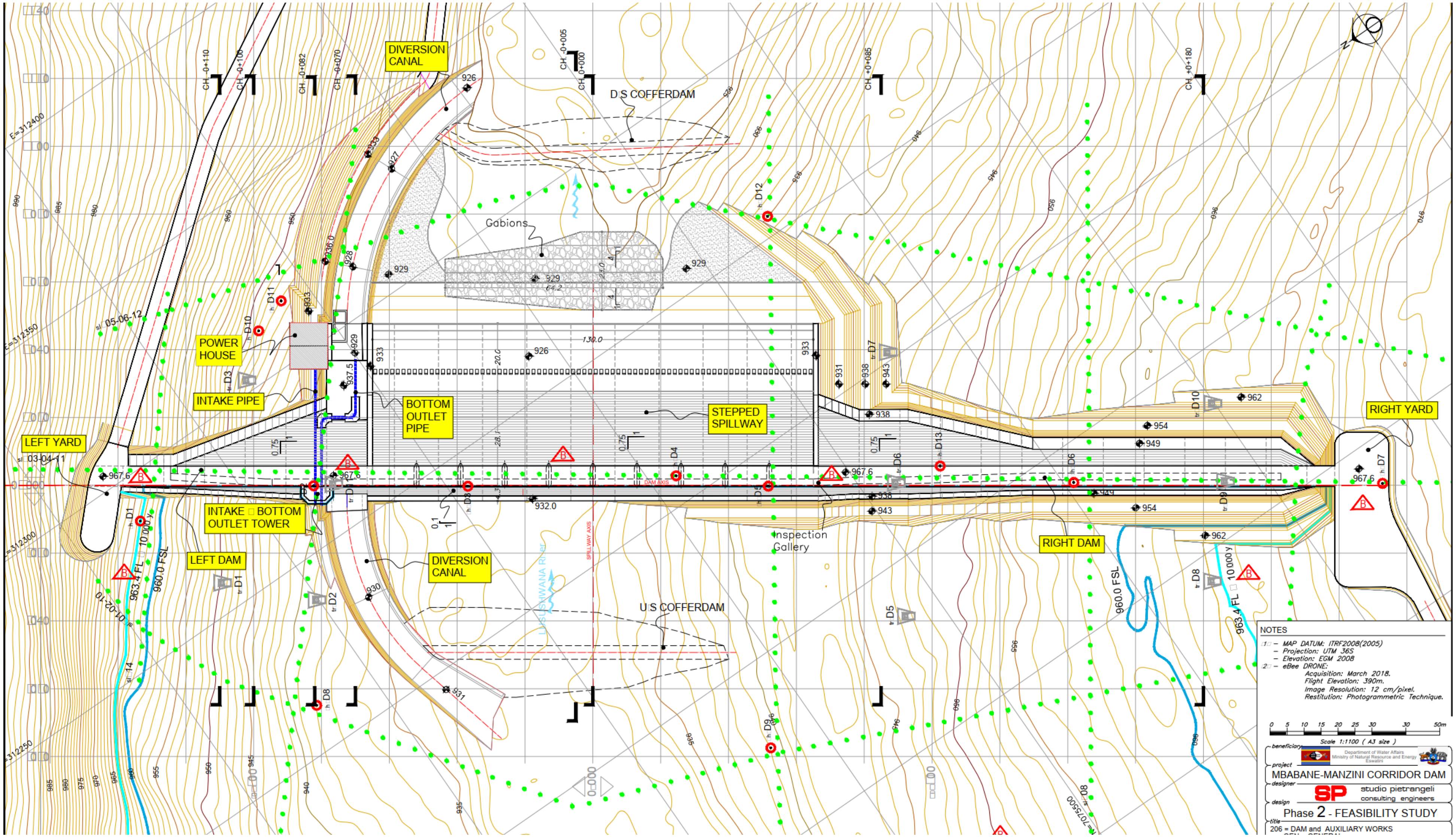


Figure 5-9: Layout of the Nondvo Dam and Auxiliary Works (Studio Pietrangeli, 2019)

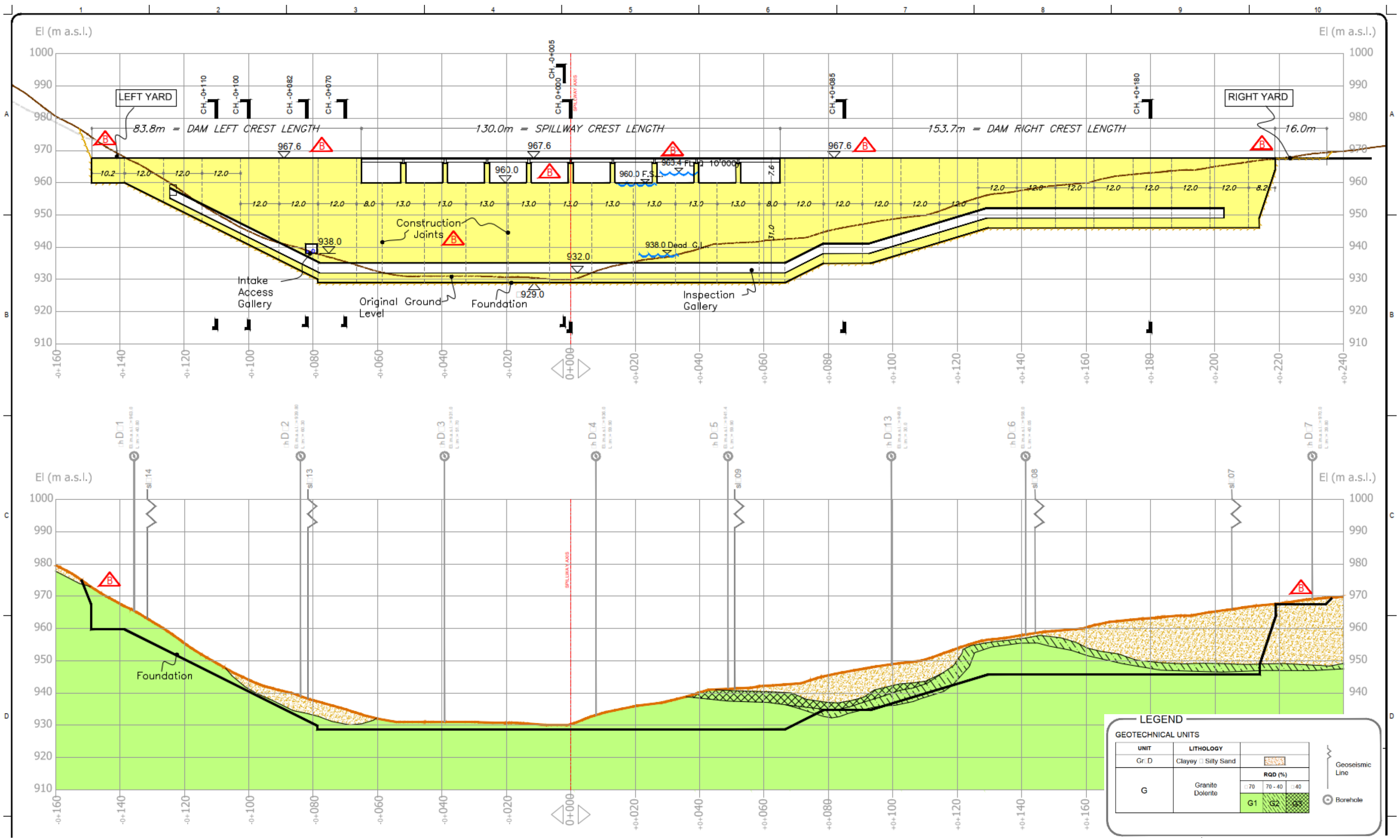


Figure 5-10: Layout Showing Profile of the Dam along the Dam Alignment Axis (from upstream view) (Studio Pietrangeli, 2019)

5.6.3 DAM (NON OVERFLOW SECTIONS - LEFT AND RIGHT DAM)

Figure 5-11 and **Figure 5-12** provide typical cross-sections through the left and right non-overflow sections of the Dam, respectively.

As indicated in the figures an inspection gallery has been proposed in the dam body design. This gallery will have a dual purpose:

- during the construction period, to perform as a drainage system as well as a grouting curtain;
- during the operation and maintenance period, to maintain the drainage or to perform new grouting if required.

Additionally, to reduce the uplifts of the dam the following measures have been proposed in the design:

- a drainage system which conveys the water into a ditch inside the inspection gallery;
- a grouting curtain along the dam axis.

5.6.4 SPILLWAY

The Nondvo Dam is equipped with an un-gated spillway located in the central part of the RCC dam. The spillway and relevant works (downstream dissipation device) was designed to safely pass up to a design flow corresponding to a return period of 10,000 years, and the passage of higher floods up to the extreme flood level (PMF) of 965.9 masl, was guaranteed without dam and spillway permanent structure (crest, lateral walls and chute walls) overtopping.

The spillway structure includes:

- an uncontrolled overflow crest with a sill elevation at 960.0 masl and a net width of 130 m;
- a stepped chute downstream side of the crest having a slope of 0.75:1 (H: V) and a constant width of 130 m;
- a Type III stilling basin downstream of the chute, 130 m wide and 20 m long, as an energy dissipating device.

The stepped chute results in greater energy dissipation than a smooth chute. A weir is then located downstream of the stilling basin, at 929 masl, which maintains the tail-water levels for the proper functioning of the dissipation device.

The main characteristics thereof are summarised in **Table 5-6. Figure 5-13** provides a plan layout while **Figure 5-14** provides a cross-section of the spillway.

Table 5-6: Main characteristics of the spillway

COMPONENT	DESCRIPTION	TYPE / VALUE	UNIT
SPILLWAY	Type	Ungated	
	Design Flood (TR)	1518 (@10000)	
	Spillway width	130.0	m
	Sill elevation	960	masl
	Chute type	Stepped	
	Energy Dissipater	Stilling basin type III	

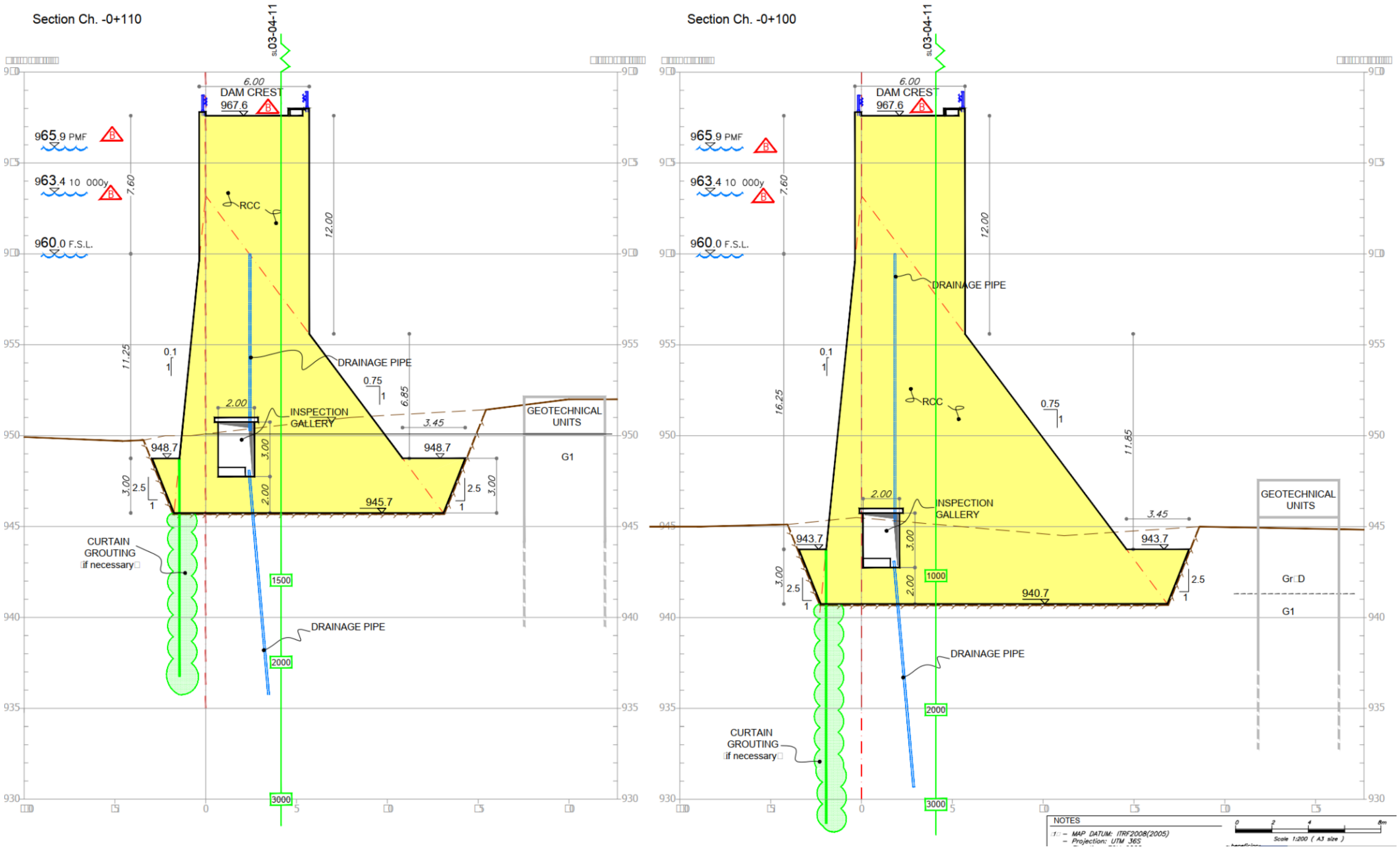


Figure 5-11: Left Dam - Typical Cross-section (Studio Pietrangeli, 2019)

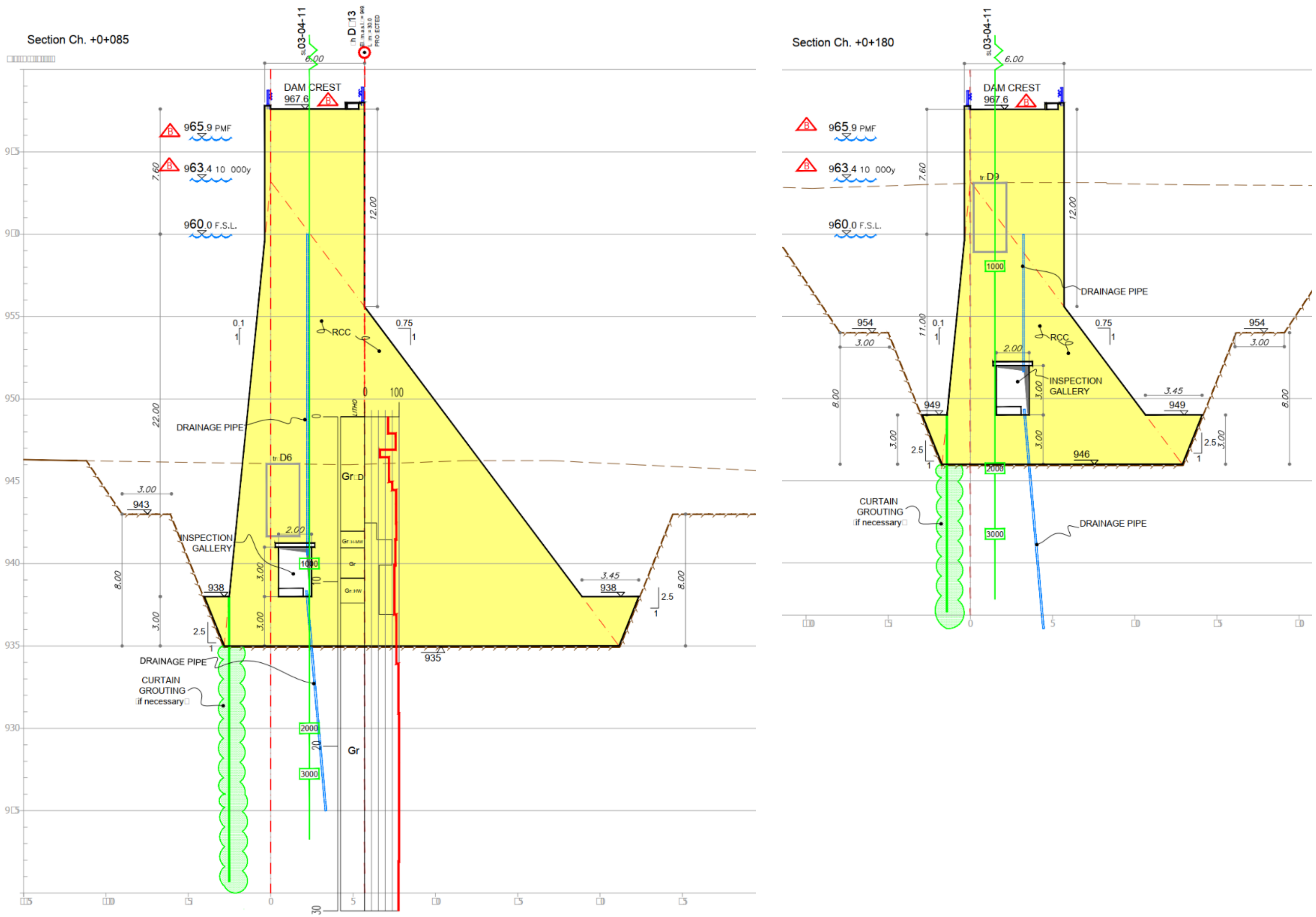


Figure 5-12: Right Dam - Cross-section of the Typical Non-overflow Section of the Dam (Studio Pietrangeli, 2019)

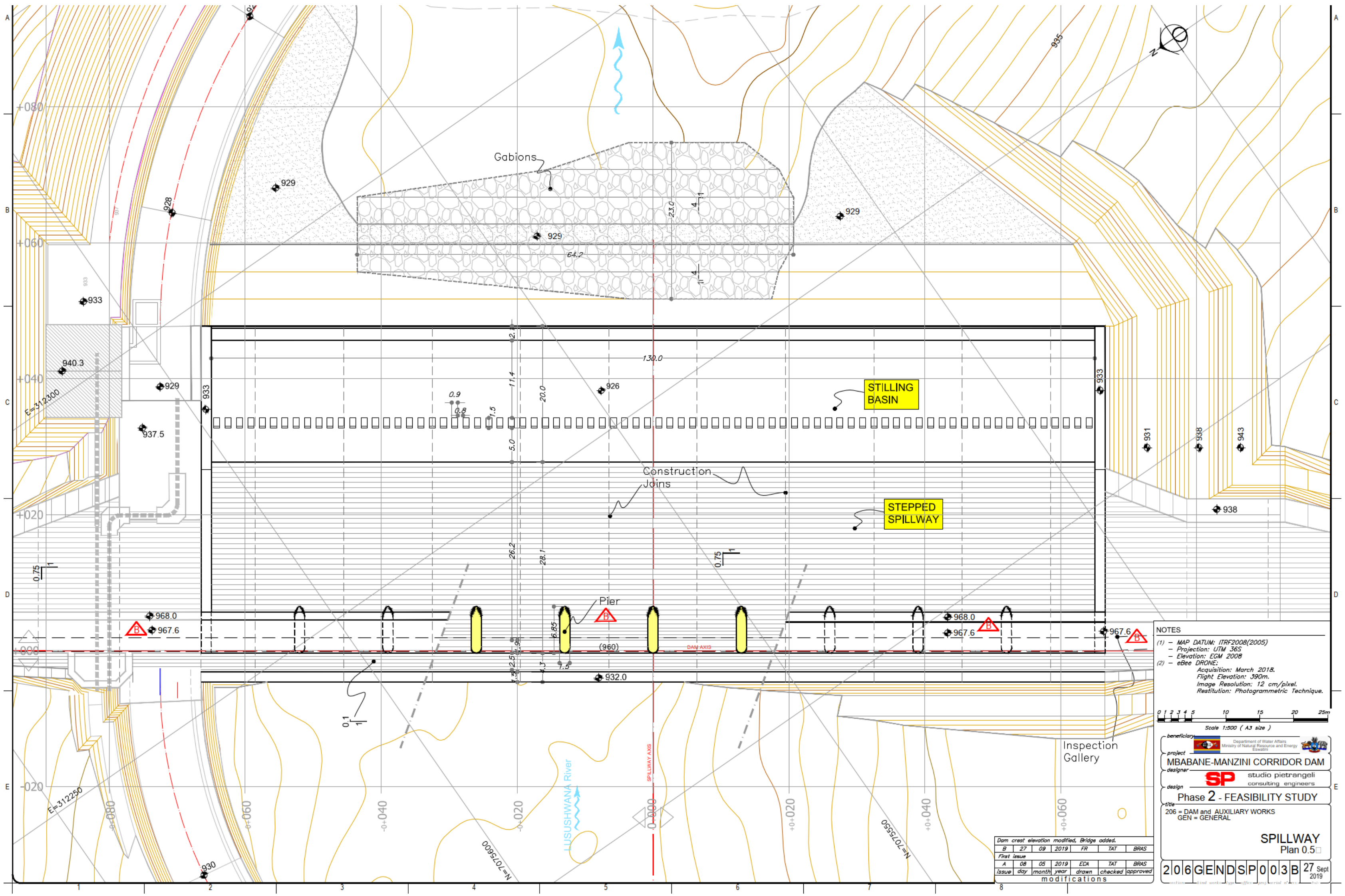


Figure 5-13: Spillway and Stilling Basin (Studio Pietrangeli, 2019)

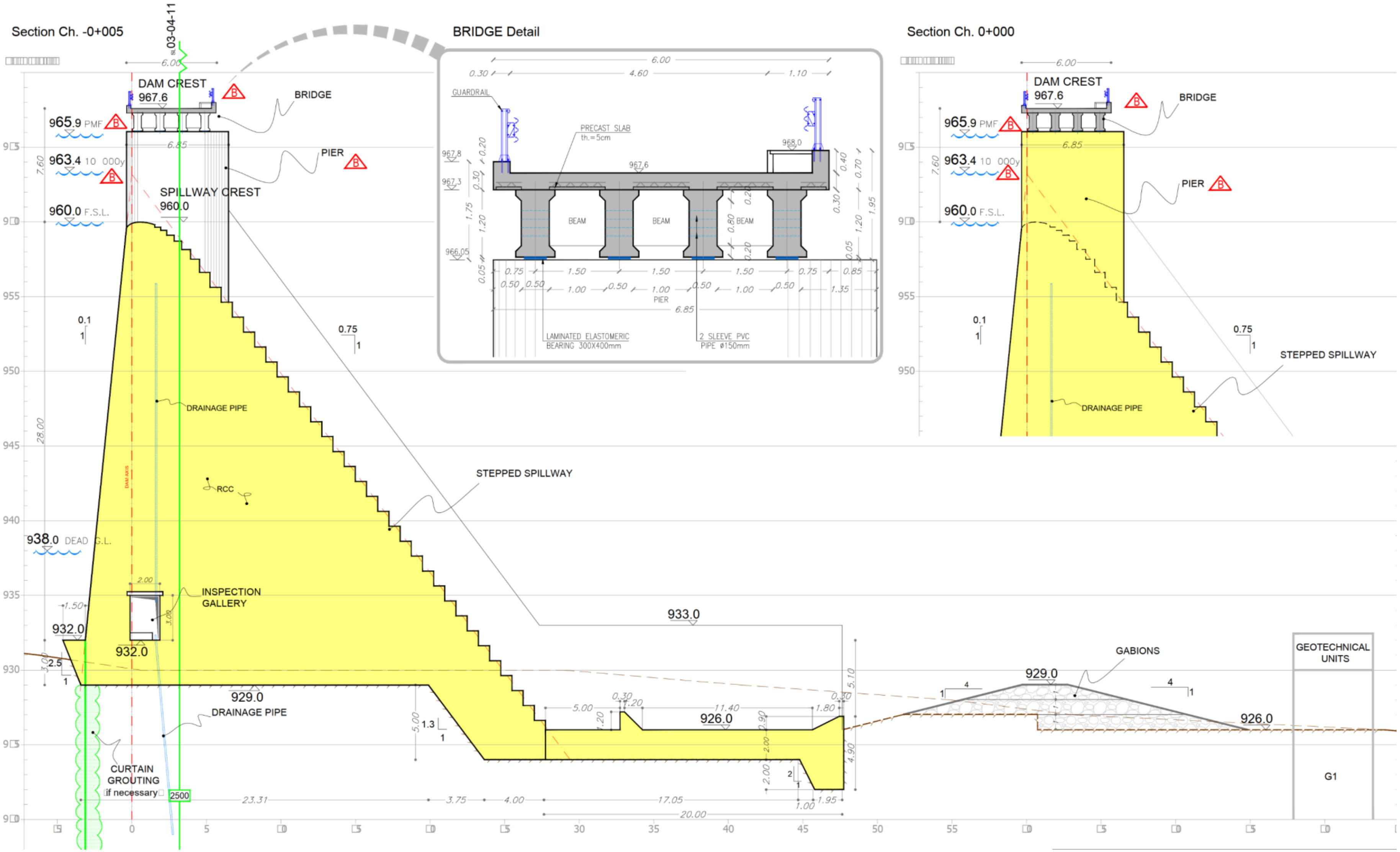


Figure 5-14: Cross-section of the Spillway (Studio Pietrangeli, 2019)

5.6.5 INTAKE

The intake and bottom outlet towers are located directly above the diversion tunnel. The main purpose of the intake pipe is to derive water from the reservoir for water demand for drinking use, and ecological release. The intake has been designed in order to derive a discharge of approximately 0.5 m^3/s.

The water drawn from the reservoir will be conveyed into the powerhouse for energy production (see **Section 5.6.6**), before being released as ecological flow or conveyed as potable water.

A cross-section of the intake of the dam is provided in **Figure 5-12** and the main characteristics thereof are provided in **Table 5-5**. As indicated in **Figure 5-12** two intake pipes will be positioned at different levels (i.e. 955.0 and 945.0 masl) in the Intake and Bottom outlet tower in order to draw water that has the best quality characteristics, depending on the level of the reservoir. Each pipe is equipped with two gates and two butterfly valves, located in the Intake and Bottom outlet tower. The two gates preside over the butterfly valves, positioned at the two different levels of intake, in order to allow for maintenance activities to be undertaken on individual valves as and when required.

Each intake has been designed with its own trash-rack to prevent damage to the valves and turbine by the debris. A trash-rack cleaning machine (TRCM) is included for cleaning the debris from the intake of the power waterway and the bottom outlet. The TRCM consists of an overhead monorail track with support columns/frames mounted on the intake structure, as well as a trolley and a hydraulic controlled debris gripper. The trolley travels along the monorail track to clean the entire intake structure, one trash-rack section at a time. The debris gripper is suspended from cables and travels down to the trash-rack surface, then back up with debris held in the gripper. The rake transports the collected debris and dumps it directly into a trailer, parked at one end of the structure. The TRCM is designed to operate automatically without an operator; however, it can be operated manually by pendant control.

Table 5-7: Main Characteristics of the Intake

CHARACTERISTIC	TYPE / VALUE	UNIT
Type and material	Steel pipe	
No. of pipe (tower/intake access gallery)	2 / 1	
Diameter	600	mm
Length	~70	m
Sill elevation[6]	955.0 / 945.0	masl
Gates type	Butterfly valves	

[6] Two intake pipes will be positioned at different levels (i.e. 955.0 and 945.0 masl) in the Intake and Bottom outlet tower.

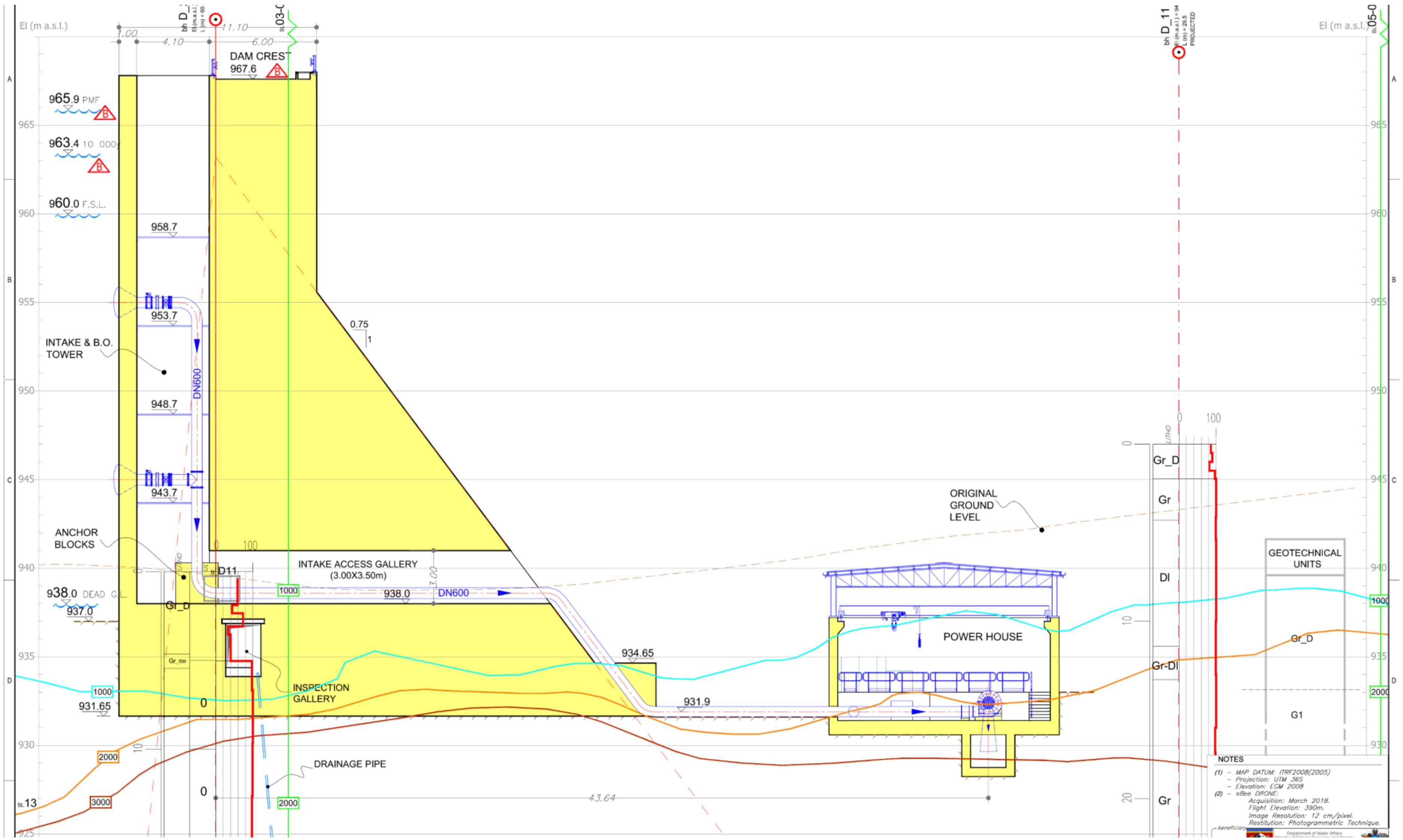


Figure 5-15: Cross-section of the Dam Intake to the Powerhouse (Studio Pietrangeli, 2019)

5.6.6 POWERHOUSE

The powerhouse is a conventional open-air powerhouse with a horizontal axis unit located on the left bank of the Lusushwana River, at the downstream toe of the dam. The powerhouse, hosting the electromechanical and electrical equipment, has a planned footprint[7] of 93.6 m^2 (**Figure 5-16**). The main characteristics thereof, and energy production, are provided in **Table 5-8**. Considering a net head of 27 m and a design discharge of 0.5 m^3/s the potential installed power is 135kW.

Table 5-8: Main Characteristics of the Powerhouse and Energy Production

CHARACTERISTIC	TYPE / VALUE	UNIT
Power house type	Surface	
Power house dimensions	13.0 x 7.2	m x m
Turbines axis elevation	932.4	masl
Turbines number	1	
Turbine type	Francis horizontal	
Design flow (Qdes)	0.5	m^3/s
Geodedic head	30	m
Energy production	1.02	GWh/yr
Plant factor	0.92	
Installed power	0.13	MW

The main mechanical equipment of the power plant includes:

- 1 x horizontal Francis turbine;
- 1 x Frequency governor;
- 1 x Main Inlet Valve (MIV);
- 1 x by-pass system;
- 1 x Powerhouse single girder crane, and
- Auxiliary mechanical systems:
  - Cooling water system;
  - Drainage and dewatering system;
  - Ventilation and air conditioning system;
  - Fire alarm and suppression system.

The main electrical equipment of the power plant includes:

- 1 x 3 phase horizontal asynchronous generator, with rated power of 145.2kVA;
- 1 x Low Voltage Switchgear;
- Powerhouse auxiliary electrical equipment (Diesel generator set[8], AC and DC system, etc.); and
- Protection, Control and Monitoring System (PCMS)[9], with a Programmable Logic Controller (PLC) system and back-up manual control panels.

[7] The main plan dimensions of the powerhouse building are 13.0 m long and 7.2 m wide.
[8] For emergency operation a standby diesel generator (1500 rpm, 10kVA, 0.8 PF) and the relevant control panel are foreseen which will be connected to the 0.4 kV AC Low voltage Switchgear.
[9] The PLC system will control and supervise the whole hydropower plant in a fully automatic manner.

The main floor, corresponding to the access level, is to be situated at 933.0 masl. The main elevations of the substructure include the turbine axis at 932.4 masl, erection-bay and generator floor at 931.4 masl and foundation slab at elevation 930.6 masl (**Figure 5-17**).

Once the water has passed through the turbine it will be conducted into a pit, located beneath the turbine at 929.0 masl, from where it will go over a sill at an elevation of 929.8 into the diversion channel (**Figure 5-19**). The sill ensures that the turbine is always submerged.

Within the diversion channel, there is a distribution pit from where the two pipes start for the treatment plant and the ecological flow. The pipeline for the water treatment plant consists of a 500 mm diameter steel pipe of approximately. The pipeline for the ecological flow consists of a 300 mm diameter steel pipe. Both pipes are approximately 4 m in length include two butterfly valves, one for operation and one for maintenance. Access to this pit is gained from the powerhouse access road, from where a vertical staircase starts (**Figure 5-21**).

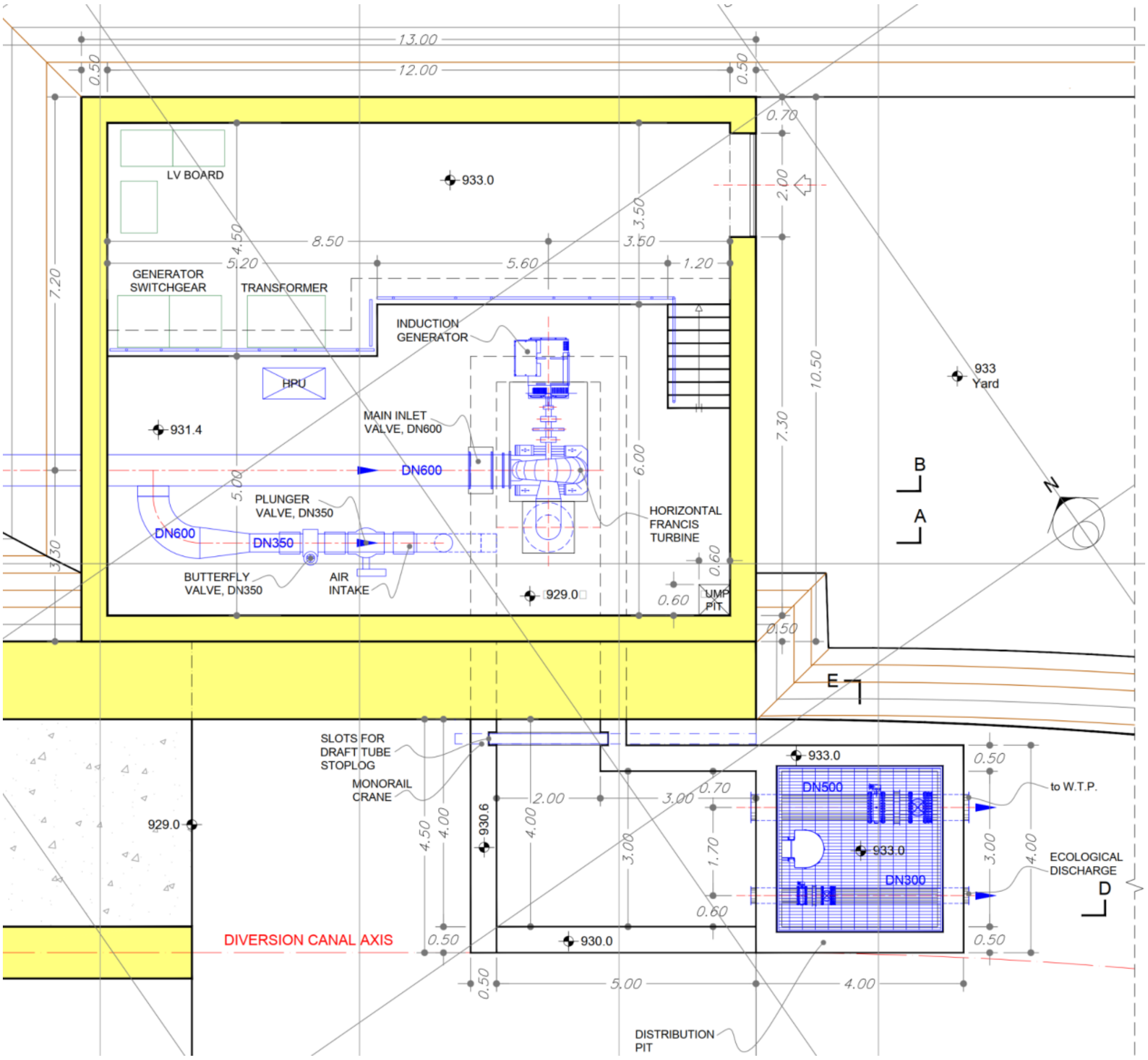


Figure 5-16: Powerhouse - Horizontal Cross-section (Studio Pietrangeli, 2019)

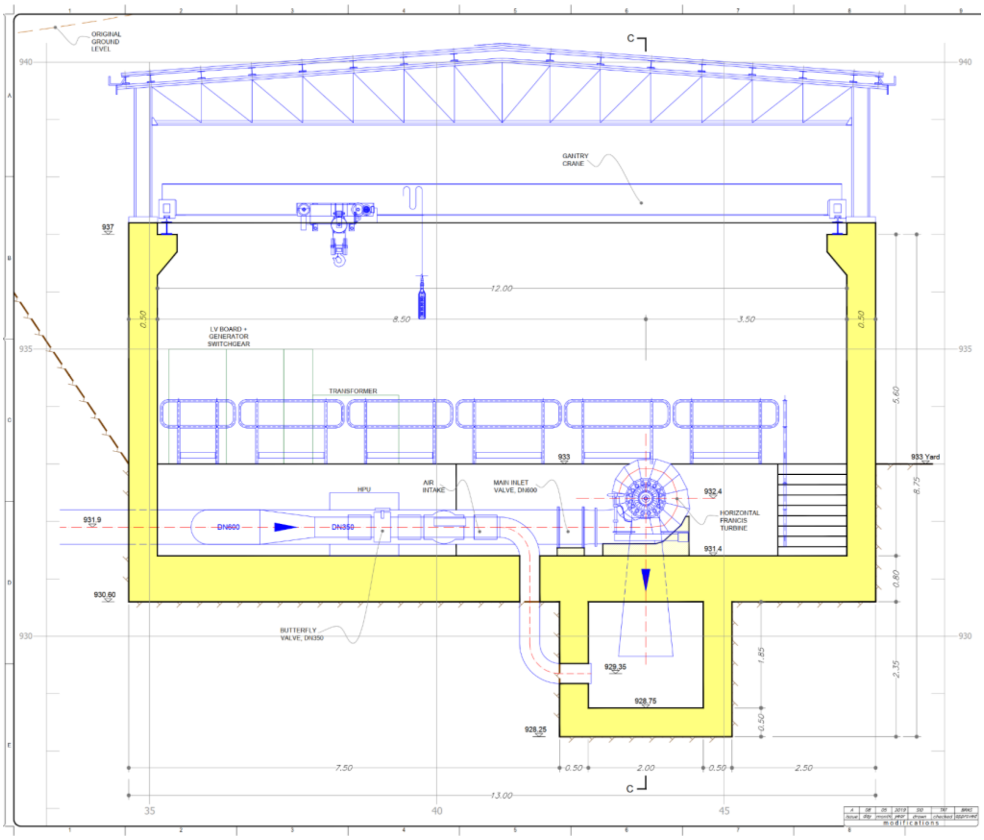


Figure 5-17: Powerhouse – Vertical Cross-section (Section A) (Studio Pietrangeli, 2019)

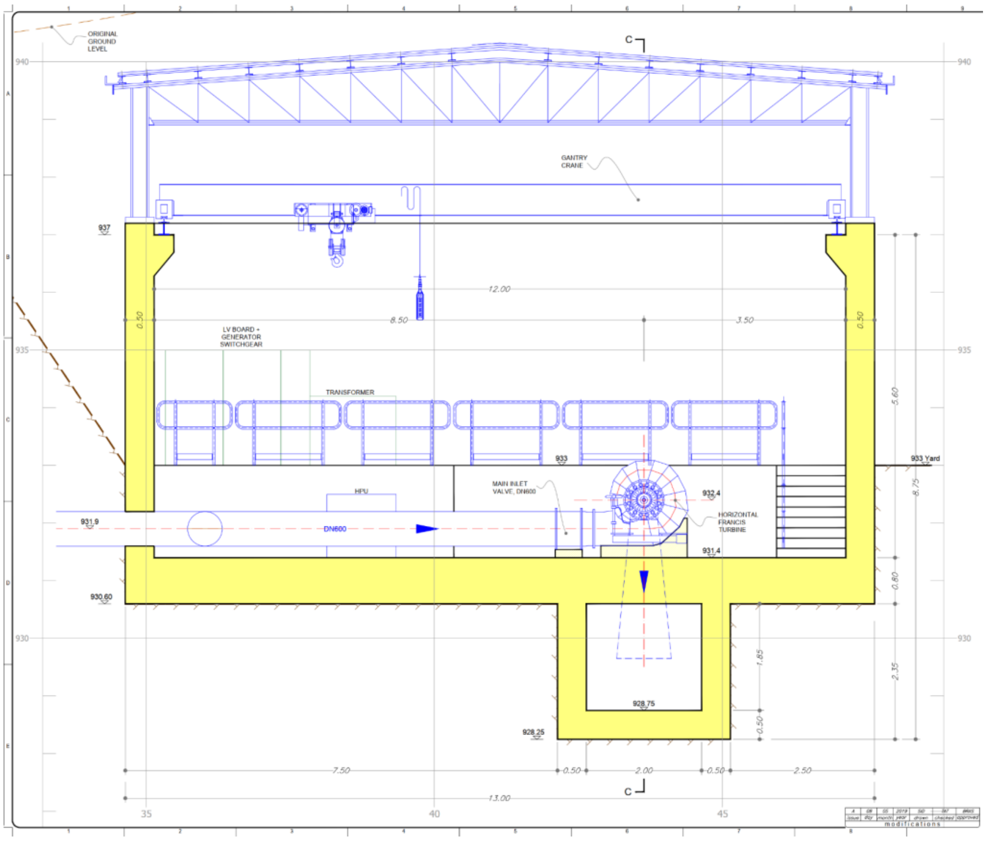


Figure 5-18: Powerhouse – Vertical Cross-section (Section B) (Studio Pietrangeli, 2019)

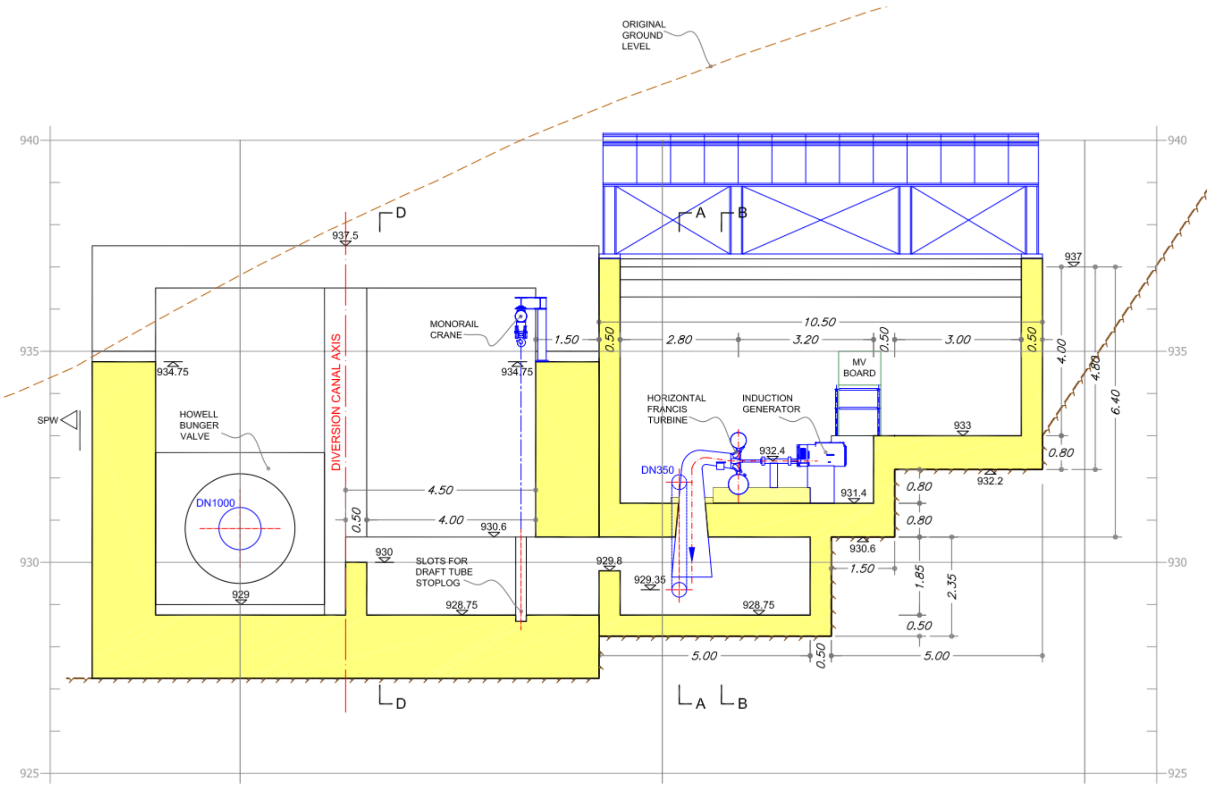


Figure 5-19: Powerhouse – Vertical Cross-section (Section C) (Studio Pietrangeli, 2019)

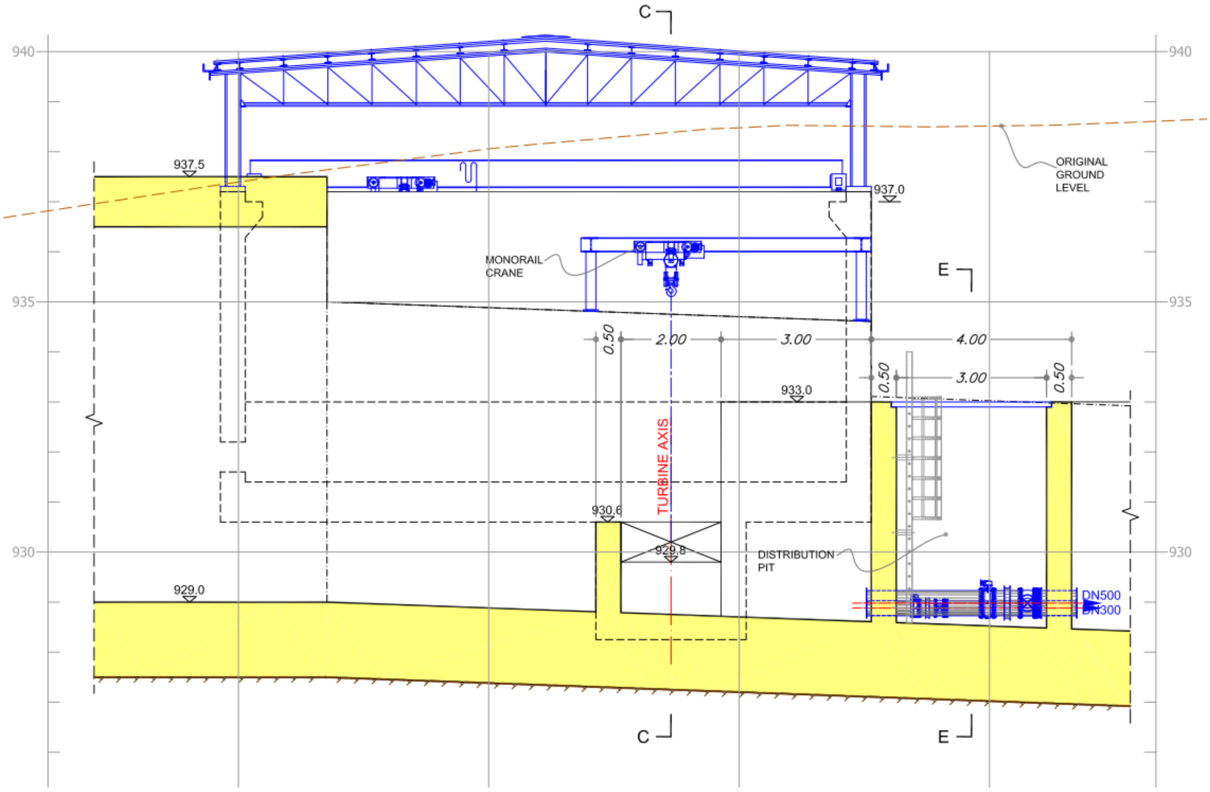


Figure 5-20: Powerhouse – Vertical Cross-section (Section D) (Studio Pietrangeli, 2019)

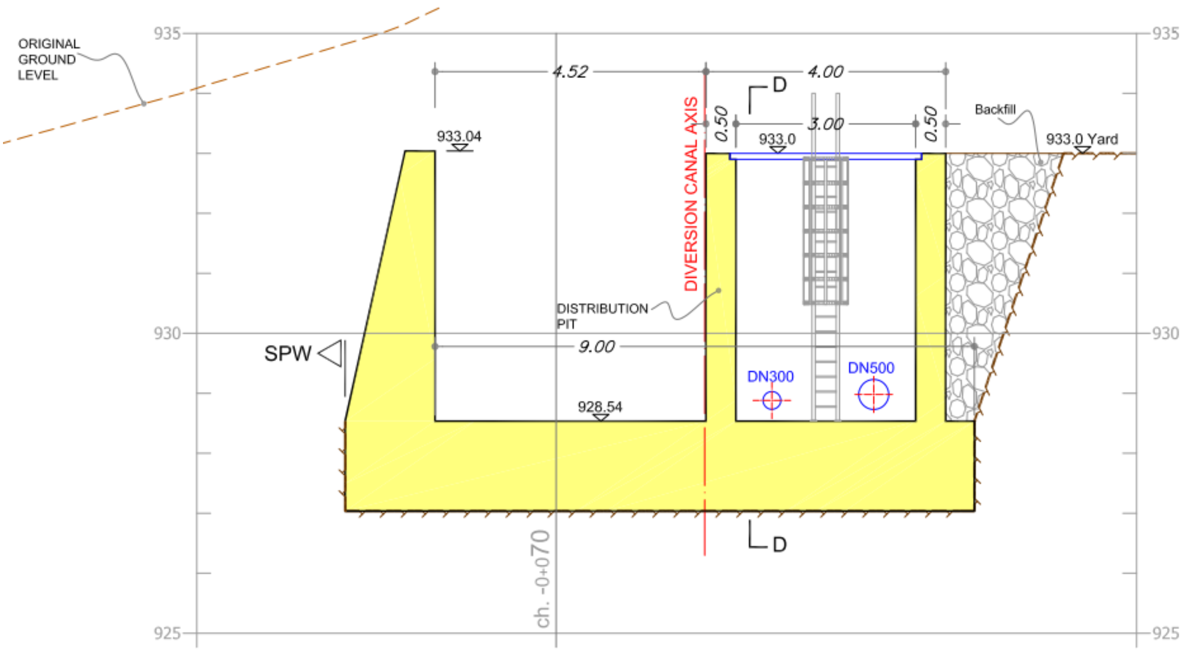


Figure 5-21: Powerhouse – Vertical Cross-section (Section E) (Studio Pietrangeli, 2019)

5.6.7 BOTTOM OUTLET

The main functions of the bottom outlet are for the drawdown of the reservoir in an emergency, or exceptional maintenance, and for controlling the rate of reservoir impounding. The bottom outlet consists of a 1000 mm diameter steel pipe of a total length of approximately 50 m.

The invert level at the entrance is 938 masl, aligning with the level of the dead volume or the reservoir in order to guarantee the functioning of the outlet during the overall lifetime of the dam.

The bottom outlet is equipped with a Howell Bunger valve, of 1 m diameter, which will be used to regulate the flow. This type of valve was selected due to its high efficiency in energy dissipation; its simple construction, low cost and high discharge coefficient. The Bottom Outlet works are designed to release up to 9.22 m^3/s.

A cross-section of the bottom outlet is provided in **Figure 5-22** and the main characteristics thereof are summarised in **Table 5-9**.

Table 5-9: Main Characteristics of the Bottom Outlet

CHARACTERISTIC	TYPE / VALUE	UNIT
Type and material	Steel pipe	
No. of pipe (tower/intake access gallery)	1	
Diameter	1000	mm
Length	~50	m
Sill elevation	939.0	masl
Valve for energy dissipation	Howell Bunger	

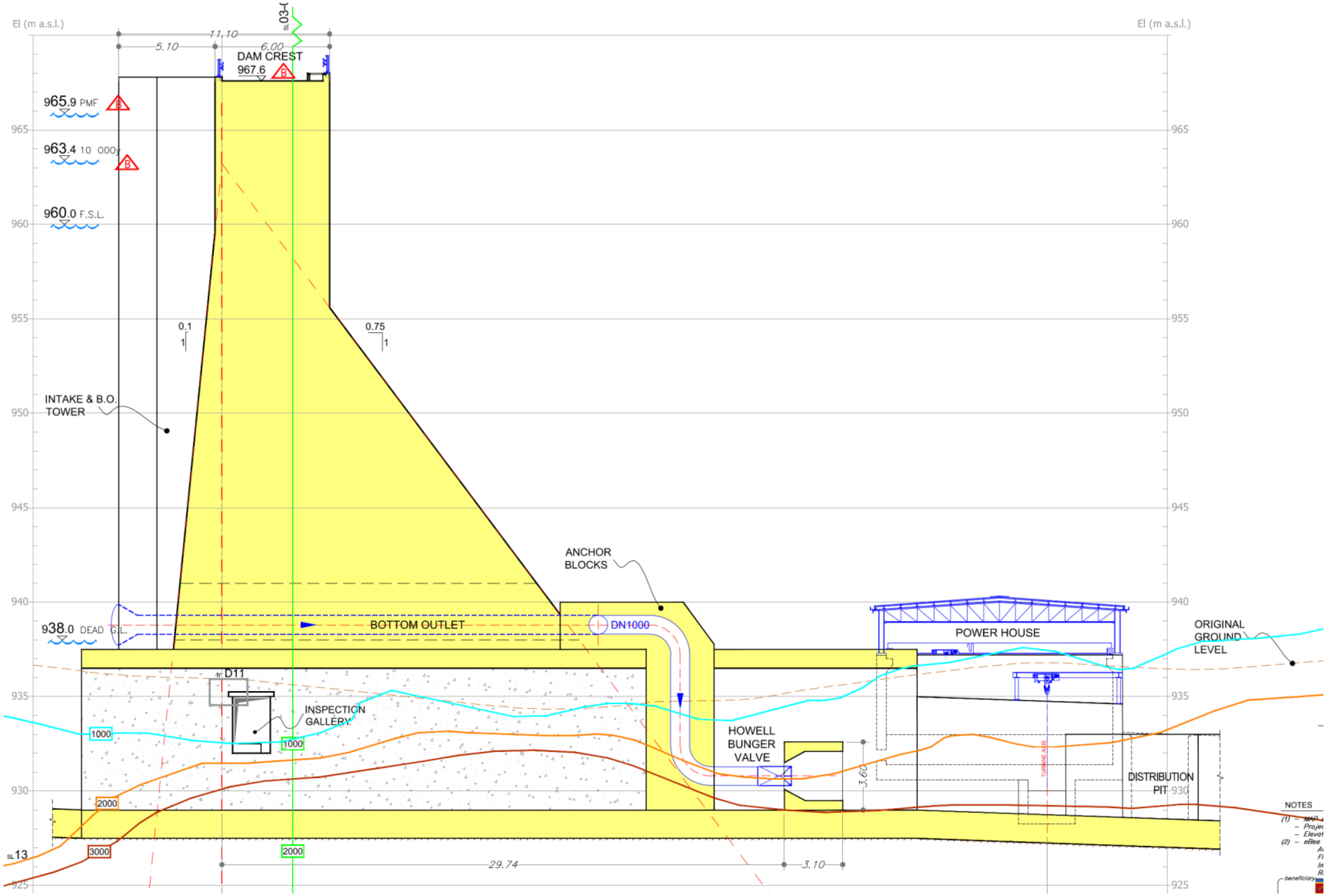


Figure 5-22: Cross-section of the Bottom Outlet (Studio Pietrangeli, 2019)

An analysis was undertaken to evaluate the time needed to drawdown the reservoir from the full supply level to the level of 938 masl. The maximum mean monthly inflow to the reservoir was considered to estimate the maximum emptying time, while the minimum mean monthly inflow was used to determinethe minimum emptying time of the reservoir, these are March (1.7 m^3/s) and Aug - Sept (0.3 m^3/s) respectively. The reference value for the time taken to drawdown the reservoir level was assigned as 1 m/day in order to mitigate the risk of the reservoir hillside instability due to excess water backpressure. The maintenance of this limit is guaranteed by closing the Howell Bunger valve by 80% during the drawdown after 27 days (el. 946 masl) when the inflow is maximum, and after 20 days (el. 948.5 masl) with the minimum inflow, respectively. According to the study carried out, the reservoir elevation will reach a level of 938 masl after 38 days with a maximum inflow, while in the event of a constant minimum inflow the reservoir will be drawn down after 31 days.

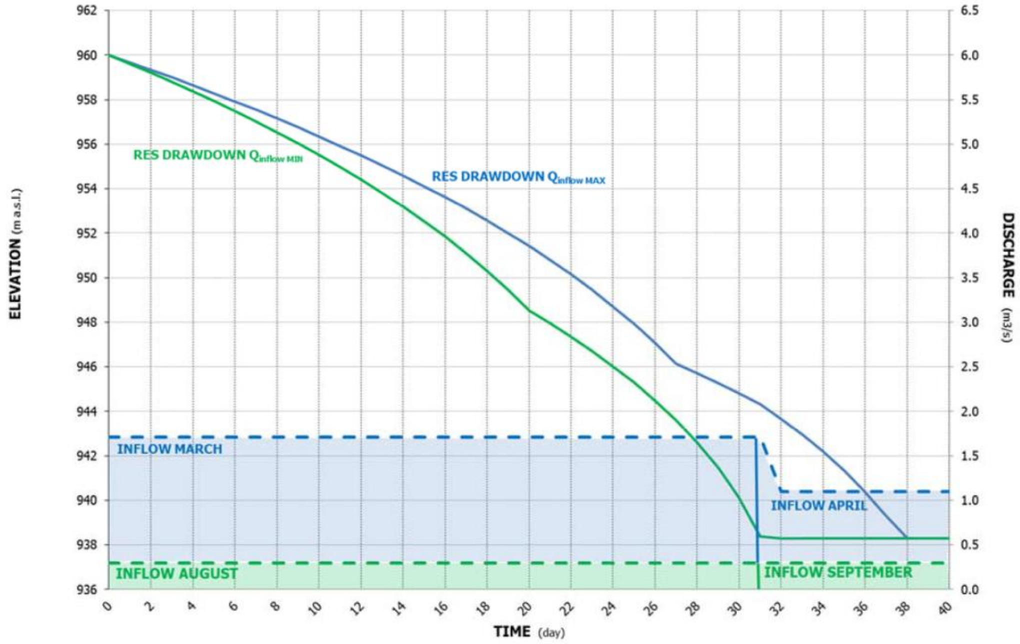


Figure 5-23: Reservoir Routing in case of Drawdown

5.7 ASSOCIATED INFRASTRUCTURE

5.7.1 CONSTRUCTION MATERIALS

The construction materials required mainly coarse and fine concrete aggregates, cement and reinforcing steel for the dam and all the concrete structures.

Table 5-10 provides the estimated quantities of materials required for the Project.

Table 5-10: Volume of Construction Materials Required

MATERIAL	VOLUME	UNIT
Concrete aggregate	140,000	m^3
Rockfill	10,000	m^3
Cement	20,500	Ton
Reinforcing Steel	1,900	ton

CONCRETE AGGREGATE AND ROCKFILL

Since alluvial materials are not available near the proposed dam site, crushing, sieving and washing procedures will have to be applied to obtain concrete aggregate, these activities will take place at the quarry. A quarry with sufficient suitable materials has been identified very close to the dam, approximately one-hundred meters upstream dam axis, on the left bank above the inundation level (**Figure 5-24**). **Figure 5-25** provides an aerial photograph of the quarry site. Approval for the quarry will be obtained from the EEA before mining.

The quarry area has been investigated via two geotechnical boreholes and laboratory testing of the material which included laboratory tests Specific Gravity, Los Angeles Test, sulphate content in acid, chloride content and potential alkali-silica reactivity.

Figure 5-24: Location of Quarry Area

Figure 5-25: Aerial Photograph of the Proposed Quarry Site

CEMENT

Table 5-11 identifies potential cement suppliers earmarked for the Project. The characteristics and quality of the cement supplied by the indicated suppliers, together with the production capacity in relation to the construction program, are considered adequate for the needs of the Project.

Table 5-11: Identified Cement Suppliers

SUPPLIER	COUNTRY	PRODUCTION CAPACITY	DISTANCE TO SITE
		(Mton/year)	(km)
Afrisam Cement	Eswatini	N/A	25
Sephaku Cement	South Africa	1.4	250
Intercement	Mozambique	1.0	145

REINFORCED STEEL

Table 5-12 identifies potential reinforced steel suppliers earmarked for the Project. The characteristics and quality of the reinforcing steel supplied by the indicated suppliers, together with the production capacity in relation to the construction program, are considered adequate for the needs of the Project.

Table 5-12: Identified Reinforcement Steel Suppliers

SUPPLIER	COUNTRY	PRODUCTION CAPACITY	DISTANCE TO SITE
		(Mton/year)	(km)
Columbus Stainless	South Africa	1.0	180
Acelormittal	South Africa	1.0	190

5.7.2 SITE CAMPS AND OFFICES

The construction and operation phases require the establishment of temporary and permanent support infrastructure for effective management and facilitation of the processes to be undertaken. The anticipated support infrastructure includes workers and management camps for the housing of workers and managers throughout the construction phase. In addition, permanent offices will be established for use during the construction phase as well as the operations phase for the effective maintenance and management of the dam and associated infrastructure.

The camps and offices are to be established on the right bank of the dam close to the dam site. It is anticipated that some of the labour will also be housed in Mbabane and Manzini. Existing roads will be utilised to access the areas where these sites are to be established, with short sections of new roads having to be developed to gain access to the final sites (**Figure 5-26**).

The specific details of the support infrastructure were not available at the time of the ESIA Report (this report) being compiled, however it is anticipated that these facilities will generally consist of housing, ablutions and social facilities such as kitchens and recreation areas, catering for the labour and management requirementsof the Project.

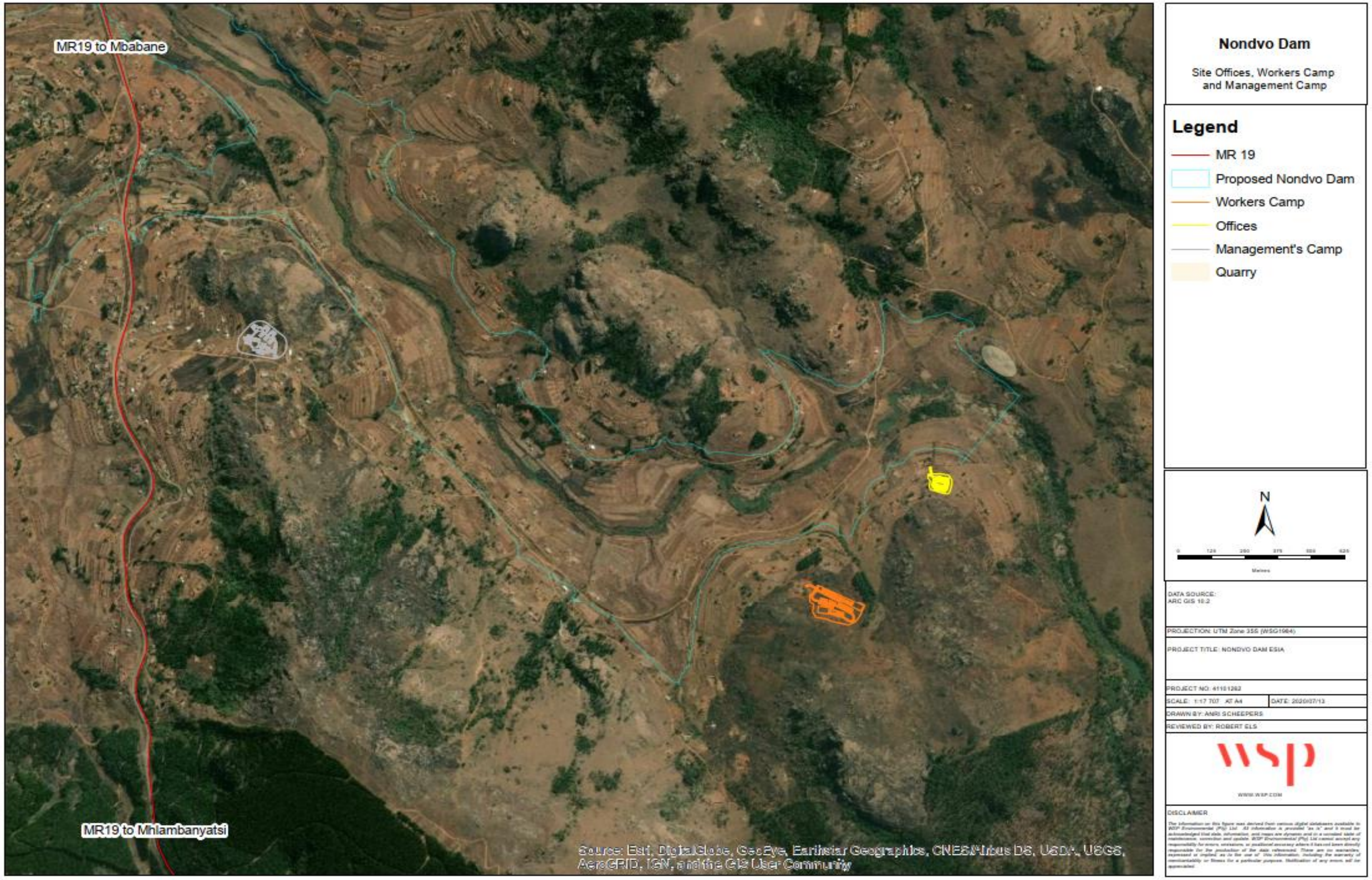


Figure 5-26: **Layout Showing Proposed Location and Extent of the Site Offices, Workers Camp and Management Camp**

5.7.3 POWER EVACUATION AND DISTRIBUTION SYSTEM

Transmission of the potential power output (130 kW) over distances greater than 10km, the commonly adopted limit for low and medium voltage transmission, would be greatly affected by losses and therefore not efficient. The final feasibility study (Studio Petrangeli, 2019) therefore identifies domestic users between the towns of Mhlambanyatsi (8km westwards), Malkerns (7 km eastwards) and Lobamba (9 km southwards) of the Project site as the potential supply area for power generated by the Project. In view of feeding the power output generated fromthe Project directly into the existing distribution network, the final feasibility study selected a preliminary perimeter of 6 km with a surface of 2 km^2 for locating the new distribution lines and relevant Low Voltage (LV) cabins (**Figure 5-27**).

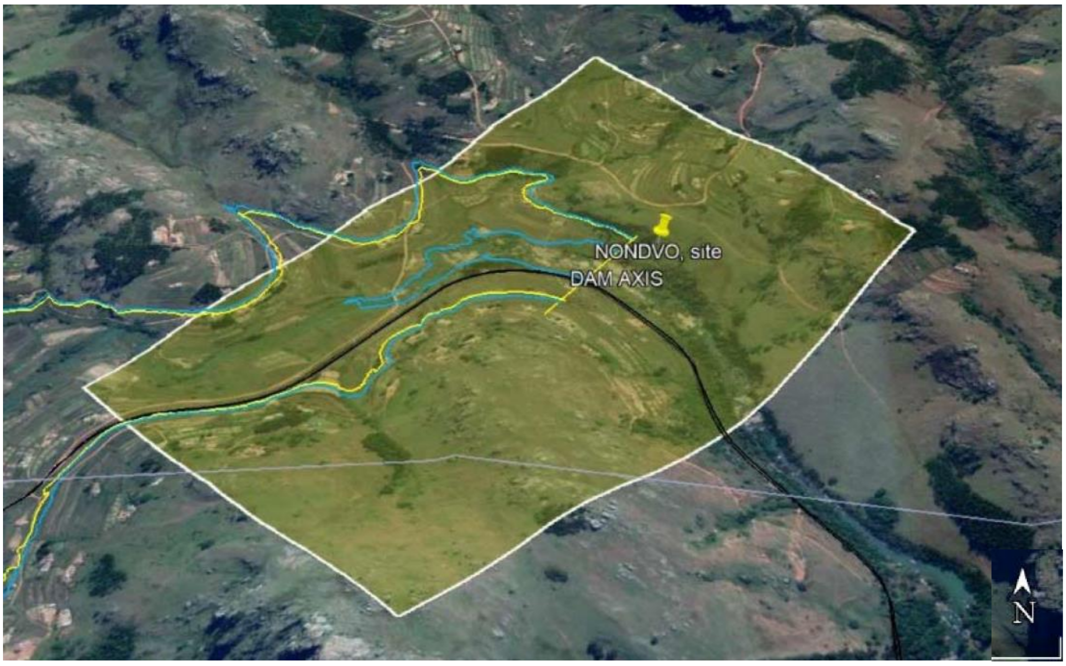


Figure 5-27: Satellite View of the Preliminary Selected Perimeter for Targeted Areas

Previous studies assessed that the present consumption density in the area would increase up to approximately 0.5 kVA per capita in the year 2035. By considering this assumption as an input, the potential 143 kVA (as derived by the active power output of 132 kW at 0.92 power factor) developed by the Nondvo hydropower plant, could meet the average demand of about 270 users.

The proposed power evacuation scheme of the Project takes advantage of the existing MV/LV distribution network for feeding final users located within the identified area surrounding the Project site.

The power evacuation scheme of the Project includes:

- 2 x 400 V AC circuits mounted on one double circuit overhead line, on wooden poles, departing from the powerhouse switchgear, leading northwards to a new LV cabin located at 312345E, 7075746S;
- 2 x 400 V AC circuits in insulated cable, which crosses the river via the cable trench located on the dam crest, leading south-westwards to a new LV cabin located at 312079E, 7075361S; and
- 2 x existing low voltage distribution cabins located Malkerns and Mbabane.

The power evacuation scheme is shown as a Single Line Diagram in **Figure 5-28**.

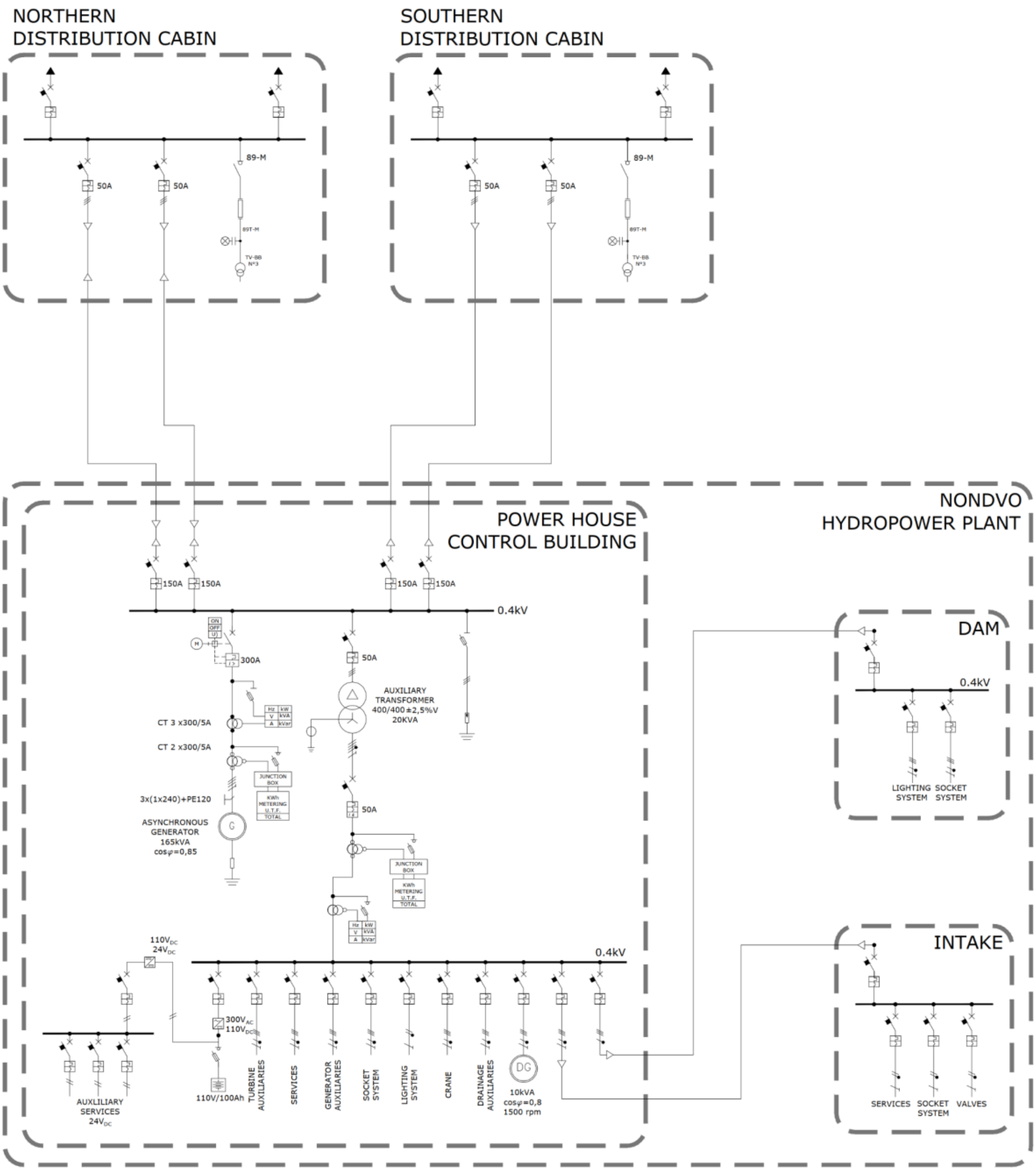


Figure 5-28: Powerhouse and Distribution System (Studio Pietrangeli, 2019)

Due to the almost continuous operation of the Nondvo HPP, it is necessary to guarantee high reliability of the generated power evacuation system. Therefore, two independent radial connections, one on either bank of the river, are provided up to new LV cabins for distribution network connection. Each of the two links is composed of two circuits for redundancy allowance. In particular, the circuits of each line are normally operated in parallel, obtaining high performances in terms of voltage drop and power losses. In case of outage of one circuit, the other is dimensioned to carry the entire design power with lower, but still acceptable performances.

Line routing was developed and assessed in such a way as to identify major geographical and environmental constraints, which could affect technical-economic trade-offs. The line routes are very short (below 1km), in a rural area indeed already electrified to a LV level.

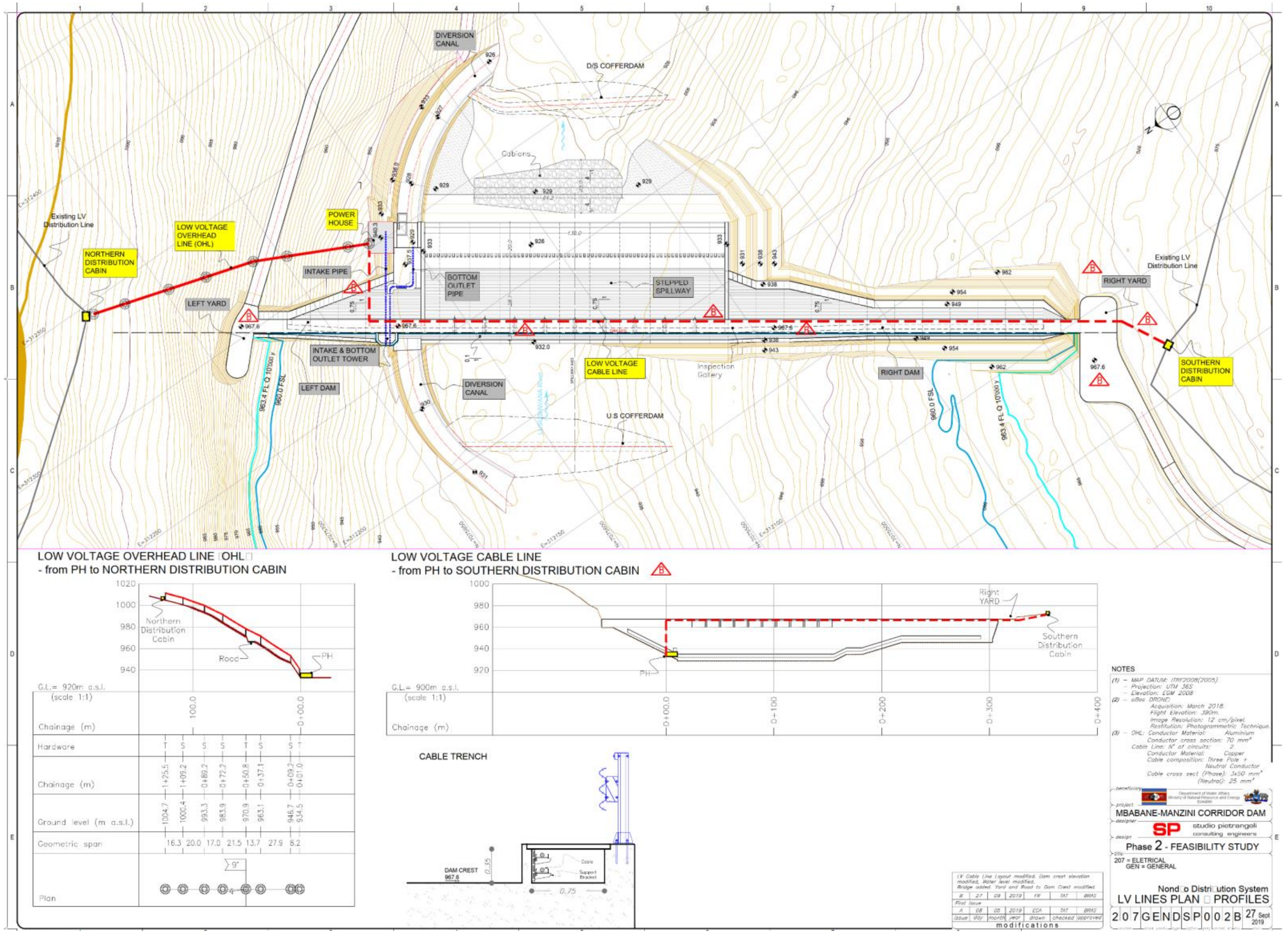


Figure 5-29: Power Evacuation Scheme Layout (Studio Pietrangeli, 2019)

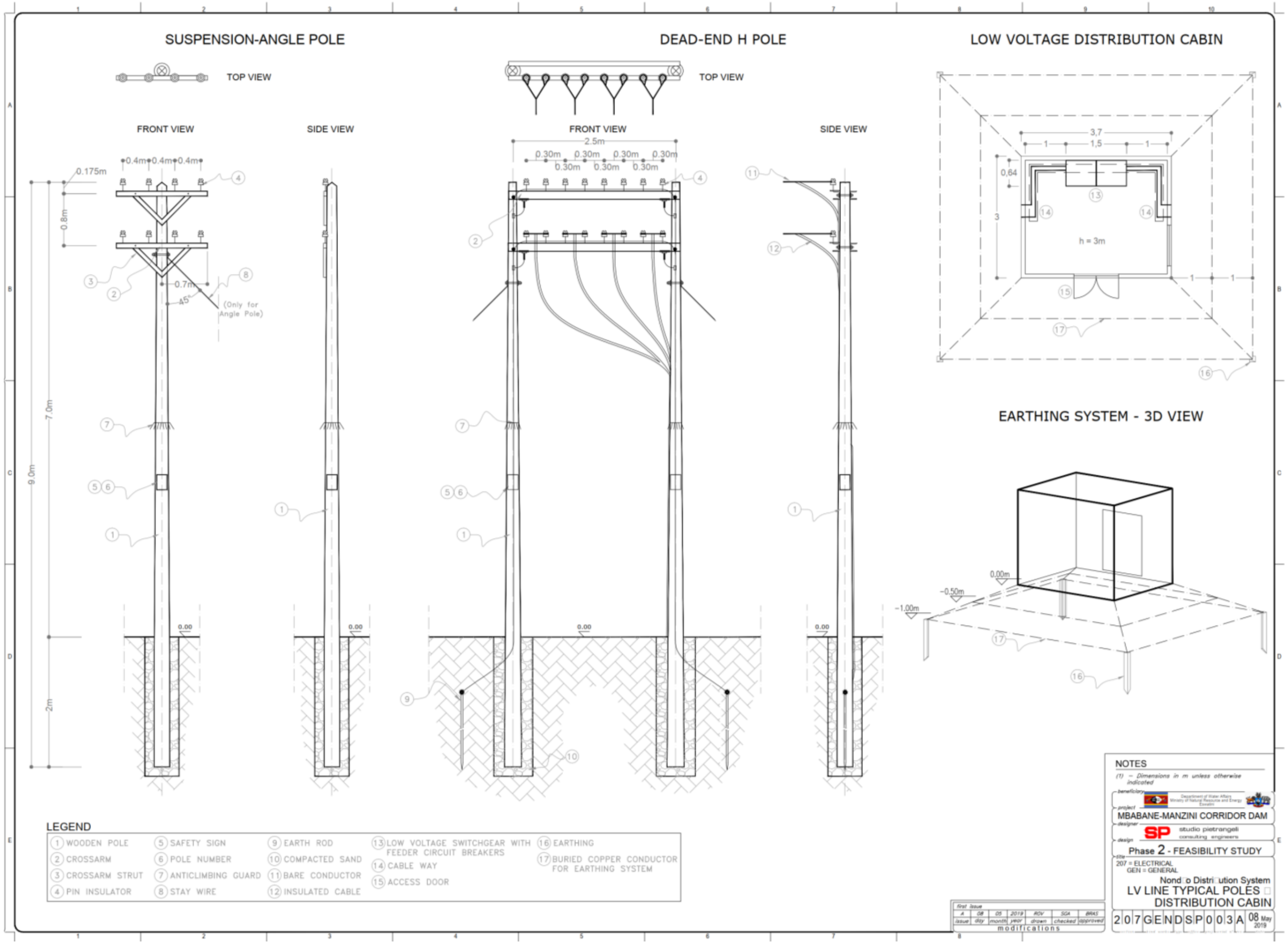


Figure 5-30: Typical Design of LV Poles and Distribution Cabin (Studio Pietrangeli, 2019)

The main characteristics of the two LV lines are summarised in **Table 5-13**.

Table 5-13: Main Characteristics of the LV Distribution Lines

LV LINE	TYPE	LENGTH	ROUTE DESCRIPTION
Northern	Overhead Line	123 m	Mainly located along a stretch parallel to the left abutment of the dam and therefore crosses an area characterized by the absence of settlements. Approximatively in the middle of the route, the line crosses two service roads envisaged for the future access to the hydropower plant.
Southern	Insulated Cable Line	347 m	The cable line is located within a cable trench from the powerhouse up to the cabin. The first stretch of the cable line departs from the powerhouse and runs up to the dam crest. After crossing the dam crest and the right yard, the line runs toward the southern distribution cabin.

5.8 RESERVOIR

As summarised in **Table 5-14** the Nondvo dam reservoir will cover an area of between 0.05 and 2.4 km^2 during normal operations (i.e. Min OL and Max OL respectively). While during flood events this area can increase to 2.9 km^2.

Table 5-14: Main Characteristics of the Reservoir

CHARACTERISTIC	ELEVATION	RESERVOIR VOLUME	RESERVOIR AREA
	masl	Mm^3	Km^2
Dead Storage capacity	938.0	0.12	0.04
Min. operating level (Min OL)	939.0	0.17	0.05
Max. operating level (Max OL)	960.0	21.6	2.4
Flood level @10’000 years (FL)	963.4	29.6	2.9
Extreme Flood Level (PMF)	965.9	38.6	3.3

Figure 5-31 graphically presents the reservoir area at Max OL (solid blue area), as well the extent of the reservoir during flooding (turquoise line). The area between the Max OL and FL level is designated as a buffer area in which no activities should be undertaken. These include the establishment of dwellings as well as linear infrastructure such as roads.

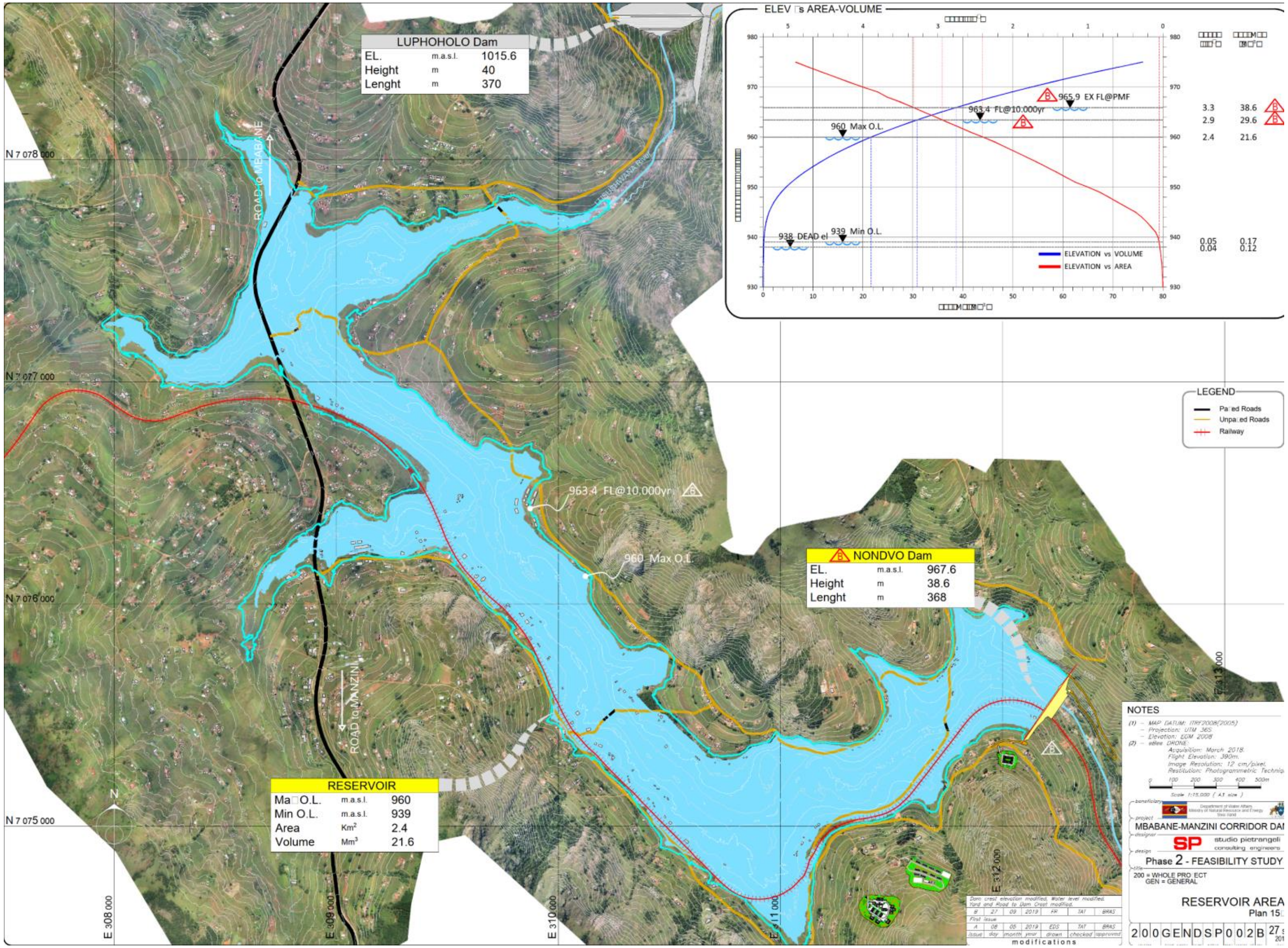


Figure 5-31: Reservoir Area (Studio Pietrangeli, 2019)

5.9 REALIGNMENT OF EXISTING LINEAR INFRASTRUCTURE

5.9.1 RAILWAY LINE

As shown in **Figure 5-31** an existing railway line runs along the Lusushwana River within the proposed reservoir area. The railway line originates at the Ngwenya Iron Ore Mine, which is located on Bomvu Ridge, northwest of Mbabane close to the north-western border of Eswatini. The railway line connected the mine with the Mozambique Railway System and was constructed for the transportation of mine materials. The mine ceased operations in the late 70s / early 80s due to a drop inthe average iron content. As such, the railway line has not been operational for approximately 30 years.

The complete route of the railway has been identified by means of the 1:250'000 scale map of the Eswatini railway lines, as the railway infrastructure within the Nondvo reservoir is not clear likely due to the fact that it has not been operational for an extended period of time.

To ensure the continued operation of the railway, should it be reinstated in the future, a route re-alignment is required along with infrastructure upgrades (i.e. establishment of bridges) to ensure the line is not flooded. A preliminary railway re-alignment is indicated in **Figure 5-32**.

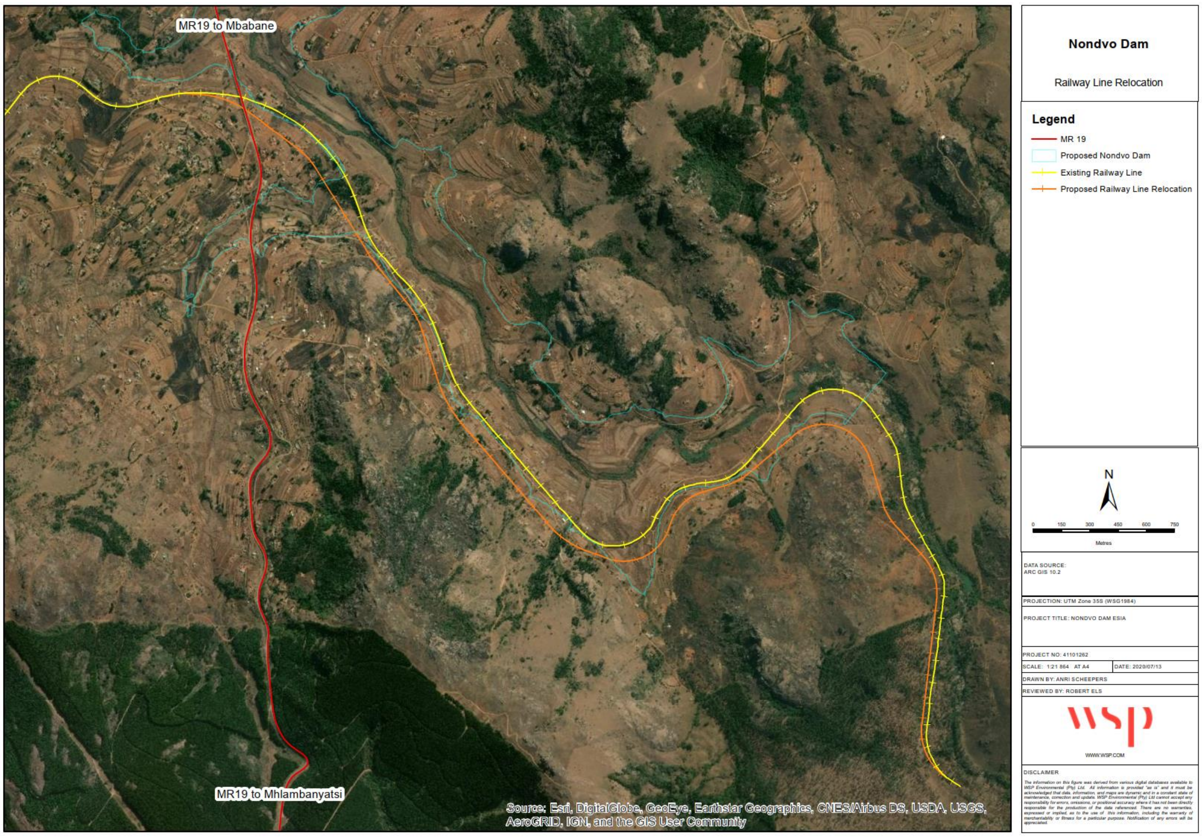


Figure 5-32: Railway Line - Existing and Proposed Re-alignment Route

The main characteristics of the realigned railway line are summarised in **Table 5-15**.

Table 5-15: Characteristics of the Railway Line Re-alignment

ASPECT	VALUE	UNIT
Length	6 250	m
Maximum slope	2.0	%
Minimum radius	250	M
Bridges (No. of)	3	#

Based on the above characteristics, re-alignment of the railway is estimated to cost between approximately 8 to 11 Million US$.

5.9.2 ROADS

MAIN ROAD (MR19)

As shown in **Figure 5-31**, two sections of the main road (MR19), connecting Mbabane and Mhlambanyatse, fall within the proposed reservoir area. Therefore, a route realignment, and potential infrastructure upgrades (i.e. establishment of bridges), are required to ensure the road is not flooded. **Figure 5-33** provides a layout of the northern section of the MR19 that will be inundated by the reservoir.

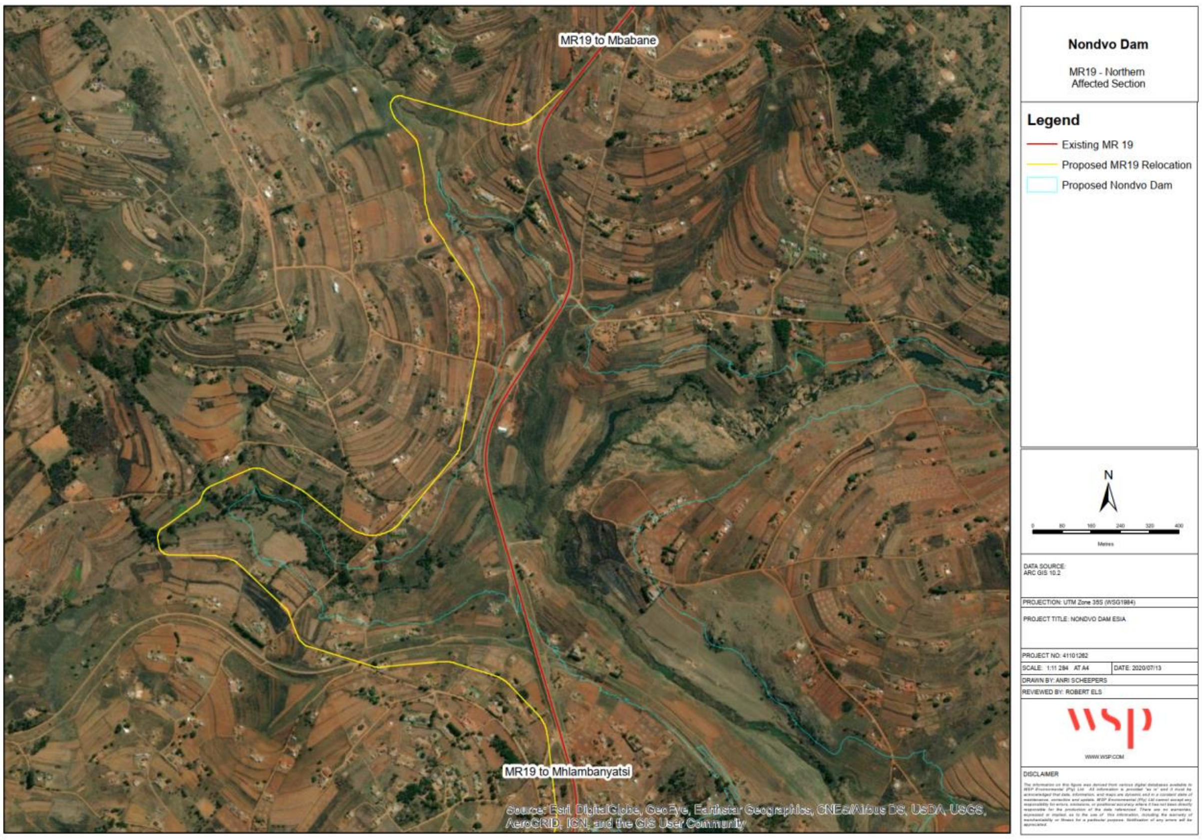


Figure 5-33: Layout Showing the Northern Affected Section of the MR19

Figure 5-34 provides a layout of the southern section of the MR19 that will be inundated by the reservoir.

Figure 5-34: Layout Showing the Southern Affected Section of the MR19

The proposed realignment of the MR 19 is provided in **Figure 5-35**. The main characteristics of the realigned MR 19 are summarised in **Table 5-16**.

Table 5-16: Characteristics of the MR 19 Re-alignment

ASPECT	VALUE
Length (m)	6’020
Maximum Slope (%)	8.8
Bridges	0

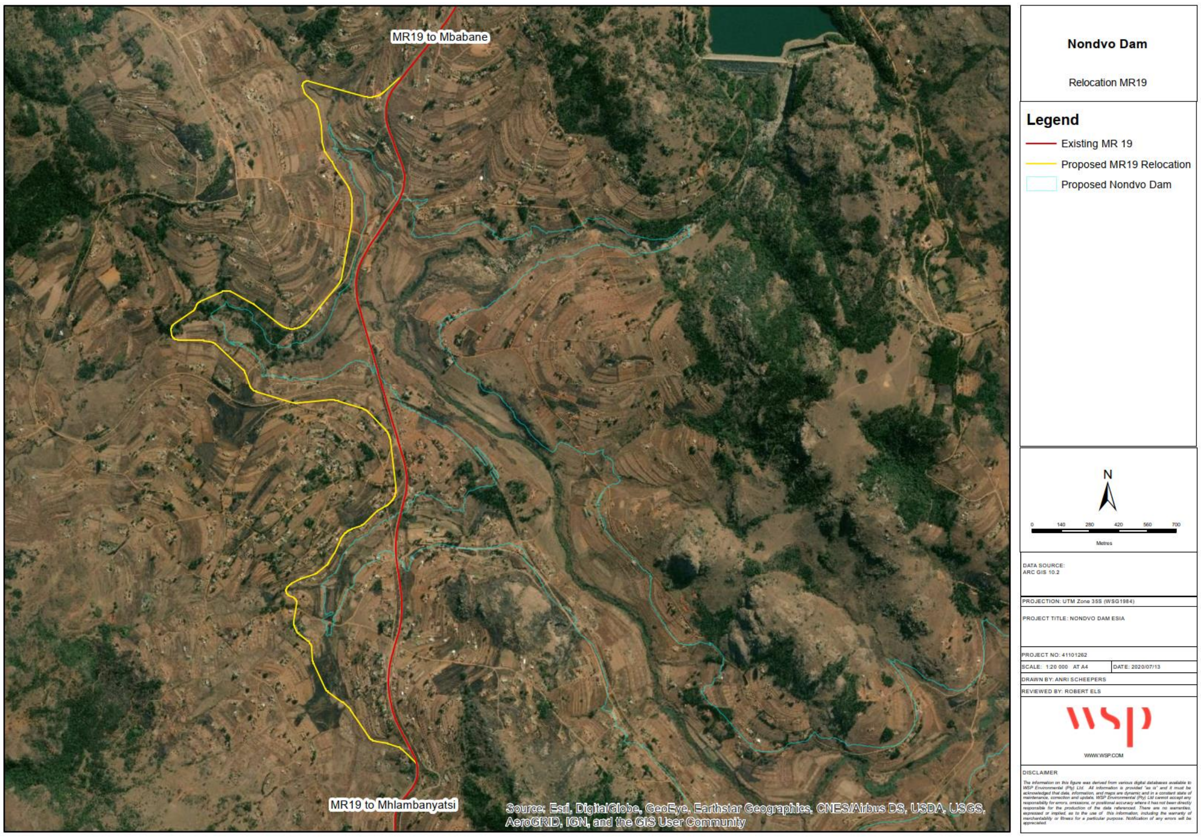


Figure 5-35: MR19 Proposed Realignment

INFORMAL ROAD NETWORK AND PEDESTRIAN CROSSINGS

Also evident in **Figure 5-31** is that the proposed reservoir area will result in the flooding of sections of the informal road network connecting the left and right banks of the Lusushwana River. As indicated in **Figure 5-36** four low-level crossings will be flooded, amongst other internal roads.

To facilitate continued access to homesteads, as well as the connectivity between the left and right banks for the communities, new infrastructure and roads will have to be established. Included in the Project design is a bridge across the dam connecting the left and right banks on the southern side of the dam. On the northern side of the dam it is anticipated that a ~150 m bridge will be required to replace the flooded low-level crossing.

The current roads foreseen in this project comprise accesses to (Studio Pietrangeli, 2020):

— Dam area and powerhouse;
— Management's camp, workers' camp and offices;

The access roads to be realised/rehabilitated cover a 9 km total length, of which:

— Approximately 1.5 km to be constructed, including access to the:
  ▪ dam site;
  ▪ camps (management's camp and worker's camp) comprising the inner roads;
  ▪ offices; and
  ▪ powerhouse.
— The remaining 7.5 km stretches will be rehabilitated. The roads will be enlarged and stabilised in order to transport heavy construction materials and machinery

In addition to the above, three low level crossings and two footbridges will be inundated by the reservoir, the location of which are shown in **Figure 5-36**. River crossing and the link between the two banks will be guaranteed by a road over the dam crest. New pedestrian crossings may be envisaged upstream of the reservoir, immediately downstream the Lupholo dam or immediately downstream the Nondvo dam.

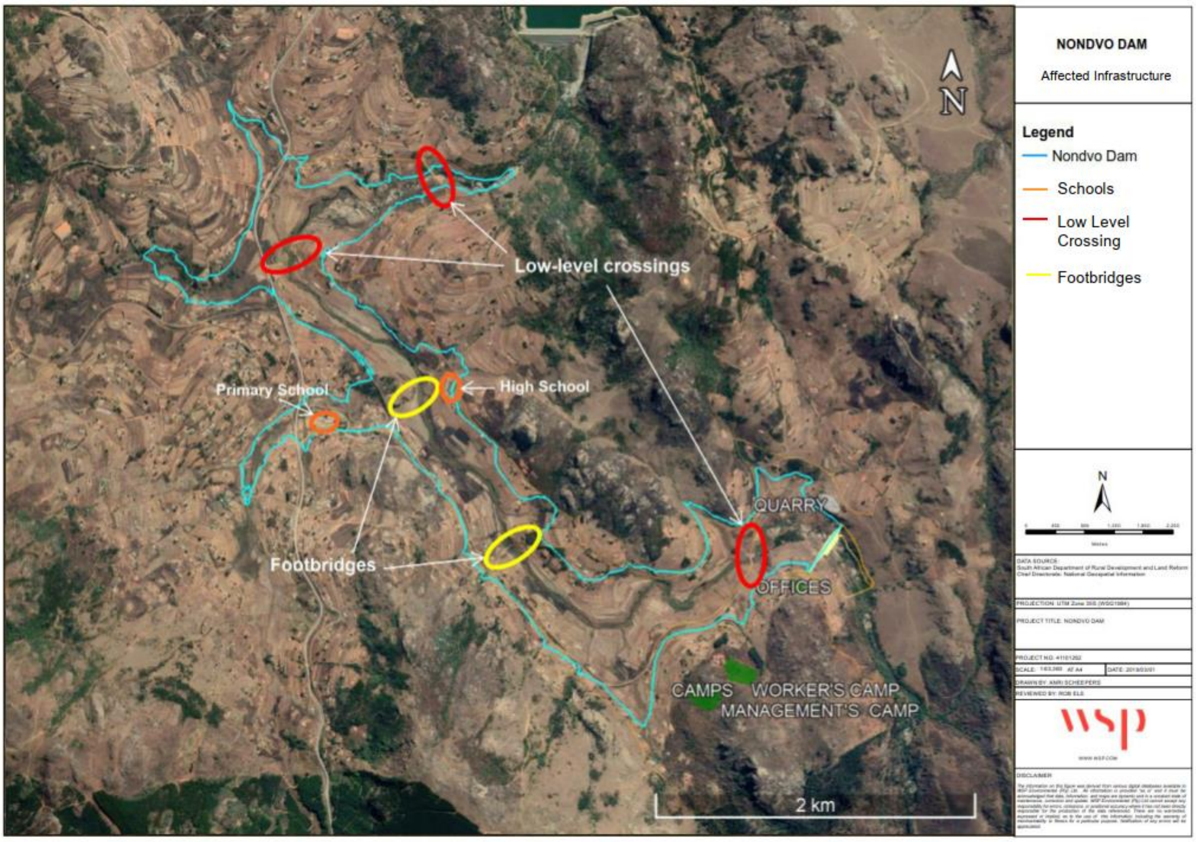


Figure 5-36: Internal Road Network, including Four Low-level Crossings, Affected by Reservoir

5.10 PROJECT SCHEDULE

CONSTRUCTION ACTIVITIES

The construction methodology will be confirmed during the detailed design phase. However, construction will generally follow:

- Foundation preparation and treatment (site clearing, remove overburden and rock scaling; dental concreting; foundation grouting);
- River diversion (construction of diversion channel and upstream and downstream cofferdams);
- RCC dam placement works:
  - RCC placement preparation (including formwork);
  - Surface preparation (roughening and bedding mortar);
  - Continuous layering and compaction (transporting, spreading and compacting of RCC);
  - RCC curing; and
  - Instrumentation (installation of mechanical and electrical equipment).

In support of the above, the following activities will be carried out:

- Transport of plant and equipment to the site;
- Site establishment (Site camp, offices, etc.) ;
- Site clearance, including removal of vegetation;

- Establishment of the quarry for source materials;
- Hauling of materials to the construction site;
- Stockpiling of materials on-site;
- Operation of a concrete aggregate crushing plant;
- Operation of a concrete batching plant; and
- Spoiling of excavated rock (if not suitable for aggregates).

Development of the Nondvo Dam, from the commencement of construction to commissioning, is anticipated to be undertaken over a 36 month period[10]. The anticipated duration of the main activities are indicated in **Table 5-17**.

Table 5-17: Anticipated Project Schedule

ACTIVITIES	PERIOD
Mobilization and Demobilization	6 Months
Roads and Camps	3 Months
Diversion Works	4 Months
Dam and Auxiliary Works	24 Months
Powerhouse	10 Months
Commissioning	4 Months
Total	**36 Months**

5.11 OPERATIONS

5.11.1 DAM OPERATIONS

It is anticipated that the role of DWA will ensure finance is secured and disbursed, the Dam is constructed; as well as playing a regulatory role during the construction and operation phases of the Project. However, the operations and maintenance of the dam will be delegated to the relevant entity through a service level agreement.

5.11.2 POWERHOUSE OPERATIONS

Given the small capacity of the plant (estimated at less than 1 MW) tailored to the potential exploitable at Nondvo site cannot reasonably be evacuated at medium voltage level system or higher. For this reason, a low voltage scheme has been conceived for connecting the new power plant to the existing distribution network.

The distribution of electricity generated as well as the operation, management and maintenance of the plant will be likely taken over by the Eswatini Electricity Company (EEC), which is already operating the run-off river plants downstream on the Lusushwana River.

[10] The duration of the construction time has been estimated on the basis of a suitable contractor's standard production for excavations, RCC, cement, etc.

5.12 LAND ACQUISITION, RESETTLEMENT AND COMPENSATION

The land-take impacts come from the inundation areas, work camp and office areas, the quarry area and dam wall as well as access roads all of which take land permanently, and the access roads, which disrupt peoples' land and other assets mostly temporarily during the period of construction.

The Involuntary Resettlement planning process started with the identification and determination of the number of the PAPs, as well as their affected assets. In order to assess the magnitude of the task, a desktop study of the affected area was undertaken and the team undertook the field visit to confirm the properties and work with community structures. The Asset registration and verification targeted homestead/household heads were undertaken over a period of two weeks from 29 July to 17 August 2019. Identification and Registration of assets occurred in presence of owners or their representatives and community representative to check for their correctness of surveyed / measured assets and ownership details.

The household's asset types that were registered included:

- Residential plot
- Dwellings primary type
- Outbuildings (Kraal, chicken coups, etc.)
- Incomplete structures
- Fruit Trees
- Fuel Trees
- Garden
- Arable land
- Commercial structures
- Informal business structures
- Forest
- Water points (stand pipe / water tanks)
- Toilets

Table 5-18 summarises the land-take impacts of the Project as caused by its major components.

Table 5-18: Land-take Impacts

PROJECT COMPONENTS IMPACTING ON PAPS LAND	NATURE OF IMPACT
Nondvo dam, including: – Dam and reservoir; – Work camps and offices; – Quarry and access roads	Establishment of the dam will result in the displacement of: – 175 HHs - of these 102 HHs will experience physical and economic displacement, while 73 HHs will experience economic displacement only. Included in the affected assets are approximately 94.2 ha of arable land and 28.8 ha of residential land. The above includes: – Two schools, namely the Bhekephi Primary School and Masibekela High School, which require relocation; and – One church, namely the Devine Healing Church, which requires relocation.
Railway line realignment	Rerouting the railway line will affect approximately 39 HHs[11].

PROJECT COMPONENTS IMPACTING ON PAPS LAND	NATURE OF IMPACT
MR19 road realignment	Rerouting the MR19 road will affect approximately 21 HHs[11].

A RAP has been developed for the Project based on the current Project description and is included in **Appendix I**.

The compensation model proposed within the RAP includes cash compensation as well as in-kind compensation, and/or a combination of both, as well as livelihood restoration options. The proposed compensation packages are to be presented and discussed with the PAPs. The aim is to provide compensation that is both beneficial and sustainable to the affected PAPs.

Cash compensation is not the preferred option however is some instances is either requested or required (such as due to limited availability of replacement land, etc.). In each situation PAPs are entitled to participate in the Livelihood Restoration Plan (LRP) which includes the provision of resettlement assistance, land-based activity training (such as improved agriculture techniques), as well as non land-based activity training such as financial management / entrepreneurial training. The objective of the RAP and LRP is to ensure that PAPs are in a position that their standards of living, income- earning capacity, production levels and overall means of livelihood are improved.

One of the major challenges associated with resettlement, particularly in rural contexts where people are reliant on land and the use of natural resources, is the restoration of existing livelihood strategies. Livelihood restoration focuses on the restoration, and potential enhancement, of livelihoods of the PAHs, as well as the existing inhabitants of the host communities, whose livelihoods will also potentially be disrupted. The overall aim of the LRP is to ensure that there is a measurable improvement in the lives and livelihoods of eligible PAHs. This section summarizes the Project's approach to livelihood restoration activities that will meet the following objectives:

- Provide sustainable livelihood packages for PAHs that are designed to enable the PAP and PAH to move beyond dependence on external resources;
- Provide mechanisms for those receiving cash compensation to optimize opportunities;
- Where possible leverage off existing skills and interests, however, also provide an environment for the development and enhancement of new skills; and
- Support self-reliance and promote socio-economic empowerment to improve, or at least restore, the livelihoods and standards of living of the displaced persons and their households.

The LRP comprises a package of livelihood restoration options that are to be offered to PAPs and PAHs. The level of support provided is to be aligned with the level of impact experienced by a household as well as their potential vulnerability.

In the context of the ongoing evolution of the project description, as peoples' individual circumstances change (e.g. through death in a family, development of a health issue, climate related impacts etc.), an adaptive approach to RAP implementation is required. Such an approach is common in resettlement planning, and RAPs are typically dynamic documents that require regular updates.

Against this background RAP refinement and updates will be undertaken within the RAP Implementation Phase, which is divided into two stages, namely a Consolidation stage and Implementation stage, as indicated below.

- Stage 1: The Consolidation Stage is to be based on final detailed designs, during which a final verification assessment and valuation, including cut-off date, will be undertaken to capture any changes in people's individual circumstances and define individual compensation packages for negotiations and acceptance by PAPs. The extend of land required for host sites will be finalised, based on PAPs acceptance of packages, and secured for allocation to individual PAPs.
- Stage 2: The Implementation Stage, during which compensation is issued and livelihood restoration activities implemented. This stage includes monitoring and evaluation of the resettlement process, including tracking impacts and objectives as well as auditing upon completion and post-project evaluation. The objective of post-project evaluation is to assess the long-term impact that resettlement has had on PAPs and host

[11] Estimated affected HHs are based on desktop review as details of the proposed realignment were not available at the time of undertaking the infield investigations.

communities, and whether compensation and livelihood restoration initiatives achieved the intended benefits in a sustainable manner.

6. ANALYSIS OF ALTERNATIVES

This part of the ESIA Report identifies various potential alternatives that would allow the project objectives to be reached, including the 'without project' option. In the present evaluation, the following potential alternatives have been identified:

- Without project;
- Alternative water impoundment options;
- Alternative dam locations;
- Alternative dam heights; and
- Alternative dam types.

These are described in more detail in the sections below.

6.1 WITHOUT PROJECT ALTERNATIVE

The "without project" alternative is not feasible as it will not allow the project objectives to be met i.e. there will continue to be insufficient storage capacity of water to supply potable water to Mbabane and Manzini.

In addition, there will not be the possible secondary benefit of utilising the proposed Nondvo Dam for small-scale hydropower generation or downstream irrigation.

6.2 ALTERNATIVE WATER IMPOUNDMENT OPTIONS

The Technical Scoping Study Report (Studio Pietrangeli, 2018) identified several alternatives to impound sufficient water in order to meet the short- and long-term water demands, in particular.

1) Raising of the Luphohlo Dam wall to increase storage capacity.
2) Raising of the Hawane Dam wall to increase storage capacity.
3) Development of the Nondvo Dam.

The Technical Scoping Study Report assessed these options independently as well as in combination. These options are in reality not considered as alternatives as all water impoundment options will be implemented but in a phased approach through separate ESIA processes. The following combinations were selected as the most promising.

1) Raising of the Luphohlo Dam wall and Development of Nondvo Dam with Max OL at 960 MASL

In this option the Luphohlo Dam wall will be raised by 5m, the existing Ezulwini power plant will be optimised, and the Nondvo Dam will be developed with a Max OL of 960 MASL. This solution guarantees a water volume of 11.9 Mm^3/year from the Luphohlo dam and 9.8 Mm^3/year from the Nondvo Dam. This volume covers both the domestic and irrigation demands. The main technical advantages of this development option are as follows:

- Increase of the energy production at the Ezulwini power plant during the dry season (+15%) with a significant reduction of energy importation;
- Additional 1.3 GWh/year produced at the Nondvo power plant;
- Meeting of the water demand in the Mbabane-Manzini corridor up to 2050, with actions divided by phases:
  - Phase 1 - Luphohlo dam raising and water supply of the short-term demand; and
  - Phase 2 - Nondvo dam construction to satisfy the 2050 demand.
- Providing water supply for irrigation of 800 ha.

With part of the volume for domestic uses supplied by Luphohlo, this solution has the additional advantage of reducing the pumping costs for water supply to Mbabane, which is located in the higher area, since the Luphohlo reservoir is about 55 m higher than the Nondvo Reservoir. In addition, the existing Water Treatment Plant (WTP) on the Luphohlo Lake and pipeline to Mbabane, whose capacity can be increased in the future as soon as the water demand meets the WTP capacity. Except for Mbabane, all the other areas can be supplied by gravity with the WTP located at the toe of the dam.

2) Raising of the Luphohlo Dam wall and transfer of water from an additional catchment to Luphohlo

In this option, the Luphohlo Dam wall will be raised by 5m, the existing Ezulwini power plant will be optimised, and a canal will be constructed to convey water from an additional catchment into the Luphohlo reservoir. This scenario foresees an abstraction of 21.7 Mm^3/year. The main advantages of this solution are as follows:

- Avoiding construction of the Nondvo dam;
- Meeting the demand in the Mbabane-Manzini corridor up to 2050; and
- Providing water supply for irrigation of 800 ha.

This option would not achieve the additional 1.3 GWh/year that would be produced at the Nondvo power plant.

A comparative analysis was undertaken and based on the outcome, the DWA selected to first continue with the Luphohlo Dam wall raising and construction of Nondvo Dam. Water supply to Mbabane/Manzini was the main consideration for selecting the Nondvo Dam site. The raising of Lake Luphohlo was the alternative, but a higher yield could be obtained from Nondvo Dam. Furthermore, the development of 800 ha as small-scale irrigation farming units would become possible with the construction of the Nondvo Dam.

It is noted that the commissioning of the ESIA for the Project was limited to the construction and operation of the Nondvo Dam. A separate ESIA is planned to be commissioned for the raising of the Luphohlo Dam wall.

6.3 LOCATION ALTERNATIVES

6.3.1 NONDVO DAM LOCATION

The proposed Nondvo Dam is proposed to be located on a tributary of the Lusushwana River. The site was identified for this purpose based on an initial multi-criteria selection process developed during the execution of the Joint Maputo River Basin Water Resources Study (JMRBWRS1; 2008) jointly undertaken by the Kingdom of Eswatini, the Republic of South Africa and the Republic of Mozambique.

DAM WALL ALTERNATIVE CONSULTATION

The DWA had established and maintained a Project Steering Committee and Stakeholder Committee. The former comprised representatives from the various relevant Government ministries and parastatals, while the latter comprised Government ministries, parastatals as well as community representatives including the office of the Member of Parliament. Aspects relating to the dam, including its proposed location were discussed during the regular meetings held by both committees.

The dam location is based on the optimal yield of the watercourses in the area and the need to have a site that is at sufficiently high altitude to enable conveyance of water by gravity so as to avoid unsustainable pumping costs.

A site visit was undertaken on 26th September 2020 wherein the community representatives were afforded an opportunity to present proposed alternative locations for the dam wall to DWA. During the site visit the community representatives submitted that in their opinion the most suitable site is at S26° 26' 42.3" E31° 07' 43.4" which is 2.9km downstream of the current proposed dam wall. Favourable aspects of this site submitted by Mantabeni Royal Kraal were:

- That the underlying geology is similar to that of current proposed dam wall;
- That the depth and narrowness of the river valley are suitable to achieving the volume of desired impounded water and enabling a dam wall that is not excessively long from one river bank to the opposite bank. This, the community felt, would be more cost effective since the construction and resettlement costs would be less than the current proposal; and
- That fewer households, if any, would need to be resettled.

The Royal Kraal found no unfavourable aspects of the site, from a social perspective.

The second possible site was identified by the community at S26° 26' 34.6" E31° 08' 06.9" which is 3.6km from the current proposed dam wall. Favourable aspects were submitted as:

- Suitable underlying geology;
- Little or no adverse impacts of resettlement
- The unfavourable aspect was submitted by the community as possibly higher construction costs compared to the site at 2.9km, particularly in view of the wider valley section and depth of valley.

The response by the Technical Feasibility Consultant was that the preferred proposed location and height of dam wall were selected due to:

- The suitability of the underlying geology at the preferred site. The alternative site immediately south of the preferred site did not present the optimal geological consistency and integrity as the preferred site, which had rocks on both abutments as well as the river bed, thereby providing optimal conditions for a solid foundation.
- The preferred site presenting the most optimal geological conditions and topography for achieving optimal water harvesting volume (to meet water present and projected water demand up to at least 2050) with the most balanced environmental and social impact in terms of advantages and disadvantages. For example, placing the dam wall further south would require a higher dam wall due to the depth of the valley, thus requiring a higher complexity of engineering and thus cost, resulting in the project not being economically feasible.

Stakeholder engagement on the selection of the best available option was undertaken and was inherently constrained by the geotechnical requirements of dam construction wherein the geology and topography are amongst the key determinants on dam location. Therefore selection of alternative sites presents diminishing returns and thus presenting less cost-effective solutions.

6.3.2 DAM WALL LOCATION

Numerous dam wall aternatives were identified based on the requirement of a reservoir volume of about 22 Mm^3. The alternatives were identified based on 1) the topography of the area acquired by a drone during the survey held in February/March 2017; 2) the preliminary geological survey of the area; and, 3) the hydrology data of the Lusushwana River.

During the Technical Scoping Study Report only three potentially feasible alternatives for the Nondvo Dam axis location were assessed. Based on the area-volume curve (**Figure 6-1**) analysis none of the other dam wall alternatives that were identified further downstream was considered viable as the dam wall height required for a reservoir volume of about 22 Mm^3 will not be economically feasible.

The coordinates of the three alternative dam locations, and area of the reservoir basin, are summarised in **Table 6-1.**

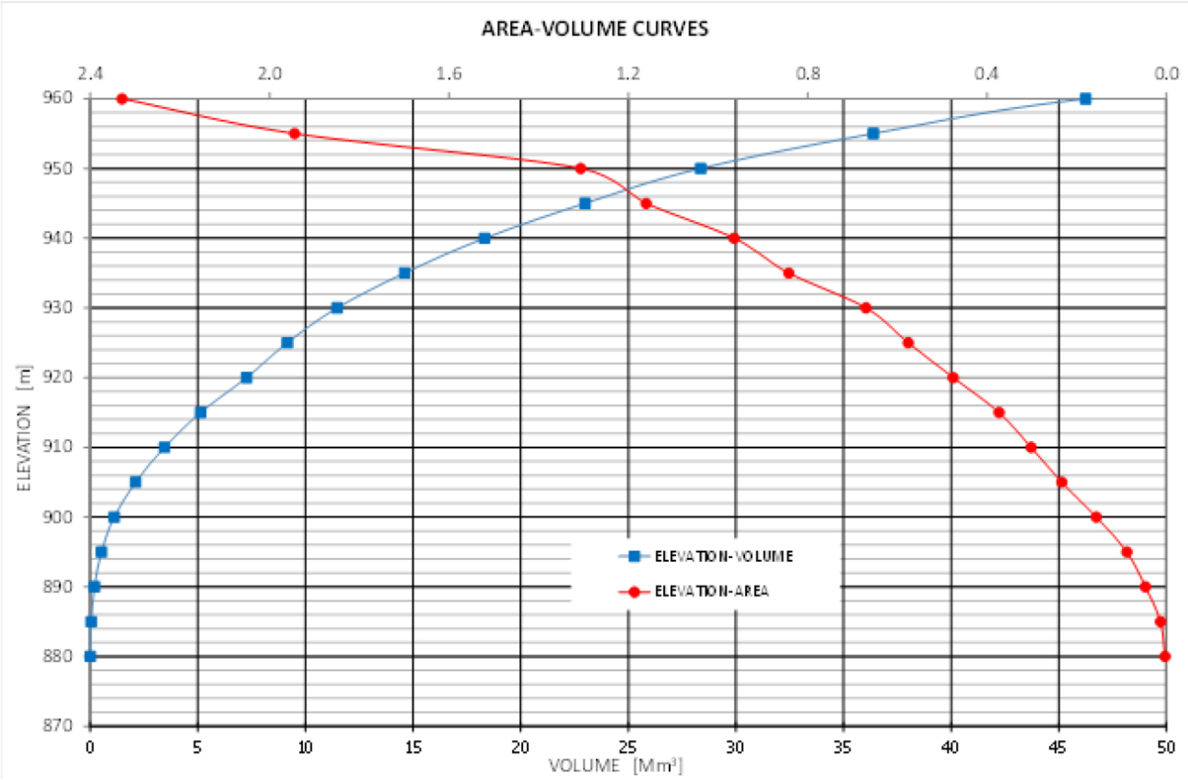


Figure 6-1: Area-Volume Curve Analysis for Downstream Wall Alternative

Table 6-1: Location Alternatives

NAME	COORDINATES (UTM-WGS84-ZONE 36J)		BASIN AREA
	E	S	KM²
Preferred Alternative	312191	7075564	645
Alternative 1 (Upstream)	312490	7075070	648
Alternative 2 (Downstream)	312790	7073930	657

Alternative 1 is located approximately 500m downstream from the preferred Alternative and Alternative 2 is located approximately 800m downstream from Alternative 1. **Figure 6-2** shows the location of the three alternatives in relation to each other.

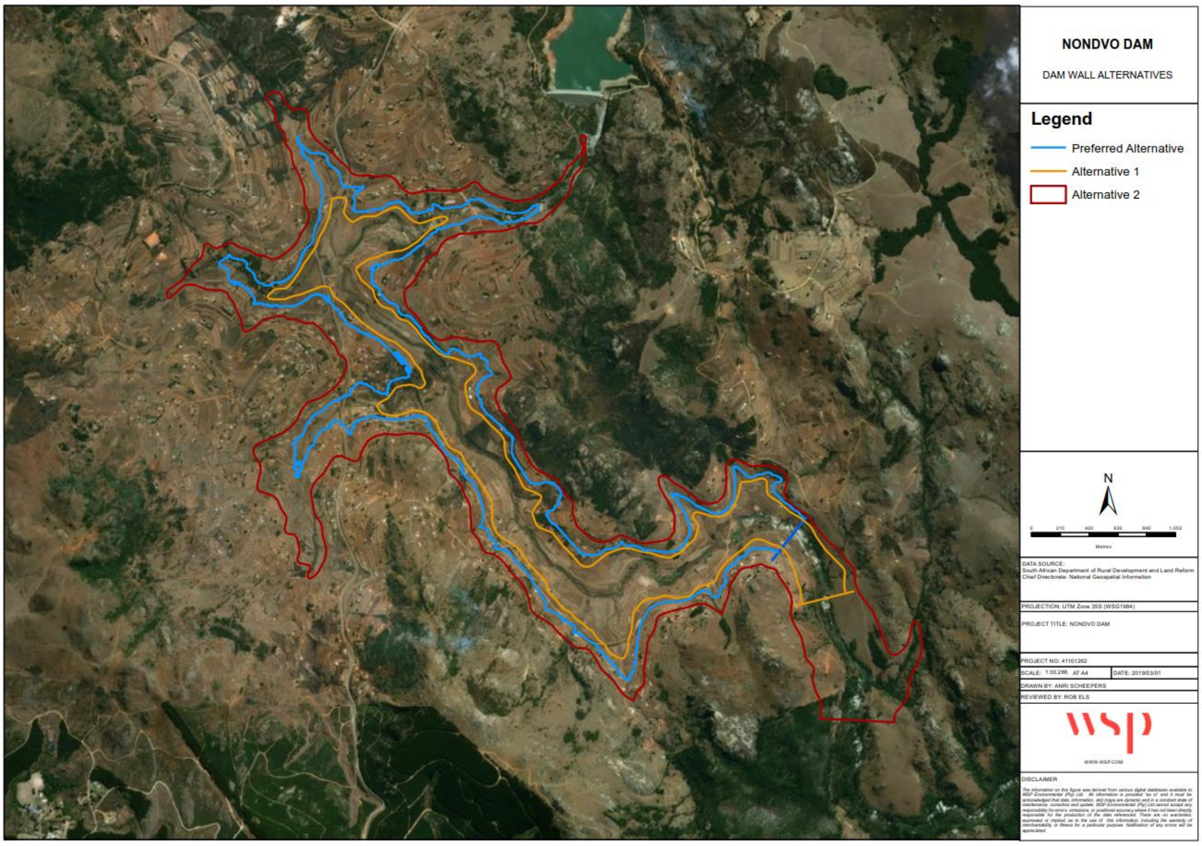


Figure 6-2: Reservoir Footprint of Dam Wall Location Alternatives (Studio Pietrangeli Consulting Engineers, 2017)

Alternative 2 has the main technical advantage of being able to collect the water of an additional left tributary of Lusushwana River; however, this will have the result of partially inundating the Mlilwane Game Sanctuary reserve. Mlilwane's diverse habitats support an extensive species list. The southern plains stretch to the Nyonyane Mountain (Execution Rock) with its exposed granite peak. Tourism is also concentrated in this southern section of the park, while guided Chubeka Trails explore the northern section, as far as Luphohlo Peak. The Nyakato viewpoint overlooks Mantenga waterfall and the Usushwana Valley below. As such this alternative was not investigated further.

The impact anticipated with the Preferred Alternative will inundate a larger area than Alternative 1 but less than Alternative 2. The Preferred Alternative and Alternative 1 will not inundate the Mlilwane Game Sanctuary reserve. The Preferred Alternative is best suited to the geological conditions.

AFFECTED HOUSEHOLDS AND INFRASTRUCTURE

The extent of resettlement is related to the occupied areas within the components planned for dam construction and impounding, which strongly depend on the selected reservoir elevation. **Table 6-2** summarise the results of the extent of resettlement and road relocation for each dam site and by varying the reservoir elevation.

Table 6-2: Impacted Facilities Relating to Alternatives (adapted from (Studio Pietrangeli Consulting Engineers, 2017))

			MAX OL (MASL)					
INFRASTRUCTURE	**UNIT**	**ALTERNATIVE.**	**930**	**940**	**950**	**960**	**970**	**980**
	No.	Alt. 1 and Preferred	N/A	-	10	100	309	647

Houses[12]	No.	Alt. 2	-	-	10	101	310	649
		Difference	-	-	0	1	1	2
Unpaved Road	km	Alt. 1 and Preferred	N/A	1.1	2.6	6.8	20.4	33.7
	km	Alt. 2	1.2	2.5	4.5	8.9	22.7	36.2
		Difference	1.2	1.4	1.9	2.1	2.3	2.5
Paved Road	km	Alt. 1 and Preferred	N/A	-	-	0.4	1.4	2.2
	km	Alt. 2	-	-	-	0.4	1.4	2.2
		Difference	-	-	-	0	0	0

6.4 DAM HEIGHT ALTERNATIVES

The Technical Scoping Study Report evaluated the reservoir volume that could be achieved for each of the alternative dam wall locations, based on varying following Max OL. The results of the evaluation are presented below.

Table 6-3: Nondvo Dam Alternatives Reservoir Routing Simulations (adapted from Pietrangeli Scoping Study, 2017)

MAX OL (MASL)	RESERVOIR VOLUME (Mm^3)		
	ALTERNATIVE 1 AND PREFERRED	ALTERNATIVE 2	DIFFERENCE
930	N/A	1.6	1.6
940	1.1	4.8	3.7
950	4.9	12.1	7.2
960	15.1	26.6	11.5
970	36.9	53.0	16.1
980	77.3	97.9	20.6

From an environmental and social perspective, the dam wall height has a significant impact on the the area that will be inundated and the associated buffer. In order to quantify the socio-economic and environmental impact on the project area, the surface area flooded by the reservoir created by Nondvo Dam was assessed through the analysis of the available satellite images, and the geo-referenced data recorded by means the GIS tools.

Figure 6-3 and **Figure 6-4** graphically indicate the existing land uses within the reservoir footprint with a dam crest of 980 MASL for a) alternative 1 and the preferred option and b) Alternative 2.

[12] Number of houses related to 88 homesteads as identified per 960 masl

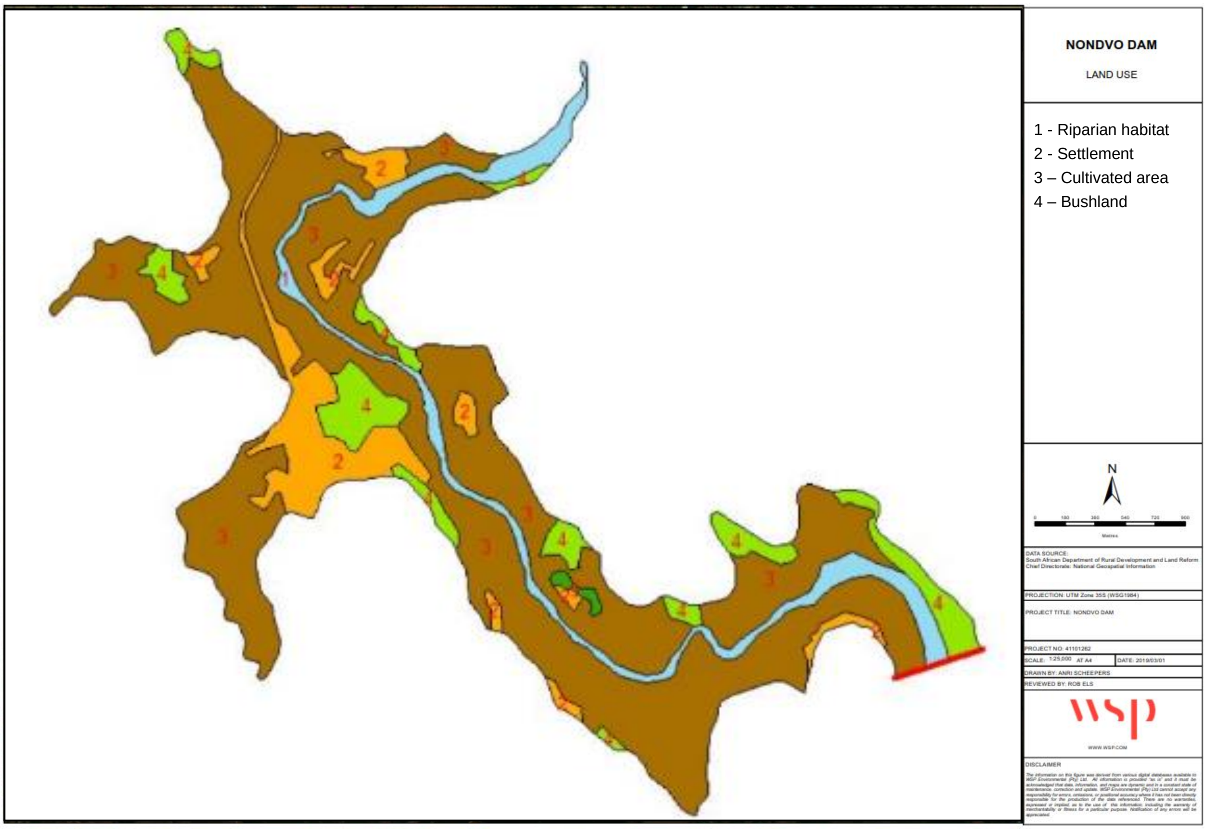


Figure 6-3: Land Use within Inundated Area for 980 masl Crest Height (Alt 1)

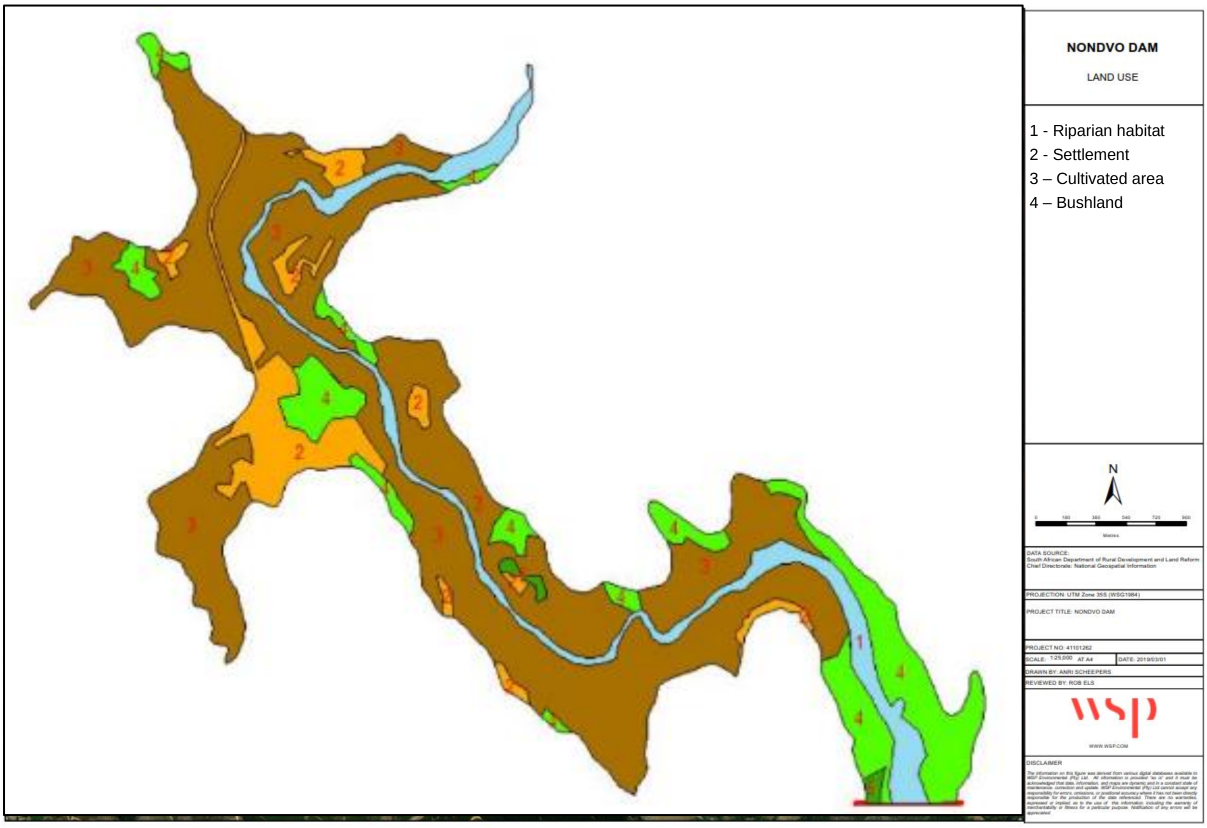


Figure 6-4: Land Use within Inundated Area for 980 masl Crest Height (Alt 2)

From **Table 6-4**, and the above layouts, it is evident that most of the area is occupied by cultivated land (377.20 ha). The main conglomerate settlements occupy 58.74ha, scattered in different locations. These aspects remain unchanged for the Alternatives.

However, the affected bushland area is noted to increase from 53.15 ha to 96.06 ha from Alternative 1 to Alternative 2. Similarly, riparian habitat along the riverbanks increases form 46.51 ha in Alternative 1 to 60.20 ha in Alternative 2. While an additional reforested area is affected in Alternative 2 increasing the coverage from 1.96 ha to 3.67 ha.

Table 6-4: Land Use within the Nondvo Dam Project Area – Different Crest Heights

	COVERAGE (HA)	
LAND USE	**ALTERNATIVE 1 AND PREFERRED (980 MASL)**	**ALTERNATIVE 2 (980 MASL)**
Riparian habitat (1)	46.51	60.20
Settlement (2)	58.74	58.74
Cultivated area (3)	377.20	377.20
Bushland (4)	53.15	96.06
Reforested area	1.96	3.67
Total	**536.56**	**595.87**

The key disadvantage of Alternative 2 is that the dam area is entirely located into the Mlilwane Game Sanctuary reserve.

In addition, to the above there is different land uses on the same project area, including the existing roads (**Figure 6-5**), a proposed 132kV electricity transmission line (**Figure 6-6**) and the re-establishment of the railway line (**Figure 6-7**).

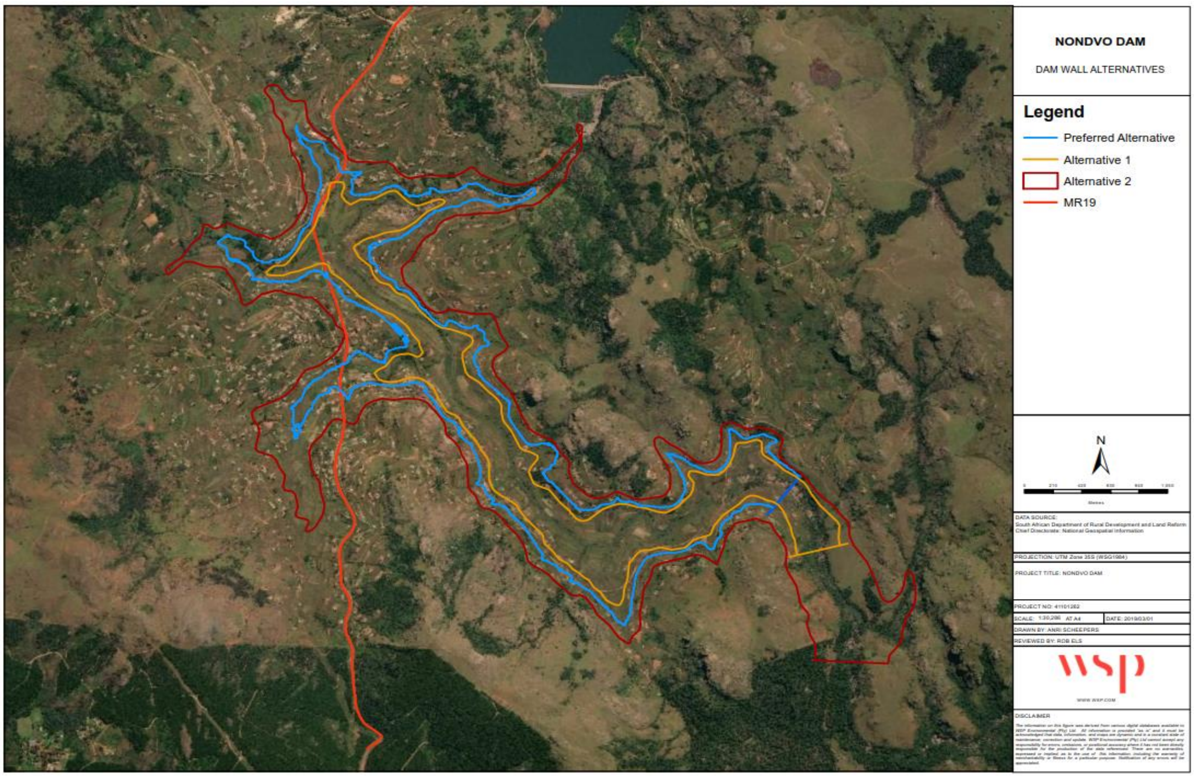


Figure 6-5: Dam Wall Alternatives in Relation to Existing Roads

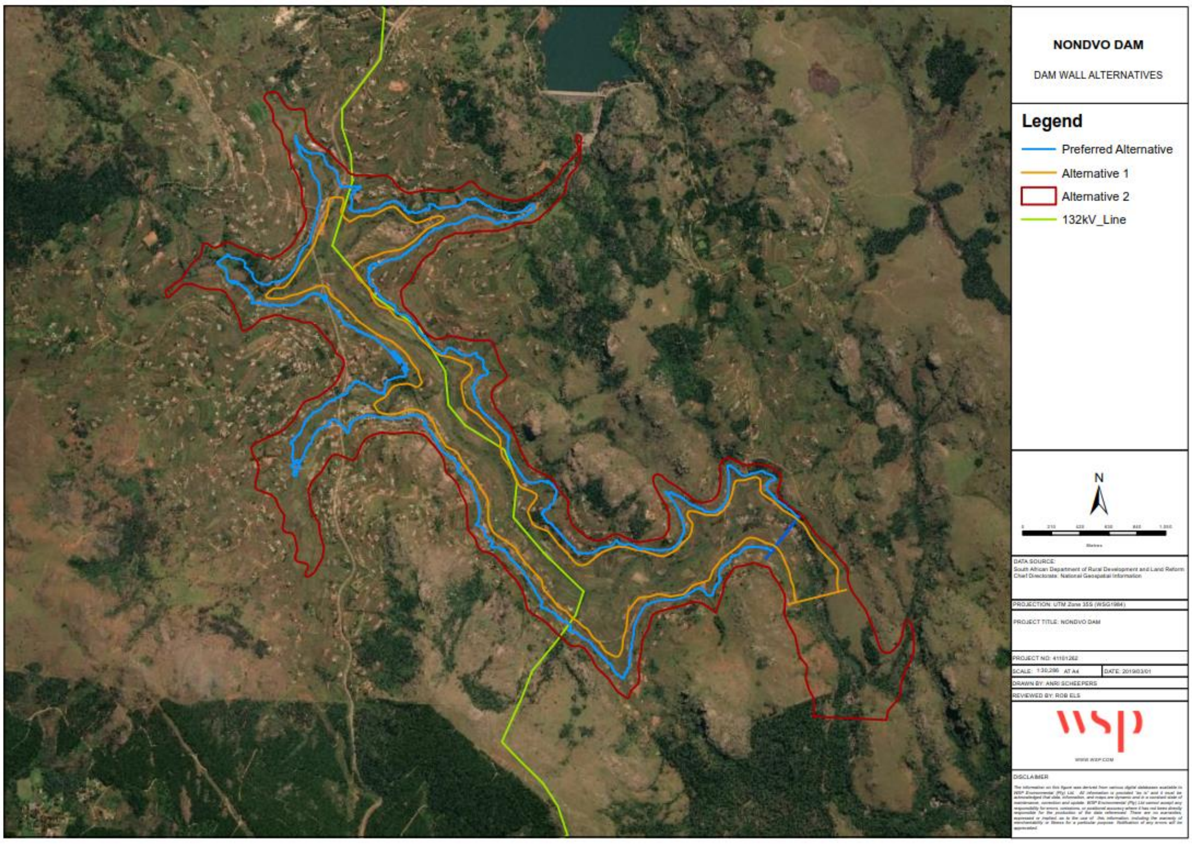


Figure 6-6: Dam Wall Alternatives in Relation to the 132KV Powerline

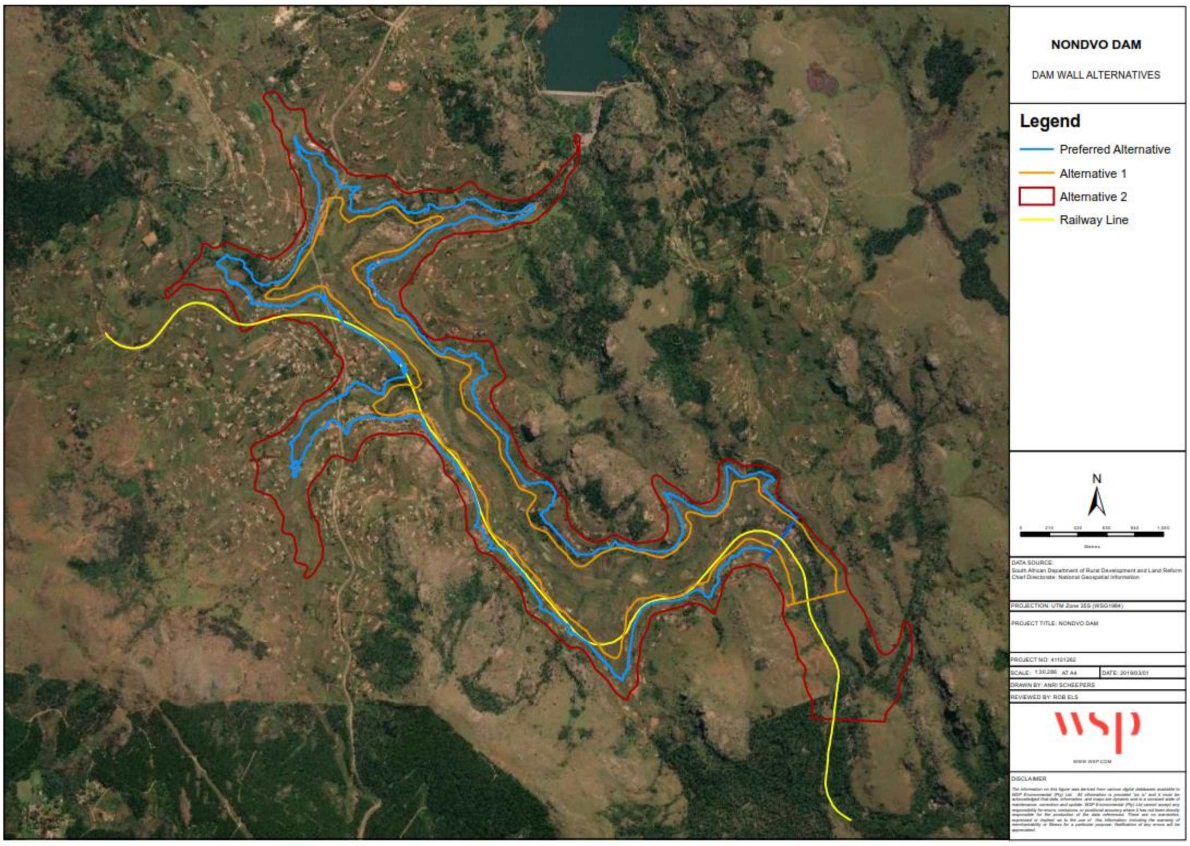


Figure 6-7: Dam Wall Alternatives in Relation to the Railway Line

6.5 DAM TYPE ALTERNATIVES

The Technical Scoping Study Report studied Gravity dam (i.e. RCC dam) and deformable dam (i.e. Concrete Faced Rockfill (CFR) dam).

In order to allow the sensitivity analysis to be carried out, a Bill of Quantity (BoQ) and cost evaluation was performed for the main elements namely the dam, powerhouse civil works, and powerhouse electrical and mechanical equipment (**Figure 6-8**). The results indicated that the construction costs are practically the same for the two dam types (CFRD and RCC), although the RCC dam has the following major advantages:

— Speed and ease of construction; and
— Safety, since the RCC dam can be overtopped without any damage and any risk of breaching.

The gravity dam solution was selected as the preferred option based on significant dam safety advantages as well as lower maintenance costs.

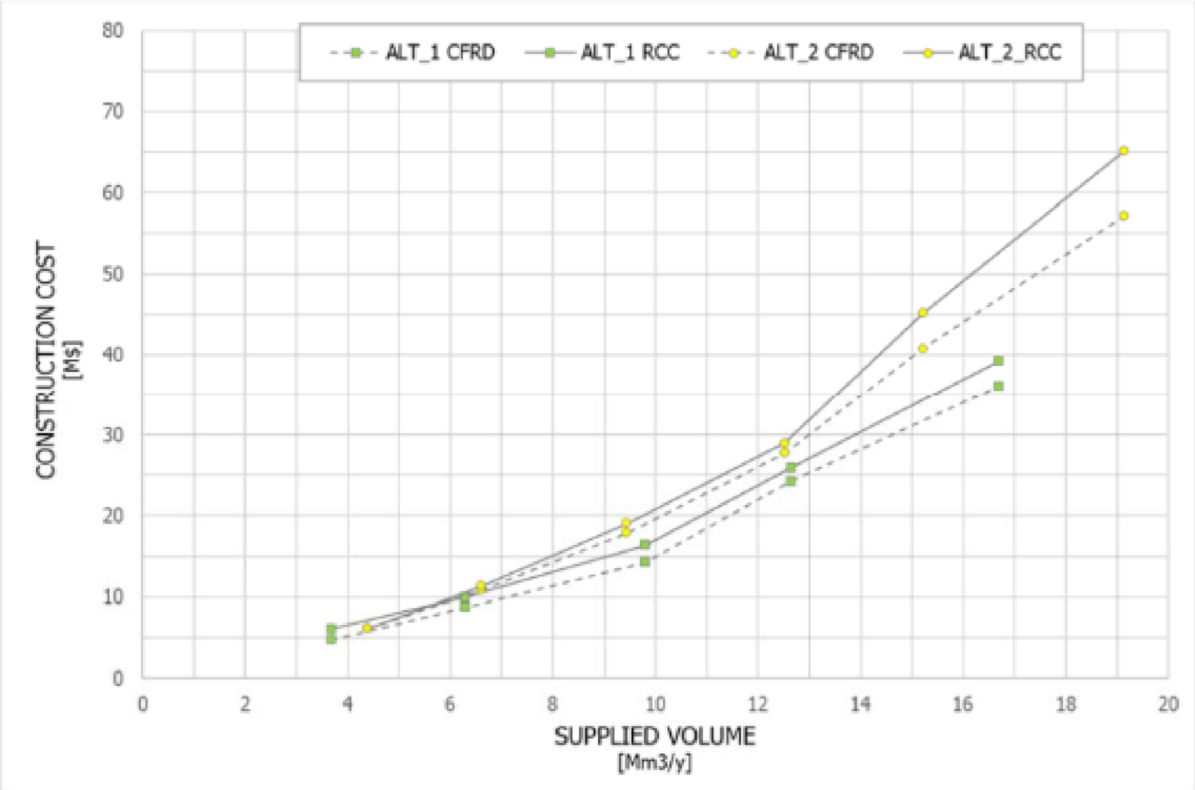


Figure 6-8: Construction costs VS Supplied Volume

6.6 SUMMARY OF ALTERNATIVES

The main conclusions are:

— The type of dam does not affect the cost of the dam, therefore Studio Pietrangeli strongly suggests selecting the RCC type which is safer;
— The dam Alternative 1 or Preferred Alternative is to be preferred in terms of supplied volume vs height of the dam;
— The dam Alternative 2 has the disadvantage to be in the Mlilwane Game Sanctuary reserve;
— The extent of resettlement is limited and acceptable for reservoir elevation minor of 960 masl, which assures the entire demand for water supply purposes up to 2050 and the water demand for irrigation; and
— In case of reservoir elevation bigger than 960 masl, the extent of resettlement increases exponentially.
— The Preferred Alternative is best suited to the geological conditions.

On the basis of the above considerations Studio Pietrangeli (2018) selected as optimum layout the RCC dam located at the Preferred Alternative, with a Full Supply Level of 960 masl. The supplied volume with an assured yield of 95% is 9.8 Mm^3/year.

7. DESCRIPTION OF THE ENVIRONMENT

Information for the Description of the Environment was obtained from the following sources:

- WSP. (2019). Mbabane - Manzini Dam: Environmental and Social Impact Assessment. Morpho-dynamics Assessment. – **Appendix C1**
- WSP. (2019). Mbabane - Manzini Dam: Environmental and Social Impact Assessment. Basin Protection Assessment. – **Appendix C2**
- WSP and SI Futures. (2019). Mbabane – Manzini Dam: Socio-Economic Impact Assessment. – **Appendix C3**
- The Biodiversity Company. (2019). Biodiversity Baseline & Impact Assessment for the Proposed Nondvo Dam Project. – **Appendix C4**
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7.1 PHYSICAL ENVIRONMENT

7.1.1 TOPOGRAPHY

An extensive topographical campaign of the Project area was carried out as part of the feasibility assessment (Studio Pietrangeli, 2018). The Project area extends along the Lusushwana River at an altitude ranging from 930 to 980 masl. The site is situated along a valley on hilly terrain with the Luphohlo mountain range rising steeply to a summit of 1,404 masl at a distance of 4 km to the northeast and another summit of 1,459 masl at a distance of 3 km to the east. Between 0.5 km and 1.5 km to the west, the terrain rises to summits ranging from 1 100 m and 1 172 masl (**Figure 7-1**). The area is also characterised by rocky outcrops and seasonal streams with steep rocky banks.

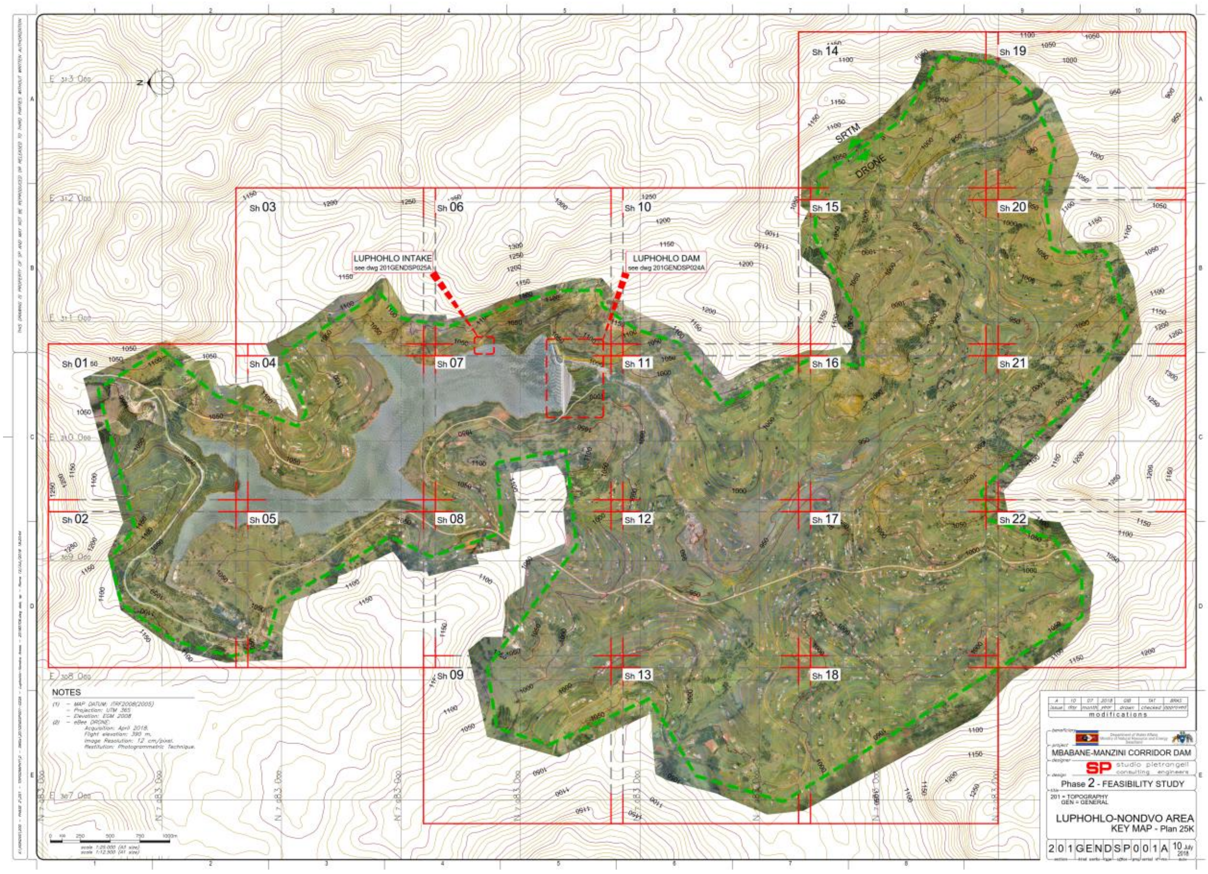


Figure 7-1: Topographical Survey Extent

7.1.2 CLIMATE

The climate of Eswatini is highly variable when considering intra-seasonal and inter-annual timescales. This is due to its varying topography and its location as a transition point of a number of climatic zones such as:

- Equatorial convergence zone (characterised by summer rains);
- Subtropical eastern continental moist maritime, characterised by onshore flow with occasional cyclones;
- Dry continental tropical; and
- Marine west Mediterranean (winter rains, with rare snow).

TEMPERATURE

Eswatini's climate is generally subtropical with hot wet summers (October to March) and cold dry winters (April-September). Eswatini's physiographic zones clearly show different climatic conditions, ranging from sub-humid and temperate in the Highveld to semi-arid and warm in the Lowveld. Mean annual temperatures vary from 17°C in the Highveld to 22°C in the Lowveld. These temperatures are zonal averages, with some variation across zones (WSP, 2019).

RAINFALL

The project site falls within the summer rainfall region of Southern Africa. Rainfall is strongly seasonal with roughly 80% of rainfall occurring between the months October and March, inclusive. The rainfall pattern in Eswatini varies considerably, mainly because of the variation in altitude. The highest rainfall occurs in the northern and central mountainous areas, with rainfall in excess of 1500 mm, while the low-lying eastern parts of the project area receiving rainfall of less than 600 mm. Precipitation is noted to vary considerably from year to year, potentially leading to periods of flash flooding or drought (WSP, 2019).

The feasibility scoping study, undertaken by Studio Pietrangeli (Studio Pietrangeli, 2018), included a water resources hydrological study. Selected rainfall stations and relevant datasets, as indicated in **Table 7-1**, were utilised for the morpho-dynamics assessment undertaken as part of this assessment (WSP, 2019). **Figure 7-2** and **Figure 7-3** graphically present the Mean Annual Precipitation (MAP) and Mean Monthly Precipitation, respectively for the selected rainfall stations. The MAP recorded by the selected stations ranges between 240 mm and 1400 mm per annum.

According to the previous studies, the Lusushwana River, belongs to the part of the Maputo basin receiving the highest amount of rainfall, with the mean annual precipitation in the vicinity of Mbabane on the Escarpment being around 1400 mm per year.

Table 7-1: Rainfall Stations and their Properties (WSP, 2018)

	COORDINATES				
STATION NAME	EAST (M)	SOUTH (M)	DATA PERIOD	NO OF YEARS OF DATA	MAP (MM)
Mbabane	308 155.4	7 100 747.6	1989; 2000-16	17	1397
Matshapa	318 320.7	7 088 705.7	2002-12; 2014-16	14	718
Mlilwane	312 297.7	7 090 835.6	2000-01; 2003; 2011-16	9	602
Malkerns	302 379.1	7 086 255.0	2000-2015	16	972
Malolotja	Unknown	Unknown	2000-01; 2003-04; 2007-16	14	844
Milawula	Unknown	Unknown	2001-04; 2006; 2009-12; 2016	10	245
San Roy Farm	300 468.3	7 080 684.7	2000-2011	12	525

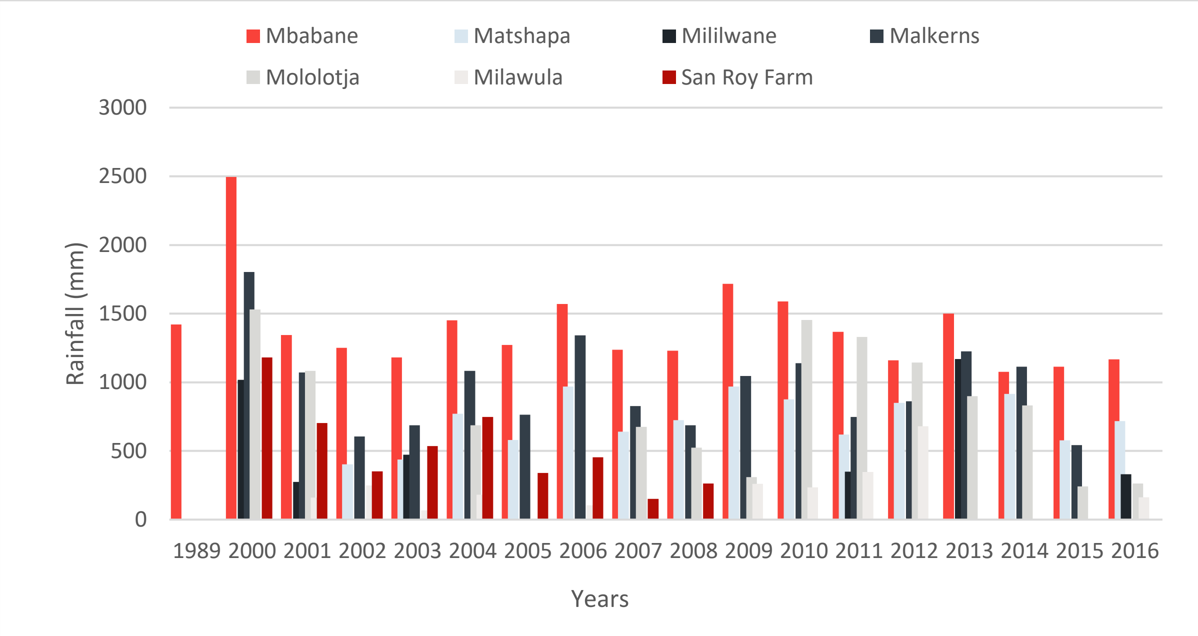


Figure 7-2: Mean Annual Precipitation at Selected Meteorological Stations (Source: WSP, 2018)

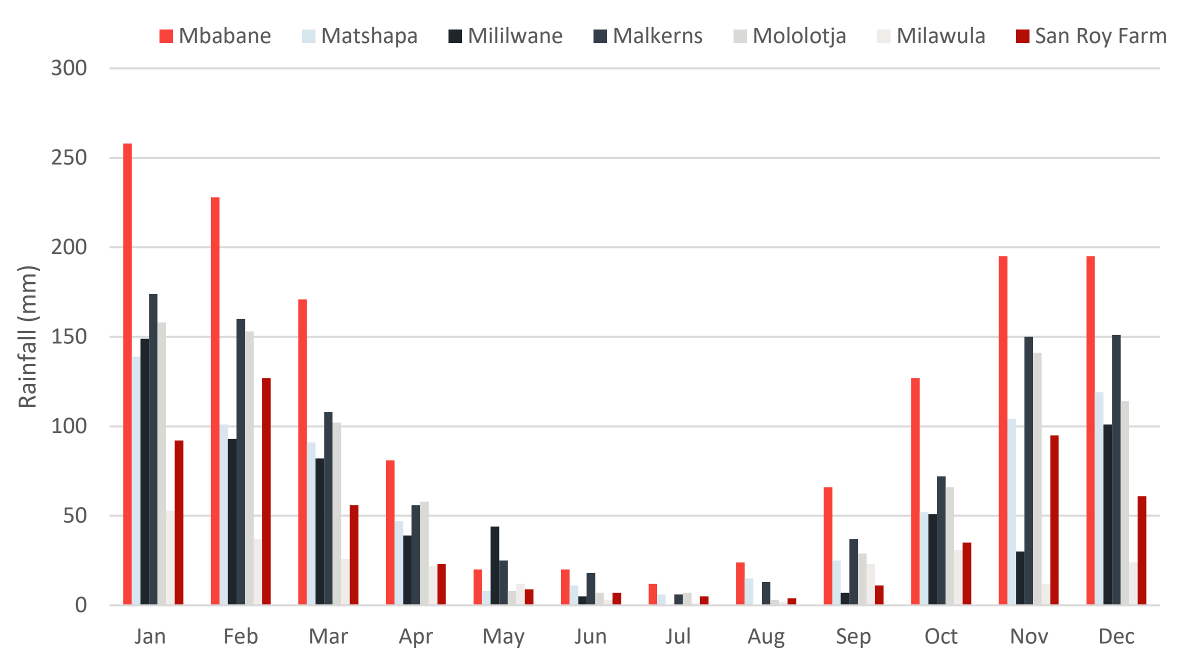


Figure 7-3: Mean Monthly Precipitation at Selected Meteorological Stations (Source: WSP, 2018)

EVAPORATION

Fairly high annual evaporation of between 1 400 and 1 600 mm is reported within the Maputo Basin (Blackhurst, 2008).

FLOODING AND EXTREME WEATHER

Recent flooding events have occurred in 2014, 1999 to 2000, 1984 and 1975 to 1976. The event in 2000 was a large regional flood affecting not just Eswatini but also Mozambique and South Africa, Botswana, Zimbabwe and Malawi (CRIDF, 2016). A Flood frequency analysis undertaken by the GoE suggests that the Lusushwana River where the Project is located has moderate flood magnitudes compared to other rivers such as the Mhlatuzana River and Lomati River which both have high flood magnitudes even though they have similar sizes. (GoE, 2014).

DROUGHT

Drought is an inherent part of Eswatini's climate system, as part of its variability due to the El Niño–Southern Oscillation pattern (and its counterpart, La Niña). Currently, the country is feeling the devastating effects of El Nino that has left dams dry, farmers losing crops and thousands of cattle dying. The poor rainfall started during the 2014/2015 season and has persisted till today.

According to the GoE, the occurrence and severity of drought conditions and reduced flows haveincreased in the recent two decades and there is a need for rationing as well as strengthening and ensuring effective monitoring of all water users.

In the Usutu Basin, the following drought events have occurred: 1971 to 1972; 1974 to 1975; 1982 to 1983; 1991 to 1992; and 1994 to 1995 (GoE, 2014). **Table 7-2** shows the probabilities of drought and wetness across the Usutu basin.

Table 7-2: Probabilities of drought or wetness in the Ustut Basin (GoS, 2014)

RIVER BASIN	PROBABILITY OF ANNUAL SPI

	<=-2.0 Extreme Drought	<=-1.0 but >-2.0 Moderate to Severe Drought	>=1.0 Moderate to Severe Wetness	>=2.0 Extreme Wetness
Usutu	2.78	15.74	12.04	2.78

7.1.3 PHYSIOGRAPHY

The headwaters of the Maputo River Basin originate on the eastern side of the great continental divide at altitudes ranging from about 1 700 masl in the north-western parts of the basin, to more than 2 000 masl in the south-western part of the basin. The western part of the basin, within which the Project site is situated, is located in the escarpment area, and is separated from the low-lying eastern coastal plains by the Lebombo Mountains.

The Escarpment falls steeply from about 1 500 m in the west to about 600 masl in the east, with sharply incised river valleys between plateau remnants and medium to high hills. Relief varies from about 130 m to 450 m. In Eswatini, this region is referred to as the Eswatini Highveld.

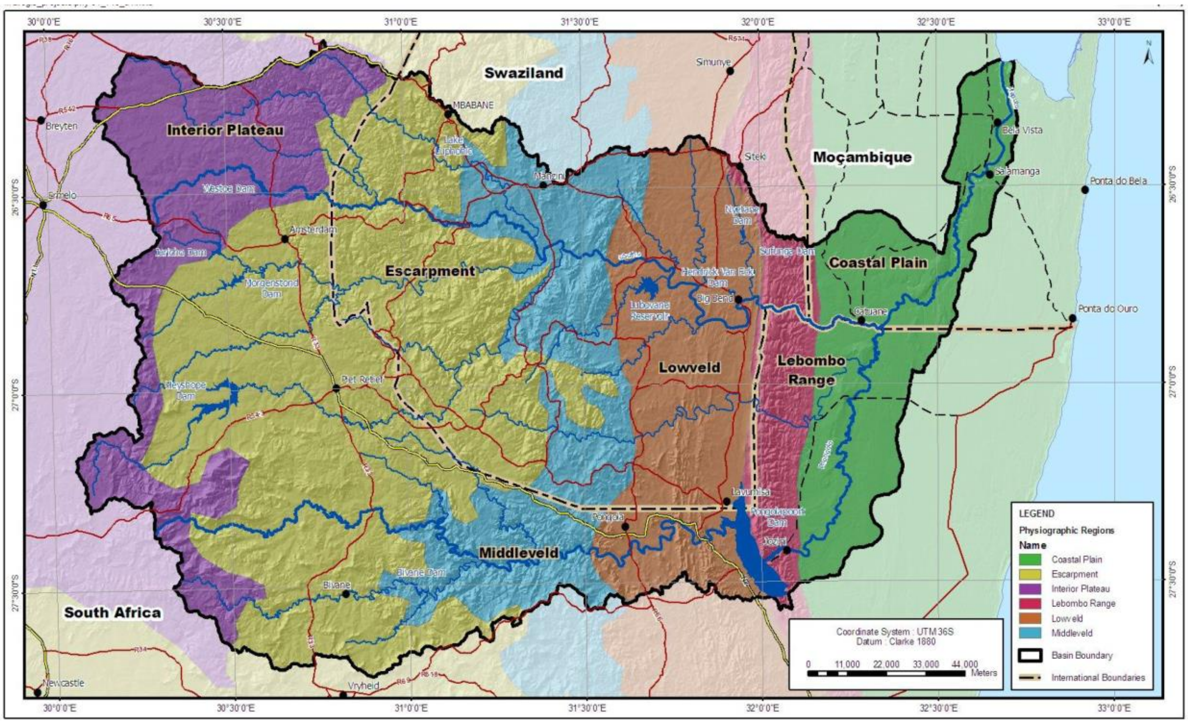


Figure 7-4: Physiographic Regions of the Maputo River Basin (Source: (Beuster, 2008))

7.1.4 GEOLOGY

The geology of the Maputo River Basin is comprised of outcrops of ancient rocks of the Basement complex in the western half of the basin (Interior Plateau, Escarpment and Middleveld), younger rocks of the Karoo Supergroup in the Lowveld and Lebombo Range, and Post-Gondwana deposits in the Coastal Plain. The geology of the Escarpment region is comprised of igneous (granites, quartzites and lava) and metamorphic (gneiss) rocks.

The Nondvo Dam is located on the Lusushwana River within a granite basement. The granite basement is affected by doleritic dikes mainly trending northwest-southeast and smaller dikes trending northeast-southwest. There are rock outcrops along the riverbanks and riverbeds. The rock is characterised by gneiss cut by pegmatite veins. The slopes are characterised by a sub-outcropping rock at some places while at higher elevations the gneiss-rounded outcrops are well visible.

The Nondvo project area is characterized by a granitic bedrock foundation belonging to the Ancient Granite (AG 3) (Lochiel Hood Granite). The main rocks outcropping in the site are:

— Gr, granite
— Dl, dolerite; and
— Pg, pegmatite veins

The left bank of the dam area is characterized by outcropping granite along a sub-vertical slope at higher elevations. The outcropping granite outlines the typical rounded shape of the batholitic body together with the characteristic sheet joints. The toe of the scarp has a less steep slope and it is covered by soil and weathered granite.

The right bank is characterized by a more regular slope of about 15-20 degrees. The granite clearly outcrops around the elevation 950 m a.s.l., near the river level. The remaining stretches are occupied by cultivated fields and it is covered by a thickness of decomposed granite (laterite).

At riverbed level the fresh granite completely outcrops. The granite is very strong and specimen recovery requires many blows of a geological hammer to fracture it (R5, ISRM 1981b) and it appears crosscut by pegmatite and quartz veins.

In the project area the occurrence of weathered rock is very low, (only 4% of the total length) as evidenced by the investigation. Most of the joints are closed (only K0 are opened) and the weathering couldn't penetrate very deep by the fractures and create a typical residual soil profile with different grades of weathering.

SEISMICITY

The Nondvo Dam will be located in Southern Africa, which is located in the interior of the large Africa plate. The African plate is considered one of the most tectonically stable areas in the world and is bounded by the South West Indian Ridge (SWIR) to the east, the Antarctic ridge (south), the mid-Atlantic ridge (west), the Hellenic arc (subduction zone) to the north and the Gulf of Aden/Afar triple junction to the north-east.

The Southern African region can be sub-divided into the following regional tectonic provinces as depicted in **Figure 7-5**:

— Kheis Thrust Belt;
— Cape Fold Belt;
— Zimbabwe Craton;
— Limpopo Mobile Belt;
— Kaapvaal Craton (includes the Bushveld complex); and
— Namaqua-Natal Mobile Belt (Studio Pietrangeli, 2019).

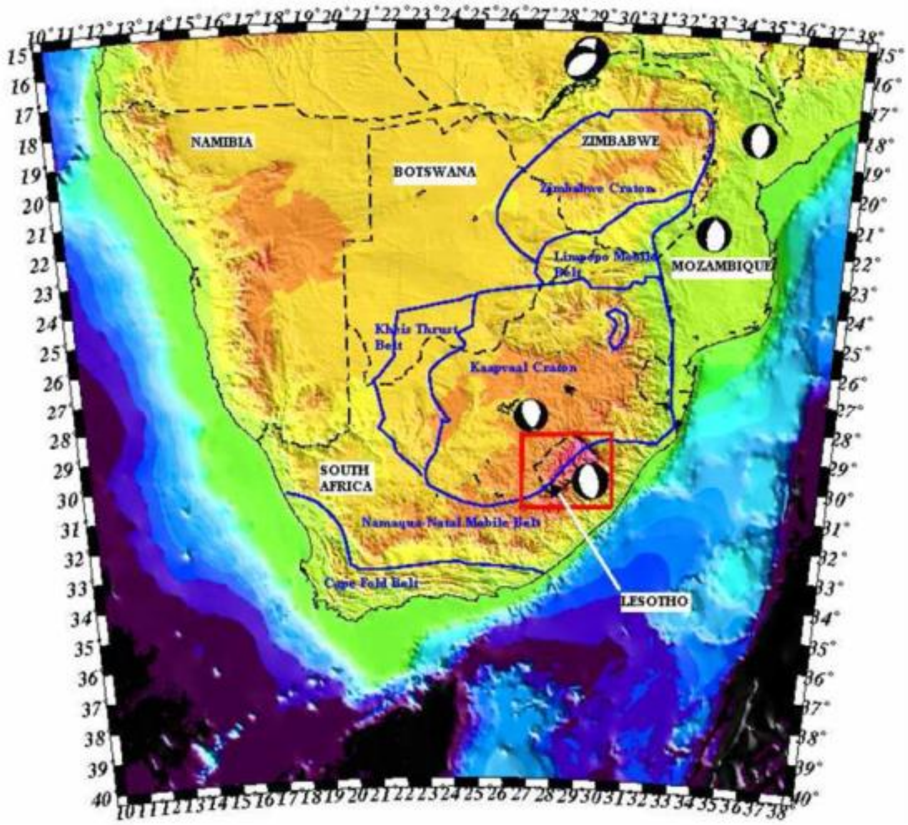


Figure 7-5: Tectonic Provinces Map for Southern Africa for the period 1620 to 2006. The provinces are modified from the South African Seismic Experiment Project (2007, Malephane)

The zones of active seismicity in Southern African are in Mozambique, Zimbabwe and northern Botswana. These activities are believed to be an extension of the East African rift system. The seismicity map of recorded events in the region is shown in **Figure 7-6**.

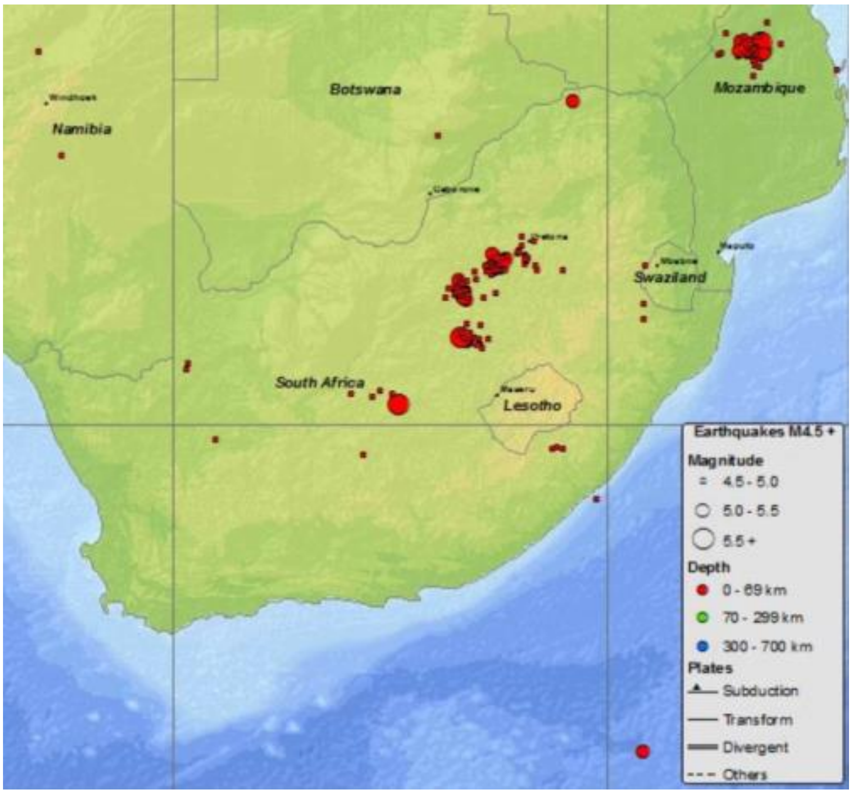


Figure 7-6: Southern Africa: Seismicity Map (Studio Pietrangeli, 2019)

Figure 7-7 shows the maximum earthquake events that occurred in the Nondvo project zone since 1900.

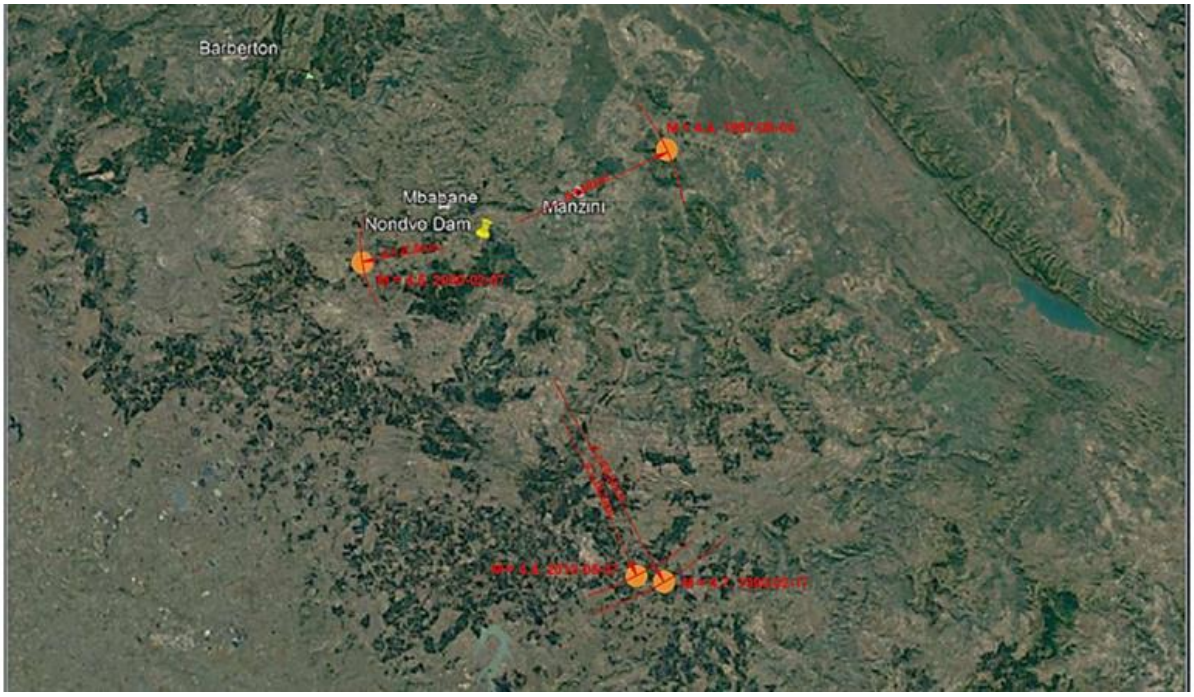


Figure 7-7: Distribution of Earthquake Eepicentres Close the Project Area since 1900 (ref. USGS Earthquake Catalog)

7.1.5 SOILS

The soils of the Maputo River Basin are unusually varied in terms of type, depth and texture. This can be attributed to the combination of steep temperature and rainfall gradients (influencing weathering processes) across the basin, the complex geology of the region (determining chemical composition and resistance to weathering), and varied relief. Soil formation in the basin is dominated by chemical processes, rather than physical (wind, ice, etc.) or biological processes. The degree of chemical weathering is influenced by temperature and rainfall, with hot, humid regions being most susceptible.

In the Escarpment region, in which the Project area is located, chemical weathering is reportedly moderate to strong. Within the Lusushwana catchment, Regosols are identified to prevail with Leptosols and Ferralsols also present. These are weakly developed mineral soils in unconsolidated materials. Texture, chemical and mineral compositions vary widely.

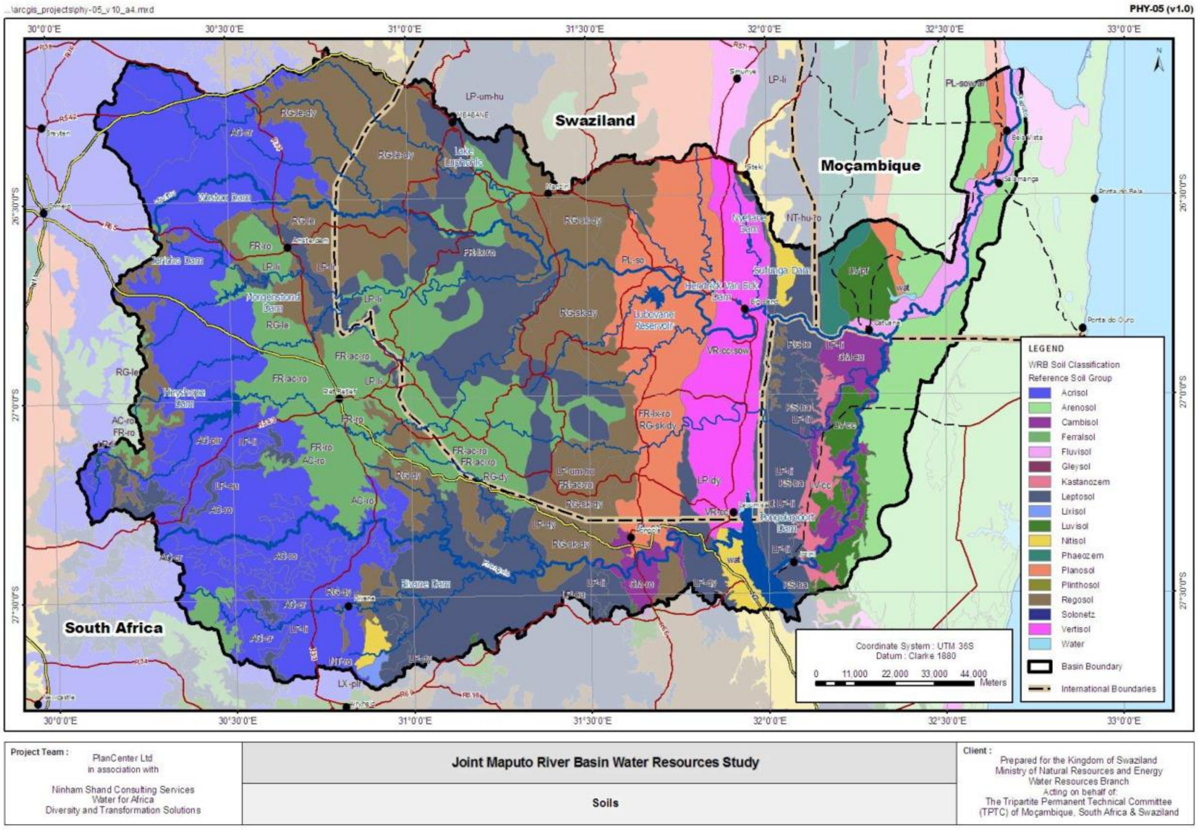


Figure 7-8: Soils of the Maputo River Basin

While the area surrounding the Nondvo Dam site appeared to be dominated by Ferralsols, Regosols and Leptosols werealso found (**Figure 7-9**).

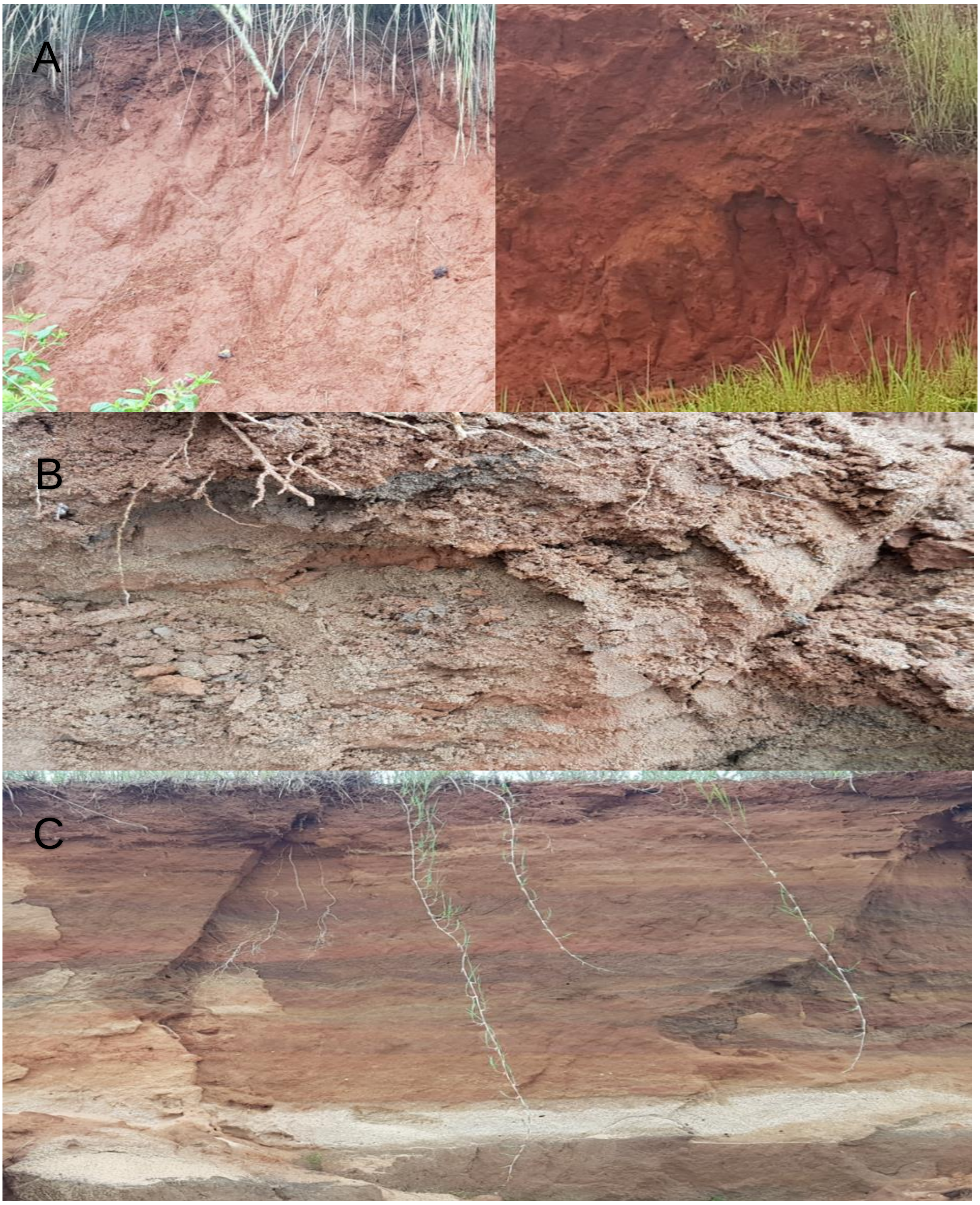


Figure 7-9: A Selection of Soils Observed within the Project Area: A Ferralsols, B: Regosols and C: Leptosols

7.1.6 DRAINAGE AND HYDROLOGY

The proposed project area falls within the Joint Maputo River Basin. The project area is located within the Pongola-Mtamvuma Water Management Area (WMA) formerly known as the Usutu to Mhlatuze WMA and within the W56C Quaternary Catchment. The specific reach considered for this study was a 34 km reach as delineated by the W56C-1514 Sub Quaternary Reach (SQR), drained by the Lusushwana and Mbabane Rivers (**Figure 7-10**).

The Lusushwana River is 28.75 km long and it originates from within South Africa and enters Eswatini in the northwestern part of the country. The river flows from its upper reaches, through the Ezulwini Valley towards the middle reaches along Lobamba, through the Matsapha industrial area until it joins the Usuthu River in Sidvokodvo.

The proposed Nondvo Dam will be situated downstream of the existing Luphohlo Dam and will extend along the Lusushwana River. The Lusushwana River is a tributary of the Great Usutu River, above its confluence with the Pongola River (**Figure 7-11**). The Lusushwana River originates on the interior plateau of South Africa and drains an area of approximately 1 190 km^2. It is a tributary of the Lusutfu River, forming the northern portion of the catchment of the Maputo Basin, and drains in an easterly direction to its confluence with the Pongola River.

Figure 7-10: Regional Drainage Setting (WSP, 2019)

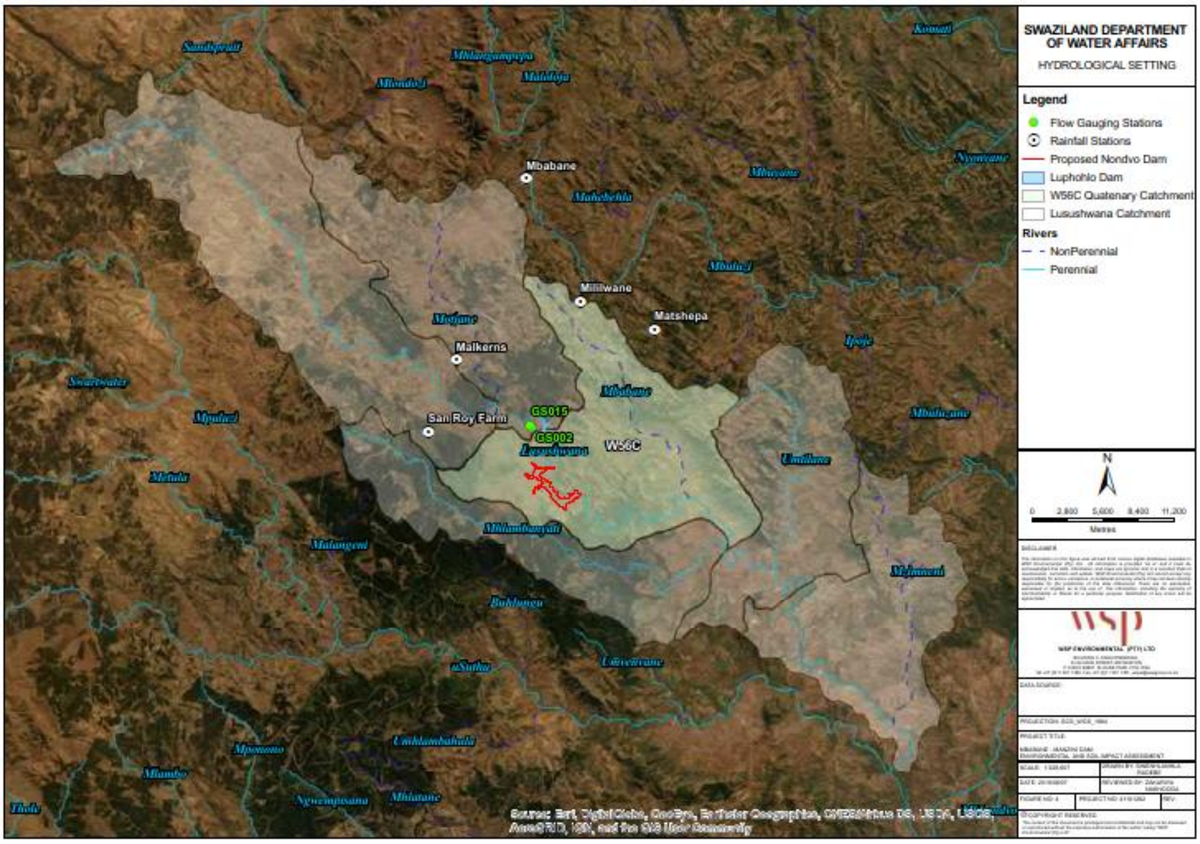


Figure 7-11: Regional Hydrological Setting (WSP, 2019)

The proposed dam wall structure will be situated approximately 7.5 km downstream of the foot of the existing Luphohlo Dam (**Figure 7-12**) wall structure (**Figure 7-13**) on the Lusushwana River (**Figure 7-14**), 8 km upstream of the Mantenga Falls (**Figure 7-15**).

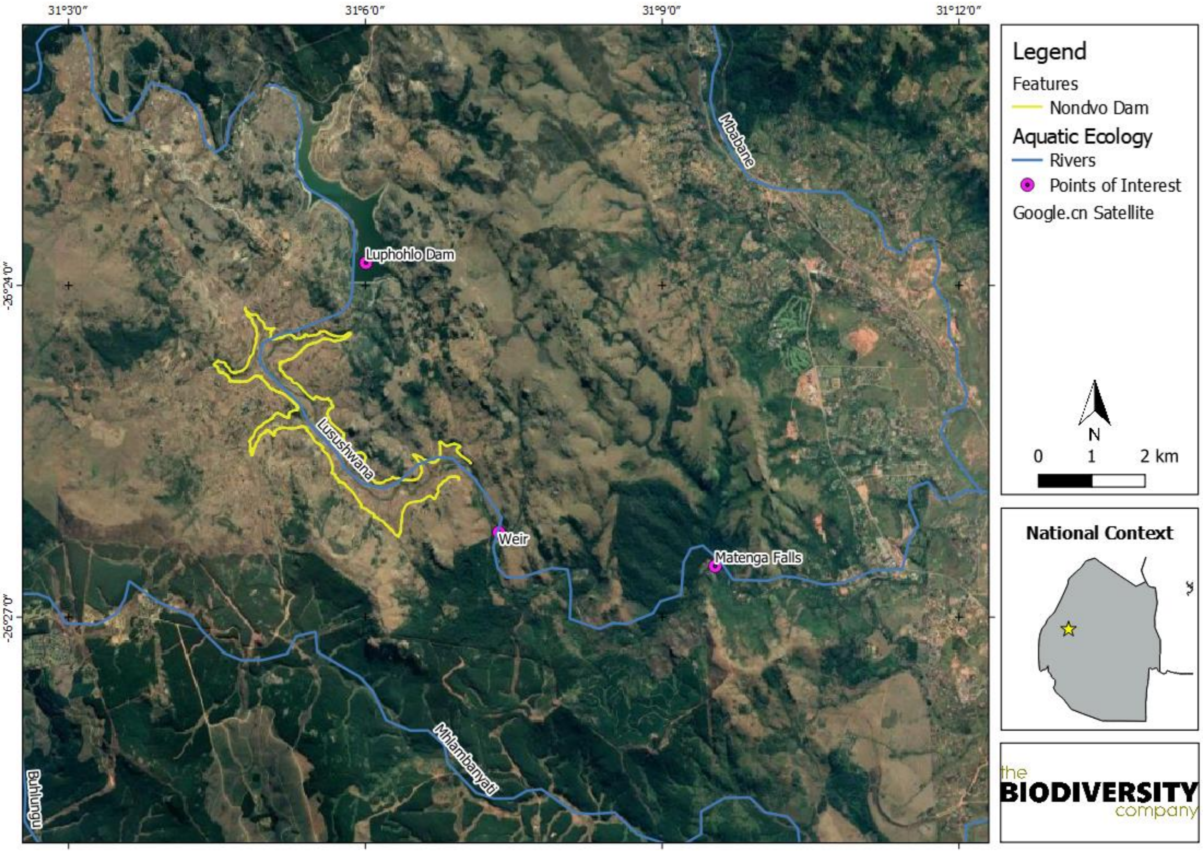


Figure 7-12: Local Hydrological Setting (TBC, 2019)

Figure 7-13: The Luphohlo Dam on the Lusushwana River Upstream of the Proposed Nondvo Dam

Figure 7-14: The Lusushwana River Downstream of the Proposed Nondvo Dam (March 2019)

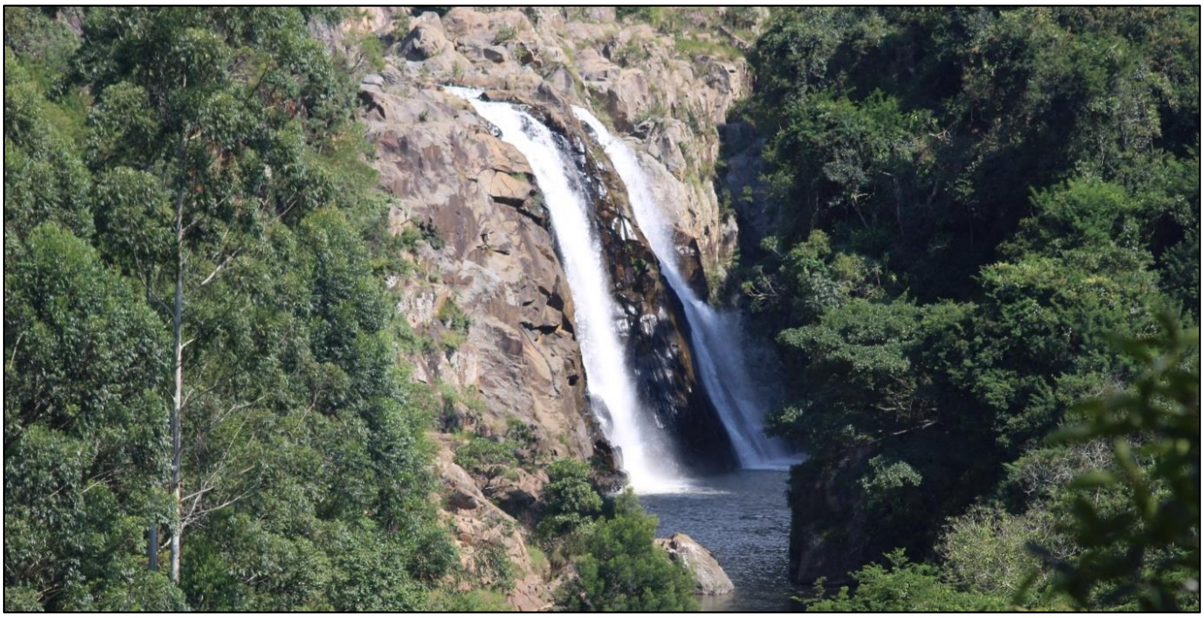


Figure 7-15: The Mantenga Falls on the Lusushwana River Downstream of the Proposed Nondvo Dam (March 2019)

Several gauging stations, recording daily flow, are located along the Lusushwana River and its tributary. Two gauging stations were identified to be of key importance for the estimate of the water balance of the river. The first being located just upstream of the Luphohlo Dam (GS015) and the second is located upstream of Matsapha and Lake Mkinkomo (GS002). Based on data from two gauging stations the highest monthly average flow (i.e. runoff trend) is shown to be reached in February, following which the river flows decrease slowly to reach the minimum values in August and September. As shown in **Figure 7-16** the mean annual flow is 11.5 m^3/s (363 Mm^3/year) and 3.5 m^3/s (120 Mm^3/year) respectively at GS002 and GS015.

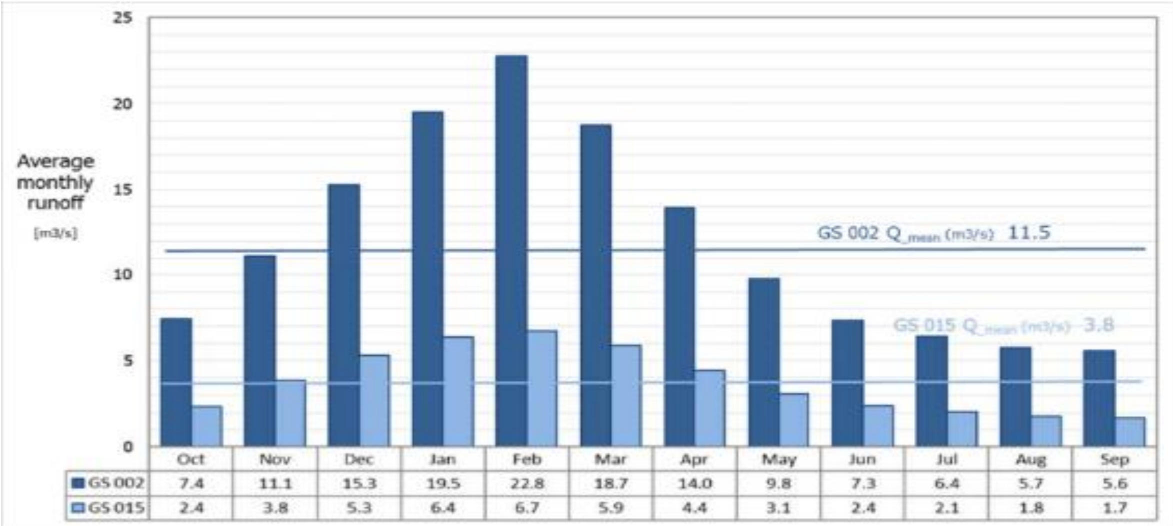


Figure 7-16: Mean Monthly Runoff Trend

7.1.7 WATER RESOURCE

WATER USE

The Lusushwana River is part of the Lusutfu Catchment. The river is 28.75 km long and it originates from within South Africa and enters Eswatini in the northwestern part of the country. The river flows from its upper reaches, through the Ezulwini Valley towards the middle reaches along Lobamba, and passes through the Matsapha industrial area until it joins the Lusutfu River in Sidvokodvo.

Water from the Lusutfu and Lusushwana River is used for all the applicable land uses in Eswatini due to the fact that the system is the largest and it runs through the major cities and agricultural zones that utilise the resource the most. Additionally, the Lusutfu Basin, which includes the Lusushwana River, is also used for tourism associated with its hot springs and for sports. According to records from the DWA, a total of 90 water permit holders have access to the Lusushwana and Lusutfu River Basin. A total of 79% of the permit holders use the resource for agricultural purposes, 9% use it for industrial purposes, 7% use it for tourism purposes and the remaining 5% is for hydropower generation in two stations (Ezulwini and Edwaleni).

WATER QUALITY

Regional

The water quality status for each of the sub-catchments within the Maputo River Basin has been assessed as part of the Joint Maputo River Basin Water Resources Study (JMRBWRS, 2008). The focus of this section is on the component of the JMRBWRS (2008) study that focuses on the Lusushwana sub-catchment as the Nondvo dam is located within this catchment.

As part of this study, an assessment of the water quality within the Lusushwana sub-catchment was suitable for irrigation and domestic water users (after treatment) (JMRBWRS, 2008). Salinity within the catchment increased downstream as a result of agricultural impacts and urban runoff, with a noticeable increase observed in the Matsapha area. A significant increase in alkalinity, hardness, calcium, ortho-phosphate and suspended sediment were also observed around the Matsapha area. These increases were attributed to land use practices within the Matsapha industrial complex, including runoff and effluent discharges (Singwane & Magagula, 2014).

Local

A total of ten water samples were collected from surface water bodies upstream and downstream of the proposed Nondvo Dam (**Figure 7-17**). These points were selected in order to ascertain baseline conditions prior to the proposed Dam being constructed in order to understand the basin influences and potential impacts of the proposed Dam.

The water quality results are summarised in **Table 7-3**. The following exceedances were highlighted:

— Aluminium

Aluminium exceeded the Eswatini Water Quality Objective guideline value at sampling point SW1, along the Motjane River upstream of the proposed Dam. The exceedance is marginal and could be attributed to the leaching of natural soils within the Motjane River catchment.

— Zinc

Zinc exceeded the most sensitive uses (MSU) at all sampling points, with the exception of SW1 and SW7. The exceedances are marginal. Zinc can be introduced into water naturally by the erosion of minerals from rocks and soil, however since zinc ores are only slightly soluble in water. Zinc is only dissolved at relatively low concentrations. Levels of Zinc observed may also be related to agricultural practices within the catchment (i.e. fertigation).

— Turbidity

Turbidity was exceeded at all sampling points with the exception of SW4. The exceedances are likely as a result of heavy rainfall experienced prior to sampling, thereby increased runoff and sediment entering the watercourse. Sampling point SW4 was located within the Luphohlo Dam, therefore sediment had settled, resulting in a lower Turbidity.

Based on the laboratory analysis, the water quality within the Lusushwana River, proximal to the proposed dam site is of relatively good quality, however, this needs to be contextualised as the high runoff during the site assessment would result in dilution of potential contaminants that may have otherwise been evident. It is therefore recommended that a formal monitoring programme be implemented to ascertain medium to long terms water quality trends.

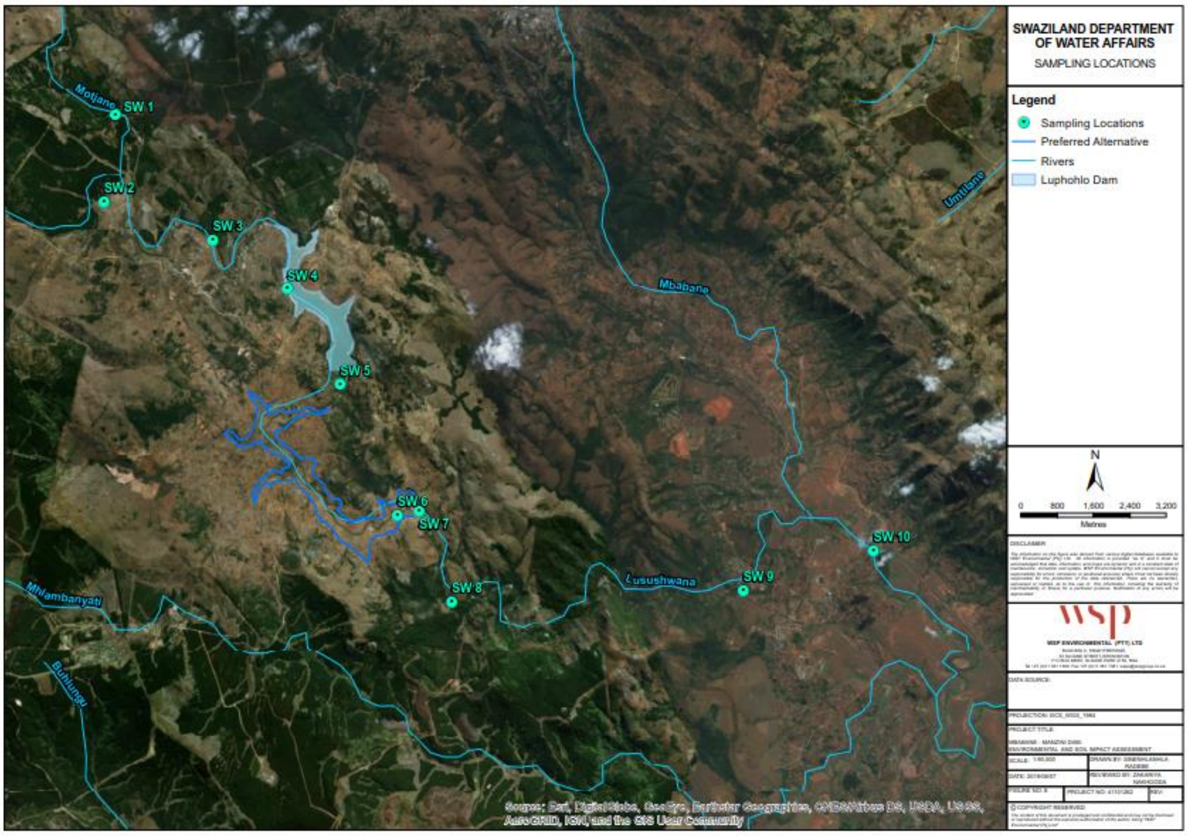


Figure 7-17: Water Quality Sampling Locations

Table 7-3: Water Quality Results

Analyte	Guidelines	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Aluminium	**0.2 mg/l**	**0.244**	0.034	0.144	0.091	0.047	0.062	<0.02	<0.02	0.166	0.179
Antimony	**20 ug/l**	<2	<2	3	<2	<2	<2	<2	<2	<2	<2
Arsenic	**10 ug/l**	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Barium	**700 ug/l**	10	9	10	9	11	9	8	7	7	12
Boron	**500 ug/l**	<12	<12	<12	<12	<12	<12	<12	<12	<12	<12
Cadmium	**0.003 mg/l**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	**12 ug/l**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Copper	**0.3 ug/l**	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7
Iron	**1 mg/l**	0.254	0.193	0.384	0.288	0.198	0.287	0.134	0.156	0.387	0.233
Lead	**0.2 ug/l**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	**0.5 mg/l**	0.008	<0.002	0.01	0.002	0.176	0.034	0.029	0.023	0.019	0.015
Mercury	**0.001 mg/l**	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	**20 ug/l**	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Selenium	**10 ug/l**	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Sodium	**40 mg/l**	4.2	4.7	4.9	4.6	5.2	4.0	4.2	3.9	4.0	4.7
Uranium	**15 ug/l**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	**3 ug/l**	3	**5**	**15**	**4**	**7**	**5**	<3	**4**	**5**	**4**
Fluoride	**1 mg/l**	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chloride	**1 500 mg/l**	3.3	2.9	3.2	3.2	3.7	3.3	3.4	3.3	3.4	3.9

Analyte	Guidelines	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Sulphate	**1 000 mg/l**	2.5	2.4	2.3	2.7	2.7	1.9	1.9	1.8	2.0	2.7
Nitrite as N	**0.3 mg/l**	0.037	0.037	0.040	0.040	0.040	<0.006	0.037	<0.006	<0.006	0.043
Nitrate as N	**10 mg/l**	0.41	0.34	0.43	0.41	0.36	0.27	0.29	0.29	0.25	0.52
Free Cyanide	**70 mg/l**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Electrical Conductivity	**1 800 uS/cm**	71	61	70	62	70	65	67	56	47	60
Free Chlorine	**0.1 mg/l**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Free Ammonia as N	**0.6 mg/l**	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
pH	**6.5-8.5**	7.66	7.64	7.71	7.64	7.66	7.29	7.69	7.59	7.43	7.29
Total Dissolved Solids	**500 mg/l**	110	108	81	82	91	106	78	67	69	96
Turbidity	**5 NTU**	**84.8**	**49.7**	**24.5**	3.9	**13.3**	**21.8**	**7.1**	**6.4**	**26.5**	**81.0**

POLLUTION SOURCES

Wastewater treatment works or industrial plants usually discharge their effluents to streams or rivers through conduits such as outfall pipes, ditches or canals (point sources). The quality of the waste discharges will conform to standards prescribed in licences, permits or other forms of authorisations (JMRBWRS, 2008). Within the Lusushwana sub-catchment, there are seven known wastewater treatment works thatpotentially contribute to the deterioration of surface water within the basin (JMRBWRS, 2008).

Non-point source or diffuse pollution is largely caused by rainfall and the associated surface runoff that mobilises contaminants from the surface of the catchment. Non-point sources can originate from a widespread area, such as storm wash-off from urbanised or agricultural land uses. Salinity from irrigation return flows appears to be one of the main water quality influences in the basin.

The water quality assessment was undertaken by Singwane & Magagula (2014) using the World Health Organisation Objectives, The Eswatini Water Quality Objectives and the South African Water Quality Guidelines for Ecosystems. According to Singwane & Magagula (2014), threats to the Lusushwana River occur from:

- The Matsapha Industrial Complex and the associated activities, including:
  - Petroleum storage; and,
  - Improper treatment and disposal of domestic and industrial wastewater.
- Sand mining along the banks of the River; and,
- Agricultural activities along the River banks.

For the Lusushwana sub-catchment a monitoring strategy is recommended for salinity, immediate management action is recommended in urban and industrial areas for organic, dye and hydrocarbon pollution, a nutrient management strategy should be developed to contain nutrient enrichment, and land-care programmes should be implemented to contain erosion and sediment wash-off (JMRBWRS, 2008).

7.1.8 GEOMORPHOLOGY

The Lusushwana River rises 25 km upstream of the current project area, within proximity to the South Africa-Eswatini border (i.e. approximately 5 km south of the Oshoek border post). The Lusushwana River in its upper reaches is a characteristic upland watercourse, with steep gradients, moderate widths (±3 m) and cobbled substrates (Rountree et al., 2000). Downstream of the Luphohlo Dam, the flow and gradient in the watercourse become gentle and present lowland river gradients (Rountree et al., 2000). As a resultant effect of the Luphohlo Dam, which has reduced flood peaks and overall discharge, over and above the geomorphological effects of the reduced gradient, the instream channel of the Lusushwana River forms deep slow-flowing pools thatare densely vegetated.

Within the lower reaches of the proposed inundation zone, and in the proximity of the proposed dam wall, the gradients of the Lusushwana River increase to a class C geo-class representing a rejuvenated lower foothill zonation (Rountree et al., 2000). The effect of the increased gradient has created bedrock cascades with intermittent pools and shallow runs. In addition, large instream boulders and bedrock complexes create diverse habitats of cascades, pools and rapids. The zone of rejuvenation continues until downstream of the Mantenga Falls, whereafter lowland geomorphic watercourses were observed. Downstream of the Mantenga Falls, and following the confluence with the Mbabane River, the Lusushwana River has typical lowland characteristics as indicated by the increased width and sandy substrates of the watercourse.

7.1.9 LAND USE

The Lusushwana River and the middle and lower reaches of the other Usuthu tributaries cascade down the escarpment through North-eastern Mountain Grassland. Much of this grassland has been replaced by extensive commercial eucalypt and pine plantations. Large areas along the middle reaches of the Ngwempisi and Lusushwana Rivers are used for dryland, subsistence farming. The urban areas of Mbabane, Matsapha and Manzini are located in the lower Lusushwana catchment, and surrounded by scattered rural settlements (JMRBWRS, 2008).

The Lusushwana River has multiple uses; it supplies the Matsapha Industrial Complex, Manzini City and surrounding areas with water. Other uses include fishing, recreation, irrigation and the river being a sink of urban and industrial waste for the biggest industrial area in Eswatini, the Matshapa Industrial Complex (Singwane & Magagula, 2014).

The project area consists of a mixture of naturally vegetated areas as well as plantations and agricultural areas. There is evidence of densely populated rural development within the Mantabeni and Siphocosini communities with residential homesteads and subsistence farming practices that include crop production and livestock grazing.

The project site is within the Mantabeni and Siphocosini Royal Kraals, which are densely populated with residential homesteads. The communities within the Royal Kraals have peri-urban characteristics in that they are situated on the fringe of the Mbabane and Ezulwini urban areas and, although separated from these urban areas by a mountain range, the landscape is a transition between urban and rural.

The primary localised land use to the proposed dam comprises dense clusters of residential homesteads, most of which have arable land used for subsistence agriculture, except along the banks of the Lusushwana River, which is characterised by riparian vegetation. Social amenities such as public schools, clinics, shops, churches and the two Imiphakatsi (Royal Kraals) of Siphocosini and Mantabeni are interspersed among the homesteads, predominantly in close proximity to the tarred main road (MR19).

To the north of the project site is the Luphohlo Dam, which is a multipurpose dam whose primary use is hydropower generation. The dam was established in 1984 with a dam wall height of 45 m and a capacity of 23.6 million m^3 (GoS, 2001). Secondary uses from the dam include recreation and potable water supply. To the west is the Luphohlo mountain range, on which the Mlilwane Wildlife Sanctuary is situated and extends 10 km southward. A private commercial forestry plantation, in which the private company village of Mhlambanyatsi is situated, is located 4 km to the southwest.

The distribution of the identified land-use coverage within the proposed reservoir footprint is provided in **Table 7-4** and is graphically presented in **Figure 7-18**.

Table 7-4: Land Use within the Proposed Nondvo Dam Project inundation Area

LAND USE	SQUARE KILOMETRE (KM^2)	PERCENTAGE (%)
Forest	148.7	22.9
Mosaic Forest-Shrubland-Grassland	113.3	17.5
Savannah	204.8	31.6
Cropland	123.9	19.1
Bare Ground	28.7	4.4
Urban and Built	27.5	4.2
Water Bodies	1.1	0.2

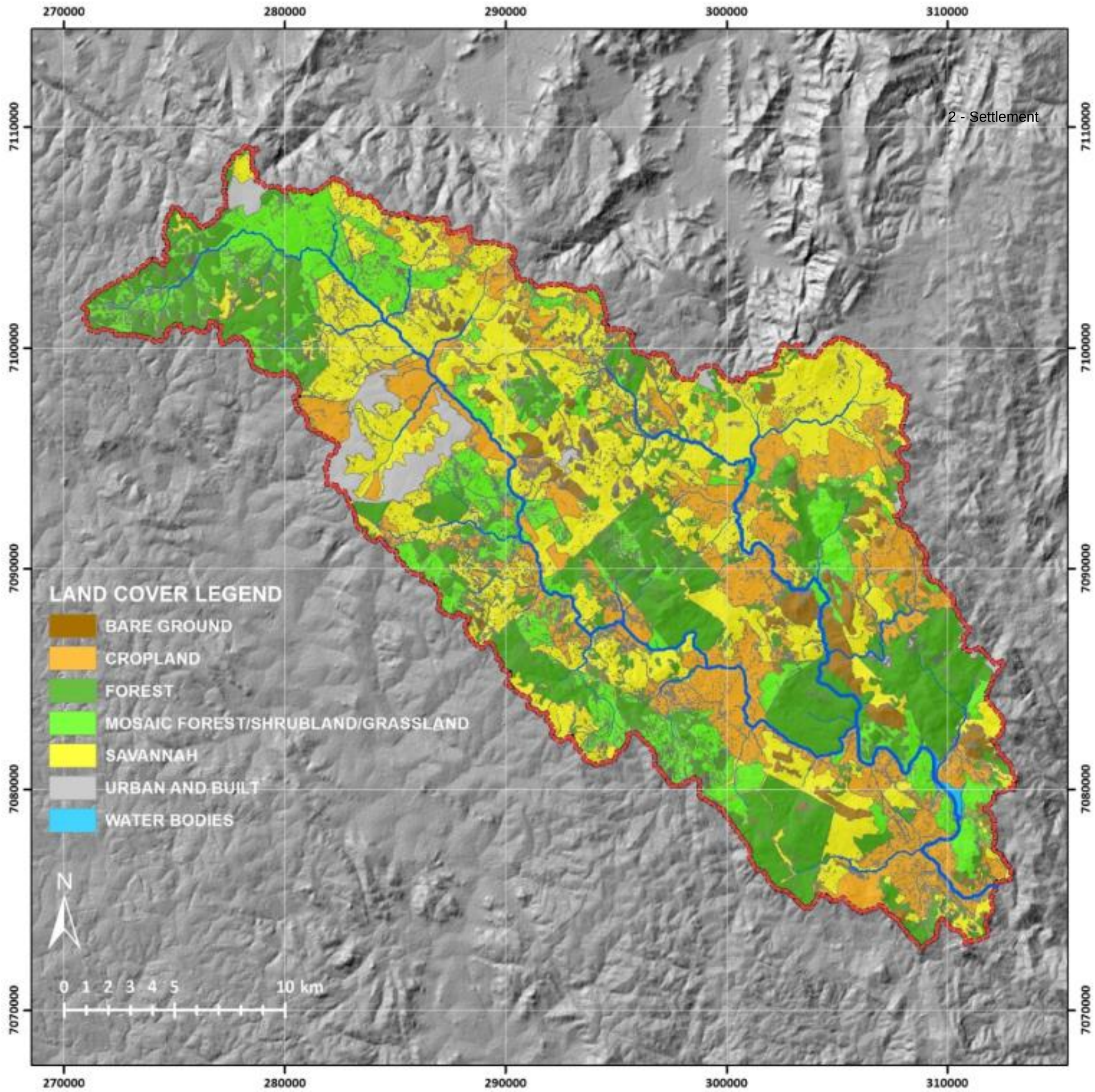


Figure 7-18: Land Use within the Project Affected Area (Studio Pietrangeli, 2018)

Subsistence farming is undertaken on the cultivated land and rain-fed maize and sorghum production are the principal agricultural activities. According to a study carried out by the University of Eswatini the gross margin of maize in subsistence farming is about 81 US$/ha (Studio Pietrangeli, 2018).

7.2 BIOLOGICAL ENVIRONMENT

7.2.1 PROTECTED AREAS

Based on the South African National Biodiversity Institute (SANBI) (2005) Protected Areas Map and the National Protected Areas Expansion Strategy (NPAES) the project area does not overlap with any formally or informally protected area (**Figure 7-19**) but does occur in very close (<1 km) proximity to the Mlilwane Wildlife Sanctuary. This protected area is further divided into Mantenga Nature Reserve in the northern section and Mlilwane Wildlife Sanctuary in the southern section.

The Mantenga Nature Reserve, proclaimed in 1994, is a protected area of 725ha in a secluded corner of the Ezulwini Valley, just 2 km from a major road. It contains not only the Mantenga Waterfalls but also the cultural village, Ligugu Lemaswati ("pride of the Swazi people"). This nature reserve is home to vervet monkeys, baboons, warthogs, nyalas and duikers as well as the Endangered Bald Ibis.

The Mlilwane Wildlife Sanctuary is Eswatini's pioneer conservation area. Mlilwane was proclaimed in 1961. The name 'Mlilwane' ('Little Fire' in siSwati) was derived from the numerous fires started by lightning strikes on the Mlilwane Hill but now holds significance as the little fire that ignited the conservation movement in Eswatini. Mlilwane's diverse habitats support an extensive species list (including Suni antelopes and the Blue Crane) on its 4 560 ha property.

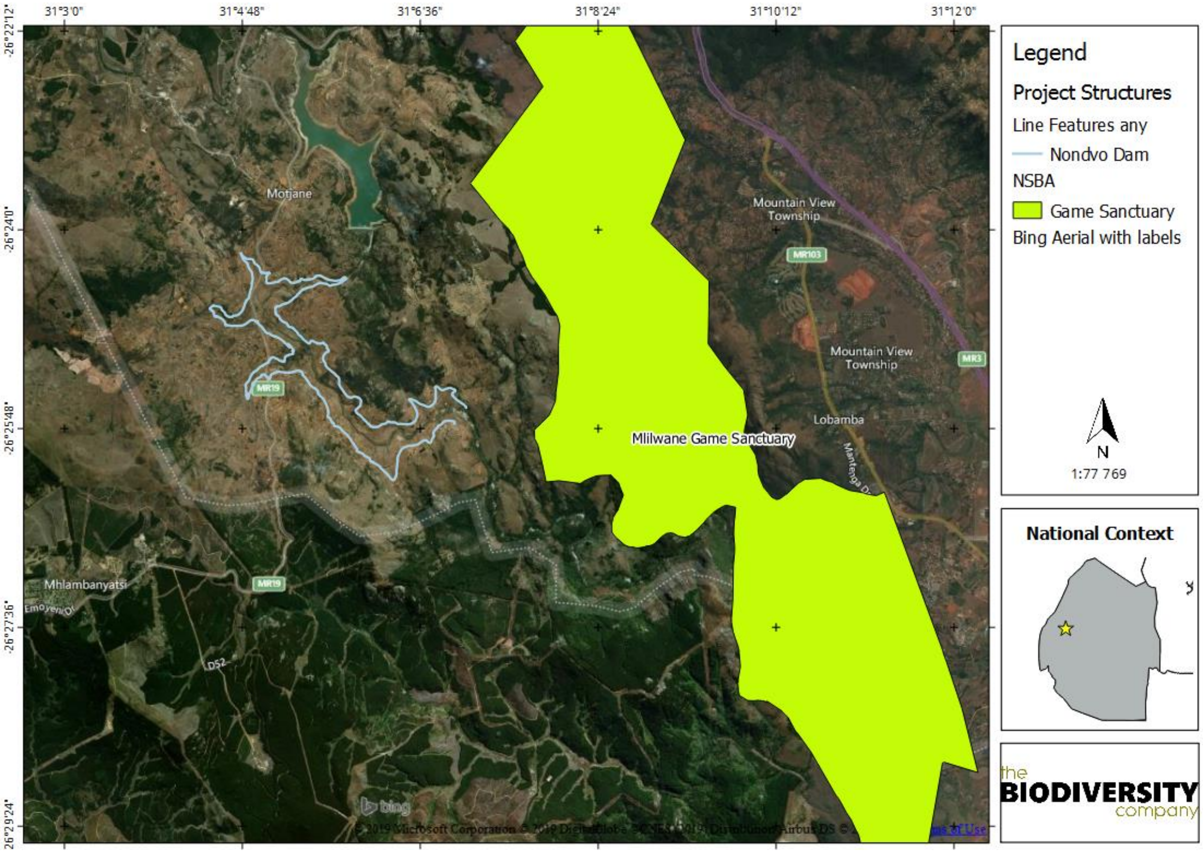


Figure 7-19: Formally Protected Areas Adjacent to the Project Area (Source, http://www.thekingdomofeswatini.com/central-eswatini/mantenga-reserve-village-falls/)

7.2.2 HABITAT STATUS ASSESSMENT

HABITAT TYPES

Seven preliminary habitat types were delineated for the project footprint area and the associated Discrete Management Unit (DMU). The approximate area that each habitat covers within the respective area is presented in **Table 7-5**. The extent of the habitats and DMU are shown in **Figure 7-20**, with representative photos of each shown in **Figure 7-21** to **Figure 7-24**, and are briefly discussed below.

As evident from \ **Table 7-5** the Transformed: Homesteads and Subsistence Farming dominate (77,95%) the extent of the project footprint area. Whereas the extent of the DMU is collectively dominated by the Rocky Grassland (37,67%) and Homestead and Subsistence Farming (37,35%). The Transformed: Commercial Plantations and Alien Invasive Tree Clumps comprises approximately a third (21,81%) of the extent of the DMU.

Table 7-5: Preliminary Habitat Types

HABITAT	DMU Area (ha)	DMU Proportion (%)	FOOTPRINT AREA Area (ha)	FOOTPRINT AREA Proportion (%)
Semi-Natural: Rocky Grassland	2016,62	37,67	1.82	0,62
Semi-Natural: Indigenous Tree Clumps	5,26	0,09	0,0	0,0
Transformed: Commercial Plantations	576,60	10,56	0,0	0,0
Transformed: Alien Invasive Tree Clumps	601,79	11,25	2,23	0,75
Transformed: Homesteads and Subsistence Farming	2054,04	37,35	229,95	77,95
Riverine (Wetlands, River & Riparian Habitat)	76,3	1,33	61,0	20,68
Luphohlo dam	100,39	1,75	-	-
Total	**5341,0**	**100**	**295**	**100**

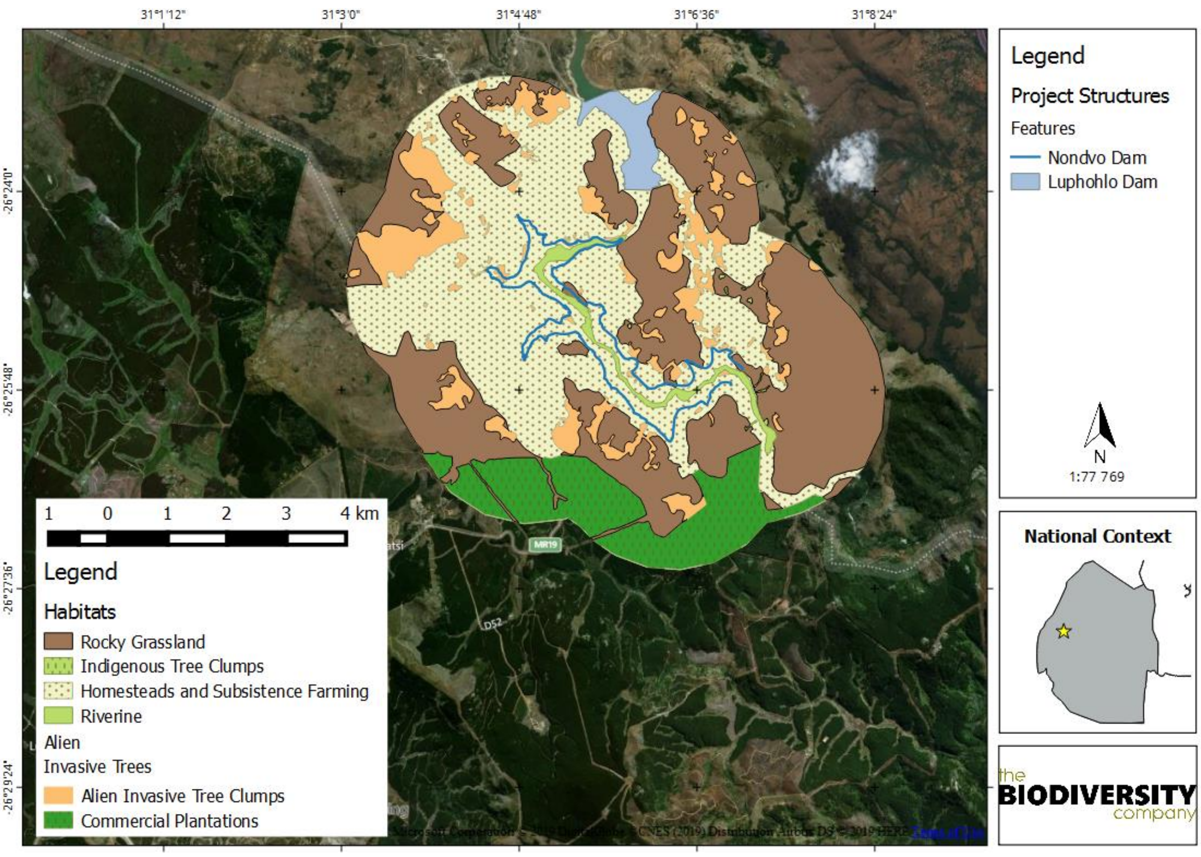


Figure 7-20: Habitats Delineated for the Project Area (TBC, 2019)

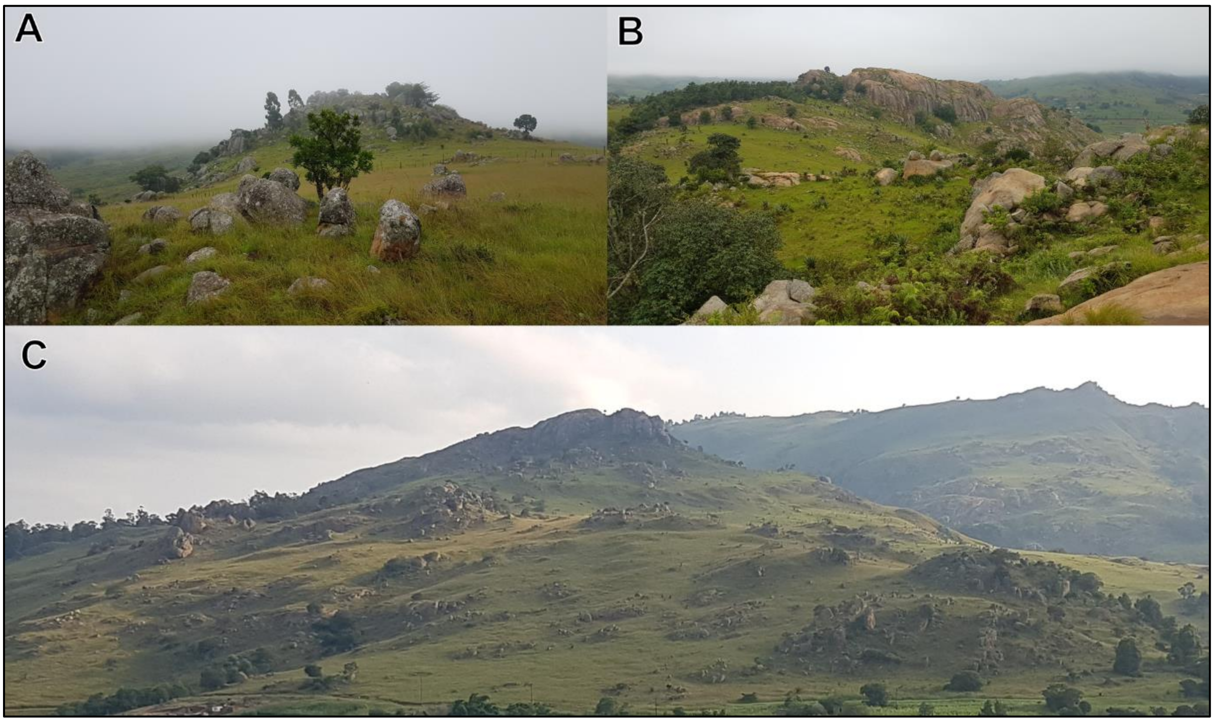


Figure 7-21: Representative Photos for the Preliminary Habitats Delineated uring Survey; A, B & C) Semi-Natural: Rocky Grassland

Figure 7-22: Representative Photos for the Preliminary Habitats Delineated during Survey; D) Semi-Natural: Indigenous Tree Clumps; E) Transformed: Plantations/Alien Tree Clumps

Figure 7-23: Representative Photos for the Preliminary Habitats Delineated during Survey; F, G & H) Transformed: Homesteads and Subsistence Farming

Figure 7-24: Representative Photos for the Preliminary Habitats Delineated during Survey; I, J & K) Wetlands, River & Riparian Habitat

Semi-Natural: Rocky Grassland

The Semi Natural Rocky Grassland habitat was the most expansive habitat within the DMU. The habitat consisted of areas with a high density of rocks and boulders and grassland areas in between. The habitat has been infringed upon by the local community and the associated livestock, which has had the largest impact on this habitat. Portions of the habitat that were more treacherous and had a high density of boulders and rocks were noted to be less impacted by infringement (i.e. in a more natural, pristine condition). This habitat type has undergone impacts associated with human activity such as the removal of trees and herbaceous material, which is most likely used by the local community for firewood and/or medicine.

Typical tree species associated with these outcrops were limited due to the number of rocks and a lack of deep soils but included *Protea caffra*, *Psychotria capensis, Dalbergia armata*. Most of the Aloe species, including the listed *Aloe ecklonis*, occurred in large densities within this habitat. Herbaceous and graminoid plants occurred in-between many of the rocks but occurred in higher densities within the grassland areas.

The Rocky Grassland forms part of a unique habitat within the region that plays a role within the faunal species makeup within the area by providing refugia, food and a more natural environment in comparison to the vast plantations that surround the area.

One IUCN Red-listed Data plant species was recorded within this habitat, *Alepidea amatymbica*, which is listed as EN. According to the Eswatini Red Data plant list (Eswatini National Trust Commission, 2017c), one Red Data plant species, *Aloe ecklonis* (VU), was recorded within this habitat in small colonies. Additionally, several of the protected plant species according to the Flora Protection Act 2002 were identified within this habitat.

This habitat unit can be regarded as highly important, not only within the local landscape, but also regionally. The habitat sensitivity is considered high-critical, due to the plant species recorded and the role of this habitat to biodiversity.

Semi-Natural: Indigenous Tree Clumps

This habitat within the project area is characterised by tall dense clumps of trees that occur in the drainage lines, or areas with large quantities of water available, where the tree roots could establish. The vegetation is mainly comprised of several tree species including *Syzygium gerrardii, Faurea rochetiana, Dombeya rotundifolia, Cussonia sphaerocephala, Erythrina latissima, Diospyros lycioides, Diospyros whyteana* as well as *Pterocarpus angolensis*.

No IUCN Red-listed or Eswatini Red Data Plants species were recorded within this habitat. *Berchemia zeyheri, Dombeya rotundifolia, Pterocarpus angolensis* and *Cyathea dregei* are plants listed in the Flora Protection Act of 2002 that were recorded within this unit.

Due to the fact that this habitat is connected to, and functions with the Rocky Grassland, it can be regarded as moderate-highly important within the landscape. The sensitivity of this habitat is therefore moderate-high.

Transformed: Commercial Plantations and Alien Invasive Tree Clumps

Collectively, the transformed habitat, associated with commercial plantations and invasive tree clumps, is the third most expansive habitat within the DMU. This habitat is characterised by areas severely dominated by alien invasive tree species, especially *Pinus pinaster* and *Acacia mearnsii* but also *Eucalyptus* sp. These areas have little to no natural vegetation that can survive and compete with the alien species.

No IUCN or Eswatini Red Data Plants species were recorded within this habitat unit. This habitat is assigned a low sensitivity.

Transformed: Homesteads and Subsistence Farming

The Homesteads and Subsistence Farming habitat is one of the largest habitats within the DMU. This habitat is characterised by areas cleared of natural vegetation mainly for subsistence agriculture, as well as roads, housing and business infrastructure. Vegetation structure ranges from low sparse herbland to tall closed shrubland consisting of non-native crops and weeds. These crops (mainly maize and sorghum) are used for essential sources of food and income for the local community and drives the large-scale disturbance of the natural environment. Most of the alien and/or invasive plant species occurred within this habitat due to the continued impact and the fact that many species are species that are used for agriculture. Small patches of natural vegetation do exist within the habitat, but due to the adjacent anthropogenic activities are either fragmented or severely degraded due to edge effects. A large portion of the alien invasive plant species occurring in this habitat type were planted for aesthetic reasons.

No IUCN or Eswatini Red Data Plants species were recorded within this habitat unit. This habitat is assigned a low sensitivity.

Riverine (Wetlands, River & Riparian Habitat)

Riverine habitats are found within the lower-lying areas of the project area and include flowing open water habitats with exposed protruding bedrock and low riverine fringe vegetation, wetlands and small episodic streams.

The vegetation is characterised by some tall trees that still exist in small patches to more open areas with water constituent herbs and grasses in several areas. Plant species associated with this habitat unit include *Breonadia salicina*, *Combretum erythrophyllum*, *Syzygium cordatum*, *Miscanthus junceus*, *Buddleja salviifolia* as well as *Leersia hexandra*. *Typha capensis* and *Phragmites mauritianus* were plant species being more hydrophytic. *Crinum bulbispermum* occurred inconspicuously in areas that haven't been degraded too much. Some alien and/or invasive plant species, such as *Sesbania punicea*, *Ricinus communis* and *Senna didymobotrya* occurred along and within the habitat due to the dispersal of seeds via water, however the infringement of these species was less severe than in other normal conditions.

Due to the role that this habitat plays as a water source for the local community, this area has been infringed upon, and utilised extensively. Washing of clothes, sand mining and bathing occurs on a daily basis leaving the habitat in a constant state of disturbance. This habitat, even though degraded, is still important as a movement corridor for several faunal species, especially birds and mammals, and plays a vital role as a water resource not only for the biodiversity but also the local community.

No IUCN Red-listed or Eswatini Red Data Plants species were recorded within this habitat. *Breonadia salicina, Pterocarpus angolensis, Schizostylis coccinea, Crinum bulbispermum* and *Cyathea dregei* are plants listed in the Flora Protection Act of 2002 that were recorded within this unit.

Due to the role that this habitat plays it can be regarded as moderate-highly important within the local landscape. The sensitivity of this habitat is therefore moderate-high.

FLORISTIC ANALYSIS

A total of 201 plant species, across 67 families, were recorded during the survey. **Table 7-6** indicates the number of species recorded per growth form. Of the species recorded the dominant growth forms within the project area consist of herbs (26.87%) and Graminoid (15.92%) followed by shrubs (16,67%). The Poaceae family represented 15,92 % of the recorded plant species, followed by Asteraceae (11,94 %), Fabaceae (7,46 %), Rubiaceae (4,98 %), with a large majority of the rest being 0.50% (refer to **Table 7-6** for further detail).

NOTE: Many areas within the project area were trampled and grazed at the time of fieldwork, which complicated representative sampling within this habitat. Although not accurately portrayed throughout the species effort curves, the habitat type represents a fairly high number of species and species diversity for the project area.

Table 7-6: Dominant Growth Forms of the Recorded Plant Species within the Project Area

GROWTH FORM	# OF SPECIES	%
Carnivore	1	0,50
Climber	5	2,49
Creeper	1	0,50
Dwarf Shrub	6	2,99
Geophyte	9	4,48
Graminoid	32	15,92
Herb	54	26,87
Hydrophyte	2	1,00

GROWTH FORM	# OF SPECIES	%
Hyperhydate	1	0,50
Lithophyte	4	1,99
Shrub	30	14,93
Succulent	21	10,45
Suffrutex	2	1,00
Tree	33	16,42
Grand Total	**201**	**100**

Alien and/or Invasive Plant Species

A total of 52 (25.87%) alien and/or invasive plant (AIP) species were recorded within the project area. The majority of these were recorded within the transformed, modified and riparian habitat types. A list of all the AIP's recorded within the project area is given in **Table 7-7**. Many of these species are cultivated food plants or used as ornamental garden plants.

Table 7-7: AIP's Recorded within the Project Area

FAMILY	TAXON	USES	MEDICINE	FOOD
Agavaceae	*Agave americana L. subsp. americana var. americana*	Ornamental, Hedge		
	Agave sisalana Perrine	Ornamental, Hedge		
Amaranthaceae	*Achyranthes aspera L. var. aspera*	Traditional Medicine	X	
	Amaranthus hybridus L. subsp. hybridus var. hybridus			
Araceae	*Monstera deliciosa Liebm.*			
Asteraceae	*Bidens pilosa L.*	Traditional medicine	X	
	Ageratum houstonianum Mill.			
	Campuloclinium macrocephalum (Less.) DC.	Ornamental		
	Crepis hypochaeridea (DC.) Thell.			
	Cirsium vulgare (Savi) Ten.			
	Cosmos bipinnatus Cav.	Traditional Medicine	X	
	Xanthium spinosum L.			
	Hypochaeris radicata L.			
	Tagetes minuta L.	Traditional medicine, Insect Repellent	X	
Bignoniaceae	*Jacaranda mimosifolia D. Don*	Ornamental		
	Tecoma stans (L.) Juss. ex Kunth var. stans			
Cactaceae	*Cereus jamacaru DC.*	Hedge, Ornamental		

FAMILY	TAXON	USES	MEDICINE	FOOD
	Opuntia ficus-indica (L.) Mill.	Hedge		X
Cannaceae	*Canna indica L.*	Ornamental		
Caricaceae	*Carica papaya*			X
Euphorbiaceae	*Ricinus communis L.*	Ornamental, Castor-oil		
Fabaceae	*Acacia mearnsii De Wild.*	Tanbark, Firewood		
	Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	Ornamental		
	Sesbania punicea (Cav.) Benth.			
Lauraceae	*Persea americana Mil.*			X
Meliaceae	*Melia azedarach L.*	Ornamental		
Moraceae	*Morus alba L.*			X
Musaceae	*Musa sp (Banana)*			X
Myrtaceae	*Eucalyptus camaldulensis Dehnh.*	Timber, Firewood, Ornament		
	Psidium guajava L.			X
Nyctaginaceae	*Bougainvillea glabra Choisy*	Ornamental		
	Mirabilis jalapa L.			
Onagraceae	*Oenothera stricta Ledeb. ex Link subsp. stricta*			
Papaveraceae	*Argemone ochroleuca Sweet subsp. ochroleuca*	Traditional medicine	X	
Phytolaccaceae	*Phytolacca octandra L.*			
Pinaceae	*Pinus pinaster Aiton*	Timber		
Poaceae	*Paspalum dilatatum Poir.*			
	Cortaderia selloana (Schult.) Asch. & Graebn.	Ornamental, Dune Stabilisation		
	Paspalum urvillei Steud.			
	Zea mays (Maize)			X
	Saccharum officinarum L.			X
Proteaceae	*Grevillea robusta A. Cunn. ex R.Br.*	Ornamental, Timber		
Rosaceae	*Prunus persica (L.) Batsch var. persica*			X
	Pyracantha angustifolia (Franch.) C.K. Schneid.	Ornamental, Hedge		
	Rubus proteus C.H. Stirt.			X
Rubiaceae	*Richardia brasiliensis Gomes*			

FAMILY	TAXON	USES	MEDICINE	FOOD
Salicaceae	*Populus alba L. var. alba*	Timber, Shelter, Ornamental		
Solanaceae	*Datura ferox L.*			
	Solanum mauritianum Scop.	Ornament		
	Solanum sisymbriifolium Lam.			
Verbenaceae	*Verbena bonariensis L.*	Ornamental		
	Lantana camara L.	Ornament, Hedge		

Socio-Economically Important Plants

At least 76 species (37.81%) of the total plant species recorded are regarded as important with regards to providing at least 1 (one) important known secondary ecosystem service (**Table 7-8**). Of the 37 species, the majority (14 species) are species that are cultivated as a food source, whereas 28 of the plant species have some documented medicinal properties associated with them.

Table 7-8: Selection of Significant Plant Species Recorded within the Project Area

FAMILY	TAXON	USES
Acanthaceae	*Thunbergia dregeana Nees*	Traditional medicine
Agapanthaceae	*Agapanthus inapertus P. Beauv. subsp. inapertus*	Ornamental
Agavaceae	*Agave americana L. subsp. americana var. americana*	Ornamental, Hedge
	Agave sisalana Perrine	Ornamental, Hedge
Amaranthaceae	*Achyranthes aspera L. var. aspera*	Traditional Medicine
Amaryllidaceae	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	Traditional medicine, Ornamental
	Boophone disticha (L.f.) Herb.	Traditional Medicine
Apiaceae	Alepidea amatymbica	Traditional Medicine
Apocynaceae	*Carissa bispinosa (L.) Desf. ex Brenan*	Traditional Medicine
Araceae	*Zantedeschia albomaculata (Hook.) Baill.*	Ornamental
Araliaceae	*Cussonia sphaerocephala Strey*	Traditional medicine
Asphodelaceae	*Aloe ecklonis Salm-Dyck*	Traditional medicine; Inflorescence eaten
	Aloe arborescens Mill.	Ornamental
	Aloe cooperi Baker	Ornamental
	Aloe marlothii A. Berger	Ornamental
Asteraceae	*Bidens pilosa L.*	Traditional medicine
	Cosmos bipinnatus Cav.	Traditional Medicine
	Tagetes minuta L.	Traditional medicine, Insect Repellent
	Campuloclinium macrocephalum (Less.) DC.	Ornamental

FAMILY	TAXON	USES
	Helichrysum cooperi Harv.	Love Charm
Bignoniaceae	*Tecoma capensis (Thunb.) Lindl.*	Traditional medicine, Ornamental
	Jacaranda mimosifolia D. Don	Ornamental
Cactaceae	*Cereus jamacaru DC.*	Hedge, Ornamental
	Opuntia ficus-indica (L.) Mill.	Hedge
Cannaceae	*Canna indica L.*	Ornamental
Caricaceae	*Carica papaya*	Fruit Eaten
Combretaceae	*Combretum apiculatum Sond.*	Firewood
Commelinaceae	*Commelina africana L. var. krebsiana (Kunth) C.B. Clarke*	Traditional Medicine
Crassulaceae	*Crassula sarcocaulis Eckl. & Zeyh.*	Traditional Medicine
	Crassula vaginata Eckl. & Zeyh. subsp. vaginata	Traditional Medicine
Euphorbiaceae	*Euphorbia ingens E. Mey. ex Boiss.*	Traditional medicine, Fish poison
	Ricinus communis L.	Ornamental, Castor-oil
Fabaceae	*Burkea africana Hook.*	Traditional Medicine, Tanning
	Dichrostachys cinerea (L.) Wight & Arn.	Firewood, Fence Poles, Traditional medicine
	Pterocarpus angolensis DC.	Furniture, Ornaments, Traditional medicine
	Acacia mearnsii De Wild.	Tanbark, Firewood
	Pseudarthria hookeri Wight & Arn. var. hookeri	Ornamental
	Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	Ornamental
Iridaceae	*Gladiolus crassifolius Baker*	Traditional Medicine
	Watsonia watsonioides (Baker) Oberm.	Traditional Medicine
	Dietes grandiflora N.E.Br.	Ornamental
Lamiaceae	*Stachys nigricans Benth.*	Traditional Medicine
Lauraceae	*Persea americana Mil.*	Fruit Eaten
Melastomataceae	*Dissotis princeps (Kunth) Triana*	Traditional Medicine
Meliaceae	*Melia azedarach L.*	Ornamental
Moraceae	*Morus alba L.*	Fruit Eaten
Musaceae	*Musa sp (Banana*	Fruit Eaten
Myrtaceae	*Syzygium cordatum Hochst. ex C. Krauss subsp. cordatum*	Traditional Medicine
	Eucalyptus camaldulensis Dehnh.	Timber, Firewood, Ornament
	Psidium guajava L.	Fruit Eaten
Nyctaginaceae	*Bougainvillea glabra Choisy*	Ornamental

FAMILY	TAXON	USES
Orchidaceae	*Eulophia angolensis (Rchb.f.) Summerh.*	Love Charm
Papaveraceae	*Argemone ochroleuca Sweet subsp. ochroleuca*	Traditional Medicine
Pedaliaceae	*Ceratotheca triloba (Bernh.) Hook.f.*	Traditional Medicine
Pinaceae	*Pinus pinaster Aiton*	Timber
Poaceae	*Hyparrhenia hirta (L.) Stapf*	Thatching
	Cortaderia selloana (Schult.) Asch. & Graebn.	Ornamental, Dune Stabilisation
	Cymbopogon nardus (L.) Rendle	Thatching
	Zea Mays (Maize)	Fruit Eaten
	Saccharum officinarum L.	Fruit Eaten
Proteaceae	*Grevillea robusta A. Cunn. ex R.Br.*	Ornamental, Timber
	Protea caffra Meisn. subsp. falcata (Beard) Lötter	Traditional medicine
Rhamnaceae	*Berchemia zeyheri (Sond.) Grubov*	Traditional Medicine, Furniture, Ornaments
Rosaceae	*Pyracantha angustifolia (Franch.) C.K. Schneid.*	Ornamental, Hedge
	Prunus persica (L.) Batsch var. persica	Fruit Eaten
	Rubus proteus C.H. Stirt.	Fruit Eaten
Rubiaceae	*Breonadia salicina (Vahl) Hepper & J.R.I. Wood*	Furniture, Boats, Floors
	Vangueria infausta Burch.	Traditional medicine
Salicaceae	*Populus alba L. var. alba*	Timber, Shelter, Ornamental
Sapotaceae	*Englerophytum magalismontanum (Sond.) T.D.Penn.*	Traditional Medicine, Fruit for wine, Syrup and Jam
Scrophulariaceae	*Buddleja salviifolia (L.) Lam.*	Fishing rods, Assegaai, Traditional Medicine
Solanaceae	*Solanum mauritianum Scop.*	Ornamental
Ulmaceae	*Trema orientalis (L.) Blume*	Fruit Eaten
Verbenaceae	*Lippia javanica (Burm.f.) Spreng.*	Traditional Medicine
	Verbena bonariensis L.	Ornamental
	Lantana camara L.	Ornamental, Hedge

Ecology of Plants

At least 68.16% (137 species) of the total plant species recorded are regarded as indigenous to Southern Africa (SANBI, 2019). Nine plants were regarded as endemic. The ecology of the recorded plants and the percentage of indigenous plants versus non-indigenous plants is presented in **Figure 7-25** respectively. **Figure 7-26** presents some photographs of plant species recorded for this assessment.

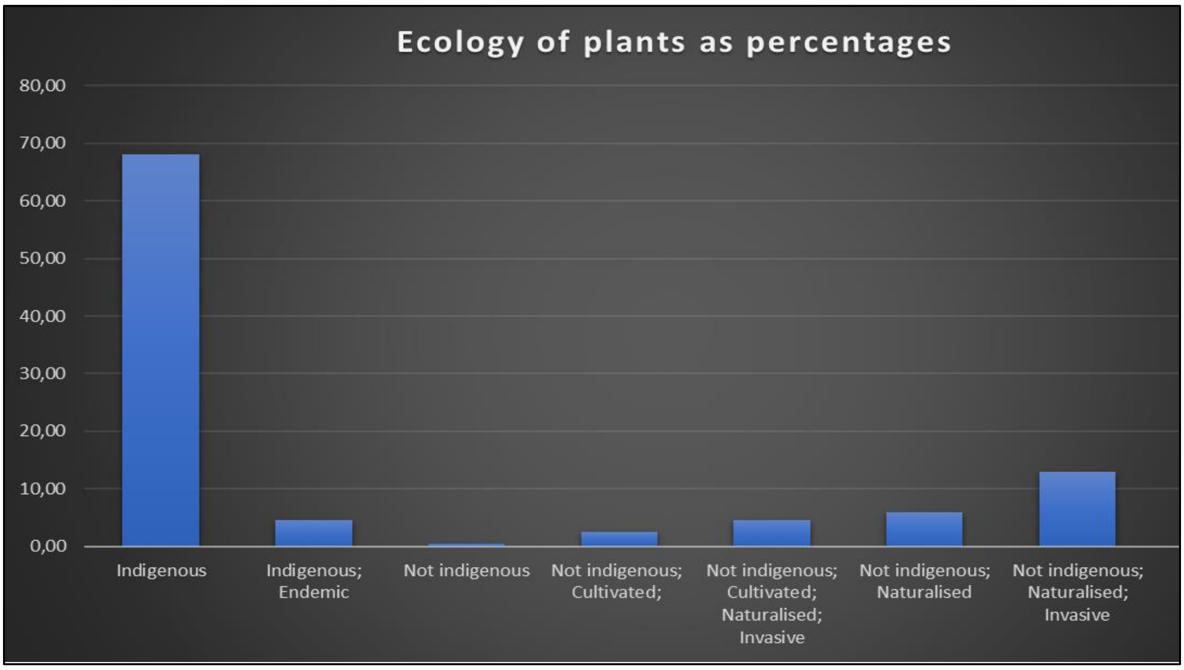
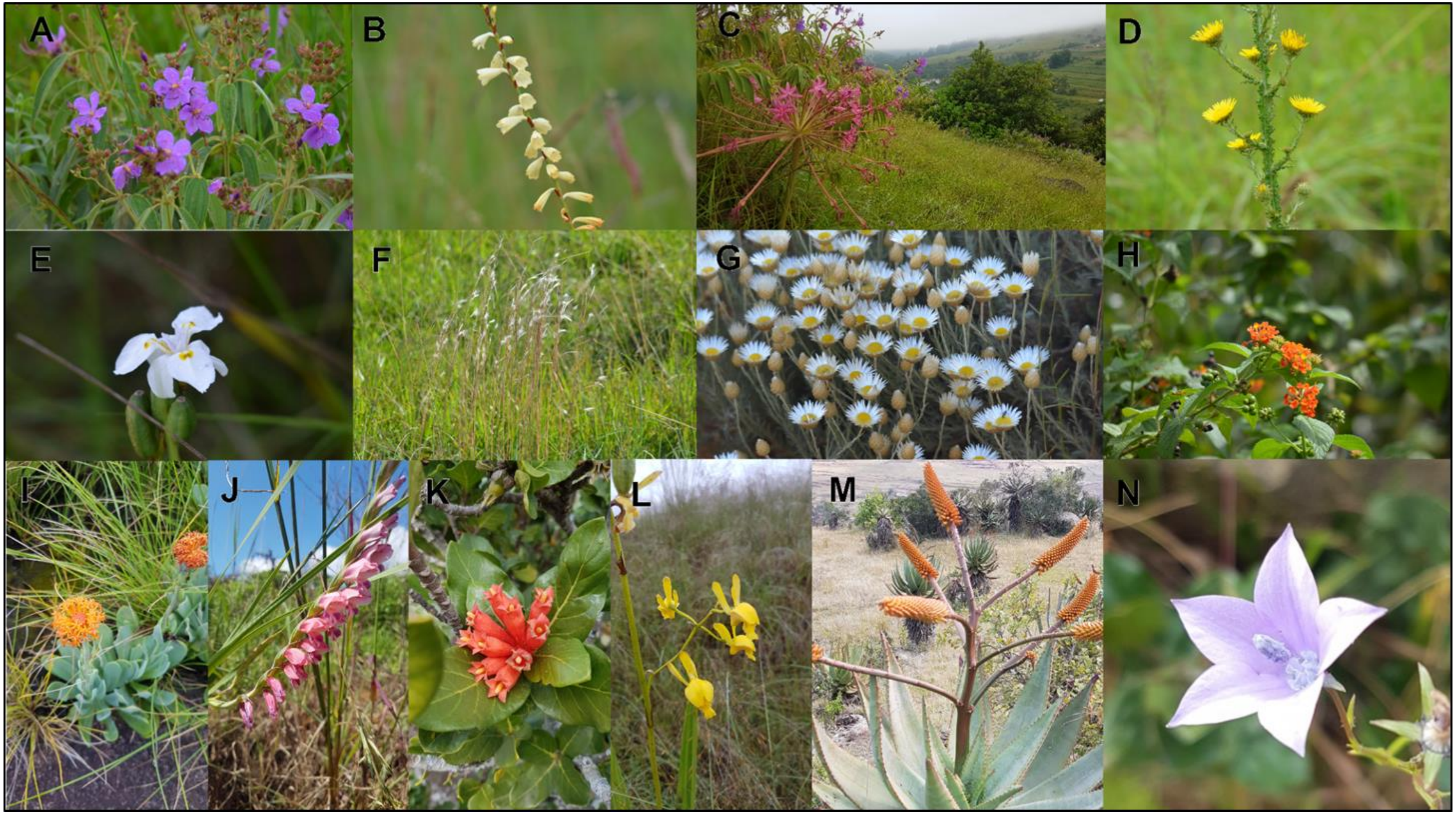


Figure 7-25: Ecology of the Recorded Plants



A) *Dissotis princeps*; B) *Watsonia watsonioides*; C) *Brunsvigia grandiflora*; D) *Berkheya echinacea*; E) *Dietes grandiflora*; F) *Andropogon eucomus*; G) *Helichrysum argyrolepis*; H) *Lantana camara* I) *Kleinia galpinii*; J) *Gladiolus crassifolius*; K) *Breonadia salicina*; L) *Eulophia angolensis*; M) *Aloe marlothii*; N) *Wahlenbergia krebsii*

Figure 7-26: A Selection of Plant Species Observed within the Proposed Project Area during the Dual Season Survey

Species of Conservation Concern

Sixteen plant SCC were observed within the project area during the dual season survey. The majority of the species were recorded in the Rocky Grassland habitat as well as some in the Riparian habitat.

The primary threat to *Alepidea amatymbica* (EN) which is protected both internationally and nationally is over-exploitation for the traditional medicine trade. Some of these species with their Red-listing status are presented in **Table 7-9** and presented in **Figure 7-27**.

Table 7-9: Plant SCC Recorded during the Dual Season Survey

FAMILY	TAXON	IUCN/RED LIST	ESWATINI RED LIST	FLORA PROTECTION ACT 2002	GROWTH FORM	HABITATS
Amaryllidaceae	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	LC		Schedule B: Protected-VU	Hydrophyte; geophyte;	Riparian
	Boophone disticha (L.f.) Herb.	LC		Schedule A: Protected-EN	Succulent; geophyte;	Rocky Grassland, Riparian
Apiaceae	*Alepidea amatymbica Eckl. & Zeyh.*	**EN**		Schedule B: Protected-VU	Herb	Rocky Grassland
Asphodelaceae	*Kniphofia linearifolia Baker*	LC		Schedule B: Protected-VU	Herb	Riparian, Indigenous Tree Clumps, Rocky Grassland
	Aloe ecklonis Salm-Dyck	LC	VU B1B2cD2		Succulent; Herb	Rocky Grassland
Crassulaceae	*Crassula alba Forssk. var. alba*	LC	Endemic		Succulent; Herb	Rocky Grassland
	Crassula vaginata Eckl. & Zeyh. subsp. vaginata	LC	Near-Endemic		Succulent; Herb	Rocky Grassland
Cyatheaceae	*Cyathea dregei Kunze*	LC		Schedule B: Protected-VU	Tree	Riparian, Indigenous Tree Clumps, Rocky Grassland, Homesteads and Subsistence Farming
Fabaceae	*Pterocarpus angolensis DC.*	LC		Schedule A: Protected-EN	Tree	Riparian, Indigenous Tree Clumps, Rocky Grassland, Homesteads and subsistence Farming
Iridaceae	*Aristea angolensis Baker*	LC		Schedule B: Protected-VU	Herb	Rocky Grassland
	Schizostylis coccinea Backh. & Harv.	LC		Schedule B: Protected-VU	Herb	Riparian
	Watsonia watsonioides (Baker) Oberm.	LC	Near-Endemic	Schedule B: Protected-VU	Geophyte; herb;	Rocky Grassland

FAMILY	TAXON	IUCN/RED LIST	ESWATINI RED LIST	FLORA PROTECTION ACT 2002	GROWTH FORM	HABITATS
Malvaceae	*Dombeya rotundifolia (Hochst.) Planch. var. rotundifolia*	LC		Schedule C: Protected-Rare	Tree	Indigenous Tree Clumps, Rocky Grassland
Proteaceae	*Protea caffra Meisn. subsp. falcata (Beard) Lötter*	LC		Schedule B: Protected-VU	Tree; shrub	Rocky Grassland, Indigenous Tree Clumps
Rhamnaceae	*Berchemia zeyheri (Sond.) Grubov*	LC		Schedule B: Protected-VU	Tree; shrub	Riparian, Indigenous Tree Clumps
Rubiaceae	*Breonadia salicina (Vahl) Hepper & J.R.I. Wood*	LC		Schedule B: Protected-VU	Tree	Riparian

A) *Alepidea amatymbica*; B) *Crassula vaginata*; C) *Aristea angolensis*; D) *Aloe ecklonis*; E) *Boophone disticha*; F) *Breonadia salicina*; G) *Kniphofia linearifolia*; H) *Pterocarpus angolensis*

Figure 7-27: SCC Recorded during the Field Survey

7.2.3 HERPETOFAUNA

Overall, herpetofaunal diversity is noticeably high within the project area, especially considering the increased levels of anthropogenic disturbances on site. During the wet season survey, 19 reptiles and nine amphibians were recorded while in the dry season five reptile species and three amphibians were recorded. The complete list of expected species is provided in **Appendix C4** for reptiles and amphibians, respectively.

WET SEASON

Analysis of data captured in the field, a total of 19 reptile species were observed during the wet season survey, representing 19% of the expected 102 species. For amphibians, nine species were observed representing 21% of the expected 43 species. **Table 7-10** lists all the herpetofaunal species recorded during the wet season survey within the project area.

Three endemic and one near-endemic species were recorded (**Table 7-10**). A selection of photographs taken during the wet season survey of amphibians and reptiles is provided in **Figure 7-28** to **Figure 7-30**.

The endemic *Hyperolius semidiscus* (Yellow-striped Reed Frog) was recorded during the wet season survey and is listed as Regionally Extinct according to the Eswatini Fauna Red List which is based on the "Threatened Vertebrates of Eswatini" (Monadjem et al., 2003).

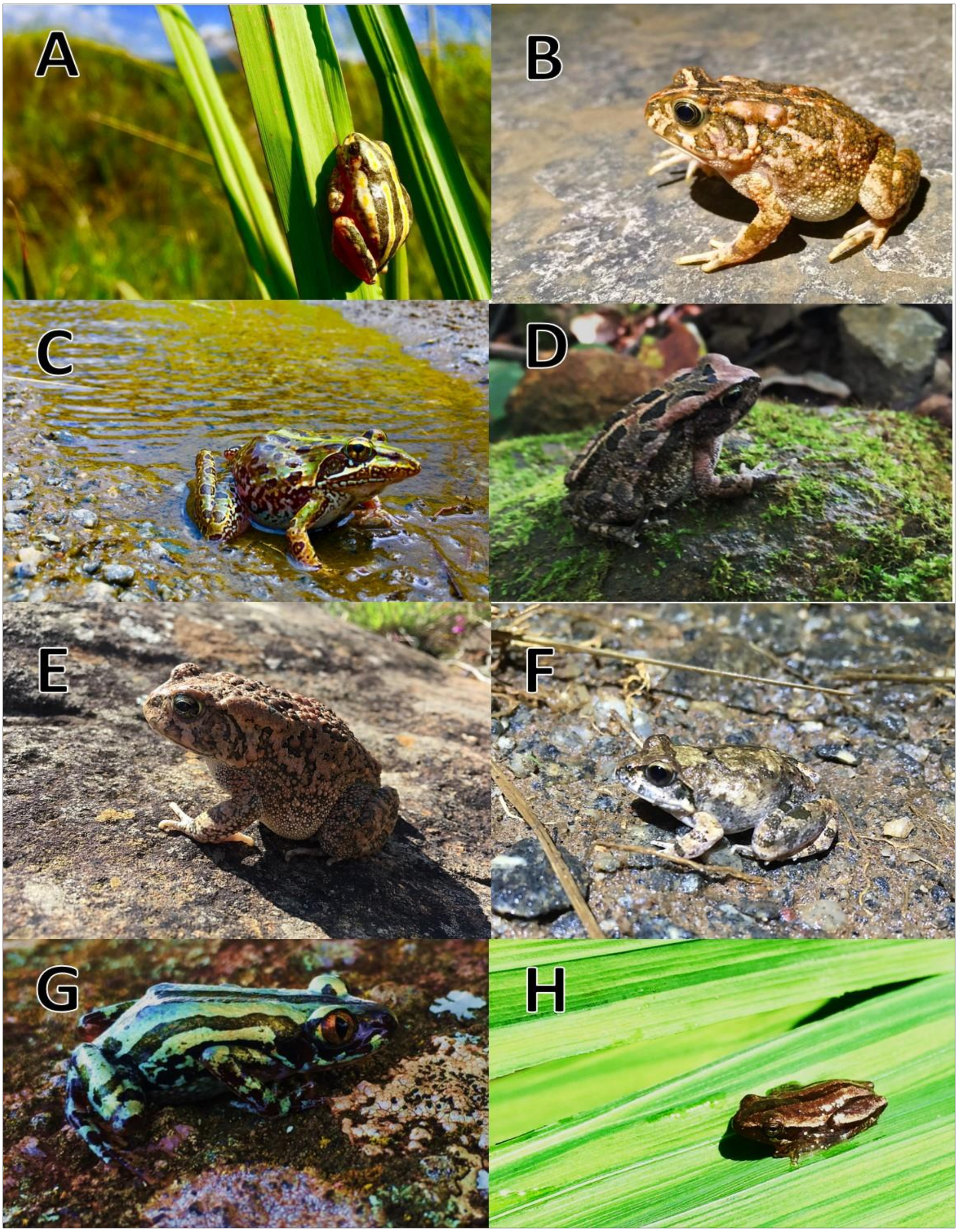
Table 7-10: List of All Herpetofauna Recorded within the Project Area during the Wet Season Survey

		CONSERVATION STATUS		
SPECIES	**COMMON NAME**	**Eswatini Regional Listing**	**IUCN (2017)**	**ENDEMIC**
Reptiles				
Acanthocercus atricollis	Southern Tree Agama	LC	LC	No
Agama aculeata distanti	Eastern Ground Agama	LC	LC	No
Boaedon capensis	Brown House Snake	LC	LC	No
Chondrodactylus turneri	Turner's Gecko	LC	Unlisted	No
Cordylus vittifer	Common Girdled Lizard	LC	LC	**Near-endemic**
Dendroaspis polylepis	Black Mamba	LC	LC	No
Hemidactylus mabouia	Common Tropical House Gecko	LC	Unlisted	No
Homopholis wahlbergii	Wahlberg's Velvet Gecko	LC	LC	No
Leptotyphlops sp.	Thread Snake	LC	Unlisted	No
Lycodonomorphus laevissimus	Dusky-bellied Water Snake	LC	LC	**Endemic**
Lygodactylus capensis	Common Dwarf Gecko	LC	Unlisted	No
Naja mossambica	Mozambique Spitting Cobra	LC	Unlisted	No
Panaspis wahlbergii	Wahlberg's Snake-eyed Skink	LC	Unlisted	No
Philothamnus hoplogaster	South Eastern Green Snake	LC	Unlisted	No
Psammophis brevirostris	Short-snouted Grass Snake	LC	Unlisted	No
Scelotes mirus	Montane Dwarf Burrowing Skink	LC	LC	**Endemic**
Trachylepis margaritifer	Rainbow Skink	LC	LC	No

SPECIES	COMMON NAME	CONSERVATION STATUS Eswatini Regional Listing	IUCN (2017)	ENDEMIC
Trachylepis striata	Striped Skink	LC	Unlisted	No
Trachylepis varia	Variable Skink	LC	LC	No
Amphibians				
Amietia delalandii	Delalande's River Frog	LC	Unlisted	No
Cacosternum boettgeri	Common Caco	LC	LC	No
Hyperolius marmoratus	Painted Reed Frog	LC	LC	No
Hyperolius semidiscus	Yellow-striped Reed Frog	LC	LC	**Endemic**
Kassina senegalensis	Bubbling Kassina	LC	LC	No
Phrynobatrachus mababiensis	Dwarf Puddle Frog	LC	LC	No
Sclerophrys capensis	Raucous Toad	LC	LC	No
Sclerophrys gutturalis	Guttural Toad	LC	LC	No
Tomopterna natalensis	Tremelo Sand Frog	LC	LC	No

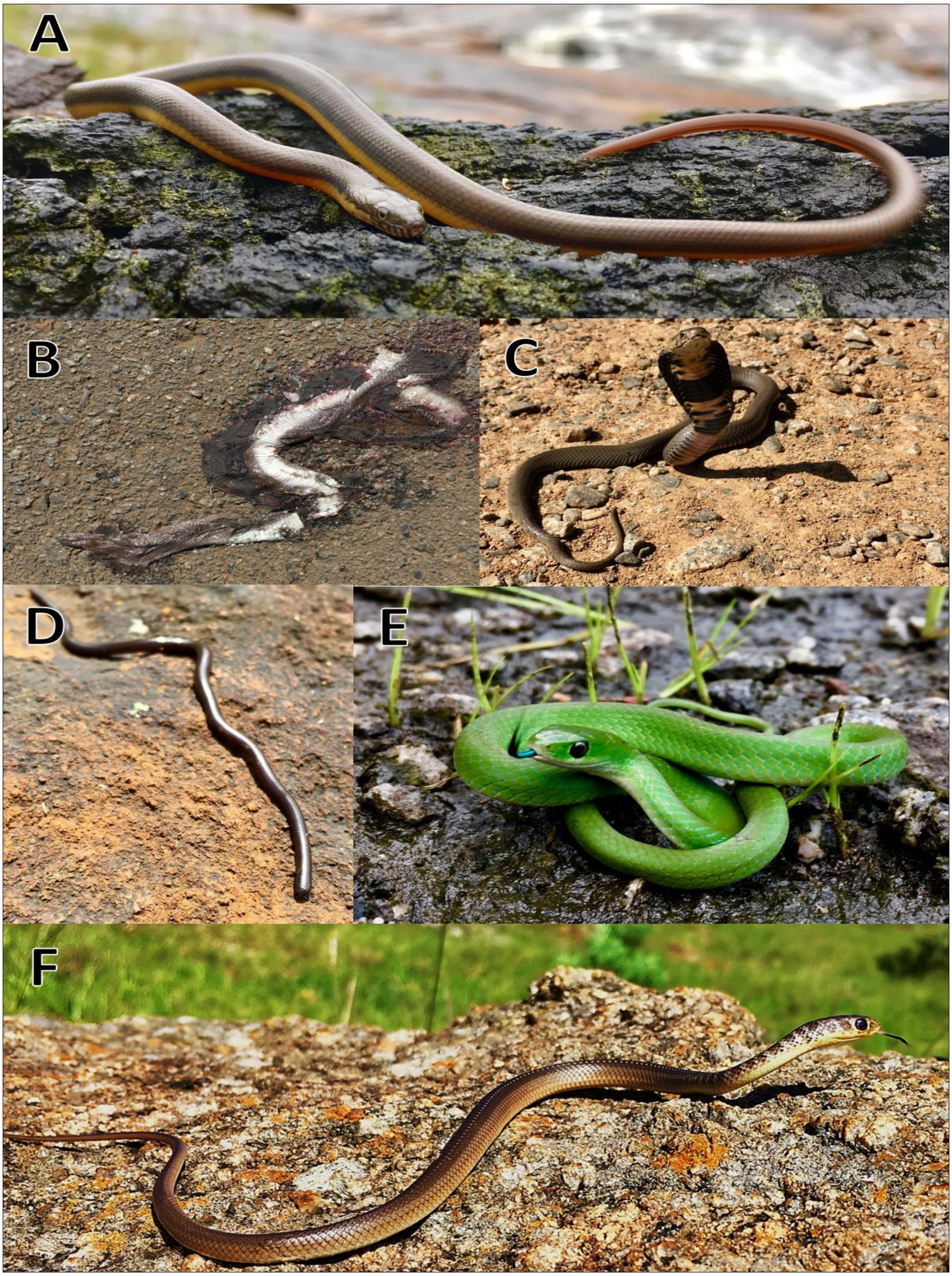
DRY SEASON

A selection of photographs taken during the dry season survey of amphibians and reptiles are provided in **Figure 7-31** and **Figure 7-32**. Three species that were not recorded in the wet season survey increased the total number of observed reptiles (to 21) and amphibians (to 11). One endemic gecko species was recorded, the Spotted Dwarf Gecko (*Lygodactylus ocellatus ocellatus*).



A) Painted Reed Frog (*Hyperolius marmoratus*), B) & E) Guttural Toad (*Sclerophrys gutturalis*), C) Delalande's River Frog (*Amietia delalandii*), D) Raucous Toad (*Sclerophrys capensis*), F) Natal Sand Frog (*Tomopterna natalensis*), G) Bubbling Kassina (*Kassina senegalensis*) and H) Yellow-striped Reed Frog (*Hyperolius semidiscus*)

Figure 7-28: Some of the Amphibian Species Recorded within the Project Area during the May 2019 Survey



A) Dusky-bellied Water Snake (*Lycodonomorphus laevissimus*), B) Brown House Snake (*Boaedon capensis*), C) Mozambique Spitting Cobra (*Naja mossambica*), D) Thread Snake (*Leptotyphlops sp.*), E) South Eastern Green Snake (*Philothamnus hoplogaster*), and F) Short-snouted Grass Snake (*Psammophis brevirostris*)

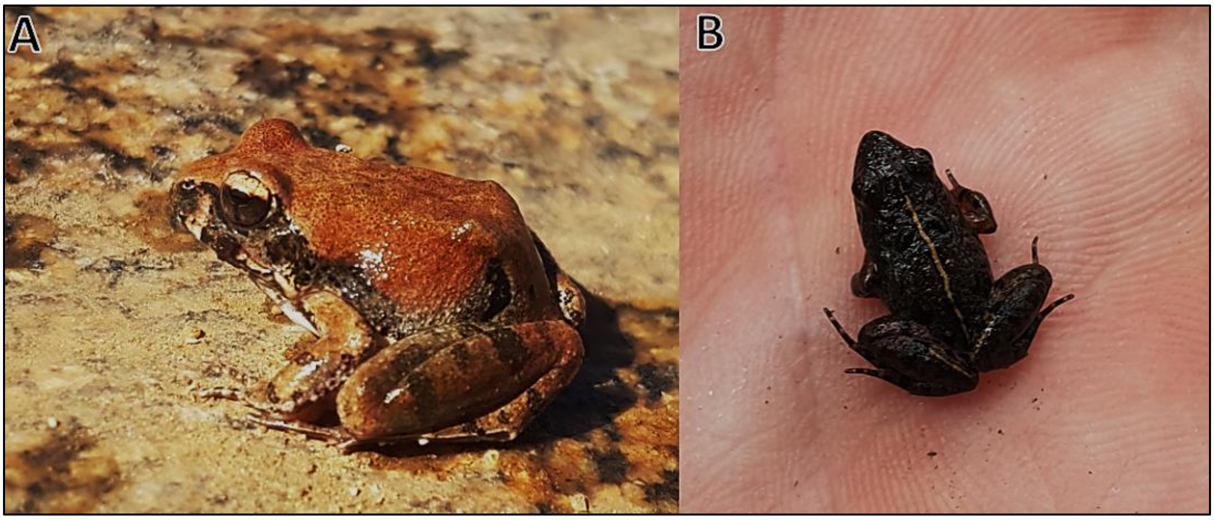
Figure 7-29: Some of the Reptile Species Recorded in the Project Area during the March 2019 Survey

A) Rainbow Skink (*Trachylepis margaritifer*), B) & C) Common Girdled Lizard (*Cordylus vittifer*), D) Wahlberg's Velvet Gecko (*Homopholis wahlbergii*), E) Montane Dwarf Burrowing Skink (*Scelotes mirus*), and F) Eastern Ground Agama (*Agama aculeata distanti*)

Figure 7-30: Some of the Recorded Lizard Species from the Project Area

A) Southern Rock Agama (*Agama atra*), B) Wahlberg's Snake-eyed Skink (*Panaspis wahlbergii*), C) Rainbow Skink (*Trachylepis margaritifer*), and D) Spotted Dwarf Gecko (*Lygodactylus ocellatus ocellatus*)

Figure 7-31: Reptile Species Recorded in the Dry Season



A) Natal Sand Frog (*Tomopterna natalensis*), and B) Dwarf Puddle Frog (*Phrynobatrachus mababiensis*)

Figure 7-32: Some of the Amphibian Species Recorded in the Dry Season

HERPETOFAUNA HABITAT ASSOCIATION

Semi-Natural : Rocky Grassland

The Common Girdled Lizard (*Cordylus vittifer*), Wahlberg's Velvet Gecko (*Homopholis wahlbergii*), Rainbow Skink (*Trachylepis margaritifer*) and Variable Skink (*Trachylepis varia*) were the four most common reptiles found on the rocky slopes of these grassland habitats. **Figure 7-33** shows an example of this habitat from within the project area. Although not recorded during surveys, the Near Threatened and endemic Swazi Flat Gecko (*Afroedura major*) is expected to occur in this habitat. During the dry season survey, an endemic species of gecko (*Lygodactylus ocellatus ocellatus* – Spotted Dwarf Gecko) was recorded in this habitat type.

These, predominantly sloped, areas provide habitat for some of the amphibian species that are not associated with fast-flowing or permanent water (e.g. Raucous Toad (*Sclerophrys capensis*)). Small streams and drainage lines intersected various portions of this habitat. These, more permanently wet, areas provide suitable habitat for the Common River Frog (*Amietia delalandii*), Common Caco (*Cacosternum boettgeri*) and some of the Reed Frog (*Hyperolius*) species.

Although not recorded during surveys, the two near threatened and endemic Grass Lizard species (*Chamaesaura aenea and Chamaesaura macrolepis*) are expected to occur in the grassland areas of this habitat. This habitat type is considered important reptile habitat (especially for rupicolus species) and due to the limited amount of this habitat type in the region, and its relatively pristine condition, it is considered to be of high sensitivity.

Figure 7-33: An Example of the Semi-Natural: Rocky Grassland Habitat within the Project Area

Semi-Natural: Indigenous Tree Clumps

The areas directly adjacent to, and below, the proposed dam wall is representative of this habitat type. This area is considered semi-forested and although impacted by the presence of alien plant species, is considered to be in a fairly pristine condition. Wahlberg's Snake-eyed Skink (*Panaspis wahlbergii*) and Southern Tree Agama (*Acanthocercus atricollis*) were commonly recorded in this habitat.

Due to its proximity to the river and riparian habitat, a number of amphibian species were recorded in this habitat type. Dwarf Puddle Frog (*Phrynobatrachus mababiensis*), Raucous Toad (*Sclerophrys capensis*) and both recorded Hyperolius sp. were observed in this habitat. Due to the limited amount of this habitat type in the region, it is considered to be of a moderate to high sensitivity.

Transformed: Commercial Plantations

This habitat type includes all of the major commercial tree plantations in the project area and within the DMU, as defined. These monocultures (predominantly Pine and Eucalyptus sp.) do not support even moderate species diversity. This habitat is considered extremely transformed and only two generalist reptile species were recorded (Common Dwarf Gecko (*Lygodactylus capensis*) and Variable Skink (*Trachylepis varia*)). This habitat type is considered to be of low sensitivity.

Transformed: Alien Invasive Tree Clumps

As with the commercial plantations, these stands are predominantly monocultures of alien invasive plant species. Although often interspersed with some indigenous species, this habitat is considered to be heavily transformed and only generalist reptile species, and no amphibian species, were recorded. This habitat type is considered to be of low sensitivity.

Transformed: Homesteads and Subsistence Farming

Several synanthropic reptile species are able to colonise and exploit homesteads and cropland areas. Eastern Ground Agama (*Agama aculeata distanti*), Common Dwarf Gecko (*Lygodactylus capensis*) and Variable Skink (Trachylepis varia) were all observed in this modified habitat. The Guttural Toad (*Sclerophrys gutturalis*) in particular is able to exploit disturbed habitats and is usually the only amphibian characteristic of these modified habitats. This degraded habitat has a low sensitivity.

Wetlands, River & Riparian Habitat

Only aquatic or semi-aquatic species are expected in the rivers themselves, but numerous other species are found on the shores of the river. Nile Crocodile (*Crocodylus niloticus*) was not observed in any of the rivers in the project area, however this species has been recorded downstream (in the Mlilwane Nature Reserve) and as such, it is likely to occur in the area. No Water Monitor Lizards (*Varanus niloticus*) were observed within the river itself during the field surveys but this species is expected to occur, as there is plentiful habitat present. The endemic Dusky-bellied Water Snake (*Lycodonomorphus laevissimus*) was recorded within this habitat type.

Amphibian species such as the Yellow-striped Reed Frog (*Hyperolius semidiscus*), Painted Reed Frog (*Hyperolius marmoratus*) and Delalande's River Frog (*Amietia delalandii*) breed in the temporary vegetated pools that form on the sandy shores of the river. In general, rivers are highly sensitive ecological features and the possible presence of a threatened species (Nile Crocodile) and the confirmation of an endemic species (Dusky-bellied Water Snake) within this habitat elevates its sensitivity to high.

7.2.4 MAMMALS

Eswatini is home to 106 species of mammals, of which one is critically endangered, two are endangered, five are vulnerable, and four are near threatened (IUCN, 2019) (for the full list see **Appendix C4**). No endemic mammal species are found in Eswatini. Up to 1996, no published information existed on Eswatini's mammals. An intensive 5-year survey resulted in the publication of a checklist (Monadjem, 1997) and a book on the mammals of Eswatini (Monadjem, 1998). Regional red list data is based on information compiled by the Endangered Wildlife Trust (EWT) and the SANBI for Eswatini, South Africa and Lesotho.

OBSERVED MAMMAL SPECIES RICHNESS

A total of 21 mammal species were either directly observed or deduced to be present in the project area based on visual cues (sightings, tracks, scat, etc.). During the wet season surveys, 16 mammal species were recorded (**Figure 7-21**), while during the dry season 12 mammal species were recorded (**Table 7-12**). This represents 19.81% of the 106 species expected (IUCN, 2019). In general, the observed diversity and density for mammal species werelow and very few signs of mammals were observed (such as spoor, diggings, etc). This contrasts starkly with the expected mammal species richness of the area, which was considered to be high. The high expected richness was attributed to the extensive size of the project area coupled with the ecological complexity of the area.

Subsistence hunting (especially with large packs of hunting dogs) and habitat destruction have caused a massive loss of large and medium-sized mammal species and population densities in the area. Consequently, the larger mammal species such as elephants, rhino and buffalo are now almost exclusively confined to conservation areas.

Large and medium-sized mammals were noticeably absent from the project area. However, certain areas within the proposed project area are characterized by rocky grasslands which provide sufficient habitat and refugia to many smaller mammal species such as rodents, bats, genets and mongooses amongst others.

Sherman trapping was carried out at three sites with 11 traps (per site) for a period of four days per season, resulting in a total of 88 trap nights. Ten motion-activated camera traps were deployed for five days (per season) while a further four cameras were put out for a period that extended over three months. The long-term monitoring done by these four cameras wasto ensure that the sampling is as robust as possible and that the likelihood of human disturbances in the form of mainly human scent does not decrease the chance of detecting shy animals. This also increased the chance of detecting any SCCs that could have been present.

WET SEASON

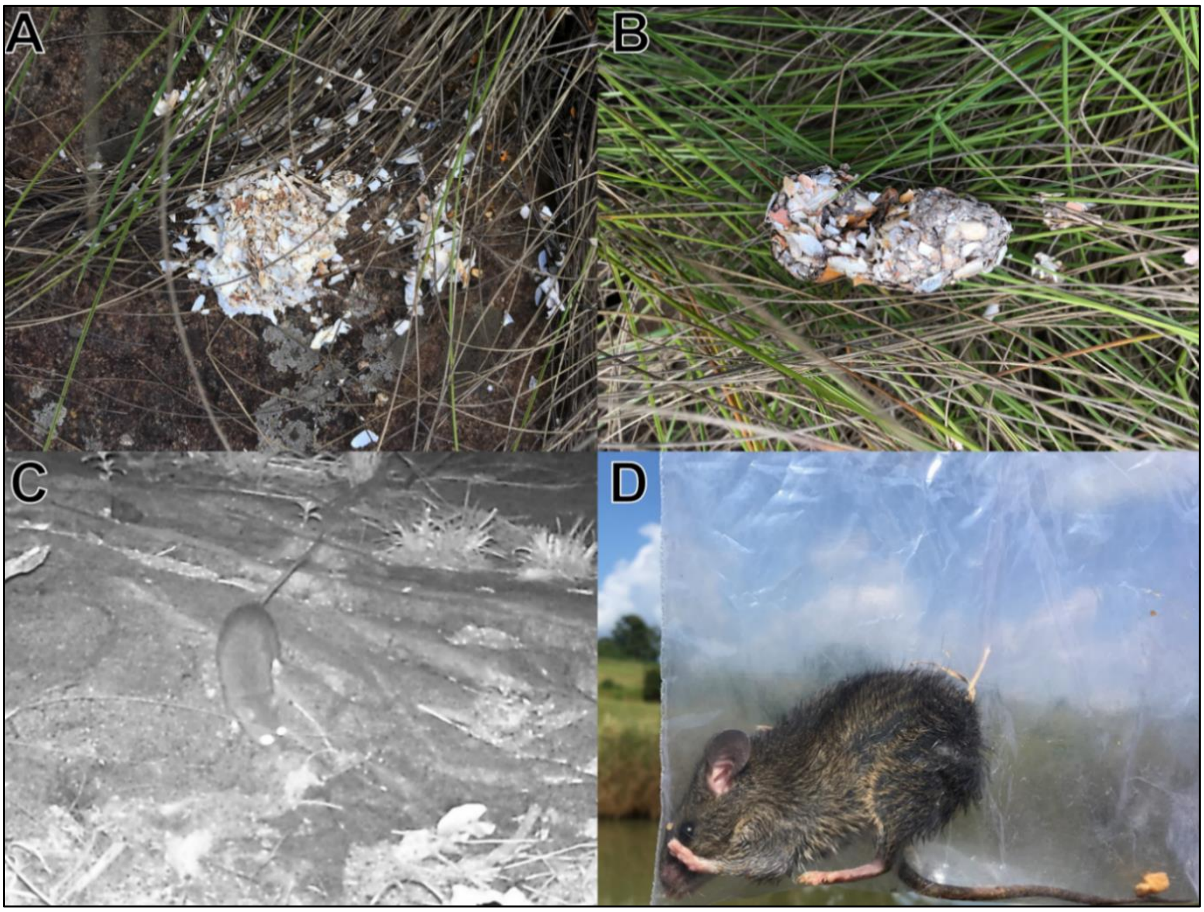
A selection of photographs of mammal species observed during the wet season survey are provided in **Figure 7-34** to **Figure 7-36**. The full list of observed species is shown in **Figure 7-21**.

Table 7-11: Mammal Species Observed, or Deduced to be Present in the Project Area based on Visual Signs (Tracks, Scats etc.) within the Proposed Project Area during the Wet Season Survey

		CONSERVATION STATUS		
SPECIES	**COMMON NAME**	**Eswatini Regional Listing**	**IUCN (2019)**	**ENDEMIC**
Aethomys ineptus (cf)	Tete Veld Rat	LC	LC	No
Amblysomus septentrionalis	Highveld Golden Mole	NT	NT	No
Aonyx capensis	Cape (African) Clawless Otter	NT	NT	No
Atilax paludinosus	Water Mongoose	LC	LC	No
Chaerephon pumilus	Little Free-tailed Bat	LC	LC	No
Chlorocebus pygerythrus	Vervet Monkey	LC	LC	No
Genetta maculata (cf)	Rusty-spotted Genet	LC	LC	No
Herpestes sanguineus	Slender Mongoose	LC	LC	No
Ichneumia albicauda	White-tailed Mongoose	LC	LC	No
Neoromicia capensis	Cape Serotine Bat	LC	LC	No
Neoromicia nana	Banana Bat	LC	LC	No
Pipistrellus hesperidus	African Pipistrelle	LC	LC	No
Procavia capensis	Rock Hyrax	LC	LC	No
Rattus novegicus	Brown Rat	Exotic		No
Sylvicapra grimmia	Common Duiker	LC	LC	No
Tadarida aegyptiaca	Egyptian Free-tailed Bat	LC	LC	No

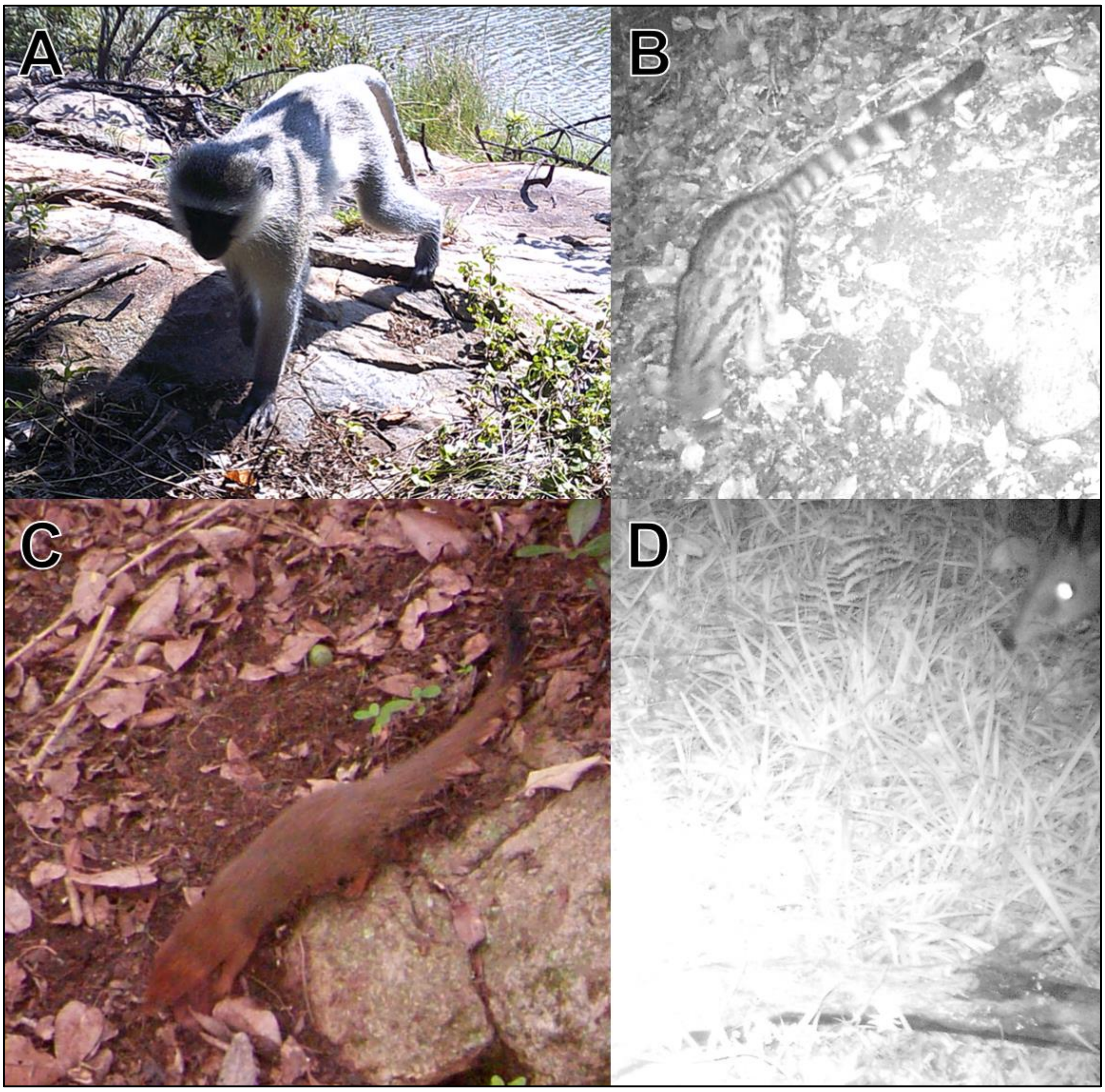
A) Water Mongoose (*Atilax paludinosus*) footprint, B) Rusty-spotted Genet (*Genetta maculata cf*) footprint, C) Vervet Monkey (*Chlorocebus pygerythrus*), D) Highveld Golden Mole (*Amblysomus septentrionalis*), E) Rock Hyrax (*Procavia capensis*), and F) Tete Veld Rat (*Aethomys ineptus cf*)

Figure 7-34: A Selection of Mammal Species Observed within the Proposed Project Area during the Wet Season Survey



A & B) Cape Clawless Otter (*Aonyx capensis*) droppings, C and D) Brown Rat (*Rattus novegicus*)

Figure 7-35: A Selection of Images of Mammals Observed during the Wet Season Survey



A) Vervet Monkey (*Chlorocebus pygerythrus*), B) Rusty-spotted Genet (*Genetta maculata*), C) Slender Mongoose (*Herpestes sanguineus*) and D) Common Duiker (*Sylvicapra grimmia*)

Figure 7-36: Some of the Mammal Species Recorded on Camera Traps

DRY SEASON

A selection of photographs of mammal species observed during the dry season survey are provided in **Figure 7-37** and **Figure 7-38**, while the full list of species recorded are shown in **Table 7-12**.

Table 7-12: Mammal Species Observed, or Deduced to be Present in the Project Area based on Visual Signs (Tracks, Scats etc.) within the Proposed Project Area during the Dry Season Survey

		CONSERVATION STATUS		
SPECIES	COMMON NAME	ESWATINI REGIONAL LISTING	IUCN (2019)	ENDEMISM
Aethomys ineptus	Tete Veld Rat	LC	LC	No
Atilax paludinosus	Water Mongoose	LC	LC	No

SPECIES	COMMON NAME	CONSERVATION STATUS ESWATINI REGIONAL LISTING	IUCN (2019)	ENDEMISM
Cephalophus natalensis	Natal Red Duiker*	NT	LC	No
Chlorocebus pygerythrus	Vervet Monkey	LC	LC	No
Genetta maculata	Rusty-spotted Genet	LC	LC	No
Herpestes sanguineus	Slender Mongoose	LC	LC	No
Hystrix africaeaustralis	Cape Porcupine	LC	LC	No
Ichneumia albicauda	White-tailed Mongoose	LC	LC	No
Lepus saxatilis	Scrub Hare	LC	LC	No
Mastomys natalensis	Natal Multimammate Mouse	LC	LC	No
Procavia capensis	Rock Hyrax	LC	LC	No
Pronolagus crassicaudatus	Natal Red Rock Rabbit*	LC	LC	No

A) Natal Multimammate Mouse (Mastomys natalensis), B) Rock Hyrax (Procavia capensis), C) White-tailed Mongoose (Ichneumia albicauda), D Slender Mongoose (Herpestes sanguineus), E) Vervet Monkey (Chlorocebus pygerythrus) and F) Scrub Hare (Lepus saxatilis) droppings

Figure 7-37: Some of the Mammal Species Recorded in the Dry Season

A) Rusty-spotted Genet (*Genetta maculata*), B) Water Mongoose (*Atilax paludinosus*), C) Natal Red Duiker (*Cephalophus natalensis*). and D) Natal Red Rock Rabbit (*Pronolagus crassicaudatus*)

Figure 7-38: Some of the Mammal Species Recorded by Camera Trap in the Dry Season

SPECIES OF CONSERVATION CONCERN

A total of 17 Species of Consevation Concern (SCC) are expected in the area, three of these species were recorded. They are the Cape Clawless Otter (*Aonyx capensis*), Highveld Golden Mole (*Amblysomus septentrionalis*) and Natal Red Duiker (*Cephalophus natalensis*).

MAMMAL HABITAT ASSOCIATION

In order to determine the strength of the association of the observed mammal species with their habitat a Detrended Correspondence Analysis (DCA) was done. DCA is a multivariate statistical analysis, based on binary presence-absence data of the species with the different habitats. The species richness was divided into habitat associations. The Cape Clawless Otter and Water Mongoose have a very high affinity for the wetland riverine area, while the Highveld Golden Mole and Natal Red Rock Rabbit can be found in the Semi-natural Rocky Grasslands. The Banana Bat has a strong association with the transformed homesteads and subsistence farming, this is due to the large numbers of Banana trees inthe area that this insectivorous bat uses for roosting. The association of the Natal Red Duiker with the Semi-Indigenous tree's habitat is a result of the forest and thicket habitats that these species are restricted to. The other species are mostly generalist with no restriction to their habitat preference and are more likely to adapt tonew habitats.

Some of the species were found in more than one habitat. However, this does not mean that the species is a resident in the area but may still utilise the habitat for foraging. In total, the largest number of species were found in the Semi-natural: Rocky Grasslands (27%) followed by the transformed: Commercial Plantations/Transformed: alien invasive tree clumps that account for 22% of the species (**Figure 7-39**).

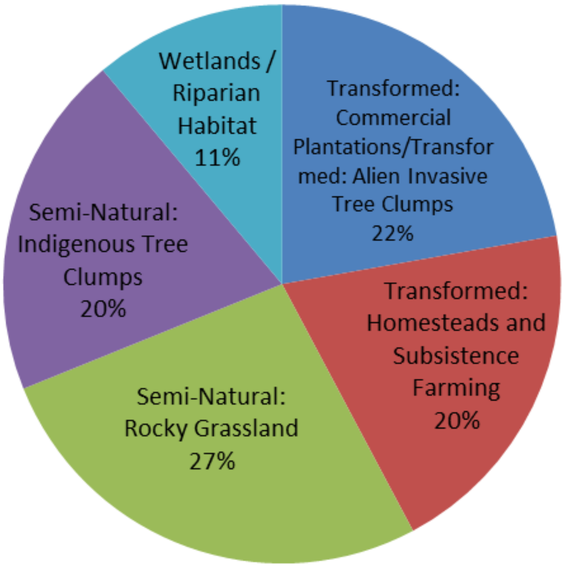


Figure 7-39: The Percentage of Mammal Species found in each Habitat Type

HABITAT SENSITIVITY

The habitat sensitivity of the mammals is based on the number of species as well as SCCs found in each habitat type (**Figure 7-40**).

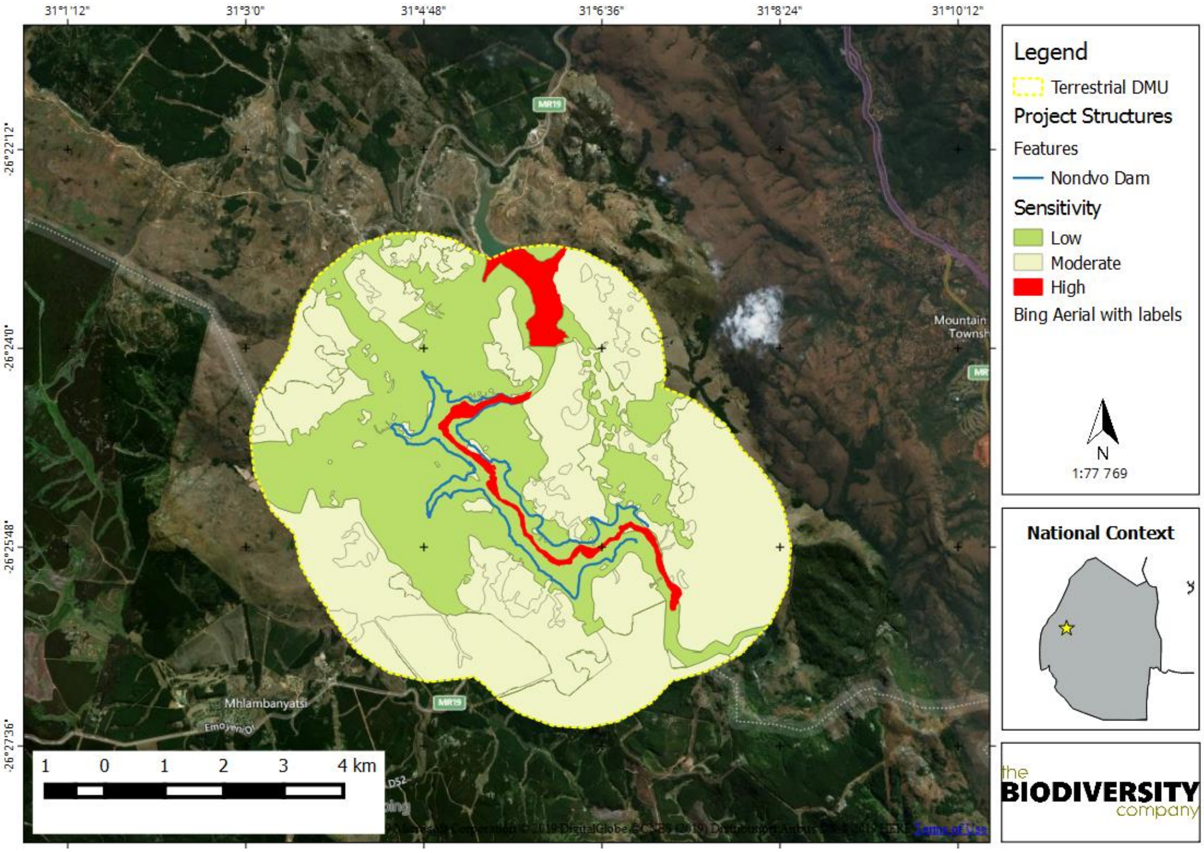


Figure 7-40: Habitat Sensitivity of the Mammal Habitats

Areas given a high sensitivity are important habitats for the species and in most cases are still in a natural condition. This was also given a high rating because of the importance of the areas as a water source for mammal species. One SCC found exclusively in the areas given a high sensitivity is the Cape Clawless Otter (*Aonyx capensis*). While the areas given a low sensitivity are mostly the areas surrounding the homesteads where the habitat has been altered extensively and does not support a large number of mammal species anymore. Moderate sensitivity was given to areas that mostly function as a habitat for generalist species.

7.2.5 AVIFAUNA

NATIONAL CONTEXT

Eswatini is home to 518 bird species, of which four are introduced species (Rock Dove, Indian Myna, House Sparrow (considered naturalised) and Rose-ringed Parakeet). Twenty threatened species occur in Eswatini (Lepage, 2009; Lepage, 2019). Of the 518 species found in the area, 52 are only rarely or accidentally seen, they are species such as Dark Chanting-Goshawk (*Melierax metabates*), Rufous-bellied Heron (*Ardeola rufiventris*) and Great White Pelican (*Pelecanus onocrotalus*). The diversity of birds is considered high despite the relatively small size of the country (17,364 km^2). The spread of birds can be found across the country's six physiographic zones: Highveld, Upper Middleveld, Lower Middleveld, Western Lowveld, Eastern Lowveld and Lubombo Range or four ecosystems: montane grassland, savanna-woodland mosaic, forest and aquatic systems. Eswatini does not have endemic bird species, however; 52 species can be found that are near-endemic and occur only in Eswatini and South Africa (CBD, 2009). Of the near-endemic birds, 50% occur in the grassland, 25% in the savanna-woodland, 23% in the forest and 1% in the aquatic ecosystem (Monadjem et al., 2003).

According to IUCN (2019) the country supports two critically endangered birds (*Necrosyrtes monachus* (Hooded Vulture) and *Gyps africanus* (White-backed Vulture)); three endangered birds, six near-threatened birds, and six vulnerable species.

REGIONAL CONTEXT

Three Important Bird and Biodiversity Areas (IBAs) can be found in Eswatini according to Birdlife International. These IBAs cover 580km^2, or 3.3%, of the area of the country. They are the Malolotja Nature Reserve IBA, Hlane and Mlawula Game Reserves IBA, and Mahamba Mountain IBA.

The closest IBA to the project area is the Malolotja Nature Reserve IBA, which is approximately 38 km from the site. This 1800 ha nature reserve is home to 280 bird species and one of the only places Blue Swallow (*Hirundo atrocaerulea*) can be seen on a regular basis (Birdlife International, 2019). Other significant species found here include Denham's Bustard (*Neotis denhami*), Ground Woodpecker (*Geocolaptes olivaceus*), Striped Flufftail (*Sarothrura affinis*), Black-winged Lapwing (*Vanellus melanopterus*), Southern Bald Ibis (*Geronticus calvus*), Sentinel Rock-Thrush (*Monticola explorator*), Buff-streaked Chat (*Oenanthe bifasciata*), Broad-tailed Warbler (*Schoenicola brevirostris*), Eastern Long-billed Lark (*Certhilauda semitorquata*) and Gurney's Sugarbird (*Promerops gurneyi*) (Cohen et al., 2006). The site is dominated by the rugged mountains of the Silotfwane, Mgwayiza and Ngwenya ranges. Steep valleys and gorges cut into this mountain escarpment, while deep river valleys and gentle rolling grassland plains dominate the adjacent landscape. Sour highland grassveld covers the gently undulating hills and slopes interspersed with narrow drainage lines (Birdlife International, 2019). The project area has similar habitat to the IBA and as such similar species can be expected to occur in the area, should the area not have been disturbed by human presence.

LOCAL CONTEXT

More than 300 species have been recorded in the general area (Roberts multi-media database, 2015). The SSC includes Blue Swallow (*Hirundo atrocaerulea*), Red-winged Francolin (*Scleroptila levaillantii*), Denham's Bustard (*Neotis denhami*) and White-bellied Korhaan (*Eupodotis senegalensis*) that are residents. Other grassland species of interest include Black-winged Lapwing (*Vanellus melanopterus*) and Broad-tailed Warbler (*Schoenicola brevirostris*). Buff-streaked Chat (*Campicoloides bifasciata*) is found on exposed Rocky Grassland slopes and Gurney's Sugarbird (*Promerops gurneyi*) is common (Birdlife South Africa, 2019).

The Riverine habitat associated with the Lusushwana River includes species such as African Finfoot (*Podica senegalensis*), Half-collared Kingfisher (*Alcedo semitorquata*) and Mountain Wagtail (*Motacilla clara*). The associated forests and exotic plantations can include Bat Hawk (*Macheiramphus alcinus*) and the "near-threatened" Crowned Eagle (*Stephanoaetus coronatus*), Forest Buzzard (*Buteo trizonatus*), African Cuckoo Hawk

(*Aviceda cuculoides*), Tambourine Dove (*Turtur tympanistria*), Bush Blackcap (*Lioptilus nigricapillus*), Barratt's Warbler (*Bradypterus barratti*), Olive Bush-Shrike (*Chlorophoneus olivaceus*), Black-bellied Starling (*Notopholia corrusca*), Olive Sunbird (*Cyanomitra olivacea*), Swee Waxbill (*Coccopygia melanotis*), Green Twinspot (*Mandingoa nitidula*) and Forest Canary (*Crithagra scotops*).

WET SEASON

During the wet season survey, 93 species were recorded. The list of observed species ispresented in **Table 7-13**. Some of the species observed in the wet season are shown in **Figure 7-41** and **Figure 7-42**.

Table 7-13: Avifauna Species Observed during the Wet Season

		CONSERVATION STATUS	
SPECIES	**COMMON NAME**	**REGIONAL (ESKOM, 2015)**	**IUCN (2019)**
Accipiter tachiro	Goshawk, African	Unlisted	LC
Alcedo cristata	Kingfisher, Malachite	Unlisted	Unlisted
Alopochen aegyptiacus	Goose, Egyptian	Unlisted	LC
Anas sparsa	Duck, African Black	Unlisted	LC
Anas undulata	Duck, Yellow-billed	Unlisted	LC
Andropadus importunus	Greenbul, Sombre	Unlisted	LC
Anthus leucophrys	Pipit, Plain-backed	Unlisted	LC
Apalis thoracica	Apalis, Bar-throated	Unlisted	LC
Apus affinis	Swift, Little	Unlisted	LC
Ardea cinerea	Heron, Grey	Unlisted	LC
Batis capensis	Batis, Cape	Unlisted	LC
Bostrychia hagedash	Ibis, Hadeda	Unlisted	LC
Bubulcus ibis	Egret, Cattle	Unlisted	LC
Burhinus capensis	Thick-knee Spotted	Unlisted	LC
Buteo buteo	Buzzard, Steppe	Unlisted	LC
Buteo rufofuscus	Buzzard, Jackal	Unlisted	LC
Buteo trizonatus	Buzzard, Forest	Unlisted	NT
Butorides striata	Heron, Green-backed	Unlisted	LC
Camaroptera brachyura	Camaroptera, Green-backed	Unlisted	LC
Cecropis abyssinica	Swallow, Lesser Striped	Unlisted	LC
Centropus burchellii	Coucal, Burchell's	Unlisted	Unlisted
Cercomela familiaris	Chat, Familiar	Unlisted	LC
Ceryle rudis	Kingfisher Pied	Unlisted	LC
Chalcomitra amethystina	Sunbird, Amethyst	Unlisted	LC

SPECIES	COMMON NAME	CONSERVATION STATUS	
		REGIONAL (ESKOM, 2015)	IUCN (2019)
Chlidonias leucopterus	Tern, White-winged	Unlisted	LC
Chrysococcyx caprius	Cuckoo, Diderick	Unlisted	LC
Cinnyris afer	Sunbird, Greater Double-collared	Unlisted	LC
Cisticola aberrans	Cisticola, Lazy	Unlisted	LC
Cisticola fulvicapilla	Neddicky, Neddicky	Unlisted	LC
Cisticola juncidis	Cisticola, Zitting	Unlisted	LC
Cisticola textrix	Cisticola, Cloud	Unlisted	LC
Cisticola tinniens	Cisticola, Levaillant's	Unlisted	LC
Colius striatus	Mousebird, Speckled	Unlisted	LC
Columba livia	Dove, Rock	Unlisted	LC
Corvus albus	Crow Pied	Unlisted	LC
Cossypha caffra	Robin-chat, Cape	Unlisted	LC
Cossypha heuglini	Robin-Chat, White-browed	Unlisted	LC
Crithagra mozambicus	Canary, Yellow-fronted	Unlisted	LC
Dicrurus adsimilis	Drongo, Fork-tailed	Unlisted	LC
Dryoscopus cubla	Puffback, Black-backed	Unlisted	LC
Emberiza flaviventris	Bunting, Golden-breasted	Unlisted	LC
Euplectes orix	Bishop, Southern Red	Unlisted	LC
Falco biarmicus	Falcon, Lanner	VU	LC
Gallirex porphyreolophus	Turaco, Purple-crested	Unlisted	LC
Geronticus calvus	Ibis, Southern Bald	VU	VU
Halcyon albiventris	Kingfisher, Brown-hooded	Unlisted	LC
Hedydipna collaris	Sunbird, Collared	Unlisted	LC
Hirundo atrocaerulea	Swallow, Blue	CR	VU
Hirundo fuligula	Martin, Rock	Unlisted	Unlisted
Hirundo rustica	Swallow, Barn	Unlisted	LC
Indicator minor	Honeyguide, Lesser	Unlisted	LC
Laniarius ferrugineus	Boubou, Southern	Unlisted	LC
Lanius collaris	Fiscal, Common (Southern)	Unlisted	LC
Lonchura cucullata	Mannikin, Bronze	Unlisted	LC
Lybius torquatus	Barbet, Black-collared	Unlisted	LC

SPECIES	COMMON NAME	CONSERVATION STATUS REGIONAL (ESKOM, 2015)	IUCN (2019)
Macronyx croceus	Longclaw, Yellow-throated	Unlisted	LC
Merops apiaster	Bee-eater, European	Unlisted	LC
Milvus migrans	Kite, Black	Unlisted	LC
Mirafra africana	Lark, Rufous-naped	Unlisted	LC
Motacilla aguimp	Wagtail, African Pied	Unlisted	LC
Motacilla clara	Wagtail, Mountain	Unlisted	LC
Muscicapa caerulescens	Flycatcher, Ashy	Unlisted	LC
Numida meleagris	Guineafowl Helmeted	Unlisted	LC
Onychognathus morio	Starling, Red-winged	Unlisted	LC
Oriolus larvatus	Oriole, Black-headed	Unlisted	LC
Passer diffusus	Sparrow, Southern Grey-headed	Unlisted	LC
Passer domesticus	Sparrow, House	Unlisted	LC
Phylloscopus trochilus	Warbler, Willow	Unlisted	LC
Ploceus cucullatus	Weaver, Village	Unlisted	LC
Ploceus ocularis	Weaver, Spectacled	Unlisted	LC
Pogoniulus chrysoconus	Tinkerbird, Yellow-fronted	Unlisted	LC
Prinia subflava	Prinia, Tawny-flanked	Unlisted	LC
Promerops gurneyi	Sugarbird, Gurney’s	Unlisted	NT
Pternistis swainsonii	Spurfowl, Swainson's	Unlisted	LC
Pycnonotus tricolor	Bulbul, Dark-capped	Unlisted	Unlisted
Quelea quelea	Quelea, Red-billed	Unlisted	LC
Sarothrura elegans	Flufftail, Buff-spotted	Unlisted	LC
Saxicola torquatus	Stonechat, African	Unlisted	LC
Scopus umbretta	Hamerkop, Hamerkop	Unlisted	LC
Sphenoeacus afer	Grassbird, Cape	Unlisted	LC
Streptopelia capicola	Turtle-dove, Cape	Unlisted	LC
Streptopelia semitorquata	Dove, Red-eyed	Unlisted	LC
Streptopelia senegalensis	Dove, Laughing	Unlisted	LC
Strix woodfordii	Owl, African Wood	Unlisted	LC
Tachybaptus ruficollis	Grebe, Little	Unlisted	LC
Tachymarptis melba	Swift, Alpine	Unlisted	LC

SPECIES	**COMMON NAME**	**CONSERVATION STATUS** **REGIONAL (ESKOM, 2015)**	**IUCN (2019)**
Terpsiphone viridis	Paradise-flycatcher, African	Unlisted	LC
Trachyphonus vaillantii	Barbet Crested	Unlisted	LC
Turdus olivaceus	Thrush, Olive	Unlisted	LC
Turtur chalcospilos	Wood-dove, Emerald-spotted	Unlisted	LC
Upupa africana	Hoopoe, African	Unlisted	LC
Uraeginthus angolensis	Waxbill, Blue	Unlisted	LC
Vanellus melanopterus	Lapwing, Black-winged	Unlisted	LC
Vidua macroura	Whydah, Pin-tailed	Unlisted	LC
Zosterops virens	White-eye, Cape	Unlisted	LC

(Red text) denotes listed species, conservation status

A) Yellow-throated Longclaw (*Macronyx croceus*), B) Cattle Egret (*Bubulcus ibis*), C) African Paradise Flycatcher (*Terpsiphone viridis*), D) Dark capped Bulbul (*Pycnonotus tricolor*), E) Buff-streaked Chat (*Oenanthe bifasciata*) and F) Amethyst Sunbird (*Chalcomitra amethystina*)

Figure 7-41: Some of the Bird Species Observed in the Wet Season

A) Red-collared Widowbird (*Euplectes ardens*), B) Pin-tailed Whydah (*Vidua macroura*), C) Burchell's Coucal (*Centropus burchellii*), D) African Wood Owl (*Strix woodfordii*), E) Steppe Buzzard (*Buteo buteo*), and F) Lesser Striped Swallow (*Hirundo abyssinica*)

Figure 7-42: Some of the Bird Species Observed in the Wet Season

DRY SEASON

During the dry season survey 77 avifaunal species were observed, the full list of species found is shown in **Table 7-14**. **Figure 7-43** and **Figure 7-44** shows some of the species recorded in the project area during the dry season. One avifaunal SCC was recorded – the Lanner Falcon, which is listed as VU.

Table 7-14: Avifaunal Species Recorded in the Project Area during the Dry Season

		CONSERVATION STATUS	
SPECIES	**COMMON NAME**	**REGIONAL (SANBI, 2016)**	**IUCN (2017)**
Accipiter melanoleucus	Sparrowhawk, Black	Unlisted	LC
Acridotheres tristis	Myna, Common	Unlisted	LC
Acrocephalus arundinaceus	Reed-warbler, Great	Unlisted	LC
Alcedo cristata	Kingfisher, Malachite	Unlisted	Unlisted
Amaurornis flavirostris	Crake, Black	Unlisted	LC
Anas sparsa	Duck, African Black	Unlisted	LC
Andropadus importunus	Greenbul, Sombre	Unlisted	LC
Bostrychia hagedash	Ibis, Hadeda	Unlisted	LC
Bradornis pallidus	Flycatcher, Pale	Unlisted	LC
Bubulcus ibis	Egret, Cattle	Unlisted	LC
Buteo rufofuscus	Buzzard, Jackal	Unlisted	LC
Centropus burchellii	Coucal, Burchell's	Unlisted	Unlisted
Cercotrichas leucophrys	Scrub-robin, White-browed	Unlisted	LC
Chalcomitra amethystina	Sunbird, Amethyst	Unlisted	LC
Cinnyris afer	Sunbird, Greater Double-collared	Unlisted	LC
Cinnyris talatala	Sunbird, White-bellied	Unlisted	LC
Cisticola juncidis	Cisticola, Zitting	Unlisted	LC
Cisticola tinniens	Cisticola, Levaillant's	Unlisted	LC
Colius striatus	Mousebird, Speckled	Unlisted	LC
Columba guinea	Pigeon,Speckled	Unlisted	LC
Corvus albus	Crow Pied	Unlisted	LC
Corvus capensis	Crow, Cape	Unlisted	LC
Corythaixoides concolor	Go-away-bird, Grey	Unlisted	LC
Cossypha caffra	Robin-chat, Cape	Unlisted	LC
Crithagra mozambicus	Canary, Yellow-fronted	Unlisted	LC
Crithagra sulphurata	Canary, Brimstone	Unlisted	Unlisted
Dicrurus adsimilis	Drongo, Fork-tailed	Unlisted	LC
Dryoscopus cubla	Puffback, Black-backed	Unlisted	LC

SPECIES	COMMON NAME	CONSERVATION STATUS	
		REGIONAL (SANBI, 2016)	IUCN (2017)
Emberiza tahapisi	Bunting, Cinnamon-breasted	Unlisted	LC
Estrilda astrild	Waxbill, Common	Unlisted	LC
Falco biarmicus	Falcon, Lanner	VU	LC
Fulica cristata	Coot, Red-knobbed	Unlisted	LC
Gallirex porphyreolophus	Turaco, Purple-crested	Unlisted	LC
Halcyon albiventris	Kingfisher, Brown-hooded	Unlisted	LC
Hirundo rustica	Swallow, Barn	Unlisted	LC
Hypargos margaritatus	Twinspot, Pink-throated	Unlisted	LC
Lagonosticta rubricata	Firefinch, African	Unlisted	LC
Laniarius ferrugineus	Boubou, Southern	Unlisted	LC
Lanius collaris	Fiscal, Common (Southern)	Unlisted	LC
Lonchura cucullata	Mannikin, Bronze	Unlisted	LC
Lybius torquatus	Barbet, Black-collared	Unlisted	LC
Macronyx capensis	Longclaw, Cape	Unlisted	LC
Macronyx croceus	Longclaw, Yellow-throated	Unlisted	LC
Megaceryle maximus	Kingfisher, Giant	Unlisted	Unlisted
Merops pusillus	Bee-eater, Little	Unlisted	LC
Monticola rupestris	Rock-thrush, Cape	Unlisted	LC
Motacilla aguimp	Wagtail, African Pied	Unlisted	LC
Motacilla capensis	Wagtail, Cape	Unlisted	LC
Muscicapa adusta	Flycatcher, African Dusky	Unlisted	LC
Oenanthe bifasciata	Chat, Buff-streaked	Unlisted	LC
Onychognathus morio	Starling, Red-winged	Unlisted	LC
Oriolus larvatus	Oriole, Black-headed	Unlisted	LC
Pandion haliaetus	Osprey	Unlisted	LC
Parisoma subcaeruleum	Tit-babbler, Chestnut-vented	Unlisted	Unlisted
Passer diffusus	Sparrow, Southern Grey-headed	Unlisted	LC
Passer domesticus	Sparrow, House	Unlisted	LC
Passer melanurus	Sparrow, Cape	Unlisted	LC
Phalacrocorax africanus	Cormorant, Reed	Unlisted	LC
Ploceus cucullatus	Weaver, Village	Unlisted	LC
Ploceus velatus	Masked-weaver, Southern	Unlisted	LC

		CONSERVATION STATUS	
SPECIES	**COMMON NAME**	**REGIONAL (SANBI, 2016)**	**IUCN (2017)**
Prinia subflava	Prinia, Tawny-flanked	Unlisted	LC
Pternistis natalensis	Spurfowl, Natal	Unlisted	LC
Pycnonotus tricolor	Bulbul, Dark-capped	Unlisted	Unlisted
Quelea quelea	Quelea, Red-billed	Unlisted	LC
Riparia paludicola	Martin, Brown-throated	Unlisted	LC
Saxicola torquatus	Stonechat, African	Unlisted	LC
Streptopelia capicola	Turtle-dove, Cape	Unlisted	LC
Streptopelia semitorquata	Dove, Red-eyed	Unlisted	LC
Streptopelia senegalensis	Dove, Laughing	Unlisted	LC
Thamnolaea cinnamomeiventris	Cliff-chat, Mocking	Unlisted	LC
Trachyphonus vaillantii	Barbet Crested	Unlisted	LC
Turdus olivaceus	Thrush, Olive	Unlisted	LC
Turdus smithi	Thrush, Karoo	Unlisted	LC
Upupa africana	Hoopoe, African	Unlisted	LC
Uraeginthus angolensis	Waxbill, Blue	Unlisted	LC
Urocolius indicus	Mousebird, Red-faced	Unlisted	LC
Zosterops virens	White-eye, Cape	Unlisted	LC

A) Cape Wagtail (*Motacilla capensis*), B) Jackal Buzzard (*Buteo rufofuscus*), C) Little Bee-eaters (*Merops pusillus*), D) Olive Thrush (*Turdus olivaceus*), E) Southern Grey-headed Sparrow (*Passer diffusus*) and F) Common Fiscal (*Lanius collaris*)

Figure 7-43: Some of the Avifaunal Species Recorded in the Dry Season

A) Buff Streaked Chat (*Oenanthe bifasciata*), B) Crested Barbet (*Trachyphonus vaillantii*), C) Brown Hooded Kingfisher (*Halcyon albiventris*), D) Cattle Egret (*Bubulcus ibis*), E) Giant Kingfisher (*Megaceryle maximus*), and F) Greater Double-collared Sunbird (*Cinnyris afer*)

Figure 7-44: Some of the Avifaunal Species Recorded in the Dry Season

AVIFAUNAL TROPHIC GUILDS

Overall, the project area supports a moderate to high density of small to medium-sized birds comprised mainly of seed and insect-eating species, but also includes some large raptors. Large raptors detected onsite included Lanner Falcon, Jackal Buzzard and Forest Buzzard. One larger raptor, namely the Osprey, was observed in the downstream area.

Analysis of the major avifaunal trophic guilds reveals that the species composition within the project area is dominated by diurnal ground insectivores (IAD), granivores (IGD) and omnivores (OMD). This pattern is true for both the wet and the dry season. This guild pattern makes sense given the large portions of the Rocky Grassland habitats in the project area, which provides an abundance of high seed-yielding grasses and weedy annuals. In contrast, nocturnal carnivores (CGN and CAN) were the least prevalent and occupied a lower representation than would be expected, based on the number of expected species of this class. This can be explained by the presence of rural development in the area and likely cultural beliefs that portray owls as omens of bad luck and death (for example), ultimately resulting in their persecution and death (EWT, 2015). The extensive impacts on the Riverine habitat and its disturbed nature might explain the lack of water-associated insectivores (IWD).

AVIFAUNA HABITAT ASSOCIATION

Five avifaunal habitat types were identified within the project area, namely the Riverine (Riparian and Wetland) Habitat; Transformed: Commercial Plantations/Transformed: Alien Invasive Tree Clumps Habitat; Transformed: Homesteads and Subsistence Farming Habitat; Semi-Natural: Indigenous Tree Clumps Habitat and Semi-Natural: Rocky Grassland Habitat. Most species were recorded in the rocky grassland followed by the semi-natural tree clumps. The distribution of avifaunal species per habitat types is presented in **Figure 7-45**.

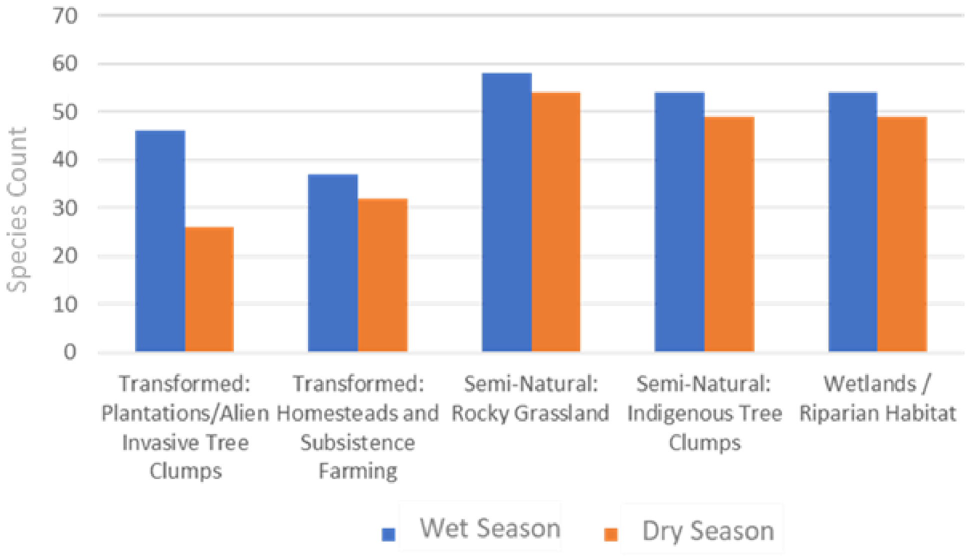


Figure 7-45: Avifauna Species Habitat Distribution

Riverine (Riparian and Wetland) Habitat

This habitat starts at the Luphohlo Dam and extends along the Lusushwana River. The riparian habitat provides important foraging habitat for darters, cormorants, ducks, geese, and Kingfishers. Its steep banks provide nesting habitats for bee-eaters and kingfishers. However, significant mudflats and shallow shoreline habitats are largely lacking; limiting the number of wading bird species likely to occur. Nevertheless, densely vegetated backwaters provide suitable habitat for crakes, and moorhens. The riparian understory is characterised by an abundance of small estrildids. Noteworthy species typically associated with this habitat included Green-backed Heron, Black Crake, Burchell’s Coucal, Pied Kingfisher, Brown-hooded Kingfisher, Giant Kingfisher, Malachite Kingfisher, White-browed Robin-Chat, Purple-crested Turaco, Great Reed-warbler, African Black Duck and Sombre Greenbul.

Transformed: Commercial Plantations/ Alien Invasive Tree Clumps

This habitat represents areas where Pine and Eucalyptus sp trees are commercially grown. These areas have been extensively altered and do not support a great number of species. A few insectivorous species can be found on the fringes of these plantations, one such species is the Common Fiscal. Alien vegetation was also prevalent in the project area, with a large number of clumps found. These plants often have fruits that attract species such as the Red-faced Mousebird, Speckled Mousebird, Grey go-away-bird, Black Collared - and Crested Barbets.

Transformed: Homesteads and Subsistence Farming

This habitat represents land that has been completely transformed through anthropogenic land-use practices (e.g. settlements, croplands, infrastructure and soccer fields). The avifaunal assemblage associated with it is characterised by common, adaptable and commensal species. Species that occurred in particularly high abundances within this habitat include Pied Crow, Dark-capped Bulbul, Bronze Mannikin and House Sparrow.

Semi-Natural: Indigenous Tree Clumps

This habitat is formed by tall indigenous trees and shrubs forming forest-bushveld areas. The under-canopy of this habitat is dominated by grasses and some ferns. Avifaunal species associated with this habitat include Forest Buzzard, Ashy Flycatcher, Cape White-eye, Greater Double-collared Sunbird and Buff-spotted Flufftail.

Semi-Natural: Rocky Grassland

This habitat covers the largest area of the DMU and as such supports the greatest number of species. It is made up of open grasslands with sections of rocky outcrops. This habitat supports a range of species including granivores, omnivores, insectivores and even carnivores. A number of prey species were observed in this area for predatory bird species such as the Jackal Buzzard. Smaller species include Yellow-throated Longclaw, Fork-tailed Drongo, Buff-streaked Chat, African Stone Chat, Mocking Cliff Chat and Natal Spurfowl.

SPECIES OF CONSERVATION CONCERN

The species below are the avifaunal SCC (**Table 7-15**) that were observed within the project area.

Table 7-15: Avifaunal SCCs Recorded in the Project Area

		CONSERVATION STATUS	
SPECIES	**COMMON NAME**	**Regional (Eskom, 2015)**	**IUCN (2019)**
Buteo trizonatus	Buzzard, Forest	Unlisted	NT
Falco biarmicus	Falcon, Lanner	VU	LC
Geronticus calvus	Ibis, Southern Bald	VU	VU
Hirundo atrocaerulea	Swallow, Blue	CR	VU

HABITAT SENSITIVITY

Results of this avifaunal survey highlight the Riparian and Rocky Grassland habitats as supporting a diverse and unique avifaunal assemblage and were given a high sensitivity. The Transformed: plantation and Alien vegetation as well as Indigenous tree clumps habitats supports the second-highest bird diversity. The indigenous tree clumps remain in a largely intact state and as such are assigned a Moderate sensitivity. The birds found in the plantations and alien vegetation have adapted and this habitat has become an important part of the ecosystem and was given a moderate sensitivity. The Homestead's habitats are considerably more impacted and support similar compliments of common and adaptable species and therefore are assigned a Low sensitivity from an avifaunal perspective. The avifaunal habitat sensitivity map is shown in **Figure 7-46**.

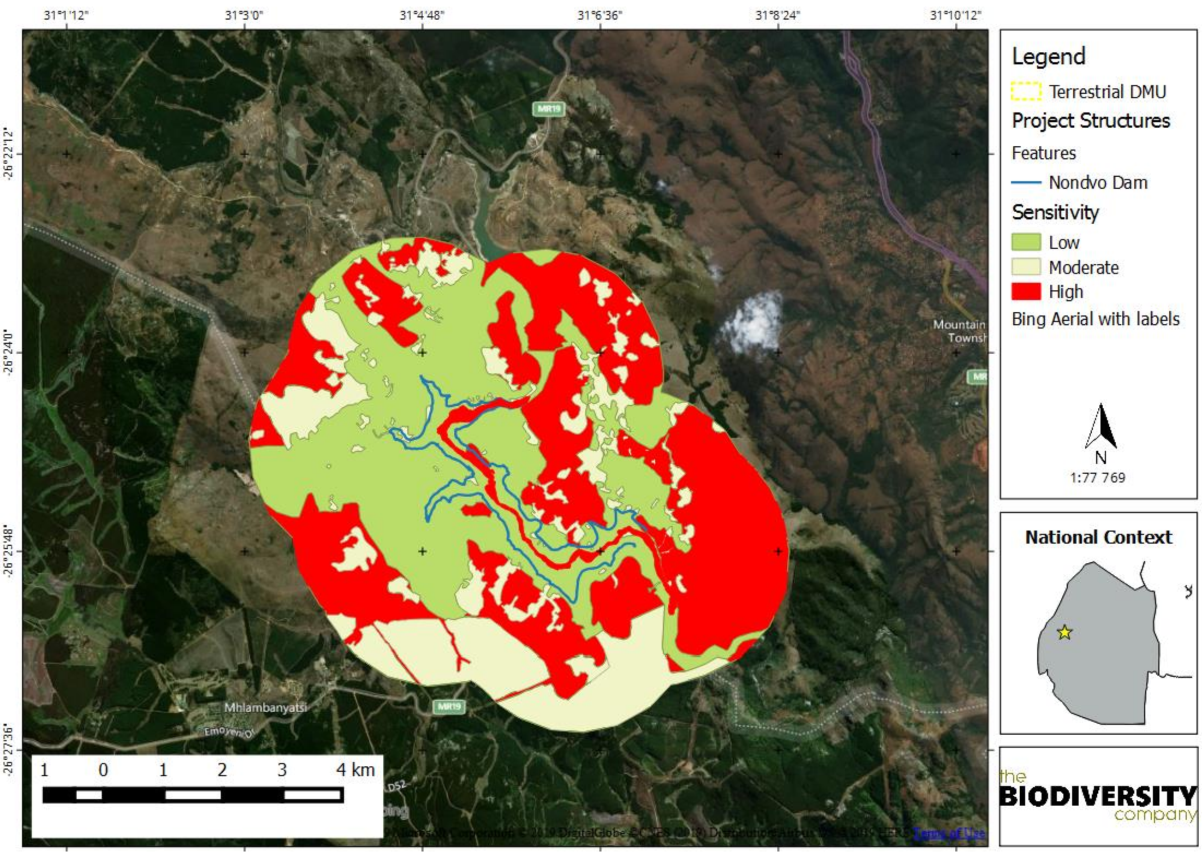


Figure 7-46: Avifaunal Habitat Sensitivity

7.2.6 AQUATIC ECOLOGY

WATER QUALITY

In situ water quality analyses was conducted at upstream and downstream sites for the project area to characterise physical water quality parameters during the assessment. These results are important to assist in the interpretation of biological results due to the direct influence water quality has on aquatic life forms. Water quality results were compared to Target Water Quality Ranges for South African Aquatic Ecosystems (DWAF, 1996), as conditions were comparable to those in South Africa.

The results of the *in situ* water quality assessment indicate no parameters which exceed the established water quality guideline values in DWAF (1996). The pH values obtained were found to be neutral at 7.0±0.1, and to be statistically similar ($p>0.05$) between the high and low flow periods, with a nominal variation between the sites or surveys. The water temperatures observed were found to range from 17±0.4°C in the low flow (May 2019) survey to a significantly increased ($p<0.05$) temperature of 24±1.0°C in the high flow (March 2019) confirming the seasonal water temperature range. The levels of dissolved oxygen were observed at values exceeding the recommended threshold effect concentration of 5.0 mg/l at all sites considered in this assessment.

The level of dissolved solids, as measured by conductivity, wasfound to be statistically similar between the surveys and sites at a mean and SEM of 60±2.1 µS/cm. This low dissolved solid result indicates a natural state of dissolved elements, similar to what can be expected for the zonation of the watercourse. Land-use activities in the catchment considered were thus determined to not significantly affected the levels of dissolved solids. The water clarity observed, as measured by turbidity, during the assessment was found to be higher in the low flow survey as would be expected. However, the difference in water turbidity was not significant between surveys and corroborates the conductivity results, in that water quality is largely natural. It is important to note, that suspended solid content would increase during rainfall events, as was observed at S1 in the March 2019 survey, which increased the turbidity readings to 50 NTU. The conditions whereby the instream slow-flowing and densely-vegetated habitats compounded by the effect of the Luphohlo impoundment were determined to mitigate this impact at the downstream sites and further increased turbidity levels were not observed.

Overall, based on the assessed parameters the water quality observed in the Lusushwana River was derived to be natural, with low conductivity, neutral pH levels and fair clarity. The observed water quality would not have any impact on local riverine ecology.

HABITAT ASSESSMENT

Intermediate Habitat Integrity Assessment

According to the instream habitat index, the instream ecological habitat is largely modified (class D). A large loss of natural habitat and biota was noted to have occurred in the assessed watercourse. The central causative factor for the high degree of modification can be attributed to the Luphohlo Dam, which has inundated a significant portion of the Lusushwana River reach above the Mantenga Falls. The effect of the inundation is further compounded by the presence of a weir, which was recorded in the lower reaches. In addition to the direct inundation impacts, flow modification downstream of the impoundment was determined to have an impact on the physical condition of the river channel and bed, whereby erosional forces and river velocity had reduced to form numerous slow-flowing pools with sand/mud substrates. It is noted that following the confluence of the watercourse rising in the flow volumes in the Lusushwana River increase, and the overall impact is reduced in the lower reaches of the Lusushwana River.

It is noted that the instream modification of the Lusushwana River has resulted in reduced flooding events, whereby the floodplains are sufficiently inundated. In addition, the sediment regime of the Lusushwana River has been altered by the presence of the Luphohlo Dam, reducing the volumes of sediment deposited on river bends, the margins and floodplains. Adding a cumulative effect of the currently existing conditions to flow modification, sedimentation from the myriad of forestry activities in the catchment compounded by livestock and subsistence agriculture has likely added to the degree of fine sedimentation in the watercourse, and thus differs from natural reference conditions.

Water quality modification was determined to be low, with no significant source of poor water quality in the catchment. Land use in the catchment presents diffuse sources for contamination, with no industrial activities clearly observable in the immediate upstream areas. Subsistence agriculture, which has encroached into wetland areas would present diffuse agricultural runoff with a potential to contain herbicide and increased nutrient loads.

The riparian habitat of the Lusushwana River was determined to be largely modified (class D). The central factors resulting in this impact could be attributed to exotic vegetation encroachment. Stands of invasive forestry-related vegetation was observed throughout the considered river reach assessed in this assessment. Dominant non-native vegetation included *Eucalyptus sp*. which was found to have encroached into the upper zone of the riparian areas. In addition to Eucalyptus, stands of *Pinus sp* and *Acacia mearnsii* were also observed throughout the project area.

In addition to alien vegetation, sand mining activities were noted in the historical floodplain areas where sufficient material had been deposited. These activities have a direct impact on the condition of the riparian zone. These areas, once abandoned, also serve as vector areas for the continued proliferation of alien vegetation. Further assessment of the riparian habitat is provided in the subsequent sections.

Riparian Habitat

The extent of the marginal edge of the riparian zone was dependent on the extent of the instream conditions and geomorphological structures. In the slow-flowing waters that make up the majority of the inundation zone, the marginal, and to a degree the instream zone, consisted of dense stands of *Phragmites sp.* with instream marginal stands observed. Within the pool systems where flow allowed for the accumulation of substrates, marginal vegetation consisted of a mix of vegetation including submerged grasses, *Cyperus*, sedges and *Phragmites*.

The lower zone of the riparian vegetation consisted of a variety of sedges, Cyperus and *Persicaria sp*.. The lower zone of the riparian habitat was typically confined to an area within approximately 0.5-1m from the instream river edge.

The upper zone native vegetation consisted of woody trees such as River Bush-willow (*Combretum erthrophyllum)*, Waterberry (*Syzygium cordatum*) and Matumi (*Breonadia salicina*). Additionally, the upper zone of the riparian habitat was heavily affected by non-native woody taxa as listed in the riparian Intermediate Habitat Integrity Assessment. The upper zone of the riparian habitat was largely defined by the macro channel as depicted in the aerial photo. It is noted that within the bedrock areas some riparian vegetation had rooted in isolated patches, this was noted to add to the extent of the riparian area.

The riparian zone of the Lusushwana River was noted to support numerous ecosystem services such as sand provision for the mining activities, as well as the provision of woody material utilised in forestry activities. The delineation of the riparian habitat is presented in **Figure 7-47**.

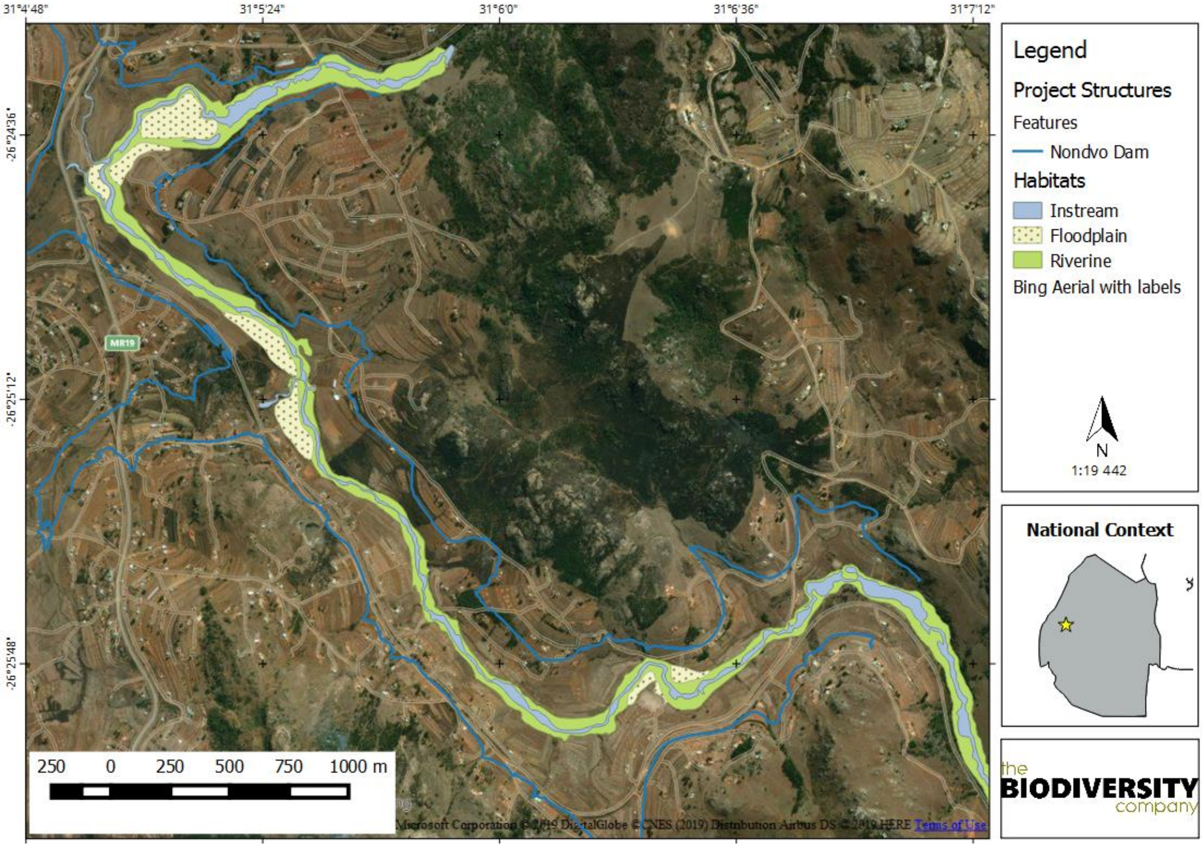


Figure 7-47: Riparian Habitat in the Lusushwana River

AQUATIC INVERTEBRATE COMMUNITIES

Invertebrate Habitat and Biotope

A biotope rating of available habitat was conducted at each site assessed to determine the suitability of habitat to macroinvertebrate communities. The Lusushwana River within the project area was classed as lower foothills. Each geo-class has different weightings for the various biotopes according to importance value. The categories were calculated according to the biotope rating assessment as applied in Tate and Husted (2015).

Invertebrate habitat in the considered river reach was dominated by submerged bedrock and marginal vegetation, established out of the current in bedrock pools. This habitat would provide sufficient substrates for taxa in the Hemiptera order. The stones-in-current biotope within the geomorphological setting is considered to be one of the more productive substrates and thus represent important habitat. The stones–in-current habitat was however largely located in isolated collections in the watercourse, within bedrock cracks or between boulders, which had allowed for their accumulation. It is anticipated that the limited stones habitat would affect the diversity of Ephemeroptera, Plecoptera, and Trichoptera (EPT) aquatic macroinvertebrates.

The biotope diversity observed during the survey was found to be statistically higher in the May 2019 survey ($p<0.05$), whereby habitat had improved from a rating of 32±3.8 to 39±2.3. The improvement in habitat diversity could be attributed to the accessibility of the watercourse following the cessation of high flow conditions.

Aquatic Invertebrate Indices

The South African Scoring System version 5 (SASS5) sensitivity scores observed in the Lusushwana River during the survey period werefound to be high, with limited variability between the sites and survey at 194±9.4 (n=13). The diversity of the macroinvertebrate community was found to be high, with 33±1.3 (n=13) observed at each site considered. The most encountered taxa observed during the assessment was shared amongst Oligochaeta, Potamonautidae, Caenidae, Baetidae, Libullidae, Corixidae, Gerridae, Gyrinidae, Ceratopogoniidae and Chironomidae which were recorded at 100% of the sites. Whilst Atyidae, Baetidae, Chlorocyphidae, Ceonagrionidae, Gomphidae, Vellidae, Hydropsyhchidae, Belastomatidae, Dytiscidae and Simulidae were recorded at 92% of the sites assessed. Rare families observed during the assessment included Porifera, Lestidae, Dipseudopsidae, Psephenidae and Athericidae and were recorded at 7% of the sampled sites.

The invertebrate assemblage sampled typically represented moderately sensitive taxa. The sensitivity of the assemblage as measured in Average Score Per Taxon (ASPT) was 5.8±0.1 and confirmed that the assemblage was largely composed of tolerant taxa. The overall EPT% contribution to the invertebrate assemblage was found to be moderate at 24±1.3%. Typical EPT% contributions included taxa such as high flow adapted Heptageniidae and generalist but sensitive taxa such as Leptophlebidae. Infrequently, highly sensitive Oligoneuridae were observed in the Lusushwana River. Perlidae taxa were also infrequently observed, and were largely absent from the sites in proximity to the Luphohlo Dam wall.

Approximately one-third of the invertebrate community sampled at the sites consistently represented oxygen breathing taxa such as the high Frequency of Occurrence (FROC) taxa including Corixidae, Gerridae and Gyrinidae. Other abundant taxa observed were those adapted to marginal vegetation habitats and this further increased the dominance of air breathers. Spatial trends versus biotope ratings were compared and are presented in **Figure 7-48**. As can be noted in the trend analysis, limited correlations between biotope ratings and overall sensitivity scores were observed. An increasing trend from upstream to downstream was observed in the SASS5 sensitivity scores. During the multivariate assessment of the invertebrate community and weighted biotope ratings, no significant (p>0.05) association with the recorded biotopes and the invertebrate families was positively obtained during the assessment. Some associations between taxa such as Heptageniidae, Tricorythidae and Chlorocyphidae were derived to have strong non-significant associations with Stones-in-Current habitats. Strong associations between Nepidae were observed with Marginal Vegetation-In–Current; an expected result. As can be observed in the seasonal assessment, no significant associations between the sampled invertebrate taxa and the season were depicted, which corroborates the non-significant differences in the various indices. Additionally, no significant associations were observed with the physical water quality data, which further confirms that the water quality conditions were largely natural.

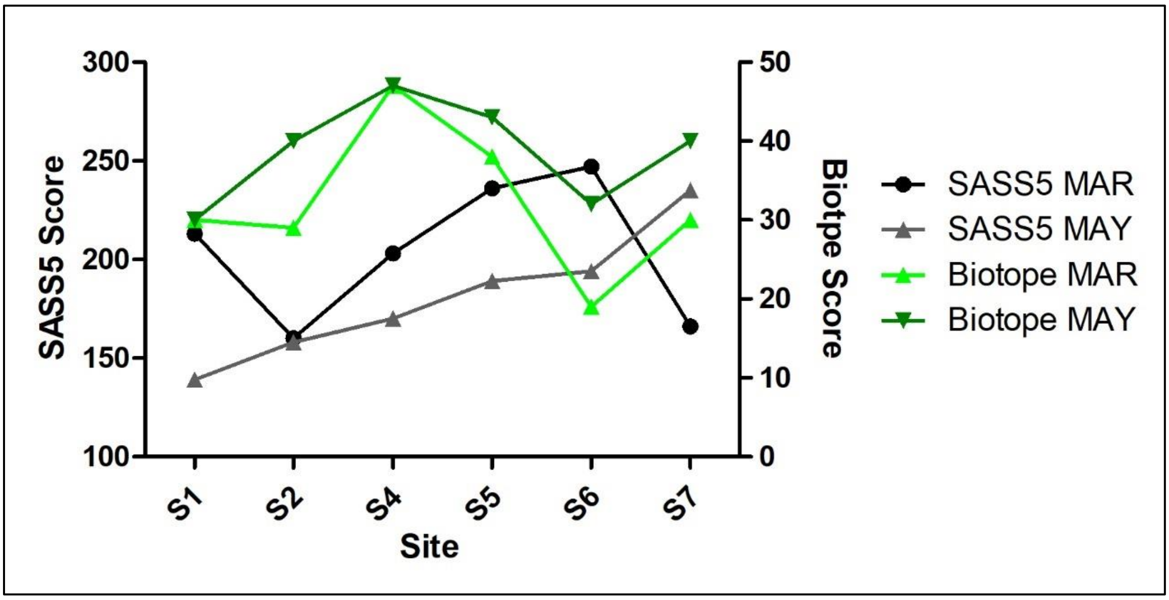


Figure 7-48: Spatial Trends of Biotope Ratings and SASS5 Scores

Odonata

Given the sensitivity of Odonata to both water quality and the condition of the local habitat, the diversity of Odonata can serve as an effective mechanism for the monitoring of cumulative impacts and environmental degradation. In addition, Odonate diversity can also be an effective endpoint for assessing the diversity of aquatic macroinvertebrate taxa within a given river reach. The key Odonate taxa observed during the assessment are presented in **Figure 7-49**. A total of 42 different Odonata taxa, representing 9 families were observed during the survey. The most diverse group of taxa observed were the Libelludiae, a family with a high tolerance to both water and habitat quality modification. Observed taxa sensitive to the disturbance of marginal riparian habitat included *Phaon iridipennis, Agriocnemis* and the various *Lestes* species observed. These taxa have a preference for full canopy cover and overhanging marginal vegetation and indicate that there were sufficient conditions in isolated areas on the assessed watercourse.

Overall the diversity of Odonata was considered to be high, with a high level of sensitivity. It is noted that no species listed other than Least Concern were observed in the project area, with the Odonata community widely distributed (IUCN, 2019).

Top left: *Trithemis sticta*, Top Right: *Lestes plagiatus*, Bottom left: *Pseudagrion hageni*, Bottom Right: *Palpopleura jucunda*

Figure 7-49: Key Odonate Taxa Observed during the 2019 Surveys

HABITAT CHARACTERISATION

The fish habitat of the Lusushwana River, varied spatially, with slow-flowing vegetated pools below the Luphohlo Dam, bedrock sheet flow with isolated pools and riffle habitat within proximity and downstream of the proposed dam wall. Diverse velocity depth classes and river geomorphic units were noted to be present in the watercourse, these were dominated by slow deep and fast shallow bedrock runs. The results of the Habitat Cover Rating (HCR) assessment completed for each site is presented in **Figure 7-50**.

As observed in **Figure 7-50**, sites S4, S5 and S8 contained the highest diversity of fish cover during the assessments. The clear dominance of the fast shallow bedrock runs can be observed in the cover ratings, and was found to be present at each of the sites sampled.

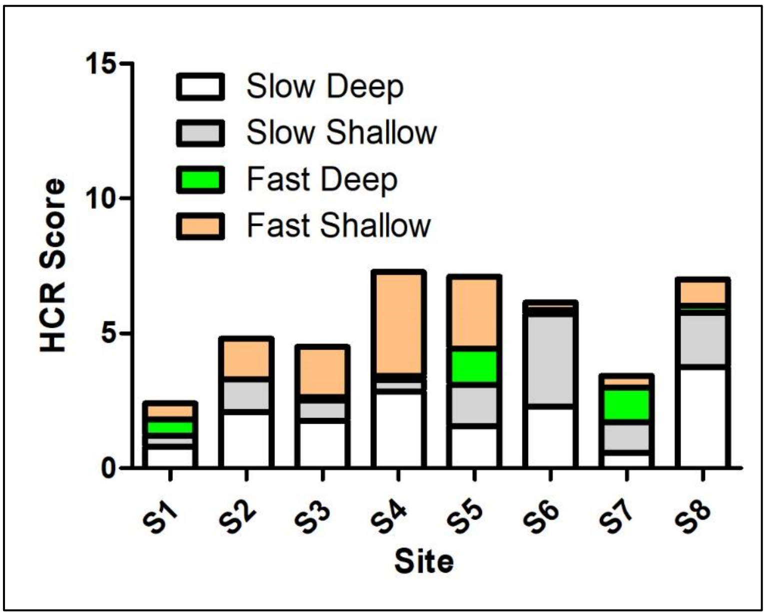


Figure 7-50: Habitat Cover Ratings Obtained at the Sampling Points (March and May 2019)

FISH COMMUNITY

The project area considered in this assessment is located within the Zambezian Lowveld Freshwater Ecoregion. This ecoregion is known to contain approximately 120 freshwater fish species of which 22 are known to be endemic. The lower reaches of the rivers in this ecoregion are known to support numerous seasonal pans and extensive floodplains.

Based on the available desktop data a total of 34 species of fish are expected in the watercourse, indicating a diverse and sensitive fish fauna (**Table 7-16**). As presented in the table, a number of threatened and range-restricted species are expected in the watercourse. Three listed taxa are expected in the watercourse. These include the Near Threatened *Oreochromis mossambicus* and *Labeobarbus nelspruitensis* as well as the Vulnerable *Chiloglanis emarginatus* (IUCN, 2019). A single Data Deficient species, *Marcusenius pongolensis*, is also expected in the watercourse.

The observed species, their sizes and respective Frequency of Occurrence arepresented in **Table 7-17**.

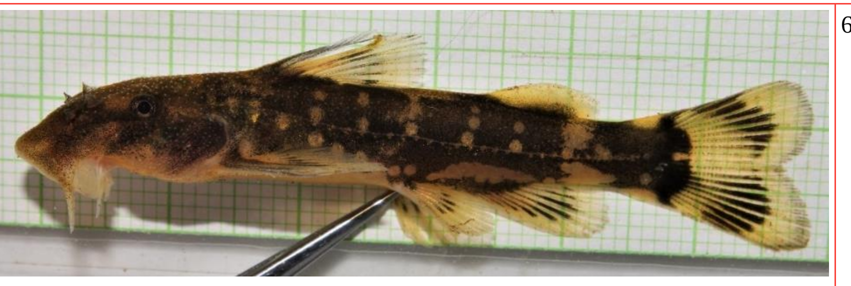
Table 7-16: Expected Species for the Lusushwana River in the Upper Usuthu-Phongola River Systems and their Respective IUCN Status

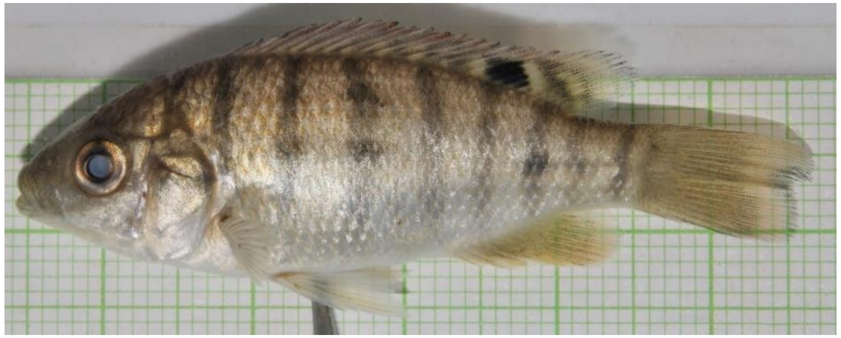
FAMILY	SPECIES	IUCN STATUS (IUCN 2019)
Amphiliidae	*Amphilius uranoscopus*	LC
Anguillidae	*Anguilla mossambica*	LC
Cichlidae	*Coptodon rendalli*	LC
Cichlidae	*Oreochromis mossambicus*	NT
Cichlidae	*Pseudacrenilabrus philander*	LC
Cichlidae	*Tilapia sparrmanii*	LC
Clariidae	*Clarias gariepinus*	LC
Cyprinidae	*Enteromius afrohamiltoni (Southern)*	LC
Cyprinidae	*Enteromius annectens*	LC
Cyprinidae	*Enteromius anoplus*	LC

FAMILY	SPECIES	IUCN STATUS (IUCN 2019)
Cyprinidae	*Enteromius crocodilensis*	LC
Cyprinidae	*Enteromius pallidus*	LC
Cyprinidae	*Enteromius paludinosus*	LC
Cyprinidae	*Enteromius trimaculatus*	LC
Cyprinidae	*Enteromius unitaeniatus*	LC
Cyprinidae	*Enteromius viviparus*	LC
Cyprinidae	*Labeo congoro*	LC
Cyprinidae	*Labeo cylindricus*	LC
Cyprinidae	*Labeo molybdinus*	LC
Cyprinidae	*Labeo rosae*	LC
Cyprinidae	*Labeo ruddi*	LC
Cyprinidae	*Labeobarbus marequensis*	LC
Cyprinidae	*Labeobarbus polylepis*	LC
Cyprinidae	*Engraulicypris brevianalis*	LC
Cyprinidae	*Opsaridium peringueyi*	LC
Cyprinidae	*Labeobarbus nelspruitensis*	NT
Mochokidae	*Chiloglanis anoterus*	LC
Mochokidae	*Chiloglanis emarginatus*	VU
Mochokidae	*Chiloglanis paratus*	LC
Mochokidae	*Chiloglanis swierstrai*	LC
Mormyridae	*Marcusenius pongolensis*	DD
Mormyridae	*Petrocephalus wesselsi*	LC
Poeciliidae	*Micropanchax johnstoni*	LC
Schilbeidae	*Schilbe intermedius*	LC

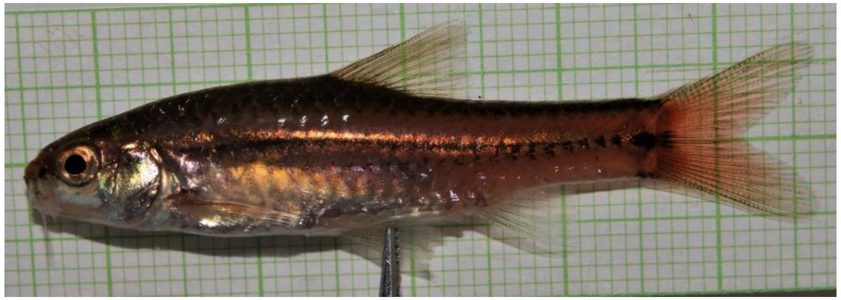
Table 7-17: Fish Species Observed during the March and May 2019 Surveys

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Amphilius uranoscopus	Stargazer Catlet		59±2.0	21	3
Clarias gariepinus	Sharptooth Catfish		311±38	71	9
Chiloglanis anoterus	Pennant-tailed Suckermouth		61±2.1	71	55

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Chiloglanis emarginatus	Phongolo Suckermouth		61.5±1.7	14	11
Coptodon rendalli	Red-breast Tilapia		45±2.1	78	26

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Tilapia sparrmanii	Banded Tilapia		57±3.8	100	57
Oreochromis mossambicus	Blue Kurper – Mossambique Tiliapia		59±2.0	100	42

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Labeo cylindricus	Red-eyed Labeo		245±2.8	7	8
Labeobarbus polylepis	Smallscale Yellowfish		151±5.8	14	4
Enteromius trimaculatus	Three-spot Barb		47.9±1.8	100	82

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Enteromius viviparus	Bowstripe Barb		40±1.0	28	16
Enteromius cf. anoplus	Chubby-head Barb		86.0±0.0	7	1
Enteromius eutania	Orange-fin Barb		41±1.3	7	7

SPECIES	COMMON NAME	PHOTOGRAPH	AVERAGE SIZE (MM)	FROC (%)*	INDIVIDUALS COLLECTED
Opsaridium peringueyi	Southern-barred Minnow		30±3.5	7	9
Anguilla mossambica	African Longfin Eel		251±6.0	14	3
Micropterus salmoides	Large-mouth Bass		174±3.6	57	14
		(*) denotes FROC (%) = Frequency of Occurrence Frequency of Occurrence, was found to be Oreochomis mossambicus, Enteromius trimaculatus and Tilapia sparrmanii observed at 100% of the sampling points			

Sixteen different species were observed during the 2019 surveys. A total of 347 individual fish were captured during the survey representing a poor catch per unit effort (CPUE) of 0.01 fish per unit effort. This low CPUE provides some indication of the abundance of fish in the Lusushwana River, which was determined to be low.

The most abundant fish species sampled in 2019 was the species *Enteromius trimaculatus* which was represented by 82 individuals during the surveys. The second most abundant fish species, at 57 individuals were*Tilapia sparrmanii. T. sparrmanii* abundance values were followed by *Chiloglanis anoterus*, which was represented by 55 individuals.

The most commonly observed species as determined by the Frequency of Occurrence, was found to be *Oreochomis mossambicus*, *Enteromius trimaculatus* and *Tilapia sparrmanii* observed at 100% of the sampling points. *Coptodon rendalli* was observed at 78% of the sampling points during the 2019 survey. Thus, Cichlidae represented the most common fish family observed during the survey. This indicates the dominance of cichlid favouring habitats in the project area. Despite riverine conditions in the lower reaches of the watercourse, lowered flows, and the presence of impoundments in the upper and middle reaches favoured the formation of cichlid-rich environments, and thus the proliferation of these taxa.

The Mantenga Falls on the Lusushwana River were determined to not be a migratory barrier to *Anguilla mossambica*, which was observed upstream of the falls. The distribution of remaining observed species in the Lusushwana River reach considered in this assessment was determined to be separated by the Mantenga Falls. Whilst several species of fish were observed above and below the falls, taxa such as *Labeo cylindricus*, *Enteromius eutania* and *Opsaridium peringueyi* were only observed below the falls, thus indicating a migratory barrier for non-anguillid fish. Whilst the falls were determined to be a barrier, it is anticipated that the existing Lupophlo Dam would present a barrier to migratory taxa. This was confirmed with no samples of *Anguilla mossambica* upstream of the dam wall. The distribution of *Enteromius anoplus* was also observed to be limited to the areas above the Luphohlo Dam, with the species not sampled below the impoundment.

The size class of the fish taxa observed ranged from the larger *Clarias gariepinus* of 311±38 mm to 30 mm represented by juvenile *Opsaridium peringueyi*. The average size class of the fish assemblage was determined to be 107 mm indicating a relatively small fish size.

Two listed species *Oreochomis mossambicus* (NT) and *Chiloglanis emarginatus* (VU) were observed during the survey. It is noted that *C. emarginatus* has been noted to be common in Eswatini. Despite this, *C. emarginatus* habitat is in decline across its distribution, with its known extent of occurrence at 16 663 km^2 and an area of occupancy of 2 522 km (IUCN, 2019). *O. mossambicus* occupies a wide geographic range in numerous eastern flowing rivers in Southern Africa. The species is however threatened by hybridization with *O. niloticus*. The species was therefore listed due to the rapid decline in the *O. mossambicus* populations. The rheophilic adapted species *Labeobarbus nespruitensis* is expected in the river reach. *L. nelspruitensis* was however not observed during the survey, with only *Labeobarbus polylepis* found in the Lusushwana River.

The non-native species, *Micropterus salmoides* was observed in high frequency (57%) in the sites assessed. This species is known to negatively affect local native fish communities, and is anticipated to have had a direct impact on the results obtained in this assessment. The presence of *M. salmoides* may be the limiting factor responsible for the poor CPUE observed in this assessment. This may be particularly true for the various *Enteromius* species observed in low abundance across the project area.

Overall, the fish community of the Lusushwana River reaches assessed during this assessment was found to be dominated by Cichlidae. Indicating a slow-flowing habitat dominance across the project area and confirming impacted conditions established in the IHIA. The Mantenga Waterfall was found to be a migratory barrier to non-anguillid taxa and a limiting factor for the distribution of fish species in the watercourse. Flow and habitat transformation sensitive and listed taxa, including *Chiloglanis emarginatus*, were observed during the assessment indicating that the fish community will be sensitive to changes inflow.

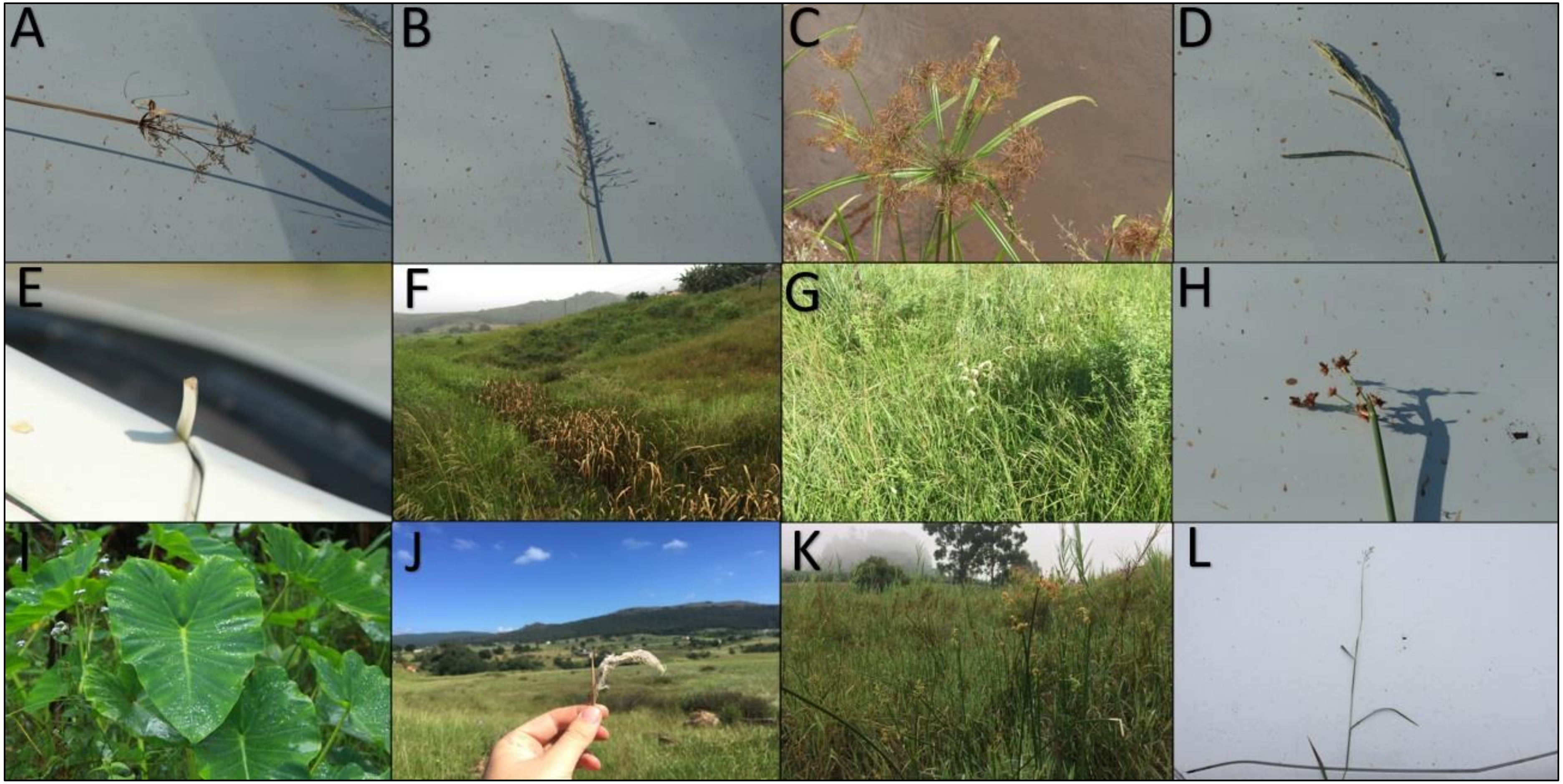
7.2.7 WETLAND ECOLOGY

Wetland ecology plays a significant role in ecosystem services, given the fact that many ecosystem services are dependent on wetland conditions. Hydrophytes increase the level of biodiversity in wetlands, increase the value of habitats, and various other ecosystem services including water purification, flood attenuation, etc. Various hydrophytic plant species were identified during the site survey period within the delineated wetlands, including

Schoenoplectus brachyceras, Leersia hexandra, Colocasia, Typha capensis, Imperata cylindrica, Juncus kraussii, Cyperus sexangularis, Cyperus triangularis, Sporobolus pyramidalis and *Echinochloa holubii* (**Figure 7-51**).

Hydromorphic soil forms identified in the delineated wetlands include the Katspruit and Tukulu soil forms. The Tukulu soil form consists of an Orthic A-horizon on top of a Neocutanic B-horizon (**Figure 7-52**), which in turn is underlain by an unspecified material with signs of wetness. The soil family group identified for the Tukulu soil form on-site has been classified according to the South African soil classification (Soil Classification Working Group, 1991) as the Hoeko (1210) soil family due to the red colour of the soil and the non-luvic processes involved in this soil form.

The Katspruit soil form consists of an Orthic A-horizon on top of a G-horizon (**Figure 7-52**). The soil family group identified for the Katspruit soil form on-site has been classified as the Lammersmoor (1000) soil family due to the non-calcareous nature of the G-horizon.



A: *Schoenoplectus brachyceras*. B: *Sporobolus pyramidalis*. C: *Cyperus sexangularis*. D: *Echinochloa holubii*. E: *Cyperus triangularis* (cross sectional presentation of triangular stem). F: *Typha capensis*. G: *Imperata cylindrica*. H: *Schoenoplectus brachyceras*. I: *Colocasia*. J: *Imperata cylindrica*. K: *Juncus kraussii*. L: *Leersia hexandra*.

Figure 7-51: Hydrophytes Identified within the Delineated Wetlands.

A: G-horizon. B: Orthic A-horizon with colour variations. Unspecific material with signs of wetness. D: Silt accumulated in vegetation. E: Unspecified material with signs of wetness. F: Unspecified material with signs of wetness. G: G-horizon. H & I: Orthic A-horizon with fibrous plant material

Figure 7-52: Hydromorphic Soil Forms Identified in the Delineated Wetlands

Channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps were identified during the site assessment (**Figure 7-53**). The channelled valley bottom wetlands are associated with river systems and have been classified as wetlands given the volume and type of soil as well as the presence of a wide variety of hydrophytes within the system and its banks.

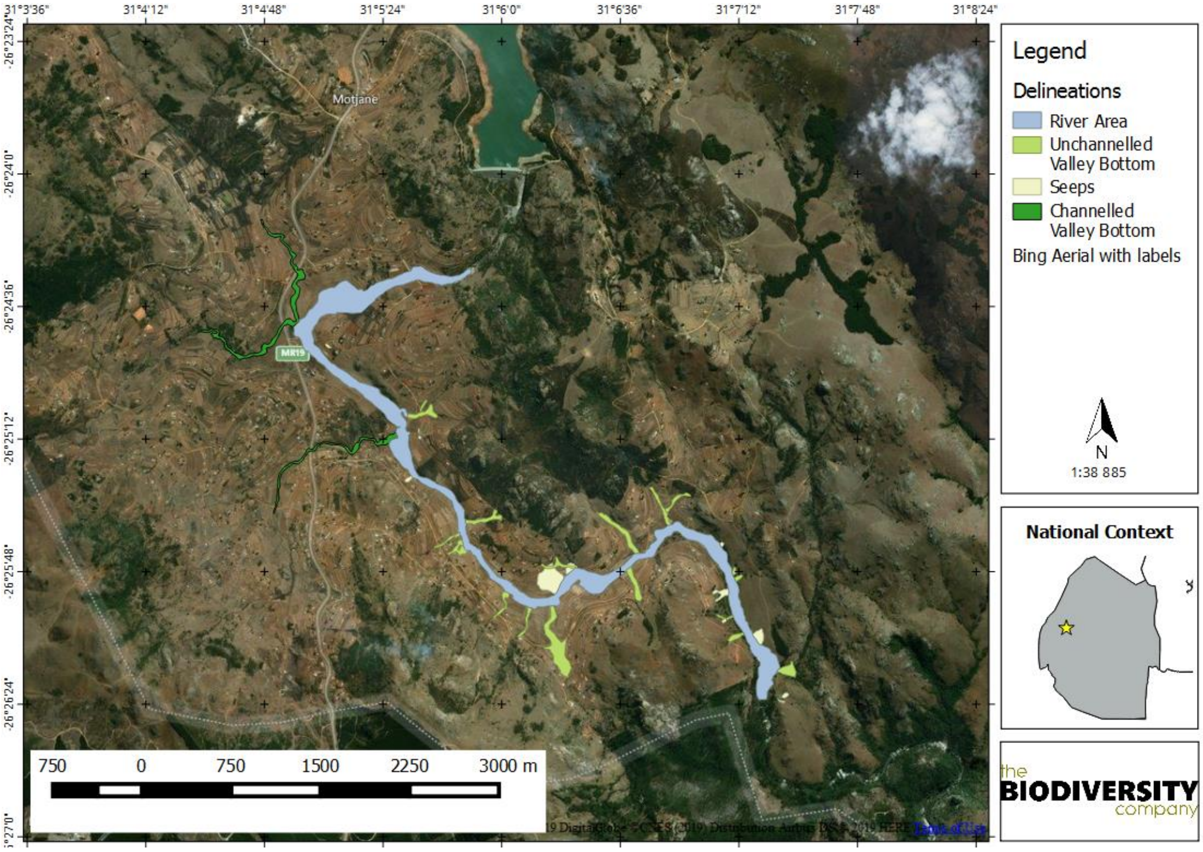


Figure 7-53: The Wetland Areas Delineated for the Assessment

The majority of wetlands within the proposed inundation area are unchannelled valley bottom wetlands, which in some cases are also characterised by a channel. The channels within the unchannelled valley bottom wetlands are a result of erosion and are not characterised by a finite channel as in the case of the channelled valley bottom wetlands. These channels differ in-depth and in some cases intermittently change into diffuse flow and back into channelled flow throughout the unchannelled valley bottom system. Unlike the channelled valley bottom wetlands, these system's outer edges are characterised by saturated soil forms that are not dependent on the water from the erosional gully/channels that are concentrated in the wetlands.

The hillslope seeps are characterised by diffuse sub-surface flows that feed watercourses downslope of the seeps. These systems are characterised by temporary saturated zones with a low diversity of wetland vegetation (if any).

7.2.8 ECOSYSTEM SERVICES

The project area of influence includes the inundated area itself, which covers approx. 210 ha. The inundation of the reservoir will result in the direct loss of various ecosystem services identified within the reservoir area. A regulated area surrounding the inundated area has not been assigned as part of the assessment area given the lack of impacts expected towards ecosystem services up-slope from the inundated area. An additional 52,2 ha project area has been included for the study to determine potential direct and indirect risks towards ecosystem services identified downstream of the proposed dam wall (**Figure 7-54**).

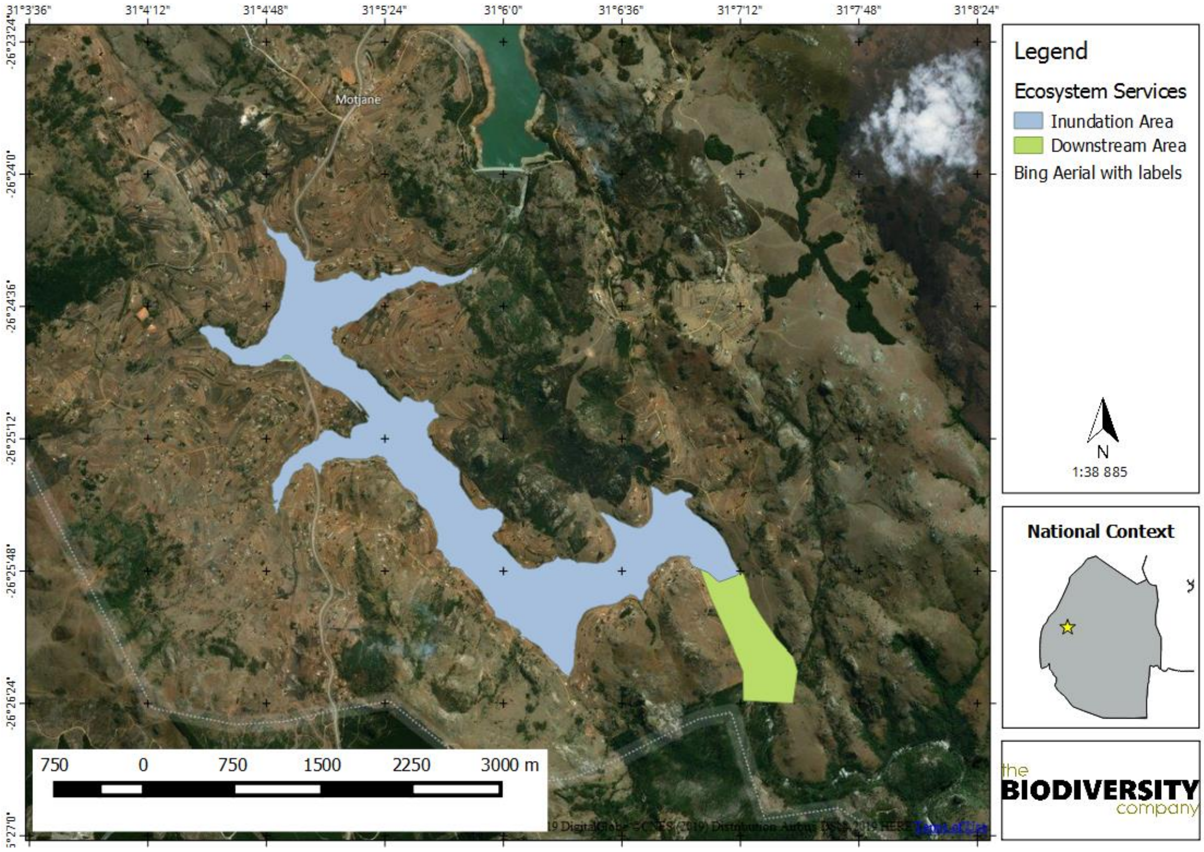


Figure 7-54: The Project Area of Influence Considered for the Ecosystem Services

The Ecosystem Services (ES) Toolkit by Preston & Raudsepp-Hearne (2017) has been used to determine the value of ecosystem services in the current land-use. This assessment has focussed on qualitative data rather than quantitative data (with the exception of loss in hectares) given the fact that financial values and compensation for ecosystem services will be discussed in the social assessment.

The following environmental sensitivity has been identified to be of high concern given the parameters and results determined:

- General farming activities;
- Raw materials from the environment;
- Freshwater;
- Waterflow regulation;
- Water purification;
- Soil formation;
- Water cycle; and
- Habitat.

GENERAL FARMING ACTIVITIES

Approximately 107,2 ha of the DMU (340,18 ha) is covered in crop fields, of which only 2,26 ha is located within the downstream area and the rest (104,76 ha) located within the proposed inundation area (**Figure 7-55**).

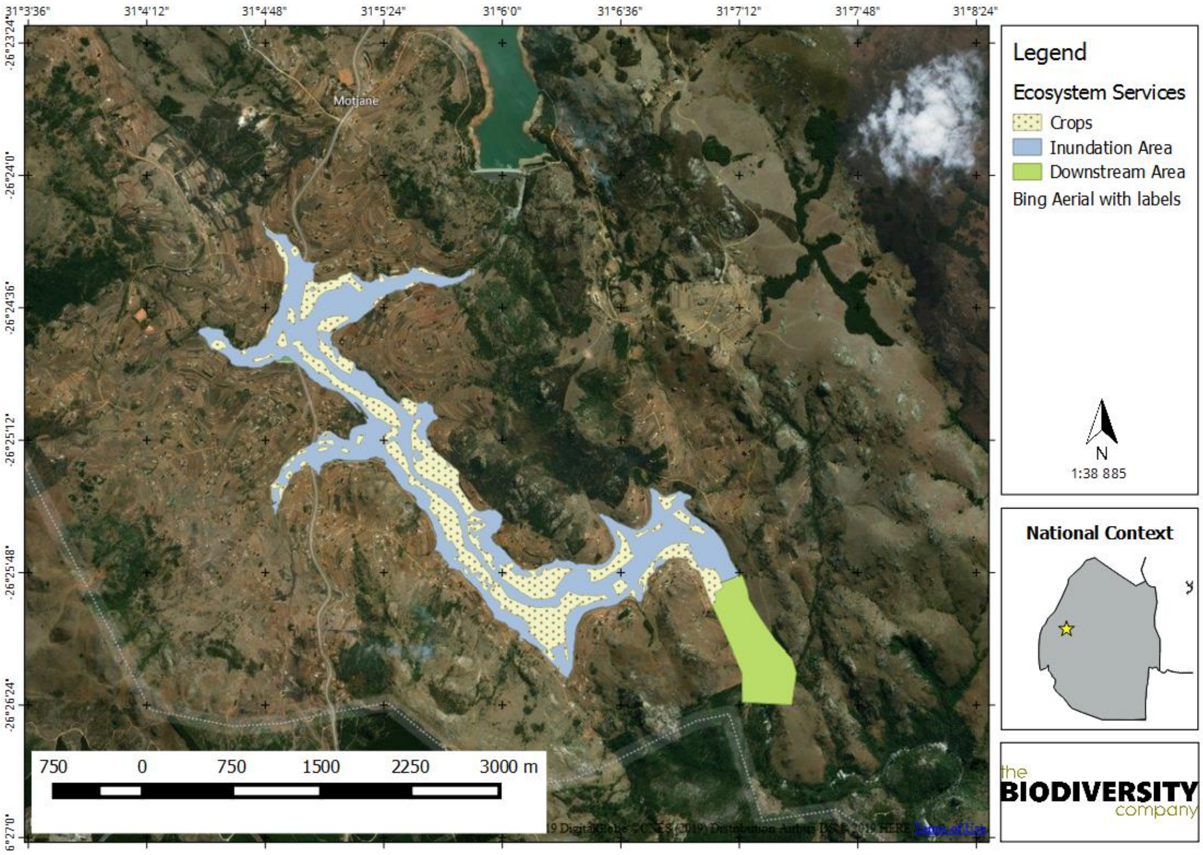


Figure 7-55: The Location and Extent of Ccrop Fields Delineated for the Assessment

RAW MATERIALS FROM THE ENVIRONMENT

Approximately 28,36 ha of the DMU is characterised by densely grown tree patches. These areas are often utilised for timber to use for building purposes, energy or cooking. The majority (17,4 ha) of the delineated densely grown tree patches are located in the downstream project area (where indirect, unlikely impacts are expected) with 10,96 ha located within the proposed inundation area (**Figure 7-56**).

Sand mining also takes place within the banks of the river system in the proposed inundation area (**Figure 7-57**). This area covers approximately 5,15 ha and is important to the well-being of the local community.

Very little to no signs of the community harvesting reeds or grass were identified during the site assessment, ultimately rendering the delineated tree areas as the most likely source of raw materials in the relevant project area.

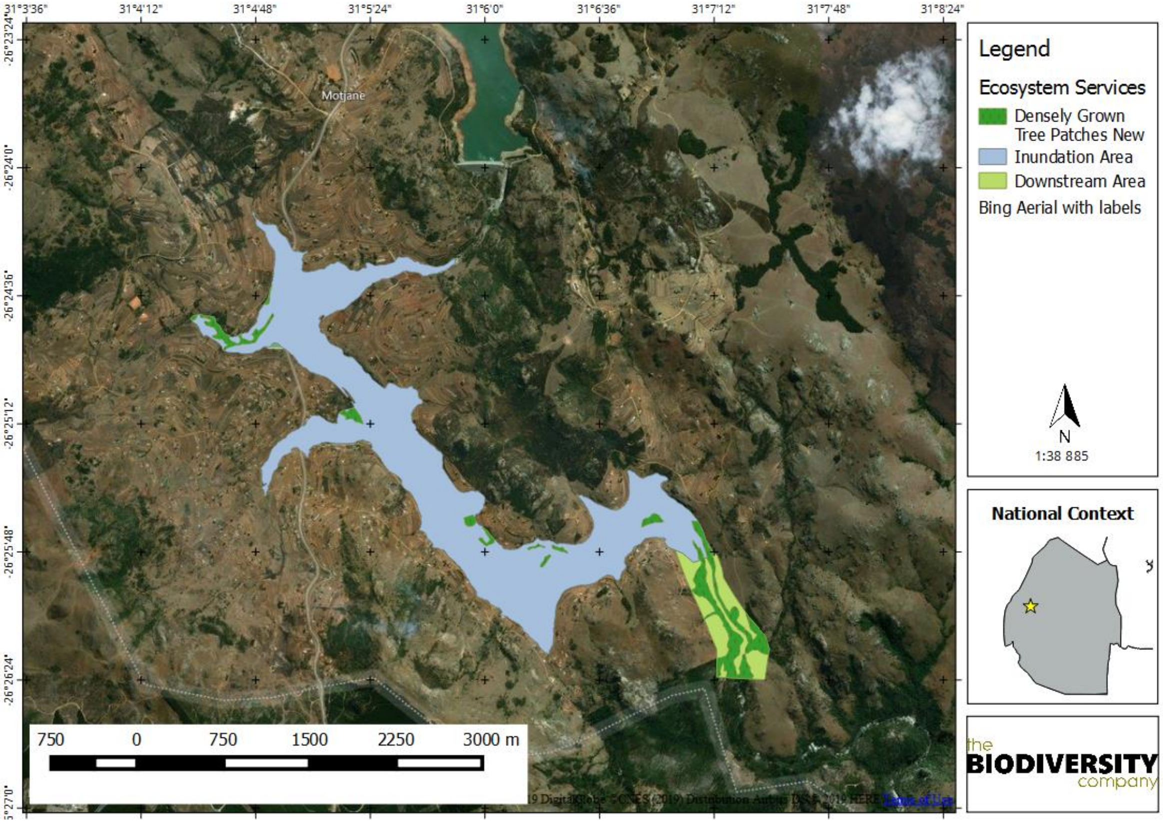


Figure 7-56: The Location and Extent of Densely Grown Tree Patches Delineated for the Assessment

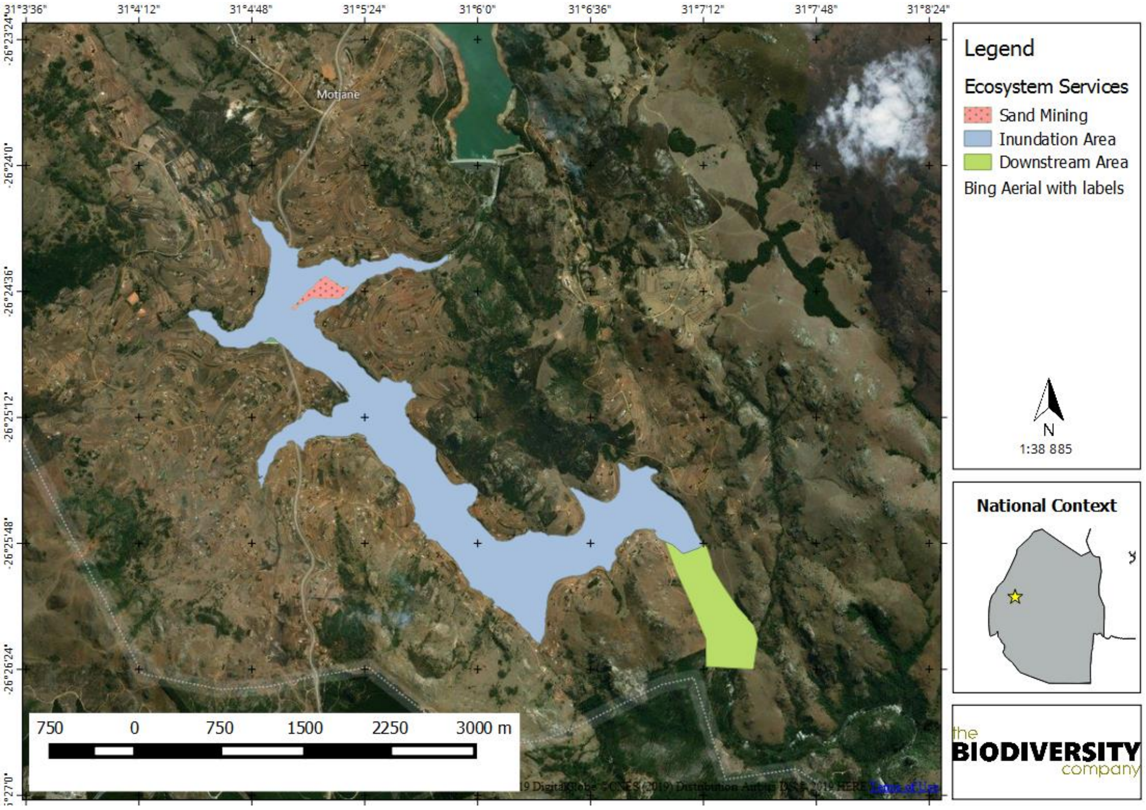


Figure 7-57: The Location and Extent of Sand Mining Identified for the Assessment

FRESH WATER

Watercourses were identified throughout the project area to determine the potential for potable fresh water for the surrounding community. Four types of watercourses have been identified during the site assessment, namely wetlands (in the form of channelled valley bottom wetlands, unchannelled valley bottom wetlands and seeps) as well as a river system. The delineated channelled valley bottom wetlands cover 9,3 ha of the proposed inundation area, unchannelled valley bottom wetlands cover 14,29 ha with hillslope seeps covering approximately 4,35 ha of the inundated area. The delineated river system (which includes in-stream habitat, riparian areas and associated floodplain areas) covers approximately 63,29 ha of the project area (**Figure 7-58**).

The community is provided with potable water by means of water pipelines and pipelines extending from mountains to households, ultimately providing families with clean water from springs high up in the catchment (**Figure 7-59**).

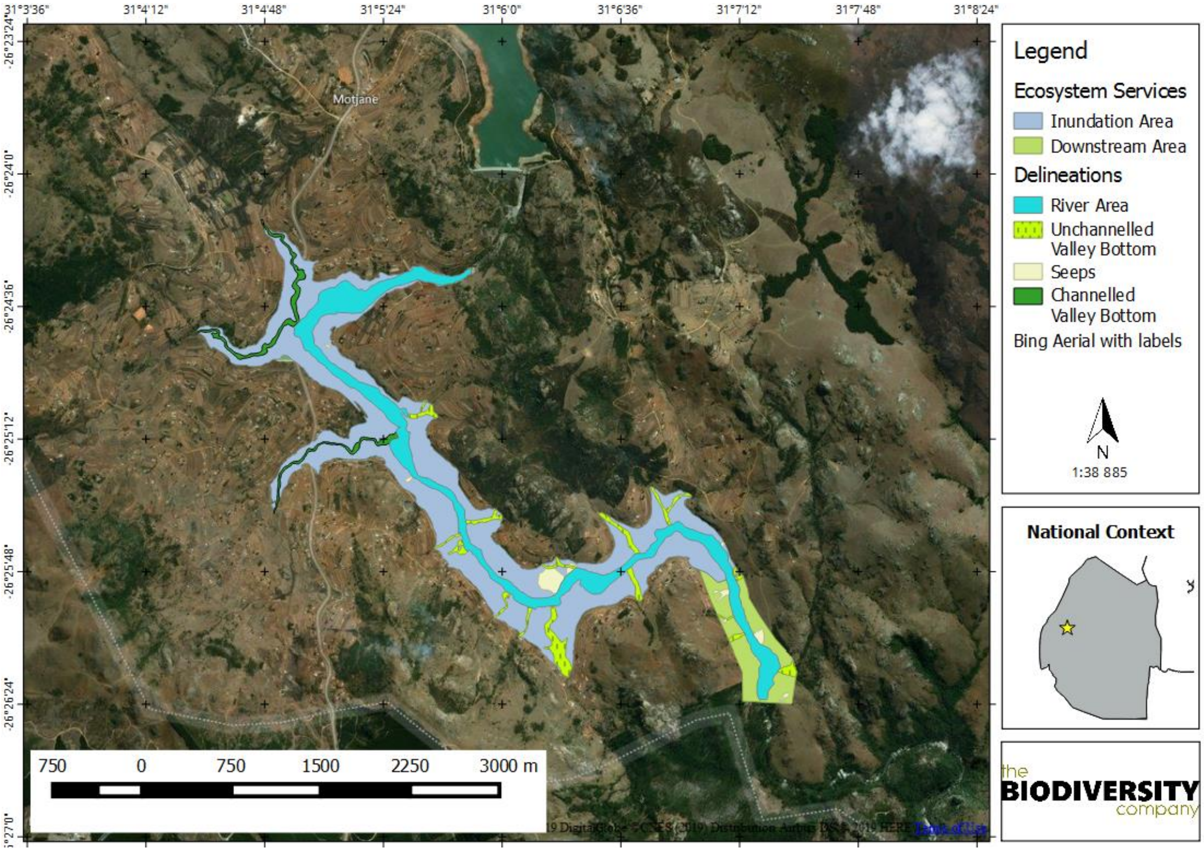
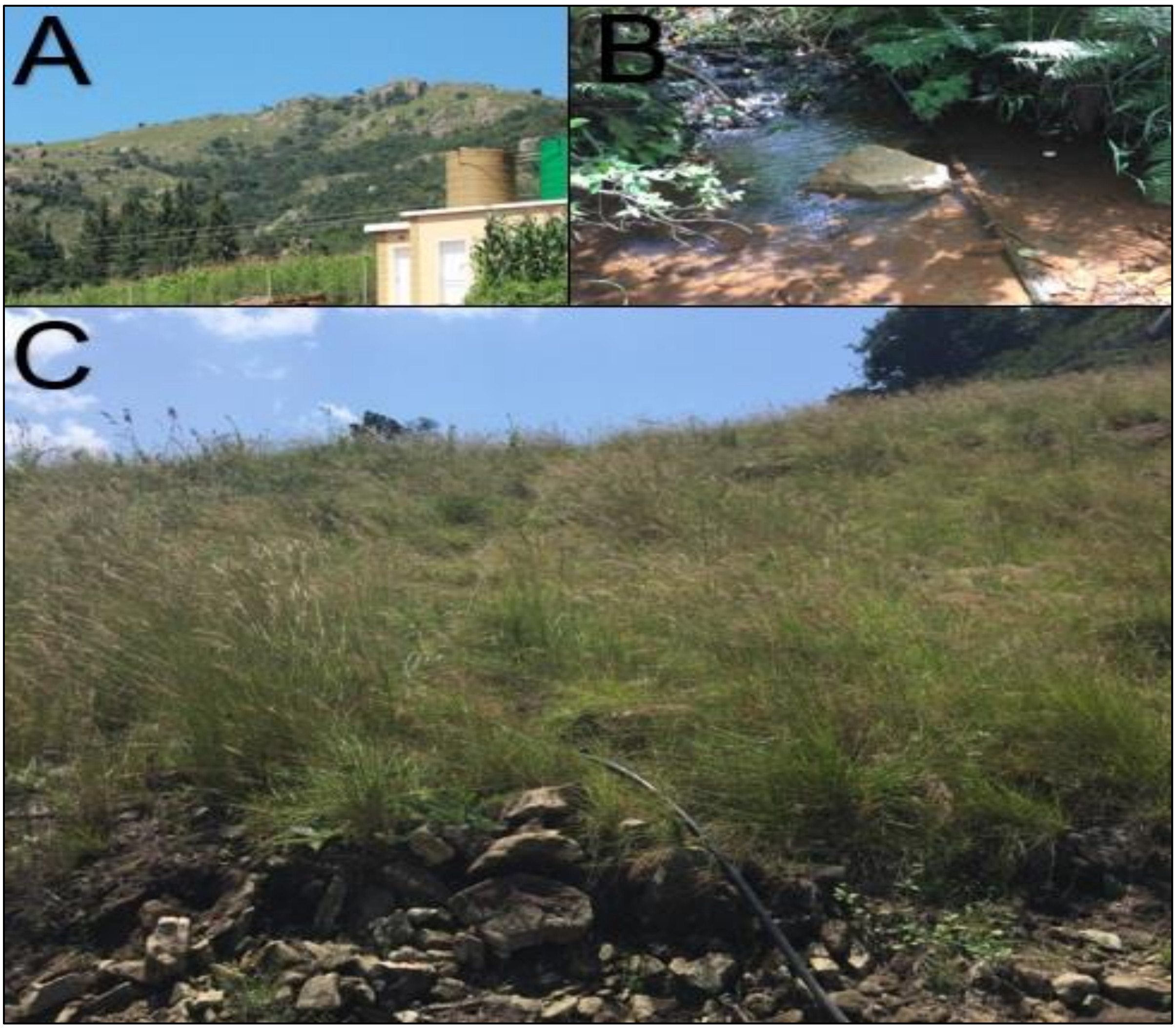


Figure 7-58: The Extent of the Delineations Considered for the Assessment



A: Reservoir tanks storing water. B: Pipeline within wetland system. C: Pipeline leading from mountain tops to lower laying households.

Figure 7-59: Pipeline Systems Throughout the Project Area

WATER FLOW REGULATION

The water flow regulation services associated with the above-mentioned watercourses have been assessed and quantified by means of basic calculations associated with relevant parameters. These parameters have been rated on a scoring basis from one to three (with three being "High", two being "Moderate" and one being "Low").

The river system has been scored 1,9 (out of 3,0) due to the frequency of stormflows spreading across the system, the sinuosity of the stream channel, the contribution of the watercourse's catchment to run-off characteristics and the rainfall intensity of the region. The unchannelled valley bottom wetland has also been scored an average score of 1,9 for water flow regulation due to the presence of dense patches of hydrophytes, the gentle slope of the watercourse and the frequency at which stormflows spread across the wetland.

The channelled valley bottom wetlands have been scored slightly lower (1,8) given the absence of vegetation directly within the stream channel with hillslope seeps being scored much lower (1,2) given the slope of the wetland (generally steeper than other watercourses) and the fact that stormflows do not frequently spread across the relevant wetland.

PURIFICATION OF WATER

The river system has been scored the lowest “Water Purification” ecosystem service score of all four watercourse types, with an average score of 0,7. This weak score is attributed to the lack of hydrophytes and hydromorphic soils (given the dominance of alluvial sediment) as well as the velocity of flow. The channelled valley bottom wetlands and the hillslope seeps have been scored 1,7 with the unchannelled valley bottom wetlands determined to have an average ecosystem service score for “Purification of Water” of 2,6. The latter score is attributed to the presence of hydrophytes, the presence of hydromorphic soils and the fact that the system is characterised by diffuse flows as oppose to channelled flow. The presence of crop fields in close proximity potentially threatens watercourses given the application of fertilisers and herbicides which ends up in watercourses. The potential of contamination emphasises the need for a watercourse to purify water, which ultimately results in a higher ecosystem service score for “Purification of Water” (**Figure 7-60**).

The ability of watercourses to trap sediment also increases the ecosystem service score of a watercourse given the fact that contaminants often are adsorbed by soil particles.

Figure 7-60: Evidence of Contamination of Water Resources

SOIL FORMATION

For soil formation, the river system has been rated 1,0 given the continuous deposition and removal of sediments adjacent to the river system and the presence of rocky outcrops (due to sediments washing away). The channelled valley bottom wetlands and the unchannelled valley bottom wetlands have been scored an average ecosystem service score for Soil Formation of 2,5 given the lack of rocky outcrops with the hillslope seeps being scored 2,0.

WATER CYCLE

The average ecosystem service score for "Water Cycle" has been scored 1,0 for the hillslope seeps given the fact that the main driver for the water cycle is transpiration rather than evaporation given the lack of surface water and the dominance of sub-surface flows. The river system has been scored 1,5 with the channelled valley bottom wetlands scored 1,6. The unchannelled valley bottom wetland has been determined to have the highest environmental sensitivity score for the water cycle given the fact that flows within this watercourse are very diffuse and the gentle slope of the wetland.

ECOLOGICAL STATUS

The Lusushwana River reach is classified as modified habitat. Based on the assessed water quality parameters, the water quality was derived to be natural, with low conductivity, neutral pH levels and fair clarity. Instream habitats were found to be modified as a result of the existing Luphohlo Dam, whereby flow and channel morphology had been impacted. The riparian habitat was determined to be modified as an effect of the Luphohlo impoundment compounded by the presence of extensive stands of alien vegetation. Aquatic macroinvertebrate assemblages were found to be diverse, but composed of largely tolerant invertebrate taxa. A reflection of the high diversity of aquatic macroinvertebrates was corroborated through the direct observation of 42 Odonata taxa.

The fish community of the Lusushwana River reaches assessed during this study was found to be dominated by Cichlidae, indicating the dominance of slow-flowing habitats across the study area. The Mantenga Waterfall was found to be a migratory barrier to non-anguillid taxa and a limiting factor for the distribution of fish species in the watercourse. However, the existing flows were such that sensitive and listed fish species such as *Chiloglanis emarginatus* (VU) were observed during the study indicating that the fish community was still sensitive to changes inflow.

7.3 SOCIO-ECONOMIC ENVIRONMENT

From a 2010 Eswatini Census-Based Poverty study done (most recent) the following results were observed.

— None of the areas within the Lusushwana River basin have 100% access to drinking water but 93% of the major areas along the basin, including the project area (Siphocosini), have drinking water standards and coverage above the national average (57.7%). Only Mdzimba has levels lower than the national average.

— A total of 87% of the areas have a higher sanitation level than the national average (77.4%). This is typical of areas close to economic hubs and it indicates the efforts done by the government and all parties involved.

— Only 40% of the areas have a net enrolment for primary education above the national average (76.3%) and 73% of the areas have a net enrolment for secondary education above the national average (34.3%). Few people have attended secondary education in Eswatini but most of the people found within the Basin have enrolled for secondary education.

— More males (96.1%) are literate than females (94.9%) and only in Sidvokodvo are males and females slightly below the national averages. The rest of the areas have individuals above the national averages.

— None of the areas have 100% access to electricity, but 93% of the areas have better access to electricity than the national average (65.8%). All the areas still use wood for fuel but they are generally above the national average (31%) including Sphocosini (project area).

— None of the areas have 100% access to fixed telephone lines or mobile phones. Access to the internet is very low. Mbabane had the highest access (41.8%) and the rest were very low at the time of the survey. Due to mobile / 3g penetration these statistics are not likely to represent the current situation and could be higher.

7.3.1 POPULATION DEMOGRAPHICS AND PATTERNS

The Kingdom of Eswatini is a land-locked country, comprising 17 400 km^2, situated in southern Africa bordering the Republic of South Africa (to the north, west and south) and Mozambique (to the east). Of this land, 62% is under permanent pasture and 7% is forested which is indicative of the key industries in the country, which are sugar cane and timber. The nation holds a very strong cultural heritage under the monarchy and continuously strives to enlarge its economic base and standing in the global and regional economies.

Eswatini comprises four administrative districts: Manzini, Hhohho, Shiselweni and Lubombo. The proposed project is located in the Hhohho District in the north-west of the country and the nearest major town is Mbabane which is administered by its own Municipal Council. Hhohho is divided into 14 Tinkhundla (constituencies or administrative centres) with its administrative centre in Mbabane, the administrative capital city of Eswatini, and comprises a population of 309 184.

Whilst the Hhohho District is the most economically advanced region of Eswatini, as it comprises the capital city of the country and urbanised areas amongst which Ezulwini is one of the fastest-growing in terms of urban development, the area in which the project is situated is rural and has a low economic growth profile.

The Mbabane – Manzini corridor, therefore, represents the economic hub of the country with a generally youthful and economically active population, particularly when compared to the rural areas.

The project area is situated within the Mantabeni and Siphocosini Royal Kraals, which include 12 communities namely: Mhlane, Spete (1 and 2), Ncabaneni, Sithobela, Masibekela, Mahothoza, Mahlatsini, Ndlolotsi, Majadvula, Ndlelalula, Mkhumbe and Mhlane. The Royal Kraals of Mantabeni and Siphocosini is situated in the Hhohho administrative District, under the Motjane (Tikundla) constituency in Eswatini. It is located about 17.5 kilometres from the capital city of Mbabane.

According to the 2017 Census and the World Population Review (2019), the population of Eswatini is 1,093 238 Million people and that of Mantabeni and Siphocosini is 7 482. The total number of households is 1 320 in the 12 villages.

7.3.2 LANDOWNERSHIP AND SETTLEMENTS

Land ownership within the Lusushwana River Basin is typical of the three land ownership systems in Eswatini. There is a mix of Eswatini Nation Land, Title Deed Land and Crown Land in that order. The Lusushwana Basin traverses 11 Tinkhundla Centres i.e. Sigangeni, Mhlambanyatsi, Motjane, Mbabane East, Mbabane west, Hhukwini, Mahlanya, Lobamba, Ludzeludze, Manzini South and Nhlambeni.

The project site and its vicinity falls under the Eswatini Nation Land, Sigangeni Inkhundla, Siphocosini and Mantabeni area and the subjects in that area report to Chief Machawe Dlamini and Chief Indvuna Mbetse respectively. No Royal Kraal and land disputes were reported.

Human settlement within the Lusushwana Basin can be categorized into rural, urban and privately-owned settlements. The rural settlements are under the Eswatini Nation Land system, the urban settlements are under the Crown Land and Title Deed Land systems and privately owned land or farms are under the Title Deed Land system.

Most of the households that were established between 1-10 years ago (31.55%) belong to the category of homeowners between the ages of 35-55 as compared to 60.97% of those who have lived in the community between 11-40 years. Older homesteads have more established homes often built from brick and mortar or mud, toilets, kraals, sheds, traditional grain sheds, fields, forests and boreholes. Similarly, sheds and kraals are invariably made out of wood. The older homesteads are located throughout the village not necessarily on the periphery like those of the new residents who are often located in the outskirts of the village closer to the main roads. Another striking feature about these new homestead owners is the fact that they do not often possess a lot of property such as fields, forests, kraals and sheds and their homes are modern and often have toilets and bathrooms in their homes as well as outside. Yet mostly older homesteads invariably have their toilets and showers outside.

7.3.3 HOUSING

The majority of the housing infrastructure in the project area are detached immovable houses built from concrete blocks and roofed with iron sheets or tiles. These may be in clusters as in the case of extended families or single units with side structures. The houses range from a simple bedsitter (bedroom, kitchen and living room), to larger dwellings with 3 or 4 bedrooms. The average house in the project area has at least 2 bedrooms, a kitchen and a living room with an estimated building cost of approximately E60,000. Photos of households / dwellings located within the project area are provided in **Table 7-18**.

Table 7-18: Photos of Households / Dwellings within the Project Area

7.3.4 LIVELIHOOD AND ECONOMIC ACTIVITIES

Skills and Occupation

Based on interviews, people between 18-55 years comprise 65% of the population while those above 56 and older make 32.09% of the community. The number of both those who are currently unemployed and those seeking work in the past three months is 12.50%. Data provided in this study is consistent with the general statistics provided of Eswatini (22%) which confirms the high level of unemployment. 56.68% Respondents did not have any skills while 34.22% have skills and 5.88 were uncertain of this question. The skills associated with the community members of Mantabeni and Siphocisini are outlined in **Table 7-19**.

Table 7-19: Skill of Community Members

SKILLS	PERCENTAGE
Bricklaying	18.18 %
Brickmaking	11.76%
Roofing	10.70%
Driving	7.49%
Carpentry	5.88%
Welding/Metal Work	3.74%
Electrical	3.74%
Plumbing	3.21%
Tiling	2.14%
Cabinet Making	0.53%
Thatching	0.53
Iron Mongering	0.53%

It is essential to note that among the people who reside in these two villages there is a spread of careers that people are involved in. There are two members of parliament, teachers who teach in both the local primary and high school, two soldiers, Policemen, Engineers, Public Servants, Farmers and Shop Owners (**Table 7-20**).

Table 7-20: Occupation of Community Members

TYPE OF EMPLOYMENT	ACTUAL NUMBERS	PERCENTAGES
Formal employment	70	37.43
Self Employed	22	19.25
On Farm Production (Animal and Farm Production)	13	6.96
Informal Employment	8	4.28
Piece Work	10	5.35
Not in Labour Market	36	19.25
Unemployed not seeking work	18	9.63
Unemployed Seeking work in the past 3 Months	5	2.67

MEANS OF LIVELIHOOD

Six main sources of livelihoods were identified from the household responses. The dominant income-generating activities in the Mantabeni and Siphocisini ranged from business and wage employment both in the formal and informal sectors. Various descriptions of what the people in the village do for a living were identified and fell into eight categories as shown in **Table 7-20**.

115 PAPs stated that they did not have any reliable income, while 14 lived below E1000 / per month. Fifty-five stated that their monthly expenditure was in excess of E3000 and beyond.

It was established that out of the 115 people with unreliable income some are self-employed while others are farmers engaged in agriculture and livestock farming. The fact that there have been variable incomes could be explained by the impacts of drought in crop failure due to insufficient and scantily spread rainfall.

Often some household heads work outside the community in Mbabane, Manzini or even in South Africa in some instances. It was established that often families are taken care of by family members working outside the community. Forty out of 175 Household respondents indicated that certain family members provide remittance from outside their community for upkeep. Out of those who provided remittance - sons constituted 8.56%, daughters 4.81%, fathers 4.28%, mothers 3.74% and 6.95% other.

This data is consistent with the statistics provided by the Eswatini Household Income and Expenditure Survey of 2016/17 which indicated that 11.39% received money from outside the country while 42.99% received it from inside the country.

Subsistence farming is the main source of staple food production and is the livelihood foundation of the rural people in Africa. Each of the 187 households visited during the survey had either a garden and or fields thatare in operation. All 187 respondents had fruit trees such as guava, avocado pears, peaches, bananas, mulberry and others in their homesteads. Livestock the households raised included poultry, goats, sheep, pigs, and cattle. Out of the 187 respondents, none went to bed without meals on any given day. This was also supported by the fact that most of the gardens in the homesteads had signs that they were being cultivated. Additionally, most people indicated that their gardens and fields are their primary source of livelihood. However, other families that lived below the poverty line". According to Youth and Public Policy 2015, 63% of the Eswatini population live on less than $1 per day. **Table 7-21** shows the various means of livelihood in the community.

Table 7-21: Means of Livelihood

TYPE OF MEANS OF LIVELIHOOD	NUMBER OF RESPONDENTS	PERCENTAGE %
Farmer	93	49.73
Vegetables and Fruit Sales	58	31.02
Formally Employed	51	27.27
Livestock Sales	31	16.58
Casual Labour	20	10.70
Pension	11	5.88
World Food Programme AID (WFP)	5	2.67
Artisan	1	0.53
Other	43	22.99

SOURCE OF ENERGY

Of the community members, 78.67% of electricity is used mainly for lighting while 11.23 % use candles. 48.66%Households use firewood for cooking and 44.39% use electricity while the number of households using gas and solar is 4.46%. According to the Eswatini Household Income and Expenditure Survey 2016/17, 63.67% of households have access to electricity and 64.38% use it for lighting and 32.50% for cooking.

INCOME GENERATION

Hundred and thirteen household owners stated that their vegetable gardens require water, 68 needed water for their livestock, 68 for fruit trees and 51 did not specify. Hundred and fifteen respondents indicated that income from these properties vary and is unreliable. Sixteen percent indicated that they annually derived E2000 and above, and those earning between E1000-1500 were 2%, 1% earn between E500-1000. The rest of the respondents did not provide data.

7.3.5 ACCESS TO AND UTILISATION OF NATURAL RESOURCES

FRESHWATER ACCESS

There are various sources of freshwater in both Mantabeni and Siphocosini. Out of 179 respondents, 63 indicated that they have connection taps, 35 use public standpipes, 24 streams or rivers, 22 from the well, 19 hand-pumped boreholes, 5 traditional hand-dug wells, 4 from springs, 4 from electric pump borehole, 2 rainwater tanks and 2 other sources. Regarding the condition of water, 106 respondents were very positive stating that the water was clean even though during the winter months of June and July the volume decreased. The positive aspect of the community water is the fact that it is free, very clean and reliable. Negative aspects to the village water were that it may be prone to drought and inconsistent during winter months, and lack of maintenance plan is a challenge. The distance from the water source varies from 1-5 km with 5 km being the furthest a person would travel to get water. Out of 177 respondents 156 accessed water within 0-1 km, 8 travelled further and the assumption was that this often occurred during winter months.

In African countries where the majority of the people still live in rural areas and are still enduring the challenges related to inadequate supply of water and poor sanitation, the job of providing water and ensuring proper and hygienic sanitation still lies with women (UN Commission on Sustainable Development, 2013). Women tend to be users, providers and managers of water and in Eswatini like many other countries, it is the cultural practice for women and girls to fetch water used for household purposes.

7.3.6 SOCIAL INFRASTRUCTURE

A number of basic public facilities including schools, health centres and churches, as well as shops, are present within the project area providing essential services to the local community. Two schools, five informal businesses, and one church are noted to be located within the proposed inundation area and associated buffer zone. The associated financial value of the two schools and church have been estimated at roughly USD60,000.

Table 7-22: Photos of Social Infrastructure within the Project Area


Shop


Shop


School


School

HEALTH STATUS

There is only one clinic/health facility that serves the community of Mantabeni and Siphocosini located in Siphocosini. Respondents indicated having visited the clinic occasionally for various sicknesses. Some respondents further indicated that they have been referred to hospitals in Mbabane for serious illnesses by the health facility. The distance people travel between the village and the clinic in Siphocosini and public hospital in both Mbabane and Manzini varies.

HIV / AIDS AWARENESS

Eswatini like so many other Southern African countries has not been spared the effects of HIV/AIDS epidemic. Despite being the country with the smallest population of 1 336 933, Eswatini remains the highest with HIV prevalence in the world with devastating impacts. However, it is stated that over the past decade there have been great efforts to reverse the impacts through improved access to health facilities and other related HIV testing facilities and the provision of free ARVs.

Out of 179 respondents to the question of being aware of HIV, 172 responded positively while seven stated that they were not aware thereof. From the analysis of the survey, it was clear that extensive awareness campaigns in the community have been conducted using mediums such as radio, clinic, public gatherings, school children, pamphlets and posters, workplace and clinic.

Hundred forty-nine respondents acknowledged having tested for HIV/AIDS while 32 indicated that they had not. Sixty-nine respondents had tested in the past three months, 26 in the past 6 months, 30 in the past year, and 22 in the past 2 years.

In general, a conclusion can be drawn that Eswatini Government has fared well in its efforts to curb new infections and destigmatising HIV/AIDS.

7.3.7 EDUCATION

21.39% Respondents have tertiary and vocational education, 39.58% have a high school education, 31.02% have primary education and 3.07% are illiterate.

7.3.8 TRANSPORTATION INFRASTRUCTURE

ROADS

The proposed dam site is accessible via the MR-19 Road, between Mbabane and Mhlambanyatsi, and a network of existing local unpaved roads, as indicated in **Figure 7-61**. Establishment of the dam will however result in a 1.83 km section of the paved road being flooded, as such this section of road would need to be rerouted to facilitate the continued movement of vehicles along this route.

Figure 7-62 and **Figure 7-63** show the sections of the paved road that will be affected by the Nondvo Dam reservoir.

The reservoir will also result in the inundation of parts of the existing unpaved road network servicing the project area. New sections of road will therefore potentially have to be constructed to ensure continued access to remaining homesteads that do not require relocation however to which access via the existing road network may be cut-off due to the reservoir. Furthermore, the existing road network, with the exclusion of the MR19, consist of poorly maintained unpaved roads. Upgrading of the access roads will likely be required to facilitate all-weather access to the dam wall for the construction and operation phases.

Photos of the MR-19 Road are provided in **Table 7-23** and photos of the existing local unpaved roads and associated infrastructure, including low level crossings, are provided in **Table 7-24**.

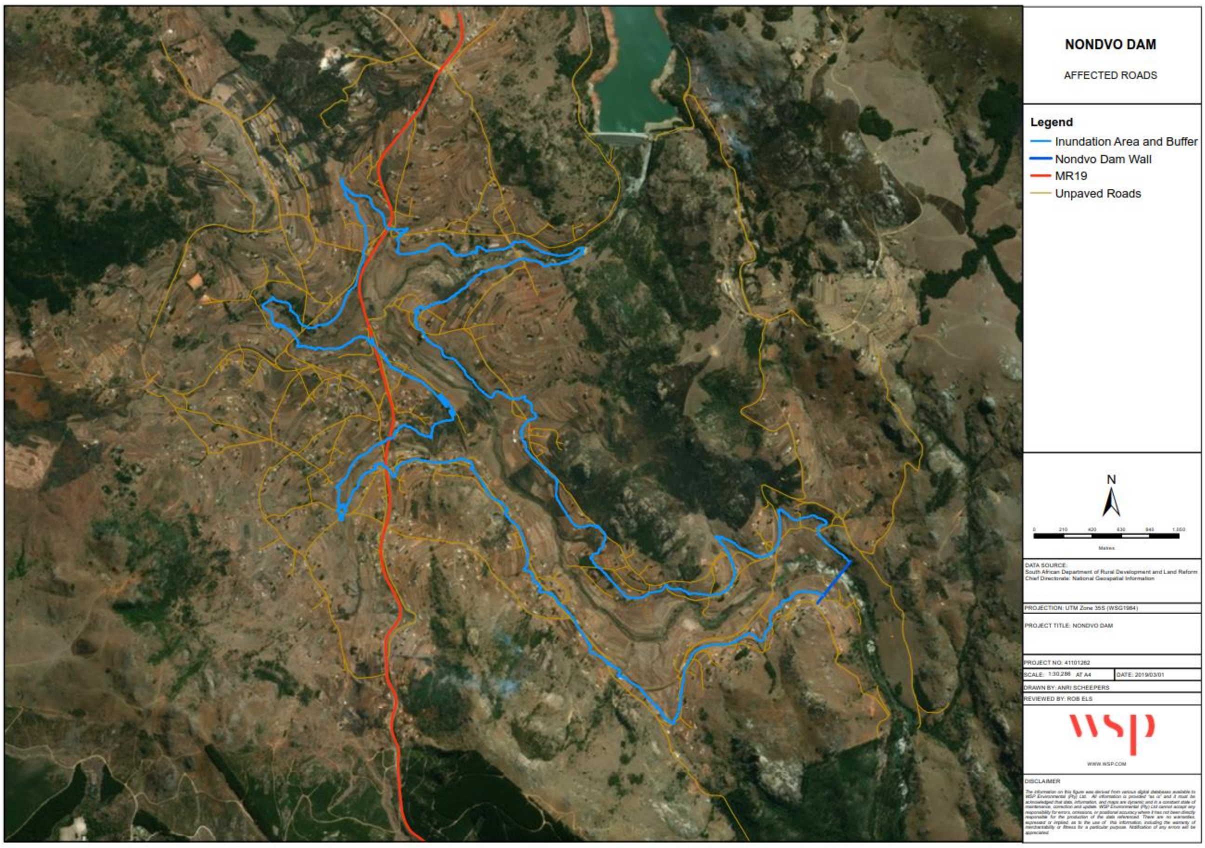


Figure 7-61: Existing Road Network within the Project Area

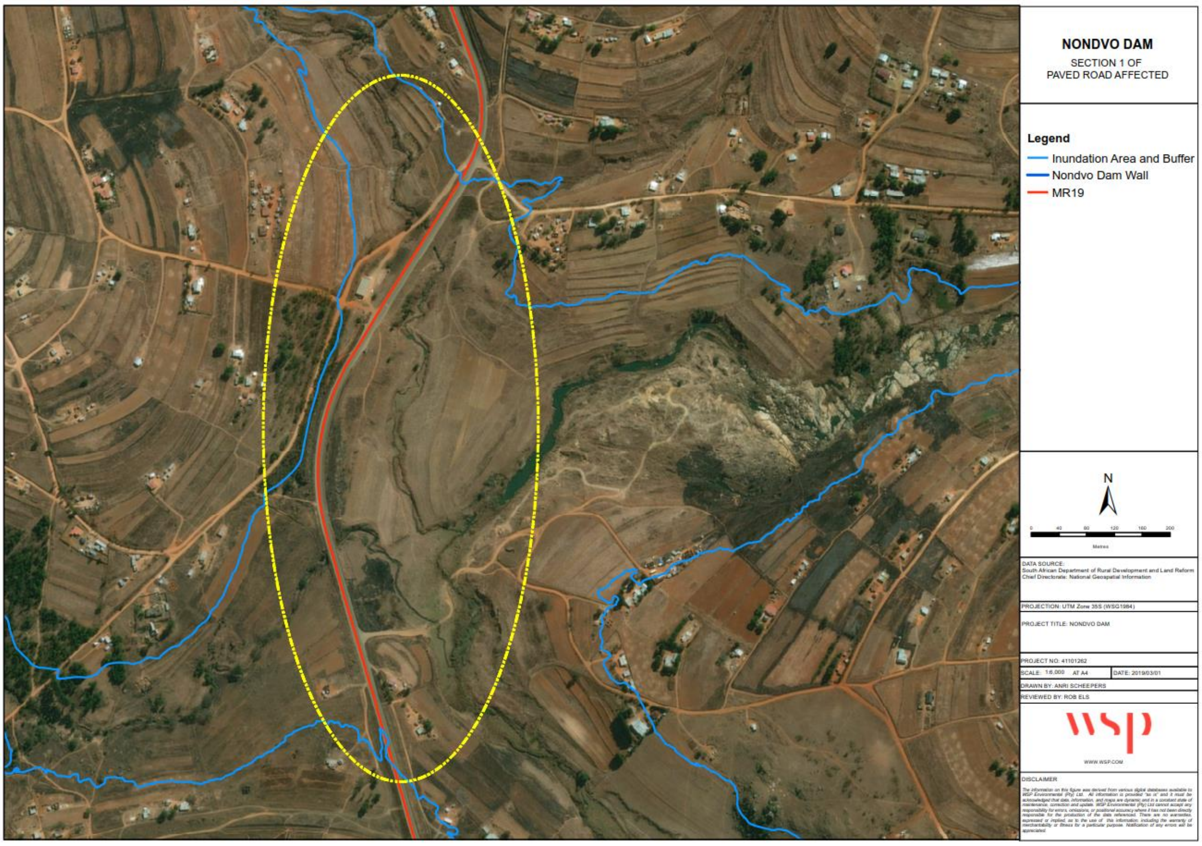


Figure 7-62: Section 1 of Paved Road Affected by the Proposed Reservoir

Figure 7-63: Section 2 of Paved Road Affected by the Proposed Reservoir

Table 7-23: Photos of Road Infrastructure (MR-19) within the Project Area

Table 7-24: Photos of Road Infrastructure (Unpaved Roads) within the Project Area

RAILWAY LINE

An existing railway line route, which is currently out of service, runs along the Lusushwana River. The railway line originates at the Ngwenya Iron Ore mine located on Bomvu Ridge, northwest of Mbabane and near the north-western border of Eswatini. It was built for the transportation of mine material, connecting the mine with the Mozambique Railway System. The mine was closed in the 1970s/80s due to a drop of the average iron content, along with the mine closure use of the railway line ceased.

Figure 7-64 provides photos of railway tracks still in place to the southwest of the Project site. **Figure 7-65** indicates a partially decommissioned section of the railway line route affected by the proposed dam and reservoir. The Eswatini Railway, which is a parastatal organization that provides transport services for import and export commodities as well as transit cargo, was consulted and a map of the Eswatini railway lines, 1:250’000 scale, obtained indicting the railway line route. **Figure 7-66** shows the railway line route and sections affected by the proposed dam and reservoir. A detailed railway servitude / route alignment study is required to be undertaken to confirm the route and condition of the railway line as well as to determine the viability of realignment for reinstatement of the railway line.

Figure 7-64: Photo of Railway Infrastructure within the Project Area

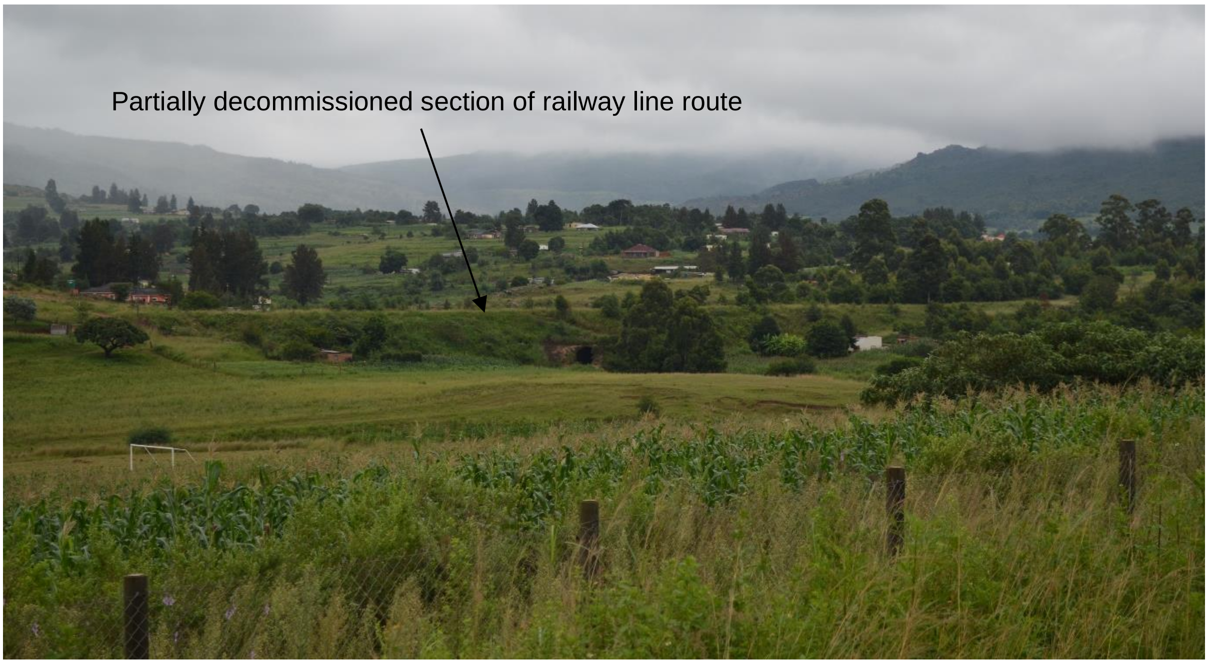


Figure 7-65: Photo Showing Partially Decommissioned Section of the Railway Line within the Project Area

Figure 7-66: Existing Railway Line Route and Affected Section Requiring Relocation

7.3.9 POWER AND TELECOMMUNICATION LINES

A network of overhead powerlines (less than 33kV) and telecommunication lines, supported by a single wood pole, are located within the project area. The network provides electricity and fixed telecommunications to the households and facilities in the area. Photos providing an indication of the existing power and telecommunication network in the project area are provided in **Table 7-25**.

Table 7-25: Photos of Overhead Power and Telecommunication Lines in the Project Area

In addition to the existing powerlines, a 132KV powerline has been approved and contractors appointed to commence with construction. The location of the 132KV powerline is illustrated in **Figure 7-67**.

Figure 7-67: Authorised 132KV Powerline

7.3.10 VULNERABILITY AND MARGINALISATION

Vulnerable groups are distinct categories of social and economically distressed people who might suffer disproportionately from the effects of displacement. These may be an ethnic minority, women and child-headed households, impoverished youth, the poorest (based on the poverty line), the disabled and elderly.

Out of a total of 182 respondents for this particular question 36 were reported to have disabilities. These 36 people with disabilities, 18 suffer from impaired mobility, 2 blindness, 2 mutes and 4 unspecified.

GENDER EQUALITY

In the case of Mantabeni and Siphocosini, the percentage of single women who have followed the process of uKukhonta (the application process to live in the community from the Chief or Inner Council) are 33 and make up 17.65% of the population of 187 respondents. The level of separation and divorce in the community was recorded at 2.14%.

Mostly the single women who live in the community are new residents and the majority are in public service. Additionally, there were two categories of women whose properties were bequeathed to them as the only survivors in their families while others are widowed.

POSITION OR ROLE OF WOMEN

No overt evidence of discrimination or marginalisation of women was recorded throughout the survey. For instance, women of Mantabeni and Siphocosini are actively engaged in social and economic activities be it formal or informal in their communities like their male counterparts. This practice is consistent with the gender policies of the country.

7.4 ARCHAEOLOGY, HERITAGE AND CULTURAL HERITAGE

7.4.1 INDIGENOUS PEOPLE

SAN / BUSHMEN

The first known inhabitants of the survey area were the San, also known as Bushmen. The San have been in Eswatini for the past 20,000 years. Initially, they inhabited the middle veld with a combination of good hunting and gathering, large rivers, no Tsetse Fly and a warm climate. However, with the influx of black pastoralists from 450 CE onwards the San were increasingly marginalised. As hunter-gatherers, the San had no concept of the permanent ownership of animals. To the San the only way that you could 'own' an animal was by killing it, then it became the property of the hunter, otherwise, animals roamed free for the taking.

Pastoralists however had a strong concept of the private ownership of animals, particularly those that they regarded as 'their' cattle, sheep and goats. The San hunted and killed cattle at will. These conflicting cultural views of animal ownership caused animosity between the San and cattle owners.

The result was that the San were increasingly marginalized by the more powerful black settlers into areas not suitable for cattle grazing or agriculture, like the highveld of Eswatini. When the Dlamini extended hegemony into Eswatini in the 19th century they had a deliberate San eradicating policy. Masson has termed the San highveld occupation sites as 'refugia'. The San sometimes left paintings on granite overhangs and archaeological sites, these are evidence of their occupation. They would have been painted after the trance ceremonies to show what had occurred during the trance. The last genetic and cultural San individual died in the middle 1950s in Pigg's Peak, according to two reliable oral sources.

In the Nondvo survey area there would originally have been extensive reed beds on the comparatively flat river flood plains. Vestiges of these reeds remain, however they have been almost entirely destroyed by ploughing. The reed beds would have attracted bands of San, particularly when birds were nesting. Eggs would have been a reliable and easily obtainable protein source.

BLACK PASTORALISTS

The first black pastoralists entered what is present-day Eswatini in around 450 CE. The language that they spoke and their tribal identity is not known, archaeologists have termed it the Silverleaves culture. The first known and named black people in Eswatini were Sotho-speaking clans that entered from the highveld from the 11th century onwards. There is evidence from sites in Eswatini that there were increasing numbers of Sotho-speaking communities from around 1550 onwards. Many of their descendants, such as the Mnisi and Magagula clans, self-identify as Sotho to this day within the wider context of Swazi culture.

Oral history collected during the heritage survey indicates that the Nondvo river valley was sparsely populated. This is consistent with known pre-historic high altitude settlement patterns. The rainfall of between 1 200 to 1 800 mm per annum in the highveld leached nutrients out of the soil, making for poor cattle grazing in winter and marginal agriculture. Both the San and the black pastoralists preferred the middleveld. The lowveld had rich soils, but was malaria-infested and Tsetse Fly ridden. Large rivers crossed the lowveld, but there was no widespread network of streams, making for extremely long distances between water sources.

NGUNI SETTLERS

During the 19th century Nguni speaking people, under Dlamini leadership, settled in central and then northern Eswatini from the 1820s onwards. They were primarily driven northwards by militaristic Zulu expansion from the south. The Dlamini hegemony sought a specific middleveld granite landscape. This had rocky granite outcrops a broad valley and a stream or river in the middle, like Lobamba. The river provided water and the floodplains provided the ideal terrain for agriculture and cattle grazing. The rocky outcrops could be natural fortresses and boulder chokes could be used as strategic retreats in times of Zulu raids.

7.4.2 COLONIAL ERA

During the colonial era from 1907 to 1968, the survey area was Native Concession number 10,2 administered through the system of chiefs. Later it became Swazi Nation Land. At this period total population was low because middleveld sites were preferred, and land was available there.

Mantabeni and Siphocosini were sparsely settled until the road between Mhlambanyatsi and Mbabane was tarred in the 1990s. Mpetse Dlamini, who is over 90 years old and a lifelong Mantabeni resident, says that until the early 1980s only two families were living there. This is consistent with general population densities in the highveld prior to rapid population growth after independence in 1968. After the road was tarred buses started operating regularly, and the area became a rural dormitory suburb of the capital. There was an influx of residents and building construction, a process that continues.

7.4.3 CHIEFS

The project site lies within two chieftainships: Mantabeni being led by Chief Mafelenkhosini Mashampu Sifiso Khumalo, and Siphocosini by Chief Jabhane Dlamini.

7.4.4 GRAVES

GRAVES OF CHIEFS AND THEIR RELATIONS

The graves of Chiefs, their spouses, next of kin and members of the Royal Household are situated at the base of the summits of the mountains immediately to the east of the project site. The burial sites extend from approximately 1 km south of the Luphohlo Dam wall to 2.5 km south of the Luphohlo Dam wall. Although not fenced, the burial sites are demarcated by clearing a narrow strip of vegetation around the perimeter as and when necessary. To the west of the project site, there is only one grave of a member of the Royal Household at the base of a rock formation approximately 400m south of Mantabeni Umphakatsi.

GRAVES OF COMMUNITY MEMBERS

Graves are situated relatively close to homesteads. In some cases, two or more homesteads, usually of the same family name, share a burial site. In all cases, the deceased are buried individually, i.e. one person per grave. While family graves are generally above 970 metres above sea level, one gravesite belonging to the Zwane family at Mhlane at the south end of the project site is approximately 964 metres above sea level, which is 1 m below the Flood Level contour.

Those families which are within the proposed inundation area also have their gravesites above the 970 m contour. The reason for gravesites being generally above 970 m is that the lower-lying areas are used mainly for cultivation. Most of the homesteads situated below 970 m are relatively recent in the history of the communities.

Locations of graves are shown in **Figure 7-68** and photos are shown in **Table 7-26**.

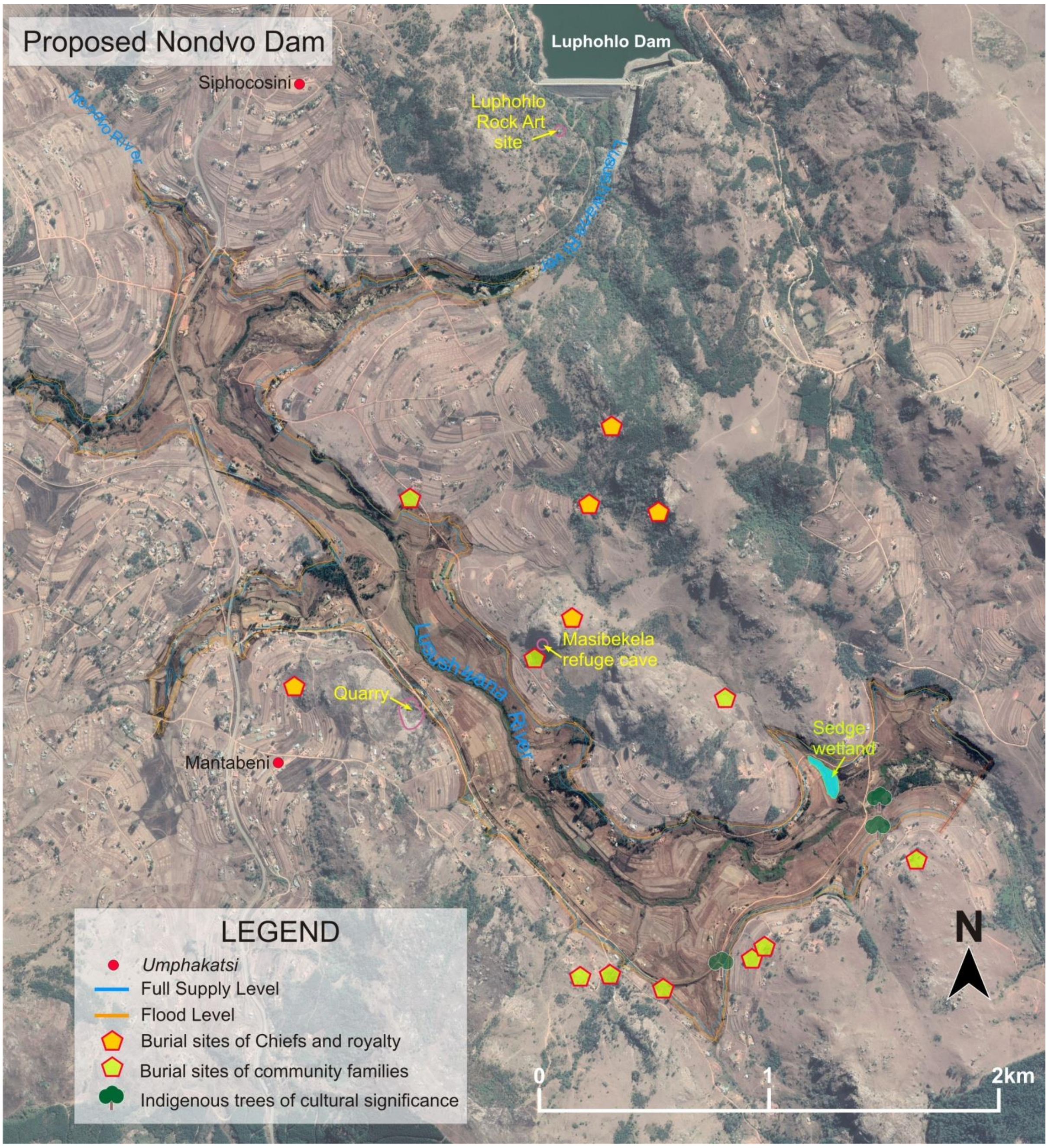


Figure 7-68: **Location of Archaeological and Cultural Heritage Sites**

7.4.5 ARCHAEOLOGICAL AND CULTURAL HERITAGE SITES

SAN / BUSHMAN ERA ARCHAEOLOGICAL SITE

There is one archaeological site from the San / Bushman era. This is immediately below the Luphohlo dam wall, at 26º 24’ 05.94” S and 31º 05’ 54.69” E shown in **Figure 7-68**.

The site is a rock painting on Lochiel Granite in the cleft of a small granite boulder cluster. The site was first recorded in the 1960s by Masson. At that time, it was a clear polychrome painting of an antelope, however over time this has faded to the point of near invisibility. There are several other indistinct markings in ochre. Photos are shown in **Table 7-26**.

There is no known archaeological deposit associated with this site, and the lack of an overhang or cave makes one unlikely. Nor are there any signs of tools below. The site is in the Rock Art Register as Luphohlo, details are stored in the Rock Art Research Institute at the University of the Witwatersrand.

INDUSTRIAL ARCHAEOLOGY SITES

Railway Line

The KaDake to Maputo railway line bed runs along the proposed southern edge of the dam before entering two long tunnels in Mlilwane Game Reserve. The track has been long removed, however the bed is largely intact. In mountainous terrain as a rule of thumb around three-quarters of the cost of a new rail line is invested in the bed, rather than the track and trains. Therefore, the existing disused railway bed was and is a significant investment.

During the subsequent years of its disuse, homesteads have been allocated land by the Mantabeni Inner Council through Swazi law and custom to settle in close proximity to the railway line and have thus encroached into the reserve.

Quarry

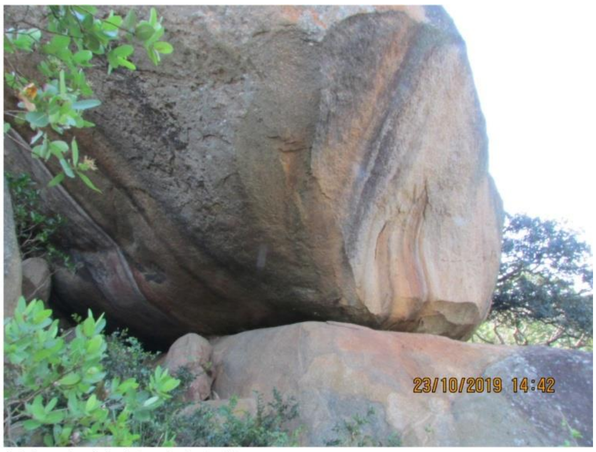
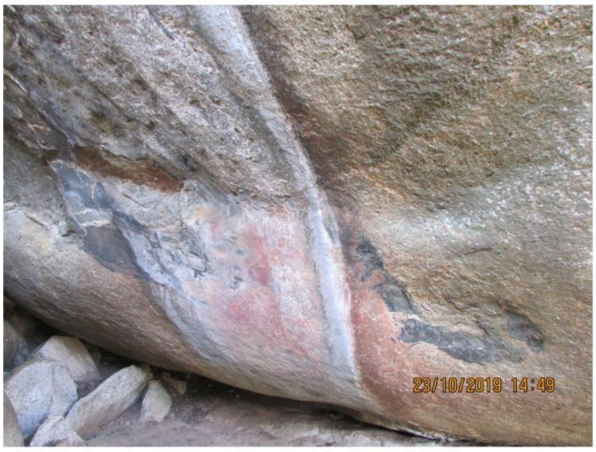
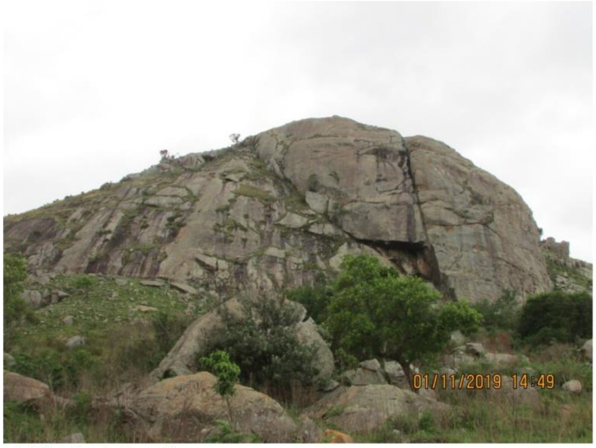
There is an old quarry at 26° 25' 29.7"S and 31° 05' 32.9"E with substantial granite reserves. The disused quarry, covering approximately 12 650 m^2, is situated within Land Concession 2 of Farm 1032 (L2/1032) and on the boundary of the flood level. L2/1032, itself measuring 13.3641 ha (133 641m^2), was established in 1966 for purposes of establishing the quarry site which was used for sourcing quarry stone for the railway construction in 1969. The quarry was not formally closed or rehabilitated because the quarry had not been exhausted and it indeed provided a source of material for the upgrading of the Mbabane to Mhlambanyatsi section of the MR19 in 1991.

The homesteads along the gravel road from Bhekephi Primary School to the quarry are within L2/1032 and settled along the gravel road after the establishment of L2/1032.

HERITAGE SITE

There is one heritage site in the survey area, an underground refuge. This is formed by a boulder choke composed of huge granite boulders that have fallen from Masibekela mountain on the north of the Nondvo River. Typically, in these geological formations soil accumulates over the boulders and vegetation grows on top of them, often concealing the extent of the underground passageways. The Masibekela boulder choke is between the track and the rock massif. This was used as a refuge in times of Zulu military incursions, or the perceived threat of them. Several residents repeated this account of usage, the Makhanya homestead which is close to the site, provided access. The boulder choke has a few remains of refuge pottery within it, evidence of occasional use. It is located directly at the base of Masibekela mountain, at 26° 25’ 21.16” S and 31° 05’ 50.93” E, shown in **Figure 7-68**. Photos are shown in **Table 7-26**.

Table 7-26: Archaeological and Cultural Heritage Sites

 a) Luphohlo Rock Art site.	 b) Luphohlo Rock Art site.
 c) Faded rock painting at Luphohlo Rock Art site.	 d) Faded animal figures at Luphohlo Rock Art site.
 e) Masibekela refuge cave.	 f) Disused quarry.

g) Indigenous vegetation immediately upstream of proposed dam wall.

h) Umvangati/ Wild teak trees within inundation area at south end of project site.

i) Harvesting of thatching grass within inundation area at south end of project site.

j) Use of local building materials at homestead within inundation area at south end of project site.

k) Wetland from which sedges are harvested for making baskets and grass mats.

l) Family graves withing within inundation area at south end of project site.

7.5 VISUAL LANDSCAPE

Landscape character is the description of the pattern of the landscape, resulting from particular combinations of natural (physical and biological) and cultural (land use) factors, as discussed above, focusing on the inherent nature of the land.

7.5.1 NATURAL ENVIRONMENT

The valley along the Lusushwana River, below the Luphohlo Dam, forms the basis for the visual character of the site. The Project area extends along the Lusushwana River at an altitude ranging from 930 to 980 masl. The site is situated along a valley on hilly terrain characterised by rocky outcrops and seasonal streams with steep rocky banks. Although the valley has been highly transformed by human settlements, cultivation, and clusters of wattle and eucalyptus trees, which are alien invasive plants that have spread from commercial forestry plantations, the surrounding mountains and rock formations remain scenic. The scenery is complemented by the natural vegetation along the watercourses and amongst rocky outcrops, both of which have become a refuge for natural vegetation from the pressures of crop production and the annual burning of mountain grassland for livestock grazing.

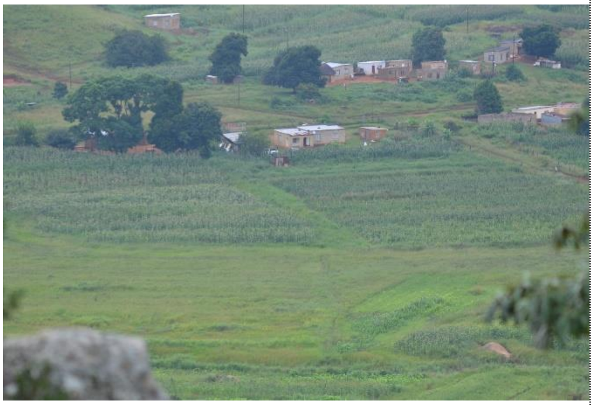
The reduced flow along the Lusushwana River downstream of Luphohlo Dam has diminished the extent of the river significantly compared to its state prior to the construction of the Luphohlo Dam. The diminished scenery of the river is somewhat mitigated by the remaining pools and rapids along isolated sections. However, the natural beauty of these areas is disturbed by the use of these areas for activities such as bathing and washing of clothes. Furthermore, uncontrolled sand mining along the river beds leaves scars along the embankment.

Table 7-27 provides photos of some of the aspects of the natural environment, and disturbance thereof, within the Project area. Additional characterisations have been provided in the preceding sections.

Table 7-27: Photos Providing Visual Characterisation of the Project Area

Hilly terrain characterised by rocky outcrops	
	
	

Human settlements and cultivation



Pools and rapids along isolated sections of the Lushuswana River

Washing in river and un-rehabilitated quarry

7.5.2 BUILT ENVIRONMENT

Situated in a rural area, the project site does not have formalised documented controls on physical planning, building designs and architectural styles. Each respective Umphakatsi, through its Inner Council, designates general areas for residential, commercial, social facilities (schools, clinics, churches, etc.), communal grazing and recreational use. There are no cadastral surveys of the designated areas to produce property and land-use boundaries.

Persons wishing to settle in the area or establish an enterprise apply for, and are granted / refused permission by the Chief, through the Inner Council, to do so in accordance with the Khonta system (Swazi law and custom). This process applies to governmental, parastatal utility and non-governmental organisations, including churches intending to establish physical infrastructure in the area.

The lack of formalised physical planning and control over building design, as well as the aspiration towards brick and mortar building construction, has further produced an array of architectural styles. Closer to the Main Road, houses are similar to those in urban areas and further away from the Main Road towards the south end of the project site, where homesteads are more remote, there is a blend of traditional and western building techniques, resulting in rectangular thatched huts built with stick and mud walls.

There are no homesteads constructed using completely traditional building materials, techniques and layout. However, in some homesteads, the functions of the various structures, such as the matriarchal hut and cattle byre retain their traditional functions and symbolisms. Generally, the homesteads at the southern end of the project site are more sparsely distributed compared to those near the Main Road, a characteristic that creates a noticeably more tranquil atmosphere. Despite being less opulent, the homesteads at the southern end are less visually obtrusive than those closer to the Main Road.

The relevance of the aesthetic of the built environment at the project site is that the tranquillity and visual appeal of the rural landscape is rapidly becoming diminished by the rapid rate of development closer to the Main Road. As land for settlement near the Main Road is becoming scarce, congestion is gradually spreading to the more remote sections of the community. **Table 7-28** provides photos of some of the aspects of the built environment within the Project area. Additional characterisations have been provided in the preceding sections.

Table 7-28: Photos Showing Visual Characterisation of the Built Enviornment in the Project Area

7.5.3 VISIBILITY OF PROJECT INFRASTRUCTURE AND RESERVOIR

The key visual receptors identified include surrounding homesteads and social facilities such as schools, healthcare facilities and churches as well as users of the MR-19. No tourist areas are noted within the areas surrounding the dam. It is evident from **Figure 7-69** that majority of the homesteads are located around the north-western and western sections of the dam, with limited settlement on the eastern and southern sections. Additionally, the MR19 runs along the north-western section of the dam.

The dam infrastructure is located at the south-eastern portion of the Project area (**Figure 7-69**), of which the RCC dam structure, which is the most significant structural element of the dam, is situated within a narrow fairly isolated section of the valley.

A limited number of homesteads, currently eight, are located on the right bank below the dam (**Figure 7-70**) with the remainder of the area below the dam being in a largely natural state (**Figure 7-71**) with the exception of large tracts of eucalyptus forests. Downstream tourist activities include the Mlilwane Wildlife Sanctuary as as well natural hot springs.

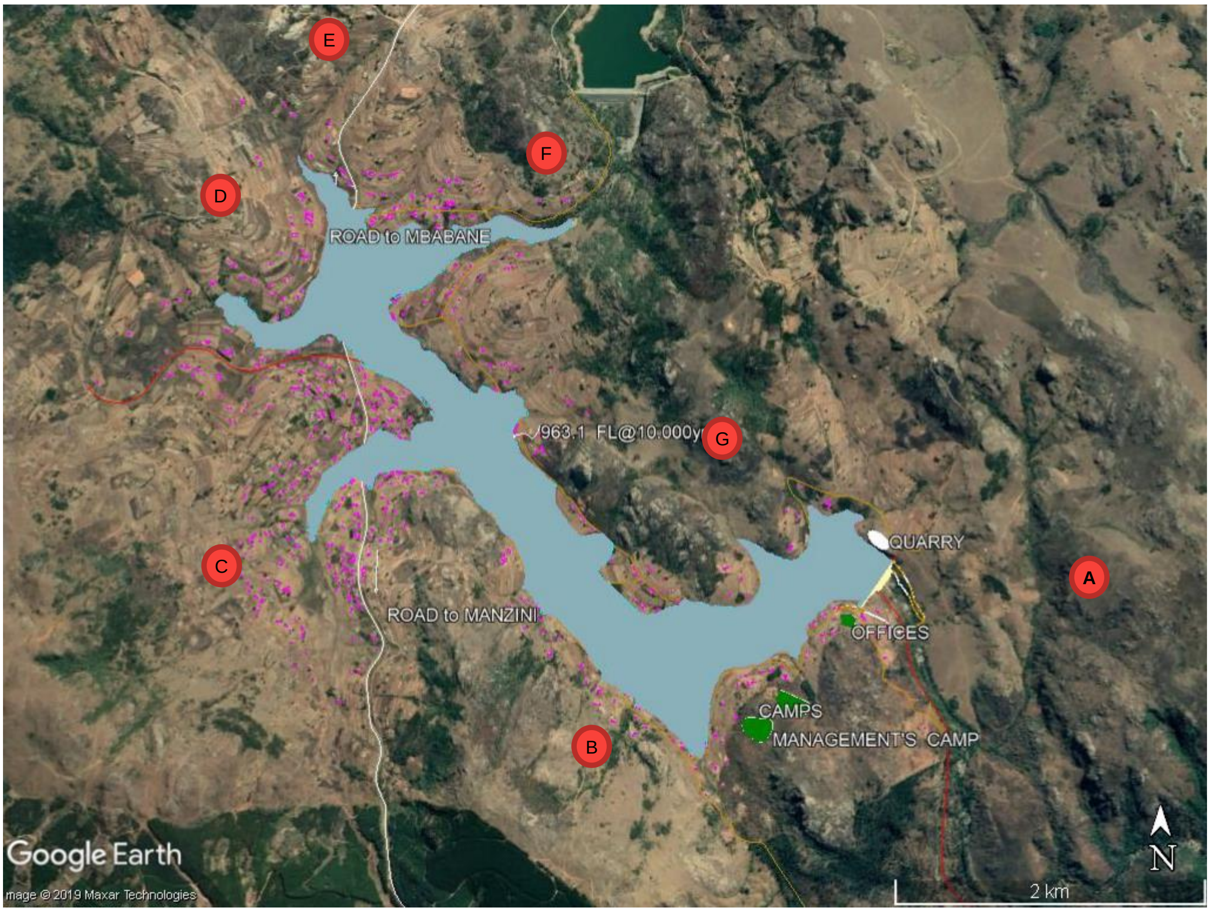


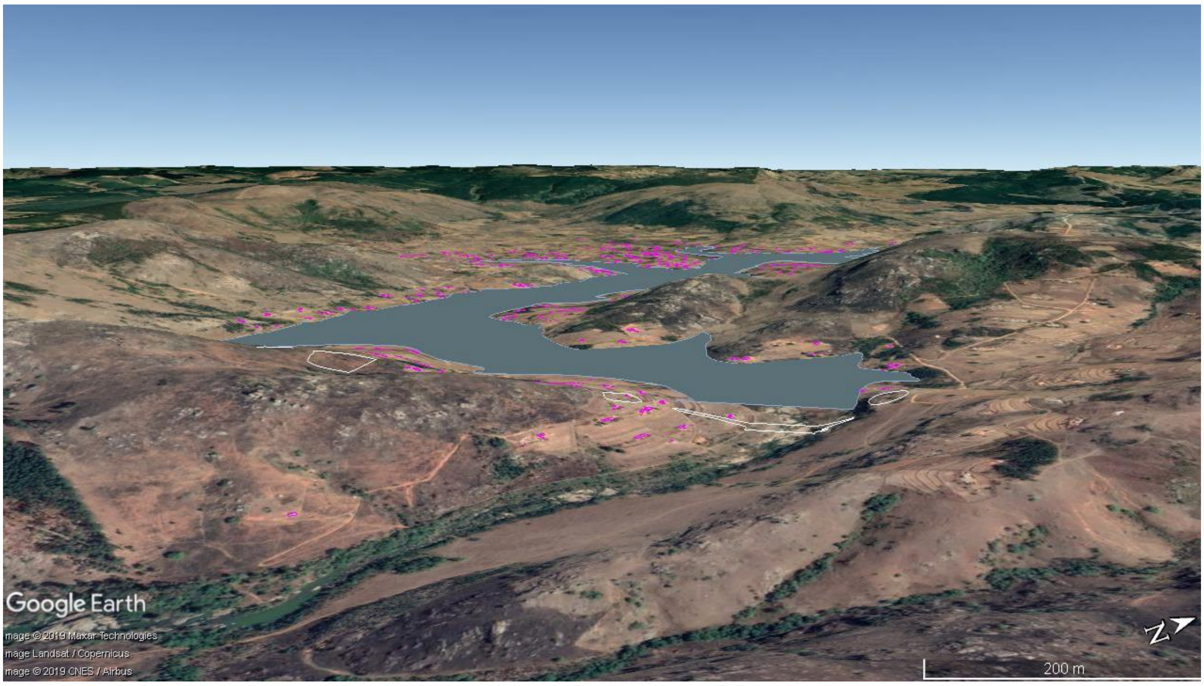
Figure 7-69: Visual Receptors – Main Vantage Points

Figure 7-70: Homesteads Located Below the Dam (Pink)

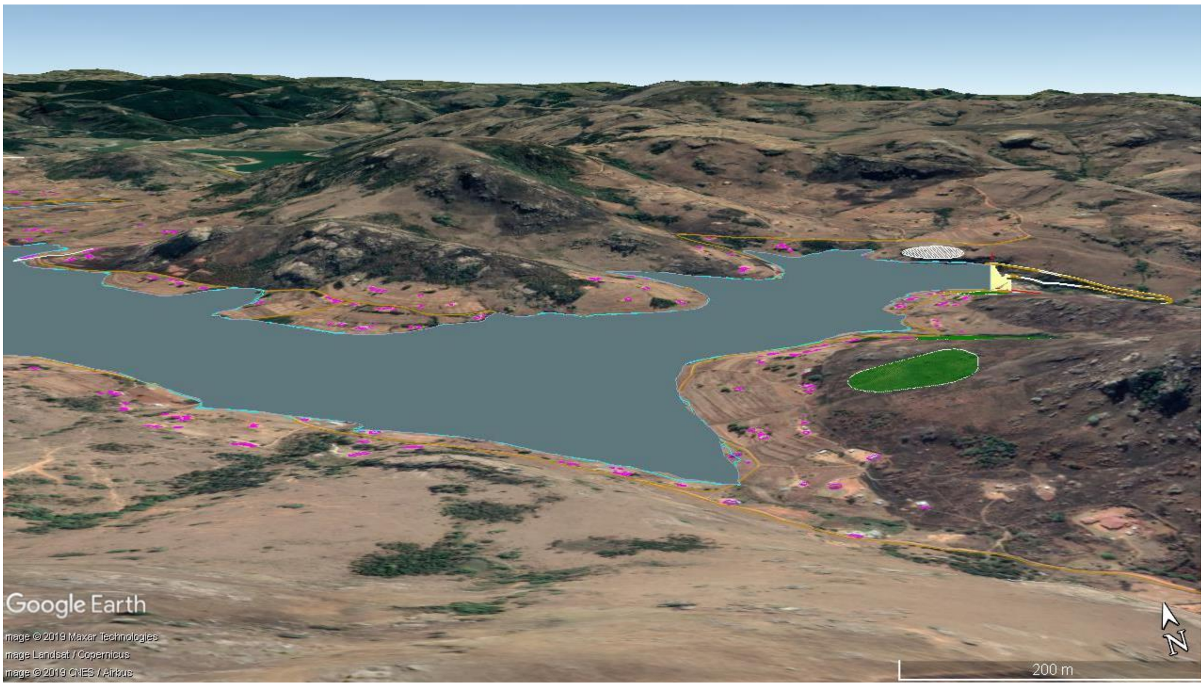
Figure 7-71: View Downstream from Dam Site

Basic visual interpretations are provided in **Table 7-29** from various vantage points aroud the dam as indicated in **Figure 7-69**.

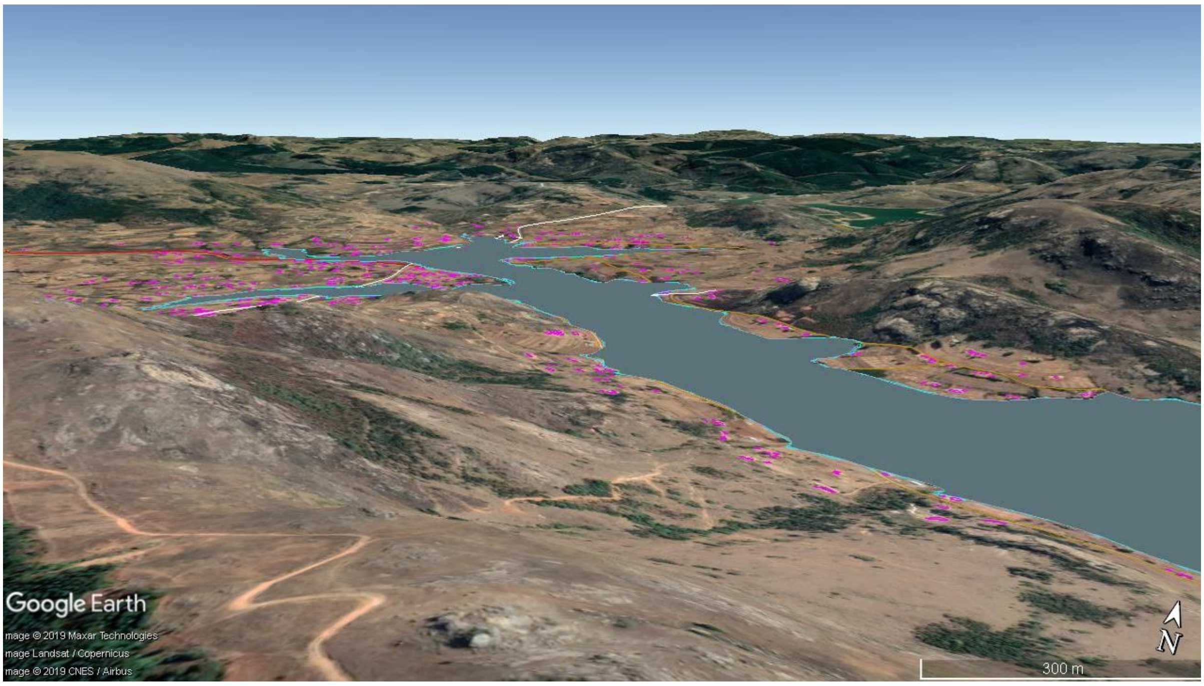
Table 7-29: Basic Visual interpretations of the Dam Reservoir from Various Vantage Points



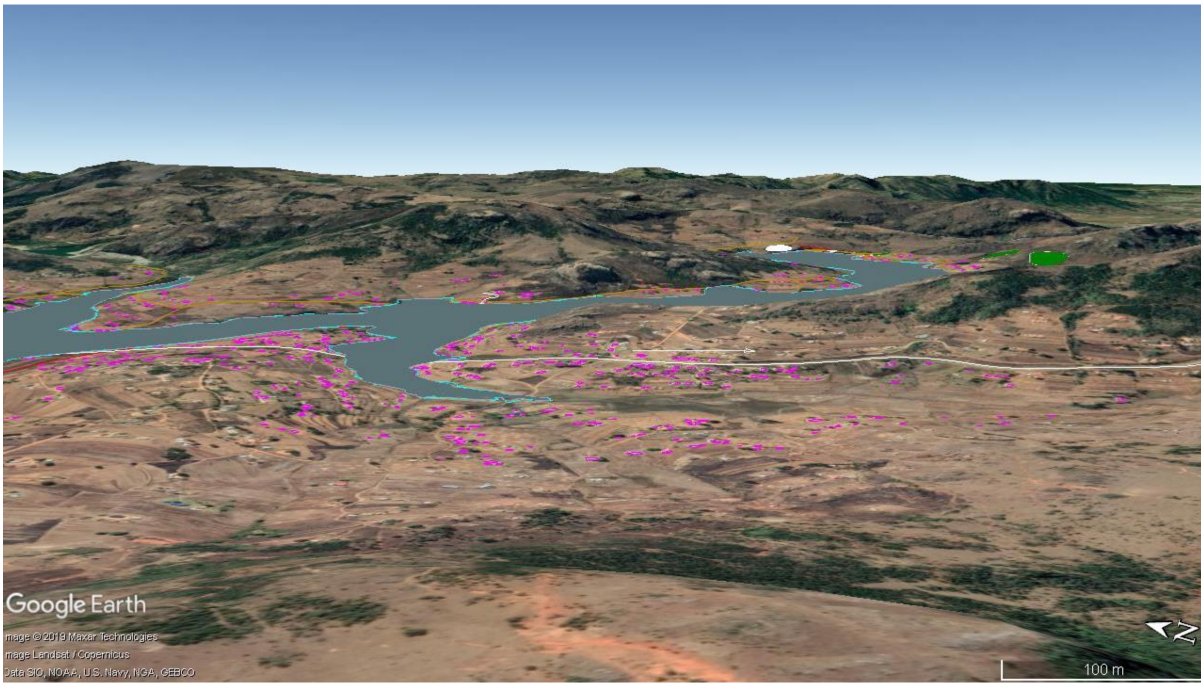
View of the dam from the south-east (Vantage Point A) in a north-westerly direction



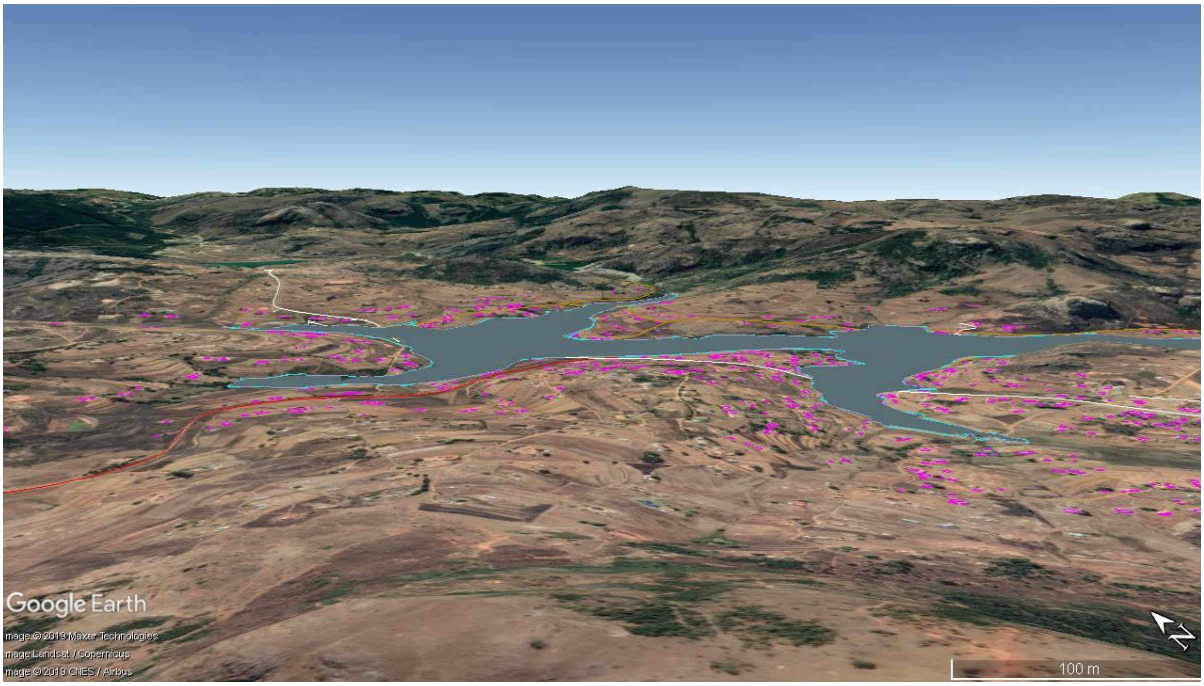
View of the dam from the south-west (Vantage Point B) in an northeasterly direction



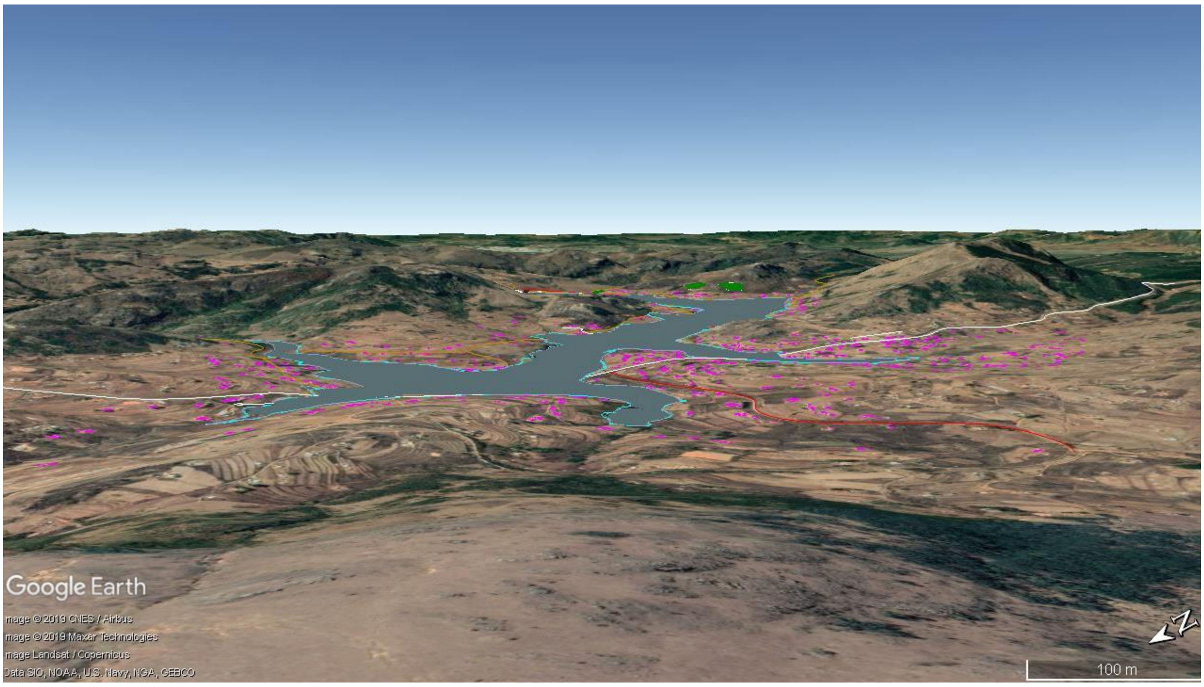
View of the dam from the south-west (Vantage Point B) in an northerly direction



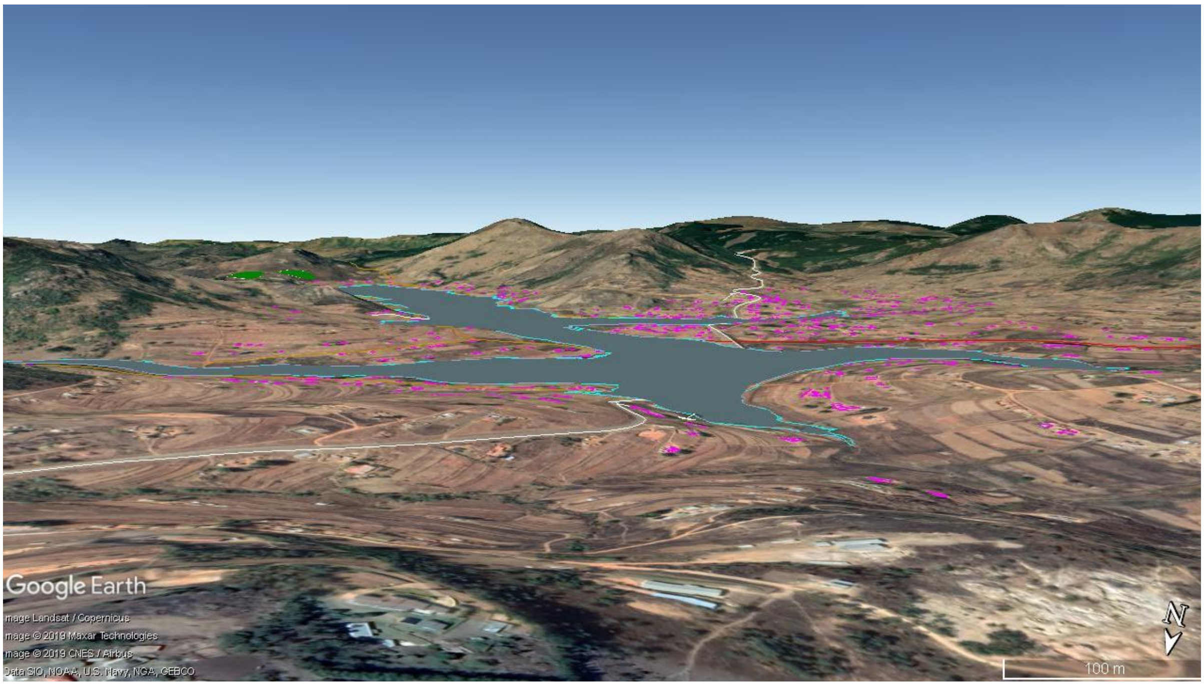
View of the dam from the west (Vantage Point C) in an easterly direction



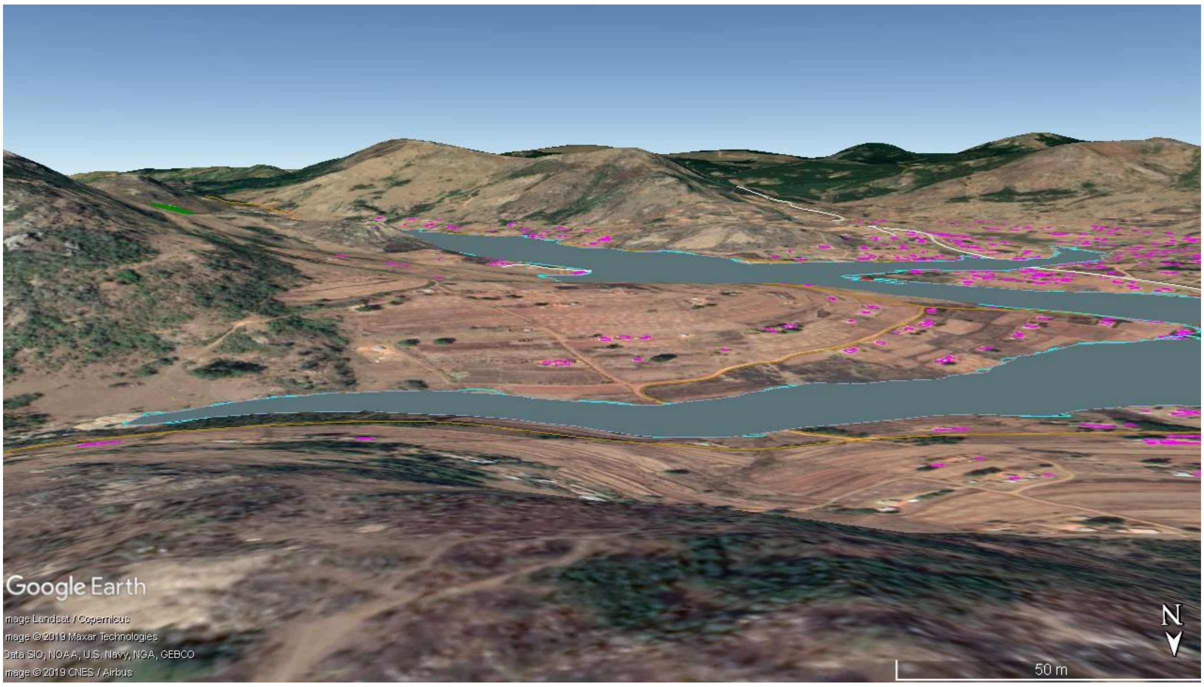
View of the dam from the west (Vantage Point C) in an north-easterly direction



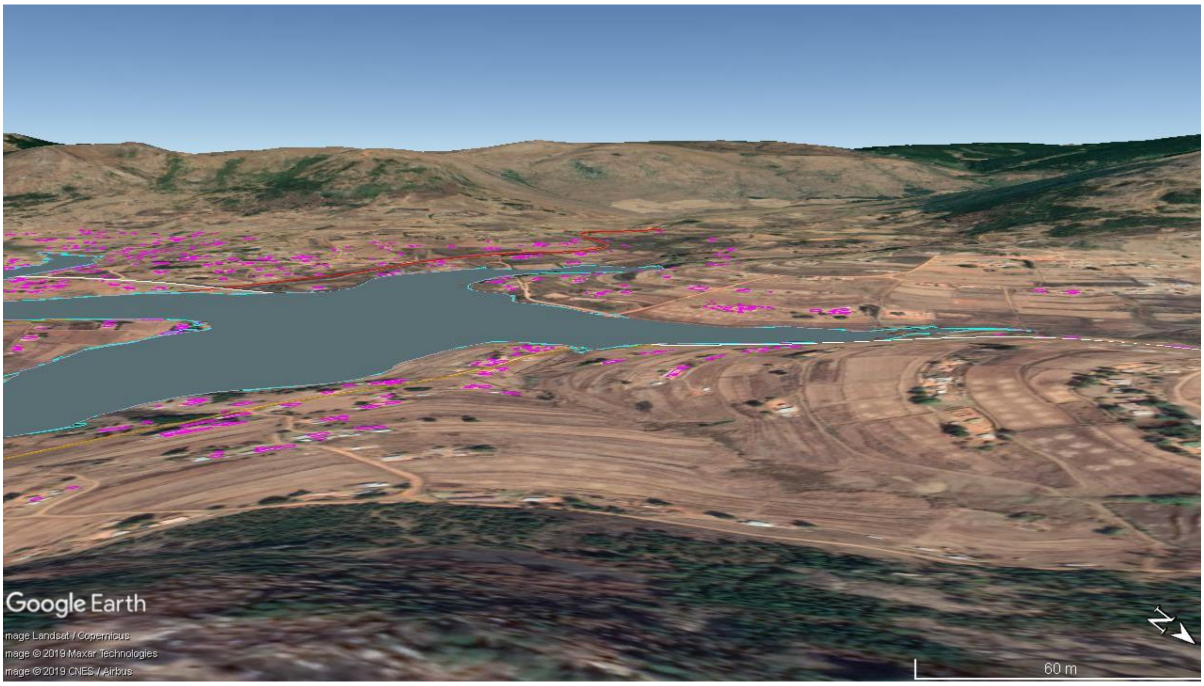
View of the dam from the north-west (Vantage Point D) in an south-easterly directio.



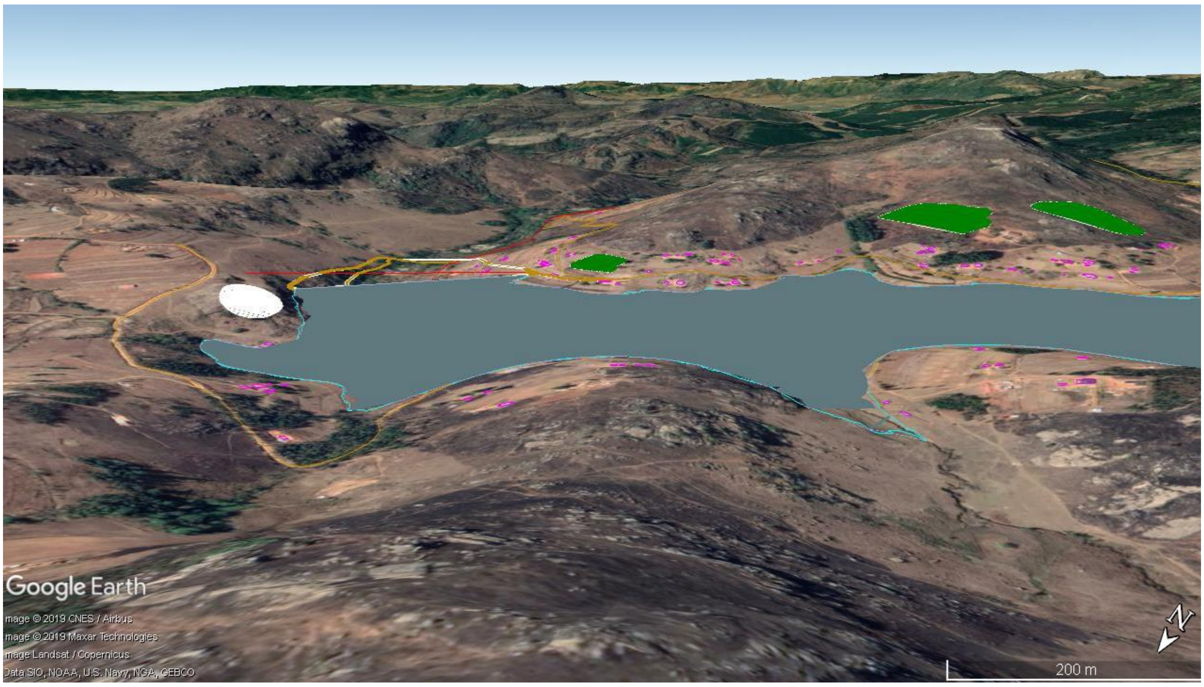
View of the dam from the north (Vantage Point E) in an southerly direction



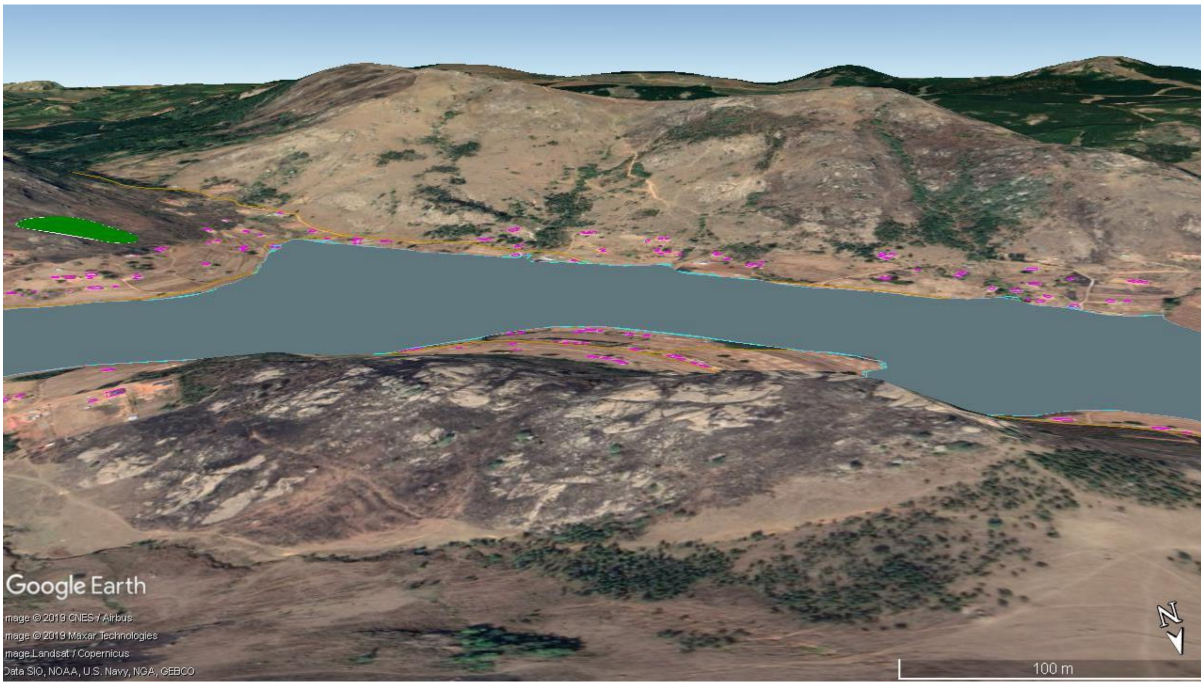
View of the dam from the north (Vantage Point F) in an southerly direction



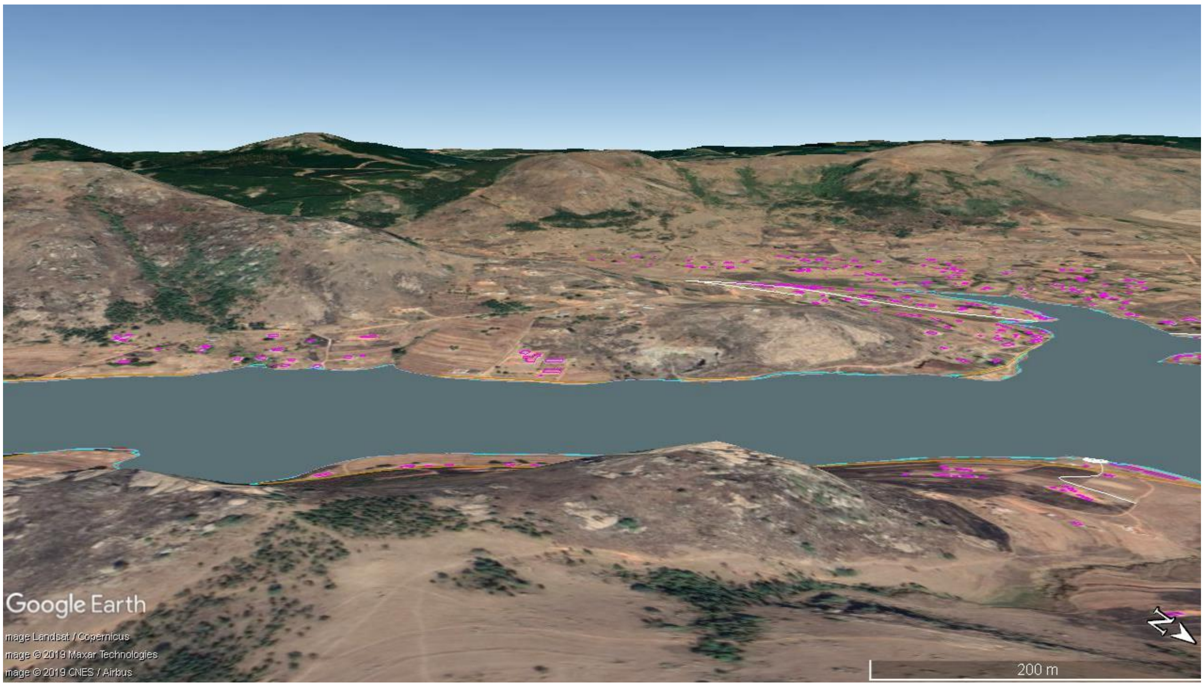
View of the dam from the north (Vantage Point F) in an south-westerly direction



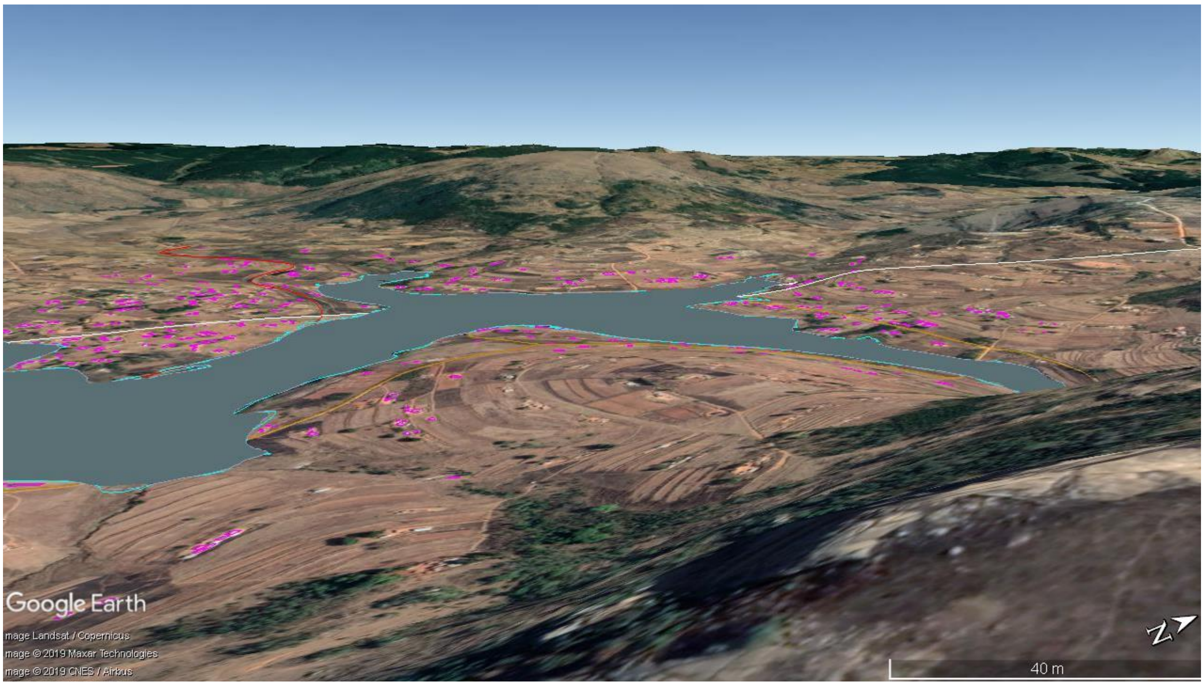
View of the dam from the east (Vantage Point G) in an south-easterly direction



View of the dam from the east (Vantage Point G) in an south-westerly direction



View of the dam from the east (Vantage Point G) in an westerly direction



View of the dam from the east (Vantage Point G) in an north-westerly direction

Although the dam structure for the Nondvo Dam will be RCC type and not Rockfill type, the Project will be very similar in look and feel to the Luphohlo Dam. Images from the Luphohlo Dam have been included in **Table 7-30** to provide visual representation of the proposed dam.

Table 7-30: Images of the Luphohlo Dam

8. STAKEHOLDER ENGAGEMENT

8.1 OVERVIEW

Stakeholder engagement is an inclusive process conducted throughout the project life cycle. Where properly designed and implemented, it supports the development of strong, constructive and responsive relationships that are important for the successful management of a project's environmental and social risks.

Stakeholder engagement is most effective when initiated at an early stage of the project development process, and is an integral part of early project decisions and the assessment, management and monitoring of the Project's environmental and social risks and impacts.

Stakeholder engagement must be free of manipulation, interference and intimidation. It must be conducted based on timely, relevant, understandable and accessible information in a culturally appropriate format. It involves interactions between identified groups of people and provides stakeholders with an opportunity to raise their concerns and opinions and ensure that this information is taken into consideration when making project decisions.

The stakeholder engagement process is guided by the following key principles of stakeholder engagement and will adhere to these principles throughout the life of the Project:

— Inclusiveness in the representation of views, including women, vulnerable and/or minority groups;
— Two-way dialogues that give both the company and stakeholders the opportunity to exchange views and information, to listen, and to have their issues heard and addressed;
— Respect for local traditions, languages, timeframes, and decision-making processes;
— Provide meaningful information in a format and language that is tailored to the needs of the local communities and other affected stakeholders; and
— Provide consultation and decision-making information as early as possible.

The public is an important source of local information and traditional knowledge about the Project's likely environmental and social impacts. Stakeholder engagement provides an opportunity to work with the public and addressing any concerns raised. This process goes well beyond the ESIA process, as it will continue throughout the life of the Project. The objectives of the stakeholder engagement for this ESIA are to:

— Identify relevant individuals, organisations and communities who may be interested in or affected by the proposed project;
— Clearly outline the scope of the proposed project, including the scale and nature of the existing and proposed activities;
— Identify viable project alternatives that will assist the relevant authorities in making an informed decision;
— Identify shortcomings and gaps in existing information;
— Identify key concerns raised by stakeholders that should be addressed in the ESIA and specialist studies;
— Present the results of the ESIA, the potential environmental impacts assessed, whether positive or negative, and mitigation measures defined; and
— To inform and provide the public with information and an understanding of the proposed project, issues and solutions.

8.2 THE ROLES AND RESPONSIBILITIES OF THE STAKEHOLDER

The roles and responsibilities of stakeholders in a stakeholder consultation process usually include one or more of the following:

— Assisting in the identification and prioritisation of issues that need to be investigated;

- Making suggestions on alternatives and means of preventing, minimising and managing negative impacts and enhancing potential project benefits;
- Assisting in or commenting on the development of mutually acceptable criteria for the evaluation of decision options;
- Contributing information on public needs, values and expectations;
- Contributing local and traditional knowledge; and
- Verifying that their issues have been considered.

Registered stakeholders have the right to bring to the attention of the competent authority any issues that they believe may be of significance to the consideration of the application. The rights of stakeholder are qualified by certain obligations, namely:

- Stakeholders must ensure that their comments are submitted within the timeframes that have been approved by the relevant competent authority;
- Serve a copy of the comments submitted directly to the competent authorities, the Proponent or the Environmental Assessment Practitioner; and
- Disclose to the EAP any direct business, financial, personal or other interest that they might have in the approval or refusal of the application.

8.3 PROJECT STAKEHOLDERS

LIST OF STAKEHOLDERS

Factors considered in the identification of stakeholders included the nature, type and location of the proposed project. Several categories of stakeholders were considered, namely government institutions, NGOs, communities and private companies that are close to the project area. Stakeholder groups that will be engaged with through the development of the Scoping and ESIA studies are briefly described in **Table 8-1**.

Table 8-1: Identification of Stakeholders

STAKEHOLDER CATEGORY	STAKEHOLDER
Governmental agencies	Relevant governmental agencies.
Public transport associations	Public transport operators' associations whose members are likely to be affected by the realignment of public roads.
Nature conservation areas	Nature conservation areas that are likely to be affected by the project and/ or may have suitable habitats for relocated flora and fauna species.
Landowners	Landowners, such as neighbouring small-scale and large-scale farms.
Affected communities	Communities (villages) affected by the proposed project.
Displaced households	The potentially affected persons that are likely to be either physically or economically displaced by the proposed project. These are households that are located or that possess crops or any other asset within the Project affected area.
Industrial and commercial stakeholders	Industrial or commercial organizations potentially affected by the proposed project.
NGOs	Relevant NGOs at national and local levels in the fields of conservation, environment, social development and Human Rights.

Various institutions support the agriculture and water sectors in Eswatini, these are identified as follows:

AGRICULTURE

NO.	INSTITUTION	RESPONSIBILITIES
1	Ministry of Agriculture	Governance, policy and legislation in the sector and ensuring national food security.
2	National Agricultural Marketing Board (NAM)	Marketing agricultural products, processing, storage, transportation, distribution and sale of vegetables. Issuing import/ export permits of scheduled products.
3	National Maize Corporation (NMC)	Marketing and storage of white maize and guarantees a market to local maize farmers and provides good quality maize meal at reasonable prices to consumers.
4	Eswatini Water and Agricultural Development Enterprise (ESWADE)	To empower smallholder farmers on ENL through water and agricultural development projects.
5	Eswatini Dairy Board	To develop and regulate the dairy industry, food security, poverty reduction, investment promotion, job creation and export promotion.
6	Eswatini Cotton Board	Promote production, processing and sale of cotton lint and seed. Control seed access; facilitate research and extension.
7	University of Eswatini– Faculty of Agric.	Training, research and advisory services.
8	Non-governmental Organizations	Drought relief and humanitarian assistance, input supply, marketing and advisory services.
9	Private Service Providers	Input supply, marketing and advisory services.
10	Farmer Organizations	Input supply, marketing, and advisory services.

WATER

The National Water Authority (NWA) is responsible to advise the Minister on policy directions relating to water affairs at national level.

The DWA within the Ministry of Natural Resources and Energy is the secretariat for the NWA, and it provides technical support and advice to the authority. It is composed of the Water Resources Branch, the Rural Water Supply Branch and the Geological Surveys Unit.

The other ministries that are recognised as key to water resources development are:

NO.	INSTITUTION	RESPONSIBILITIES
1	Ministry of Agriculture	Design and construction of small irrigation dams.
2	Ministry of Economic Planning and Development	Allocate resources to national policy objectives and priority development initiatives.
3	Ministry of Health	Construction of pit latrines and providing hygiene education on the proper use of drinking water and sanitation facilities.

VULNERABLE GROUPS

In terms of the IFC's Policy and Performance Standards on Social and Environmental Sustainability and the IFC's Guidance Notes to the Performance Standards, the definition of a disadvantaged or vulnerable group is as follows:

"individuals or groups within the project area of influence who could experience adverse impacts from the proposed project more severely than others based on their vulnerable or disadvantaged status. This status may stem from an individual's or group's race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status. In addition other factors should be considered such as gender, ethnicity, culture, sickness, physical or mental disability, poverty or economic disadvantage and dependence on unique natural recourses."

The stakeholder engagement process has, and will continue to, identify whether any disadvantaged or vulnerable groups are potentially impacted by the Project. In the event that vulnerable groups are identified, engagement will utilise participatory approaches in order to ensure that their views are taken into account.

8.4 STAKEHOLDER ENGAGEMENT UNDERTAKEN

8.4.1 SCOPING STAGE STAKEHOLDER ENGAGEMENT

The first step included the drafting of a Stakeholder Engagement Plan (SEP) that defined all of the proposed stakeholder engagement activities, throughout the ESIA process. The SEP, attached as **Appendix F**, outlines the engagement process undertaken as part of the ESIA and is considered to be a "live document" that will be updated and refined throughout the ongoing ESIA process.

The overall aim of the SEP is to ensure that a consistent, comprehensive, coordinated and culturally appropriate approach is taken to stakeholder engagement and project disclosure throughout the ESIA. It is further intended to demonstrate the commitment of the DWA to an 'international best practice' approach to engagement.

In line with current international best practice, the SEP aims to ensure engagement that is free of manipulation, interference, coercion and intimidation. It also aims to ensure that stakeholder engagement is conducted on the basis of timely, relevant, understandable and accessible information, in a culturally appropriate format. In this way, the SEP seeks to ensure that stakeholder groups are given sufficient opportunity to voice their opinions and concerns, and that these concerns influence project decisions.

The SEP, therefore:

- Outlines the approach to be adopted to engagement, showing how this will be integrated into the rest of the ESIA process;
- Identifies stakeholders and mechanisms through which they will be included in the ESIA process; and
- Serves as a way to document engagement undertaken throughout the ESIA.

During the Scoping stage, an initial stakeholder database was compiled based on the project characteristics, the socio-economic profile of the project area, similar studies developed in the region, the analysis of existing databases, knowledge of the team; and consultations with different government institutions. This stakeholder list serves as the basis for the public meeting invitations. During the public consultation meetings, an attendance register was made available for all the attendees to facilitate formal registration of interest. The stakeholder database has been updated on an ongoing basis throughout the ESIA process.

A matrix highlights the level of interest and influence on the Project that each particular stakeholder bears. On this basis, stakeholders with high interest and influence on the Project will be engaged to solicit information sufficient to arrive at a suitable scope of assessment. The engagement exercise will inform the identified stakeholders of the project details and enlist comments on other relevant stakeholders and key issues of interest to be assessed during the ESIA and specialist studies.

For Scoping meetings there is no prescribed timeframe for advertising, therefore in practice the timeframe applied is that for advertising public notices for Public Reviews as stipulated in Regulation 11(1)(c)(iii).

Four scoping meetings for respective target groups were held:

- Meeting at Mantabeni chiefdom (Inner Council) for the rural community nearest to proposed Nondvo Dam on 13 February 2019;

- Meeting at Mantabeni chiefdom (Community) for the rural community nearest to proposed Nondvo Dam on 23 February 2019;
- Meeting at Siphocosini chiefdom (Community) for the rural community nearest to the existing Luphohlo Dam on 9 February 2019; and
- Meeting at Siphocosini chiefdom (Inner Council) for the rural community nearest to the existing Luphohlo Dam on 13 February 2019;

The rationale for a scoping meeting at each traditional centre (Umphakatsi) is that this is where information is disseminated to community members. Communities do not have combined meetings as some issues are peculiar to each respective community. Furthermore, it is necessary to be cognisant of, and thus avoid potential underlying tensions between communities, such as issues arising from land disputes.

The Scoping Meetings were conducted in English and translated to Siswati and vice versa in order to facilitate optimal participation.

In addition to the Scoping Meeting, additional meetings were held with the Hhohho and Manzini Regional Administrators, and associated chiefs, in order to disseminate project information to all the potentially affected communities.

Arrangements were made, through the local authorities[13] , to ensure the presence of the local communities directly affected and/or closer to the project area in this meeting. The style and content of the presentation took into account the target audience of each meeting to ensure that all stakeholders were able to effectively participate in the discussion. Translation to Siswati was arranged for the meetings held at the local level. A Comment and Response Register (CRR) has been compiled and attached to the SEP. The CRR has been continuously updated throughout the ESIA process.

ISSUES AND CONCERNS RAISED DURING SCOPING STAGE CONSULTATION

The main issues raised during consultation include:

- Why the ESIA focuses on Nondvo Dam only and does not include the raising of Luphohlo Dam and Hawane Dam.
- It was requested that directly affected communities be prioritised in the stakeholder engagement process.
- The development of additional houses in the impacted area will result in additional compensation claims.
- The local communities are unsure how they will benefit from the Project.
- The Siphocosini *Indvuna* requested that a community representative needs to be involved in the specialist studies
- The Siphocosini Inner Council requested local labourers to be hired where appropriate
- The Eswatini Railway mentioned that the re-established of the old railway line is being investigated
- Eswatini Electricity Company advised that they have a 132kV Transmission Line planned for installation at the Nondo Dam project site

The full Issues and Concerns Register is included in the SEP.

8.4.2 ESIA STAGE STAKEHOLDER ENGAGEMENT

During the ESIA process five ESIA meetings for respective target groups were held:

- Meeting at Mantabeni chiefdom (Inner Council) for the rural community nearest to proposed Nondvo Dam on 31 July 2019;
- Meeting at Mantabeni chiefdom (Community) for the rural community nearest to proposed Nondvo Dam on 17 August 2019;

[13] Ministry of Tinkundla, office of the Regional Administrator.

- Meeting at Siphocosini chiefdom (Inner Council) for the rural community nearest to the existing Luphohlo Dam on 31 July 2019;
- Meeting at Siphocosini chiefdom (Community) for the rural community nearest to the existing Luphohlo Dam on 3 August 2019; and
- Meeting at Siphocosini chiefdom (Inkundla) for the rural community nearest to existing Luphohlo Dam on 22 October 2019.
- Public Meeting at the Eswatini National Library, Mbabane on 28 November 2019.
- Stakeholder Review Meeting at Hilton Garden Inn, Mbabane on 18 March 2020.
- Stakeholder Review Meeting at Emafini Country Lodge, on 10 September 2020.
- Mantabeni Inner Council Site Visit, on 26 September 2020.

ISSUES AND CONCERNS RAISED DURING ESIA STAGE CONSULTATION

The main issues raised during consultation include:

- Whether PAPs must continue with improvements to their homesteads and cultivation plans.
- Whether proposed community development programmes should continue.
- Concerned about where the PAPs will be relocated to.
- Resettlement by the railway line and main road realignment.
- Accessibility between the community and across the dam.
- Relocation of community services, such as schools.
- Socio-economic benefits of the proposed dam to the affected community.
- Potential impacts on cultivated lands
- Potential risk with living in close proximity to two dams.
- Inadequate information on supporting infrastructure.
- Estimated commencement date of implementation.
- Climate Change Adaptation.
- Tourism potential and local community benefits.
- Request to investigate dam wall locations further downstream.

The full Issues and Concerns Register is included in the SEP.

8.4.3 TRANSBOUNDARY ENGAGEMENT

Transboundary engagement has been undertaken by the DWA in terms of notifying the Department of Water and Sanitation (South Africa), Department of Environmental Affairs (South Africa) as well as other agencies responsible for the transboundary management of water resources to which the Project Proponent is a party, such as the Incomati Maputo Watercourses Tripartite Agreement, 2002 and the Joint Water Commission Treaty, 1992.

8.5 STAKEHOLDER ENGAGEMENT PLAN

The SEP (**Appendix F**) is a live document that includes an overview of the ESIA Phase public consultation process and its findings (stakeholder database, community concerns, etc); and is developed further for implementation during the construction and operations phase in conjunction with the appropriate implementing agency.

The purpose of the SEP is to effectively share project information with beneficiaries and PAPs to enhance their understanding and support for the Project. This includes an effective beneficiary feedback mechanism with an agreed response time, in which the project beneficiaries can provide feedback to the project owner, contractors and Project Implementing Unit during the project implementation.

The strategy identifies the most effective channels of communications and communication tools (e.g. press release formats).

9. IMPACT ASSESSMENT

9.1 INTRODUCTION

During the Scoping Phase the main issues and potential impacts associated with the proposed project were determined at both a desktop level based on existing information as well as fieldwork and specialist input. These potential impacts were used to inform the scope of the data gathering and field surveys required to supplement the data as the basis for the assessment of impacts.

The assessment of impacts and mitigation evaluated the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the impact assessment methodology are to validate impacts identified through a matrix, identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts.

The specialist team identified potential biophysical and social impacts based on the field surveys and data gathering. The impacts were assessed in accordance with the Impact Assessment Methodology outlined in **Section 3.3**. The detailed impact assessment is contained in **Appendix H**.

9.2 SCOPING OF ENVIRONMENTAL AND SOCIAL ISSUES

9.2.1 IDENTIFICATION AND CLASSIFICATION OF PROJECT INTERACTIONS

An interactions matrix was used as a scoping tool to identify interactions between the project components and environmental resources/receptors. Interactions were classified in one of three categories as indicated in **Table 9-1**.

Table 9-1: Interaction Classification Criteria

COLOUR	NATURE	DESCRIPTOR
White		An interaction is not reasonably expected.
Light Shading	(+) / (-)	An interaction is reasonably possible, but none of the resulting impacts are likely to result in significant effects.
Dark Shading	(+) / (-)	An interaction is reasonably possible, and at least one of the resulting impacts is likely to lead to an effect that is significant.

Source: African Development Bank Integrated Safeguards System Guidance Materials (2015)

Interactions that are coloured white have been ‘scoped out’ of further consideration in the ESIA process. Interactions with light shading have also been ‘scoped out’, but a discussion that includes the evidence base (e.g. past experience, documented data, etc.) is provided to justify the basis upon which this decision was made. Interactions with dark shading are retained for further consideration in the ESIA process.

Various project features and activities that could reasonably act as a source of impact were identified. These are listed down the vertical axis of the interaction’s matrix (**Table 9-2**). The resources and receptors relevant to the baseline environment are listed across the horizontal axis of the matrix. Each resulting cell on the scoping matrix thus represents a potential interaction between a project activity and a resource or receptor.

Table 9-2: Interaction Matrix

PROJECT PHASE AND ACTIVITIES	ENVIRONMENTAL RESOURCES										SOCIAL RESOURCES						
	Topography and Geology	Soil, Land Use and	Hydrology (Surface	Hydrogeology (Ground	Terrestrial Biodiver	Aquatic Biodiversity	Air Quality	Noise and Vibratio	Climate Change and	Visual	Economy and Livelihoo	Social and Cultural	Landuse (Incl. Econom	Social Infrastructure	Health and Safety	Community Safety	Archaeology and Cultural
CONSTRUCTION PHASE																	
Resettlement of PAPs					-						-	-	-			-	-
Transportation of equipment and materials to site							-	-									
Site Clearance					-	-	-	-		-							-
Establishment of contractor's camp and laydown areas								-									
In-migration of workers												-			-	-	
Operation of construction machinery, equipment and generators							-	-									
Construction of access roads and rerouting of affected roads							-	-		-							
Construction of the dam and associated infrastructure	-		-				-	-		-	-	-	-	-			
Realignment of railway infrastructure		-			-					-							
Generation of general and hazardous waste		-	-	-											-		
General construction activities								-									
Blasting activities	-				-		-	-								-	
OPERATIONAL PHASE																	
Inundation		-	-	+	-	-			-		-		-		-	-	-
Operation and maintenance of the Nondvo Dam		-	-	+		-				+	-		-				
Generation of general and hazardous waste			-												-		
Major structural failure		-	-		-	-				-	-				-	-	

9.3 IMPACTS ON THE BIOPHYSICAL ENVIRONMENT

9.3.1 GEOLOGY AND TOPOGRAPHY

CONSTRUCTION PHASE

The geology of the area will be impacted on at the dam construction site, particularly at the dam wall, as large foundations will be constructed into the underlying geology. The underlying granite rock will provide adequate foundations for the dam wall.

A quarry will be established in order to obtain construction material for the dam wall. The extraction of material will have an impact on geology by removing soil cover and exposing the underlying rock.

Construction of the dam wall will result in the alteration of the topography in and around the proposed dam site. In order to establish the railway line and access roads cut to fill will be used to level the sites.

Table 9-3: Geology and Topography – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Blasting and large foundations constructed into the underlying geology and establishment of a quarry to extract material will remove soil cover and expose underlying rock.	Construction	Negative	2	2	5	5	5	70	N3	2	1	5	5	5	65	N3
				N3 - High							N3 - High						

9.3.2 SOIL, LAND USE AND LAND CAPABILITY

CONSTRUCTION PHASE

Soil and Bank Erosion

Construction activities associated with the Nondvo Dam could lead to soil disturbance at a number of locations, specifically at the dam wall site, diversion channel, quarry, access roads and railway line. Given that the soils in the project area include Regosols, which are susceptible to erosion, soils in the project area could be exposed to an increased risk of soil erosion and degradation (e.g. through compaction). As such potential soil impacts in and around the proposed dam site, during the construction phase of the dam, may include:

- Soil compaction and erosion during construction;
- Soil destabilisation as a result of excavation;
- Landslides and other types of soil movements in the works areas; and
- Soil erosion and potential landslides due to water level changes in the reservoir.

Rainfall on unconsolidated sediment also has the potential to an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems may occur.

Bank erosion is often associated with the evolution of meanders, which might occur as a result of construction of the proposed dam. Additionally, during construction of the dam, removal or disturbance of protective vegetation from stream banks may result in bank erosion.

The risk of sedimentation is directly linked to the risk of erosion, as eroded soil particles may end up in nearby watercourses as sedimentation. As erosion is a risk at the site and it is close to watercourses, so is sedimentation. As erosion will have a cumulative effect, so will sedimentation.

The surface profile of the site will be changed during the construction phase. This will affect water flow, sedimentation and erosion patterns. This cannot be mitigated against.

Although topsoil will be lost from the site during the construction phase, it can potentially be transferred to an alternative area for continued cultivation

River Morphology Modification Downstream

The dam construction site will trap sediment and prevent the normal sediment load distribution downstream of the river. Consequently, a major impact on the downstream river channel could be to make it deeper and narrower, among a number of related morphological impacts.

The surface profile of the site will be changed during the construction phase. This will affect water flow, sedimentation and erosion patterns.

Table 9-4: Soil, Land Use and Land Capability – Construction Phase

Aspect (Pre-defined) Defn: The result of an activity, which causes the impact	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Soils in the project area (dam wall site, diversion channel, quarry, access roads and railway line) could be exposed to increased soil erosion due to excavation and destabilisation resulting in potential loss of topsoil; and increased sedimentation. Secondary impacts to downstream ecosystems may occur.	Construction	Negative	3	2	3	4	4	48	N2	2	2	3	2	3	27	N1
				N2 - Medium							N1 - Low						
Construction and foundations of dam wall and quarry	Trapping of sediment will prevent the normal sediment load distribution downstream potentially resulting in a deeper and narrower channel and other related morphological impacts. Clear water has the capacity to carry more sediment than turbid water. The release of clear water is therefore likely to increase erosion and collapse of river banks downstream of the dam.	Construction	Negative	3	3	3	4	4	52	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						

OPERATIONAL PHASE

Soil Erosion

Soil erosion is not a very significant potential problem at the Nondvo Dam site, but areas of sparse land cover will leave the soil vulnerable to the erosive influences of wind and water. Continual use, monitoring and management of an operational dam will lead to some erosion and measures will need to be put in place to prevent eroded areas from spreading. This will have a cumulative effect on the soils identified at the sites, as eroded areas will spread until measures are put in place to stop the erosion.

River Morphology Modification Downstream

The proposed dam will trap sediment, especially heavy gravels and cobbles, and thus prevent the normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower. In addition, the reservoir causes the suspended particles to settle, thereby limiting its storage capacity and at the same time limits the flow of sediments downstream, which hampers agricultural activities on floodplains owing to limited nutrient-rich sediments. Decreased load of sediments carried by the river will cause scouring of the riverbed downstream.

Additional impacts of a dam may include:

– Reduced natural function, water quality, oxygen, turbid flow and available river habitats;
– A dam can affect water temperature, which can affect the species in the river and the environment needed for spawning which may affect river shape;
– Alteration of the topography in and around the proposed Nondvo Dam site might be altered due to the construction of the dam;
– Alteration of the geology of the area at the dam construction site (dam wall site);
– Incision may occur immediately downstream of the dam;
– Channel narrowing thus peak flows are affected;

– Loss of secondary channel;
– Colonization of bars by vegetation and sediment trapping; and,
– Alluvial fans stabilization.

Irrigation Opportunities

During the operational phase the Nondvo Dam will provide the potential for irrigation of approximately 800 ha of vegetable production, this will result in the establishment of additional agricultural land.

Table 9-5: Soil, Land Use and Land Capability – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Areas of sparse land cover will leave the soil vulnerable to the erosive influences of wind and water resulting in possible erosion and sedimentation.	Operational	Negative	3	2	3	4	4	**48**	**N2**	2	1	3	3	3	**27**	**N1**
				N2 - Medium							**N1 - Low**						
Water Irrigation	During the operational phase water for irrigation of 800 ha of agricultural land will be made vailable.	Operational	Positive	3	2	3	4	3	**36**	**P2**	4	3	3	4	4	**56**	**P2**
				P2 - Medium							**P2 - Medium**						
Inundation of the reservoir area	Sediment trapping will prevent normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower.	Operational	Negative	3	3	3	4	4	**52**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						

9.3.3 HYDROLOGY AND HYDROGEOLOGY

CONSTRUCTION PHASE

Surface Water Quantity

Water is an anticipated requirement for construction. If water is abstracted from the Lusushwana River, this could decrease the natural volume of water within the River.

Surface Water Quality

The development of roads and construction camps would result in the clearing of the natural vegetation, exposing the underlying soils, thereby increasing the potential for sediments to be washed down into the Lusushwana River. The removal of vegetation can also result in a loss of surface roughness, resulting in decreased infiltration and increased surface water runoff causing increased surface water flows to the Lusushwana River.

At the construction base camp, an influx of workers are anticipated. There exists the possibility of inadequate handling of waste and wastewater at the temporary on-site disposal and sanitation facilities. As a result, there is a risk of pathways to the Lusushwana River being exposed and transporting these wastes downstream.

Excavations and blasting are anticipated in order to create suitable foundations for the dam wall. Owing to the disturbances within the watercourse and its banks, increased sediments are anticipated to enter the Lusushwana River which would increase turbidity, therefore negatively impact the quality of water within the river. Vehicle or equipment leaks (hydrocarbons) may occur whilst they are operating on site. Equipment such as cranes, excavators, concrete tankers will also be present on site. The hydrocarbons could be transported to the river via natural pathways, impacting on the water quality.

An element of water contamination from hazardous substances is unavoidable during the construction of a dam. This occurs as a result of leaks or spills of concrete onto soil or water resources, as well as oils, fuel, grease (from construction vehicles) and sewage from temporary on-site ablution facilities. The likelihood of changes to downstream oxygen levels and increased algae blooms are likely.

Discharge of Effluent

Wash services are required to accommodate workers onsite, workers camp and management camp. Temporary ablution facilities (chemical toilets) are proposed to appropriately contain and treat waste for off-site disposal. The incorrect siting of chemical toilers (i.e. within 100m of a watercourse or stream) and loss of containment could lead to pollution of the receiving environment (soil, groundwater and surface water), leading to secondary health impact to ecosystems and communities (ground- and surface water users). In addition, potable water is required.

Downstream River Flow Modifciation

The construction activities will change the river flow, which is likely to result in the following impacts:

– Change in flow can affect the slope of upstream and downstream watercourses;
– Reduction of flow might result in loss of turbulent flow and may reduce dissolved oxygen concentrations and impoundment;
– Changes in velocity and volumes of flow would influence erosion thereby changing the natural shape of the streams;
– Changing the frequency, duration, magnitude, timing, predictability and variability of flow events, and
– Altering surface and subsurface water levels.

Table 9-6: Hydrology and Hydrogeology – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Water abstraction for construction could temporarily decrease the natural volume of water within the River.	Construction	Negative	3	3	3	2	3	**33**	**N2**	2	3	3	2	3	**30**	**N1**
				N2 - Medium							**N1 - Low**						
Construction and foundations of dam wall and quarry	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Construction	Negative	5	3	5	5	5	**90**	**N3**	5	3	5	5	3	**54**	**N2**
				N3 - High							**N2 - Medium**						
Construction and foundations of dam wall and quarry	Rainfall on eroded / unconsolidated sediment has the potential to result in an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems functioning may occur.	Construction	Negative	3	3	3	2	5	**55**	**N2**	2	2	3	2	5	**45**	**N2**
				N2 - Medium							**N2 - Medium**						
Accidental Release / spills of small quantities of potential contaminants into soils, water bodies, and groundwater	Runoff creates a preferential pathway and exposure of contaminants into the subsurface (groundwater) and downstream watercourses leading to a deterioration in water quality and secondary health impacts on aquatic ecosystems and water users (community).	Construction	Negative	2	1	1	2	3	**18**	**N1**	2	1	1	2	2	**12**	**N1**
				N1 - Low							**N1 - Low**						
Inundation of the reservoir area	The incorrect siting of chemical toilets and loss of containment could lead to pollution of the receiving environment (soil, groundwater and surface water), leading to secondary health impacts on downstream aquatic ecosystems and water users (surface and ground), and maintenance of livelihoods.	Construction	Negative	3	3	3	2	5	**55**	**N2**	1	1	3	2	4	**28**	**N1**
				N2 - Medium							**N1 - Low**						

OPERATIONAL PHASE

Environmental Flow (Water Quantity, Abstraction, Withdrawal)

Operation of the Nondvo Dam will result in changes to the river flow regime. The change in environmental flow downstream of a dam has the potential to result in continuous environmental impacts. Life in and around a river evolves and is conditioned on the timing and quantities of river flow. Therefore, the construction and operation of the dam are likely to result in the following impacts:

— Alteration of the downstream flow pattern of the river both reducing its overall volume and changing its seasonal variations impacting aquatic and riparian life and downstream receptors;
— Alteration of the flow at the Mantenga Falls[14];
— Loss of turbulent flow reducing dissolved oxygen concentrations if released via outlet works;

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[14] The Project is not anticipated to impact the Mantega Falls as the current ecological flow, as released by the Lupholo Dam, will be maintained.

- Super saturation if released via the spillway;
- Increase of turbulent flow resulting in oxygen super-saturation;
- Increased water loss rate in the area through evaporation;
- Increased recharge of the underlying aquifer through infiltration; and
- Changes in velocity and volumes of flow would influence erosion thereby changing the natural shape of the streams.

Water Quality

During the inundation process the initial filling of the reservoir will increase in concentrations of nutrients and organic matter because of the decomposition of inundated vegetation and possible mobilisation of nutrients from agricultural activities taking place within the project area. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation). There is an increased likelihood of changes to downstream oxygen levels and the potential of algae blooms within the dam. As the dam fills to its anticipated capacity, existing households and associated infrastructure would be inundated. This includes existing septic tanks, which would have a negative impact on the water quality.

The trapping and consequent stagnation of water as a result of the existence of a dam causes physical, thermal and chemical changes to the previously-flowing water, which can cause a serious decline in the quality of the water in and downstream of the reservoir.

The water quality impacts associated with the dam infilling are anticipated to be similar for downstream users as they will be receiving water from the dam via controlled releases.

Evaporation

The evaporation from the Nondvo Dam will be higher than the evaporation rate from the natural surface water, this is due to the increase in the surface area of the water. The evaporation rate is high and the evaporation losses from Nondvo Dam will also be high.

Flow Modification

Dam inundation alters the amount of sediment production, retention and transportation in the system. Water released from a dam is likely to be clear because of settling of suspended load within the dam (White, 2000). The operation of the proposed dam may result in the following impacts:

- Decrease in nutrients to downstream users as a result of sediment settling within the Dam; and,
- Water released from the dam is likely to be clear because of settling of suspended load within the reservoir. Clear water has the potential capacity to carry more sediment than turbid water. The release of clear water is therefore likely to increase erosion and collapse of river banks downstream of the dam.

The dam would change the time, size and frequency of flow events in the river. Changes in velocity and volumes of flow would influence erosion thereby changing the natural shape of the watercourses.

Seepage from the dam wall may occur depending on the design. This would possibly result in baseline flows during the dry season being larger than the naturally occurring baseline flow. The inundation of the dam would increase the surface area of the water bodies within the basin. Evaporation will increase as a result of the larger surface area of the dam compared to the River. Groundwater recharge may increase as a result of water storage increasing infiltration.

There may be higher demand placed on the resource as a result of containment by an influx of people and potential tourism activities, thereby reducing flows within the catchment.

Dam Failure

Although considered unlikely, the failure of the Nondvo Dam is a possibility. This would result in a significant change to the morphology and habitat within and downstream of the dam. Although the water quantity would increase, downstream users would be highly impacted on as the volume and velocity of water could cause houses and farms located along the banks of the river to be flooded resulting in significant negative social impacts within the basin.

Flooding

The existence of a dam tends to reduce the effect of flooding downstream, yet flooding of a drainage basin can be caused by the overtopping of upstream dams as a result of prolonged periods of rainfall. Flooding results in major changes in river morphology. Major effects of flooding include the creation of bars, pools and rapids which then influence the morphology of the river.

Loss of Seasonal Flooding

Seasonal flooding fertilizes and waters flood plains and clears or redistributes debris in river channels. These beneficial effects of flooding will cease once the Nondvo Dam wall is constructed.

Downstream River Flow Modification

The dam wall will retain the surface water runoff which would naturally have flowed in the Lusushwana River. The existence of a dam will change the river flow, which is likely to result in the following impacts:

- Change in flow can affect the slope downstream watercourses;
- Reduction of flow might result in loss of turbulent flow and may reduce dissolved oxygen concentrations and impoundment;
- Changes in velocity and volumes of flow would influence erosion thereby changing the natural shape of the streams;
- Altering the seasonality of flows;
- Changing the frequency, duration, magnitude, timing, predictability and variability of flow events;
- Redcuing the availability of water for abstraction downstream; and
- Altering surface and subsurface water levels.

Table 9-7: Hydrology and Hydrogeology – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Operation of the Nondvo Dam will result in changes to the river flow regime and ecosystems: — Seasonal variation impacting aquatic and riparian systems downstream. — Loss of turbulent flow reducing dissolved oxygen concentrations; — Increase of turbulent flow resulting in oxygen super-saturation; — Increased water loss rate due to increased evaporation; — Increased recharge of the underlying aquifer through infiltration; and — Changes in velocity and volumes of flow resulting in changes to natural shape of the streams.	Operational	Negative	3	3	3	4	4	52	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						
Inundation of the reservoir area	Initial inundation of the reservoir will increase in concentrations of nutrients and organic matter due to decomposition of inundated vegetation and possible mobilisation of nutrients from previous agricultural activities. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation).	Operational	Negative	4	3	3	4	4	56	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						
Inundation of the reservoir area	Dam inundation alters the amount of sediment production, retention and transportation in the system.	Operational	Negative	3	3	3	4	5	65	N3	2	2	3	2	5	45	N2
				N3 - High							N2 - Medium						
Dam wall failure	Flow and velocity of water during dam failure and flooding has potential to result in loss of households and social assets downstream.	Operational	Negative	4	3	3	3	3	39	N2	4	3	3	3	1	13	N1
				N2 - Medium							N1 - Low						
Flooding	Major effects of flooding include the creation of bars, pools and rapids which then influence the morphology of the river.	Operational	Negative	3	3	3	4	4	52	N2	2	2	3	3	3	30	N1
				N2 - Medium							N1 - Low						
Reduced water flow in the Lushushwana River downstream of the dam	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Operational	Negative	3	3	3	4	5	65	N3	2	2	3	2	5	45	N2
				N3 - High							N2 - Medium						

9.3.4 RIVERINE ECOLOGY

CONSTRUCTION PHASE

Habitat Loss

During the construction activities there will be the direct alteration of the instream and riparian habitats resulting in the permanent modification of the habitats at a local scale. The active excavations, blasting and construction of the diversion and coffer dams will alter the nature of the hydrology in the Lusushwana River which will ultimately result in a loss of riverine habitat. During these activities, runoff from exposed earthworks will contain elevated suspended and dissolved materials which may impact downstream river reaches and their associated aquatic ecology.

Additional habitat level impacts can be anticipated through erosion and sedimentation of excavated and disturbed surfaces whereby bedrock and cobbled substrates with flowing waters become silted, this will reduce the effective area of aquatic habitat on the local spatial framework.

River Flow Alteration

Following the diversion of the watercourse, hydrological changes to the nature of the river flow will occur and will have resultant negative impacts to aquatic biota within a local spatial framework downstream of the construction activities. This kind of impact will particularly affect downstream *Chiloglanis* populations.

Migration Barrier

The presence of the construction activities within the instream areas will present an immediate migration barrier upstream or downstream and thereby serve to fragment the populations of biota in the watercourse. The existing Luphohlo Dam does not have a fishway and therefore the existing fauna above the Mantenga Falls and the foot of the Luphohlo Dam wall consists of fragmented populations. Migratory Eels were observed upstream of the Mantenga Falls, indicating that the species are still utilising the remaining habitats downstream of the Luphohlo Dam. However, the additional river reaches to be inundated would not be considered a significant area to be lost given the existing migratory barriers present.

The active construction of the dam wall will make use of concrete materials and various steelworks. The presence of concrete materials present contamination hazards for downstream aquatic ecology. It is however anticipated that the construction area will be dry as maintained through the coffer dams and diversion channel, thereby limiting this impact.

Table 9-8: Riverine Ecology – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Direct alteration of the instream and riparian habitats resulting in the permanent modification of the habitats at a local scale.	Construction	Negative	3	2	1	5	3	**33**	**N2**	3	2	1	5	2	**22**	**N1**
				N2 - Medium							**N1 - Low**						
Construction and foundations of dam wall and quarry	Temporary loss of riverine habitat and affecting Chiloglanis emarginatus (IUCN, 2019) – a Vulnerable species.	Construction	Negative	3	1	1	3	3	**24**	**N1**	3	1	1	3	2	**16**	**N1**
				N1 - Low							**N1 - Low**						
Construction and foundations of dam wall and quarry	Construction activities instream will present an immediate migration barrier with potential to fragment the populations of biota in the watercourse.	Construction	Negative	5	3	5	5	4	**72**	**N3**	5	3	5	5	3	**54**	**N2**
				N3 - High							**N2 - Medium**						
Inundation of the reservoir area	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	Operational	Negative	5	2	3	5	5	**75**	**N3**	5	2	3	5	5	**75**	**N3**
				N3 - High							**N3 - High**						

OPERATIONAL PHASE

Considering the data available for this area, the operating regime of the existing Luphohlo Dam indicates an Ecological Water Requirements release flow rate of 4.4 Mm^3/year (JMRBWRS, 2008) and this will be released for the proposed Nondvo Dam.

Inundation of Riverine Habitats

The most obvious impact during the operational phase will be the direct inundation of riverine habitats. The operational impacts of the proposed project will result in the inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat.

Rivers exist within a continuum of linked physical parameters and are important corridors for flows of energy, matter and biology (McCartney, 2009). The fluctuating dynamic conditions within a riverine continuum are maintained by the constantly changing flow regime which produces a diverse array of aquatic habitats and subsequent biodiversity (Vannote et al., 1980). Nutrients and sediment (matter) generated in the headwaters of the watercourse are recycled downstream and form the primary drivers affecting plant growth and ecological productivity. Natural flood regimes regularly inundate floodplains and increase organic matter decomposition and nutrient cycling, this process has led to the biological evolution of complex adaptive strategies which are often coupled to the flood regime. The construction of a dam disrupts the river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall. Based on the available literature, as well as reviews of the impacts of impoundment, post impoundment impacts directly influence a myriad of factors in watercourses that ultimately alter the ecological structure and function of riverine ecosystems (Kingsford, 2000).

Alteration of Flow Regime of the Lusushwana River

The waterbody located upstream of the proposed Nondvo Dam will be converted from a lotic to a lentic system whereby obvious habitat modifications would be anticipated. This will have an immediate impact on biota with preferences to lotic habitats such as *Chiloglanis*, *Labeobarbus* and the abundant *Platycypha caligata*. (**Figure 9-1**). Furthermore, it can be anticipated that taxa adapted to lentic conditions will proliferate, this includes the alien invasive species *Micropterus salmoides*.

Figure 9-1: *Platycypha caligata* (March 2019)

In addition to the upstream inundation, dams alter the downstream flow regime which can impact the relative volume of water discharge, the permanence of low flows as well as the frequency and magnitude of flood peaks. A common consequence of this is the reduced frequency of overbank flooding, this was noted to have already occurred downstream of the existing Luphohlo Dam. Changes in the flow regime of the downstream river reach can impact negatively on the breeding cues of local fish communities which have evolved to react with particular flood-related stimuli, this is typically enhanced for flow releases to meet diurnal variation in hydroelectricity demands. As noted above, an Ecological Flow Requirement release of 4 Mm^3/year was recommended (JMRBWRS, 2008).

Alteration of Thermal Regime of the Lusushwana River

The impounded body of water will be deeper than 20 m and therefore it is likely that temperature and oxygen stratification would take place. This may have an impact on downstream water quality as well as temperature lifecycle cues for aquatic ecology as a result of releases. Releases from the hypolimnion of a reservoir have shown to be "least natural" due to the significant impact the release has on water temperatures.

Water Chemistry

Historical assessments of impoundments indicate that the structures are sinks for various elements and nutrients. Consequently, water that is discharged has a different chemical composition to the inflows into the reservoir. Dissolved nutrients such as phosphorous increase in the reservoir as a result of the decaying submerged vegetation and soil. This increases the chemical and biological oxygen demand and can decrease the concentration of biologically available oxygen. Subsistence agricultural activities within the impoundment catchment will therefore concentrate in the Nondvo Dam.

According to McCartney (2009), the quality of water released from a stratified reservoir is associated with the elevation of the outflow structure relative to the different stratified layers in the waterbody. Releases from the reservoir surface contain low concentrations of nutrients and are typically well-oxygenated, whilst releases from the bottom are typically cold, rich in nutrients and low in oxygen.

Sedimentation

The reduction in flow velocity of the flow in the Lusushwana River will result in the enhancement of sedimentation. However, the rate of sedimentation is dependent on the physiographic features of the catchment area as well as the local land use. Based on available data, approximately 0.5% – 1% of storage volumes in reservoirs across the world are lost due to sediment capture (Mahmood, 1987). Large fluctuations in the water levels of reservoirs can result in the erosion of the reservoir shoreline which can add to existing sediment loads. In addition, disproportionately discharged water volumes can also lead to erosion of the instream channel and riverbanks downstream of impoundments. This is compounded by the reduced sediment loads of the downstream river system which inherently increases the erosional capacity of the watercourse. The existing Luphohlo Dam has modified instream sediment characteristics. The presence of an additional instream barrier will prevent the movement of additional sediments generated between the foot of the Luphohlo Dam and the proposed Nondvo Dam wall. However, given the local geology of the area which is characterised by hard granites and the limited spatial extent between the above-mentioned two locations, this impact is anticipated to be negligible.

The continued operation of the linear infrastructure such as roadways and bridges present long-term disturbed areas which may be subject to erosion.

Bed Armouring

During the operation of the Nondvo Dam it is likely that the easily removable material downstream of the dam wall will be removed and will become armoured with rocks. These rocks will impact the habitat for aquatic species and will likely result in reduced diversity.

Aquatic Biodiversity

The presence of the instream barrier will alter migratory patterns for the observed Eel species (*Anguilla mossambica*) and it can be anticipated that migratory habitats upstream of the dam wall will be inaccessible. The alteration of the existing flow regime of the Lusushwana River will reduce the available habitats available downstream which will impact local fish communities, particularly rheophilic taxa such as *Labeobarbus* and the listed *Chiloglanis* species. The anticipated reduced flood peaks and flood durations are anticipated to impact floodplain conditions in the lower Lusushwana River and reduced biodiversity and biomass can be anticipated. The alteration of the flow regime will also affect instream, marginal and riparian vegetation which have reproductive and vegetative processes that are typically controlled by dynamic interactions of periods inundation and desiccation.

Table 9-9: Riverine Ecology – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	Operational	Negative	5	2	3	5	5	**75**	**N3**	5	2	3	5	5	**75**	**N3**
				N3 - High							**N3 - High**						
Inundation of the reservoir area	Habitat modifications will potentially have an immediate impact on biota with preferences to lotic habitats such as Chiloglanis, Labeobarbus and Platycypha caligata (i.e. loss) and proliferation of taxa adapted to lentic conditions including alien invasive species Micropterus salmoides.	Operational	Negative	2	2	1	5	4	**40**	**N2**	2	1	1	5	2	**18**	**N1**
				N2 - Medium							**N1 - Low**						
Inundation of the reservoir area	Alteration of downstream flow regime can impact on the relative volume of water discharge, permanence of low flows as well as the frequency and magnitude of flood peaks leading to reduced frequency of overbank flooding and negative impacts on the breeding cues of local fish communities.	Operational	Negative	4	2	3	4	5	**65**	**N3**	3	2	3	4	5	**60**	**N2**
				N3 - High							**N2 - Medium**						
Inundation of the reservoir area	Dissolved nutrients such as phosphorous increase in the reservoir as a result of the decaying submerged vegetation and soil. This increases the chemical and biological oxygen demand and can decrease the concentration of biologically available oxygen. Releases from the reservoir surface contains low concentrations of nutrients and is typically well oxygenated, whilst releases from the bottom are typically cold, rich in nutrients and low in oxygen.	Operational	Negative	3	2	3	5	3	**39**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						
Additional instream barrier	Easily removable material downstream of the dam wall will be removed and become armoured with rocks resulting in reduced habitat and aquatic species diversity.	Operational	Negative	2	2	1	5	4	**40**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						
Additional instream barrier	Alteration of migratory patterns for the observed Eel species (Anguilla mossambica) due to migratory habitats upstream of the dam being inaccessible.	Operational	Negative	4	3	3	5	4	**60**	**N2**	4	3	3	5	4	**60**	**N2**
				N2 - Medium							**N2 - Medium**						
Additional instream barrier	Large fluctuations in the water levels of reservoirs can result in the erosion of the reservoir shoreline; erosion of the instream channel and riverbanks downstream of impoundments adding to existing sediment loads. This is compounded by the reduced sediment loads of the downstream river system which inherently increases the erosional capacity of the watercourse.	Operational	Negative	2	2	1	5	4	**40**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						

9.3.5 TERRESTRIAL ECOLOGY

CONSTRUCTION PHASE

Destruction, Further Loss and Fragmentation of Vegetation Community

The construction of the Nondvo Dam, including the dam wall, quarry, construction camps, railway line realignment and internal access roads will result in further loss and fragmentation of the vegetation community. Access roads and servitudes; clearing new roads/servitudes as well as widening of existing roads/servitudes will remove habitats for terrestrial plant species. Construction camps and laydown areas; these areas need to be cleared of vegetation for safe operation and therefore available habitat for terrestrial plant species will be reduced. Dam wall and bridge construction; site establishment and the placement of this physical structure as well as supporting infrastructure on natural habitat will effectively remove habitat for terrestrial plant species through blasting and excavation followed by the building of foundations etc. Quarry and borrow pit areas for aggregate used for the dam wall and road construction will lead to an additional loss. Stochastic events such as fire from events such as cooking or smoking of workers; discarding of lit cigarette butts and/or glowing embers from cooking fires being blown into surrounding vegetation may cause runaway fires to remove habitat for terrestrial plant species that would otherwise have been available.

Displacement, Mortalities and Disturbance of Faunal Communities

Displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances (such as site clearance, dust, light, vibrations, poaching and noise). There may be an increase in direct faunal mortalities due to collisions with vehicles, clearing of vegetation, increased poaching or drowning during inundation.

Displacement/loss of fauna (including rare or IUCN listed species) due to the removal of vegetation will result in the direct loss of habitat forcing the species to move into new areas where more challenges may be present. Disruption of faunal populations by interfering with their movements and/or breeding activities. Direct mortalities from earthmoving or transport vehicles and increased traffic due to construction work and the transportation of staff/materials.

Spread and/or establishment of alien and/or invasive species

There is an increased potential for the establishment of alien and invasive vegetation. Disruption in natural areas of phytomass, disturbance of soil and introduction by humans due to human movements will increase the potential and likelihood of the establishment of alien and invasive vegetation.

Infringement by Humans into Natural Areas

Infringement by humans into the natural areas due to increased access, with associated impacts such as poaching, litter and introduction of diseases and feral species such as cats and dogs. Loss of targeted high-value plant species (logging, medicinal and tradable species) and the transport of these items due to increased access and in-migration provided by the inundation zone edge and associated roads. With increased access to isolated/fragmented populations of plants, the logging of high-value plant species becomes more probable, especially in the Rocky Grassland.

Table 9-10: Terrestrial Ecology – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Spread and/or establishment of alien and/or invasive species, especially in areas that are cleared.	Construction	Negative	4	3	3	4	4	**56**	**N2**	2	1	3	2	2	**16**	**N1**
				N2 - Medium							**N1 - Low**						
Construction of the linear infrastructure	Destruction, further loss and fragmentation of the vegetation community.	Construction	Negative	4	3	5	5	4	**68**	**N3**	4	2	3	5	4	**56**	**N2**
				N3 - High							**N2 - Medium**						
Increased vehicular activities along roadways and in public areas	Displacement, direct mortalities and disturbance of faunal community (including threatened species) due to habitat loss and disturbances (such as site clearance, dust, light, vibrations, poaching and noise)	Construction	Negative	4	3	3	3	4	**52**	**N2**	3	2	3	2	2	**20**	**N1**
				N2 - Medium							**N1 - Low**						
Infringment by humans into natural areas	Infringement by humans into the remaining natural areas, with associated impacts such as poaching, litter and introduction of diseases and feral species such as cats and dogs.	Construction	Negative	4	3	3	4	4	**56**	**N2**	3	2	3	2	2	**20**	**N1**
				N2 - Medium							**N1 - Low**						

Operational Phase

Destruction, Further Loss and Fragmentation of the Vegetation Community

Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances will occur. Flooding of the area will effectively remove habitats for terrestrial plant species resulting in the drowning of fauna from flooding of the inundation zone. Chemicals used on site such as herbicides and cleaning surfactants have the potential to contaminate the nearby watercourses and adversely affect exposed individuals. Sensory disturbance, during operation (e.g. noise, dust, vibrations) is anticipated to be minimal given the nature of the development.

Continued habitat degradation (litter and alien vegetation encroachment)

The edges of the new inundation area will likely be degraded by impacts such as sand mining and livestock drinking, alien vegetation will become a concern in these disturbed areas.

Infringetment by Humans into Natural Areas

Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter, road killings and introduction of feral species such as cats, vermin and dogs. The unregulated movement of local people into the areas surrounding the inundation zone will likely result in the clearing of vegetation for housing and agriculture. This exacerbates the direct impact of the loss of vegetation due to the project components. The new settling area will have an increase in challenges, secluded areas that might still be present will now be under pressure due to activities such as poaching.

Loss in Genetic Diversity, Habitat Fragmentation and Disruption of Habitat Corridors

Due to the new geographical barrier that will be formed by the dam (the area will be divided into two sections) ultimately making it impossible for fauna and flora species to crossbreed/pollinate. The barrier restricts dispersal and migration for terrestrial species and therefore causes habitat fragmentation.

Introduction of new waterborne diseases

With the influx of water into the area, the likelihood of waterborne diseases such as amoebiasis, bilharzia, botulism and giardiasis increase as untreated sewage from the old homesteads and surroundings will now be found in the water. All these diseases will pose a risk to the local fauna that will likely not have a natural resistance.

Table 9-11: Terrestrial Ecology – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances.	Operational	Negative	4	3	5	4	5	**80**	N3	4	2	5	5	4	**64**	N3
				N3 - High							N3 - High						
Inundation of the reservoir area	Continued habitat degradation (litter, fire and alien vegetation encroachment)	Operational	Negative	4	3	5	4	4	**64**	N3	3	3	5	4	3	**45**	N2
				N3 - High							N2 - Medium						
Inundation of the reservoir area	Loss in genetic diversity, habitat fragmentation and disruption of habitat corridors	Operational	Negative	5	4	5	4	5	**90**	N3	4	4	3	4	4	**60**	N2
				N3 - High							N2 - Medium						
Inundation of the reservoir area	Introduction of new waterborne diseases	Operational	Negative	4	3	5	4	4	**64**	N3	4	3	3	4	3	**42**	N2
				N3 - High							N2 - Medium						
Infringment by humans into natural areas	Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter and feral species such as cats and dogs	Operational	Negative	4	3	5	5	4	**68**	N3	3	3	5	5	3	**48**	N2
				N3 - High							N2 - Medium						

9.3.6 ECOSYSTEM SERVICES

OPERATIONAL PHASE

Impacts to General Farming Activities

Approximately 104,76 ha of the proposed inundation area is used for general farming activities (livestock and cultivation). All of the delineated farming areas will be completely removed during the inundation of the reservoir area, ultimately resulting in the loss of 104,76 ha farmland. Even though the proposed land use (a dam/reservoir) will provide irrigation possibilities, farming land will be lost.

As for the downstream project area, 800 ha of farmland has been identified. It has been assumed that the dam wall has been engineered in such a way that dam wall failure will not occur and that flooding events will occur infrequently and in an insignificant manner. Therefore, no impacts are expected to the crop fields downstream of the dam wall.

Raw Materials from the Environment

The proposed inundation area is covered by approximately 10,96 ha of dense tree patches, which is expected to be completely removed by means of the proposed inundation. The downstream area is covered in 17,4 ha of dense patches of trees. It has been assumed that the dam wall has been engineered in such a way that dam wall failure will not occur and that flooding events will occur infrequently and in an insignificant manner. Therefore, no impacts are expected to the dense patches of trees downstream of the dam wall. As for sand mining, an area of 5,15 ha in size has been identified within the proposed inundation area and this resource will be lost.

Freshwater

The proposed inundation area is covered in channelled valley bottom wetlands (9,3 ha), unchannelled valley bottom wetlands (14,29 ha), hillslope seeps (4,35 ha) and a river system (63,29 ha). These watercourses are all expected to be lost after the proposed inundation. Even though these sources are a steady source of freshwater (some more so than others), the proposed land use is for a dam/reservoir which indicates permanent inundation. The proposed land use will therefore increase freshwater resources instead of a complete removal of resources.

Water Flow Regulation

Water flow regulation refers to the ability of a watercourse to decrease the velocity of flows and therefore minimise the possibility of flooding events. All four identified watercourses (in the current land use) are characterised by moderate environmental sensitivity scores (ranging from 1,2 to 1,9 out of 3). The proposed land use includes permanent inundation and the engineering of a dam wall thatwill regulate floods (**Figure 9-2**).

The water flow regulation ecosystem service score is expected to increase significantly given the fact that the proposed dam wall will regulate floods better than any other watercourse could. Therefore, a positive impact is expected for this particular ecosystem service.

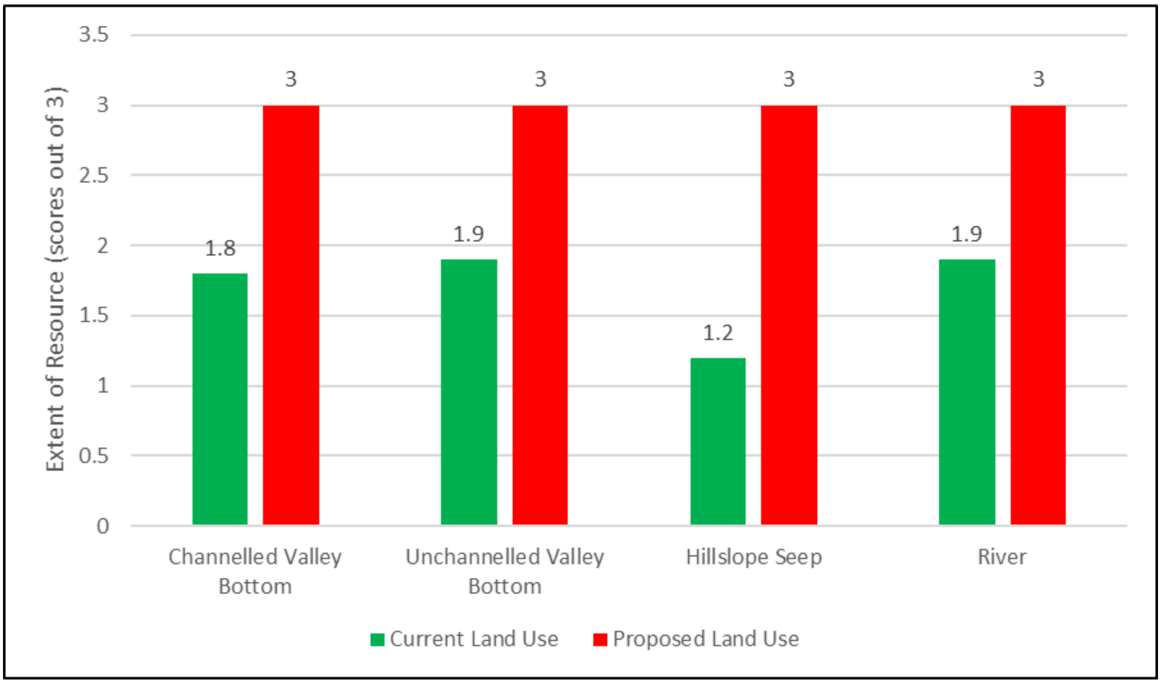

Figure 9-2: Water Flow Regulation Scores (out of a total of 3) Calculated for each of the Identified Watercourses during the Current- and Proposed Land Use

Purification of Water

The water purification score for the four identified watercourses ranges from low to high (from 0,7 to 2,6 out of 3) in the current land use. These scores are expected to drop to 1,1 (in the river's case increasing to 1,1) given the fact that hydrophytes and hydromorphic soils will be lost during the proposed inundation (**Figure 9-3**).

The overall purification of water ecosystem service score will be decreased with the proposed land use. It, therefore, is however worth noting that the largest of the identified watercourses is the river system, which purification of water score is expected to increase, therefore compensating for the other three watercourses. It, therefore, is the specialist's opinion that this ecosystem service score will not be affected too much by the proposed activities and that no mitigation or compensation will be required.

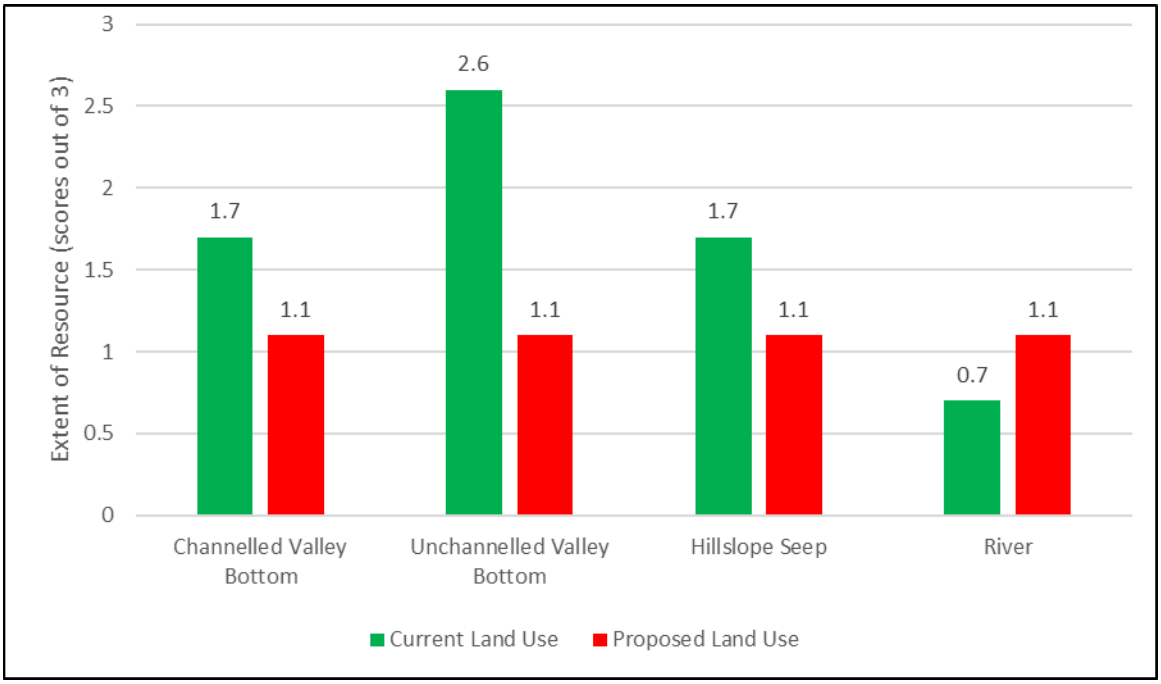

Figure 9-3: Purification of Water Scores (out of a total of 3) Calculated for each of the Identified Watercourses during the Ccurrent- and Proposed Land Use

<u>Soil Formation</u>

The soil formation score for the four identified watercourses ranges from moderate to high (from 1,0 to 2,5 out of 3) in the current land use. These scores are expected to drop to 0,5 given the loss of watercourses (**Figure 9-4**). Even though alluvial sediments will accumulate within the proposed dam, hydromorphic properties will be lost.

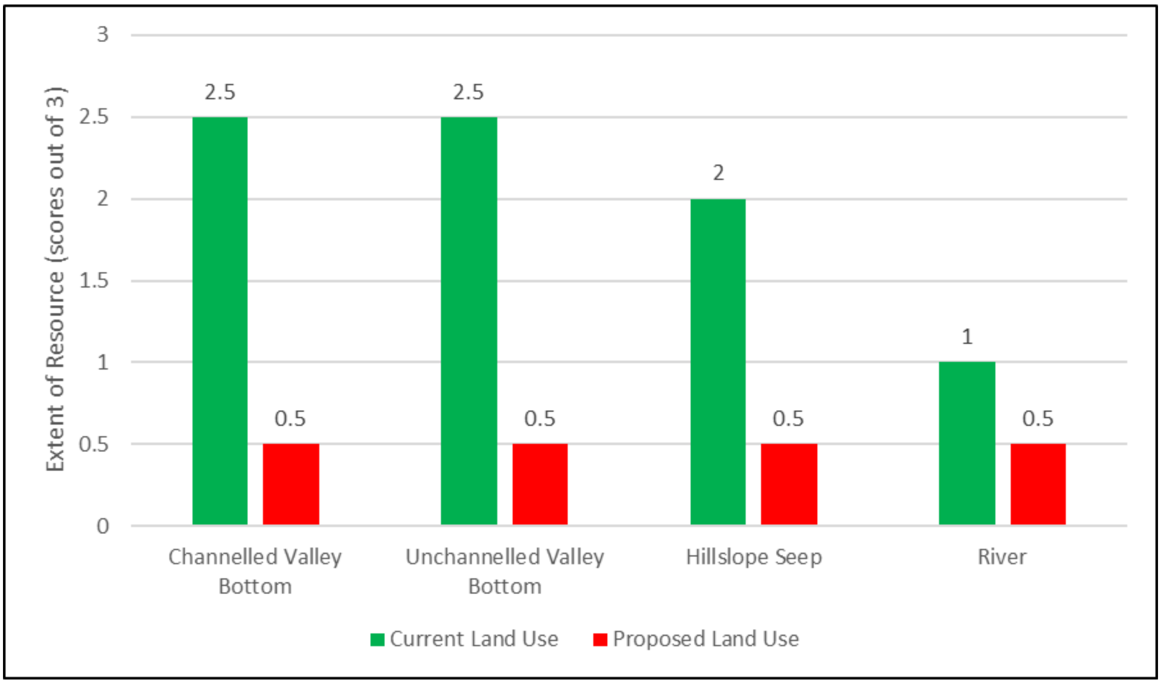

Figure 9-4: Soil Formation Scores (out of a total of 3) Calculated for each of the Identified Watercourses during the Current- and Proposed Land Use

Water Cycle

The water cycle score for the four identified watercourses ranges from moderate to high (from 1,0 to 2,0 out of 3) in the current land use. The score for the water cycle is set to remain the same from the current to the proposed land use for the channelled valley bottoms, decrease in the unchannelled valley bottom wetland's case, increase in the hillslope seep's case and also slightly increase in the river's case to a score of 1,6 (**Figure 9-5**).

Only the unchannelled valley bottom wetland's ecosystem service score for the water cycle is expected to decrease with the other system's scores either expected to remain the same from the current to the proposed land use or increase insignificance. The river system which represents the majority of the watercourse's ecosystem service score for the water cycle is expected to increase. It, therefore, is the specialist's opinion that a positive impact is expected for this particular ecosystem service score.

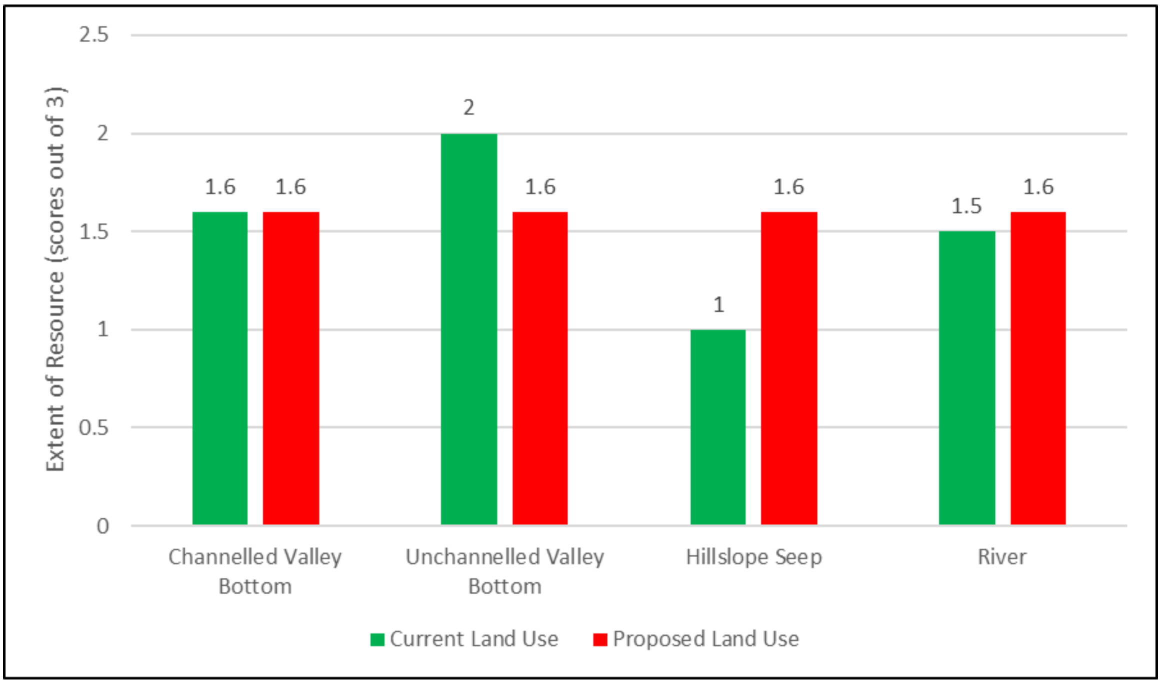

Figure 9-5: Water Cycle Scores (out of a total of 3) Calculated for each of the Identified Watercourses during the Current- and Proposed Land Use

Altered Water Quality and Flow Downstream

During the inundation process the initial filling of the reservoir will increase in concentrations of nutrients and organic matter because of the decomposition of inundated vegetation and possible mobilisation of nutrients from agricultural activities taking place within the project area. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation). There is an increased likelihood of changes to downstream oxygen levels and the potential of algae blooms within the dam. As the dam fills to its anticipated capacity, existing households and associated infrastructure would be inundated. This includes existing septic tanks, which would have a negative impact on the water quality.

The trapping and consequent stagnation of water as a result of the existence of a dam causes physical, thermal and chemical changes to the previously-flowing water, which can cause a serious decline in the quality of the water in and downstream of the reservoir.

The proposed inundation will alter the seasonal variation in downstream water temperatures, and may delay early season water temperature increases that provide spawning cues in fish. The impact will be localised, as river temperatures recover to ambient levels with distance downstream, depending mainly on the discharge.

Operation of the proposed dam is expected to have direct negative impacts on the downstream aquatic ecosystem because of reduced total flow and alterations in flow patterns, but conditions are expected to recover with distance downstream because of tributary contributions.

Increased Pressure on Downstream Natural Resources

Rivers are longitudinally linked systems withprocesses occurring in the upper reaches impacting downstream reaches. Downstream communities make use of a wealth of natural resources, or ecosystem services, that are freely and readily available These natural resources provide households with valuable sources of food, fuel, income, building materials and various other uses. The loss of access and/or availability of these natural resources will have an impact on numerous households' way of life. Vital services include wood collection, fishing, grazing of livestock, collecting medicinal plants, collecting thatching grass and utilising sand for the construction of houses.

Table 9-12: Ecosystem Services – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	The inundation of the reservoir area will result in an alteration of ecosystem services	Operation	Negative	3	2	3	5	3	39	N2	3	2	3	5	3	39	N2
				N2 - Medium							N2 - Medium						
Inundation of the reservoir area	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	Operation	Negative	3	5	3	5	4	64	N3	3	5	3	5	4	64	N3
				N3 - High							N3 - High						
Inundation of the reservoir area	The inindation of the Nondvo Dam will reults in altered wayer quality and flow downstream	Operation	Negative	3	2	3	5	3	39	N2	3	2	3	5	2	26	N1
				N2 - Medium							N1 - Low						
Inundation of the reservoir area	Altered water quality and flow could modify downstream ecosystem services.	Operation	Negative	3	2	3	5	3	39	N2	3	2	3	5	2	26	N1
				N2 - Medium							N1 - Low						

9.3.7 WASTE GENERATION

CONSTRUCTION PHASE

Table 9-13 provides a summary of the typical general and hazardous waste types that are likely to be generated onsite during construction.

Table 9-13: Description of Construction Phase General Waste Streams

WASTE CATEGORY	WASTE TYPE	TYPICAL CONSTITUENTS
General Waste	Domestic Waste	Paper and cardboard packaging, empty plastic and metal containers (non-hazardous original contents), etc.
	Mixed Industrial	Wood, plastic, packaging etc.
	Metal Waste	Ferrous and non-ferrous scrap and stainless steel, cast-iron removed pipelines
	Spoil Material	Excavations, trenching and terracing will result in the generation of spoil material
	Biomass	Cleared vegetation
Hazardous Waste	Oily Waste	Used lubricant and hydraulic oils and hydrocarbon-based solvents
	Oil Contaminated Waste	Solid material (rags, etc.) that has come into contact with and contains traces of oil or grease
	Health Care Risk Waste (HCRW)	Waste generated at workers camp clinic
	Sewage Effluent	Effluent from chemical ablution facilities.

The presence of construction workers has the potential to increase litter on site in the absence of adequate waste receptacles. This results in unsightly working areas and possible entry into terrestrial habitats and watercourse leading to secondary impacts on local wildlife (in the case of ingestion and entrapment), aquatic ecosystems and downstream community (water users). Furthermore, waste materials may attract pest species / vectors into working areas leading to potential health implications to construction staff and community members.

Spoil material unsuitable for reuse as bedding, backfill and bedding material has the potential to disrupt land use and habitats if inappropriately manage / disposed of illegally.

Waste generation (domestic waste, mixed industrial and metal waste) and a lack of appropriate separation, temporary storage and recycling (i.e. not aligned with the Waste Hierarchy) has the potential to result in unnecessary waste material to landfill.

As there are no existing recycling companies or facilities within the project area, general waste will be disposed of at the existing landfills in Mbabane.

Hazard waste generation and inappropriate management and disposal have the potential to lead to contamination of soil, groundwater and surface water; as well as the poisoning of fauna (direct contact, and ingestion).

As there are no registered hazardous waste collectors located within the project area, the registered hazardous waste collector company will transport hazardous waste to appropriate facilities in South Africa.

Table 9-14: Waste Generation – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Generation of general waste	Presence of workforce and absence of adequate waste receptacles results in increased litter potentially leading to secondary impacts on terrestrial and aquatic ecology.	Construction	Negative	3	3	3	3	4	**48**	**N2**	2	1	3	2	3	**24**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of general waste	Spoil material unsuitable for reuse as bedding and backfill material has the potential to disrupt land use and habitats if not managed appropriately.	Construction	Negative	3	2	3	3	4	**44**	**N2**	2	2	3	2	3	**27**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of general waste	The lack of inappropriate waste separation has the potential to result in unnecessary waste to landfill.	Construction	Negative	2	2	3	3	4	**40**	**N2**	2	1	1	1	3	**15**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste could lead to contamination of soil, groundwater and surface water; and poisoning of fauna.	Construction	Negative	3	2	3	3	3	**33**	**N2**	2	1	1	2	2	**12**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	Lack of waste minimisation measures will lead to regional impacts and increased project construction costs as registered hazardous waste collectors are located outside the project area.	Construction	Negative	2	2	3	3	4	**40**	**N2**	2	1	1	1	3	**15**	**N1**
				N2 - Medium							**N1 - Low**						

OPERATIONAL PHASE

Table 9-13 provides a summary of the typical general and hazardous waste types that are likely to be generated onsite during operation. The hazardous was will be generated by ongoing maintenance at the dam wall and powerhouse.

Table 9-15: Description of Operational Phase General Waste Streams

WASTE CATEGORY	WASTE TYPE	TYPICAL CONSTITUENTS

Hazardous Waste	Oily Waste	Used lubricant and hydraulic oils and hydrocarbon-based solvents
	Oil Contaminated Waste	Solid material (rags, etc.) that has come into contact with and contains traces of oil or grease

Waste generation (domestic waste and mixed industrial) and a lack of appropriate separation, temporary storage and recycling (i.e. not aligned with the Waste Hierarchy) has the potential to result in unnecessary waste material to landfill.

Table 9-16: Waste Generation – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste generated during maintenance activities at the hydro power station and railway line could lead to contamination of soil, groundwater, surface water and poisoning of fauna.	Operational	Negative	3	2	3	3	3	33	N2	2	1	1	2	2	12	N1
				N2 - Medium							N1 - Low						

9.3.8 AIR QUALITY

CONSTRUCTION PHASE

Dust and Particulates

The release of particulate matter (PM) to atmosphere and its migration by wind vectors impacts on ambient air quality. PM varies in size from particles that are only visible under an electron microscope to soot or smoke particles that are visible to the human eye. PM contributes greatly to deteriorations invisibility, as well as posing major health risks, as small particles (aerodynamic diameter <10 microns PM_{10}) can penetrate deep into lungs, while even smaller particle sizes (aerodynamic diameter <2.5 microns, $PM_{2.5}$) can enter the bloodstream via capillaries in the lungs, with the potential to be laid down as plaques in the cardiovascular system. Health effects include respiratory problems, lung tissue damage, cardiovascular problems and cancer. Acidic particles may damage buildings, vegetation and acidify water sources[15].

The following construction activities result in PM emissions: vegetation clearing and exposure of bare soil to wind, excavation, drilling and jackhammering concrete batching plant, blasting at the quarry, and movement of machinery and vehicles particularly on dirt roads.

Dust emissions will primarily be a nuisance factor to nearby receptors (e.g. onsite workers, and roadside kiosks and residents in the immediate vicinity of the quarry and dam wall). However, if suspended particulates exceed short-term guidelines, acute health issues (e.g. eye irritation, breathing problems) may arise.

The construction phase air quality impacts are considered to be temporary.

Gaseous Emissions

A secondary source of gaseous (e.g. nitrogen dioxide, sulphur dioxide and carbon monoxide) and particulate emissions may include exhaust from vehicles and other diesel engines of earthmoving equipment. In addition, illegal open burning of solid waste on site can contribute to a reduction in ambient air quality.

Although vehicular emissions will result in an increase in ambient concentrations of pollutants in remote areas compared to the baseline situation, vehicular emissions are not likely to result in ambient concentrations beyond WHO health guidelines**.**

[15] The United States Environmental Protection Agency (USEPA) (undated): **Health and Environmental Effects of Particulate Matter (PM)**, https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm

Waste burning can result in temporary and intermittent exceedances of short-term guidelines in the vicinity of the burning activity leading to potential health implications within the surrounding community).

Table 9-17: Air Quality – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increased dust emissions will result in reduced ambient air quality resulting primarily in a nuisance factor to nearby receptors (e.g. onsite workers and residents)	Construction	Negative	2	2	3	2	3	**27**	**N1**	2	2	3	2	3	**27**	**N1**
				N1 - Low							**N1 - Low**						
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increased concentration of pollutants (gaseous emissions) will result in reduced ambient air quality	Construction	Negative	1	2	3	2	3	**24**	**N1**	1	2	3	2	3	**24**	**N1**
				N1 - Low							**N1 - Low**						

OPERATIONAL PHASE

Agricultural Activities

Agricultural activities are known to release particulate matter and nitrogen-containing compounds (NO_2, NO, NH_3, N_2O), however the volume and type of emissions are dependent on the type of vegetables being produced. There is thus the potential that the increase in agricultural land due to the availability of irrigation of an additional 800 ha may result in additional emissions being released to the atmosphere.

Table 9-18: Air Quality – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increase in agricultural land (800ha) due to the availability of irrigation may result in additional methane emissions being released to the atmosphere.	Operational	Negative	1	2	3	2	4	**32**	**N2**	3	3	1	3	3	**30**	**N1**
				N2 - Medium							**N1 - Low**						

9.3.9 CLIMATE CHANGE AND GREEN HOUSE GAS

CONSTRUCTION PHASE

Release of Airborne Pollutants to Atmosphere

The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others. The potential impacts associated with the establishment of the proposed dam with regards to the climate include:

- Limited carbon emissions from plant and equipment on the site during construction and operation phases; and
- Potential carbon emissions resulting from the decomposition of vegetation because of the inundation of woody vegetation within the dam basin, and from the clearing of land in the surrounding areas.

Wetland Loss

The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The delineated channelled valley bottom wetlands cover

9,3 ha of the proposed inundation area, unchannelled valley bottom wetlands cover 14,29 ha with hillslope seeps covering approximately 4,35 ha of the inundated area. The loss of the wetland areas will result in the removal of the wetland sink. Due to the role that this habitat plays as a water source for the local community, this area has been infringed upon, and utilised extensively. Washing of clothes, sand mining and bathing occurs on a daily basis leaving the habitat in a constant state of disturbance. This habitat, even though degraded, is still important as a movement corridor for several faunal species, especially birds and mammals, and plays a vital role as a water resource not only for the biodiversity but also the local community.

Table 9-19: Climate Change – Construction Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others	Construction	Negative	2	2	3	3	4	40	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						
Inundation of the reservoir area	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	Construction	Negative	3	5	3	5	4	64	N3	3	5	3	5	4	64	N3
				N3 - High							N3 - High						

OPERATIONAL PHASE

Release of Airborne Pollutants to Atmosphere

During filling of the reservoir the existing vegetation and soils are submerged and start decomposing. This decomposition can deplete the oxygen level in the water. Decomposing organic matter can also lead to a release of the greenhouse gases methane and carbon emissions. The amount of decomposing material reduces with time and as such the carbon emissions are reduced over time.

Generation of Hydropower

The generation of hydropower can be considered a positive impact, as energy is generated from a renewable resource, thus resulting in lesser use of fossil fuel-derived power. However, the magnitude of the impact is minor due to the small size of the hydropower unit (1 MW). The overall significance is considered low.

Table 9-20: Climate Change – Operational Phase

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	The operation of the dam will result in the dam basin area filling to capacity which will result in the inundation of vegetation. There are potential carbon emissions that will be released by the decomposing of woody vegetation	Operational	Negative	3	2	3	3	4	44	N2	3	2	3	3	4	44	N2
				N2 - Medium							N2 - Medium						
Hydropower generation	The generation of hydropower can be considered a positive impact, as energy is generated from a renewable resource, thus resulting in lesser use of fossil fuel derived power	Operational	Positive	1	1	1	4	4	28	P1	1	1	1	4	4	28	P1
				P1 - Low							P1 - Low						

9.4 IMPACTS ON THE SOCIO-ECONOMIC ENVIRONMENT

The aim of this section is to identify the potential socio-economic impacts associated with the proposed Project. In each instance, a distinction is drawn between impacts that are likely to occur during the construction phase and those that are most likely to occur during the operational phase. As the proposed development has a long design life (i.e. in excess of 25 years) impacts associated with the decommissioning phase have not been addressed. It is recommended that should the Project be implemented, a decommissioning assessment be undertaken, and a designated management plan be compiled, closer to the time of decommissioning in terms of the relevant legislative process in place at the time.

9.4.1 DISTURBANCE AND LOSS OF SOCIAL AND ECONOMIC ACTIVITIES

CONSTRUCTION PHASE

Permanent loss of livelihoods, displacement and resettlement (Physical and economic displacement)

Construction and inundation of the reservoir will result in an area of approximately 2.4 km^2 of land being developed / flooded. In order to facilitate the establishment of the dam, relocation (i.e. physical displacement) and compensation, (i.e. economic displacement) of PAPs within the Project footprint will be required. Based on the feasibility designs of the Project, at least 210[16] households / PAPs fall within the project footprint and will therefore require relocation of compensation (i.e. physical or economic displacement). The properties fall either within the construction footprint of the dam, or associated infrastructure, or within the inundation area of the reservoir.

Of the affected PAPs, a total of 122 require a combination of physical and economic displacement. These comprise 113 households (including dwellings, outbuildings, agricultural fields and other assets), 3 churches, 2 schools, 1 formal business (shop) and 3 informal shops (Spaza shops).

The communities in the area are mostly dependant on agriculture namely farming of livestock and crops. Furthermore, there are a number of vulnerable people in the local communities who, by virtue of their gender, age, physical or mental disability, economic disadvantage or social status would potentially be more adversely affected by the Project, and who may be limited in their ability to deal with the negative consequences or take advantage of the anticipated Project's development benefits. Land users engaged in crop cultivation and livestock farming will experience economic displacement, affecting their ability to produce food and cash crops/ produce. Given the shortage of arable land in the area, it is expected that this loss of land will have a significant impact on food security, household income and livelihoods for the affected families. This will be further aggravated for those who face displacement relating to changing availability of other natural resources (e.g. medicinal and fuel plants), indirectly impacting subsistence livelihoods and traditional household structures.

PAPs will have a choice of compensation packages which include cash and in-kind compensation. Cash compensation is not the preferred option however is some instances is either requested or required (such as due to limited availability of replacement land, etc.). In each situation PAPs are entitled to participate in the Livelihood Restoration Plan (LRP) which includes the provision of resettlement assistance, land-based activity training (such as improved agriculture techniques), as well as non land-based activity training such as financial management / entrepreneurial training.

Challenges also exist for the introduction of resettled PAPs in host communities due to potential differences in community structures and loss of support networks. Inadequate resettlement and livelihood restoration planning and implementation could have a long-term impact on PAP's livelihoods and support structures.

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[16] The socio-economic and RAP activities undertaken as part of the ESIA process have been undertaken on the Project feasibility designs as per the Final Feasibility Report, dated October 2019, undertaken by Studio Pietranglei. The exact number of households and affected assets will be confirmed during RAP implementation should the Project be implemented.

Physical and Economic displacement requires a separate RAP (in accordance with international lender requirements). The objective of the RAP and LRP is to ensure that PAPs are in a position that their standards of living, income-earning capacity, production levels and overall means of livelihood are improved.

Temporary Loss of Livelihoods (Economic Displacement)

Economic displacement refers to the loss of assets or access to assets that leads to the loss of income sources or other means of livelihood. In this case, the construction and inundation of the Nondvo Dam will result in the loss of access to agricultural land, grazing land and natural resources.

Of the 210 identified PAPs a total of 90 PAPs have been identified[17] that will require compensation for the direct loss of assets (i.e. economic displacement). Land users engaged in crop cultivation and livestock farming will experience economic displacement, affecting their ability to produce food and cash crops/ produce. Given the shortage of arable land in the area, it is expected that this loss of land will have a significant impact on food security, household income and livelihoods for the affected families. This will be further aggravated for those who face displacement relating to the loss of, or loss of access to, natural resources (e.g. medicinal plants, grasses, trees providing ecosystem services such as traditional medicines and sources of fuel), impacting subsistence livelihoods and traditional household structures.

This impact will be experienced directly as a result of a combination of: i) lost access to these land-based livelihoods and resources from which the majority of the population in the Nondvo Dam Project area derive an income; ii) increased competition for land by displaced people and migrants moving into the area (e.g. work-seekers); iii) lack of alternatives; and iv) increased time and cost due to extended traveling distances to and from areas where resources are still available as well as impeded access.

The main economic activities that will be affected by the Nondvo Dam Project are discussed below.

— Loss of Access to Agricultural Land

  A large portion of the productive agricultural land in the area is located in the proposed inundation area as this falls within the existing floodplain. Given the existing scarcity of arable land within Mantabeni and Siphocosini and Eswatini at large, there is a high likelihood that affected people may not be provided with land for the loss of their fields.

— Loss of Access to Grazing Land

  The Nondvo Dam Project will result in a loss of access to grazing areas, specifically resulting from inundation. All directly affected grazing will be permanently lost and affected people will be expected to find alternate grazing, thus placing an additional strain on existing grazing resources beyond the Nondvo Dam Project footprint.

— Loss of Access to Natural Resources

  Project activities that will impact access to natural resources include:

  - Vegetation clearance during construction;
  - Establishment of temporary and permanent infrastructure
  - Inundation;
  - Establishment of new settlements, grazing and agricultural fields; and
  - Increased population due to in-migration of work and business-seekers.

  The loss of access to natural resources may be exacerbated by the generally degraded vegetation in the Nondvo Dam Project Area and increased competition for the remaining natural resources by both local people and in-migrants.

Site clearance / inundation of plants used by communities (ecosystem services)

This impact will involve the clearance of vegetation and topsoil in the dam wall and auxiliary works infrastructure footprint, quarry and site camps / offices. Combined these areas effectively form a small

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[17] The RAP will identify the exact impacts, the individual households and customary areas (and users) that will be affected.

portion of the project area. However, the inundation of the Nondvo Dam will result in the flooding of an area approximately 2.4 km^2 in extent. This will be a direct impact that will result in a loss of grassland and rocky outcrop habitats containing important plant resources that are used by the communities.

Majority of the plant species used by local communities for food, medicinal or spiritual purposes are located within the rocky outcrop / grassland mosaic habitats that are prevalent throughout the project area. While this vegetation mosaic has been heavily overgrazed within the development footprint and has moderate to low biodiversity value, a number of useful plant species were identified within the general vicinity of the infrastructure footprints. Given the high reliance of local communities on a wide range of useful plants, although they appear to be widespread and fairly common within the project area, their sensitivity to site clearance is assigned as *Medium*.

The impact of site clearance on important plant resources will be a direct, negative, long-term to permanent impact that will definitely take place. However, the extent of the impact will be relatively small (limited to the impact footprint), and the vegetation type is ecologically degraded.

Resettlement at Host Communities

Several potential impacts may result from the resettlement of PAPs within identified host communities, these include:

— increased pressure on infrastructure / social services;
— increased competition for land;
— increases demand for goods and services; and
— conflict between resettled PAPs and host community members.

The appearance of resettled people into the community increases demand for goods and services. While this generally increases the trade of small business operators (which is usually positive), it also increases demand on public services, which may not be able to cope with the additional demand. This may result in increased congestion or delays in being able to access services. There may even be shortages of key requirements, water, electricity, fuel etc. The increased demand in the economy may potentially lead to local inflation.

Additionally, there may be resentment between the host community and the resettled households, especially if the host community feels that the resettled people are being given special treatment, like modern houses, preferential access to jobs or other benefits that are not available to them. In some cases, this resentment may result in a degree of unpleasantness displayed towards the resettled people, with the relocated people being made to feel that they are not welcome. In severe cases there can be hostility or violence between the host community and resettled people.

Table 9-21: Social Economic Activities – Construction Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Physical Displacement and Resettlement of Affected Households	The Project will result in physical displacement of 102 households in Mantabeni and Siphocosini below the reservoir Max. OL	Construction	Negative	5	4	5	5	5	**95**	**N3**	3	4	3	5	4	**60**	**N2**
				N3 - High							**N2 - Medium**						
Economic Displacement of Affected Households	Loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will affect PAPs ability to produce food and cash crops/ produce.	Construction	Negative	4	3	3	4	5	**70**	**N3**	3	2	3	4	4	**48**	**N2**
				N3 - High							**N2 - Medium**						
Loss of plant resources used by the community	Loss of vegetation will result from site clearance in the infrastructure footprint during construction as well as due to flooding during inundation of reservoir area.	Construction	Negative	3	3	5	5	4	**64**	**N3**	2	2	3	3	2	**20**	**N1**
				N3 - High							**N1 - Low**						

9.4.2 EMPLOYMENT CREATION, ECONOMIC OPPORTUNITIES AND DIVERSIFICATION

CONSTRUCTION PHASE

Creation of Employment, Procurement and Local Business Opportunites

Employment (formal and informal) and other income generation opportunities in the Nondvo Dam Project Area and the surrounding area are very scarce, specifically for those with no or low levels of education. The majority of the local population is involved in subsistence agricultural activities (i.e. crop and livestock production) as their primary livelihood strategy. There are some small enterprises providing basic services throughout the project area, these include selling fresh and processed foods, basic groceries, alcohol, etc. These businesses are predominantly located along the Mhlambanyatsi Road (MR19).

As indicated in the results of the SES, there is a potential that 10% of the community (approximately 130 people) may have the requisite skill sets for employment on the project (i.e. large-scale water infrastructure). This excludes the potential for unskilled employment, of which there is a larger labour pool within the community that could fulfill these roles.

In addition to direct employment opportunities, many indirect and induced employment opportunities will potentially be created within the supply chain (indirect), to meet the needs of the migrant work-seekers and the Project workers who will have increased levels of disposable income.

In terms of procurement of goods and services, the project area has limited established businesses. The majority of local businesses are micro-and small-scale enterprises that deliver goods and services required by the local population.

Table 9-22: Employement Creation, Economic Opportunites and Diversification – Construction Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Creation of Employment, Procurement and Local Business Opportunities	Generation of employment (formal and informal) and other income generation opportunities in the Nondvo Dam Project area and the surrounding area.	3	3	3	2	3	**33**	**P2**	4	3	3	2	4	**48**	**P2**
		P2 - Medium							**P2 - Medium**						

OPERATIONAL PHASE

Economic Opportunities and Diversification

A large portion of The Mantabeni and Siphocosini population is currently dependent on agricultural activities and livestock, which limits economic opportunities beyond subsistence-based agriculture. During the operational phase the number of direct Project employees[18] and Project procurement requirements will be dramatically reduced in comparison to the construction phase. As such, a limited number of locally-based businesses will be able to service the operational needs – which will include fuel supply, food, and office materials.

However, as a result of the Project, the area will be more accessible and the reservoir will potentially be seen as an attraction, resulting in an increase in the number of tourists visiting the area. It is also likely that following the long construction phase, some of the workers and migrant work-seekers will remain; thus, the population is likely to increase as compared to the current baseline. With an increase in visitors, a likely increase in the resident population, and increased exposure to a more active economy, local entrepreneurs will continue to provide businesses that meet the ongoing needs and demands.

Additionally, the economy, which is almost exclusively focused on agriculture, is likely to become more diversified through an influx of people with a greater variety of skills and offerings. Agriculture is likely to

[18] Project employment figures were not available at the time of the assessment.

remain the foundation of the economy for most households. However, the need to offer alternate goods and services (e.g. accommodation, meals, fresh produce, cleaning, entertainment/ recreation, curios) to the operational workers, newcomer and local people should result in diversification of the economy of Mantabeni and Siphocosini. In the future, post-construction, many people are likely to have an improved opportunity to generate income from other activities beyond agriculture.

While economic opportunities and the possibility for economic diversification will arise as a result of increased demand from operational workers, work-seekers and visitors; the onus will remain on individuals to start-up/ enhance businesses to benefit from the increase in demand. It is likely that these opportunities could be taken by outsiders with the means to respond quickly to the demand. Locals may find it more difficult to set-up competitive businesses due to a lack of skill and financial resources. The aesthetic nature of the environment of the area and the presence of the nearby Nature Reserve may also enhance the degree to which diversification of the economy is achieved post-dam construction.

The benefits to the local economy would be experienced as a positive impact that would deliver direct, indirect and induced opportunities. Direct Project opportunities will be more limited in the local economy; these are more likely to generate national and regional and international benefits. The impact will be experienced at the local level as a result of localised demand for goods and services through increased spending by workers, residents, commuters and visitors/tourists.

Growth in the Local Tourism Sector

The establishment of the Nondvo Dam is anticipated to result in an aesthetic benefit to the area, potentially attracting tourists. Should recreational actives be permitted on the dam the potential for tourism attraction would increase. Eswatini has well-developed tourism sector and is well known for its excellent hospitality hence it would not be difficult to build on the back of such a foundation.

The growth of the tourism sector will also facilitate the creation of induced employment for local people, especially the youth. There will be opportunities for people to start a range of small businesses, including hospitality services (e.g. accommodation, meals, transport), tour guiding services (e.g. hiking trails, botanical/ avian/ ecological trails), amongst others. However, it is anticipated that it will take a considerable length of time for tourism to increase, even after the 36-month construction phase is completed; establishing tourism facilities and activities will require an investment of funding and support to local entrepreneurs.

Disruption of Downstream Economic Activities

The changes in thedownstream flow patterns can s disrupt economic activities and social organization downstream. Farming patterns on floodplains can be affected and may require irrigation water. Fish populations could reduce which will impact downstream economic feasibility of fisheries downstream of the dam wall.

Economic activities and social organization in the downstream regions can therefore be disrupted with increased rates of out-migration, reduced agricultural productivity and hence reduced land prices.

Table 9-23: Employment Creation, Economic Opportunites and Diversification – Operational Phase

Economic Opportunities and Diversification	The number of direct Project employment and procurement requirements will be dramatically reduced during operation (no accurate figures are currently available); however, as a result of the Project, the area will be more accessible and the reservoir will potentially be seen as an attraction resulting in increased number of tourists visiting the area. Additionally some of the workers and migrant work-seekers will remain following construction; thus the population is likely to increase as compared to the current baseline. The economy, which is almost exclusively focused on agriculture, is likely to become more diversified through an influx of people with a greater variety of skills and offerings.	Operation	Positive	3	3	3	4	4	**52**	**P2**	3	3	3	5	4	**56**	**P2**
				P2 - Medium							**P2 - Medium**						
Downstream Economic Activities	Disruption of downstream economic activities as a result of reduced flow	Operation	Negative	4	2	3	5	4	**56**	**N2**	3	3	3	5	4	**56**	**N2**
				N2 - Medium							**N2 - Medium**						
Growth in the local tourism sector	It would be recommended that the Nondvo Dam serve multi purposes. This strategy would increase the footprint of tourist and contribute to the income generation of the local area. Aggressive marketing well ahead of construction, including promotion of the nearby nature reserve, would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be developed at the site. Growth of the tourism sector will also facilitate creation of induced employment for local people, especially the youth.	Operation	Positive	3	2	3	5	2	**26**	**P1**	3	3	3	5	3	**42**	**P2**
				P1 - Low							**P2 - Medium**						

9.4.3 INTRODUCTION AND MOVEMENT OF WORKERS INTO / OUT OF LOCAL COMMUNITIES

CONSTRUCTION PHASE

Increased Cost of Living and Debt Generation

Most people living in the project area are self-employed. They mostly rely on remittances from family members, government grants and ad hoc income earned from the selling of agricultural produce and harvesting of natural resources. Increased demand for goods and services is likely to result in increased prices.

Households living in the area currently do not pay for their land or housing other than where maintenance or expansions are required. Even then, locally available materials are largely used for construction purposes. The prices of food and basic household goods are most likely to increase and have the most prominent negative effect on the cost of living for local residents. Additionally, increased travelling distance around the reservoir will increase the cost of travel to reach important public services such as clinics, trading posts, schools and places of worship.

Simultaneously, however, local people will be able to sell their goods / services at higher prices, thus potentially generating more income. Some business people in the area are concerned that during the construction phase, customers will want to purchase goods on credit and may then leave without settling their debt to the service providers.

Levels of income are low and the economy is largely subsistence-based. As such, local people will be sensitive to price increases, especially if they are not able to increase their income simultaneously. However, the majority of people already rely on their subsistence crops for most of the year. Since many community members indicated they are positive about the potential new opportunities to sell goods and services and claim to be aware of the potentially negative consequences of the Project on the local economy, the sensitivity of the majority of households to price increases is therefore rated Medium. Households who are able to respond to demands for goods and services, and benefit through increased income generation, will be far less sensitive (Low) to this impact. People living in the most isolated villages are likely to be the most sensitive as access to the area increases resulting in increased demand and rising costs.

This impact will be indirect and negative for most people, primarily for the residents in the most isolated locations. The Project's need for goods and services and the related demand from work-seekers will have an indirect effect on supply and demand, and prices of goods and services. The extent will be local and the duration will be short-term as related to the construction phase. As project workers leave the area, incomes reduce and migrants begin moving away, prices may decrease slightly. However, the area will be more accessible and is likely to attract visitors and business people, thus prices will likely remain elevated (levels are not known and difficult to predict).

Exacerbation of anti-social behaviour and increased prevalence of sexually transmitted infections (STIs) and HIV/AIDs

The process of Ukukhonta (i.e. the application process to live in the community from the Chief or Inner Council) is credited to regulating the influx of migration into new communities. However, with the proposed dam construction it could be tricky to control the entry of people because of heightened construction activities. In this instance, these job seekers are only there temporarily with no intentions of permanent relocation. Eswatini has experienced a high rate of HIV/AIDS infections and deaths. However, with the concerted effort to enhance health awareness campaigns and distribution of antiretrovirals, new HIV infections have reportedly declined. It is essential to note that anti-social behaviour is influenced by many factors. There is a high probability that relationships will be formed which may lead to a resurgence of STIs and STDs including HIV infections. Currently the level of crime in the villages of Mantabeni and Siphocosini is insignificant.

Some of the anti-social behaviour likely to occur are described below.

- Increase in crime levels given that many of the migrants to the area will not have income or access to land to generate a livelihood.
- An increase in disposable income within the project area (among workers) could result in an increase in alcohol and drug abuse, increased incidences of prostitution and casual sexual relations. These activities could lead to an increased incidence of STIs and HIV, and increased numbers of teenage and unwanted pregnancies. The increased prevalence of diseases would affect contractors, employees, local residents and the families/ sexual partners of anyone becoming infected in the project area.
- Young girls are likely to enter into relationships with migrant workers (and work-seekers) in the hope that they will be able to leave the area and secure a 'better' lifestyle. However, they are likely to end up dropping out of school with unwanted pregnancies, STIs and HIV.
- General unrest may arise as a result of increased pressure for resources, resentment towards those who secure employment and procurement opportunities as well as benefits from other Projects (specifically if the beneficiaries are from outside the area).

This negative impact will arise as a direct result of construction workers, and indirectly via migrant work-seekers to the area. The impact will be experienced at a local level; however, the impact duration will likely be long-term as improved access and the attraction to the area will facilitate ongoing migration in and out of the project area. This impact will affect the individuals and families that engage in such activities, while crime could affect anyone.

Disruption to Family and Community Structures

The proposal of the Nondvo Dam Project provides new prospects and expectations of employment opportunities. Employment opportunities (albeit relatively limited in duration) offered by the Project contractors will provide income that is likely to be far beyond what is generated by agricultural work. Those who are employed will learn new skills that may enable them to secure construction work in the future. There are also high expectations that the employment opportunities will lead to an improved standard of living.

It is probable that those employed during the construction phase would aim to secure further work in the construction sector with their newly acquired skills and experience, leading to a longer term disruption to social and economic networks. It is also possible that once young men and women have experienced paid work with their acquired skills in the construction field may opt to go find work elsewhere. Similarly it is anticipated that these newly acquired skills may inadvertently cause a shortage of available farming skills and family support networks during the construction phase, and beyond. However, since these young people will have enough money that they would send home (as it is the norm with African families) to get hired help in agriculture

While the number of employment opportunities and job requirements are not yet known, it is expected that these opportunities will be relatively small in comparison to the size of the eligible population; despite the fair number of employment opportunities that are likely to be available. Following construction, it is conceivable that while some people will attempt to secure further paid employment outside the agricultural sector, most are likely to be forced to return to existing livelihood activities and household responsibilities. It is unlikely that the Project would result in a permanent loss of household support or farming expertise.

Increased Pressure on Social Infrastructure and Services

The Nondvo Dam Project Area has one clinic, primary school and high school and is regarded as semi-rural. However, the possible influx of work seekers and additional contractor's workforce may add more stress on the existing resources. It is however anticipated that in view of the high unemployment rate in the country, most of the work seekers will be both single and married men. It is very highly unlikely that they would bring their families. Thus, less impact on schools and more demand for land, healthcare, water and sanitation and waste management is anticipated. The technical team has already identified both the management and contractors' office and worker's campsite in Mhlane, separating them from the community.

Besides Project workers, the anticipation of employment, other income generation opportunities, and benefits linked to improved local infrastructure and services, will likely result in a significant influx to the area. The current lack of well-maintained infrastructure in the form of roads, bridges and footbridges would certainly collapse under the strain of the influx of large trucks and other construction equipment. As for public transportation, shops and lounging areas are almost non existent, especially in the villages of Mhlane and Spete1. It would be commendable for locals if they could seize the opportunity rather than rely on employment from the Nondvo Dam Project, and start their own business and supply the services required since there will be a high demand for them. It is essential to note that the influx of job seekers, whether short or long-term is immaterial because the pressure will still be exerted on the resources in their current form.

Given the already strained social infrastructure and services in the project area, additional pressure from outsiders would further overload the existing services, such as clinics, water and sanitation, and land. There is limited land to allocate to newcomers for farming, natural resources additionally water and sanitation and waste management services are inadequate.

Table 9-24: Movement of Workers Into / Out of Local Communities – Construction Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased Cost of Living and Debt Generation	Increased demand for goods and services is likely to result in increased prices. Simultaneously, however, local people will be able to sell their goods / services at higher prices, thus potentially generating more income. Increased travelling distance around the reservoir will increase the cost of travel around the dam to reach important public services such as clinics, trading posts, schools and places of worship.	4	3	5	3	4	**60**	**N2**	2	2	1	2	3	**21**	**N1**
		N2 - Medium							**N1 - Low**						
Exacerbation of Anti-Social Behaviour due to in migration (influx of job seekers)	Expectations regarding possible employment opportunities may result in the area surrounding the site experiencing an influx of job seekers. Migrants will bring with them differing cultures, religious beliefs, norms and values; they influence young people to change in a manner that may not be accepted by the more conservative/ traditional sector of the population. Resulting increased prevalence of Sexually Transmitted Infections (STIs) and HIV/AIDS as well as crime.	4	3	5	5	4	**68**	**N3**	3	3	3	4	3	**39**	**N2**
		N3 - High							**N2 - Medium**						
Disruption to Family and Community Structures	Employment opportunities may inadvertently cause a shortage of available farming skills and family support networks during the construction phase. Additionally people employed in the construction work may aim to secure further work in the construction sector elsewhere, with their newly acquired skills and experience may be required, leading to a long term absence from family and disruption to family setting and social structures and improved economic networks.	3	3	5	4	4	**60**	**N2**	3	3	3	3	4	**48**	**N2**
		N2 - Medium							**N2 - Medium**						
Increased pressure on social infrastructure and services	The Project area has one clinic, primary school and high school and is regarded as semi-rural. The possible influx of job seekers and additional contractor's workforce may add more stress on the existing resources.	3	3	5	4	4	**60**	**N2**	3	3	3	3	4	**48**	**N2**
		N2 - Medium							**N2 - Medium**						

OPERATION PHASE

Increased Cost of Living and Debt Generation

The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. It is likely that the prices of goods and services may readjust to meet market demand, reaching a more stable/ normalised level. Given that the population of the area is likely to remain somewhat elevated, and economic diversification is probable, prices will stabilise, albeit at a higher relative level than they are currently.

In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available. The area will be more accessible and attractive to visitors and new residents, they are likely to bring new merchants that sell an increased diversity of goods, and thus tempting people to purchase goods that ordinarily would not have been available to them. Currently, there is limited public transport with few taxis operating in the area; and away from the Mhlambanyatsi Road (MR19) most people walk or hire private cars to larger items. With potentially improved road networks there is likely to be an expansion of transport options available representing an increased cost of living.

Post-construction and the completion of the associated job opportunities, the general standard of living could deteriorate over time as a result of decreased levels of affordability (linked to decreased income compared to the more prosperous construction Phase) although it is still expected to remain better than before construction. The standard of living could be counter-balanced by improved economic opportunities and improved accessibility to markets and critical social infrastructure and other services.

The sensitivity of the population will vary. Some people will be able to increase and maintain their increased levels of income generation, while others (specifically the elderly and more traditional people) will continue their lifestyles in a manner similar to current levels. Everyone will be affected by an increase in the cost of living; some people will be able to accommodate the increase and given the expectation and potential for new market opportunities. This impact is considered negative and will continue as an indirect consequence of the changing nature of the area.

Continuation of anti-social behaviour and increased spread of sexually transmitted infections (STIs) and HIV/AIDs

Anti-social behaviour, as described above, is expected to continue into the operational life of the Project. There will no longer be Project workers and many migrant work-seekers will likely leave the area in search of opportunities elsewhere. As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo Project area.

As with the construction phase impact, HIV and STIs, casual sexual relationships, prostitution, unwanted pregnancies, an increase in drug and alcohol abuse, and crime are likely to persist to some degree. Long-distance truck drivers and migrants in search of work opportunities are likely to be the most significant contributors to the spread of HIV and STIs and may increase the demand for prostitution and attract local women to enter into relationships with them.

Following the proposed 36-month construction phase, people would already have experienced an increase in the anti-social behaviour. While an increase in anti-social behaviour is not desirable, people will have adapted to the increased risks and exposure especially where economic matters are concerned.

While the level of confidence in this impact is low, the negative impact of ongoing anti-social behaviour and spread of HIV/AIDS is expected to continue into the operational phase as a result of the inevitable changes that the years of the construction phase will precipitate, and as an indirect result of 'outsiders' visiting and travelling through the area.

Table 9-25: Movement of Workers Into / Out of Local Communities – Operational Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased cost of living	The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available.	4	2	3	5	4	56	N2	3	3	3	5	4	56	N2
		N2 - Medium							N2 - Medium						
Continuation of Anti-Social Behaviour and Spread of STIs and HIV/AIDS	As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and new ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo Project Area.	3	4	5	4	4	64	N3	3	4	3	5	4	60	N2
		N3 - High							N2 - Medium						

9.4.4 DEMAND ON LOCAL UTILITIES – ENERGY

CONSTRUCTION PHASE

Additional power requirements for construction purposes and services or facilities in the various housing, camp and work areas are likely to place additional pressure on the existing electricity supply in the Project area which may result in overloading and possible blackouts (i.e. periods without electricity to the area).

Additional water usage required for construction purposes and services or facilities in the various housing, camp and work areas is likely to place additional pressure on existing water supply in the Project area, which may result in periods of water shortage in the piped infrastructure.

Loss of electricity and / or piped water for periods would result in negative impacts on the social functioning of the households. More significantly, public service facilities such as clinics, schools as well as shops (i.e. businesses) within the Project would not function properly without electricity / water.

Table 9-26: Demand on Energy Utilities – Construction Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Demand on local utilities - Energy	Additional power requirements for construction purposes and services or facilities in the various housing, camp and work areas is likely to place additional pressure on existing electricity supply.	Construction	Negative	4	2	1	2	3	27	N1	3	2	1	2	2	16	N1
				N1 - Low							N1 - Low						
Demand on local utilities - Water	Additional water requirements for construction purposes and services or facilities in the various housing, camps and work areas is likely to place additional pressure on existing water supply.	Construction	Negative	4	2	1	2	3	27	N1	3	2	1	2	2	16	N1
				N1 - Low							N1 - Low						

OPERATION PHASE

The Nondvo Dam includes a small hydropower plant with a rated power generation of less than 1MW. The energy generated by the Project is to be utilised for operational purposes of the dam as well as distribution of electricity to the local communities, by connecting into existing electrical distribution infrastructure, thereby potentially increasing their quality of life. It is anticipated that the distribution of electricity generated, as well as the operation, management and maintenance of the hydropower plant, will be taken over by the EEC.

The additional source of electricity would result in positive impacts on the quality of life of the households not already connected to the national grid. The power source may also result in improved stability of the power supply to the community.

Table 9-27: Demand on Energy Utilities – Operational Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Demand on local utilities - Energy	The energy generated by the project is to be utilised for operational purposes of the dam as well as distribution of eleciticity to the local population near the reservoir and thus thereby increasing their quality of life.	3	2	5	5	4	60	P2	3	2	5	5	4	60	P2
		P2 - Medium							P2 - Medium						

9.4.5 DISTURBANCE FROM INCREASED NUISANCE FACTORS (NOISE, DUST, VIBRATION)

CONSTRUCTION PHASE

Mantabeni and Siphocosini are familiar with traffic, especially those that reside along the main roads in the villages and the MR19. People still walk distances to catch taxis or buses when going to the town major centres such as Mbabane. However, the majority of the project area remains quiet and peaceful due to the lack of vehicle ownership within the community and rural nature of the area.

The air quality in the area is generally good with the main pollutants arising from localised (village-level) combustion of solid fuels (shrubs for cooking and heating, and burning of crop residue and household waste, as well as a low level of dust generated from traffic on unpaved roads and vehicle emissions. Wind-blown dust and some smoke from burning grassland occur in the drier months.

Construction activities will generate uncharacteristic disturbances resulting in a range of nuisance factors (notably increased levels of noise and decreased air quality). Air, noise and vibration disturbances will occur on commencement of Project advance works with site clearing, blasting in quarry area, access road construction, establishment of site camps and offices, and stockpiling of rock.

These nuisance factors will continue to varying levels and across the project area for the duration of the construction phase (estimated at 36 months). The advanced works will predominantly affect Mhlane village due to its proximity to the site establishment areas. Construction of the dam and ongoing activities at the camps works areas and quarry, will create disturbances that will largely affect Mhlane and Spete1, due to their proximity to these activities. Disturbances related to traffic noise and dust generation will affect the villages located along the transport routes. The extent of these disturbances is anticipated to vary substantially on a daily basis, depending on the type and schedule of activities and the prevailing weather.

The number of construction contractors and staffing for each contract is not yet known. During the advanced infrastructure programme, they will be working regular working hours; however, for the dam construction, there is the potential that construction activities will be undertaken on a 24-hour schedule. The potential activities that will generate the disturbances in the project area are:

- Travel and operation of construction vehicles and heavy machinery of different types (mainly diesel-powered);
- Use of mobile diesel generators;
- The presence of construction workers and work-seekers;
- Blasting at the quarry sites and at various locations, as required;
- Bulldozing and exposure of disturbed bare ground and soil / rock dumps; and
- Lights during night work (if required).

Construction vehicles (including transport of large volumes of rock / aggregate from quarries and crushing plants), and machinery will be used on an almost ongoing basis throughout construction and will be the sources of most noise and dust disturbance (along with intermittent blasting). Diesel-powered generators will likely be used throughout the Project.

Construction activities will be undertaken during normal working ours, however in exceptional circumstances, such as during concrete pouring which cannot be stopped once commenced, work outside of these hours will be required. Where construction activities are required to take place outside of normal working, the Contractor is to provide sufficient notification (at least 48 hours) to the community of such works."; and "Night work is therefore only permitted under exceptional circumstance. During nighttime construction works, the noise levels will be most significant given the very low prevailing ambient noise levels at night. These sounds will disturb sleep patterns and could result in a lack of productivity and focus during daytime tasks, and general irritation of local residents.

It is expected that construction workers will either be housed in the designated, access-controlled construction camps, or they will be employed from the local villages and therefore reside in their own homes. During work hours, the presence of the workers can result in elevated noise levels linked to actual work activities, as well as loud conversations between the workers.

Blasting will be required at the quarry site and at various locations where hard ground needs levelling or rock needs to be removed. Blasting will result in intermittent loud noise and dust generation. In addition, it is likely that there may be fly-rock associated with each blast, depending on the manner in which blasting is managed.

Dust will largely be generated by the clearance of topsoil and exposure of loose sand or soil as the construction contractor clear the footprint for the Project infrastructure and begin blasting and removing rock from the construction footprint and quarry site. The exposed soil may be blown across the area during dry periods and as a result of the passage of construction vehicles back and forth, especially during the dry winter periods between May and October. Increased levels of dust can be a nuisance in that it could dirty houses and the clean washing hung out to dry; it may aggravate those with existing respiratory conditions, and it could impact crops.

Physically, these nuisance factors will lead to noise, dust and potentially (for some people) an unwanted visual change in the landscape character. Some people may experience emotional and psychological distress as a result of the ongoing disturbances; this is most likely to be the case near schools and healthcare facilities where learning and healing could be affected, and in the closest villages. The majority of the construction-related disturbances will occur at a local level and will affect households, infrastructure, villages and road users in the immediate vicinity of the dam wall and quarry area.

Local residents are accustomed to living in an environment free from the disturbances that can be expected from construction-related nuisance factors. As such, all residents will be affected; however, it is expected that most will adapt to/ accept the disturbances, which are short-term in nature.

Mhlane and Spete1 villages are located closest to the dam wall footprint and quarry site, while numerous other villages are located along the main transport routes. These villages will be the most impacted given their proximity to the construction sites. Mhlane and Spete1 villages are going to be directly affected by the advanced works, the dam construction, as well as by activities resulting from other Project components.

Besides the most directly affected villages, other receptors that may be more sensitive than others to these nuisance factors include:

— Residents located near to the construction sites where work is undertaken at night; noise levels are elevated at night;
— Students at nearby schools are likely to find it difficult to concentrate on their classes when noise levels are elevated. In addition, the activities are going to be new and exciting and will captivate the attention of many students, thus distracting them and diverting their attention away from their lessons;
— People with respiratory conditions could experience an exacerbation of the condition as a result of increased levels of dust in their environment;
— People who have livelihood activities located closest to the directly affected footprint (e.g. crops, grazing) may incur damages to their produce resulting from the fly-rock and dust; and
— Sites of religious/ traditional and cultural significance could be disturbed.

How each individual experiences these disturbance factors are highly subjective; for instance, some will welcome the sounds as an indication of development and anticipation of a better life; while others will place a higher value on the silence associated with a rural environment.

The disturbances arising as a result of the construction phase nuisance factors will be negative and direct in nature (as related to Project activities). The impact will be experienced locally, largely at a site level (around the Project footprint and along transport routes). The direct construction-related disturbances are highly likely to occur and will persist for the duration of the construction phase (short-term); Mhlane and Spete1 will be most affected given their close proximity to all activities.

Table 9-28: Nuisance Factors – Construction Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Disturbance from increased nuisance factors (Noise, Dust, Vibrations)	Construction activities will generate uncharacteristic disturbances resulting in a range of nuisance factors (notably increased levels of noise, decreased air quality and vibrations).Damage to households structures from heavy traffic and rock fall from the blasting operations.	4	2	1	2	5	45	N2	3	2	1	2	2	16	N1
		N2 - Medium							N1 - Low						

9.4.6 PUBLIC SAFETY - INCREASED SAFETY RISKS TO PEOPLE AND ANIMALS

CONSTRUCTION PHASE

A number of potential hazards threaten the public safety and security during the construction phase, these include:

— Short-term dust is primarily a nuisance factor to nearby receptors (e.g. onsite workers, roadside kiosks and residents) but may cause acute health issues (e.g. eye irritation, breathing problems) if acceptable standards are exceeded.
— Improper chemical storage and handling may expose the communities to hazardous chemicals, which may affect their health.
— People and livestock falling into open trenches leading to injuries and in some cases, fatality.
— Movement of construction machinery and vehicles resulting in increased potential for road accidents leading to injury to pedestrians and other motorists and in some cases, fatality.
— Blasting at sites could result in fly rock during the blasting activities.
— Large exposed water body during inundation phase.

With the exception of the road connecting Mbabane and Mhlambanyatsi (MR19), roads in the Project area are unsealed and in relatively poor condition, particularly over the rainy season. Apart from a bus service, there is little to no public transport offered on the road network in and around the villages. During the construction phase there will be an increase in vehicular movement, including abnormal loads, along the roadways in the Project area.

The local population and animals will likely be more at risk during the initial phases of the construction process, given that they will not be used to the risks that will arise during construction. Children, in particular, are going to be the most sensitive given that they are likely to want to investigate and explore the construction sites, equipment and materials. Increased safety risks will result in direct negative impacts on the community.

Table 9-29: Public Safety Risk – Construction Phase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	A number of hazards threaten the public safety and security during the construction phase, including increased traffic movement, handling of hazardous chemicals, rock blasting during quarry mining.	5	2	5	5	3	**51**	**N2**	3	2	3	2	3	**30**	**N1**
		N2 - Medium							**N1 - Low**						

OPERATIONAL PHASE

The excavation at the end of the life of the quarry will pose a safety hazard to people, livestock and pets due to the near-vertical cliffs which will result in fatal incidents of falling from height, being struck by heavy rocks dislodged from the cliff face and being crushed by large discarded rocks tipping over. Water accumulating at the base of the abandoned quarry may cause drowning of people and domesticated animals wandering into the site.

The safety of downstream communities could be influenced by seasonal flooding.

Table 9-30: Public Safety Risk – Operational Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	The excavation at the end of the life of the quarry will pose a safety hazard to people, livestock and pets due to the near-vertical cliffs which will result in fatal incidents of falling from height, being struck by heavy rocks dislodged from the cliff face and being crushed by large discarded rocks tipping over.	Operation	Negative	4	1	5	5	4	60	N2	1	1	1	2	2	10	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Water accumulating at the base of the abandoned quarry may cause drowning amongst people and domesticated animals wandering into the site.	Operation	Negative	5	1	5	5	4	64	N3	1	1	1	1	2	8	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	The safety of downstream communities could be influenced by seasonal flooding.	Operation	Negative	4	1	5	5	4	60	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						

9.4.7 OCCUPATIONAL HEALTH AND SAFETY RISKS

CONSTRUCTION PHASE

The operation of earthmoving equipment and construction vehicles will cause hazards which may result in accidents leading to injuries and fatalities in the workplace.

Working in close proximity will expose employees to drowning hazards, such as when walking or driving on unstable surfaces along the water's edge, sudden flooding of the worksite due to heavy downpour, employees bathing in nearby pools during lunch breaks or after work. This risk of drowning is identified based on recorded incidents in the community.

Skin contact with wet concrete and other chemicals such as chemical stabilizers and waterproofing agents, petrol and diesel will cause irritation and long term exposure will cause dermatitis.

Workplace noise may cause noise-induced hearing loss (a recognised illness) while long term exposure to dust may cause or exacerbate pre-existing respiratory conditions.

Inclement weather such as persistent rain, extreme cold, extreme heat may cause shock to the body, triggering conditions such pneumonia in the case of wet and cold, and heat stroke in the case of heat.

Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.

Table 9-31: Occupational Health and Safety Risk – Construction Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M	E+	R+	D)x	P=	S	Rating	(M	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	The operation of earthmoving equipment and construction vehicles will cause hazards which will result in accidents leading to injuries and fatalities in the workplace.	Construction	Negative	5	1	5	5	4	64	N3	2	1	1	3	2	14	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	Working in close proximity will expose employees to drowning hazards, such as when walking or driving on unstable surfaces along the water's edge, sudden flooding of the worksite due to heavy downpour, employees bathing in nearby pools during lunch break or after work. This risk of drowning is identified based on recorded incidents in the community.	Construction	Negative	4	1	5	5	3	45	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Skin contact with wet concrete and other chemicals such as chemical stabilizers and waterproofing agents, petrol and diesel will cause irritation and long term exposure will cause dermatitis.	Construction	Negative	3	1	1	4	4	36	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Workplace noise will cause noise-induced hearing loss (a recognised illness) while long term exposure to dust will cause or exacerbate pre-existing respiratory conditions.	Construction	Negative	5	1	5	5	5	80	N3	2	1	5	5	2	26	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	Inclement weather such as persistent rain, extreme cold, extreme heat will cause shock to the body, triggering conditions such pneumonia in the case of wet and cold, and heat stroke in the case of heat.	Construction	Negative	3	1	1	3	4	32	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.	Construction	Negative	5	5	3	4	4	68	N3	2	2	3	4	3	33	N2
				N3 - High							N2 - Medium						

OPERATION PHASE

Employees of the dam operator and hydropower plant will be exposed to wet conditions by virtue of working with water. Continual exposure to wet conditions will cause health hazards such as pneumonia. Working with high voltage and high current at the hydropower plant will cause electric shock hazards.

Diving when undertaking inspections, repairs and maintenance will expose divers to safety hazards of being pulled by underwater currents and being sucked into outlets or slammed against hard surfaces such as the dam wall. This may result in serious injuries or drowning

Table 9-32: Occupational Health and Safety Risk – Operational Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	Employees of the dam operator and hydropower plant will be exposed to wet conditions by virtue of working with water. Continual exposure to wet conditions will cause health hazards such as pneumonia.	Operation	Negative	4	1	5	5	3	45	N2	2	1	1	2	2	12	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Working with high voltage and high current at the hydropower plant will cause electric shock hazards.	Operation	Negative	5	1	5	5	4	64	N3	2	1	1	2	2	12	N1
				N3 - High							N1 - Low						

9.4.8 SECURE WATER SUPPLY, IRRIGATION AND PROMOTION OF SOCIAL AND ECONOMIC GROWTH (PRE-MITIGATION)

OPERATION PHASE

The completion of the Nondvo Dam Project water infrastructure will ensure reliable water supply in Manzini, Mbabane and surrounding areas as well as water supply for irrigation of 800 ha of agricultural land in the project area.

Well-managed and maintained infrastructure has the potential to enhance development, attract investors, and foreign direct investment (FDI). Once there are investors and FDI is realised this would assist in improving the country's economic outlook, GDP and employment. However, on the regional note the SADC Regional Water Supply and Sanitation Programme's overarching aim is to facilitate the SADC Member States to effectively improve and fast-track the provision of safe water supply and sanitation (WSS) contributing to socio-economic growth, poverty reduction, promote good public health, regional integration and poverty alleviation. Infrastructure assets, such as roads, electricity, water, and telecommunications services are essential inputs for both the private and public sectors. The availability of reliable infrastructure assets can increase returns and levels of investment and therefore accelerate economic growth. Furthermore, infrastructure assets assist in linking disparate parts of a country, which helps businesses access new customers, and develop new markets, driving both productivity and economic growth.

The positive impact of increased Government revenue will be a direct impact as it relates to revenue generated by the Nondvo Dam Project and indirect positive as it relates to Government spending in the country. The Nondvo Dam Project has the potential to induce associated growth and development in areas where spending occurs. This benefit will continue throughout the operational life of the Nondvo Dam Project.

Table 9-33: Secure water supply, irrigation and promotion of social and economic growth – OperationPhase

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Ease of Shortage of Water in Manzini and Mbabane, Irrigation of agricultural land and Promotion of Social and Economic Growth	The completion of the Nondvo Dam Project water infrastructure will ensure reliable water supply in Manzini, Mbabane and surrounding areas as well as water supply for irrigation of 800 ha of agricultural land in the project area. The availability of reliable infrastructure assets can increase returns and levels of investment and therefore accelerate economic growth.	4	4	5	5	5	90	P3	0	0	0	0	0	0	#N/A
		P3 - High							#N/A						

9.4.9 VISUAL IMPACTS

CONSTRUCTION PHASE

The relocation of households and other social infrastructure from within the Project footprint will result in increased congestion of the built areas as the availability of land in the area is extremely limited. This will be accentuated by the potential unavailability of replacement agricultural land for affected households for continued subsistence agriculture, resulting in reduced areas of open land. Although the increased congestion will potentially result in a diminished sense of open space for the communities, the overall sense of open space within the rural countryside will remain intact as the project infrastructure makes up a very small portion of the Project footprint, and is located in a fairly isolated section of the valley. As such, the reservoir area will remain open space for the duration of the construction period.

Construction activities will introduce new machinery and structures into the landscape. The movement of the additional construction vehicles and machinery on the untarred roads in the Project area will result in additional dust, which has the potential to lead to temporarily reduced visibility within close proximity to the construction areas. However, excluding vehicle and equipment movement along the access roads, the majority of the construction activities will be contained to the south-eastern section of the Project footprint (including dam site, quarry and site camps), which is situated in a fairly isolated section of the valley. Furthermore, these construction activities may create a visual attraction due to the novelty of such large-scale construction and may attract people to view the dam construction process.

Development of the dam structure and reservoir will not have a direct visual impact on these sites, however it is noted that reduced environmental flows may impact upon these activities. Due to the hilly nature of the Project area, there is no single vantage point from which one will be able to see the full extent of the entire reservoir.

Table 9-34: Visual – Construction Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Degradation of scenery of near-pristine areas / built environment	Unplanned construction of resettlement housing in host community may lead to degradation of scenery into near-pristine areas and of the built environment by increased housing density.	Construction	Negative	3	2	5	5	3	45	N2	1	2	1	5	2	18	N1
				N2 - Medium							N1 - Low						
Change in sense of place and landscape characteristics	Construction activities will introduce new machinery and structures into the landscape. Construction vehicles, dust and equipment will have a visual impact on viewers and general visibility (clarity of the air) within close proximity to the site.	Construction	Negative	2	2	1	2	5	35	N2	2	2	1	2	3	21	N1
				N2 - Medium							N1 - Low						

OPERATION PHASE

Development of the dam will result in a 38 m high dam wall and a reservoir with a surface area of approximately 2.4 km^2, at maximum operating level.

The dam wall and associated infrastructure are located in the less developed south-eastern portion of the Project area. The physical structure will face southward, with a small section of the wall infrastructure appearing above the Max. OL of the reservoir. As there are a very limited number of receptors below the dam, and due to the hilly topography of the area, the infrastructure will not be visually obtrusive to both the local community and visitors passing through the area and along the MR19.

From an aesthetic perspective the reservoir, which will be seen from visual receptors throughout the area, will enhance the visual aesthetics of the surrounding mountainsides and preserve the open space and tranquillity of the rural landscape. Additionally, the construction of resettled homesteads to at least meet minimum building regulation requirements will potentially be a general improvement of the visual attractiveness of the host community(ies).

People's perceptions and experiences of landscapes vary, with memory and association also important factors. As such, the value of visual characteristics is difficult to quantify in absolute terms.

Table 9-35: Visual – Operational Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Change in sense of place and landscape characteristics	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and disturbed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape. The impact is considered positive as the reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	Operation	Positive	3	2	5	5	4	60	P2	3	2	5	5	4	60	P2
				P2 - Medium							P2 - Medium						

9.4.10 CULTURAL HERITAGE (INCLUDING ARCHAEOLOGY) IMPACTS

CONSTRUCTION AND OPERATION PHASE

Disturbance of Archaeological sites

The San / Bushman painting site is located 610 m from the northeast inlet of the proposed dam. The Flood Level of the proposed dam is 965 masl, whereas the Rock Art site is 996 masl. While the Rock Art site is not at risk of being inundated, it is at risk of being disturbed by Project activities such as clearing for access roads that will link with the existing D95 gravel road that runs from the MR19 junction to the Luphohlo Dam wall. D95 was proclaimed a public road by the Ministry of Public Works and Transport through General Notice 98 of 1998 under Section 7 of the Roads and Outspans Act, 1931. Additionally, the provision of access roads will expose the site to more visitor traffic, thereby accelerating the deterioration of the site that has thus far been retarded by its seclusion, which resulted from the construction of Luphohlo Dam. Such deterioration will be exacerbated by allowing visitor access to the site to remain uncontrolled or unmanaged.

The Rock Art site is not suitable for tourism because the painting is barely accessible in a rocky cleft, and is extremely faded. Leaving the site open to uncontrolled or unmanaged visitor access will result in further deterioration. Therefore, rather than leave the site to continue to deteriorate, one option is to professionally restore the paintings and control visitor access thereafter. Where restoration costs and loss of authenticity through restored paintings are inhibitive or outweigh the benefit, then another option is to professionally produce a replica of the paintings, display them on an interpretive plaque a safe distance, e.g. 30m from the site, such that visitors, including the local community, may still be able to see the site from such safe distance. The objective of such preservation options is not so much for tourism, but for the local community to appreciate or recognize the occupation of the area by earlier cultures. Few people within the local community are aware of the site.

Disturbance of Heritage sites

The Masibekela refuge cave is situated at 1090 masl and 110 m east of the proposed dam, and therefore is not at risk of inundation. It is however at risk of disturbance from potential road construction and relocation of existing homesteads from the inundation area. The risk of disturbance from homesteads is real since new homesteads have recently been allocated land and thus homestead development is rapidly encroaching further up the mountainside, approaching the refuge cave.

The Masibekela site is suited to being one component of a cultural heritage tour; however, the site is not sufficiently important to be a primary destination. An option is to include it as part of a broader cultural tourism package. In order to enable appreciation of its cultural heritage significance amongst the local community and visitors, an interpretive plaque placed at a viewpoint along the access road on the west side of the mountain is an option.

The railway line servitude will be inundated by the proposed dam. Although the line is disused, the servitude is still operative in that Eswatini Railways continues to pay royalties for the servitude and intends reviving the line for transporting iron ore from Ngwenya. Due to inundation it will not be possible to preserve any section of the servitude at the project site for posterity of industrial heritage. There are no aspects of the railway line bed that demonstrate peculiar technological innovation that would warrant conservation.

There are no peculiar aspects about the quarry that render it conservation-worthy, i.e. there are no geomorphological features of special interest exposed by previous workings, it does not have any human-made features demonstrating peculiar industrial or technological innovation and it does not form a peculiar habitat or refuge for flora and fauna. Potential re-use as a source of water is negated by the proposed dam.

In view of the intention to revive the railway line or its possible realignment, the use of the quarry is likely to resume and expand further into the as yet un-mined sections of L2/1032. Since the quarry is on the edge of the Flood Level, the existing access point at the quarry will be obstructed by the dam, necessitating either establishing an alternative access route, or relocating, or expanding the quarry further northwards into L2/1032. The possible resumption and expansion of the quarry will likely displace adjacent homesteads, particularly those outside the Flood Level, but within L2/1032.

Access to / Disturbance of Graves of Chiefs and their relations

The graves of Chiefs and their relations are outside the inundation area and thus will not be inundated. The ease of access to the graves by community members living on the west side of the dam will be reduced by the physical barrier caused by the water body. Accessing the graves via the east of the mountain is not feasible as there are no vehicle tracks leading to the graves from the east and there are near-vertical cliffs. Reduced access will therefore cause physical and emotional alienation from the graves and burial sites.

Access to / Disturbance of Graves of community members

The graves of the majority of the homesteads are mostly outside the inundation area. While they will not be inundated, they are likely to be disturbed during the construction of alternatives roads around the inundation area. The graves of the Zwane families at the south end of the Project site are in the inundation area and therefore will need to be relocated. The graves of families in the vicinity of the proposed project offices will be at risk of being disturbed during site clearing for the offices and vehicle parking.

Graves of homesteads that will be resettled will be addressed through the Resettlement Action Plan. Graves that will not be relocated will be at risk of being accidentally disturbed by other human activities not related to the Project, particularly since in some cases they are concealed under dense vegetation or have become indiscernible.

Homesteads that will be resettled as a result of inundation, construction of access roads, realignment of the railway and the MR19 will be alienated from their graves and burial sites.

Disturbance / loss of indigenous vegetation

Project implementation will result in loss of indigenous vegetation through site clearing for construction of the dam, establishment of a new quarry site, access roads, realignment of the railway line and power lines, construction of resettled and relocated homesteads and relocation of burial sites of affected homesteads. Inundation will also result in vegetation loss.

From a cultural heritage perspective, the loss of indigenous vegetation will cause a loss of species of cultural significance such as timber and grasses used for construction, as well as plants used for medicinal purposes.

Loss of wildlife

Project implementation will result in the loss of natural habitats through site clearing for project offices, worker's camps, access roads, realignment of railway, the MR19, powerlines and resettlement of homesteads. The loss of habitats will also cause conflicts between humans and wildlife where some mammals will seek refuge within cultivated fields and consequently be killed by humans.

Inundation and operation of the dam will attract aquatic fauna and birds, but the attraction of large mammals will be limited due to the homesteads and cultivation surrounding the dam. The attraction of birds, although a positive impact, is likely to be limited by the prevalence of alien invasive plants.

Resettlement of homesteads to sites that are in close proximity to formally protected areas, such as Mlilwane, and informally protected areas such as Usutu Forest, will cause conflicts between humans and wildlife. Conflicts will be through increased likelihood, or attempts, or actual incidents of poaching. Another form of conflict will arise from noise pollution, which will either cause behavioural changes amongst some species of wildlife or cause them to flee towards the quieter interior of protected areas, thereby reducing their range area.

Deminishing of Natural Environment

The dam will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.

In view of the scarcity of remaining land for homesteads, resettlement and relocation of homesteads to higher up the mountain sides will diminish the scenery of the mountains.

Intrusive Built Environment

The dam wall will face southward where there are no homesteads or access routes, therefore the wall will not be visually obtrusive to both the local community and visitors passing through the area and along the MR19.

Resettlement and relocation of homesteads will increase congestion of built areas, thus diminishing the sense of open space of the rural countryside. This will be accentuated by the need to provide adequate space for continued subsistence agriculture, thus forcing homesteads into more congested areas. Congested spaces will further degrade the rural lifestyle wherein residents presently feel safe to leave their homesteads unattended without having to worry about burglaries. Presently the open space enables neighbours to easily lookout for each other's homesteads thus mitigating crime. Therefore congestion will degrade the sense of community and sense of belonging amongst residents, both characteristics which are part of cultural heritage.

From an aesthetic perspective, a positive impact of constructing resettled homesteads to at least meet minimum building regulation requirements will be the general improvement of the visual attractiveness of the host community. Amongst the residents who will not be resettled, the disparity in building standards between opulent and impoverished homesteads will persist, thereby diminishing the aesthetic appeal of the community and rural landscape around the dam.

Diverse and Conflicting Values Attached to Heritage Resources

Flora and Fauna

The various impacts on heritage resources are likely to trigger or expose the diverse and or/ conflicting societal values attached the such resources. Such diversity in the attachment of values is influenced by the differing world views amongst different groups of people. For example, one of the discussions arising during the engagement of Project Affected Persons was the listing of one of the project's justifications for the selected location as being the need to avoid encroachment into Mlilwane Wildlife Sanctuary. Some Project Affected Persons submitted that this demonstrated that plants and animals were accorded by project engineers and proponents a higher value than fellow humans. They proposed that the dam be located further south, along the boundary of Mlilwane or in neighbouring commercial forests so as to further mitigate involuntary displacement (Community meetings of 17th August 2019; 26th September 2020). Meanwhile the technical arguments for the proposed location emphasized the suitability of the geology, the long term financial return on investment as well the optimal balance of impacts on humans and wildlife of the proposed location.

Graves

While no objections were raised against the relocation of household graves during the engagement of Project Affected Persons, they submitted that the project will need to ensure that all burial rituals will need to be respected and financed by the project. It is nevertheless prudent to anticipate incidents where some individuals or households may have extenuating circumstances feeling uncomfortable with relocating their graves when the time arrives. These will include, but not limited to ancestral ties to the land upon which the household and/ or family graves are situated. This is a situation which at times may not be fully appreciated by proponents of development.

Rock Art Site

The Rock Art Site is potentially in danger of being inadvertently destroyed by the pressure on land for residential settlements, particularly as it is presently not fenced, nor signposted to warn the public of its presence. The risk is that some Project Affected Persons may choose to resettle on the available land near the Rock Art Site the land is close to where they already live. When advised not to encroach upon the site, they will feel dejected that preference is being given to the protection of a rock upon which the ancient paintings are barely legible.

Table 9-36: Cultural Heritage – Construction Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Disturbance of archaeological / heritage sites by project activities	Rock Art site Masibekela refuge cave	Construction	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Disturbance of archaeological / heritage sites by project activities	Graves of Chiefs and their relations	Construction	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Loss of archaeological / heritage sites by inundation	Graves of community members	Construction	Negative	5	2	4	2	5	65	N3	3	2	3	2	3	30	N1
				N3 - High							N1 - Low						
Potential unearthing / discovery (i.e. chance find) of archaeological / heritage sites	Graves of Chiefs and their relations. Graves of community members	Construction	Positive	1	1	5	1	2	16	P1	1	5	1	1	3	24	P1
				P1 - Low							P1 - Low						
Potential unearthing / discovery (i.e. chance find) of archaeological / heritage sites	Rock Art site Masibekela refuge cave	Construction	Positive	1	1	5	1	2	16	P1	1	1	1	1	1	4	P1
				P1 - Low							P1 - Low						
Damage and loss of indigenous vegetation / wildlife.	Damage and loss of indigenous vegetation. Loss of wildlife	Construction	Negative	4	2	3	5	5	70	N3	2	2	1	5	3	30	N1
				N3 - High							N1 - Low						
Disturbance by human activity.	Degradation of scenery by encroachment of houses into near-pristine areas and housing density	Construction	Negative	2	5	5	2	3	42	N2	1	2	1	1	2	10	N1
				N2 - Medium							N1 - Low						
Conflict	Conflict in perceptions of value and thus conflict in approaches to handling heritage resources, leading to delays or obatscles to project implementation.	Construction	Negative	5	5	5	3	4	72	N3	1	2	1	1	2	10	N1
				N3 - High							N1 - Low						

Table 9-37: Cultural Heritage – Operational Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Deterioration of archaeological / heritage resources by uncontrolled visitor access.	Rock Art site Masibekela refuge cave	Operation	Negative	1	1	5	5	5	60	N2	1	1	1	1	4	16	N1
				N2 - Medium							N1 - Low						
Disturbance and lack of access to grave of Chiefs and their relations / community members	Reduced access will cause physical and emotional alienation from the graves and burial sites.	Operation	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Lack of access to indigenous plant resources lost through inundation.	Loss of species of cultural significance such as timber and grasses used for construction, as well as plants used for medicinal purposes	Operation	Negative	4	2	3	4	4	52	N2	3	2	2	2	2	18	N1
				N2 - Medium							N1 - Low						
Attraction of fauna to project site due to availability of water	Attraction of fauna to project site due to availability of water	Operation	Positive	1	1	5	5	4	48	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						
Enhancement of aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	The dam will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	Operation	Positive	1	5	5	1	5	60	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						
Enhancement of aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	Improved aesthetic appeal of resettled homesteads.	Operation	Positive	1	5	5	1	5	60	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						

9.4.11 TOURISM AND RECREATION POTENTIAL DOWNSTREAM

OPERATIONAL PHASE

The dam wall will retain the surface water runoff which would naturally have flowed in the Lusushwana River. This will result in a reduced flow at the Mantenga waterfall and the Usushwana Valley which is important tourism attractions.

The Mantenga Nature Reserve, proclaimed in 1994, is a protected area of 725ha in a secluded corner of the Ezulwini Valley, just 2 km from a major road. It contains not only the Mantenga Waterfalls but also the cultural village, Ligugu Lemaswati ("pride of the Swazi people"). This nature reserve is home to vervet monkeys, baboons, warthogs, nyalas and duikers as well as the Endangered Bald Ibis.

The Project is however not anticipated to impact the Mantega Falls as the current ecological flow, as released by the Lupholo Dam, will be maintained.

Table 9-38: Downstream Tourism Potential – Operational Phase

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Downstream Economic Activities	The reduced flow may result in a reduction of downstream tourism potential.	Operation	Negative	3	3	3	4	4	**52**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						

10. CUMULATIVE IMPACTS

10.1 INTRODUCTION AND METHODOLOGY

The ESIA process serves to assess, mitigate and manage the environmental and social impacts of individual projects but may be insufficient for identifying and managing incremental impacts on areas or resources used or directly affected by a given development from other existing, planned, or reasonably defined developments. The IFC Good Practice Handbook: Cumulative Impact Assessment and Management defines cumulative impacts as follows:

> *"Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to in this document as "developments") when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities."*

The CIA process analyses the potential impacts and risks of proposed developments in the context of the potential effects of other human activities and natural environmental and social external drivers on the chosen valued environmental and social components (VEC) over time and proposing sound measures to avoid, reduce or mitigate the impacts as far as possible.

10.2 CONSIDERATION OF REGIONAL PROJECTS

During the ESIA regional projects were identified through discussions in stakeholder workshops and literature review. Information on the likelihood of the projects proceeding and the implementation timeframes was generally limited or unavailable. Rapid, qualitative assessment of the potential cumulative implications of these regional projects is provided in **Table 10-1**. Due to the close proximity, the Luphohlo Dam and the 132 KV powerline will have a similar AoI as Nondvo Dam.

Table 10-1: Current and Proposed Regional Projects

REGIONAL PROJECT	POTENTIAL CUMULATIVE EFFECT
The Luphohlo Dam Wall Raising The Hawane Dam Wall Raising	— Soil, Land Use and Land Capability ▪ Erosion — Hydrology and Hydrogeology ▪ Surface water quantity ▪ Surface water quality ▪ Environmental flow ▪ Evaporation ▪ Flow modification ▪ Dam wall failure ▪ Flooding — Riverine Ecology ▪ Habitat loss — Terrestrial Ecology ▪ Loss of habitat ▪ Loss of fauna — Waste generation — Air quality

REGIONAL PROJECT	POTENTIAL CUMULATIVE EFFECT
	— Climate change — Socio-Economics ▪ Loss of livelihoods, displacement and resettlement ▪ Loss of medicinal plants ▪ Temporary employment creation ▪ Additional water for domestic use and irrigation ▪ Nuisance factors
The Ethemba Dam Construction	The impact associated with the Ethemba Dam will be very similar to the impacts associated with Nondvo Dam.
Construction of the 132 KV powerline	— Soil, Land Use and Land Capability ▪ Erosion — Hydrology and Hydrogeology ▪ Surface water quality — Riverine Ecology ▪ Habitat loss — Terrestrial Ecology ▪ Loss of habitat ▪ Loss of fauna — Waste generation — Air Quality — Climate Change — Socio-Economics ▪ Loss of livelihoods, displacement and resettlement ▪ Loss of medicinal plants ▪ Temporary employment creation ▪ Nuisance factors

10.3 BIOPHYSICAL CUMULATIVE IMPACTS

The area has previously and presently been impacted by rural development along with agricultural practices. In the future, should the Nondvo Dam be built, the area will be completely changed and the surrounding areas will experience even greater stressors. Currently there is still viable habitat in the inundation zone and even more sensitive habitat within the DMU that will be lost. The cumulative impact of the Project is rated as high should the Project go ahead and as moderate for the current state of the environment.

The nature and extent of the potential cumulative impacts of the proposed development were assessed by adding the existing and proposed project impacts with potential future developments. The cumulative impacts associated with the Project include:

- Water quality and quantity impacts on the Lusushwana River;
- Augmentation of urban water supplies to the urban areas of Mbabane and Manzini (current: 8.4 Mm^3/a in 2005 to 10.4 Mm^3/a in 2030);
- Development of large-scale irrigation agriculture near Malkrerns; and
- Proposed dams in the Usuthu River catchment (JMRBWRS, 2008) (**Figure 10-1**).

Figure 10-1: Proposed Impoundments in the Usuthu/Maputo River Catchment (JMRBWRS, 2008)

Should the proposed Nondvo Dam project proceed, water quality (increased salinity) impacts in the Lusushwana River near Manzini can be anticipated as a result of reduced flows, particularly during the operation and initial flooding of the reservoir. This would likely be compounded through increased water demand in the urban areas of Mbabane and Manzini.

Should the proposed Nondvo Dam and the proposed irrigation projects near Malkerns proceed, water quality deterioration in the Lusushwana River would be anticipated as a result of the loss of dilution capacity and an influx of irrigation return flows.

Should the development of impoundments in the Usuthu / Maputo Rivers proceed, it is likely that there will be an impact to floodplains within the lower reaches of the watercourse. This will likely result in the further alteration of hydrology, sediment loads and local ecology in the Pongola River floodplains and Makatini Flats in proximity to the Ndumo Game Reserve in South Africa.

10.4 SOCIO-ECONOMIC CUMULATIVE IMPACTS

The construction of the Nondvo Dam, in addition to the other regional projects will result in a cumulative impact that will change the socio-economics of the area. It is anticipated that that for all the projects there will be livelihoods lost and displacement and resettlement will occur. The 132 KV powerline has already received authorisation to proceed and the resettlement and compensation process has commenced. The 132 KV powerline is proposed in the same location as the Nondvo Dam and the two projects will not be able to co-exist in the manner they are currently proposed (**Figure 7-67**). The powerline will have to be realigned in order for the Nondvo Dam to be feasible. It is thus anticipated that additional households will need to be relocated for the realignment of the powerline.

Figure 10-2: Authorised 132KV Powerline

Even though there are negative socio-economic impacts there will also be cumulative positive socio-economic impacts associated with water supply for domestic, industrial and irrigation purposes. In addition, there will be temporary employment opportunities for each of the projects. These impacts have a significant influence on the economics of Eswatini.

11. IMPACT STATEMENT

The ESIA was undertaken in a manner consistent with the international safeguards specifically the AfDB IESIA Guidelines (AfDB, 2015), as well as the laws and regulations of the Kingdom of Eswatini.

A detailed baseline study campaign was carried out between February and September 2019 involving the collection of primary data on a range of environmental components raging from ecological and hydrological to social. Stakeholder engagement was undertaken which sought to identify issues and concerns of government, community, commercial/business and NGOs.

Potential environmental impacts were identified through detailed analysis of the proposed project activities and the associated impact sources. The pre-and post-mitigation (residual) significance of impacts was assessed using a methodological framework developed by WSP to meet the combined requirements of international best practice and the relevant EIA Regulations.

The residual impacts (positive and negative) that were assessed as medium or high are discussed in **Table 11-1** and **Table 11-2**. There are three residual impacts with high negative sensitivity. These include:

- The permanency of the impact to geology by the quarry and dam wall construction.
- The inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat.
- The alteration of the flow regime of the river due to the construction of the dam wall.

Table 11-1: Medium and High Impacts - Construction Phase

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
Biophysical Environment			
Geology and Topography	Blasting and large foundations constructed into the underlying geology and establishment of a quarry to extract material will remove soil cover and expose underlying rock.	High	This impact is considered high due to the permanence of the removal of construction material for the dam wall construction. This impact cannot be mitigated and will remain once construction is completed. Material, is however required for the dam wall construction and there is no other feasible alternative. This is not considered a fatal flaw.
Soil, Land Use and Land capability	Trapping of sediment will prevent the normal sediment load distribution downstream potentially resulting in a deeper and narrower channel and other related morphological impacts. Clear	Medium	The dam wall will trap sediment which will result in morphological impacts. These impacts will be reduced to some

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
	water has the capacity to carry more sediment than turbid water. The release of clear water is therefore likely to increase erosion and collapse of river banks downstream of the dam.		extent by the construction of anti-erosion structures, however it is anticipated that the impact of sediment trapping will remain.
Hydrology and Hydrogeology	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Medium	During the construction phase the flow will be changed. This will be managed by the construction of the diversion channel and cofferdams to allow for continued flow downstream. However, the residual impact will have a medium significance.
	Rainfall on eroded / unconsolidated sediment has the potential to result in an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems functioning may occur.	Medium	During the construction phase it is anticipated that erosion will occur on areas cleared for linear infrastructure, construction camps, quarry and dam wall construction. It is anticipated that erosion from these areas will occur, even though the impact can be mitigated to some extent the residual impact will have a medium significance.
Riverine Ecology	Construction activities instream will present an immediate migration barrier with the potential to fragment the populations of biota in the watercourse.	Medium	During the construction phase a migration barrier will be created. This will be managed by the construction of the diversion channel and cofferdams to allow for fish movement. In addition, temporary fish ladders can be installed. However, the residual impact will have a medium significance.
	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to the river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	High	In order to establish the Nondvo Dam an area of approximately 19.7 ha of instream and 55.9 ha of riparian habitat, this impact is unavoidable and there are no mitigation measures. This is not considered a fatal flaw.
Terrestrial Ecology	Destruction, further loss and fragmentation of the vegetation community.	Medium	During the construction of the Nondvo Dam the habitat will be fragmented, there is limited mitigation that can be implemented.

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
Climate Change and Green House Gases	The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others.	Medium	The potential impacts associated with the establishment of the proposed dam with regards to the climate include: — Limited carbon emissions from plant and equipment on the site during construction and operation phases; and — Potential carbon emissions resulting from the decomposition of vegetation because of the inundation of woody vegetation within the dam basin, and from the clearing of land in the surrounding areas.
	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink.	High	In order to establish the Nondvo Dam an area of approximately 19.7 ha of instream and 55.9 ha of riparian habitat, the greenhouse gases being emitted from the decomposing of woody material cannot be mitigated. This impact is unavoidable and there are no mitigation measures.
Socio-Economic Environment			
Disturbance and Loss of Social and Economic Activities	The Project will result in physical displacement and relocation of approximately 210 households in Mantabeni and Siphocosini.	Medium	The 210 households requiring resettlement and compensation (i.e. physical and economic displacement) will be managed through a RAP and LRP to be implemented. However, this will still result in the disturbance and loss of social and economic activities.
	Loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will affect PAPs ability to produce food and cash crops/ produce.	Medium	The loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will be managed through a RAP and LRP to be implemented. However, this will still result in the disturbance and loss of social and economic activities.
Employment Creation, economic Opportunities and Diversification	Generation of employment (formal and informal) and other income generation opportunities in the Nondvo Dam Project area and the surrounding area	Medium	The benefit associated with employment creation and economic opportunities will be enhanced by the development and implementation of a Labour Recruitment Policy and Guidelines.

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
			This is considered a benefit.
Introduction and Movement of Workers into / Out of Local Communities	Expectations regarding possible employment opportunities may result in the area surrounding the site experiencing an influx of job seekers. Migrants will bring with them differing cultures, religious beliefs, norms and values; they influence young people to change in a manner that may not be accepted by the more conservative/ traditional sector of the population. Resulting in increased prevalence of STIs and HIV/AIDS as well as crime.	Medium	An influx of potential workers into the area cannot be prevented, however the impacts associated can be reduced. Labour Recruitment Policy and Guidelines will be developed and implemented. In addition, a Code of Conduct will be developed and signed by all employees of the contractors together with their employment contract.
	The Project area has one clinic, primary school and high school and is regarded as semi-rural. The possible influx of work seekers and additional contractor's workforce may add more stress on the existing resources.	Medium	An influx of potential workers into the area cannot be prevented, it is also difficult to manage the usage of social services by migrants. This residual impact will have a medium significance.
Disruption to Family and Community Structures	Employment opportunities may inadvertently cause a shortage of available farming skills and family support networks during the construction phase. Additionally people employed in the construction work may aim to secure further work in the construction sector with their newly acquired skills and experience, leading to a longer term disruption to social and economic networks.	Medium	It is anticipated that these newly acquired skills may inadvertently cause a shortage of available farming skills and family support networks during the construction phase, and beyond. However, since these young people will have enough money that they would send home (as it is the norm with African families) to get hired help in agriculture
Increased safety risks to people and animals	Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.	Medium	An influx of potential workers cannot be prevented, however the living arrangements can be managed as per the guidance provided by the World Health organisation (WHO) for COVID-19.

Table 11-2: Medium and High Impacts - Operational Phase

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
Biophysical Environment			
Soil, Land Use and Land Capability	During the operational phase water for irrigation of 800 ha of agricultural land will be made available.	Medium	During the operational phase the Nondvo Dam will provide the potential for irrigation of approximately 800 ha of vegetable production, this will result in the establishment of additional agricultural land.
	Sediment trapping will prevent normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower.	Medium	The dam construction site will trap sediment and prevent the normal sediment load distribution downstream of the river. In order to increase the morphological diversity of the Lusushwana River, environmental improvements will be implemented:
Hydrology and Hydrogeology	Operation of the Nondvo Dam will result in changes to the river flow regime and ecosystems: — Seasonal variation impacting aquatic and riparian systems downstream. — Loss of turbulent flow reducing dissolved oxygen concentrations; — Increase of turbulent flow resulting in oxygen super-saturation; — Increased water loss rate due to increased evaporation; — Increased recharge of the underlying aquifer through infiltration; and Changes in velocity and volumes of flow resulting in changes to the natural shape of the streams.	Medium	During the operational phase the flow will be changed. This will be managed by maintaining an ecological flow release of 4 Mm^3/year.
	Initial inundation of the reservoir will increase in concentrations of nutrients and organic matter due to the decomposition of inundated vegetation and possible mobilisation of nutrients from	Medium	In order to establish the Nondvo Dam an area of approximately 19.7 ha of instream and 55.9 ha of riparian habitat. It is

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
	previous agricultural activities. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation).		recommended that all large trees be removed from the inundation area in order to avoid
	Dam inundation alters the amount of sediment production, retention and transportation in the system.	Medium	During the operational phase it is anticipated that the dam wall and inundation will alter the sediment production. This impact cannot be mitigated entirely and the residual impact will have a medium significance.
	Change in flow (reduced quantity) downstream of the dam affecting downstream ecological functioning and disruption of supply to users.	Medium	During the operational phase the flow will be changed. This will be managed by maintaining an ecological flow release of 4 Mm^3/year.
Riverine Ecology	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	High	The construction of a dam disrupts the river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall. Based on the available literature, as well as reviews of the impacts of impoundment, post impoundment impacts directly influence a myriad of factors in watercourses that ultimately alter the ecological structure and function of riverine ecosystems (Kingsford, 2000).
	Alteration of downstream flow regime can impact on the relative volume of water discharge, the permanence of low flows as well as the frequency and magnitude of flood peaks leading to reduced frequency of overbank flooding and negative impacts on the breeding cues of local fish communities.	Medium	During the operational phase the flow will be altered which can impact the downstream river ecology. This will be managed by maintaining an ecological flow release of 4 Mm^3/year. This is not considered a fatal flaw.
	Alteration of migratory patterns for the observed Eel species (*Anguilla mossambica*) due to migratory habitats upstream of the dam being inaccessible.	Medium	During the operational phase the dam wall will create a barrier for fish movement. This impact cannot be mitigated and will have a residual impact with a medium significance.

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
Terrestrial Ecology	Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances	High	During the operational phase of Nondvo Dam the habitat will be fragmented, there is limited mitigation that can be implemented.
	Continued habitat degradation (litter, fire and alien vegetation encroachment)	Medium	The edges of the new inundation area will likely be degraded by impacts such as sand mining and livestock drinking, alien vegetation will become a concern in these disturbed areas. There are minimal mitigation measures that can be implemented and the residual impact will have a medium significance.
	Loss in genetic diversity, habitat fragmentation and disruption of habitat corridors	Medium	Due to the new geographical barrier that will be formed by the dam (the area will be divided into two sections) ultimately making it impossible for fauna and flora species to cross breed/pollinate. The barrier restricts dispersal and migration for terrestrial species and therefore causes habitat fragmentation. There are minimal mitigation measures that can be implemented and the residual impact will have a medium significance.
	Introduction of new waterborne diseases	Medium	With the influx of water into the area, the likelihood of waterborne diseases such as amoebiasis, botulism and giardiasis increase as untreated sewage from the old homesteads and surroundings will now be found in the water.
	Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter and feral species such as cats and dogs	Medium	The infringement of humans exacerbates the direct impact of a loss of vegetation due to the project components. The new settling area will have an increase in challenges, secluded areas that might still be present will now be under pressure.
Ecosystem Services	The inundation of the reservoir area will result in an alteration of ecosystem services	Medium	Due to the inundation of the reservoir the overall water ecosystem service score will be decreased with the proposed land use. It therefore is however worth noting that the largest of the identified watercourses is the river system, which purification of water

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
			score is expected to increase, therefore compensating for the other three watercourses.
	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	High	In order to establish the Nondvo Dam an area of approximately 19.7 ha of instream and 55.9 ha of riparian habitat, the greenhouse gases being emitted from the decomposing of woody material cannot be mitigated. This impact is unavoidable and there are no mitigation measures.
Climate Change	The operation of the dam will result in the dam basin area filling to capacity which will result in the inundation of vegetation. There are potential carbon emissions that will be released by the decomposing of woody vegetation	Medium	There are potential carbon emissions resulting from the decomposition of vegetation because of the inundation of woody vegetation within the dam basin, and from the clearing of land in the surrounding areas.
Socio-Economic Environment			
Ease of Shortage of Water in Manzini and Mbabane, Irrigation of agricultural land and Promotion of Social and Economic Growth	The completion of the Nondvo Dam Project water infrastructure will ensure reliable water supply in Manzini, Mbabane and surrounding areas as well as the water supply for irrigation of 800 ha of agricultural land in the project area. The availability of reliable infrastructure assets can increase returns and levels of investment and therefore accelerate economic growth.	High	This is considered a significant benefit of the Project.
Employment Creation, economic Opportunities and Diversification	The number of direct Project employment and procurement requirements will be dramatically reduced during operation (no accurate figures are currently available); however, as a result of the Project, the area will be more accessible, and the reservoir will potentially be seen as an attraction resulting in an increased number of tourists visiting the area. Additionally, some of the workers and migrant work-seekers will remain following construction; thus the population is likely to increase as compared to the current baseline. The economy, which is almost exclusively focused on agriculture, is likely to become more	Medium	The benefits to the local economy would be experienced as a positive impact that would deliver direct, indirect and induced opportunities. Direct Project opportunities will be more limited in the local economy. The impact will be localised but with the potential to extend to other areas of interest within Hhohho District. This is considered a benefit.

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
	diversified through an influx of people with a greater variety of skills and offerings.		
Downstream Economic Activities	Disruption of downstream economic activities as a result of reduced flow.	Medium	During the operational phase the flow will be changed. This will be managed by maintaining an ecological flow release of 4 Mm^3/year.
Introduction and Movement of Workers into / Out of Local Communities	The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available.	Medium	Post-construction and the completion of the associated job opportunities, the general standard of living could deteriorate over time as a result of decreased levels of affordability (linked to decreased income compared to the more prosperous construction phase) although it is still expected to remain better than before construction.
	The establishment of the Nondvo Dam would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be permitted at the site. This would increase the footprint of tourists and contribute to the income generation of the local area. Construction of tourism facilities by local entrepreneurs and partnerships in the area may increase. Growth of the tourism sector will also facilitate the creation of induced employment for local people, especially the youth	Medium	There is a potential tourism opportunity that will increase the local economy. This is considered a benefit.
	As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo project area.	Medium	It is likely that during the operational phase the needs and wants of the local community might change. It is unclear whether this will be a wanted or unwanted change and is discussed as a negative impact.

RECEIVING ENVIRONMENT	IMPACT DESCRIPTION	RESIDUAL SIGNIFICANCE	DISCUSSION
Demand on local utilities - Energy	The energy generated by the Project is to be utilised for operational purposes of the dam as well as the distribution of electricity to the local population near the reservoir and thus thereby increasing their quality of life.	Medium	Security of electrical supply in the area will potentially result in increased quality of life and economic development. This is considered a benefit.
Visual Impacts	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and disturbed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountainsides and preserve the tranquillity of the rural landscape. The impact is considered positive as the reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	Medium	From an aesthetic perspective the reservoir, which will be seen from visual receptors throughout the area, will enhance the visual aesthetics of the surrounding mountainsides and preserve the open space and tranquillity of the rural landscape. This is considered a benefit.
Downstream Tourism Potential	The reduced flow may result in a reduction of downstream tourism potential.	Medium	During the operational phase the flow will be changed. This will be managed by maintaining an ecological flow release of 4 Mm^3/year.

An Environment and Social Management Plan (ESMP) has been developed. The ESMP represents the commitments to address and manage the potential negative and enhance the positive impacts associated with the Nondvo Dam. The key intent of the ESMP is to ensure that the environmental and social objectives of the Project are met, and it is based on the various components of the Project throughout the design, construction and operational phases.

The ESMP makes recommendation for institutional strengthening (including capacity building) and assigns responsibilities for the implementation of enhancement and mitigation measures as well as the completion of the monitoring programs.

The ESIA has not identified any fatal flaws which would restrict the development of the proposed Nondvo Dam.

A RAP has been developed as part of the Project, which focuses on displacement issues in more detail.

12. CONCLUSION AND RECOMMENDATIONS

12.1 CONCLUSION

The main purpose of Nondvo Dam is the storage of water for the supply of potable water to Mbabane and Manzini, which are currently suffering from intermittent water shortages, and where the anticipated future water demand is deemed to be highest. The additional water supply is also anticipated to facilitate the growth of the population alongside the "Corridor" area connecting these two cities. Possible secondary benefits of the proposed dam are the potential for utilising the Nondvo Dam head for small-scale hydropower generation, as well as utilising the stored water for irrigation of approximately 800 Hectares (ha) of agricultural land in the surrounding region.

The ESIA included and assessed the components listed below:

- River diversion works;
- Nond Dam and auxiliary works;
  - Dam wall;
  - Spillway;
  - Intake;
  - Powerhouse (i.e hydropower plant); and
  - Bottom outlet.
- Quarry;
- Site camps and offices;
- Electrical distribution system, connection to the existing low voltage electricity distribution scheme;
- Temporary access roads; and
- Railway line realignment.

The following components are excluded from the ESIA:

- Water distribution infrastructure (i.e pipeline network connecting dam to end-users);
- Realignment of the inundated internal access roads; and
- Host community impacts has only been included at a high-level.

The above aspects have been excluded from the ESIA due to the fact that they were not identified or assessed within the Technical Feasibility Study (Studio Pietrangeli, 2019). Regarding host sites for displaced PAPs, two potential host sites were identified, however impacts at the host communities and selection of the preferred site were not part of the ESIA.

The Nondvo Dam has been defined as a Category 3 Project in terms of the EAARR and the EEA. This is in line with a Category 1 investment project as defined in terms of OS 1 of the AfDB Integrated Safeguards System. In terms of other international standards this is in line with Category A Projects of the World Bank environmental and social safeguard policy categorisation and IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts, focusing on the significant environmental and social issues of a project.

The ESIA has identified various project impacts (both positive and negative) that may be incurred by the dam construction and operation. The high impacts (positive and negative) identified in the ESIA include the following:

- The permanency of the impact to geology by the quarry and dam wall construction.
- The inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat, which cannot be mitigated.
- The alteration of the flow regime of the river due to the construction of the dam wall.
- The benefit of water supply to Mbabane and Manzini, and the corridor in-between.

— Irrigation of 800 ha of agricultural areas.

An ESMP has been developed which represents the commitments to address and manage the potential negative and enhance the positive impacts associated with the Nondvo Dam. The key intent of the ESMP is to ensure that the environmental and social objectives of the Project are met, and it is based on the various components of the Project throughout design, construction and operational phases.

Extensive stakeholder consultation was undertaken with all potential stakeholders identified during the Scoping Phase and ESIA Phase. Several categories of stakeholders were considered, namely government institutions, NGOs, communities and private companies that are close to the project area. During the consultation process numerous engagements were held and comments received. The stakeholder engagement undertaken is outlined in the SEP, attached in **Appendix F**. Stakeholder consultation will continue during the ESIA Phase Public Disclosure Process.

A RAP has been developed as part of the Project and issued as a standalone document. The RAP focuses on physical and economic displacement issues in more detail.

The ESIA has not identified any fatal flaws that would restrict the development of the proposed Nondvo Dam. With effective implementation of the mitigation measures detailed within the ESMP and associated management plans, identified negative impacts can be reduced to acceptable levels while the positive impacts can be maximised to provide significant benefits to the region.

12.2 RECOMMENDATIONS

The proposed Nondvo Dam should be approved for development with the following key recommendations:

— The ESIA is limited to the project description as contained in this report. Should the Project be implemented any changes in the project description that have the potential to materially affect the findings of the ESIA should be evaluated.

— The ESIA has been undertaken on the feasibility designs as per the Final Feasibility Report, dated October 2019, undertaken by Studio Pietrangeli (Studio Pietrangeli, 2019). Due to the Project being in the feasibility stage and not yet the final design stages there may be a need to revisit the findings of this ESIA and the management measures contained in the ESMP to ensure the findings and mitigation are still relevant.

— Amendments of the EMPs may be required should any design changes or updated construction information have environmental or social implications that are different from the findings of this ESIA Report.

— A detailed assessment of the project components below needs to be undertaken prior to the Project being implemented:
  - Water distribution infrastructure (i.e pipeline network connecting dam to end-users);
  - Realignment of the inundated internal access roads; and
  - Identificationof host community(ies) and assessment of impacts.

— Implement the recommendations outlined in the Dam Safety Plan (Knights Piesold, 2019).

— An Ecological Flow Requirement (EFR) release of 4 Mm^3/year is recommended (JMRBWRS, 2008) however a PROBFLO assessment to determine and assess the current EFR is to be undertaken as part of the detailed design.

— Implement the ESMP (**Appendix B**).

— Implementation of the RAP (in accordance with international lender requirements).

— The ESIA recommendations and ESMP are critical environmental management tools to be implemented during the construction phase; however, their effectiveness is underpinned by the level of adoption by the construction contractor. To this end, these documents should be made available to the contractor for inclusion in its own environmental and social management system.

In summary, the positive benefits of the proposed water supply to Mbabane and Manzini far outweigh the negative impacts and the proposed Nondvo Dam is recommended for development.

12.3 WAY FORWARD

Upon finalisation the ESIA Report will be submitted to the EEA (i.e. the regulatory authority) for review. Upon completion of the initial review by the EEA, the EEA will issue the Proponent with the comments to be addressed. The Consultant will address comments received from the EEA by amending the ESIA Report and ESMP accordingly, in consultation with the Proponent. The amended ESIA Report will be resubmitted to the EEA for approval prior to issuing for Public Review.

The EEA will then issue its final decision on whether or not the proposed Project is authorised to proceed (i.e. issue an Environmental Compliance Certificate). Where the proposed project is authorised by the EEA to proceed, the EEA will specify the conditions of authorisation as well as any additional requirements for compliance monitoring (i.e. the frequency at which Project Compliance Reports shall be submitted to the EEA).

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APPENDIX

A

ESIA TEAM ROLES AND RESPONSIBILITIES

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Key Experts				
Jean Marc Evenat	International Advisor	30	Certificate in Eco-Industrial Toxicology MSc. (Environmental Sciences) Certificate in Ecology BSc. (Geography)	Jean-Marc has successfully completed up to 17 hydroelectric power projects in Africa, South Asia, South and Central America and Canada. Most of the ESIA's carried out by Jean-Marc have been aligned with World Bank operational policies, IFC PS's and as such, he has a sound understanding of these performance criteria. He has worked directly for the IFC and the African Development Bank, and has interacted with several other international banks and development finance institutions. In addition to international performance standards, he has worked with local environmental and social regulations across Africa
Amelia Briel	Environmentalist	13	MSc. (Environmental Toxicology) BSc. (Hons), (Zoology) BSc. (Biological Sceince)	Amelia Briel has 14 years of experience in Environmental Management, especially within the mining and water infrastructure field. She is a certified Environmental Assessment Practitioner and a registered Professional Natural Scientist. Amelia manages the Environmental Section at Knight Piésold and oversees all projects at a strategic level. She specialises in large-scale infrastructure development projects such as dams, hydropower, pipelines and mines. Her project experience in Swaziland includes managing the completion of the Feasibility Study for the Ethemba Dam, including the Environmental and Social Impact Assessment and Resettlement Action Plan.
Antoine Moreau	Expert Participative Approach and Consultation	32	PhD. (Public Participation in Environmental Management) MSc. (Sociology) BSc. (Sociology)	Extensive experience of delivering resettlement assignments in Africa (to IFC PS and African Development Bank (AfDB) requirements). He has held position as Lead Sociologist, Safeguard Specialist and RAP Coordinator for projects in the following countries: Tanzania, Zambia, Uganda, DRC, Kenya, Angola, Cameroon, Chad, Congo, Gabon, Burundi, Gabono, and Republic of Equatorial Guinea

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Andrew Husted	Ecologist	12	MSc. (Aquatic Health) BSc. (Hons), (Aquatic Health) BSc. (Zoology and Botany)	The Ecological Project Lead for Construction of the Pavua dam, and power generation ESIA in compliance with IFC and World Bank Standards as well as lead on other ESIAs in the mining sector in compliance with IFC and World Bank Standards in Cameroon and Liberia. In addition to overseeing the project ecological team he also provided specialist aquatic ecological inputs, flow requirements and managed the ecology for the project.
Karen King	River Morpho–dynamic Specialist	14	MSc. (Hydrology) BSc. (Hons), (Hydrology) BSc. (Hydrology and Soil Science)	Karen King is a professional hydrologist and soil scientist specialising mining/development hydrology, monitoring, water resources planning, catchment-scale hydrological modelling, flood studies, water balances, storm water management planning, wetland delineation, water research, agricultural studies, soil science and related risk assessments and management plans. She has been primarily involved in the engineering hydrology and soil science fields, initially as a soil science lecturer at UKZN for 3 years, and then as a hydrologist in various engineering consultancies both in South Africa and in the United Kingdom. Karen has undertaken work in 7 countries and is currently studying toward a PhD in hydrology. In 2012 she co-published "Exploring Water Resources Sustainability in a Trans-Boundary Context. Water and Sanitation Africa" Her professional affiliations and registrations include: South African Council for Scientific Professions – Professional Natural Scientist (Earth Scientist) (PriSciNat); Water Institute of South Africa; The Golden Key Honour Society; and International Water Association.
Greg Mathews	Basin Protection Specialist	17	BSc. (Hons), (Hydrology) BSc. (Hydrology, Geography and Geology)	Key specialism and experience in surface water, groundwater and contaminated land related projects. He has managed and implemented a number of turnkey projects in the industrial, mining, agricultural and governmental sectors. His specialities include surface and groundwater assessments, monitoring and modelling, stormwater management plans, flood risk assessments, industrial and mine water and effluent management and contaminated land risk assessment and remediation. Greg has been involved in numerous water related projects where he has used his hydrological background successfully in the assessment of environmental related impacts to the hydrological environment and recommendations on mitigation requirements. Further to this, Greg has been involved in a number of high profile due diligence, waste and waste classification, environmental risk assessment and remediation based projects in Southern Africa including three years involvement in the ESIA for the Lower Orange River Hydropower Project (nine mini hydroelectric stations feeding into the national grid) for Nampower (Pty) Ltd, Namibia.

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Non Key Experts				
Mbuso Kingsley	Support Environmentalist (Local)	19	Instruments of Environmental Management BSc. (Environmental Sciences)	Mbuso has extensive knowledge of Swaziland policy and legislative environment and professional working relationships with the SEA and other key governmental stakeholders. His position as Environmental consultant since 2009 has allowed him to devlop his expertise in Environmental Auditing, ESIA; SEAs and stakeholder engagement. Before entering the consulting sector he was in the employ of Ubombo Sugar Limited (Illovo) as Environmental Officer, Quality Assurance Officer; and progressed to Risk Control Manager.
Anri Scheepers	Support Environmentalist (International)	10	BA. (Hons), (Geography and Environmental Management) BA. (Geography)	Anri has extensive experience in managing environmental studies the field of economic development, planning, and ESIA. She has undertaken more than 10 ESIA's within southern Africa ranging from industrial to infrastructure projects. Her key strength is the ability to manage and integrate large teams of specialists operating across thematic areas typically associated with ESIA processes.
Robert Els	Support Environmentalist	6	BSc. (Hons), (Geography) BSc. (Environmental Sciences)	Robert's areas of expertise include: undertaking Environmental Impact Assessments (EIAs) and Basic Assessments, developing Environmental Management Programmes (EMPs), undertaking site audits (EHS Due Diligence and Environmental Control Officer). He has also completed Environmental and Social Impact Assessments (ESIA) to the African Development Bank standards. He has experience in a broad range of sectors, including industrial developments, agri-industrial parks, infrastructure (roads, water supply and wastewater treatment facilities) and mining. Robert has undertaken assignments for a range of South African and international Clients in South Africa and Africa.
Gordon O'Brien	Aquatic Survey (incl. wetlands, Ecosystem Services)	2	PhD. (Aquatic Health) MSc. (Aquatic Health) BSc. (Hons), (Aquatic Health) BSc. (Zoology and Botany)	A well-educated ecologist specialising in aquatics and environmental flows and ecosystem services; with two years in-field experience in the Nile Basin, Lesotho and South Africa. Key experience includes Instream Flow Requirement determination for Lesotho Highland Water Development study (Phase 2 Polihali Dam) using the PROBFLO approach which is now being implemented internationally; and Development of customised Nile Environmental Flows Framework including technical manual and implementation guidelines. He is well placed to assess fish communities and their wellbeing and response to altered flows.

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Luke Verburgt	Herpetofauna Survey	12	MSc. (Zoology) BSc. (Hons), (Zoology) BSc. (Zoology)	Luke specialises in the following: Fauna surveys (including Herpetofauna) , ecological assessments, biodiversity monitoring surveys, GIS mapping and spatial analyses, environmental monitoring plans, biodiversity action plans, and IFC critical habitat assessments. He has used these skill since 2007 in the following countries: South Africa, Lesotho, Angola, Mozambique, Malawi, Madagascar, Liberia, Namibia, and DRC.
Llewelyn Coertzen	Botanical Survey	6	BSc. (Hons) (Wildlife Management) BSc. (Animal Science)	Lleweleyn is a general ecologist and botanist registered with SACNASP and a certified SASS5 practitioner. Areas of key expertise include vegetation / botanical studies, spatial ecology and GIS mapping. He has extensive experience with water supply, energy and linear development projects and worked in the following countries since 2007: South Africa, Mozambique, and Liberia,
Lukas Niemand	Invertebrates and Avifauna Survey	13	MSc. (Restoration Ecology and Zoology) BSc. (Hons), (Entomology) BSc. (Zoology and Entomology)	Lukas is a terrestrial ecologist registered with SACNASP and member of the Entomological Society of Southern Africa. Areas of key expertise include: Avifauna Assessments and Surveys, Invertebrate Assessments, Biodiversity and Ecological Assessments, ESMPs, and Environmental Education. He has used these skill since 2004 in the following countries: South Africa, Mozambique, and Liberia.
Samuel Laurence	Mammal Survey	12	BSc. (Hons), (Wildlife Management) BSc. (Conservation Biology and Marine Biology)	Samuel is SACNASP registered for Zoological Science & Ecological Science. Key area of expertise include: Mammal Assessments and Surveys, Botanical / Biodiversity and Ecological Assessments, ESMPs, Environmental Education, Health and Safety; and Training. He has experience within the hydrology, energy (including transmission); and linear development sectors in the following countries: South Africa, Malawi, Mozambique. Specifically he has carried out Flora and Fauna Biodiversity Assessment for inclusion in ESIA for hydroelectric projects in Mozambique and Malawi.
Ursula Verburgt	Ecological Technician	6	MSc. (African Mammalogy) MSc. (Zoology) BSc. (Hons), (Biology)	Senior Manager, Logistics Coordinator and SASS5 practitioner who currently fulfils the following project roles: Assistant Herpetologist, Assistant Mammologist, Logistics coordination, Aquatic Invertebrate Assessments (SASS5), and Water quality testing. She has had field experience within the following countries since 2008: South Africa, Mozambique and Liberia.

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Campbell Abrahamson	Dam Safety	48	BSc, Civil Engineering	Key specialism and experience in the design and construction supervision of dams and hydraulic structures (intake works, pump stations, pipe lines and river works). He has also been responsible for the planning and management of hydraulic gate installations and tunnels relating to these dam projects. As an approved engineer to perform dam safety evaluations in South Africa, he has undertaken a number of these for both Category II and III dams. He has taken responsibility for major aspects of various feasibility studies in South Africa.
Colin Holmes / Andrew Pickles	Hydrological Support (Field)	4-5	MSc. (Applied Environmental Science) BSc. (Environmental Science) / BSc. (Hons), (Hydrology)	Colin Holmes (Pr.Sci.Nat) is an Environmental Scientist a SACNASP registered Professional Natural Scientist and an accredited Carbon Footprint Analyst with experience in monitoring, conducting Water-Use Licence Applications, IWWMPs, Carbon Footprint Analyses and Freshwater Aquatic Delineation and Functional Assessments.
Tjengisa Dlamini	Socio-Economic Survey Supervisor	18	Diploma (Sustainable Rural Development) Diploma (Social Studies) B-Tech (Business Economic)	An experienced Resettlement Officer and Social Projects Coordinator, Tjengisa has: — Successfully worked in various environmental and resettlement projects and other community related projects throughout the Kingdom of Swaziland. Experience whilst working with resettlement projects has entailed developing the affected communities through identifying, establishing and advising on economic development opportunities with the affected areas. — Research and community skills, with the ability to keep information collected or discussed with affected stakeholders confidential. — Communication skills through presentation of written and verbal reports to stakeholders, including affected communities. Of particular relevance to this project, he has worked on resettlement team (primary interface with communities and facilitation of focus groups) on the following projects: Lower Usuthu Smallholder Irrigation Project; and Maguga Dam for the Komati Basin Water Authority (KOBWA).

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Bob Forrester	Heritage Specialist	30	BA (Archaeology and Anthropology)	Extensive experience within Swaziland (fluent in both English and Swahili) having filled positions within the following institutions: – Swaziland Archaeological Research Association under Swaziland National Trust Commission (SNTC) – European Union Office of the European Commission in the Kingdom of Swaziland – Swaziland National Museum under Swaziland National Trust Commission (SNTC) He was awarded in 2013 a Sahee Foundation Fellowship to co-write "The Holographic Kingdom", an academic book exploring history, archaeology and ritual in Swaziland. He has conducted archaeological scoping surveys for large areas, including 860ha for proposed sugarcane industry development.
Louis Maziya	Translator	18	BSc. (Maths and Physics)	Louis, who is fluent in English and Swahili has worked in various community development and infrastructure development projects throughout Swaziland, undertaking and supervising data collection as well as liaising with project affected communities; including supervision of a baseline survey for the Swazi Rail Project carried out by REDI.
Social Survey Investigators x 14				Locally selected
Marie Andree' Burelle	Social Survey Specialist	8	Postgraduate Diploma in Teaching in Higher Education, Université du Québec à Montréal Master's degree in Anthropology, Université de Montréal, Quebec	Marie-Andrée Burelle is an anthropologist specializing in intercultural relations, education, as well as in dynamic and religious conflicts. Over the past few years, she has held coordination, research and teaching positions. With WSP, Ms. Burelle contributes to the preparation of environmental and social impact studies, as well as population resettlement plans at the international level. She has contributed to the development of efficient socio-economic surveys methods for RAP and ESIA purposes and has led numerous teams of surveyors in Africa and in the Caribbean. She has also worked on the incorporation of aboriginal traditional knowledge and land use for projects in Africa and in the North of Canada.
Flavie Armand	Socio-Economic Database Specialist	11	Master's degree in Environment, Université du Québec à Trois Rivières Bachelor's degree in Geography, Université du Québec à Trois Rivières	Flavie Armand is a geographer since 2006. Prior to joining the WSP team, she managed environmental community projects and gained several years of teaching experience in physical and human geography at the Cégep de Trois-Rivières. Within WSP, she has been involved in ESIAs as well as in environmental monitoring and management projects. Within these mandates, she participated in the economic, social and psychosocial aspects related to infrastructure projects. She works mainly in social and economic population data processing and in producing technical reports. She has also participated in environmental and social impact assessments of projects on the African continent, including interconnection projects of power lines and mines, where she manages the population data collection process of individuals that will need to be relocated as part of these projects.

NAME	ROLE	YEARS EXP.	QUALIFICATIONS	EXPERIENCE AND SPECIALISM FOR ASSIGNED ROLE
Mthokozisi Sibeko	Local Stakeholder Engagement Advisor	11	B.A Social Science, University of Swaziland	Mr. Sibeko has worked as a development planner, environmentalist, trainer and researcher in several organisations in Swaziland. Key experience related to stakeholder engagement within this project is his coordination role in the development of Chiefdom/Community Development Plans for the seven chiefdoms affected by the Lower Usuthu Smallholder Irrigation Project (LUSIP) in the Lubombo Region. Prior to this he fulfilled the role as Project Administrator of the Integrated Water Resource Management Demonstration Project; and Facilitator for the Integrated Sustainable Rural Development (ISRD) workshops for rural development practitioners from the Lubombo region. Computer literacy skills include: MS Office & MS Project; AutoCAD; ArcGIS 9.2; SPSS; STATA; and Adobe Photoshop. Mthokozisi also works as Land Use planner consultant for integrated development projects.

APPENDIX

B ESMP / CMP

GOVERNMENT OF THE KINGDOM OF ESWATINI, MINISTRY OF NATURAL RESOURCES AND ENERGY - DEPARTMENT OF WATER AFFAIRS

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE PROPOSED MBABANE - MANZINI CORRIDOR DAM PROJECT, ESWATINI

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

23 JUNE 2021 FINAL

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF THE PROPOSED MBABANE - MANZINI CORRIDOR DAM PROJECT, ESWATINI

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

GOVERNMENT OF THE KINGDOM OF ESWATINI, MINISTRY OF NATURAL RESOURCES AND ENERGY - DEPARTMENT OF WATER AFFAIRS

TYPE OF DOCUMENT (VERSION)
FINAL

PROJECT NO.: 41101626
DATE: JUNE 2021

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QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
Remarks	DRAFT ESMP	Draft Final ESMP	Draft Final ESMP	Draft Final ESMP
Date	January 2020	August 2020	March 2021	June 2021
Prepared by	Carla Elliott	Carla Elliott	Carla Elliott	Carla Elliott
Checked by	Robert Els	Robert Els	Robert Els	Robert Els
Authorised by	Nigel Seed	Nigel Seed	Nigel Seed	Nigel Seed
Project number	41101262	41101262	41101262	41101262
Report number	01	01	01	01
File reference	W:\000 NEW Projects\41101262 - Nondvo Dam ESIA Eswatini\02 ES\2-REPORTS\01-Draft\ESMP			

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This Environmental and Social Impact Assessment Report (Report) has been prepared by WSP Environmental Proprietary Limited (WSP) and Maphanga Mitchell Associates (MMA) and on behalf and at the request of the Government of the Kingdom of Eswatini, Ministry of Natural Resources and Energy - Department of Water Affairs (Client), to provide the Client with an understanding of the environmental impacts associated with the proposed Mbabane – Manzini Dam Project.

Unless otherwise agreed by us in writing, we do not accept responsibility or legal liability to any person other than the Client for the contents of, or any omissions from, this Report.

To prepare this Report, we have reviewed only the documents and information provided to us by the Client or any third parties directed to provide information and documents to us by the Client. We have not reviewed any other documents in relation to this Report, except where otherwise indicated in the Report.

PRODUCTION TEAM

CLIENT

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Project Director:	Nigel Seed
Support Environmentalist (International):	Anri Scheepers
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SUBCONSULTANTS

Knight Piésold – Environmentalist (Study Lead):	Amelia Briel
Maphanga Mitchell Associates – Support Environmentalist (Local):	Mbuso Kingsley

ACRONYMS

ACRONYM	DESCRIPTION
AfDB	African Development Bank
AIP	Alien Invasive Plant
AoI	Area of Influence
ASPT	Average Score Per Taxon
BP	Best Practice
CEMP	Construction Environmental Management Plan
CH	Critical Habitat
CLO	Community Liaison Officer
CMP	Comprehensive Mitigation Plan (used interchangeably with ESMP)
CPLO	Community Participation Liaison Officer
CR	Critically Endangered
CRE	Chief Resident Engineer
DMU	Discrete Management Unit
DoE	Department of Energy
DWA	Department of Water Affairs
EAARR	Environmental Audit, Assessment and Review Regulations (2000)
EA	Environmental Assessment
ECO	Environmental Control Officer
EEA	Eswatini Environment Authority
EEC	Eswatini Electricity Company
EFR	Ecological Flow Requirement
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EN	Endangered
ENTC	Eswatini National Trust Commission
EP	Evacuation Plan
EPC	Engineering, Procurement & Construction
ERP	Emergency Response Plan
ES	Ecosystem Services
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan (used interchangeably with CMP)
ESMS	Environmental and Social Management System
ESWADE	Eswatini Water and Agricultural Development Enterprise
FL	Flood Level @ $Q_{10,000}$
FROC	Frequency of Occurrence

ACRONYM	DESCRIPTION
FSL	Full Supply Level
GHG	Greenhouse Gases
GoE	Government of Eswatini
GRM	Grievance Redress Mechanism
H&S	Health and Safety Officer
HMMP	Hazardous Materials Management Plan
HPP	Hydropower Plant
IESIA	Integrated Environmental and Social Assessment
IFC	International Finance Corporation
ID	Irrigation District
IUCN	International Union for Conservation of Nature
JMRBWRS	Joint Maputo River Basin Water Resources Study
KPI	Key performance targets and indicators
LRP	Livelihood Restoration Plan
masl	Meters above sea level
MNRE	Ministry of Natural Resources and Energy
MSDS	Material Safety Data Sheet
MTEA	Ministry of Tourism and Environmental Affairs
MoA	Ministry of Agriculture
MoF	Ministry of Finance
NGOs	Non-Governmental Organisations
NWA	National Water Authority
PAP	Project Affected People
PPE	Personal Protective Equipment
PSC	Project Steering Committee
RAP	Resettlement Action Plan
RCC	Roller-Compacted Concrete Dam
SCC	Species of Conservation Concern
SDMP	Spoil Disposal Management Plan
SDS	Safety Data Sheet
SDMP	Spoil Disposal Management Plan
SEP	Stakeholder Engagement Plan
SLA	Service Level Agreement
SMP	Sediment Management Plan
SP	Studio Pietrangeli Consulting Engineers
STIs	Sexually Transmitted Infections
SWMP	Stormwater Management Plan

ACRONYM	DESCRIPTION
TEA	Tourism Economic Assessment
ToR	Terms of Reference
URBA	Usuthu River Basin Authority
WHO	World health Organisation
WUA	Water User Association

GLOSSARY

TERM	DESCRIPTION
Biodiversity	The variability among living organisms from all sources including, inter alia, terrestrial and aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems
Catchment	The area from which rainfall flows into a river, lake, or reservoir.
Comprehensive Mitigation Plan	A document containing a description of the mitigation measures to be implemented that would prevent, reduce or otherwise manage the environmental impacts of a project and done according to the reporting requirements in the Second Schedule of the Environmental Audit, Assessment and Review Regulations, 2000.
Critical habitat	Areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species; (ii) habitat of significant importance to endemic and / or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and / or unique ecosystems; and/or (v) areas associated with key evolutionary processes (see IFC PS6, Paragraph 16).
Critically Endangered	A taxon is Critically Endangered (CR) when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by IUCN criteria (www.iucnredlist.org).
Cultural heritage	The range of material (tangible) culture, as well as practices, performance, indigenous knowledge, oral traditions / history that is bequeathed from one generation to the next, and which each subsequent generation moulds and adapts.
Dam	A dam is a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply.
Disadvantaged or vulnerable groups	Individuals or groups within the Project are of influence who could experience adverse impacts from the proposed project more severely than others based on their vulnerable or disadvantaged status. This status may stem from an individual's or group's race, colour, sex, language, religion, political, or other opinion, national or social origin, property, birth or other status. In addition other factors will be considered such as gender, ethnicity, culture, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.
Diversity	An expression of the variety of species that exist in a community.
Economic displacement	Loss of assets or access to assets that leads to loss of income sources or means of livelihood.
Ecosystem services	Defined as the benefits that people obtain from nature. These are typically divided into four categories. — Provisioning services are the goods or products obtained from ecosystems, such as food, timber, medicines, fibre, and freshwater; — Regulating services are the benefits obtained from an ecosystem’s control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards; — Cultural services are the nonmaterial benefits obtained from ecosystems, such as recreation, spiritual values, and aesthetic enjoyment; and — Supporting services are the natural processes that maintain the other ecosystem services, such as nutrient cycling and primary production.

TERM	DESCRIPTION
Endangered	A taxon is classified as Endangered (EN) when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by the IUCN criteria (www.iucnredlist.org) or provisionally assessed by an expert group.
Environment	Means the whole or any component of: — Nature, including air, land, water, soils, minerals, energy other than noise, and living organisms other than humans; — The interaction between the components of nature and between those components and humans; — Physical, aesthetic and cultural qualities or conditions that affect the health and well-being of people.
Environmental Compliance Certificate	Means a certificate issued by the Authority under Regulation 15, which certifies that the Authority has consented to an existing undertaking continuing to operate, or, to a proposed project proceeding, subject to the operator or proponent complying with the conditions specified in the certificate and in the approved comprehensive mitigation plan.
Environmental Impact	Means any positive or negative impact, on the natural and/or environment, on any form of life, on the social, economic and/or cultural conditions that influence human life, or on any interrelationship between these elements or factors, which is, will be, or may be, directly or indirectly caused by an existing or proposed project, policy, plan or programme.
Environmental Impact Assessment	Means the process of predicting and evaluating the likely environmental impacts of a proposed project where the scale, extent and significance of the environmental impacts cannot be easily determined.
Environmentally Sensitive Area	Means an area which merits a high degree of environmental protection because the environment in that area, or any constituent part of it, is rare, endangered, or sensitive to harm, or has particular environmental, archaeological, social, or cultural significance or value, whether or not the area is legally or administratively protected, and includes areas designated as environmentally sensitive by the Minister.
Erosion	Erosion (geologic). — The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep. Erosion (accelerated). — Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or a catastrophe in nature, such as a fire, that exposes the surface.
Flood plain	The nearly level plain that borders a stream and is subject to flooding unless protected artificially.
Groundwater	Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.
Habitat	The environmental or ecological area in which an animal, plant species or other organism lives.
Homesteads	A homestead is one or more dwellings and adjacent outbuildings.
Infiltration	The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material
Invasive aliens	Species are identified as invasive aliens when (i) they are non-native to an ecosystem, and (ii) their introduction is liable to cause environmental harm, or harm to human health and livelihoods, because they spread rapidly and have negative effects on native species through competition, predation, or disease. Invasive species can be flora, fauna, or other organisms (e.g. microbes) but generally refer to plants.

TERM	DESCRIPTION
Natural Resources	Means any component of nature, capable of being utilised by humans and includes air, land, water, soils, minerals, energy, living organisms other than humans, and genetic resources, and for the purposes of this definition, “genetic resources” means any material of plant, animal, microbial or other origin containing functional units of heredity, of any actual or potential value.
Pollution	Any change in the environment which has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future.
Project Areas of Influence	The Project's Area of Influence (AoI) includes the primary project site(s) and related facilities that the proponent (including its contractors) develops or controls; associated facilities that are not funded as part of the project (funding may be provided separately by a proponent or a third party including the government), and whose viability and existence depend exclusively on the project and whose goods or services are essential for the successful operation of the project; areas potentially impacted by cumulative impacts from further planned development of the project; and areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location. The Area of Influence does not include potential impacts that would occur without the project or independently of the project.
Proponent	Means a person responsible for initiating a project and obtaining the appropriate authorization.
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, inform decision making, plan and monitor in terms of a proposed project, programme or development.
Reservoir	A large natural or artificial lake used as a source of water supply.
Resettlement Action Plan	The document in which a project sponsor or the responsible entity specifies the procedures that it will follow and the actions that it will take to mitigate adverse effects, compensate losses, and provide development benefits to persons and communities affected by an investment project.
Runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.
Soil	A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1 TERMS OF REFERENCE

A Joint Maputo River Basin Water Resources Study (JMRBWRS) was jointly undertaken by the Kingdom of Eswatini, the Republic of South Africa and the Republic of Mozambique (Skoy Plancenter Ltd, 2008). During this study, a multi-criteria selection process was developed and applied to a number of proposed water supply projects in order to identify the most promising options for further investigation. The Government of the Kingdom of Eswatini, Ministry of Natural Resources and Energy, Department of Water Affairs (DWA) appointed Studio Pietrangeli Consulting Engineers (Studio Pietrangeli) to undertake the relevant scoping and feasibility studies for the multipurpose project to "*identify and design a project that meets competing water demands up to the Horizon 2050 through optimizing its dimensions and costs and minimizing socio-environmental impacts*".

The construction of a new dam – Nondvo Dam – has been identified as a long term solution (up to 2050). The main purpose of Nondvo Dam is the storage of water for the supply of potable water to Mbabane and Manzini, which are currently suffering from intermittent water shortages, and where the anticipated future water demand is deemed to be highest. The additional water supply is also anticipated to facilitate the growth of the population alongside the "Corridor" area connecting these two cities as well as the generation of hydropower. Possible secondary benefits of the proposed dam are the potential for utilising the Nondvo Dam head for small-scale hydropower generation, as well as utilising the stored water for irrigation of approximately 800 Hectares (ha) of agricultural land in the surrounding region.

The tender to perform the Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP) and Resettlement Action Plan (RAP) was awarded to WSP Environmental (Pty) Ltd. (WSP) in partnership with Maphanga Mitchell and Associates (MMA), and Knight Piésold.

1.1.2 OBJECTIVES OF THE ESMP

The ESMP[1] aims to bring the project into compliance with national environmental and social legal requirements as outlined in **Section 4: Policy, Legislative and Regulatory Framework** of the ESIA, and lender requirements – African Development Bank (AfDB) Integrated Environmental and Social Impact Assessment (IESIA) Guidelines (AfDB 2009; 2015).

Where relevant the ESMP broadly considers other Environmental and Social (E&S) international safeguard standards as good practice guidelines:

- World Bank Group Environmental and Social Safeguard Policies - Policy Objectives and Operational Principles (OPs).
- International Finance Corporation (IFC) and World Bank Group Environmental, Health and Safety (EHS) Guidelines, as follows:
  - EHS General Guidelines (April 2007);
  - EHS Guideline for Water and Sanitation (December 2007).

Specific requirements are referenced in the ESMP where relevant, along with the national and international guidelines and standards for monitoring purposes (**Section 7**).

[1] Referred to as Comprehensive Mitigation Plan (CMP) in the Environmental Audit, Assessment and Review Regulations (2000).

The primary objectives of the ESMP is to outline:

- Feasible and cost-effective measures to prevent, mitigate, minimise or compensate/offset negative impacts and enhance positive impacts;
- Monitoring requirements;
- Community consultation measures;
- Institutional strengthening measures;
- Training and capacity building requirements to strengthen environmental and social capacities amongst implementing agents;
- Measures for emergency response to health and safety;
- Estimated costs of residual impacts and proposed measures.

The ESMP will from part of the bidding and contract documentation to which the selected contractor/s need to comply. Furthermore, the ESMP is considered a dynamic document as management actions may be subject to changes as a result of feedback received during project implementation and / or in response to unexpected impacts with a magnitude different to that predicted at the time the ESIA was finalised. As such the ESMP will be reviewed and updated at regular intervals throughout the Project implementation.

1.1.3 MITIGATION APPROACH

The Mitigation Hierarchy (**Figure 1-1**) has been applied when proposing prevention, compensation and mitigation measures within the ESMP:

- **Avoid / Prevent:** Avoidance or prevention refers to the consideration of options in project location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services, and people. This is referred to as 'the best option', but it is acknowledged that avoidance or prevention is not always possible.
- **Minimise:** Minimisation refers to the consideration of alternatives in the project location, siting, scale, layout, technology and phasing that would minimise impacts on biodiversity, ecosystem services and people. Acceptable options to minimise will vary and include: abate, rectify, repair, and/or restore impacts, as appropriate.
- **Rehabilitate / Restore:** Rehabilitation refers to the consideration of the rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to a near-natural state or an agreed land use.
- **Offset:** Offsetting refers to the consideration of measures over and above rehabilitation to compensate for the residual negative effects on biodiversity ecosystem services and people, after every effort has been made to minimise and then rehabilitate impacts.

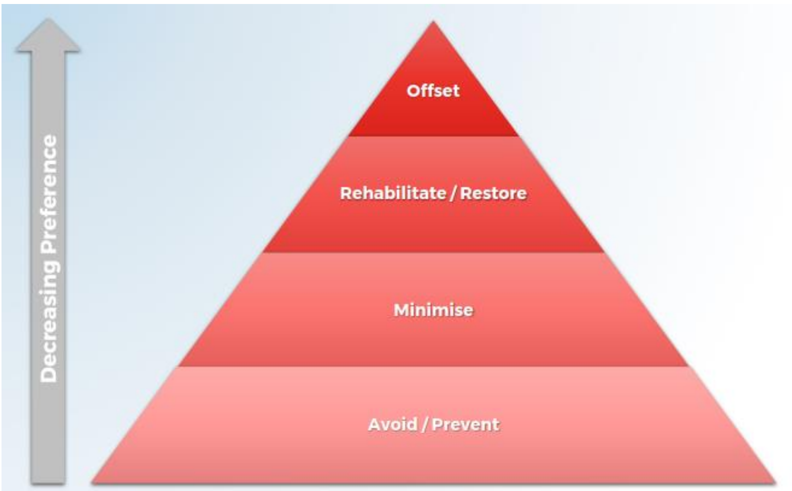

Figure 1-1: Impact Assessment Mitigation Hierarchy

1.1.4 STRUCTURE OF THE ESMP

This report presents the ESMP deliverable as **Appendix B** of the ESIA.

The ESMP also integrates, or at least refers to, any initiatives such as resettlement and livelihood plans, that contribute to enhance the project environmental or social performance. The RAP, together with Livelihood Restoration Plan (LRP), is presented as a stand-alone report.

The ESMP is structured as follows:

Chapter 1: **Introduction -** indicates the terms of reference, objectives of the ESMP, indicates the mitigation approach utilised, as well as the structure of the ESMP.

Chapter 2: **Project Description** - provides an overview of the project location, components and planned implementation phases.

Chapter 3: **Results of the Environmental and Social Impact Assessment –** provides a summary of the environmental and social impacts and associated significance pre- and post-mitigation.

Chapter 4: **ESMP Governance** – identifies and establishes of responsibilities among the various organizations for the implementation of the ESMP as well as the environmental awareness and institutional strengthening and capacity building recommendations for key institutions.

Chapter 5: **Reporting** – overview of key documentation and reporting requirements.

Chapter 6: **Mitigation and Enhancement Measures** - details measures to address the impacts outlined in the ESIA, in order to accrue project benefits (enhancement measures) or to reduce potentially adverse environmental and social impacts to acceptable levels (mitigation measures). Presented per phase: Pre-construction, Construction and Operational.

Chapter 7: **Environmental and Social Monitoring Plan** – stipulates monitoring activities to ensure that mitigation and enhancement measures are implemented, generate intended results, and that corrective actions are taken as required. Includes international and national standards against which monitoring results will be analysed.

Chapter 8: **Summary of the Implementation Schedule** – summarises all activities related to the proposed control measures (enhancement and mitigation), and monitoring plans – and associated estimated budgets.

Chapter 9: **Public Consultation and Disclosure** – overview of community engagement requirements to ensure successful implementation of the ESMP.

Chapter 10: **Conclusion and Recommendation** – concluding statement on effectiveness of the ESMP.

2 PROJECT DESCRIPTION

2.1 PROJECT OVERVIEW

Following the completion of a detailed feasibility study undertaken by Studio Pietrangeli (Studio Pietrangeli, 2019), it was determined that the Project would comprise a 38.6 m high gravity rolled compacted concrete (RCC) Dam and small hydropower plant (HPP) of less than 1 MW. The dam will harvest flows along the Lusushwana River, regulated by the upstream Luphohlo Dam, and associated tributary, the Nondvo River; resulting in a storage reservoir with a total storage capacity of approximately 22 Mm^3, delivering an assured yield of 9.8 Mm^3 per year. The reservoir will cover a surface area of approximately 2.4 km^2 (240 ha) at maximum operating level (Max. OL) across two Chiefdom areas, namely Siphocosini and Mantabeni.

The dam will provide water to Mbabane, Manzini and the areas between (i.e. Mbabane and Manzini corridor) to meet water demands up to 2050, for the following uses:

- potable, industrial and tourist use;
- irrigation of approximately 800 ha; and
- energy production.

To facilitate the above services the Project includes a number a components: river diversion works (canal and coffer dam); dam and auxiliary works; associated infrastructure (site camps and office, quarry, power evacuation and distribution); reservoir (inundation area); and re-alignment of existing linear infrastructure (railway and road). **Table 2-1** provides a breakdown of the identified aspects and the relevant sections in which they are discussed within the ESIA.

Table 2-1: Identification of aspects constituting the Project

ASPECT	COMPONENTS	SECTION IN ESIA
River Diversion Works	Canal and coffer dams	5.3
Dam and Auxiliary Works	Dam (Non-overflow Sections - Left and Right Dam)	5.4.1
	Spillway	5.4.2
	Intake	5.4.3
	Powerhouse	5.4.4
	Bottom Outlet	5.4.5
Associated Infrastructure	Quarry	5.5.1
	Site Camps and Offices	5.5.2
	Power evacuation and distribution	5.5.3
Reservoir	Inundation area	5.6
Re-alignment of existing linear infrastructure	Railway infrastructure	5.7.1
Land acquisition, resettlement and compensation	Resettlement Action Plan (RAP)	Standalone report

2.2 PROJECT LOCATION

The Project area is situated approximately 12 km south of Mbabane and 26 km north-west of Manzini, along the south-eastern boundary of the Hhohho Region, Eswatini (**Figure 2-1**).

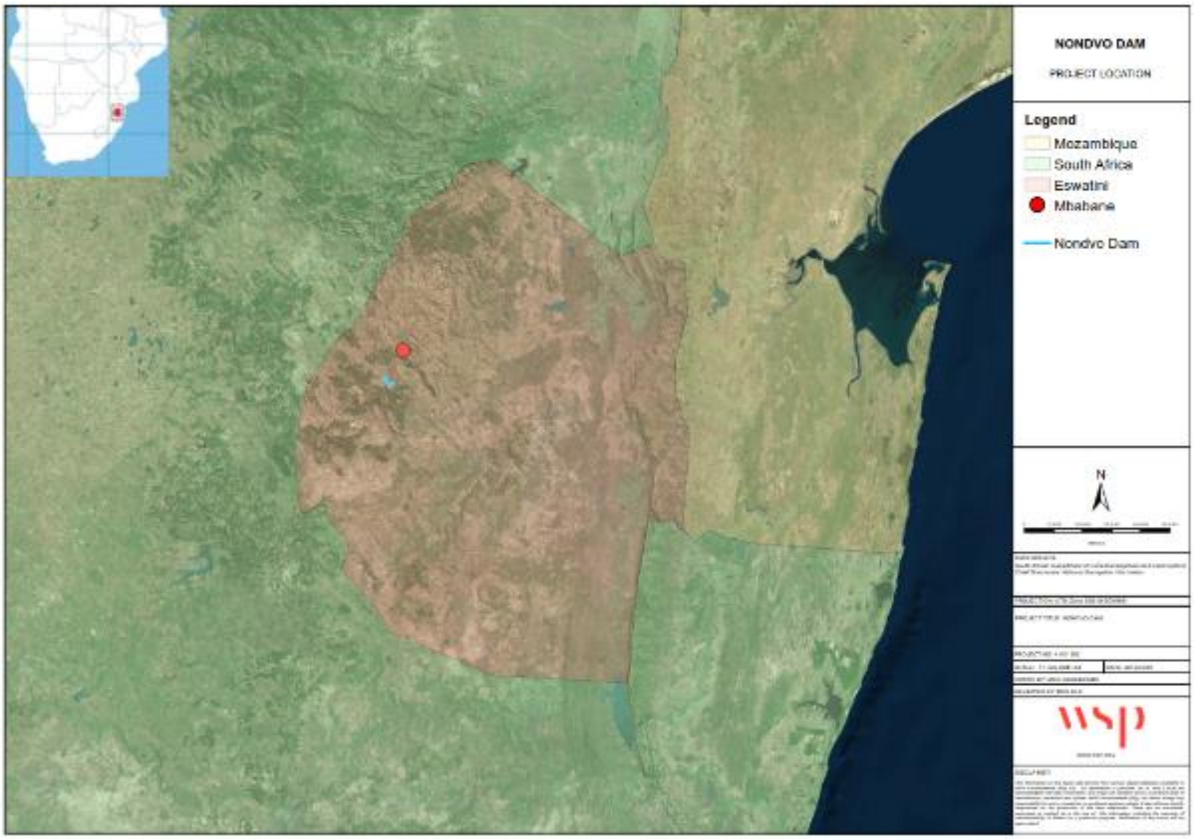

Figure 2-1: Map Indicating the Project Location

The Nondvo Dam is to be situated on the Lusushwana River, at the following coordinates 26°25'39.04"S and 31°7'0.98"E (UTM, WGS84: 312220E; 7075564S), approximately 7 km downriver of the existing Luphohlo Dam. The dam will harvest flows along the Lusushwana River, regulated by the upstream Luphohlo Dam, and associated tributary, the Nondvo River. **Figure 2-2** indicates the proposed locality of the Nondvo Dam and extent of the inundation area.

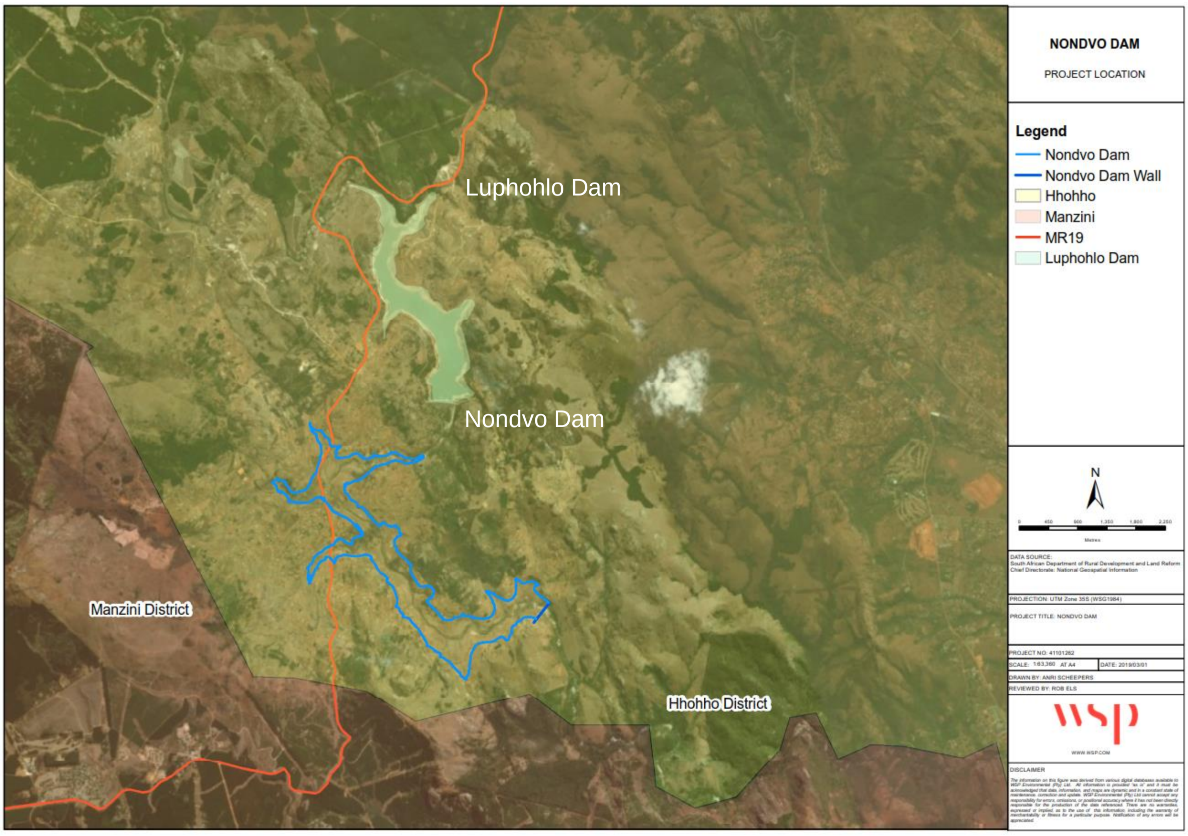

Figure 2-2: Proposed Nondvo Dam (WSP, 2019)

2.3 PROJECT PHASES

Typically, large-scale infrastructure consists of the following primary phases:

— **Pre-Construction Phase**: Project's planning process and authorisations; land acquisition and Engineering, Procurement & Construction (EPC) contracting.

— **Construction Phase**: Construction labour, transportation and the use of heavy equipment, land preparation, construction of temporary facilities (site offices and security), sourcing of materials; demobilisation of the workforce and location cleaning / dismantling of project construction remnants; and rehabilitation.

— **Operational Phase**: Regular maintenance requirements over the lifetime of the project to ensure optimal efficiency and effectiveness (including labour and material / equipment resourcing).

— **Decommissioning Phase**: Due to the nature of this development, the operational phase is assessed as lasting indefinitely and there are no closure or post-closure phases in this scenario.

Construction and operational activities are detailed in Chapter 5 of the ESIA.

The proposed dam is likely to be in operation for the considerable future (well beyond 2050 as a minimum). Therefore, the likely impacts of decommissioning cannot be accurately predicted at this stage. However, impacts during decommissioning are likely to be similar in nature to those identified for the construction phase and will be managed in cognisance of the applicable legislation.

2.4 PLANNED IMPLEMENTATION

2.4.1 CONSTRUCTION ACTIVITIES

The construction methodology will be confirmed during the detailed design phase. However, construction will generally follow:

- Foundation preparation and treatment (site clearing, remove overburden and rock scaling; dental concreting; foundation grouting)
- River diversion (construction of diversion channel and upstream and downstream cofferdams);
- RCC dam placement works
  - RCC placement preparation (including formwork);
  - Surface preparation (roughening and bedding mortar);
  - Continuous layering and compaction (transporting, spreading and compacting of RCC);
  - RCC curing;
  - Instrumentation (installation of mechanical and electrical equipment).

In support of the above, the following activities will be carried out:

- Transport of plant and equipment to the site;
- Site establishment (Site camp, offices etc.);
- Site clearance, including removal of vegetation;
- Establishment of quarry for source materials;
- Hauling of materials to the construction site;
- Stockpiling of materials on site;
- Operation of a concrete aggregate crushing plant;
- Operation of a concrete batching plant; and
- Spoiling of excavated rock (if not suitable for aggregates).

2.4.2 CONSTRUCTION SCHEDULE

Development of the Nondvo Dam, from commencement of construction to commissioning, is anticipated to be undertaken over a 36 month period[2]. The anticipated duration of the main activities are indicated in **Table 2-2**.

Table 2-2: Anticipated Project Schedule

ACTIVITY	PERIOD	YEAR 1												YEAR 2												YEAR 3											
	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Mobilization and Demobilization	6 Months																																				
Roads and Camps	3 Months																																				
Diversion Works	4 Months																																				
Dam and Auxiliary Works	24 Months																																				
Powerhouse	10 Months																																				
Commissioning	4 Months																																				
Total	36 Months																																				

On completion of the works, all temporary works constructed by the Contractor, unless otherwise specified or directed, shall be removed from the site. The Contractor shall make safe all areas affected by temporary works

[2] The duration of the construction time has been estimated on the basis of a suitable contractor's standard production for excavations, RCC, cement, etc.

and reinstate natural drainage. The Contractor shall finish, reinstate, clean up, and relinquish the site at the end of the Defects Liability Period or such earlier times as directed.

3 RESULTS OF ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The ESIA identifies, describes and assesses the significance of impacts based on a semi-quantitative methodology.

The impact significance without mitigation measures is assessed with the design controls in place. The residual impact is what remains following the application of mitigation and management measures, and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during project implementation to verify that actual impacts are the same as those predicted in this ESIA Report. Impact significance pre- and post- mitigation are summarised below.

3.1 CONSTRUCTION PHASE

3.1.1 BIOPHYSICAL

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Blasting and large foundations constructed into the underlying geology and establishment of a quarry to extract material will remove soil cover and expose underlying rock.	Construction	Negative	2	2	5	5	5	**70**	**N3**	2	1	5	5	5	**65**	**N3**
				N3 - High							**N3 - High**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Soils in the project area (dam wall site, diversion channel, quarry, access roads and railway line) could be exposed to increased soil erosion due to excavation and destabilisation resulting in potential loss of topsoil; and increased sedimentation. Secondary impacts to downstream ecosystems may occur.	Construction	Negative	3	2	3	4	4	**48**	**N2**	2	2	3	2	3	**27**	**N1**
				N2 - Medium							**N1 - Low**						
Construction and foundations of dam wall and quarry	Trapping of sediment will prevent the normal sediment load distribution downstream potentially resulting in a deeper and narrower channel and other related morphological impacts. Clear water has the capacity to carry more sediment than turbid water. The release of clear water is therefore likely to increase erosion and collapse of river banks downstream of the dam.	Construction	Negative	3	3	3	4	4	**52**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Water abstraction for construction could temporarily decrease the natural volume of water within the River.	Construction	Negative	3	3	3	2	3	**33**	**N2**	2	3	3	2	3	**30**	**N1**
				N2 - Medium							**N1 - Low**						
Construction and foundations of dam wall and quarry	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Construction	Negative	5	3	5	5	5	**90**	**N3**	5	3	5	5	3	**54**	**N2**
				N3 - High							**N2 - Medium**						
Construction and foundations of dam wall and quarry	Rainfall on eroded / unconsolidated sediment has the potential to result in an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems functioning may occur.	Construction	Negative	3	3	3	2	5	**55**	**N2**	2	2	3	2	5	**45**	**N2**
				N2 - Medium							**N2 - Medium**						
Accidental Release / spills of small quantities of potential contaminants into soils, water bodies, and groundwater	Runoff creates a preferential pathway and exposure of contaminants into the subsurface (groundwater) and downstream watercourses leading to a deterioration in water quality and secondary health impacts on aquatic ecosystems and water users (community).	Construction	Negative	2	1	1	2	3	**18**	**N1**	2	1	1	2	2	**12**	**N1**
				N1 - Low							**N1 - Low**						
Inundation of the reservoir area	The incorrect siting of chemical toilets and loss of containment could lead to pollution of the receiving environment (soil, groundwater and surface water), leading to secondary health impacts on downstream aquatic ecosystems and water users (surface and ground), and maintenance of livelihoods.	Construction	Negative	3	3	3	2	5	**55**	**N2**	1	1	3	2	4	**28**	**N1**
				N2 - Medium							**N1 - Low**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Direct alteration of the instream and riparian habitats resulting in the permanent modification of the habitats at a local scale.	Construction	Negative	3	2	1	5	3	**33**	**N2**	3	2	1	5	2	**22**	**N1**
				N2 - Medium							**N1 - Low**						
Construction and foundations of dam wall and quarry	Temporary loss of riverine habitat and affecting Chiloglanis emarginatus (IUCN, 2019) – a Vulnerable species.	Construction	Negative	3	1	1	3	3	**24**	**N1**	3	1	1	3	2	**16**	**N1**
				N1 - Low							**N1 - Low**						
Construction and foundations of dam wall and quarry	Construction activities instream will present an immediate migration barrier with potential to fragment the populations of biota in the watercourse.	Construction	Negative	5	3	5	5	4	**72**	**N3**	5	3	5	5	3	**54**	**N2**
				N3 - High							**N2 - Medium**						
Inundation of the reservoir area	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	Operational	Negative	5	2	3	5	5	**75**	**N3**	5	2	3	5	5	**75**	**N3**
				N3 - High							**N3 - High**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	Spread and/or establishment of alien and/or invasive species, especially in areas that are cleared.	Construction	Negative	4	3	3	4	4	**56**	**N2**	2	1	3	2	2	**16**	**N1**
				N2 - Medium							**N1 - Low**						
Construction of the linear infrastructure	Destruction, further loss and fragmentation of the vegetation community.	Construction	Negative	4	3	5	5	4	**68**	**N3**	4	2	3	5	4	**56**	**N2**
				N3 - High							**N2 - Medium**						
Increased vehicular activities along roadways and in public areas	Displacement, direct mortalities and disturbance of faunal community (including threatened species) due to habitat loss and disturbances (such as site clearance, dust, light, vibrations, poaching and noise)	Construction	Negative	4	3	3	3	4	**52**	**N2**	3	2	3	2	2	**20**	**N1**
				N2 - Medium							**N1 - Low**						
Infringment by humans into natural areas	Infringement by humans into the remaining natural areas, with associated impacts such as poaching, litter and introduction of diseases and feral species such as cats and dogs.	Construction	Negative	4	3	3	4	4	**56**	**N2**	3	2	3	2	2	**20**	**N1**
				N2 - Medium							**N1 - Low**						
Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	The inundation of the reservoir area will result in an alteration of ecosystem services	Operation	Negative	3	2	3	5	3	**39**	**N2**	3	2	3	5	3	**39**	**N2**
				N2 - Medium							**N2 - Medium**						
Inundation of the reservoir area	The inundation of the Nondvo Dam basin w ill result in the loss of the channelled valley bottom w etlands, unchannelled valley bottom w etlands and hillslope seeps. The loss of the w etland areas w ill result in the removal of the w etland sink	Construction	Negative	3	5	3	5	4	**64**	**N3**	3	5	3	5	4	**64**	**N3**
				N3 - High							**N3 - High**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Generation of general waste	Presence of workforce and absence of adequate waste receptacles results in increased litter potentially leading to secondary impacts on terrestrial and aquatic ecology.	Construction	Negative	3	3	3	3	4	**48**	**N2**	2	1	3	2	3	**24**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of general waste	Spoil material unsuitable for reuse as bedding and backfill material has the potential to disrupt land use and habitats if not managed appropriately.	Construction	Negative	3	2	3	3	4	**44**	**N2**	2	2	3	2	3	**27**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of general waste	The lack of inappropriate waste separation has the potential to result in unnecessary waste to landfill.	Construction	Negative	2	2	3	3	4	**40**	**N2**	2	1	1	1	3	**15**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste could lead to contamination of soil, groundwater and surface water; and poisoning of fauna.	Construction	Negative	3	2	3	3	3	**33**	**N2**	2	1	1	2	2	**12**	**N1**
				N2 - Medium							**N1 - Low**						
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	Lack of waste minimisation measures will lead to regional impacts and increased project construction costs as registered hazardous waste collectors are located outside the project area.	Construction	Negative	2	2	3	3	4	**40**	**N2**	2	1	1	1	3	**15**	**N1**
				N2 - Medium							**N1 - Low**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increased dust emissions will result in reduced ambient air quality resulting primarily in a nuisance factor to nearby receptors (e.g. onsite workers and residents)	Construction	Negative	2	2	3	2	3	**27**	**N1**	2	2	3	2	3	**27**	**N1**
				N1 - Low							**N1 - Low**						
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increased concentration of pollutants (gaseous emissions) will result in reduced ambient air quality	Construction	Negative	1	2	3	2	3	**24**	**N1**	1	2	3	2	3	**24**	**N1**
				N1 - Low							**N1 - Low**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Construction and foundations of dam wall and quarry	The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others	Construction	Negative	2	2	3	3	4	**40**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						
Inundation of the reservoir area	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	Construction	Negative	3	5	3	5	4	**64**	**N3**	3	5	3	5	4	**64**	**N3**
				N3 - High							**N3 - High**						

3.1.2 SOCIO ECONOMIC

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Physical Displacement and Resettlement of Affected Households	The Project will result in physical displacement and relocation of approximately 210 households in Mantabeni and Siphocosini below the reservoir Max. OL.	Construction	Negative	5	4	5	5	5	**95**	**N3**	3	4	3	5	4	**60**	**N2**
				N3 - High							**N2 - Medium**						
Economic Displacement of Affected Households	Loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will affect PAPs ability to produce food and cash crops/ produce.	Construction	Negative	4	3	3	4	5	**70**	**N3**	3	2	3	4	4	**48**	**N2**
				N3 - High							**N2 - Medium**						
Loss of plant resources used by the community	Loss of vegetation will result from site clearance in the infrastructure footprint during construction as well as due to flooding during inundation of reservoir area.	Construction	Negative	3	3	5	5	4	**64**	**N3**	2	2	3	3	2	**20**	**N1**
				N3 - High							**N1 - Low**						
Host Community Impacts	Introduction of the relocated PAPs into the host community will result in increased pressure on land, infrastructure, goods, and services. In severe cases these may result in conflict.	Construction	Negative	3	2	3	4	4	**48**	**N2**	3	2	1	2	2	**16**	**N1**
				N2 - Medium							**N1 - Low**						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased Cost of Living and Debt Generation	Increased demand for goods and services is likely to result in increased prices. Simultaneously, however, local people will be able to sell their goods / services at higher prices, thus potentially generating more income. Increased travelling distance around the reservoir will increase the cost of travel around the dam to reach important public services such as clinics, trading posts, schools and places of worship.	4	3	5	3	4	60	N2	2	2	1	2	3	21	N1
		N2 - Medium							N1 - Low						
Exacerbation of Anti-Social Behaviour due to in migration (influx of job seekers)	Expectations regarding possible employment opportunities may result in the area surrounding the site experiencing an influx of job seekers. Migrants will bring with them differing cultures, religious beliefs, norms and values; they influence young people to change in a manner that may not be accepted by the more conservative/ traditional sector of the population. Resulting increased prevalence of Sexually Transmitted Infections (STIs) and HIV/AIDS as well as crime.	4	3	5	5	4	68	N3	3	3	3	4	3	39	N2
		N3 - High							N2 - Medium						
Disruption to Family and Community Structures	Employment opportunities may inadvertently cause a shortage of available farming skills and family support networks during the construction phase. Additionally people employed in the construction work may aim to secure further work in the construction sector elsewhere, with their newly acquired skills and experience may be required, leading to a long term absence from family and disruption to family setting and social structures and improved economic networks.	3	3	5	4	4	60	N2	3	3	3	3	4	48	N2
		N2 - Medium							N2 - Medium						
Increased pressure on social infrastructure and services	The Project area has one clinic, primary school and high school and is regarded as semi-rural. The possible influx of job seekers and additional contractor's workforce may add more stress on the existing resources.	3	3	5	4	4	60	N2	3	3	3	3	4	48	N2
		N2 - Medium							N2 - Medium						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Demand on local utilities - Energy	Additional power requirements for construction purposes and services or facilities in the various housing, camp and work areas is likely to place additional pressure on existing electricity supply.	Construction	Negative	4	2	1	2	3	27	N1	3	2	1	2	2	16	N1
				N1 - Low							N1 - Low						
Demand on local utilities - Water	Additional water requirements for construction purposes and services or facilities in the various housing, camps and work areas is likely to place additional pressure on existing water supply.	Construction	Negative	4	2	1	2	3	27	N1	3	2	1	2	2	16	N1
				N1 - Low							N1 - Low						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Disturbance from increased nuisance factors (Noise, Dust, Vibrations)	Construction activities will generate uncharacteristic disturbances resulting in a range of nuisance factors (notably increased levels of noise, decreased air quality and vibrations).Damage to households structures from heavy traffic and rock fall from the blasting operations.	4	2	1	2	5	45	N2	3	2	1	2	2	16	N1
		N2 - Medium							N1 - Low						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	A number of hazards threaten the public safety and security during the construction phase, including increased traffic movement, handling of hazardous chemicals, rock blasting during quarry mining.	5	2	5	5	3	51	N2	3	2	3	2	3	30	N1
		N2 - Medium							N1 - Low						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	The operation of earthmoving equipment and construction vehicles will cause hazards which will result in accidents leading to injuries and fatalities in the workplace.	Construction	Negative	5	1	5	5	4	64	N3	2	1	1	3	2	14	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	Working in close proximity will expose employees to drowning hazards, such as when walking or driving on unstable surfaces along the water's edge, sudden flooding of the worksite due to heavy downpour, employees bathing in nearby pools during lunch break or after work. This risk of drowning is identified based on recorded incidents in the community.	Construction	Negative	4	1	5	5	3	45	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Skin contact with wet concrete and other chemicals such as chemical stabilizers and waterproofing agents, petrol and diesel will cause irritation and long term exposure will cause dermatitis.	Construction	Negative	3	1	1	4	4	36	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Workplace noise will cause noise-induced hearing loss (a recognised illness) while long term exposure to dust will cause or exacerbate pre-existing respiratory conditions.	Construction	Negative	5	1	5	5	5	80	N3	2	1	5	5	2	26	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	Inclement weather such as persistent rain, extreme cold, extreme heat will cause shock to the body, triggering conditions such pneumonia in the case of wet and cold, and heat stroke in the case of heat.	Construction	Negative	3	1	1	3	4	32	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.	Construction	Negative	5	5	3	4	4	68	N3	2	2	3	4	3	33	N2
				N3 - High							N2 - Medium						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Degradation of scenery of near-pristine areas / built environment	Unplanned construction of resettlement housing in host community may lead to degradation of scenery into near-pristine areas and of the built environment by increased housing density.	Construction	Negative	3	2	5	5	3	45	N2	1	2	1	5	2	18	N1
				N2 - Medium							N1 - Low						
Change in sense of place and landscape characteristics	Construction activities will introduce new machinery and structures into the landscape. Construction vehicles, dust and equipment will have a visual impact on viewers and general visibility (clarity of the air) within close proximity to the site.	Construction	Negative	2	2	1	2	5	35	N2	2	2	1	2	3	21	N1
				N2 - Medium							N1 - Low						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Disturbance of archaeological / heritage sites by project activities	Rock Art site Masibekela refuge cave	Construction	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Disturbance of archaeological / heritage sites by project activities	Graves of Chiefs and their relations	Construction	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Loss of archaeological / heritage sites by inundation	Graves of community members	Construction	Negative	5	2	4	2	5	65	N3	3	2	3	2	3	30	N1
				N3 - High							N1 - Low						
Potential unearthing / discovery (i.e. chance find) of archaeological / heritage sites	Graves of Chiefs and their relations. Graves of community members	Construction	Positive	1	1	5	1	2	16	P1	1	5	1	1	3	24	P1
				P1 - Low							P1 - Low						
Potential unearthing / discovery (i.e. chance find) of archaeological / heritage sites	Rock Art site Masibekela refuge cave	Construction	Positive	1	1	5	1	2	16	P1	1	1	1	1	1	4	P1
				P1 - Low							P1 - Low						
Damage and loss of indigenous vegetation / wildlife.	Damage and loss of indigenous vegetation. Loss of wildlife	Construction	Negative	4	2	3	5	5	70	N3	2	2	1	5	3	30	N1
				N3 - High							N1 - Low						
Disturbance by human activity.	Degradation of scenery by encroachment of houses into near-pristine areas and housing density	Construction	Negative	2	5	5	2	3	42	N2	1	2	1	1	2	10	N1
				N2 - Medium							N1 - Low						
Conflict	Conflict in perceptions of value and thus conflict in approaches to handling heritage resources, leading to delays or obatscles to project implementation.	Construction	Negative	5	5	5	3	4	72	N3	1	2	1	1	2	10	N1
				N3 - High							N1 - Low						

3.2 OPERATIONAL

3.2.1 BIOPHYSICAL

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Areas of sparse land cover will leave the soil vulnerable to the erosive influences of wind and water resulting in possible erosion and sedimentation.	Operational	Negative	3	2	3	4	4	48	N2	2	1	3	3	3	27	N1
				N2 - Medium							N1 - Low						
Water Irrigation	During the operational phase water for irrigation of 800 ha of agricultural land will be made vailable.	Operational	Positive	3	2	3	4	3	36	P2	4	3	3	4	4	56	P2
				P2 - Medium							P2 - Medium						
Inundation of the reservoir area	Sediment trapping will prevent normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower.	Operational	Negative	3	3	3	4	4	52	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Operation of the Nondvo Dam will result in changes to the river flow regime and ecosystems: — Seasonal variation impacting aquatic and riparian systems downstream. — Loss of turbulent flow reducing dissolved oxygen concentrations; — Increase of turbulent flow resulting in oxygen super-saturation; — Increased water loss rate due to increased evaporation; — Increased recharge of the underlying aquifer through infiltration; and — Changes in velocity and volumes of flow resulting in changes to natural shape of the streams.	Operational	Negative	3	3	3	4	4	**52**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						
Inundation of the reservoir area	Initial inundation of the reservoir will increase in concentrations of nutrients and organic matter due to decomposition of inundated vegetation and possible mobilisation of nutrients from previous agricultural activities. This is likely to alter trophic conditions and biodiversity in the river downstream during the first few years (i.e. the period of maturation).	Operational	Negative	4	3	3	4	4	**56**	**N2**	2	2	3	3	4	**40**	**N2**
				N2 - Medium							**N2 - Medium**						
Inundation of the reservoir area	Dam inundation alters the amount of sediment production, retention and transportation in the system.	Operational	Negative	3	3	3	4	5	**65**	**N3**	2	2	3	2	5	**45**	**N2**
				N3 - High							**N2 - Medium**						
Dam wall failure	Flow and velocity of water during dam failure and flooding has potential to result in loss of households and social assets downstream.	Operational	Negative	4	3	3	3	3	**39**	**N2**	4	3	3	3	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						
Flooding	Major effects of flooding include the creation of bars, pools and rapids which then influence the morphology of the river.	Operational	Negative	3	3	3	4	4	**52**	**N2**	2	2	3	3	3	**30**	**N1**
				N2 - Medium							**N1 - Low**						
Reduced water flow in the Lushushwana River downstream of the dam	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	Operational	Negative	3	3	3	4	5	**65**	**N3**	2	2	3	2	5	**45**	**N2**
				N3 - High							**N2 - Medium**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	Operational	Negative	5	2	3	5	5	**75**	**N3**	5	2	3	5	5	**75**	**N3**
				N3 - High							**N3 - High**						
Inundation of the reservoir area	Habitat modifications will potentially have an immediate impact on biota with preferences to lotic habitats such as Chiloglanis, Labeobarbus and Platypcypha caligata (i.e. loss) and proliferation of taxa adapted to lentic conditions including alien invasive species Micropterus salmoides.	Operational	Negative	2	2	1	5	4	**40**	**N2**	2	1	1	5	2	**18**	**N1**
				N2 - Medium							**N1 - Low**						
Inundation of the reservoir area	Alteration of downstream flow regime can impact on the relative volume of water discharge, permanence of low flows as well as the frequency and magnitude of flood peaks leading to reduced frequency of overbank flooding and negative impacts on the breeding cues of local fish communities.	Operational	Negative	4	2	3	4	5	**65**	**N3**	3	2	3	4	5	**60**	**N2**
				N3 - High							**N2 - Medium**						
Inundation of the reservoir area	Dissolved nutrients such as phosphorous increase in the reservoir as a result of the decaying submerged vegetation and soil. This increases the chemical and biological oxygen demand and can decrease the concentration of biologically available oxygen. Releases from the reservoir surface contains low concentrations of nutrients and is typically well oxygenated, whilst releases from the bottom are typically cold, rich in nutrients and low in oxygen.	Operational	Negative	3	2	3	5	3	**39**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						
Additional instream barrier	Easily removable material downstream of the dam wall will be removed and become armoured with rocks resulting in reduced habitat and aquatic species diversity.	Operational	Negative	2	2	1	5	4	**40**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						
Additional instream barrier	Alteration of migratory patterns for the observed Eel species (Anguilla mossambica) due to migratory habitats upstream of the dam being inaccessible.	Operational	Negative	4	3	3	5	4	**60**	**N2**	4	3	3	5	4	**60**	**N2**
				N2 - Medium							**N2 - Medium**						
Additional instream barrier	Large fluctuations in the water levels of reservoirs can result in the erosion of the reservoir shoreline; erosion of the instream channel and riverbanks downstream of impoundments adding to existing sediment loads. This is compounded by the reduced sediment loads of the downstream river system which inherently increases the erosional capacity of the watercourse.	Operational	Negative	2	2	1	5	4	**40**	**N2**	3	2	3	5	1	**13**	**N1**
				N2 - Medium							**N1 - Low**						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances.	Operational	Negative	4	3	5	4	5	**80**	N3	4	2	5	5	4	**64**	N3
				N3 - High							N3 - High						
Inundation of the reservoir area	Continued habitat degradation (litter, fire and alien vegetation encroachment)	Operational	Negative	4	3	5	4	4	**64**	N3	3	3	5	4	3	**45**	N2
				N3 - High							N2 - Medium						
Inundation of the reservoir area	Loss in genetic diversity, habitat fragmentation and disruption of habitat corridors	Operational	Negative	5	4	5	4	5	**90**	N3	4	4	3	4	4	**60**	N2
				N3 - High							N2 - Medium						
Inundation of the reservoir area	Introduction of new waterborne diseases	Operational	Negative	4	3	5	4	4	**64**	N3	4	3	3	4	3	**42**	N2
				N3 - High							N2 - Medium						
Infringment by humans into natural areas	Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter and feral species such as cats and dogs	Operational	Negative	4	3	5	5	4	**68**	N3	3	3	5	5	3	**48**	N2
				N3 - High							N2 - Medium						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Inundation of the reservoir area	The inundation of the reservoir area will result in an alteration of ecosystem services	Operation	Negative	3	2	3	5	3	**39**	N2	3	2	3	5	3	**39**	N2
				N2 - Medium							N2 - Medium						
Inundation of the reservoir area	The inundation of the Nondvo Dam basin will result in the loss of the channelled valley bottom wetlands, unchannelled valley bottom wetlands and hillslope seeps. The loss of the wetland areas will result in the removal of the wetland sink	Operation	Negative	3	5	3	5	4	**64**	N3	3	5	3	5	4	**64**	N3
				N3 - High							N3 - High						
Inundation of the reservoir area	The inindation of the Nondvo Dam will reults in altered wayer quality and flow downstream	Operation	Negative	3	2	3	5	3	**39**	N2	3	2	3	5	2	**26**	N1
				N2 - Medium							N1 - Low						
Inundation of the reservoir area	Altered water quality and flow could modify downstream ecosystem services.	Operation	Negative	3	2	3	5	3	**39**	N2	3	2	3	5	2	**26**	N1
				N2 - Medium							N1 - Low						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste generated during maintenance activities at the hydro power station and railway line could lead to contamination of soil, groundwater, surface water and poisoning of fauna.	Operational	Negative	3	2	3	3	3	**33**	N2	2	1	1	2	2	**12**	N1
				N2 - Medium							N1 - Low						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	Increase in agricultural land (800ha) due to the availability of irrigation may result in additional methane emissions being released to the atmosphere.	Operational	Negative	1	2	3	2	4	32	N2	3	3	1	3	3	30	N1
				N2 - Medium							N1 - Low						

Aspect (Pre-defined) *Defn: The result of an activity, which causes the impact*	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Release of airborne pollutants emissions to atmosphere (vehicular emissions and dust)	The operation of the dam will result in the dam basin area filling to capacity which will result in the inundation of vegetation. There are potential carbon emissions that will be released by the decomposing of woody vegetation	Operational	Negative	3	2	3	3	4	44	N2	3	2	3	3	4	44	N2
				N2 - Medium							N2 - Medium						
Hydropower generation	The generation of hydropower can be considered a positive impact as energy is generated from a renewable resource, thus resulting in lesser use of fossil fuel derived power	Operational	Positive	1	1	1	4	4	28	P1	1	1	1	4	4	28	P1
				P1 - Low							P1 - Low						

3.2.2 SOCIO-ECONOMIC

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Creation of Employment, Procurement and Local Business Opportunities	Generation of employment (formal and informal) and other income generation opportunities in the Nondvo Dam Project area and the surrounding area.	3	3	3	2	3	33	P2	4	3	3	2	4	48	P2
		P2 - Medium							P2 - Medium						

Economic Opportunities and Diversification	The number of direct Project employment and procurement requirements will be dramatically reduced during operation (no accurate figures are currently available); however, as a result of the Project, the area will be more accessible and the reservoir will potentially be seen as an attraction resulting in increased number of tourists visiting the area. Additionally some of the workers and migrant work-seekers will remain following construction; thus the population is likely to increase as compared to the current baseline. The economy, which is almost exclusively focused on agriculture, is likely to become more diversified through an influx of people with a greater variety of skills and offerings.	Operation	Positive	3	3	3	4	4	52	P2	3	3	3	5	4	56	P2
				P2 - Medium							P2 - Medium						
Downstream Economic Activities	Disruption of downstream economic activities as a result of reduced flow	Operation	Negative	4	2	3	5	4	56	N2	3	3	3	5	4	56	N2
				N2 - Medium							N2 - Medium						
Growth in the local tourism sector	It would be recommended that the Nondvo Dam serve multi purposes. This strategy would increase the footprint of tourist and contribute to the income generation of the local area. Aggressive marketing well ahead of construction, including promotion of the nearby nature reserve, would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be developed at the site. Growth of the tourism sector will also facilitate creation of induced employment for local people, especially the youth.	Operation	Positive	3	2	3	5	2	26	P1	3	3	3	5	3	42	P2
				P1 - Low							P2 - Medium						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased cost of living	The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available.	4	2	3	5	4	56	N2	3	3	3	5	4	56	N2
		N2 - Medium							N2 - Medium						
Continuation of Anti-Social Behaviour and Spread of STIs and HIV/AIDS	As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and new ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo Project Area.	3	4	5	4	4	64	N3	3	4	3	5	4	60	N2
		N3 - High							N2 - Medium						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Demand on local utilities - Energy	The energy generated by the project is to be utilised for operational purposes of the dam as well as distribution of eleciticity to the local population near the reservoir and thus thereby increasing their quality of life.	3	2	5	5	4	60	P2	3	2	5	5	4	60	P2
		P2 - Medium							P2 - Medium						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	The excavation at the end of the life of the quarry will pose a safety hazard to people, livestock and pets due to the near-vertical cliffs which will result in fatal incidents of falling from height, being struck by heavy rocks dislodged from the cliff face and being crushed by large discarded rocks tipping over.	Operation	Negative	4	1	5	5	4	60	N2	1	1	1	2	2	10	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Water accumulating at the base of the abandoned quarry may cause drowning amongst people and domesticated animals wandering into the site.	Operation	Negative	5	1	5	5	4	64	N3	1	1	1	1	2	8	N1
				N3 - High							N1 - Low						
Increased safety risks to people and animals	The safety of downstream communities could be influenced by seasonal flooding.	Operation	Negative	4	1	5	5	4	60	N2	1	1	1	1	2	8	N1
				N2 - Medium							N1 - Low						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Increased safety risks to people and animals	Employees of the dam operator and hydropower plant will be exposed to wet conditions by virtue of working with water. Continual exposure to wet conditions will cause health hazards such as pneumonia.	Operation	Negative	4	1	5	5	3	45	N2	2	1	1	2	2	12	N1
				N2 - Medium							N1 - Low						
Increased safety risks to people and animals	Working with high voltage and high current at the hydropower plant will cause electric shock hazards.	Operation	Negative	5	1	5	5	4	64	N3	2	1	1	2	2	12	N1
				N3 - High							N1 - Low						

Aspect	Impact Summary	Pre-Mitigation							Post-Mitigation						
		(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Ease of Shortage of Water in Manzini and Mbabane, Irrigation of agricultural land and Promotion of Social and Economic Growth	The completion of the Nondvo Dam Project water infrastructure will ensure reliable water supply in Manzini, Mbabane and surrounding areas as well as water supply for irrigation of 800 ha of agricultural land in the project area. The availability of reliable infrastructure assets can increase returns and levels of investment and therefore accelerate economic growth.	4	4	5	5	5	90	P3	0	0	0	0	0	0	#N/A
		P3 - High							#N/A						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Change in sense of place and landscape characteristics	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and disturbed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape. The impact is considered positive as the reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	Operation	Positive	3	2	5	5	4	60	P2	3	2	5	5	4	60	P2
				P2 - Medium							P2 - Medium						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Deterioration of archaeological / heritage resources by uncontrolled visitor access.	Rock Art site Masibekela refuge cave	Operation	Negative	1	1	5	5	5	60	N2	1	1	1	1	4	16	N1
				N2 - Medium							N1 - Low						
Disturbance and lack of access to grave of Chiefs and their relations / community members	Reduced access will cause physical and emotional alienation from the graves and burial sites.	Operation	Negative	1	1	5	5	2	24	N1	1	1	1	1	1	5	N1
				N1 - Low							N1 - Low						
Lack of access to indigenous plant resources lost through inundation.	Loss of species of cultural significance such as timber and grasses used for construction, as well as plants used for medicinal purposes	Operation	Negative	4	2	3	4	4	52	N2	3	2	2	2	2	18	N1
				N2 - Medium							N1 - Low						
Attraction of fauna to project site due to availability of water	Attraction of fauna to project site due to availability of water	Operation	Positive	1	1	5	5	4	48	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						
Enhancement of aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	The dam will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	Operation	Positive	1	5	5	1	5	60	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						
Enhancement of aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape.	Improved aesthetic appeal of resettled homesteads.	Operation	Positive	1	5	5	1	5	60	P2	2	5	5	1	5	65	P3
				P2 - Medium							P3 - High						

Aspect	Impact Summary	Stage	Character	Pre-Mitigation							Post-Mitigation						
				(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
Downstream Economic Activities	The reduced flow may result in a reduction of downstream tourism potential.	Operation	Negative	3	3	3	4	4	52	N2	2	2	3	3	4	40	N2
				N2 - Medium							N2 - Medium						

4 ESMP GOVERNANCE

4.1 INSTITUTIONAL RESPONSIBILITIES

The implementation of enhancement and mitigation measures as well as the completion of the monitoring program requires the clear establishment of responsibilities among the various organizations involved in project. **Table 4-1** to **Table 4-6** identify the responsibilities of the financier, the implementing agencies and other stakeholders in applying the ESMP, particularly the monitoring program.

Table 4-1: International Lender

ORGANISATION	DESCRIPTION	ROLES
African Development Bank (AfDB)	Financing of the feasibility studies, ESIA and ESMP, detailed design and implementation supervision.	Review of monitoring results to evaluate success of mitigation as part of project supervision. Through its Compliance and Safeguards function, conduct compliance audits or appoint an independent monitoring team to the project if there is a serious risk of noncompliance with internal policies and procedures, or in other cases that the lender deems appropriate.

Table 4-2: Implementing Agencies

ORGANISATION	DESCRIPTION / MANDATE	ROLES / RESPONSIBILITIES
Ministry of Finance (MoF)	Borrower and guarantee the loan funding on behalf of the Government of Eswatini (GoE).	— Responsible for signing the Loan Agreement(s) with the identified and approved funder/s. — Issue funds to the DWA for payments.
Department of Water Affairs (DWA)	DWA is the main implementing agent of this project (construction phase). To ensure the asset is properly operated and maintained, the DWA will play a dual role of support and regulation. The supportive role entails ensuring that some systems, requirements and mechanisms are in place and established.	— Ensure financing is secured and disbursed and that the Dam is constructed. — Procure the services of the Contractor, Consulting Engineer and service providers; and financial management, monitoring and reporting thereon. — Develop key performance targets and indicators (KPI's), which will form part of the Service Level Agreement (SLA) with the appointed entity. — Monitor the performance of the contractor against the conditions of the ESMP, environmental licence and contract environmental and social specifications and reporting to the lender on key management or monitoring tasks set out in the ESMP. — Reporting to the GoE and Funder/s as per an agreed schedule. — Project management functions (this is overall management and supervision of project activities).

ORGANISATION	DESCRIPTION / MANDATE	ROLES / RESPONSIBILITIES
		— Supervise the implementation of the ESMP (during construction). — Ensure the relocation and compensation programme is implemented effectively. — Submit any substantial changes, updates or amendments to the ESIA and ESMP to the Eswatini Environmental Authority (EEA). — Ensure that copies of the Authorisation and relevant permits issued and agreements are available at the construction site at all time; and, ensure that the contractor/s and all staff are familiar with or made aware of the contents thereof. — Ensure environmental audits are conducted during construction to confirm that the project complies with all conditions of the authorisation and lender requirements. — As the secretariat arm of the NWA, the DWA will manage all contractual obligations with the appointed entity (this includes managing the SLA, performance contracting etc.). Provide progress reports to the NWA and other relevant ministries like Ministry of Agriculture (MoA), Ministry of Tourism and Environmental Affairs (MTEA). — Carry out monitoring and evaluation of the operations and maintenance activities by the appointed entity.
Appointed Managing Entity	A managing entity will be appointed by the DWA. The appointed entity will be responsible for operation and maintenance of the dam. Contracted by DWA through a service level agreement (SLA), the terms and conditions of the SLA will be subjected to scrutiny of the funders during the project appraisal process.	— Ring-fence this project, so that, lessons learnt and experiences will be recorded as part of knowledge development and management. Ring-fencing the project will also streamline reporting on performance targets and KPIs set by funders and/or the DWA. — In managing the asset, the appointed entity will use the same internal systems, procedures and processes it currently uses for its operations; and, this also applies to the business model and value creation principle it embraces. — Reporting to the DWA through monthly, quarterly and annual reports; scheduled meetings and site visits. — In terms of human capital, the appointed entity will avail a team from within, which will possess varied skills in civil engineering, climate specialist, IT/technology specialist, accounting/finance specialist, risk and audit specialist, health and safety specialist, social and environmental specialists.

ORGANISATION	DESCRIPTION / MANDATE	ROLES / RESPONSIBILITIES
		— Monitor quality, reliability and availability of water supply. — Hold consultative and information sharing sessions with Eswatini Electricity Company (EEC) and Eswatini Water and Agricultural Development Enterprise (ESWADE) (if ESWADE will be responsible for managing the irrigation aspect of the programme).
Project Steering Committee (PSC)	Will be made-up of individuals from within the DWA who have varied skills that are complementary (project coordinator who is a civil engineer or water specialist; procurement specialist; project management specialist; environmental specialist; social facilitation specialist; contracts management specialist/accountant; scribe etc.).	— The PSC would advise and assist the Director to implement the project. — Oversee the implementation issues like gender mainstreaming, related awareness campaigns etc.

Table 4-3: Water Sector Institutions

ORGANISATION	DESCRIPTION / MANDATE	ROLES / RESPONSIBILITIES
National Water Authority (NWA)	The NWA as representative of the Political principal and owner of the asset. Responsibility to ensure that prior to the planning phase and by the time the asset becomes operational, all necessary regulatory aspects have been addressed and established.	— Responsibilities are yet to be defined by PSC
Usuthu River Basin Authority (URBA)	URBA - comprised of various water sectors.	— Responsibilities are yet to be defined by PSC
Irrigation District (ID)	ID reports to the URBA. They are responsible for operations and maintenance of works in the district.	— Responsibilities are yet to be defined by PSC
Water User Association (WUA)	This is not a statutory body and is established by permit holders in a defined area.	— Responsibilities are yet to be defined by PSC

Table 4-4: Irrigation Government Institutions

INSTITUTION	MANDATE	ROLES / RESPONSIBILITIES
Ministry of Agriculture (MoA) & Ministry of Natural Resources and Energy (MNRE)	Oversee management and development of water resource for efficient irrigation.	— Responsibilities are yet to be defined by PSC
MNRE & Ministry of Tourism and Environmental Affairs (MTEA)	Oversee the management, exploitation and utilisation of natural resources; and, environmental affairs.	— Responsibilities are yet to be defined by PSC
Eswatini Water and Agricultural Development Enterprise (ESWADE)	Established in 1999 by the GoE to facilitate planning and implementation large water an agricultural development project assigned by Government. — Assists in irrigation installation.	— Responsibilities are yet to be defined by PSC

INSTITUTION	MANDATE	ROLES / RESPONSIBILITIES
	— Facilitate mobilization of funds for undertaking agricultural and water projects as assigned by Government. — Technical advisor to the MNRE and in the Transboundary Water Commissions on water and agricultural issues.	

Table 4-5: Energy Government Institutions

INSTITUTION	MANDATE	ROLES / RESPONSIBILITIES
Department of Energy (DoE)	Custodian of policy and operational activities pertaining to the energy sector. Its mission is to effectively manage the national energy resources and to work towards affordable energy provision for all in the Country.	— Responsibilities are yet to be defined by PSC
Eswatini Electricity Company (EEC)	Established by the EEA (2007) to supply and distribute power, the EEC manages the national grid.	— Responsibilities are yet to be defined by PSC

Table 4-6: Project Appointed Contractors and Specialists

ORGANISATION	DESCRIPTION	ROLE
Design and Supervision Engineers	The module assumes that Studio Pietrangeli Consulting Engineers (SP) will be retained to oversee and monitor that the dam is built according to specifications of the design. SP resident engineers (about 2) will always be on sight for the duration of the construction phase; and will be led by a Chief Resident Engineer (CRE). It is crucial that these individuals be fluent in English. SP will carry a direct responsibility for the effective implementation of the environmental management requirements.	— Appointment of an Environmental Manager and Health and Safety (H&S) Manager to assist the DWA Project Manager through daily oversight and communication with the contractor. — Compile a detailed Construction Environmental Management Plan (CEMP), specifying the requirements actionable by the contractor for tender purposes. All aspects identified within this ESMP will be included as a minimum.
EPC Contractors	A detailed CEMP will be developed by the design and Supervision engineers. These roles and responsibilities are not prescriptive and exhaustive and are merely suggestions. – Implement and adhere to the contract specifications in accordance with the requirements of the ESMP. Ensure that all sub-contractors also obey the same. – Report any non-compliance within 12 hours of the event occurring to the CRE. – Ensure that all employees and sub-contractors attend environmental awareness training sessions. – Ensure all parties entering the construction site wear relevant personal protective equipment (PPE) at all times.	– Prepare Method Statements as per the CEMP. – Conduct monthly on-site auditing to assess performance against the requirements of CEMP. – Complete appropriate training requirements. – Implement and maintain environmental management controls.

ORGANISATION	DESCRIPTION	ROLE
EPC Appointed Site Environment Officer	Overall responsibility for all environmental matters to ensure that all contractor and operator activities are carried out responsibly and in accordance with the ESMP, IFC and World Bank Group General and Sector EHS Guidelines and local legislation.	– Daily oversight of activities to ensure that construction activities do not result in environmental risks – Audit working areas as per CEMP and contractor specifications / method statement checklists. – Record observation and incidents; close out and sharing to raise awareness (toolbox talks). – Investigate and respond to complaints /grievances received in collaboration with EPC appointed Community Liaison Officer (CLO).
EPC Appointed Site Health and Safety (H&S) Officer	Overall responsibility for all H&S matters to ensure that all contractor and operator activities are carried out safely and in accordance with the EPC EHS Policy, ESMP, IFC and World Bank Group General and Sector EHS Guidelines and local legislation (Public Health Order (1970); and Labour Code Order, as amended (1992)).	– Daily oversight of activities to ensure that construction activities do not result in occupational and community health and safety risks – Audit working areas as per CEMP and contractor specifications / method statement checklists. – Record observation and incidents; close out and sharing to raise awareness (toolbox talks). – Investigate and respond to complaints /grievances received in collaboration with EPC appointed Community Liaison Officer (CLO).
EPC Appointed Community Liaison Officer (CLO)	The deployment of a CLO is key in the feedback mechanism as a link between the contractor and the community during the construction and operations phases; enabling consultation on construction activities, feedback on concerns raised and unintended impacts; and monitoring of the ESMP.	— Assist contractor with recruitment procedure, collaboration and working relationship with community. — Close engagement with Community Councils including monthly community liaison meetings. — Investigate and respond to complaints / grievances received in collaboration with EPC appointed Environmental Officer and H&S Officer. — Arrange community notification of planned dangerous activities (e.g. blasting) and temporary access restriction / rerouting.
Environmental Control Officer (ECO)	Independent ECO appointed by project implementing agent prior to commencement of the construction. In order to facilitate communication between the ECO, Project Manager / Environmental Manager and Contractor, it is important that a suitable chain of command is structured that will ensure that the ECO's recommendations have the full backing of the DWA project team before being conveyed to the Contractor.	— Undertake compliance audits against the ESMP and conditions of the environmental licence. — The environmental licence issued by the EEA will determine the frequency of external audits, however audits at a frequency of at least once a month are recommended — Provide support and advice to the project team, contractor and all subcontractors in the implementation of environmental

ORGANISATION	DESCRIPTION	ROLE
		management procedures and corrective actions. — Assess the efficacy of the ESMP and identify possible areas of improvement or amendment required within the ESMP. — Facilitate the amendment of the ESMP in conjunction with the Engineers Environmental representative, Engineers H&S representative, and DWA Environmental Manger (as required). — Prepare audit reports (and submit reports to the relevant committees / authority as required).
EPC appointed Ecologist / Rehabilitation Specialist	Consultant / suitably qualified internal staff	— Assist DWA and contractor with the implementation of mitigation, enhancement and monitoring measures.
EPC Appointed Heritage Specialist	Consultant / suitably qualified internal staff	— Assist DWA and contractor with the implementation of mitigation, enhancement and monitoring measures.

5 REPORTING

5.1 INCIDENT MANAGEMENT AND MITIGATION

Table 5-1 itemises the requirements for incident management and mitigation reporting.

Table 5-1: Incident Management and Mitigation Steps

DESIGNATION	ROLES AND RESPONSIBILITY
Reporting of Environmental Incidents	— Any environmental incident will be reported immediately to the EHS Manager. — Immediate correspondence will be held with the relevant staff members to determine mitigation and close-out requirements. — All significant incidents will be reported to the relevant authority as per the legal requirements.
Contents of Environmental Incident records	— Environmental incident reporting and recording will include the following information: — Time, date and nature of the incident. — Response and investigation undertaken. — Actions taken and by whom.
Continual Improvement	— Corrective and preventative action requests will be forwarded to the responsible person so that corrective action can be taken. Open non-conformances will only be closed on verification by the Environmental Manager that the corrective action has been implemented effectively in order to meet the ESMP requirements. — The cause of all incidents will be investigated to determine root cause and to ensure that corrective action is able to be implemented to ensure that there is no repeat of the incident. — A summary and review of incidents recorded during the maintenance activities will be included within a report by the EHS Manager. These reports will be made available for review by the ECO during monthly audits. — If required following an incident, a review of the efficacy of the ESMP will be undertaken by the EHS Manager in liaison with the ECO order to identify possible areas of improvement or updating or amendment required within the ESMP.

5.2 DOCUMENT CONTROL

The Contractor Environmental Officer is responsible for ensuring that up to date documentation is kept on-site within an Environmental File; this will include, as a minimum, the following:

- Up to date copy of the CEMP;
- Approved Contractor Method Statements;
- Copies of other contractor environmental information such as waste Safe Disposal Certificates;
- Environmental Audit Reports (internal and external);
- Environmental Incident Reports;
- Records of stakeholder and community complaints and follow-up actions taken; and
- Induction and training records.

5.3 ESMP REVISIONS

The ESMP adopts a proportionate and adaptive approach in that management measures recommended in **Section 6** are proportionate to the level of environmental and social risk, and are aimed at being flexible enough to be adapted to changing circumstances during project implementation.

6 MITIGATION AND ENHANCEMENT MEASURES

This chapter details the measures to address the impacts outlined in ESIA, in order to accrue project benefits (enhancement measures) or to avoid, reduce, manage and offset potentially adverse environmental and social impacts to acceptable levels (mitigation measures).

These measures are deemed to be sufficiently comprehensive and implementable with realistic timeframes which will require support through the allocation of adequate organisational capacity, training through the full project cycle.

6.1 PRE-CONSTRUCTION PHASE

Table 6-1: Site Establishment Environmental Requirements

SITE ESTABLISHMENT REQUIREMENTS	ENVIRONMENTAL REQUIREMENTS / MANAGEMENT MEASURES	RESPONSIBILITY	VERIFICATION & FREQUENCY
Site Camp Location and Layout	The Contractor will determine appropriate locations for the Contractor's site office(s), in consultation with the Engineer.	EPC Contractor	EHS Manager[3] & ECO (Once off)[4]
	The Contractor will design the management camp, contractors camp and offices to ensure future beneficial use by the local community, such as a community hall or resort.	EPC Contractor	EHS Manager[5] & ECO (Once off)[6]
	The Contractor's site office will be easily accessible from existing road infrastructure where possible and within, or in close vicinity to the work front, and will not in any way negatively impact on a valuable resource (e.g. watercourse or protected vegetation).	EPC Contractor & Design and Supervision Engineers	EHS Manger & ECO (Once off)
	Site camp infrastructure will not be situated within flood plains or wetlands, within the 1:100 year floodline, or on slopes with a gradient of greater than 1:3.		
	Prior to site establishment, liaison will take place with the landowner / inner council and reach agreement regarding the location and demarcation of any camp to be established.	CLO	EHS Manager & ECO (Once off)
	A site layout plan for each site office / camp will be submitted to the Engineer for approval. Any changes to this layout will require review. The site office layouts will make provision for (where applicable): — Access off the road network and visitor / staff parking facilities — Office facilities and a structure to shelter security staff — Ablution facilities and a potable water source — Hazardous fuel / chemical storage area and a waste storage area — Plant parking facilities and a vehicle maintenance area	EPC Contractor	Resident Engineer (RE) EHS Manager (Once off)

[3] Appointed by Design and Supervision Engineers
[4] To be undertaken at each work site
[5] Appointed by Design and Supervision Engineers
[6] To be undertaken at each work site

SITE ESTABLISHMENT REQUIREMENTS	ENVIRONMENTAL REQUIREMENTS / MANAGEMENT MEASURES	RESPONSIBILITY	VERIFICATION & FREQUENCY
	— Emergency equipment storage areas including fire extinguishers and first aid kits — Stormwater control — The facilities of the site office that require hard standing or bunded surfaces will be designed to engineering standards The layout design will be considerate of noise / dust / visual impacts of each activity area within the camp on neighbouring residents and land-users.		
	The stormwater drainage network system will be kept separate from the waste water system.	EPC Contractor CLO	EHS Manager & ECO (Once off)
	Site office yards will only be occupied and prepared once all land legal negotiations are successfully concluded and relevant consent is obtained.		
	Site office facilities and infrastructure will meet the necessary health and safety requirements.		
	Stormwater runoff from the site office footprint will be channelled to the site stormwater drainage system, which will meet relevant outfall standards, and flow reduction specifications.		
	Any service lines or networks (electricity, sewer and / or water supply will be approved by the relevant authorities prior to installation, even if temporary.		
	The disturbance to topsoil will be minimised, and compaction or removal of topsoil will be restricted to access routes and parking areas, and activity areas.		
Access & Parking Facilities	Construction work camps will be completely fenced off prior to being established, as to prevent the entry of domestic stock or wild animals and to ensure that the camp is adequately secured against theft and the entry of unauthorised persons.	EPC Contractor	CPLO / CLO[7]
	Proposed roads and routes to access site offices / camps will be approved by the Engineer and will require public notification as described by the Stakeholder Engagement Plan.	EPC Contractor	CPLO / CLO[8]
	Paved / hardened pathways will be provided between office facilities / security facilities or high pedestrian traffic areas to reduce soil erosion.	EPC Contractor	EHS Manager & ECO (Once off)

[7] To be undertaken at each work site
[8] To be undertaken at each work site

SITE ESTABLISHMENT REQUIREMENTS	ENVIRONMENTAL REQUIREMENTS / MANAGEMENT MEASURES	RESPONSIBILITY	VERIFICATION & FREQUENCY
	Driveway access and vehicle routes / turning circles on the site offices will be clearly demarcated and all vehicle movement will be confined to these routes and turning circles.		
	The construction of an access bridge will be investigated in order to prevent the need for the construction of a section of new road, thereby reducing the potential for physical displacement of households to acquire new land.		
Ablution Facilities and Water Supply	Adequate ablution and wash up facilities will be provided. Facilities will be easily accessible to all workers. The provision of ablution and wash-up facilities will not create a health nuisance to the surrounding neighbourhood and environment.	EPC Contractor	EHS Manager & ECO (Once off)
	Ablution facilities will be provided within the site office area and maintained in a hygienic condition by all users. All ablution facilities will be signposted for their intended use.	EPC Contractor	EHS Manager & ECO (Once off)
	Septic tank systems (if required) will be designed by qualified engineers. Pit latrines are forbidden.		
	Any staff washing or bathing facilities will drain into an official site drainage system / septic tank system, or alternative arrangements will be made for the collection and disposal of runoff from these areas at a suitable facility.		
	A potable water supply will be provided within the site office area. Any potable water storage facility will be animal and weather proof, and sealed / fenced to prevent potential contamination / drowning.		
Hazardous materials and waste storage facilities	Separate areas for the storage of hazardous substances and waste will be allocated. These areas will be hard standing with an impermeable surface and bunded to accommodate 110% of the volume of the containers that will be stored. These areas will be suitably signposted and secured to prevent unauthorised use / access.	EPC Contractor	EHS Manager & ECO (Once off)
	Hazardous substances storage areas will be located in such a way as to minimise the potential risk to surrounding areas.		
	A secure waste facility for general waste will be provided away from neighbours. The facility will be animal and weather proof, and fenced / locked / sealed.		
	Animal proof rubbish bins will be strategically placed around the site office areas and are required will be emptied on a daily basis at close of work to the secure waste facility.		
Plant / vehicle storage facilities	A secure area of the site office will be provided for the storage of plant / machinery. No unauthorised access to the machinery will be permitted. Signs will warn of the penalties of trespassing. The area will be hard standing (with an	EPC Contractor	EHS Manager & ECO (Once off)

SITE ESTABLISHMENT REQUIREMENTS	ENVIRONMENTAL REQUIREMENTS / MANAGEMENT MEASURES	RESPONSIBILITY	VERIFICATION & FREQUENCY
	impermeable surface, i.e. not interlocking or porous bricks) to prevent soil contamination from hydrocarbon (oil / fuel) leaks.		
	If any vehicles / machinery are refuelled on site, then refuelling will be undertaken utilising suitable spill trays, functional dispensing equipment and staff trained in the proper handling on the dispensing equipment. All precautions will be taken to not pollute the surrounding environment. Refuelling will not occur within a bank of a drainage line, stream or river, nor will refuelling occur within the 1:100 year flood plain of a watercourse.		
	Fuel tanks will conform to the relevant statutory requirements and will be housed within designated areas and elevated so that leaks can be easily detected.		
Emergency equipment storage facilities	Any burning of firebreaks around the perimeter of the site office / camp areas will be undertaken in consultation with the relevant authorities, and at an appropriate time of year. The local fire station will be informed of the proposed activity.	EPC Contractor	EHS Manager & ECO (Once off)
	Security lighting will be angled inwards on the site office / camps to reduce nuisances to neighbouring residents/land users.		
	The site office perimeters will be fenced and secured, and activity areas within the site office areas will also be secured if potentially dangerous or hazardous in nature.		
Notice Boards	The site offices will be clearly signposted as such and that no unauthorised access is permitted.	EPC Contractor	EHS Manager & ECO (Once off)
	Within the site office areas there will be signs indicating the activity areas assigned to the storage of hazardous materials, machinery and emergency equipment.		
	Health and safety information and signs will be displayed as required.		
	Relevant contact details will be made easily visible and available to the public for the purposes of complaints / concerns or emergencies.		
Community Liaison Meetings	Community Liaison Meetings will be undertaken prior to establishment to notify the community of commencement date as well as inform them of the grievance mechanism and labour policy.	CLO	ECO (Once off)

6.2 CONSTRUCTION PHASE

6.2.1 BIOPHYSICAL ENVIRONMENT

Table 6-2: Geology, Topography, Soils and Land Use Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Construction and foundations of dam wall and quarry	Blasting and large foundations constructed into the underlying geology and establishment of a quarry to extract material will remove soil cover and expose underlying rock. Soils in the project area (dam wall site, diversion channel, quarry, access roads and railway line) could be exposed to increased soil erosion due to excavation and destabilisation resulting in potential loss of topsoil; and increased sedimentation. Secondary impacts to downstream ecosystems may occur.	– Approval for the establishment of a quarry will be obtained from the EEA prior to commencement of mining. – A Baseline crack survey of all infrastructure in the vicinity of the quarry site will be undertaken prior to undertaking blasting or mining. – Topsoil will be transferred to an alternative area for continued cultivation. – Soil erosion measures will be implemented (limiting the extent of work areas, management of stormwater runoff, and sediment containment structures). – Development and implementation of a Spoil Disposal Management Plan (SDMP) –will be kept on site within Environmental File. – All spoil disposal sites will be approved by the EEA prior to site establishment. – Compacted surfaces will be kept to a minimum and vegetation rehabilitation will be implemented within the site, to prevent excessive runoff coupled with erosion, leading to sedimentation. – Bulk earthworks will limit the degree of terracing, excavation and generation of spoil material.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Excavated areas that will not be included in the development footprint will be rehabilitated to ensure slope stability, safety, and vegetative cover. — Any material sourced from outside of the project site will be from a licensed supplier. — The use of existing roads will be prioritised. New roads will be constructed as a last resort. Design and construction of river crossings for vehicles will be undertaken in a way that does not alter the flow of water in the river. — Vehicles will only be allowed to cross the river at designated crossings to avoid disturbance of the watercourse. — New access roads and the base camp will be sufficiently compacted to minimise erosion. — The use of sediment and oil traps will be implemented. Regular maintenance of these will be undertaken to prevent unnecessary dirty run-off to the River. — Basecamp/laydown areas will be developed in areas which have been previously disturbed. — Toolbox talks will include the use of spill kits, handling of hazardous materials and occupational health and safety talks.		
	Trapping of sediment will prevent the normal sediment load distribution downstream potentially resulting in a deeper and narrower channel and other related morphological impacts.	— Sedimentation control management be undertaken by a reduction and prevention of off-site sediment transport using measures such as settlement ponds and silt fences, where practical. — Compacted surfaces should be kept to a minimum and vegetation rehabilitation needs to be implemented within the site, to prevent excessive runoff coupled with erosion, leading to sedimentation. — An engineering solution is required to avoid the dam wall acting as a sediment trap and allowing the release of sufficient sediment which can be transported by the (below dam) river velocity to reduce the impact on the sandy stream banks and river habitats.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		— Soil erosion control measures will be employed (protection berms / gabions, silt traps etc.). — A Stormwater Management Plan will be developed. — Disturbed soils will be stabilised immediately through grass cover as a first step to soil stabilisation. Gabions or the use of geotextile fabric and landscaping, will be used to rehabilitate existing erosion areas. — The rehabilitation of disturbed areas will be undertaken where necessary and revegetate with indigenous plants. — A management plan will be developed for the Dam which includes a Sediment Management Plan. — An engineering solution will be developed to avoid the dam wall acting as a sediment trap and allowing the release of sufficient sediment which can be transported by the (below dam) river velocity to reduce the impact on the sandy stream banks and river habitats.		
	Illegal Sand Mining	— The Siphocosini Inkhundla in conjunction with the Royal Kraal Inner Councils will enforce the control of sand mining through Imisumpe (Land Use Officers) and Community Police. — The Commissioner of Mines or his designated officer will conduct an inspection and enforce the provisions of the Mines and Minerals Act, 2011 with respect to the prohibition of unauthorised mining. — Promotion of awareness will be undertaken to traditional authorities (Royal Kraal Inner Councils) and community members to prevent illegal sand mining.	DWA	ECO (Monthly)

Table 6-3: Hydrology and Hydrogeology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Construction and foundations of dam wall and quarry	Water abstraction for construction could temporarily decrease the natural volume of water within the River.	– Water used during the construction phase will only be abstracted from the Lusushwana River if authorisation by the DWA has been granted. – Alternative water supply for the dry months will be investigated. – Contractors will be trained on the sustainable use of water.	EPC Contractor EPC appointed Hydrologist / Ecologist	EHS Manager (Daily) ECO (Monthly)
	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	– Construction of the diversion channel and coffer dams will allow for continued flow downstream of dam construction. – Habitats (including fallen trees and branches) will be retained unless they compromise flow conveyance. – Sensitive vegetation management techniques will be used that do not impact on identified habitats. These could include hand-picking or selective cutting of in-channel and bankside vegetation, coppicing or pollarding trees instead of felling them, only removing vegetation from the centre of the channel, and limiting cutting to specific areas where there is a flow conveyance issue. – Appropriate lining materials for the dam wall will be utilised. – The lining of the dam wall will be structurally sound, therefore reducing the infiltration to groundwater. – Implementation of a maximum flow rate downstream of the dam wall will be met.		
	Rainfall on eroded / unconsolidated sediment has the potential to result in an indirect impact as runoff with higher sediment load enters surrounding drainage lines and streams leading to sedimentation of watercourses and reduced water quality. Secondary impacts to downstream ecosystems functioning may occur.	– Soil erosion control measures will be employed (protection berms /gabions / silt traps). The use of silt traps will be undertaken. – Vegetation establishment will be promoted through bank restoration and the installation of engineering structures (e.g. gravel embankments, riprap, gabions) and ecological engineering to recreate shoreline habitats similar to those		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		found along the natural rivers and ravines within the project area. – A Stormwater Management Plan (SWMP) will be developed and implemented. – An environmental management and restoration plan will be developed and implemented to ensure the rehabilitation of areas disturbed during construction that are not within the inundation area as soon as practically possible. – Disturbed soils will be stabilised immediately through grass cover as a first step to soil stabilisation. Gabions or the use of geotextile fabric and landscaping, will be used to rehabilitate existing erosion areas. – The rehabilitation of disturbed areas will be undertaken and revegetation with indigenous plants – A management plan for the Dam will be developed which includes a Sediment Management Plan. – A Work Method Statements and an Environmental Management Programme will be developed. – Activities in and on the banks of the river will be avoided as far as possible. – Vehicles and equipment will be kept in good working order and oil or fuel leaks will be repaired immediately upon detection. – No vehicle repairs are allowed in riparian areas. – Concrete will not be mixed directly on the ground. Use plastic liners and mixing trays at all times. – Waste concrete and sediment sludge will be removed to an appropriately designated storage area in order to prevent contamination during rainfall. – Cement contaminated water will be contained within the process water system / dirty water system.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– In order to increase the morphological diversity of the Lusushwana River, the following environmental improvements will be implemented: ○ Riffle construction; ○ Bar construction; ○ Boulder placement; ○ Deflectors; ○ Two-stage channels; ○ Installing large woody debris; and ○ Narrowing over-widened channels. – Where feasible, construction activities will be undertaken during the dry season. – The water quality monitoring programme will be implemented during construction of the proposed dam. This programme will be updated to accommodate the different phases of the project and extend into the operational phase. The monitoring programme will be a living document and updated in accordance to the different project phases.		
Accidental Release / spills of large quantities of contaminants into soils, water bodies, and groundwater	Runoff creates a preferential pathway and exposure of contaminants into the subsurface (groundwater) and downstream watercourses leading to a deterioration in water quality and secondary health impacts on aquatic ecosystems and water users (community).	– A Hazardous Materials Management Plan will be developed and implemented and will be kept on site within Environmental File. – Spill kits or absorbent materials will be kept on hand to clean up spills. Once used, this material will be treated as hazardous waste and dispose of it accordingly. Spills will be cleaned up immediately. – Adequate ablution facilities will be provided along with waste skips for site workers. Sanitary facilities will not be placed within 100 m of a watercourse. Refuse and solid waste will be removed at regular intervals to prevent littering.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Store all hazardous materials in a hazardous store with an impermeable floor surface and which is fenced, roofed, secured, bunded and regularly cleaned. – Material Safety Data sheets (MSDS) will be stored on site. Chemicals will be stored, transported, used and disposed of as per the manual / MSDS. Construction activities will be undertaken during the dry season. – On-site vehicles will be well-maintained. – Drip trays will be placed under leaking vehicles. – On-site pollutants will be contained in a bunded area and on an impermeable surface. – The Water Quality Monitoring Programme will be implemented during construction of the proposed dam. This programme will be updated to accommodate the different phases of the project and extend into the operational phase. The monitoring programme will be a living document and updated in accordance to the different project phases. – Oil and chemical-handling facilities will be located with consideration of natural drainage systems and environmentally-sensitive areas (e.g. watercourses and riparian areas). – Secondary containment will be included for above ground liquid storage tanks and tanker truck loading and unloading areas. – Hazardous materials storage and handling facilities will be constructed away from active traffic and protect storage areas from vehicle accidents. Covered and ventilated temporary storage areas will be provided for leaking hazardous cargo and designed to facilitate collection of leaks and spills (e.g. slope surface will allow for the capture of spills, use valve		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		catch basins that allow spills and releases to enter a dead-end sump from which spilled materials can be pumped). – Fuel dispensing equipment will be equipped with "breakaway" hose connections that provide emergency shutdown of flow should the fuelling connection be broken by movement. Fuelling equipment will be inspected daily to ensure all components are in satisfactory condition. – Site personnel will be trained on the proper procedures for: o Storage and handling of hazardous substances o Emergency response in the event of accidental spill or loss of containment. – Provision of suitable PPE and alarm bells, visual alarms, or other forms of communication will be used to reliably alert workers to an emergency. – Water quality monitoring will be undertaken for the duration of the construction phase (Refer to Monitoring Plan – **Section 7**). – Should downstream water quality be affected, communities downstream will be informed immediately, and steps taken to remedy the situation.		
Inundation of the Reservoir Area	The incorrect siting of chemical toilets and loss of containment could lead to pollution of the receiving environment (soil, groundwater and surface water), leading to secondary health impacts on downstream aquatic ecosystems and water users (surface and ground), and maintenance of livelihoods.	– Chemical toilets will be located beyond 100m of a watercourse or stream. – Sewerage generated at the contractor's camp will be handled as hazardous waste material. – Maintenance and removal of chemical toilets will be by a registered / licensed sanitation service company. – Proof of removal by a registered / licensed sanitation service company will be kept within the Environmental File. – All site personnel will use these facilities. Any employee found violating this requirement will be liable to immediate termination of employment.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Chemical toilets will be removed post-construction.		

Table 6-4: Riverine Ecology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Construction and foundations of dam wall and quarry	Direct alteration of the instream and riparian habitats resulting in the permanent modification of the habitats at a local scale. Temporary loss of riverine habitat and affecting *Chiloglanis emarginatus* (IUCN, 2019) – a Vulnerable species.	– A stormwater management plan will be developed and implemented. – Clean and dirty water separation will be completed in the instream working areas. – Clean water channels will not create an impoundment upstream of the cofferdam and instream workings. – Discharge points of clean water diversion channels will not result in erosion. – A cut off trench to reduce ingress flow into excavations will be constructed to convey water around workings. – Dirty water that has been in contact with instream workings will be conveyed to a settling pond/silt trap before being allowed to discharge into the environment. – Dewatering activities in the excavations will convey water into silt traps to reduce downstream sedimentation. – Following the completion of the instream workings, rehabilitation of the affected exposed areas in the riparian habitat will occur. An audit will be conducted within 30 days of completion.	EPC Contractor Hydrologist /Ecologist[9]	EHS Manager (Daily ECO (Monthly) Ecologist / Hydrologist (Quarterly)

[9] To be appointed by DWS as key implementing agent during construction.

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Following the completion of the instream workings, no waste material will be left within the river channel. An audit within 30 days of completion of the instream workings will ascertain whether this has been achieved. – No large boulders or material that can alter hydrology will be left within the instream areas if not originally present. An audit within 30 days of completion of the instream workings will ascertain whether this has been achieved. – Stockpile areas will be bermed to reduce runoff into local waterbodies. – Fuel and oil storage and handling will be completed in a bunded area. – Laydown yards and material storage/stockpiles will not be located within 100m of the delineated riparian zone. – An alien invasive species management plan will be implemented for all disturbed areas. – Suitable sewage infrastructure and handling which limits risks to local water quality will be in place for all working areas. – Following the completion of the construction activities, the impacted areas will be rehabilitated. An audit within 60 days of completion of the workings will ascertain whether this has been achieved. – Suitably sized culverts will be installed where roadways cross over drainage lines. – No inundation will occur upstream of culverts. – An invasive alien species management plan will be implemented for the road and bridge verges. – Erosion control measures (gabions or a suitable alternative) will be implemented at the bridge crossing structure downstream of the dam wall.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Surface run-off from the roads flowing down the embankments will be catered for with adequate concreted stormwater drainage depressions and channels with energy dissipaters that channel these flows into the river in a controlled manner. – Erosion control measures (energy dissipation) will be in place for all roadways. – Exposed road surfaces awaiting grading will be stabilised to prevent the erosion of these surfaces. Signs of erosion will be addressed immediately to prevent further erosion of the road. – Riverine aquatic biomonitoring will be undertaken for the duration of the construction phase on quarterly basis (refer to Monitoring Plan -**Section 7**). – Water quality monitoring will be undertaken for the duration of the construction phase (refer to Monitoring Plan -**Section 7**).		

Table 6-5: Terrestrial Ecology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Construction of the linear infrastructure	Spread and/or establishment of alien and/or invasive species, especially in areas that are cleared.	– It will be made an offence for any staff to bring or plant any plant species into any portion of the project area. No plant species whether indigenous or exotic will be brought into the project area, to prevent the spread of exotic or invasive species. Unless part of rehabilitation practises. – Areas that are denuded during construction will be re-vegetated with indigenous vegetation. – An alien vegetation removal and management plan will be implemented, this is specifically relevant to the construction camp and roads as well as the area surrounding the dam wall.	EPC Contractor (until area is rehabilitated) EPC appointed Ecologist / Rehabilitation Specialist	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Areas will be cleared and disturbed on a needs basis only, as opposed to clearing and disturbing a number of sites simultaneously.		
	Destruction, further loss and fragmentation of the vegetation community.	– The extent of the project area to be development will be kept to a minimum. – The development areas and access roads will be specifically demarcated so that during the construction phase, only the demarcated areas are impacted upon. – Areas rated as High sensitivity in proximity to the development areas, will be declared as 'no-go' areas during the construction phase and operational phase, and all efforts will be made to prevent access to these areas from construction workers, machinery and the local community (for areas within the project area/s). – Areas of indigenous vegetation, even secondary communities will under no circumstances be used as an area for the dumping of waste or laydown areas. – Clearing of vegetation on slopes will be minimised and where necessary, appropriate water flow management will be put in place to limit the erosion potential of exposed soil. – Staff will be educated about the sensitivity of faunal species and measures will be put in place to deal with any species that are encountered during the construction process. The intentional killing of any animals including snakes, lizards, birds or other animals will be strictly prohibited. As well as the fire risk associated with smoking and cooking. – If any large nests (comprised of sticks only) are encountered during clearing activities within 100 m of the nest will be ceased, a picture taken and sent to an appropriately qualified avifaunal specialist, for assessment of the situation and advise on the best way forward.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Blasting will be restricted to daylight hours. – Where possible, construction activities within high sensitivity areas will take place during winter (as much as possible) when the risk of disturbing sensitive life history stages (e.g. nesting) is lowest. – Prior to trimming vegetation and site activities, the area to be disturbed will be walked on foot by 1-2 individuals to create a disturbance for fauna to move off. Sites will be disturbed on a needs basis only, and just prior to the commencement of activities on the site. – Existing human waste facilities being used within the inundation zone will be identified, followed by the best practice to reduce the impact prior to flooding. For example, pumping the sewage out of conservancy tank (formal) versus filling of pits (informal) or any other method.		
Increased vehicular activities along roadways and in public areas and establishment of dam wall and quarry	Displacement, direct mortalities and disturbance of faunal community (including threatened species) due to habitat loss and disturbances (such as site clearance, dust, light, vibrations, poaching and noise)	– Signs will be put up to enforce speed limit, and speed bumps built to force slow speeds. – Blasting will be restricted to daylight hours. – Existing roads/servitudes will be considered first option over the construction of new roads/servitudes and will only be made where necessary. In addition, in the event that construction of new roads/servitudes are unavoidable, transformed areas will be prioritized over ecologically intact areas. – Where possible, construction activities within high sensitivity areas will take place during winter (as much as possible) when the risk of disturbing sensitive life history stages (e.g. nesting) is lowest. – Where possible, work will be restricted to one area at a time. – Prior to trimming vegetation and site activities, the area to be disturbed will be walked on foot by 1-2 individuals to create a	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		disturbance for fauna to move off. Sites will be disturbed on a needs basis only, and just prior to the activities on the site. – Disturbance of sites will be restricted to areas within the project footprint area only. – The extent of the project area to be developed will be kept to a minimum. – Staff will be educated about the sensitivity of faunal species and measures will be put in place to deal with any species that are encountered during the construction process. The intentional killing of any animals including snakes, lizards, birds or other animals will be strictly prohibited.		
Infringement by humans into natural areas	Infringement by humans into the remaining natural areas, with associated impacts such as poaching, litter and introduction of diseases and feral species such as cats and dogs.	– A site plan for the individual working / establishment areas will be provided in and around site indicating parking and storage areas, site offices and placement of ablution facilities. – The Contractor will inform all site staff to the use of supplied ablution facilities and under no circumstances shall indiscriminate excretion and urinating be allowed other than in supplied facilities. – The Contractor will supply sealable and properly marked domestic waste collection bins and all solid waste collected shall be disposed of at a licensed disposal facility. – Where a registered disposal facility is not available close to the site, the Contractor will provide a method statement with regard to waste management. Under no circumstances will domestic waste be burned on site. Temporary storage of domestic waste shall be in covered waste skips. – Refuse bins will be emptied and secured, to prevent unauthorized removal or access by wildlife. – A minimum of one toilet will be provided per 10 persons.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Access to the sites will be via existing routes as much as possible. Planning of access to the sites will reduce the number and extent of access routes and working areas. – The collecting and/or destruction of plants by unauthorized persons will be prevented. – Signs stating the prohibiting of poaching will be put up.		

Table 6-6: Waste Generation Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Generation of general waste	Presence of workforce and absence of adequate waste receptacles results in increased litter potentially leading to secondary impacts on terrestrial and aquatic ecology.	– Environmental awareness training on consequences of poor waste management will be provided. – Littering, burying and burning of waste will be prohibited. – Site will be cleared of litter at the end of each working day. – Provision will be made for suitable waste receptacles across all working areas within a designated area with consideration to stormwater management and labelled indicating various waste types. – Temporary storage will be undertaken in secure skips / containers. – Suitable receptacles will be provided for the storage of domestic waste at all accommodation for weekly collection and disposal. – Collection and disposal will be undertaken by licensed waste contractor for disposal at a registered landfill. – Proof of disposal will be kept on site in the Environmental File. – Waste will be disposed at an appropriate registered landfill.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	Spoil material unsuitable for reuse as bedding and backfill material has the potential to disrupt land use and habitats if not managed appropriately.	– Spoil sites will be demarcated and access controlled. – A Spoil Disposal Management Plan (SDMP) will be developed and implemented and will be kept on site within Environmental File. – Use of material for levelling and filling of erosion gullies at identified sites within the project area will be in consultation with the Environmental Manager, District Environmental Officers, and Community Councils. Strict monitoring will be undertaken in order to ensure that natural water courses are not blocked in the process.		
	The lack of inappropriate waste separation has the potential to result in unnecessary waste to landfill.	– All relevant on-site personnel will be provided with waste management training on the waste management hierarchy. – Labelled waste receptacles will be provided across the site for paper and plastic to allow for separation at source and removal offsite for recycling). – Excess construction materials which are suitable for re-use will be returned. – Recycling opportunities will be sought in order to reduce the volume of waste to landfill and harness commercial benefits for both the project team and local community. Possibilities of waste recycling and reuse: o The rock fragments generated during excavations (hard – rock excavation) can be reused. o The pallet type wood and boards that that package worksite materials and equipment can be reused as signage boards, and fencing worksites. o Recycling paper, plastics, metal, glass wood crates, cardboard and others rigid containers originating from product acquisition used and generated in site offices (paper, plastics, small batteries and lights among others).		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		o Returning chemical containers to suppliers.		
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste could lead to contamination of soil, groundwater and surface water; and poisoning of fauna.	– Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) for all hazardous wastes will be available on site. – Personnel involved in the handling of hazardous waste will be provided with the necessary PPE as stipulated in the MSDS or SDS. – Hazardous waste will be stored within impermeable bunded and ventilated storage areas, capable of containing 110% of total volume – Access to hazardous waste storage areas will be controlled. – All storage containers will be labelled, sealed and stored in accordance with MSDS or SDS requirements. – Licensed contractors will undertake the handling, treatment and disposal. – Environmental awareness training will be provided on consequences of poor waste management and handling and storage of hazardous waste.	EPC Contractor	EHS Manager (Daily ECO (Monthly)
	Lack of waste minimisation measures will lead to regional impacts and increased project construction costs as registered hazardous waste collectors are located outside the project area.	– Stringent waste segregation will be implemented to prevent co-mingling of non-hazardous and hazardous wastes.	EPC Contractor	EHS Manager (Daily ECO (Monthly)

Table 6-7: Air Quality Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Release of airborne pollutants emissions to atmosphere	Increased dust emissions will result in reduced ambient air quality resulting primarily in a nuisance factor to nearby receptors (e.g. onsite workers and residents)	– Dust suppression measures (e.g. spraying) to active earthwork areas, stockpiles, and road transportation of sediment bearing material will be implemented when required (i.e. during high wind conditions (>20 km/hr)).	EPC Contractor	EHS Manager (Daily ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
(vehicular emissions and dust)		– Appropriate freeboard on trucks hauling any loose material that could produce dust when travelling will be maintained. – Unnecessary traffic and vehicles travelling on unpaved roads will be reduced; and strict adherence to speed limits to ensure minimal dust entrainment.		
	Increased concentration of pollutants (gaseous emissions) will result in reduced ambient air quality	Vehicular Emission Controls will be implemented: – Limit idling of vehicles, particularly at site entrances. – Signs erected to request drivers and machine operators to shut down between periods of activity to limit idling. – Provision of clear and direct routes to limit vehicle kilometres travelled at the construction site. – Limiting speeds of vehicles to 40 km/h on all untarred roads (spot fines to be determined and administered by the contractor).		

Table 6-8: Climate Change Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Construction and foundation of dam wall and quarry	The construction of dam infrastructure is noted to emit greenhouse gases, including emissions associated with project construction, reservoir emissions as well as spillway emissions, amongst others.	– Carbon sequestration or storage calculations will be undertaken in order to determine the conversion of stored carbon into greenhouse gasses due to flooding of the inundation zone.	EPC Contractor	EHS Manager (Daily ECO (Monthly)

Table 6-9: Noise and Vibration Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Release of noise and vibration into the environment	Vibrations and noise emissions will result in a disturbance and nuisance factor to sensitive receptors (households, schools, clinics and places of worship)	– The contractor will ensure that all construction vehicles adhere to the legal speed limit and are properly maintained to limit excessive noise. – Project traffic routing through community areas will be reduced wherever possible. – Construction noise will be kept to a minimum by ensuring proper worker conduct, that there is no excessive revving of vehicles, no unnecessary hooting and proper use of equipment. – Use of noise barriers and deflectors will be implemented during blasting activities if in close proximity to receptors; and / or excessive complaints are received.	EPC Contractor	EHS Manager (Daily ECO (Monthly)

6.2.2 SOCIO-ECONOMIC ENVIRONMENT

Table 6-10: Heritage Resources Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Disturbance of archaeological / heritage sites by project activities	Rock Art site Masibekela refuge cave Graves of Chiefs and their relations	– Appropriate barrier mesh and signposting prohibiting unauthorised entry will be displayed to prevent disturbance by construction personnel and vehicles. – The Masibekela refuge cave and graves of Chiefs and royalty will be demarcated with appropriate barrier mesh and signposting prohibiting unauthorised entry to prevent disturbance by construction personnel and vehicles. – The demarcation will be 30m from the sites.	EPC Contractor Heritage Specialist[10]	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (As required)

[10] To be appointed by DWA as implementing agent

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Chance-finds of graves and burial sites of Chiefs and royalty will be demarcated and work in the vicinity will be suspended until further notice from the Inner Council. – Chance-finds of heritage sites will be demarcated and work in the vicinity suspended until further notice from a qualified and heritage specialist and the Eswatini National Trust Commission (ENTC).		
Loss of archaeological / heritage sites by inundation	Graves of community members	– Community burial sites and graves will be signposted to prevent accidental disturbance by construction personnel and vehicles. – Where appropriate, graves and burial sites will be fenced. – Graves at risk of being inundated and those belonging to families that will be resettled will be relocated for reburial in accordance with Swazi custom. – Graves encountered during any site clearing will be demarcated and the next of kin traced (if possible) and notified before relocation for reburial.		
Potential unearthing / discovery (i.e. chance find) of archaeological / heritage sites	Rock Art site Masibekela refuge cave	– Chance-finds of archaeological sites or material will be managed as per the Chance-Find Procedure (attached as **Appendix A**), which includes demarcation of the find site and suspension of work in the vicinity until: ○ Heritage Resource will be examined by a suitably qualified specialist. ○ Post assessment, the Heritage Specialist will provide a green light for work to resume. ○ Documentation on preservation in-situ or ex-situ. ○ Liaison with District and National Heritage Authority.		
	Graves of Chiefs and their relations. Graves of community members	– Chance-finds of graves and burial sites of Chiefs and royalty will be demarcated and work in the vicinity will be suspended		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		until further notice from the Chief's Advisory Council (Inner Council). – Graves encountered during any site clearing will be demarcated and the next of kin traced and notified before relocation for reburial.		
	Chance finds	– Chance-finds of archaeological sites or material will be demarcated and work in the vicinity will be suspended. – A qualified and experienced heritage specialist and the ENTC will be notified and engaged to make an assessment of the find and a determination of the appropriate action to be taken for the rescue and/ or preservation of the find. – Movable chance finds will be proclaimed as relics or antiques, whichever the case may be in accordance with Section 25 of the National Trust Commission Act, 1972. Thereafter they will be transported, under supervision of a qualified curator at the ENTC or other person designated by the ENTC, for preservation at the National Museum in accordance with Section 11 of the National Trust Commission Act, 1972. The ENTC will determine whether to proclaim the chance finds before transportation or vice versa, depending on whichever is more practical. – Immovable chance finds will be proclaimed as national monuments in accordance with Section 25 of the National Trust Commission Act, 1972 and protected by whatever means are practical, such as signposting the site, fencing the site or proclaiming a defined area surrounding the site as a protected area.	EPC Contractor Heritage Specialist[11]	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (As required)

[11] To be appointed by DWA as implementing agent

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– In accordance with Section 26 of the National Trust Commission Act, no person shall be permitted to destroy, damage, excavate, alter, remove from its original site or export any chance find monument, relic or antique except under the authority of and in accordance with a permit granted by the ENTC.		
Damage and loss of indigenous vegetation / wildlife.	Damage and loss of indigenous vegetation of cultural significance. Loss of wildlife.	– Indigenous plants of cultural significance and those protected under the Flora Protection Act, 2001 will be rescued for relocation to similar habitats. – Where relocation is not practical, seeds or cuttings will be collected for propagation. Relocation and propagation will be undertaken under supervision of a qualified and experienced botanist. – Access roads will be designed so as to avoid ecologically sensitive areas such as wetlands. Where routing through ecologically sensitive areas cannot be avoided, personnel and vehicles will be restricted to demarcated tracks. – Awareness will be provided to site personnel and the local community not to harm wild animals. – Where wild animals find themselves trapped in fences or confined spaces while attempting to escape construction activities, a qualified specialist will be engaged to supervise the safe rescue and relocation to a similar habitat.	EPC Contractor Ecological and Heritage Specialist[12]	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (As required)
Disturbance by human activity	Degradation of scenery by encroachment of houses into near-pristine areas and housing denisty	– Resettlement sites for homesteads will be selected such that ecologically sensitive areas such as wetlands and areas of natural beauty such as the bases of mountain summits, upon a rock massif or within 30m thereof.	EPC Contractor	EHS Manager (Daily) ECO (Monthly)

[12] To be appointed by DWA as implementing agent.

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Houses of homesteads and any other buildings that will be resettled or relocated will be designed so as to avoid being visually obtrusive against the natural background and the majority of existing buildings in the host community. – The layout of resettled homes and other buildings will be designed such that they do not cause congestion in terms of building density.	Ecological and Heritage Specialist[13]	Project Steering Committee (Quarterly) / Inner Council (As required)
Conflict	Conflict in perceptions of value and thus conflict in approaches to handling heritage resources, leading to delays or obstacles to project implementation.	– On-going dialogue between project proponent and Project Affected Parties will be undertaken as well as establishment of Resettlement Task Teams to enable amicable resolution of conflicting values attached to heritage resources.	DWA EPC Contractor Ecological and Heritage Specialist[14]	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (As required)

Table 6-11: Socio-Economic Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Physical Displacement and Resettlement of Affected Households	The Project will result in physical displacement and relocation of approximately 210 households in Mantabeni and Siphocosini below the reservoir maximum operating level.	– Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP) will be implemented. – Affected households will be included in the development and implementation of alternative livelihood strategies in accordance with World Bank Safeguard policy and International Best Practice Standards.	DWA Resettlement Specialist	EHS Manager (Daily) ECO (Monthly) Project Steering Committee

[13] To be appointed by DWA as implementing agent.
[14] To be appointed by DWA as implementing agent.

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– A Socio-economic Census of affected persons, assets and other entities will be undertaken to establish an accurate socio-economic profile that can be used as the basis for future monitoring. – The recommendations/ measures proposed in the RAP and LRP will be implemented to ensure that households retain access to social services, community infrastructure and resources where the Nondvo Dam Project results in severed access. – PAPs will have a choice of compensation packages which include cash and in-kind compensation. Cash compensation is not the preferred option however in some instances is either requested or required (such as due to limited availability of replacement land, etc.). In each situation PAPs are entitled to participate in the Livelihood Restoration Plan (LRP) which includes the provision of resettlement assistance, land-based activity training (such as improved agriculture techniques), as well as non land-based activity training such as financial management / entrepreneurial training. – Resettlement Implementation will include: o Signing of compensation agreements with affected communities; o Payment of compensation; and o Implementation and management of the resettlement programme including preparation of relocation sites; construction of replacement housing and amenities/services; physical relocation of households and their belongings; and relocation of graves and other social mitigation. – Additional aspects that will be considered as part of the RAP contract include:	CLO & Grievance Officer	(Quarterly) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		○ The socio-economic census will outline multiple providers of income and include a gender analysis as a basis for facilitating different opportunities for employment of women; ○ Criteria set for the socio-economic census for determining vulnerability of households shall ensure that vulnerable groups (poor, elderly, disabled) are included; ○ Compensation and other necessary assistance will be provided before impacts of the Project occur; ○ Arrangements and resources for resettlement will be adequate and assigned; ○ The resettlement timetable will be linked to the phasing of Project implementation; ○ Physical and economic assistance to households will be provided during relocation; ○ Households requiring relocation will be properly briefed on the advantages and disadvantages of different housing types to make informed decisions; ○ Replacement housing structures will be built to Eswatini's building and safety standards; ○ Grievance procedures will be prepared and implemented; and ○ A Monitoring and Evaluation Plan for resettlement will be prepared and implemented, and mid-term and long-term Monitoring and Evaluation audits conducted. – Compensation packages will serve as supplementary assistance so that households can meet their basic needs until they recover from their losses and restore their livelihoods to pre-Project levels.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Host site negotiations will include the office of Regional Administrator and the Ministry of Tinkundla. – Chiefs, affected households and host communities will be engaged to manage host site selection and preparation. – Continual PAP assessment will be undertaken to determine effectiveness of RAP and LRP measures.		
Economic Displacement of Affected Households	Loss of access to agricultural land for crop cultivation and livestock grazing, as well as natural resources will affect project affected people's (PAP's) ability to produce food and cash crops/ produce.	– A LRP will be developed and implemented to address economic displacement. – The RAP and all livelihood restoration and social development interventions will be designed and implemented in compliance with National Regulations and AfDB requirements as outlined in the RAP. – Projects that aim to enhance agricultural production amongst the population of the Nondvo Dam Project Area will be developed. – Land tenure negotiations will aim to ensure all affected households receive clear title to their new sites free of registration fees, licensing fees, or customary tribute payments		
Host Community Impacts	Introduction of the relocated PAPs into the host community will result in increased pressure on land, infrastructure, goods, and services. In severe cases these may result in conflict.	– Engagement with host communities will be undertaken early in the resettlement planning process. – Preliminary engagement with host communities will be undertaken with caution so as not to raise expectations or unfounded concerns about possible settlement of newcomers. – Information will be shared transparently and regularly with the host communities throughout the land-acquisition planning and implementation process. – Coordination and interaction between host communities and resettles will be facilitated to determine how and when newcomers will be incorporated in to local social and organisational structures.	DWA (with support by relevant NGO)	Project Steering Committee (Quarterly) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– The Project will consider the provision of infrastructure and facilities to serve the resettled and the host community so that the host community will also benefit. Implementation of a community development project that would benefit both displaced households and the host community is good practice that will help to build and maintain a sustainable social licence to operate.		
Loss of plant resources used by the community	Loss of vegetation will result from site clearance in the infrastructure footprint during construction as well as due to flooding during inundation of reservoir area.	– Species of significance to communities within the Project footprint and inundation zone will be identified, in liaison with traditional medicinal practitioners; who (along with PAPs) will be allowed to harvest plant resources prior to inundation. – Plants rescued by the contractors will be planted in local community nurseries for use in landscaping / rehabilitation activities. – Populations of plants considered to be important to local communities will be identified within the construction and inundation areas through discussions with traditional medicinal practitioners. – Local traditional medicine practitioners and members of local communities will be allowed and encouraged to harvest plant resources within the infrastructure footprint prior to site clearance. – Local communities will be given support to harvest and stockpile firewood and other plant resources prior to inundation.	EPC Contractor CLO & Grievance Officer Ecologist	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
		– Local communities will be supported to start nurseries/ community gardens to propagate and grow plant resources.	DWA (with support by relevant NGO)	Project Steering Committee (Quarterly) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Creation of Employment Opportunities	Generation of employment[15] (formal and informal) and other income generation opportunities in the Nondvo Dam Project area and the surrounding area.	– Labour Recruitment Policy and Guidelines will be developed and implemented. – Recruitment will be undertaken in liaison with local community structures Area Council Leaders / Inner Council to identify local labour pool. – Appropriate training and capacity building opportunities will be provided to all workers. Opportunities for rehiring into more skilled positions will be considered and applied where feasible. – Recruitment for new positions will be undertaken through liaison with local community structures to identify local labour pool. – Skills audits will be undertaken well before the construction begins to assist labour recruitment in the area. Where possible training will be provided to upskill local youth where there are skills shortages. – Local labour will be used as much as possible. – Employment of PAPs and registered community members (i.e. local labour) will be given precedence during recruitment. – A Recruitment Committee will be established. This committee will be responsible to establish the criteria for employment of both locals and outside work seekers. These criteria will be guided by the laws of the lands to ensure fairness and transparency. – A database of work seekers will be developed and shared with the contractors. – The contractor will also discuss with the Nondvo Dam Labour Recruitment Committee other jobs for which in house training	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
Increased Cost of Living and Debt Generation	Increased demand for goods and services is likely to result in increased prices. Simultaneously, however, local people will be able to sell their goods / services at higher prices, thus potentially generating more income.			

[15] Number of employment opportunities to be indicated during detailed design process.

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		could be provided. This strategy should ensure that a large pool of people are afforded opportunities to participate in the employment sector.		
Increased Cost of Living and Debt Generation	Increased demand for goods and services is likely to result in increased prices. Simultaneously, however, local people will be able to sell their goods / services at higher prices, thus potentially generating more income. Increased travelling distance around the reservoir will increase the cost of travel around the dam to reach important public services such as clinics, trading posts, schools and places of worship.	– Identification and implement of social development projects will be undertaken as a means of delivering socio-economic benefits to assist in combatting some of the challenge's households may experience. – Individuals employed on the project will be encouraged to market newly acquired skills from the construction phase to be applied in similar water construction projects. – Local retailers will be encouraged to provide necessary construction materials and other services. – Women and youth will be encouraged to form cooperatives that will take advantage of the construction period in supplying needed services during and after construction. – Vehicular bridge / crossing will be provided on the northern extent of the dam and use of the dam wall to serve as public crossing.	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
Disturbance from Increase Nuisance Factors (noise, dust, vibration)	Construction activities will generate uncharacteristic disturbances resulting in a range of nuisance factors (notably increased levels of noise, decreased air quality and vibrations). Damage to households' structures from heavy traffic and rock fall from the blasting operations.	– All construction staff will agree to a Code of Conduct (CoC) that outlines protocols and standards for working in the Project Area as part of their contract. The CoC will address the following: ○ Respect for local residents, including being considerate about noise levels, privacy, and local customs; ○ Respect for existing livelihood activities and the environment; ○ Respect for community water supplies (to prevent pollution and overuse);	DWA EPC Contractor Resettlement Specialist CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		○ No hunting, snaring or unauthorised taking of any property belonging to someone else, including removal of natural resources; ○ Zero tolerance of illegal activities by construction personnel including: illegal sale or purchase of alcohol; sale, purchase or consumption of drugs; illegal gambling or fighting; and ○ Disciplinary measures for not adhering to the CoC. Theft or purposeful damage to property and similar crimes conducted by contractor staff will be managed as dismissible offences. – Ongoing engagement and grievance management ○ DWA will present the schedule and approach to construction to the district authorities and community leadership structures to enable their understanding of the Project roll out. ○ DWA will regularly review and update the Community Participation Strategy; this strategy will be agreed upon by local community structures through the appointed CALs. ○ The contractor will appoint appropriately trained and experienced staff to implement stakeholder engagement during the course of work and shall assign adequate resources. ○ Households within the vicinity of the construction of the dam and quarry area will be resettled before construction activity begins in order to avoid any accidents and damage to property from the blast area, rock falls, and noise from the construction site. – Engineering and Operational Practices		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		o All diesel-powered construction, earth moving, and equipment will be kept at a high level of maintenance. This will include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment will serve as trigger for withdrawing it for maintenance. o All appointed contractors will include noise management provisions as part of onsite work inductions. – Traffic Management o Contractors will compile a traffic management plan / method statement relevant to their activities, which shall include a protocol for handling accidents involving other vehicles, pedestrians, animals or property. o DWA / Contractor will undertake traffic safety awareness sessions at schools and in communities during construction and early operation (until completion of dam construction). This will be done in collaboration with the Roads Directorate and Ministry of Education, as appropriate. o The appointed contractor/s will have the necessary insurance / contingency budget in place for costs incurred with accidents involving other vehicles, people, animals, agricultural land, or infrastructure. o The contractor will be required to compensate any affected community member for injured animals in terms of agreed protocols. – Dust Suppression and Emissions Management		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		○ Site clearance will be minimised as far as possible to reduce the potential for dust, and other impacts. ○ Dust suppression measures will be implemented as specified in the ESMP, which shall include wetting of roads during windy conditions and covering of stockpiles of loose material, such as soils / sand. ○ An onsite weather station will be installed to monitor general weather conditions. When wind speeds above 20 km/hr are expected, this will trigger implementation of measures to minimise dust emissions. ○ Ensure an adequate water supply on site for effective dust/particulate matter suppression, using non-potable water where possible. ○ Ensure equipment is readily available on site to clean any dry spillages; ○ Ensure fine-powdered materials are delivered in enclosed tankers and stored in areas suitable for emission control systems to prevent escape of material and overfilling during delivery. ○ For smaller supplies of fine-powder materials, ensure bags are sealed after use and stored in contained buildings to prevent dust. ○ Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site. ○ Ensure vehicles carrying materials or spoil entering and leaving sites are covered to prevent escape of materials during transport. ○ Where reasonable and feasible, haul roads will be maintained with water carts and graders, and the		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		condition of the roads will be monitored especially in high risk areas and/or during high risk periods. ○ Contractors will ensure all construction vehicles comply with their relevant emission standards. Furthermore, contractors will provide confirmation that all off road diesel equipment would meet best available diesel emissions standards or be fitted with a diesel exhaust treatment device where possible. ○ Contractors will, where possible and available, use low-Sulphur diesel in vehicles to minimise harmful emissions. – Noise Management ○ Workers will be considerate regarding noise levels and associated disruption to local people; this will be outlined in the CoC. ○ Noisy activities (e.g. blasting) will not to be scheduled at critical times (e.g. school exams, religious services/ celebrations), where located in close proximity. ○ DWA / Contractor will consult local leaders, school principals, healthcare workers and religious leaders regarding important events or occasions that may be negatively affected by construction noise in order to try to schedule these activities at different times. ○ Noise generating construction activities will only be undertaken outside normal working hours under exceptional circumstances. ○ Where noise generating construction activities are required to take place outside of normal working hours, the Contractor will provide sufficient		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		notification (at least 48 hours) to the community of such works. – Blasting and Vibration o DWA and its contractor(s) will develop blast designs and procedures that will keep noise and blasting to a minimum without compromising blast requirements. Blast plans will be compiled as method statements to be approved by the Resident Engineer. o All blasting activities will be undertaken following a planned schedule and the local communities informed of this in advance. o All safety measures related to blasting will be implemented as specified in the ESMP. o DWA and its contractor(s) will ensure that no blasting activities occur at night. – Waste Management and Water Source Management o Waste management measures will be implemented as specified in the ESMP. This will include the use of portable toilets and rubbish bins (to avoid littering); and o Water management measures will include controls on use of community water supply points by construction workers who may not be familiar with protocols of keeping supplies clean and uncontaminated. – Earthworks and Stockpiling o Stockpiles will be located away from sensitive receptors and, where necessary, covered with anchored fabrics, or seeded with sterile grass.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		○ Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. ○ Where practical, only remove any cover for exposed areas in small areas during work and not all at once.		
Exacerbation of Anti-Social Behaviour due to in migration (influx of job seekers)	Expectations regarding possible employment opportunities may result in an influx of job seekers. Migrants will bring with them differing cultures, religious beliefs, norms and values; they influence young people to change in a manner that may not be accepted by the more conservative/ traditional sector of the population; resulting potential increased prevalence of Sexually Transmitted Infections (STIs) and HIV/AIDS as well as crime.	– A Code of Conduct will be developed and signed by all employees of the contractors together with their employment contract. – Basic socio- cultural information brochure will be shared as part of Induction. – Workers from outside the Project Area will work on a rotational basis, allowing them time to return home to visit their families and rest, with the cost of their return journey covered by the contractor/s. – Provision of health care facilities for staff and local labour will be equipped with adequate medical staff and resources will handle common diseases (including STIs and HIV) and work related injuries. – Risk of gender-based violence will be addressed through mandatory training and awareness raising. – Sensitisation of women and youth on impacts of the influx of scores of workers to the project area will be provided. – Grievance Redress Mechanism (GRM) will be implemented.	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
Increased pressure on social infrastructure and services	The Project area has one clinic, primary school and high school and is regarded as semi-rural. The possible influx of work seekers and additional contractor's workforce may add more stress on the existing resources and services.	– Communities in the Nondvo Project Area will be fully informed of the preferential labour policy for recruiting workers from local villages and how they are required to register for work well in advance of construction in order that sourcing of local labour is maximised.	DWA / Inner Councils CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Construction of replacement schools will be implemented well in advance of the construction of the dam to minimize disruptions on education of the local communities.		(Quarterly) / Inner Council (as required)
Disruption to Family and Community Structures	Employment opportunities may inadvertently cause a shortage of available farming skills and family support networks during the construction phase. Additionally people employed in the construction work may aim to secure further work in the construction sector with their newly acquired skills and experience, leading to a longer term disruption to social and economic networks.	– To avoid school drop-outs the below will be undertaken: ○ Share types of job opportunities, including capacity and qualification requirements long in advance of recruitment ○ Contractor will be prohibited to employ anyone under the age of 18 years ○ Implement a skills development and capacity building programme – DWA will collaborate with local authorities and relevant organisations (e.g. donors, civil society and NGOs), where available and appropriate to develop programmes that aim to enhance agricultural production and new technologies to improve yields amongst the PAPs. – Labour Recruitment Guidelines will be implemented and allocate maximum number of unskilled and semi-skilled jobs to local residents. – Job opportunities will be shared, including capacity and qualification requirements long in advance of recruitment to provide people with motivation to complete schooling to the required level, thus discouraging school dropouts. – A skills development and capacity building programme will be implemented well in advance of recruitment to ensure that a suitable number of people attain the necessary skills.	DWA EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
Demand on local utilities - Energy	Additional power requirements for construction purposes and services or facilities in the various housing, camp and work areas is likely to place additional pressure on existing electricity supply.	– Employment of PAPs and registered community members (i.e. local labour) will be given precedence during recruitment to avoid temporary immigrants into the project area and minimise additional energy demands.	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– PAPs and registered community members will be provided with access to electricity.		Project Steering Committee (Quarterly) / Inner Council (as required)
Demand on local utilities - Water	Additional water requirements for construction purposes and services or facilities in the various housing, camps and work areas is likely to place additional pressure on existing water supply.	– Training (tool box talk) on sustainable use of water resources will be provided. – The Environmental Protection Plan (EPP) and Emergency Response Plan (ERP) will include procedures and contact details in the event of damage to existing water supply infrastructure. – PAPs and registered community members will be provided with access to potable water.	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)
Increased safety risks to people and animals	A number of hazards threaten the public safety and security during the construction phase, including increased traffic movement, handling of hazardous chemicals, open excavations and more.	– Community Liaison Meetings will be undertaken monthly to address any issues or complaints that may arise. – Adequate traffic signage will be utilised by all project stakeholders. – Existing roads running through the project area will be kept open as far as possible. Access routes may need to be temporarily diverted or closed for short periods when construction activities pose a potential safety risk. – Access to the construction sites will be restricted – Buffer strips or other methods of physical separation around hazards areas will be implemented , as well as sources of nuisance issues related to noise, odours, or other emissions. – Trenches will be barricaded. – The Emergency Response Plan will include: o Early warning of an emergency incident to communities and local authorities (e.g. details of Local Police, Local Hospital).	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		o List of potential resources available for the restoration and clean-up of the environment following a major accident. o Training of personnel for emergency response – Sign boards will display EPC Contractor contact name and numbers at working areas; and contact details for local and national emergency response authorities. – Blasting will not be carried out unless occupants of any nearby building or working area have been notified by the Contractor at least 24 hours in advance. – Road Safety Measures: o Regular maintenance of vehicles – records kept within Environmental File. o Construction vehicles will adhere to road safety regulations. o Employ flag persons will warn of dangerous conditions. o Procedures for transportation of hazardous materials will include proper labelling of containers, including the identity and quantity of the contents, hazards, and shipper contact information. o Training employees involved in the transportation of hazardous materials regarding proper shipping and emergency procedures will be undertaken. – Closure of existing community routes for site work: o Closure will be arranged by Contractor and occupiers o Barricades, traffic signs, and drums will be provided by the Contractor to suit the specific conditions. – The Contractor will be required to provide and allow access to properties that fall within, or are adjacent to, the project area. – Community access routes temporarily disturbed by site works will be made safe and re-opened to traffic overnight.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Occupational health and safety risks	The operation of earthmoving equipment and construction vehicles will cause hazards which will result in accidents leading to injuries and fatalities in the workplace.	– All operators of vehicles and machinery will be selected based on medical fitness, adequate licensing, training and experience. – All vehicles and machinery will be fit for purpose, inspected and maintained regularly to ensure continued fitness for purpose. – Traffic will be controlled by signal persons during hazardous conditions. – Site employees will be issued with reflective high visibility clothing and its use will enforced.	EPC Contractor	EHS Manager (Daily)
	Working in close proximity will expose employees to drowning hazards, such as when walking or driving on unstable surfaces along the water's edge, sudden flooding of the worksite due to heavy downpour, employees bathing in nearby pools during lunch break or after work. This risk of drowning is identified based on recorded incidents in the community.	– Cliff edges, deep excavations and hazardous water lines will be barricaded and/ or signposted as appropriate to prevent approach by site employees. – Employees will be notified of hazards of water bodies during team briefings. The prohibition of bathing in waters will be enforced through supervision.	EPC Contractor	EHS Manager (Daily)
	Skin contact with wet concrete and other chemicals such as chemical stabilizers and waterproofing agents, petrol and diesel will cause irritation and long term exposure will cause dermatitis.	– Where practical, alternatives to the use of chemicals will be explored, and where alternatives are not available employees will be trained on the safe use and disposal of chemicals. – Appropriate PPE will be provided for handling chemical substances and its use will be enforced.	EPC Contractor	EHS Manager (Daily)
	Workplace noise will cause noise-induced hearing loss (a recognised illness) while long term exposure to dust will cause or exacerbate pre-existing respiratory conditions.	– Pre-employment and regular medical examinations will be conducted on employees in order to monitor effects of occupational hazards, including noise-induced hearing loss. – Where employees are found to have a change in their relevant health conditions with respect to their tasks, further investigation will be carried out to determine the root cause/s and medical attention will be provided.	EPC Contractor	EHS Manager (Daily)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Elimination of the cause will be undertaken where practical. Where elimination is impractical, appropriate PPE will be issued and its use will be enforced.		
	Inclement weather such as persistent rain, extreme cold, extreme heat will cause shock to the body, triggering conditions such pneumonia in the case of wet and cold, and heat stroke in the case of heat.	– Work conditions will be monitored closely during inclement weather and where unsafe to continue, the respective tasks will be suspended until safe to resume. – For tasks that are not adversely affected by wet weather, rain protection will be issued. – For tasks that are obligatory during extreme heat, adequate clean water will be provided and employees will be encouraged to drink frequently.	EPC Contractor	EHS Manager (Daily)
	Large numbers of employees working in close proximity to each other and sharing hand tools will increase the likelihood of the spread of COVID-19, exacerbated by the likelihood of multiple employees living in shared accommodation both at the workers' camp and in the community. This will be further exacerbated by promiscuity amongst employees who will thus spread both COVID-19 and HIV amongst the workforce and throughout the community.	– COVID-19 mitigation measures include wearing face masks, regular hand washing and physical distancing will be implemented. This will be further strengthened by providing sanitation facilities in the workplace and continual reminders to site employees through health and safety briefings. – Where appropriate, and as far as practical, labour will be recruited from local aptly qualified persons. This will mitigate interaction with persons from outside the community who will introduce COVID-19 and/ or HIV/AIDS or contract the diseases locally and spread them further afield when visiting home. – COVID-19 measures stipulated by the WHO, that is applicable to the Nondvo Dam Project, will be implemented.	EPC Contractor	EHS Manager (Daily)
Change in sense of place	Construction activities will introduce new machinery and structures into the landscape. Construction vehicles, dust and equipment will have a visual impact on viewers and general visibility (clarity of the air) within close proximity to the site.	– Generic construction phase management measures relating to traffic management, dust suppression, noise management and blasting and vibrations will be implemented.	EPC Contractor CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Degradation of scenery of near-pristine areas / built environment	Degradation of scenery by encroachment of houses into near-pristine areas and of the built environment by increased housing density resulting from physical resettlement of PAPs.	– Resettlement Action Plan (RAP) and Livelihood Restoration Plan (LRP) will be implemented.	DWA Resettlement Specialist CLO & Grievance Officer	EHS Manager (Daily) ECO (Monthly) Project Steering Committee (Quarterly) / Inner Council (as required)

6.3 OPERATIONAL PHASE

6.3.1 BIOPHYSICAL ENVIRONMENT

Table 6-12: Geology, Topography, Soils and Land Use Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Inundation of reservoir area	Areas of sparse land cover will leave the soil vulnerable to the erosive influences of wind and water resulting in possible erosion and sedimentation.	– Soil erosion control measures (protection berms / gabions, silt traps etc.) will be implemented. – Disturbed soils will be stabilised immediately through grass cover as a first step to soil stabilisation. Gabions or the use of geotextile fabric and landscaping, will be used to rehabilitate existing erosion areas. – Stockpiled topsoil as well as areas left bare will be revegetated to protect against erosion, discourage weeds and maintain active soil microbes. – Soil stockpiles will be placed so as to prevent exposure to wind and water erosion. – Access and haul roads will have gradients or surface treatment to limit erosion, and road drainage systems will be provided. – Terracing, slope reduction, runoff velocity limitation and the installation of appropriate drainage will be incorporated into the site management plan to limit soil erosion. – Progressive rehabilitation of disturbed land will be carried out to minimize the amount of time that bare soils are exposed to the erosive effects of rain and subsequent runoff.	Appointed Managing Entity	ECO (Annual)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– The rehabilitation of disturbed areas will be undertaken where necessary and revegetate with indigenous plants – A management plan for the Dam will be developed, which includes a Sediment Management Plan (SMP). – Investigate the use of the quarry as a landfill site for the local community.		
	Sediment trapping will prevent normal sediment load distribution downstream of the dam site. A major impact on the downstream river channel could be to make it deeper and narrower.	– In order to increase the morphological diversity of the Lusushwana River, some of the following environmental improvements will be implemented: o Riffle construction; o Bar construction; o Boulder placement; o Deflectors; o Two-stage channels; o Installing large woody debris; and o Narrowing over-widened channels.		

Table 6-13: Hydrology and Hydrogeology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Dam Wall failure and flooding	Flow and velocity of water during dam failure and flooding has potential to result in loss of households and social assets downstream.	– Regular maintenances checks will be conducted on the Dam wall. – An early warning system will be developed. – Develop an Evacuation Plan for people located downstream of the Dam.	Appointed Managing Entity	Catchment Agency for the Greater Usutu River Basin ECO (Quarterly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Flooding	Major effects of flooding include the creation of bars, pools and rapids which then influence the morphology of the river.	– Flood-control measures will be implemented, such that the reservoir level be kept below a certain elevation before the onset of the wet season. – Floods will be controlled by redirecting excess water to purpose-built canals or floodways, which divert the water to temporary holding ponds or other bodies of water where there is a lower risk of flooding. – Flood patterns will be retained through dam operating rules.		
Water Abstraction	Water abstraction for construction could temporarily decrease the natural volume of water within the River.	– An abstraction plan for water stored within the dam will be developed The plan will factor in abstraction for domestic water supply, hydro-power and maintaining the ecological flows for the River. The plan will factor in the downstream water users. – Natural flows will be maintained through a controlled release plan and controlled releases of water for Domestic use.	Appointed Managing Entity	Catchment Agency for the Greater Usutu River Basin ECO (Monthly)
River Flow Modification	Change in flow (reduced quantity) downstream of a dam affecting downstream ecological functioning and disruption of supply to users.	– Implementation of a maximum flow rate downstream of the dam wall will be met. – Monitoring of inflow to the reservoir will be undertaken. – Consideration will be given to increasing the magnitude and frequency of short duration, high flow events.	Appointed Managing Entity	Catchment Agency for the Greater Usutu River Basin ECO (Quarterly)

Table 6-14: Riverine Ecology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Inundation of the reservoir area	Inundation of approximately 19.7 ha of instream and 55.9 ha of riparian habitat will result in disruption to river continuum through the obstruction of the longitudinal exchanges between the regions up and downstream of the dam wall leading to alteration of the ecological structure and function of riverine ecosystems (reproductive and vegetative functions).	– Vegetation, particularly larger trees within the inundation zone will be removed prior to the filling. – A catchment management agency will be established. – A dredging programme or sediment flushing programme will be established in line with a completed aggradation study. The dredged materials can be added to the downstream river reach to reduce erosion and maintain channel morphology. – Flushing of the reservoir will be incorporated into the operation regime to reduce residence times of water volumes. – An Ecological Flow Requirement (EFR) release of 4 Mm^3/year is will be implemented (JMRBWRS, 2008) however a PROBFLO[16] assessment to determine and assess the current EFR will be undertaken. – Riverine aquatic biomonitoring will be undertaken for the first 6 months of the operational phase on 3-month survey basis (Monitoring Plan Table – **Section 7**). – Water quality monitoring of the flow releases (refer to Monitoring Plan – **Section 7**).	Appointed Managing Entity	Catchment Agency for the Greater Usutu River Basin ECO (Quarterly) Ecologist (Quarterly)
	Habitat modifications will potentially have an immediate impact on biota with preferences to lotic habitats such as *Chiloglanis*, *Labeobarbus* and *Platycypha caligata* (i.e. loss) *and proliferation of* taxa adapted to lentic conditions including alien invasive species *Micropterus salmoides*.			
	Alteration of downstream flow regime can impact on the relative volume of water discharge, permanence of low flows as well as the frequency and magnitude of flood peaks leading to reduced frequency of overbank flooding and negative impacts on the breeding cues of local fish communities.			
Additional instream barrier	Easily removable material downstream of the dam wall will be removed and become armoured with rocks resulting in reduced habitat and aquatic species diversity.			
	Alteration of migratory patterns for the observed Eel species (*Anguilla mossambica*) due to migratory habitats upstream of the dam being inaccessible.			

[16] PROBFLO is a holistic e-flow assessment tool that incorporates regional scale ecological risk assessment methods in a robust, tested approach, for the evaluation of the social and ecological consequences of altered flows on multiple spatial scales (http://riversoflife.co.za/programme-highlights/probflo/).

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	Large fluctuations in the water levels of reservoirs can result in the erosion of the reservoir shoreline; erosion of the instream channel and riverbanks downstream of impoundments adding to existing sediment loads. This is compounded by the reduced sediment loads of the downstream river system which inherently increases the erosional capacity of the watercourse.	— Soil erosion control measures (protection berms / gabions, silt traps etc.) will be employed. — A Stormwater Management Plan will be developed. — Disturbed soils will be stabilised immediately through grass cover as a first step to soil stabilisation. Gabions or the use of geotextile fabric and landscaping, will be used to rehabilitate existing erosion areas. — Rehabilitation of disturbed areas will be undertaken where necessary and revegetate with indigenous plants — A Dam Sediment Management Plan (SMP) will be developed.	Appointed Managing Entity	ECO (Annual)

Table 6-15: Terrestrial Ecology Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Inundation of the reservoir area	Destruction, further loss and fragmentation of the vegetation community and displacement, direct mortalities and disturbance of faunal community due to habitat loss and disturbances.	– Areas rated as High sensitivity in proximity to the development areas, will be declared as ‘no-go’ areas during the operational phase, and all efforts will be made to prevent access to this area from construction workers and machinery. – Flooding of the area will be conducted over as long a time as possible, preferably 1-2 years to allow fauna to migrate. – Existing vegetation within the expected inundation zone will be cleared prior to filling of the dam, as this will cause the majority of fauna to evacuate the area.	Appointed Managing Entity	Facility EHS Manager (Continual) Relocation Specialist / Ecologist (Quarterly over first 2 years) ECO (Quarterly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– Areas above and below the dam will not be fenced off, this can function as animal corridors and can assist with genetic diversity as well as movement out of the area when being flooded.		
	Continued habitat degradation (litter, fire and alien vegetation encroachment)	– Noise will be kept to a minimum to reduce the impact of the activities on the fauna residing on the site and neighbouring areas. – The extent of the project area to be development will be kept to a minimum. – The development areas and access roads will be specifically demarcated so that during the construction phase, only the demarcated areas are impacted upon. – An alien vegetation removal and management plan will be implemented. – The alien vegetation removal and management plan will be maintained and made part of the maintenance plan. – The collecting and/or destruction of plants by unauthorized persons will be prevented. – Protection will be provided for the surrounding vegetation from unregulated settlement by the local community of the inundated area following the flooding, by regulating the movement in correlation with the ESIA and local community engagement. – All maintenance motor vehicle operators will undergo an environmental induction that includes instruction on the need to comply with speed limits, to respect all forms of wildlife.	Appointed Managing Entity	Facility EHS Manager (Continual) Relocation Specialist / Ecologist (Quarterly over first 2 years) ECO (Quarterly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	Loss in genetic diversity, habitat fragmentation and disruption of habitat corridors	– Areas above and below the dam will not be fenced off, this can function as animal corridors and can assist with genetic diversity as well as movement out of the area when being flooded.	Appointed Managing Entity	Facility EHS Manager (Continual) ECO (Quarterly)
	Introduction of new waterborne diseases	– All site staff will use supplied ablution facilities and under no circumstances will indiscriminate excretion and urinating be allowed other than in supplied facilities. A minimum of one toilet will be provided per 10 persons. – Identification of the existing human waste facilities being used within the inundation zone and pumping the sewage out and the sewage will be taken to a sewage plant (i.e. best practice to reduce the impact prior to flooding, pumping the sewage out of conservancy tank (formal) rather than filling of pits (informal) or any other method). – French drains of the houses in the inundation zone, will be pumped out and the sewage will be taken to a sewage plant. Chemicals will not be used, except if these are found to be environmentally friendly.	Appointed Managing Entity	Facility EHS Manager (Continual) ECO (Quarterly)
Infringement by humans into natural areas	Increased infringement by humans into the remaining natural areas, with associated impacts such as habitat destruction, poaching, litter and feral species such as cats and dogs	– Vermin will be controlled and poaching reduced through staff education and enforcement. – A site plan of the area will be provided on site indicating parking and storage areas, site offices and placement of ablution facilities. – The collecting and/or destruction of plants by unauthorized persons will be prevented.	Appointed Managing Entity	Facility EHS Manager (Continual) CLO (Continual) ECO (Quarterly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
		– The operator will supply sealable and properly marked domestic waste collection bins and all solid waste collected will be disposed of at a licensed disposal facility. – Where a registered disposal facility is not available close to the site, the operator will provide a method statement with regard to waste management. Under no circumstances will domestic waste be burned on site. Temporary storage of domestic waste will be in covered waste skips. – Refuse bins will be emptied and secured to prevent unauthorized removal or access by wildlife.		

Table 6-16: Ecosystem Services Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Inundation of the Reservoir	The inundation of the reservoir area will result in an alteration of ecosystem services.	– Access to the dam will be provided for the community to ensure that the abundance of freshwater be used by the local community for those households that do not make use of mountain springs and/or tap systems.	Appointed Managing Entity	Facility EHS Manager (Continual) ECO (Annual)
	Altered water quality and flow could modify downstream ecosystem services.	– Implementation of a maximum flow rate downstream of the dam wall will be met. – Ecological Flow Releases will be monitored. – Consideration should be given to increasing the magnitude and frequency of short duration, high flow events	Appointed Managing Entity	Facility EHS Manager (Continual) ECO (Annual)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	Increased pressure on downstream natural resources.	– Prevent loss of riparian vegetation due to fuelwood harvesting downstream of the dam and elsewhere (e.g. along plains drainage lines). – Construct temporary silt fences downstream of disturbed areas, where appropriate. – Include a fish ladder in the design dam wall to ensure migration of fish downstream of proposed the dam.	Appointed Managing Entity	Facility EHS Manager (Continual)

Table 6-17: Waste Generation Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Generation of hazardous waste (oil, greases, and other chemicals and associated contaminated materials)	The inappropriate management and disposal of hazardous waste generated during maintenance activities at the hydro power station and railway line could lead to contamination of soil, groundwater, surface water and poisoning of fauna.	– Oily Waste, Oil Contaminated Waste and Hazardous Chemical Containers will be disposed of at an appropriate landfill registered for the disposal of hazardous waste. Proof of disposal will be kept on site.	Appointed Managing Entity	Facility EHS Manager (Continual) ECO (Annual)

6.3.2 SOCIO-ECONOMIC ENVIRONMENT

Table 6-18: Heritage Resources Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Deterioration of archaeological / heritage resources by uncontrolled visitor access.	Rock Art Site Refuge Cave	– Dam Operator will support initiatives by the local community to maintain and preserve the Rock Art site and Masibekela refuge cave (including sponsoring or part-sponsoring fencing, plaques and access control notices).	Appointed Managing Entity CLO (Continual)	ECO (Annual) Project Steering Committee (Biannual) / Inner Council (as required)
Disturbance and lack of access to grave of Chiefs and their relations / community members.	Reduced access will cause physical and emotional alienation from the graves and burial sites.	– Dam Operator will support initiatives by the local community in maintaining access to the graves of Chiefs and royalty and community burial sites so as to protect them from disturbance and vandalism by visitors (including fencing and access control notices).		
Lack of access to indigenous plant resources lost through inundation.	Loss of species of cultural significance such as timber and grasses used for construction, as well as plants used for medicinal purposes	– Dam Operator will support local community initiatives to enhance natural habitats: ○ Sponsoring or part-sponsoring awareness campaigns ○ Control of alien invasive plants to conserve natural habitats for wildlife.		
Attraction of fauna to project site due to availability of water	Conflicts between humans and wildlife where some mammals will seek refuge within cultivated fields and consequently be killed by humans resulting in reduction of species populations over time.			
Disturbance by human activity	Degradation of scenery by encroachment of houses into near-pristine areas and housing denisty			
Conflict	Conflict in perceptions of value and thus conflict in approaches to handling heritage resources, leading to delays or obstacles to project implementation.			

Table 6-19: Socio-Economic Mitigation and Enhancement Measures

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Economic Opportunities and Diversification	Direct project employment will be dramatically reduced post construction (no accurate figures are currently available). Additionally, some of the workers and migrant work- seekers will remain following construction; thus the population is likely to increase as compared to the current baseline. The economy, which is almost exclusively focused on agriculture, is likely to become more diversified through an influx of people with a greater variety of skills and offerings.	– Implementation of livelihood restoration and social development projects will continue with directly affected households and communities until it can be demonstrated that local residents directly affected by the project are self-sufficient and able to sustain their livelihoods. – Entrepreneurial skills will be developed through collaboration with service providers such as Vocational Colleges (Gwamile Vocational and Commercial Training Institute), which will include all affected parts of the extended Project Area, as part of DWA's commitment to social development as indicated in the LRP.	DWA Livelihood Restoration Team	Facility EHS Manager (Continual) CLO (Continual) ECO (Annual) Project Steering Committee (Biannual) / Inner Council (as required)
Increased cost of living	The cost of goods and services is likely to increase gradually throughout the construction phase and remain elevated throughout the operational phase. In addition to the increased costs of items, goods and services that were previously not offered for purchase may become available.	– Social development projects will be identified and implemented as a means of delivering socio-economic benefits to assist in combatting of the challenges households may experience. – Individuals will be encouraged to market the newly acquired skills from the construction phase to be applied in similar water construction projects.		
Growth in the local tourism sector	It would be recommended that recreational activities be permitted to take place on the Nondvo Dam (i.e. serve as a multi-purpose dam). This strategy would increase the footprint of tourist and contribute to the income generation of the local area. Aggressive marketing well ahead of construction, including promotion of the nearby nature reserve, would likely attract visitors who would value the aesthetic presence of the reservoir and who enjoy water-based recreational activities that may be developed at the	– A plan will be developed to establish a committee for developing the land surrounding the Nondvo Dam. – A Tourism Economic Assessment (TEA) will be undertaken to determine the tourism potential in the project area. – The outcome of the Tourism Assessment will be a business plan where local communities can be beneficiaries from private investments.	DWA	CLO (Continual) Project Steering Committee (Biannual) / Inner Council (as required)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	site. Growth of the tourism sector will also facilitate creation of induced employment for local people, especially the youth.	– The use of the management camp, contractors camp and offices for tourism related activities will be investigated. – DWA will engage with Ministry of Tourism and Environmental Affairs, promoting collaboration with other stakeholders both in government and private industry. – DWA will engage with Ministry of Agriculture and Ministry of Tourism and Environmental Affairs, to ensure the sustainable exploitation of fish and development of sport fishing on Nondvo Dam. – DWA will engage with the Department of Finance and Commerce, Industry and Trade to facilitate provision of: o training and development to start-up and small businesses; as well as to facilitate provision for micro-loans for tourism related entities to the local community. o capacity building and training sessions to support local businesses to improve their offerings, and to comply with the strict health, safety and quality standards.		
Continuation of Anti-Social Behaviour and Spread of STIs and HIV/AIDS	As a result of increased accessibility and an inevitable flow of 'outsiders' through the area, norms, values and customs will continue to change; people will continue to be exposed to different views and ways of life. Migration in and out of the area will likely be driven more by economic / market reasons, as well as travel to schools and other social facilities that may be of a higher standard than those present in the Nondvo Project Area.	– DWA will continue to collaborate with the various stakeholders such as the Ministry of Health, Education and Training, Commerce, Industry and Trade, Agriculture to support the community in a holistic way ranging from health and welfare, economic and entrepreneurial endeavours by identify potential projects and interventions that could result in improvements to anti-social behaviour.		

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Increased safety risks to people and animals	A number of hazards threaten the public safety and security during the construction phase, including increased traffic movement, handling of hazardous chemicals, open excavations and blasting activities.	– ESMP and associated management plans will be implemented adequately. – Adequate traffic signage will be utilised for all project stakeholders. – Operators appointed CLOs will receive training regarding all the risks and associated protocols. – Communication and training about safety during the operation phase will be undertaken annually with relevant local Project stakeholders (e.g. school children, residents of villages). – Security and traffic personnel will be employed to actively manage high risk areas. – All workplace health and safety concerns will be identified and suitably mitigated to ensure the safety of the workers and local communities. – At the end of operation the quarry site will be barricaded or fenced off and signposted to prevent unauthorised entry. – The quarry site will be rehabilitated prior to the Contractor vacating the site.	Appointed Managing Entity	Facility EHS Manager (Continual) CLO (Continual) ECO (Annual)
	The safety of downstream communities could be influenced by seasonal flooding.	– Develop and implement an Emergency Preparedness Plan. – Notify communities downstream prior to the release of high volumes of water which could result in flooding.	Appointed Managing Entity & DWA	Facility EHS Manager (Continual)
Occupational health and safety risks	Employees of the dam operator and hydropower plant will be exposed to wet conditions by virtue of working with water. Continual exposure to wet conditions will cause health hazards such as pneumonia.	– Pre-employment and regular medical examinations will be conducted on employees in order to monitor	Appointed Managing Entity & DWA	Facility EHS Manager (Continual)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
	Working with high voltage and high current at the hydropower plant will cause electric shock hazards.	effects of occupational hazards, including exposure to wet working environments. – Where employees are found to have a change in their relevant health conditions with respect to their tasks, further investigation will be carried out to determine the root cause/s and medical attention will be provided. – Adequate training and supervision will be provided to exposed employees. – Appropriate PPE will be issued and its use will be enforced.		
Change in sense of place and landscape characteristics	The rural character of the area is typical of the region. The Project area is situated within a valley on hilly terrain characterised by a mix of natural areas and disturbed areas that have been transformed by human settlements and cultivation. The reservoir will enhance the aesthetics of the surrounding mountain sides and preserve the tranquillity of the rural landscape. The impact is considered positive as the reservoir will dominate the immediate visual landscape and become a visual attractor for the area.	– The entity appointed to operate the dam will support local community initiatives in enhancing and maintaining the aesthetic appeal of the area and built environment.	Appointed Managing Entity & DWA	Facility EHS Manager (Continual) CLO (Continual) ECO (Annual) Project Steering Committee (Biannual) / Inner Council (as required)
Release of water for irrigation	Potential for irrigation of approximately 800ha of additional vegetable production.	– Continued engagement between implementing parties will ensure provision of water supply.	Appointed Managing Entity & ESWADE	Entity Operations Managers (Quarterly)

ASPECT	IMPACT	MITIGATION / ENHANCEMENT MEASURE	INSTITUTIONAL RESPONSIBILITY	VERIFICATION & FREQUENCY
Tourism and Recreation Potential Downstream		– Impacts to the left tributary of Lusushwana River will be reduced where possible. – Implementation of a maximum flow rate downstream of the dam wall will be met.	Appointed Managing Entity & DWA	Facility EHS Manager (Continual) Project Steering Committee (Biannual) / Inner Council (as required)

7 MANAGEMENT PLANS

High-level management plans have been compiled and are outlined below. These high-level management plans are live documents and need to be updated and modified to the specific conditions encountered on-site during construction and operation.

7.1 HAZARDOUS MATERIALS MANAGEMENT PLAN

Hazardous substances are chemicals or materials that can cause acute or chronic harm to health, be it humans or the environment. The key potential sources of impact related to the management of hazardous chemical substances and fuel during construction relate to the risk of accidental release of hydrocarbons to the environment, accidental exposure to workers, and fire and explosion risks.

Potential impacts associated with these risks, if poorly managed, include:

- Impact to soil and/or groundwater, which may result in degradation of the resource and requirement for remedial action;
- Impacts on pastoralist livelihoods due to contamination of pasture or water resources and consequent impacts to their, health, livelihood and animals;
- Impacts on human health & safety due to either direct exposure or through fire/explosion;
- Gas emissions associated with the combustion of fuel, are mainly compounds of nitrogen, carbon including very small traces of sulphur and particulate matter; and
- Fugitive emissions from HCS & fuel storage.

The purpose of this Hazardous Materials Management Plan (HMMP) is to provide a framework for the management of hazardous substances onsite during the construction and operation of the Nondvo Dam:

- Ensure the handling and storage of hazardous substances are in accordance with relevant standards;
- To ensure that the storage and handling of chemicals and hydrocarbons on-site does not cause pollution to the environment or harm to persons;
- To ensure that the storage and maintenance of machinery onsite does not cause pollution of the environment or harm to persons.

A plan for managing the transportation, delivery, storage and handling of hazardous substances onsite is detailed below. A method statement detailing the specific storage and handling practices during construction will be prepared by the Contractor prior to the commencement of construction.

7.1.1 REGISTER OF HAZARDOUS SUBSTANCES

Contractors shall establish inventories or registers of hazardous substances on site. The inventory will be updated when new hazardous substances are introduced to the workplace or the use of existing hazardous substances is discontinued. Both the chemicals' register and the Material Safety Data Sheets (MSDSs) will be readily available at a central location or near where the chemicals are being stored or used.

7.1.2 MSDS

It is standard practice that an MSDS is provided by the manufacturer or supplier of all hazardous substances. An MSDS is required for all chemicals and substances on site. These MSDSs will be made available to all parties affected by the use or storage of the chemical. MSDSs are the key to communicating hazards and safe handling practices for chemicals. In addition, MSDS information will be made available to all employees.

7.1.3 DELIVERIES

Transport of all hazardous substances will be in accordance with the relevant legislation and regulations. Contractors are responsible for identifying and securing any necessary permits for any proposed bulk fuel storage arrangements. The supplier will fill contractors fuel tanks; fuelling is the responsibility of the licensed contractor who will be supervised by the storage/work area supervisor. No 'black-market' or 'grey-import' fuels shall be used. All fuels purchased will be legitimate and subject to required duties and taxes.

Prior to fuel transfer the operator will verify that: all fuel transfer hoses have been connected properly and couplings are tight; transfer hoses are not obviously damaged; fuel transfer personnel are familiar with procedures; for fuelling stations, personnel are located at both the fuel truck and fuel transfer tank(s) and have the ability to shut off fuel flow manually; a means of communication has been established between the two people transferring fuel; and a high liquid level shutoff device can be substituted for the person at the delivery tank, in which case operation of the shutoff will be verified each time it is used;

The fuel contractor will clean up and report any accidents or spills immediately to the project ESHS team.

7.1.4 ENVIRONMENT AND OCCUPATIONAL HEALTH AND SAFETY

The following requirements are additional to any applicable requirements established in other management plans such as the Occupational Health & Safety Management Plan:

— Storage facilities will have the applicable MSDS available;
— Smoking will be strictly prohibited from any areas where fuel loading operations take place;
— Appropriate signage will be used to identify potential spill risks;
— Any accidental damage to containment structures will be inspected immediately and appropriate repairs undertaken. The extent of damage, the remedial repairs effected together with the date of repairs and any follow up inspection will be reported in writing. Any release of fuels or other substance will be cleaned up;
— All used fuel / oil products will be collected in tanks marked "Waste Oil"; and
— All hydrocarbon associated wastes will be managed in line with a Waste Management Plan.

7.1.5 MATERIALS STORAGE

— All temporary hydrocarbon storage will be situated above ground. There will be no buried storage tanks permitted.
— All chemicals, fuels and other hazardous materials will be stored in designated and bunded areas, where the bunded area is impermeable and is impervious to the stored substance. The bunded area will contain 110% volume of the largest container stored.
— Bunds and service area platforms to be cleaned and maintained regularly.
— Spill kits will be made available on-site for the clean-up of spills and leaks of contaminants. The relevant construction crew members will be trained in their use.
— Keep a record of all hazardous substances stored on site. Clearly label all the containers storing hazardous waste.
— The storage of flammable and combustible liquids such as oils will be in designated areas which are appropriately bunded, and stored in compliance with MSDS files and applicable regulations and safety instructions.
— Chemical and hydrocarbon storage facilities shall be covered to prevent rainfall ingress into secondary containment units and well-ventilated
— Any storage and disposal permits/approvals which are required will be obtained, and the conditions attached to such permits and approvals will be compiled with.
— An effective monitoring system will be put in place to detect any leakage or spillage of all hazardous substances during their transportation, handling, installation and storage.

7.1.6 OPERATIONAL PHASE

During the operational phase of the project limited hazardous substances and chemicals will be stored onsite. During maintenance activities, contractors will need to produce a method statement detailing the specific storage and handling practices. The following measures need to be implemented onsite during the operational phase of the project.

- Hazardous substances will be stored in sealed containers within a clearly demarcated designated area.
- Care will be taken to ensure that spillage of oils and other hazardous substances are limited during maintenance. Handling of these materials will take place within an appropriately sealed and bunded area. Should any accidental spillage take place, it will be cleaned up according to specified standards regarding bioremediation.
- The storage of flammable and combustible liquids such as oils will be in designated areas which are appropriately bunded, and stored in compliance with MSDS files and applicable regulations and safety instructions.
- Used oils and chemicals:
  - Appropriate disposal will be arranged with a licensed facility in consultation with the administering authority;
  - Waste will be stored and handled according to the relevant legislation and regulations.

7.1.7 TRAINING

The contents of the HMMP will be communicated to the staff through the induction training. On-the-job training can also be undertaken through the use of Environmental Toolbox Talks. All training will be undertaken as outlined in the Training Procedure.

Examples of Toolbox Talks include:

- Storage of hazardous substances
- Working with hazardous substances
- Management of hazardous waste
- Spill Prevention

7.2 SPOIL DISPOSAL MANAGEMENT PLAN

Spoil is defined as any earthen material that is surplus to requirements or unsuitable for re-use in fill and embankments (such as unsuitable rock and soil material) or material that is contaminated. This plan has been prepared to facilitate the beneficial reuse of all material, ensuring that none is disposed off-site, except if unsuitable for reuse.

7.2.1 SPOIL TYPES

Fill is defined as earthen material excavated from one location along the corridor (for example, for a detention basin or cut excavations) and relocated elsewhere as compacted fill.

Cut and fill material will generally not be stockpiled, but will be removed from the excavation site and transported directly to the construction face for immediate reuse as compacted fill.

Unsuitable excavated material will primarily be transported to identified locations within the construction site for temporary storage for reuse or possible disposal.

7.2.2 SPOIL STRATEGY

The following provides an overview of the strategy for achieving the key spoil management objectives:

- Minimise the amount of spoil generated – this requirement will be achieved by ensuring that the design minimises the volume of spoil generated from excavation.
- Maximise the beneficial reuse of spoil on site based on its classification (both contamination category and geotechnical characteristics). Some of the spoil generated is expected to be able to be reused on site and will be suitable as general fill across the site.
- Maximise the beneficial reuse of spoil off site based on its classification (both contamination category and geotechnical characteristics)
- Dispose of spoil off site based on its contamination classification - spoil unable to be reused on site or off site would be disposed of at a facility that has the appropriate development approval to receive and store the relevant waste classification of the spoil.
- Manage the excavation, storage, transport reuse and disposal of spoil to minimise impacts and meet other environmental requirements – this includes implementing mitigation measures to manage potential impacts on traffic and soil and water, dust generation and contamination of spoil.

7.2.3 SPOIL GENERATING ACTIVITIES

The activities associated with the generation and management of spoil and fill materials are:

- clearing of vegetation;
- selection of material;
- clearing of topsoil;
- excavation of earthen material;
- blasting of earthen material (as required);
- transport of earthen material;
- storage/stockpiling of spoil, topsoil and mulch; and
- reuse of spoil, topsoil and mulch.

7.2.4 STORAGE OF SPOIL

Material which can be re-used on-site but which cannot be directly re-placed will be stored in designated stockpile areas on-site. Where space is restricted material may require temporary storage off-site prior to re-use on-site. All spoil material requiring disposal will be classified prior to disposal to ensure it is disposed at the appropriate facility. Temporary storage areas will be identified prior to commencement of construction to ensure that disturbance to local residents is minimised and to protect receiving waters from potential runoff.

7.2.5 STOCKPILE MANAGEMENT

Stockpiles will:

- generally be located within the construction site or at sites specifically identified for stockpiling;
- be located on flat areas where possible. Stockpiles are not to be placed on indigenous vegetation;
- be covered where practical to do so;
- be located more than 2 metres from existing indigenous vegetation, concentrated water flow, roads, and other restricted areas including residential areas, places of public access and site buildings;
- generally be located away from steep slopes (;
- be located at least 100 metres from any water bodies unless adequate erosion and sedimentation controls are installed;

- have sediment fences down-slope and earth banks upslope to divert water and/or use sandbags to divert run-off from disturbed areas;
- be accessible for the purpose of dust suppression (e.g. application of water sprays, covers, binding agents etc).

7.2.6 SPOIL MANAGEMENT

- All material excavated from the construction will be re-used or recycled where suitable and if cost-effective to do so. Re-use of material generated from construction will be maximised in preference to any import of fill.
- Unsuitable fill material will be used for non-structural purposes (including landscaping) on the project.
- Ensure that any spoil transported from the site is taken to a place that can lawfully accept it.
- Ensure that weed infested topsoil, as identified by a qualified ecologist, is not used in the rehabilitation works unless it is treated and sterilised in an appropriate manner.
- Cover all trucks transporting spoil to off site locations and check tailgates are secured before leaving the site.

7.3 STORMWATER AND SEDIMENT MANAGEMENT PLAN

The behaviour of sediments and stormwater in the reservoir is sensitive to reservoir levels. If the reservoir level is kept high during the flood season, incoming sediment will tend to deposit in the upper reaches of the reservoir reducing the live storage capacity. Conversely if the reservoir level is drawn down in advance of the flow season, the incoming flows will erode the previously deposited delta and move the sediment toward the dam filling the dead storage capacity.

Adopting such rules in the reservoir routing will encourage filling of the dead storage capacity preserving the live storage capacity. Various mitigation strategies can be reviewed and will be included in the final Sediment Management Plan (SMP).

The primary mitigation measures have been included in the Technical Design and include:

- Managing the in-flow of water into the construction works.
- Construction of a river diversion.
- Construction of coffer dams, including flow reduction measures.
- Management of in-stream construction to ensure bank stability.
- Installation of the Monorail Trashrack Cleaning machine at the bottom outlet.

7.3.1 RIVER DIVERSION

River diversion works shall provide protection against flooding for the area where permanent works are constructed. A hydraulic analysis to determine the water profiles along the channel and to establish the dimension of the channel and the crest of the upstream and downstream cofferdam was performed. It is commonly accepted in engineering practice and standards to design the diversion works, which are temporary works, for a flood having a 20-year return period.

According to the hydrological study the discharge corresponding to a 20-year return period is Q20 = 320 m3/s. The general plan of the diversion system is illustrated in **Figure 7-1**.

The River Diversion consists of an approximately 210 m long excavated channel, located on the left bank of the natural river, aimed at diverting water from the riverbed in the stretch comprised between the temporary upstream and downstream cofferdams. In order to avoid the inundation of the dam area, the right side of the channel consists of a vertical wall having variable height while the left side of the channel is excavated in rock.

7.3.2 UPSTREAM AND DOWNSTREAM COFFERDAM

The upstream cofferdam and downstream cofferdam are foreseen in the form of rockfill embankments with crests at an elevation of respectively 938.5 and 928.0 m a.s.l. and a length of about 85 m (both).

The design slopes of both structures are:

— 1:1.5 V/H upstream;

— 1:1.5 V/H downstream.

The embankment bodies are built by material coming from quarries and/or excavation. The cofferdams will be made watertight by an upstream facing PVC membrane. The granite rock mass crops out for the most part of the cofferdam foundations. Stripping at least the first 1 m soil layer will be carried out where rock is not found.

7.3.3 DIVERSION CANAL

In accordance with the investigation carried out, the diversion canal will be completely excavated in compact rock with an excavation slope equal to 1:3. The right side of the canal and the bottom of canal will mainly be built in concrete. The transversal section geometry variable along the canal has a bottom width of 9 m and a right side vertical wall height variable between 8 m to 4 m.

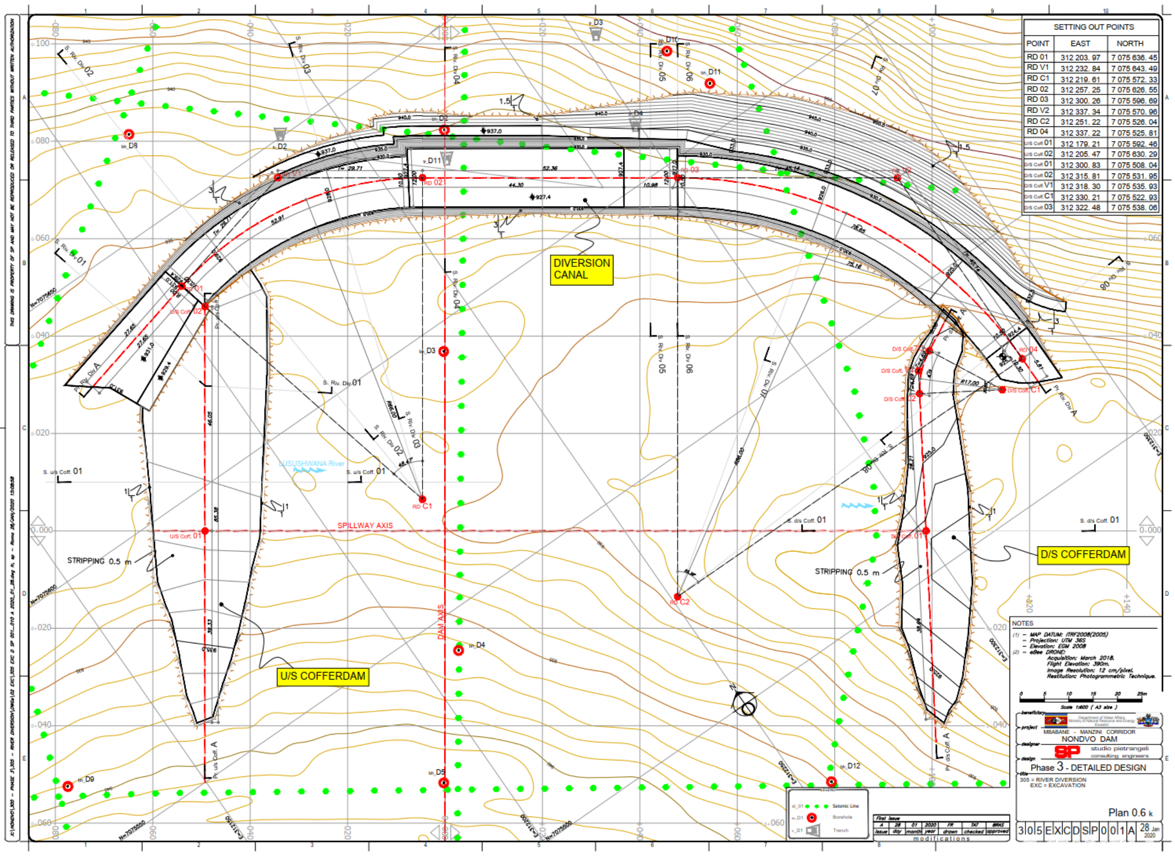

Figure 7-1: Stormwater Infrastructure

7.3.4 MITIGATION MEASURES

Additional to the design measures, secondary mitigation measures will also be employed and will depend on the water conditions at the time of dam wall construction. As a minimum the measures outlined below will be implemented:

— Soil erosion measures (limiting the extent of work areas, management of stormwater runoff, and sediment containment structures).
— Compacted surfaces will be kept to a minimum and vegetation rehabilitation needs to be implemented within the site, to prevent excessive runoff coupled with erosion, leading to sedimentation.
— The use of sediment and oil traps will be implemented. Regular maintenance of these will be undertaken to prevent unnecessary dirty run-off to the River.
— Surface run-off from the roads flowing down the embankments often scours the watercourse on the sides of the culvert causing sedimentation of the channel. This will be catered for with adequate concreted stormwater drainage depressions and channels with energy dissipaters that channel these flows into the river in a controlled manner.
— Remove waste concrete and sediment sludge to an appropriately designated storage area in order to prevent contamination during rainfall.

The DMP will be read in conjunction with the Erosion Management Plan.

A Stormwater Management Plan (SWMP) will be prepared before any construction commences and implemented during the construction phase. This plan will indicate how all surface runoff generated as a result of the project and associated activities (during both the construction and operational phases) will be managed prior to entering any natural drainage system or wetland and how surface water runoff will be retained outside of any demarcated buffer zones and subsequently released to simulate natural hydrological conditions.

The detailed SWMP will as a minimum include:

— Stormwater runoff from the site office footprint will be channelled to the site stormwater drainage system, which will meet relevant outfall standards, and flow reduction specifications.
— Soil erosion measures (limiting the extent of work areas, management of stormwater runoff, and sediment containment structures).
— Adequate concreted stormwater drainage depressions and channels with energy dissipaters that channel these flows into the river in a controlled manner.
— Provision of suitable waste receptacles across all working areas within a designated area with consideration to stormwater management and labelled indicating various waste types.
— Design layout of engineering measures

7.4 EROSION MANAGEMENT PLAN

Exposed and unprotected soils are the main cause of erosion in most situations. Therefore, this erosion management plan and the environmental protection plan are closely linked to one another and will not operate independently, but will rather be seen as complementary activities within the broader environmental management of the site and will therefore be managed together. This erosion management plan addresses the management and mitigation of potential impacts relating to soil erosion.

The objective of the plan is to provide:

— A general framework for soil erosion and sediment control, which enables the contractor to identify areas where erosion can occur and be accelerated by construction related activities.

— An outline of general methods to monitor, manage and rehabilitate erosion, ensuring that all erosion resulting from all phases of the development is addressed.

— This plan will be updated prior to project implementation so as to include relevant site specific information.

7.4.1 EROSION AND SEDIMENT CONTROL PRINCIPLES

The goals of erosion control during and after construction at the site will be to:

— Protect the land surface from erosion;

— Intercept and safely direct run-off water from undisturbed upslope areas through the site without allowing it to cause erosion within the site or become contaminated with sediment; and

— Progressively revegetate or stabilise disturbed areas.

These goals can be achieved by applying the management practices outlined in the following sections.

7.4.2 ONSITE EROSION MANAGEMENT

General factors to consider regarding erosion risk at the site includes the following:

— Soil loss will be greater during wet periods than dry periods. Intense rainfall events outside of the wet season, such as occasional summer thunder storms can also cause significant soil loss. Therefore precautions to prevent erosion will be present throughout the year.

— Soils loss will be greater on steeper slopes. Ensure that steep slopes are not devegetated and subsequently become hydrophobic (i.e. have increased runoff and a decreased infiltration rate) increasing the erosion potential.

— Soil loss is related to the length of time that soils are exposed prior to rehabilitation or stabilisation. Therefore the gap between construction activities and rehabilitation will be minimised. Phased construction and progressive rehabilitation are therefore important elements of the erosion control strategy.

— The extent of disturbance will influence the risk and consequences of erosion. Therefore site clearing will be restricted to areas required for construction purposes only. As far as possible, large areas will not be cleared at a one time, especially in areas where the risk of erosion is higher.

— Roads will be planned and constructed in a manner which minimises their erosion potential. Roads will therefore follow the contour as far as possible. Roads parallel to the slope direction will be avoided as far as possible.

— Where necessary, new roads constructed will include water diversion structures present with energy dissipation features present to slow and disperse the water into the receiving area.

— Roads and other disturbed areas will be regularly monitored for erosion. Any erosion problems recorded will be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.

— Compacted areas will have adequate drainage systems to avoid pooling and surface flow. Heavy machinery will not compact those areas which are not intended to be compacted as this will result in compacted hydrophobic, water repellent soils which increase the erosion potential of the area. Where compaction does occur, the areas will be ripped.

- All bare areas will be revegetated with appropriate locally occurring species, to bind the soil and limit erosion potential.
- Silt fences will be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
- Gabions and other stabilisation features will be used on steep slopes and other areas vulnerable to erosion to minimise erosion risk as far as possible.
- Activity at the site after large rainfall events when the soils are wet and erosion risk is increased will be reduced.
- Topsoil will be removed and stored separately during construction activities, and will be reapplied where appropriate as soon as possible in order to encourage and facilitate rapid regeneration of the natural vegetation on cleared areas (where applicable – not applicable to farmland / agricultural areas).
- Regular monitoring of the site for erosion problems during construction (ongoing) and operation (at least twice annually) is recommended, particularly after large summer thunderstorms have been experienced.

7.4.3 EROSION CONTROL MECHANISM

The contractor will use the following mechanisms to combat erosion when necessary:

- Reno mattresses
- Slope attenuation
- Hessian material
- Shade catch nets
- Gabion baskets
- Silt fences
- Storm water channels and catch pits
- Soil bindings
- Geofabrics
- Hydro-seeding and/or re-vegetating
- Mulching over cleared areas
- Boulders and size varied rocks
- Tilling

7.4.4 MONITORING

The site will be monitored continuously during construction and operation in order to determine any indications of erosion. If any erosion features are recorded as a result of the activities on site the Environmental Officer (during construction) or Site Manager (during operation) will:

- Assess the significance of the situation.
- Take photographs of the soil degradation.
- Determine the cause of the soil erosion.
- Inform the contractor/operator that rehabilitation will take place and that the contractor/operator will implement a rehabilitation method statement and management plan.
- Monitor that the contractor/operator is taking action to stop the erosion and assist them where needed.
- Report and monitor the progress of the rehabilitation weekly and record all the findings in a site register.
- All actions with regards to the incidents will be reported on a monthly compliance report which will be submitted to the Competent Authority (during construction) and kept on file for consideration during the annual audits (during construction and operation).

7.5 ALIEN VEGETATION REMOVAL AND MANAGEMENT PLAN

Invasive alien species pose the second largest threat to biodiversity after direct habitat destruction. The purpose of this Alien Vegetation Removal and Management Plan is to provide a framework for the management of alien and invasive plant species during the construction and operation of the Nondvo Dam. The broad objectives of the plan include the following:

- Ensure alien plants do not become dominant in parts or the whole site through the control and management of alien and invasive species presence, dispersal & encroachment.
- Develop and implement a monitoring and eradication programme for alien and invasive species.
- Promote the natural re-establishment and planting of indigenous species in order to retard erosion and alien plant invasion.

7.5.1 PREVENTION AND EARLY ERADICATION

A prevention strategy will be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas.

Monitoring plans will be developed which are designed to identify Invasive Alien Plant Species shortly after they arrive in the project area. Keeping up to date on which weeds are an immediate threat to the site is important, but efforts will be planned to update this information on a regular basis. When new Invasive Alien Plant Species are recorded on site, an immediate response of locating the site for future monitoring and either hand-pulling the weeds or an application of a suitable herbicide will be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

7.5.2 CONTAINMENT AND CONTROL

If any alien invasive plants are found to become established on site, action plans for their control will be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions will be developed for each location and/or each species. Appropriate registered chemicals and other possible control agents will be considered in the action plans for each site/species. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

7.5.3 GENERAL CLEARING &GUIDING PRINCIPLES

Alien control programs are long-term management projects and will include a clearing plan which includes follow up actions for rehabilitation of the cleared area. The lighter infested areas will be cleared first to prevent the build-up of seed banks. Pre-existing dense mature stands ideally will be left for last, as they probably won't increase in density or pose a greater threat than they are currently. Collective management and planning with neighbours may be required in the case of large woody invaders as seeds of aliens are easily dispersed across boundaries by wind or water courses. All clearing actions will be monitored and documented to keep records of which areas are due for follow-up clearing.

7.5.4 CLEARING METHODS

Different species require different clearing methods such as manual, chemical or biological methods or a combination of both. Care will however be taken that the clearing methods used do not encourage further invasion. As such, regardless of the methods used, disturbance to the soil will be kept to a minimum.

Fire will not be used for alien control or vegetation management at the site. The best-practice clearing method for each species identified will be used.

7.5.5 MECHANICAL CONTROL

This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ringbarking or bark stripping. This control option is only really feasible in sparse infestations or on small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice, need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labour intensive and therefore expensive, and could cause severe soil disturbance and erosion.

7.5.6 CHEMICAL CONTROL

Although it is usually preferable to use manual clearing methods where possible, such methods may create additional disturbance which stimulates alien invasion and may also be ineffective for many woody species which re-sprout. Where herbicides will be used, the impact of the operation on the natural environment will be minimised by observing the following:

- Area contamination will be minimised by careful, accurate application with a minimum amount of herbicide to achieve good control.
- All care will be taken to prevent contamination of any water bodies. This includes due care in storage, application, cleaning equipment and disposal of containers, product and spray mixtures.
- Equipment will be washed where there is no danger of contaminating water sources and washings carefully disposed of in a suitable site.
- To avoid damage to indigenous or other desirable vegetation, products will be selected that will have the least effect on non-target vegetation.
- Coarse droplet nozzles will be fitted to avoid drift onto neighbouring vegetation.
- The appropriate health and safety procedures will also be followed regarding the storage, handling and disposal of herbicides.

7.5.7 GENERAL MANAGEMENT PRACTICES

The following general management practices will be encouraged or strived for:

- Establish an ongoing monitoring programme for construction phase to detect and quantify any alien species that may become established and identify the problem species.
- Alien vegetation regrowth on areas disturbed by construction will be immediately controlled once recorded throughout the entire site during construction and operation.
- Care will be taken to avoid the introduction of alien invasive plant species to the site. Particular attention will be paid to imported material such as building sand or dirty earth-moving equipment. Stockpiles will be checked regularly and any weeds emerging from material stockpiles will be removed.
- Cleared areas that have become invaded by alien species can be sprayed with appropriate herbicides provided that these are such that break down on contact with the soil. Residual herbicides will not be used.
- The effectiveness of vegetation control varies seasonally and this is also likely to impact alien species. Control early in the wet season will allow species to re-grow and follow-up control is likely to be required. It is tempting to leave control until late in the wet season to avoid follow-up control. However, this may allow alien species to set seed before control and hence will not contribute towards reducing alien species abundance. Therefore, vegetation control will be aimed at the middle of the wet season, with a follow-up event towards the end of the wet season. There are no exact dates that can be specified here as each season is unique and management will therefore respond according to the state and progression of the vegetation.

- Alien management is an iterative process and it may require repeated control efforts to significantly reduce the abundance of a species. This is often due to the presence of large and persistent seed banks. However, repeated control usually results in rapid decline once seed banks become depleted.
- Regular vegetation control to reduce plant biomass within the site will be conducted. This will be timed so as to coincide with the critical growth phases of the most important alien species on site. This will significantly reduce the cost of alien management as this will contribute towards the control of the dominant alien species and additional targeted control will be required only for a limited number of species.
- No alien species will be cultivated on-site. If vegetation is required for aesthetic purposes, then non-invasive, water-wise locally-occurring species will be used.
- During operation, surveys for alien species will be conducted regularly. It is recommended that this be undertaken every 6 months for the first two years after construction and annually thereafter. All aliens identified will be cleared using appropriate means.

7.5.8 MONITORING

In order to monitor the impact of clearing activities, follow-ups and rehabilitation efforts, monitoring will be undertaken. This section provides a description of a possible monitoring programme that will provide and assessment of the magnitude of alien invasion on site as well as an assessment of the success of the management programme.

In general, the following principles apply for monitoring:

- Photographic records will be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records will be kept of the area from immediately before and after follow-up clearing activities. Rehabilitation processes will also be recorded.
- Simple records will be kept of daily operations, e.g. area/location cleared, labour units and, if ever used, the amount of herbicide used.
- It is important that, if monitoring results in detection of invasive alien plants, hat this leads to immediate action.

The monitoring outlined in **Table 7-1** will be implemented to ensure management of alien invasive plant species.

Table 7-1: Alien Invasive Plant Species Management

MONITORING ACTION	INDICATOR	TIMEFRAME
Construction Phase		
Document alien species present at the site	List of alien species	Pre-construction
Document alien plant distribution	Alien plant distribution map within priority areas	Pre-construction
Document & record alien control measures implemented	Record of clearing activities	3 Monthly
Review & evaluation of control success rate	Decline in documented alien abundance over time	Biannually
Operational Phase		
Document alien species distribution and abundance over time at the site	Alien plant distribution map	Biannually

MONITORING ACTION	INDICATOR	TIMEFRAME
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate. A decline in alien distribution and cover over time at the site	Biannually
Document rehabilitation measures implemented and success achieved in problem areas	Decline in vulnerable bare areas over time	Biannually

7.6 ENVIRONMENTAL PROTECTION MANAGEMENT PLAN

7.6.1 PLANT RESCUE AND PROTECTION

The purpose of the plant rescue and protection plan is to implement avoidance and mitigation measures, in addition to the mitigation measures included in the EMPr to reduce the impact of the development of the project on listed and protected plant species and their habitats, and to provide guidance on search and rescue of species of conservation concern.

This management plan will be updated prior to project implementation so as to include relevant site specific information.

Mitigation and management measures include, but are not limited to the following:

- Vegetation clearing will only commence after a walk down has been conducted by a suitably qualified ecologist / botanist and the necessary permits obtained.
- Vegetation clearing to be kept to a minimum. No unnecessary vegetation to be cleared.
- Vegetation removal will be limited to the construction site and will be removed only as it becomes necessary rather than removing all the vegetation throughout the site at once
- Materials will not be delivered to the site prematurely which could result in additional areas being cleared or affected.
- No vegetation to be used for firewood.
- Gathering of firewood, fruit, medicinal plants, or any other natural material onsite or in areas adjacent to the site is prohibited unless with prior approval of the environmental control officer (ECO).
- Construction site office and laydown areas will be clearly demarcated and no encroachment will occur beyond demarcated areas.
- All natural areas impacted during construction will be rehabilitated with locally indigenous plant species.
- A buffer zone will be established in areas where construction will not take place to ensure that construction activities do not extend into these areas.
- The use of pesticides and herbicides in the study area will be discouraged as these impacts on important pollinator species of indigenous vegetation.
- Soil stockpiles will not become contaminated with oil, diesel, petrol, garbage or any other material, which may inhibit the later growth of vegetation in the soil. Spillage can result in a loss of soil functionality thus limiting the re-establishment of flora.

7.6.2 PRINCIPLES FOR SEARCH AND RESCUE

Successful plant rescue can only be achieved if:

- Species can be removed from their original habitat with minimal damage to the plant, especially the roots.

- All plants removed are safely stored and treated according to their specific requirements prior to being transplanted again.
- They are relocated into a suitable habitat and protected from further damage and all disturbances to aid their re-establishment.
- Timing of planting activities is planned with the onset of the growing season.
- Steps are taken where necessary to aid the initial establishment of vegetation, including occasional watering.

The following principles apply in terms of plant rescue and protection:

- A permit is required to translocate or destroy any listed and protected species even if they do not leave the property. This permit will be obtained prior to any search and rescue operations being undertaken.
- Where suitable species are identified, a search and rescue operation of these species will be undertaken within the development footprint prior to the commencement of construction.
- As far as possible, timing of search and rescue activities will be planned with the onset of the growing season.
- Affected individuals will be translocated to a similar habitat outside of the development footprint and marked for monitoring purposes. For each individual plant that is rescued, the plant will be photographed before removal, tagged with a unique number or code and a latitude longitude position recorded using a hand-held GPS device.
- The rescued plants will be planted into a container to be housed within a temporary nursery on site or immediately planted into the target habitat.
- Rescued plants, if re-planted back in the wild, will be placed as close as possible to where they were originally removed. Re-planting into the wild will cause as little disturbance as possible to existing natural ecosystems. The position of the rescued individual/s will be recorded to aid in future monitoring of that plant.
- During construction, the ECO will monitor vegetation clearing at the site. Any deviations from the plans that are required will first be checked for listed species by the ECO or Environmental Officer and any listed species present which are able to survive translocation will be translocated to a safe site.
- Any listed species suitable for translocation observed within the development footprint that were not previously observed be translocated to a safe site.
- The collecting of plants or their parts will be strictly forbidden. Staff will be informed of the legal and conservation aspects of harvesting plants from the wild as part of the environmental induction training.
- Sensitive habitats and area outside project development will be clearly demarcated as no go areas during the construction and operational phase to avoid accidental impacts.

7.6.3 RE-VEGETATION AND HABITAT REHABILITATION

The purpose of the rehabilitation plan is to ensure that areas cleared or impacted during construction activities are rehabilitated with a plant cover that reduces the risk or erosion from these areas as well as restores some ecosystem function. The purpose of the rehabilitation plan for the site can be summarised as follows:

- Achieve long-term stabilisation of all disturbed areas to minimise erosion potential.
- Re-vegetate all disturbed areas with suitable local plant species.
- Minimise visual impact of disturbed areas.
- Ensure that disturbed areas are safe for future uses

The rehabilitation plan will be closely aligned with other site-specific plans for the project, including the erosion management plan, soil management plan, alien plant management plan, and plant rescue and protection plan. Prior to commencement of construction, a detailed rehabilitation plan and Method Statement for the site will be compiled by the Contractor.

Mitigation and management measures include, but are not limited to the following:

- Re-vegetation will aim to accelerate the natural succession processes so that the plant community develops in the desired way, i.e. promote rapid vegetation establishment
- Re-vegetation of disturbed surfaces will occur immediately after construction activities are completed. This will be done through seeding with locally indigenous species typical of the representative botanical unit.
- Re-vegetation of the disturbed site is aimed at approximating as near as possible the natural vegetative conditions prevailing prior to construction.
- Seeds from surrounding seed banks can be used for re-seeding.
- Rehabilitation will be executed in such a manner that surface run-off will not cause erosion of disturbed areas.
- Planting of indigenous tree species in areas not to be cultivated or built on will be encouraged.
- Habitat destruction will be limited to what is absolutely necessary for the construction of the infrastructure, including the construction of new roads. In this respect, the recommendations from the Ecological Specialist Study will be applied strictly. Personnel will be adequately briefed on the need to restrict habitat destruction, and will be restricted to the actual construction area.
- Monitoring programme to ensure that rehabilitation efforts are successful to ensure that risks such as erosion, spread of exotic species and the edge effect are avoided.

7.6.4 REHABILITATION METHODS

The following rehabilitation methods are only applicable if / where there is construction activity in areas of natural vegetation. These measures can be ignored where construction takes place on agricultural or disturbed land.

- Immediately after replacing topsoil in disturbed areas, the soil surface will be revegetated with a suitable plant cover.
- It is expected that soil seed banks of indigenous vegetation will be present to initiate initial vegetation cover. However, simply applying this topsoil to a well prepared rehabilitation site does not result in the same species richness and diversity as the surrounding areas. In some areas the natural regeneration of the vegetation may be poor and the application of seed to enhance vegetation recovery may be required.
- Where possible, seed will be collected from plants present at the site during plant rescue operations. Indigenous seeds may also be harvested for purposes of re-vegetation in areas that are free of alien or invasive vegetation, either at the site prior to clearance or from suitable neighbouring sites.
- Seed collection will be undertaken by a suitably qualified specialist who is familiar with the various seed types associated with the plant species and rehabilitation in the area.
- Seed collection will be done throughout the year as seed ripens, but can also be restricted to summer, when a large amount of the perennial seed will have ripened. The collection of unripe seeds will reduce the percentage germination thereby reducing the effectiveness of the rehabilitation efforts. Seeds will be stored in paper or canvas bags dusted with insecticide, and sown at the onset of the rainy season.
- Seed can be sown onto the soil, but will preferably be applied in conjunction with measures to improve seedling survival such as scarification of the soil surface or simultaneous application of mulch. Additional organic material will be added to the soil mix, if required, to assist with water retention during the early stages of seedling establishment.
- It will be ensured that the seed mix is as diverse as possible in the first season. After the first season, when pioneer plant communities have successfully established, attempts will be made to re-sow and replant the area with more perennial and woody species. It is a process that will require several follow-ups.
- Planting is dependent on species involved. Planting of species recommended for rehabilitation will be carried out as far as is practicable to coincide with the onset of the first significant rains. In general however, planting will commence as soon as possible after construction is completed in order to minimise the potential for erosion.
- The final vegetation cover will resemble the original (non-encroached and indigenous) vegetation composition and structure as far as practicably possible.

- Progressive rehabilitation is an important element of the rehabilitation strategy and will be implemented where feasible. Re-vegetation of disturbed surfaces will occur immediately after construction activities are completed.
- Once revegetated, areas will be protected to prevent trampling and erosion.
- No construction equipment, vehicles or unauthorised personnel will be allowed onto areas that have been vegetated.
- Where rehabilitation sites are located within actively grazed areas, they will be fenced.
- Fencing will be removed once a sound vegetative cover has been achieved.
- Any runnels, erosion channels or wash aways developing after revegetation will be backfilled and consolidated and the areas restored to a proper stable condition.

7.6.5 MONITORING AND FOLLOW-UP ACTION

Throughout the lifecycle of the development, regular monitoring and adaptive management will be in place to detect any new degradation of rehabilitated areas. During the construction phase, the ECO and contractor will be responsible for initiating and maintaining a suitable monitoring system. Once the development is operational, the project company will need to identify a suitable entity that will be able to take over and maintain the monitoring cycle and initiate adaptive management as soon as it is required. Monitoring personnel will be adequately trained. This will only be required where there were impacts in areas of natural vegetation. If not impacts on natural vegetation occurred then this will not be required.

The following are the minimum criteria that will be monitored:

- Composition and density of replanted vegetation, distinguishing between species introduced for initial revegetation only and species that are part of the pre-determined desirable end state.
- Associated nature and stability of surface soils
- Re-emergence of alien and invasive plant species. If noted, remedial action will be taken immediately.

The initial revegetation period post construction is estimated to be over a period of 6 (minimum) to 12 months (maximum), or a time period specified by the rehabilitation specialist, particularly if planting of trees and shrubs occurs. The rehabilitation phase (including post seeding maintenance) will be at least 12 months (depending on time of seeding and rainfall) to ensure establishment of an acceptable plant cover is achieved (excluding invasive plant species or weeds).

As rehabilitation success, monitoring and follow-up actions are important to achieve the desired cover and soil protection. The following monitoring protocol is recommended:

- Re-vegetated areas will be monitored every 4 months for the first 12 months following construction.
- Re-vegetated areas showing inadequate surface coverage (less than 20% within 12 months after re-vegetation) will be prepared and re-vegetated;
- Any areas showing erosion, will be re-contoured and seeded with indigenous grasses or other locally occurring species which grow quickly.

If the plants have not established and the acceptable plant cover is not achieved within the specified maintenance period, maintenance of these areas shall continue until an acceptable plant cover is achieved (excluding alien plant species or weeds). Additional seeding or planting may be necessary to achieve acceptable plant cover. Hand seeding will be considered as an option in this case.

Monitoring of rehabilitation success and follow-up adaptive management, together with clearing of emerging alien plant species will continue until the decommissioning phase has been completed.

7.7 EMERGENCY PREPARDENESS PLAN

The aim of the present chapter is to define a procedure to direct operating personnel (dam operating personnel and appointed agencies) during an emergency or unusual occurrence:

- to take specific action;

- to alert the supervisor;
- to initiate any necessary remedial actions;
- to remain in contact with the supervisor.

This plan specifies the roles of responsible parties when a dam failure is considered imminent, or when expected operational flow release threatens downstream life, property, or economic operations that depends on river flow levels. It includes the following items:

- clear statements on the responsibility for dam operations decision making and for the related emergency communications;
- maps outlining inundations levels for various emergency conditions;
- flood warning system characteristics; and
- procedures for evacuating threatened areas and mobilizing emergency forces and equipment.

The purpose of the present Emergency Preparedness Plan (EPP) is to supply the dam operating personnel with right procedures to be followed during an emergency situation or an unusual occurrence. In particular, these procedures include:

Immediate actions to be taken, and, if necessary:

- whom to notify;
- who is responsible for further actions; and
- what to do in case of loss of communication.

7.7.1 DEFINITION OF AN EMERGENCY EVENT

Depending on the level of danger and the consequent action to be taken, the threats and potential threats to the dam are classified as:

- Emergency situation: is a serious event, which develops suddenly and unexpectedly and will endanger the structural integrity of the dam. In case a dam failure, then the downstream population will be evacuated.
- Unusual occurrence: is defined as an event that takes place or a condition which develops that is not normally encountered in the routine operation of the dam and reservoir and which may endanger the dam. The threat may probably be "mastered" as long as a higher degree of threat is not reached.

7.7.2 PROCEDURES FOR EMERGENCY SITUATIONS

GENERAL PROCEDURES

The following sections illustrate the procedures to be followed for most emergency situations or unusual occurrences. The highest-ranking individual in the communications network at any time has the responsibility to make the decisions. A tape record (diary) of all decisions made and actions taken shall be kept by each reporting level. If an unlisted unusual emergency occur, the procedure judged most appropriate will be followed.

In order to provide a direct overview of the measures or actions to be taken in an emergency situation, each procedure will also be represented in a simple flow-chart.

The emergency events are classified as:

Emergency situation:

- Failure or Impending failure; and
- Large sudden water releases downstream of the dam.

Unusual occurrence:

- Abnormal dam behaviour;
- Landslide;
- Earthquake; and

— Severe storms.

For all the possible events the operating personnel shall report immediately the occurrence to the Dam Manager. In general, initial reports will include briefly the following information and be documented:

Subject:	What happened and type of incident?
Time and Date:	Daylight or standard?
Location:	Where did the incident occur?
Summary of incident:	Briefly describe the incident
Names and Titles:	Person involved
Status of incident:	Completed and pending actions/decisions

The Dam Manager has the responsibility to identify the emergency situation and to determine immediate action to be taken. The DM's notification to the stakeholders will include briefly the following information:

- classification of the emergency;
- time elapsed since the emergency situation has been detected;
- persons involved if deemed valuable to report;
- completed and pending actions and /or decisions.

FAILURE OR IMPENDING FAILURE OF THE DAM

1 operating personnel shall report immediately the occurrence to the Dam Manager;
2 the Dam Manager shall identify and evaluate the emergency, and then classify the situation as an alarm phase 3 - Evacuation;
3 the DM shall notify the alarm and the evacuation order to the following:

   i) Project Management Unit (PMU) Director;
   ii) Emergency Action Unit (EAU) Manager;
   iii) National/Regional Disaster Management (N/RDM)
   iv) Dam Safety Engineer (DSE)

4 the Dam Manager shall trigger the siren warning system to command the people evacuation;
5 the EAU Managers shall forward immediately the Alarm 3 Notification to:

   i) The Police Stations;
   ii) Affected Village Chiefs;
   iii) Red Cross;
   iv) Designed Emergency Shelter Owner/Manager;
   v) Local Radio.

6 the EAU Managers shall warn potentially affected population and start the evacuation procedure;
7 as soon as the alarm Notification is received from EAU, Village Chiefs, Local Radio shall warm potentially affected population and order the evacuation to the Meeting Points;
8 potentially affected people shall move to the designed Meeting Points following instructions provided during drill tests and with the help and support of:

   i) Village Chiefs;
   ii) Red Cross;
   iii) Local Police.

FLOODING

In case the water elevation during a flooding exceeds 961.3 m a.s.l., then the operating personnel will apply the following procedures:

1 operating personnel shall inform the Dam Manager;
2 the Dam Manager declares the Alarm Phase 1 - ALERT;
3 operating personnel will measure regularly the water surface elevation and calculate the corresponding water surface rise rate. The frequency is regulated as follows:
   — Every 60 min.: for 961.3 m a.s.l. < water elevation < 962.9 m a.s.l.
4 the Dam Manager will contact:
   i) Project Management Unit (PMU) Director;
   ii) Emergency Action Unit (EAU) manager;
   iii) Dam Safety Engineer (DSE);
   iv) Dept. of Poverty and Disasters Management Affairs (DoPDMA).

The information to be reported will include:

— Current water elevation;
— Observed water surface rise rate;
— Weather conditions in the vicinity (past, present, and predicted);
— The discharge condition of the waterway above and below the reservoir.

The Dam Manager shall keep these Stakeholders informed at an interval of not more than one day for as long as the Alarm Phase 1 persists.

If the water level exceeds 962.9 m a.s.l. the DM shall notify the Alarm Phase 2 – EMERGENCY with the procedures indicated above. The operating personnel will measure regularly the water surface elevation and calculate the corresponding water surface rise rate and increase the frequency to 15 min.

The DM shall notify the Alarm Phase 3 if water elevation during a flooding exceeds 963.4 m a.s.l. and the evacuation order to the following:

   i) Project Management Unit (PMU) Director;
   ii) Emergency Action Unit (EAU) manager;
   iii) Dept. of Poverty and Disasters Management Affairs (DoPDMA);
   iv) Dam Safety Engineer (DSE).

The procedure for the evacuation order shall be followed.

EARTHQUAKE

If an earthquake has been felt or reported in the dam area, use the following procedures:

1 the Dam Manager will immediately request an overall visual dam inspection.

If the dam is damaged to such an extent that there is an increased flow passing downstream, then immediately implement Failure or Impending Failure procedures.

If visible damage has occurred but is not serious enough to cause dam failure, then immediately:

2 Observe nature, location, and extent of damage. The description of slides, sloughs, and sudden subsidence will include:

— location;
— extent (severity);

- rate of subsidence;
- effects on adjoining structures;
- springs or seeps;
- reservoir and tailwater elevations;
- prevailing weather conditions;
- other facts believed pertinent.

3 Evaluate impending failure hazard and contact the PMU; depending on the situation, a partial drawdown of the reservoir may be decided.

4 If dam failure is not imminent, continue with a thoroughly inspection of the damage:

- both dam faces for cracks, settlement, seepages, etc.;
- abutments for possible displacement;
- drainage water and seeps;
- spillway, intake and bottom outlet structures (test operations may be necessary);
- power plant facilities;
- power and water supply and standby power unit;
- visible reservoir and downstream areas for landslides;
- other appurtenant structures.

5 If apparent damage has not occurred to the dam, embankments, or appurtenant structures, a "No Damage" report will be made to the PMU.

6 Some damage to structures may not be apparent during the inspection immediately after an earthquake. It is possible that the settlement of structures, reactivation of old slides, or the development of new slides may not occur with ground shaking and could become evident after the initial inspection. A second inspection will be made from 2 weeks to a month after the initial inspection.

IF ALL COMMUNICATIONS FROM THE DAM ARE LOST and there is potential impending failure of the dam, use the following checklist as a guide during an earthquake:

7 the Dam Manager will quickly inspect the dam and evaluate potential failure hazard;
8 check for sloughs, slides, slumps, and other signs of distress near dam abutments;
9 if failure is imminent, the Dam Manager will decide for a partial drawdown of the reservoir.

ABNORMAL DAM BEHAVIOUR

Plausibility ranges are defined for each instrument in order to provide an immediate control of readings. If a reading seems abnormal:

1 The operator will immediately inform the Supervisor of ordinary dam monitoring, who will proceed as follows:

  - the Supervisor requests a new measurement by such an instrument, in order to confirm the abnormal value and should that be the case;
  - then verify the correct working of the instrument and should that be the case, then
  - contact the Dam Manager
  - the Dam Manager will inform the Dam Safety Engineer (DSE) and the Project Management Unit (PMU) Director.

Note:

In case an anomaly has been recorded during dam inspections (slumping, new springs, etc.) the operator will inform immediately the supervisor of ordinary dam monitoring, who will proceed as follows:

1 Determine:

  - Location;
  - Nature of the anomaly;

— Size of affected area (height, width, depth, surface…);
— Extent;
— Reservoir and tailwater elevation.

2 Contact the Dam Manager, who will inform the PMU and DSE;
3 If it is necessary to further analyse the conditions, a map will be prepared showing the extent of all seep areas, springs, and any other pertinent data, including the dates of reservoir level recordings.
4 If surface measurements (readings of settlement points) may help to clarify the extent of the abnormal conditions, then such observations will be made, reported and recorded.
5 The DM classify the event and declare one of the conditions listed here below and follow the relative procedure:

— Alert Dam Monitoring Procedure –Phase 1
— Emergency – Phase 2;
— Evacuation – Phase 3

LANDSLIDE

If landslides or potential landslides, that may possibly advance into the reservoir or towards the dam, are recognized, then the Dam Manager shall proceed as follows:

1 Determine:

— Size;
— Possible cause;
— Degree of effect on operation;
— Probability of additional movements in disturbed area or in other slide areas;
— Development of new slides;
— Any other facts believed pertinent.

2 The Dam Manager will inform the following:

i) Project Management Unit (PMU) Director;

ii) Emergency Action Unit (EAU) manager;

iii) Dam Safety Engineer (DSE);

iv) National/Regional Disaster Management (N/RDM)

3 The PM classify the event and declare one of the conditions listed here below and follow the relative procedures:

— Alert – Phase 1
— Emergency – Phase 2;
— Evacuation – Phase 3.

SEVERE STORMS

After a severe storm:

1 the Dam Manager will immediately request an overall visual dam inspection;
2 the operating personnel shall report immediately the nature, location, and extent of possible damage to the Dam Manager;
3 the Dam Manager has the responsibility to identify the emergency situation and to determine immediate action to be taken.

7.7.3 NOTIFICATION AND COMMUNICATION

ALARM NOTIFICATION PROCEDURE

The general alarm notification procedure in emergency events (unusual/emergency conditions) is illustrated and described below.

INTERNAL ALARM

In a situation of "internal alert" the Dam Manager will communicate the unusual condition to the Dam Owner. Dam Owner will continuously follow up monitoring and observations. In case there is a need for proceeding to an alarm phase the notification by the Dam Owner shall follow the Phase procedures here below described.

ALARM PHASE 1

The Dam Manager will advise immediately the Dam Owner. The Dam Owner shall forward immediately the Alarm 1 Notification to:

- Dam Safety Engineer /Technical Expert;
- PMU
- Prime Minister;
- Ministerial Disaster Management Team (Team);
- The EAU Manager;

All stakeholders shall provide feedback to the Dam Owner. The Dam Owner shall keep these Stakeholders informed at an interval of not more than one day as long as the Alarm Phase 1 persists.

ALARM PHASE 2

The Dam Manager shall forward immediately the Alarm 2 Notification to:

- Dam Safety Engineer /Technical Expert;
- PMU
- Prime Minister;
- Ministerial Disaster Management Team (Team);
- The EAU Manager;

All stakeholders shall provide feedback to the Dam Owner. The Dam Owner shall keep these Stakeholders informed at an interval of not more than 12 hours for as long as the Alarm Phase 2 persists.

The EAU Manager shall forward immediately the Alarm 2 Notification to:

- The Local Police Stations;
- Local Red Cross;
- Local Radio;
- etc

All stakeholders shall acknowledge receipt of alarm notification to the EAU Manager.

ALARM PHASE 3

The Dam Manager shall forward immediately the Alarm 3 Notification to:

- Dam Safety Engineer /Technical Expert;
- PMU
- Prime Minister;
- Ministerial Disaster Management Team (Team);

— EAU Manager;
— Etc;

All stakeholders shall provide feedback to the Dam Owner. The EAU Manager shall forward immediately the Alarm 3 Notification to:

— The Local Police Station;
— Local Red Cross;
— Emergency Coordinator;
— Local Radio;

All stakeholders shall acknowledge receipt of alarm notification to the EAU Manager.

7.7.4 COMMUNICATION SYSTEM

DM COMMUNICATION

The alarm notification by the Dam Owner to the governmental emergency institutions will be through VHF radios and mobile. Written notice shall also be prepared and transmitted using one of the following means:

— E-mail;
— Fax;
— SMS;
— Mobile phone APP, if available.

In order to guarantee redundancy in the communication system, the Siren Warning System could deliver alerts to the specified person through a sequential, escalating method, e.g. networked computer, smart phone e-mail, SMS, cell phone, etc.

The communication with the DSE will be via e-mail and mobile phone.

EAU COMMUNICATION

The EAU communication will be through VHF radios and mobile phone. In case other means of communications are not operational the messages could be relayed via the police.

"KEEP AWAY FROM THE RIVER" ORDER

In case that the "Keep Away from the river" is triggered by the Dam Owner, the order to the potentially affected people will be through the Siren Warning System voice message facility. The Mobile Alert Team (MAT), local Radio and the disaster response unit warn the potentially affected people and order to stay far from the river shore.

EVACUATION ORDER

In case the evacuation alarm is triggered by DM, the notification to the villages and the potentially affected people will be through the Siren Warning System. The Mobile Alert Team (MAT), local Radio and the disaster response unit warn the potentially affected people and order the evacuation to the Meeting Point.

NOTIFICATION FEEDBACK

Feedback of notification receipt shall be promptly provided by the receiver. Feedback shall be communicated adopting the same successful communication network utilized for Notification.

NOTIFICATION REGISTER

A register of all notification shall be recorded by both parties (sender and receiver). The Register shall include the following information:

— Data and Time;

- Name of Sender and Receiver;
- Notification Code;
- Type of Alarm;
- Communication System;
- Sender Signature.

7.7.5 EMERGENCY COMMUNICATION NETWORK

Because of the vital importance of communications during emergency situations, it is mandatory to provide a primary as well as a backup communication system for communications between the Dam Owner, EAU and Local Agencies. Moreover, also an auxiliary power supply for the communication system will be ensured. The primary radio communications system will be provided (with a base station and one or more mobile units at the dam). Telephone communications will be used as backup communications system. The Emergency Action Plan will provide information on phone numbers and the radio communications system for all people involved in the EPP, together with all software and phone EPP, eventually developed for this purpose.

7.7.6 EMERGENCY WARNING SYSTEM

DEFINITION OF WATER ALARMS

In view of the fact that individuals could be alone and away from any means of ready communication, emergency warning devices such as sirens will be set up in the areas that are likely to be submerged in case of large water release and dam failure.

The location of the sirens will be chosen in order to minimize the danger of sabotage or stealing (e.g. police station, school, and public buildings) and installation, maintenance works and test operation of the sirens will be carried out by the dam operator personnel.

The water alarm sirens are usually lifted directly from the control building at the dam toe by the operating personnel. Remote controlled sirens operated by radio signals seem to be most appropriate for this use. However, also the option of a local siren triggering system will be available so that the sirens can always be activated, even in case of a radio-signal loss.

Two different water alarms shall be defined:

A. “Evacuation” alarm.

The alarm is used in case of the Emergency Level 3, illustrated in chapter 6.3.6, when the imminent failure of the dam occurs.

The alarm is given by triggering of the water alarm sirens in the area downstream of the dam.

B. “Keep Away From the River” alarm.

The alarm is used in case a Level 2 event has been notified, and the potential failure has been declared or an important water release is verified in the river stretch.

The alarm is given through:

Notification to the critical areas by the Dam Owner, Emergency Action Unit, local Radio, etc;

Triggering of water alarm sirens in the area downstream of the dam is used only in special cases.

Test operations of the water alarm sirens will be carried out at least once a year (before the beginning of the rainy season). The Dam Owner has the responsibility of organizing the test operation, which will include the simultaneous triggering of all sirens. The population will previously be informed of these tests.

Furthermore, along the river downstream, signs shall be installed for warning of an eventual large water release. The warning signs shall be placed near the dam, and close to those riverside localities known to be frequented by people. Danger warnings will be written in English and local idioms and they shall be properly graphically illustrated.

ESCAPE ROUTE AND MEETING POINTS

The affected people, after the alert, shall follow the indicated escape routes and reach as soon as possible high-level points, after which they shall reach the decided meeting points. SP has identified the escape roads and the meeting points on the basis of the results of the hydraulic numerical model.

The meeting points are high-level spots, close to the villages or houses affected by potential floods, to be reached in case of alarm in order to receive further communications and/or indications. The right location of the meeting point, as well as escape routes shall be identified on the ground by signal boards. The meeting points signs shall be visible at night, preferably luminous paint will be used, possibly along evacuation paths.

Along the river downstream, signs shall be installed warning of a large water release eventuality.

The warning signs shall be placed near bridges, fords, rapids and nearby all those riverside localities known as frequented by people. Danger warning will be written in English and local idioms and they shall be properly graphically illustrated.

7.7.7 GUIDELINES FOR EMERGENCY ACTION PLAN

GENERAL

The information illustrated in this EPP will be updated on the basis of the Maintenance and Operation Manual, when available, and the internal organization of the institution that will manage dam's behaviour on the supervision of the Dam Owner (MWS).

The Emergency Action Plan (EAP) will be performed on the basis of the information reported in this EPP and amplified with detailed information such as:

- quantitative parameters to classify univocally the emergency level;
- name, telephone number, e-mail contact of all actors who have a role managing the emergency (internal to dam and external);
- update of the notification flowchart, including detailed data (name, telephone number, etc);
- emergency action unit equipment (radio, phone, 4WD vehicle, 4WD vehicle-mounted loudspeakers, first aid kit)
- emergency warning systems & procedures
- personnel training
- local community's information plan
- detailed information on the villages affected by flood waters (number of residents, name of chief of the village, etc);

TRAINING OPERATIONAL STAFF AND EAP EXERCISES

The EAP Coordinator shall organise yearly exercises during which the EAP is tested. Each exercise shall be followed by an evaluation, and amendments to the EAP shall be made when advisable. Such amendments shall be formulated in consultation with all the stakeholders. The plan of periodical simulations shall be produced and coordinated by the governmental authorities.

EAP DISTRIBUTION

A workshop will be organised to which all the stakeholders are invited. The objectives of the workshop are to inform everybody about the purpose of the EAP, the possible scenarios (inundation map), the organisation of the EAP, and what organisational structure will be in place in case of an emergency. Each stakeholder will be informed about his/her responsibilities within the Plan and will have to be familiar with the procedures, notification form, etc.

The EAP Coordinator will adjust the EAP document, where necessary, after receiving comments from the stakeholders.

EAP UPDATES

If necessary, according to the evacuation exercise evidences, the EAP coordinator will update the EAP document. The EAP Coordinator shall review it on a yearly basis and up-date it where needed. The revised EAP shall entirely be distributed to the stakeholders.

8 ENVIRONMENTAL AND SOCIAL MONITORING PLAN

8.1 OBJECTIVES

A monitoring plan aims to ensure that mitigation and enhancement measures are implemented, that they generate intended results and that corrective actions are taken as required (activities are modified, ceased or replaced). This monitoring plan outlines both surveillance and monitoring activities.

- **Surveillance activities -** The surveillance aims to ensure that the proposed mitigation and enhancement measures are effectively implemented [during the construction phase].
- **Monitoring activities -** These activities are undertaken to measure and evaluate the project impacts on some environmental and social components of concern to determine the need to implement remedial measures, if necessary.

8.2 NATIONAL AND INTERNATIONAL STANDARDS AND GUIDELINES

These standards will be used to measure and evaluate the project impacts on environmental and social components in order to implement remedial measures as corrective action (i.e. monitoring activities).

- Water Pollution Control Regulations (2010) include Water Quality Objectives.
- South African Aquatic Ecosystems Standards (DWS, South African Water Quality Guidelines, 1996);
- World Health Organisation (WHO) Drinking Water Quality (WHO, 2008).

8.3 MONITORING IMPLEMENTATION

8.3.1 MONITORING PLAN

Table 8-1 defines the environmental and social monitoring requires to be undertaken throughout implementation of the proposed Project. The table identifies impacts and the associated monitoring measures along with relevant locations, timing and responsible parties required to undertake the monitoring and frequency thereof. Progress indicators are also identified along with associated cost estimates.

Section 8.3.2 provides a summary of budget cost estimates, which essentially cover the pre-construction, construction, post construction and 3 years of operation.

Specific measures relating to water quality and aquatic ecosystems monitoring are detailed in **Section 8.3.3** and **Section 8.3.4**.

Table 8-1: Nondvo Dam Project Environmental and Social Monitoring Plan

IMPACT	MONITORING MEASURE	LOCATION	TIMING / PHASE	RESPONSIBLE PARTY		PROGRESS INDICATOR	CONSULTATION	COST ESTIMATE
				SURVEILLANCE / IMPLEMENTATION & FREQUENCY	**MONITORING ACTIVITIES & FREQUENCY**			
Increased soil erosion and sedimentation	ECO Auditing of Soil Erosion Measures	Denuded areas and construction material stockpile	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Spoil Management Plan Proof of supply from licensed supplier		**a) EHS: EPC Project Cost** **b) ECO Monthly Construction Monitoring[17]:** € 2200 x 36 = € 79 200
		Denuded areas Downstream banks	Operation	Appointed Managing Entity / Eswatini DWA Maintenance and Operations Division	EHS Manager (Monthly) ECO (Quarterly)	Sediment Management Plan Rehabilitation Plan and Implementation Soil erosion control measures (protection berms / gabions, silt traps)		**A) EHS: Facility Internal Staff Cost** **B) ECO Quarterly Operational Monitoring[18]:** € 2860[19] x 12 = € 34 320
Change in flow (reduced quantity) downstream of a dam leading to impacts on habitats and ecosystem services.	Riverine Aquatic Biomonitoring	Section 8.3.4; Figure 8-2	Construction	EPC Contractor Independent Aquatic Ecologist (Quarterly)	EHS Manager (Daily) ECO (Monthly)	SASS5 Fish Observations (*Chiloglanis anoterus*) South African Aquatic Ecosystems Standards (DWS, 1996)	Catchment Agency for the Greater Usutu River Basin	Refer to a) and b) **c) Construction Quarterly Biomonitoring[20]:** € 2460 x 12 = € 29 520
			Operation	Appointed Managing Entity / Eswatini DWA Maintenance and Operations Division Independent Aquatic Ecologist (every 3 months over 6 month period)	ECO (Quarterly)			Refer to A) and B) **C) First year of operation Biomonitoring[21]:** € 2460 x 2 = € 4920
	Monitoring Ecological Flow Releases	Dam release point / weir	Operation	Appointed Managing Entity	EHS Manager (Monthly) ECO (Quarterly)	Releases measured against required recommended Ecological Flow Requirement release of 4 Mm^3/year[22]		Refer to A) and B)
Accidental Release / spills of large quantities of contaminants leading to reduced water quality and health impacts	ECO Auditing of Hazardous Material Management	Active work sites	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Hazardous Materials Management Plan (HMMP) Spill kits MSDS or SDS (Environmental File) Safe storage and secondary containment.		Refer to a) and b)

[17] Based on proposed construction period of 3 years
[18] Based on monitoring for first 3 years of operation on quarterly basis after which the authority / lender will reassess required frequency
[19] Based on 10% annual escalation of costs
[20] Based on proposed construction period of 3 years
[21] Based on 2 monitoring runs in first year of operation after which the authority / lender will confirm need to continue and at what frequency
[22] PROBFLO assessment to determine and assess the current EFR will be undertaken prior to Operation (cost excluded from monitoring plan).

IMPACT	MONITORING MEASURE	LOCATION	TIMING / PHASE	RESPONSIBLE PARTY		PROGRESS INDICATOR	CONSULTATION	COST ESTIMATE
				SURVEILLANCE / IMPLEMENTATION & FREQUENCY	MONITORING ACTIVITIES & FREQUENCY			
	Water Quality Monitoring	Section 8.3.2; Figure 8-1	Construction	EPC Contractor Independent Hydrologist (Bi-Monthly)	EHS Manager (Daily) ECO (Monthly)	WHO Drinking Water Quality (WHO, 2008).	Catchment Agency for the Greater Usutu River Basin	Refer to a) and b) **d) Construction Water Quality Monitoring[23]:** € 600 x 36 = € 21 600
Dam Operations and Upstream Inundation			Operation	Appointed Managing Entity Facility EHS Officer (Monthly)	ECO (Quarterly)		Independent Hydrologist	Refer to A) and B) **D) Monthly Operational Water Quality Monitoring[24]:** € 600 x 36 = € 21 600
Waterborne diseases	Monitor management of removal of sewage from existing facilities (i.e. septic tanks, French drains etc.) within inundation zone prior to inundation thereof	Area of inundation	Post Construction	Appointed Managing Entity EPC Contractor	EHS Manager (Daily) ECO (Monthly)	GPS coordinates of sites to be pumped Proof of pumped sewage disposal (including volumes) to be maintained on file	Catchment Agency for the Greater Usutu River Basin CLO Inner Council	Refer to a) and b) **e) ECO Monthly Post-Construction Monitoring[25]:** € 2200 x 3 = € 6 600
Disturbance and loss of faunal communities	Monitor for presence of fauna at project site Monitoring of poaching and killing of animals	Active work sites Areas displaying rich biodiversity baseline	Pre-construction Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Avoid natural territories as far as possible during site establishment No record of disturbance to protected species (Site Environmental File) Awareness (signs and training registers)		Refer to a) and b)
	Monitor rate of inundation – to occur over 1-2 years to allow fauna to migrate – and site clearing of woody vegetation in the correct season (winter).	Area of inundation	Post-Construction Operation	Facility Operator	EHS Manager (Monthly) ECO (Quarterly)	Method statement for bypass and release Records of release to reduce inundation Method statement for clearing of vegetation	Catchment Agency for the Greater Usutu River Basin	Refer to a) and b) and e) Refer to A and B)
Fragmentation of the vegetation community and spread of alien invasive species	ECO Auditing of revegetation efforts	Cleared areas	Construction Post-Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Rehabilitation Plan and Implementation Inactive sites re-vegetated		Refer to b) and e) **f) Labour cost for post construction control of the alien invasive species:** € 200 X 10 staff X 12 months = € 24 000
Poor general waste management leading to land use disruption	ECO Auditing / Visual Inspection	Active work sites	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Spoil Management Plan Waste receptacles Awareness (signs and training registers) Proof of Disposal at licensed facility		Refer to a) and b)

[23] Cost of analysis - based on 2 monitoring runs per month during construction (cost of hydrologist excluded)
[24] Cost of analysis - based on monitoring for first 3 years of operation on monthly basis (by internal EHS) after which the authority / lender will reassess required frequency
[25] Based on assumed pre-construction period of 3 months

IMPACT	MONITORING MEASURE	LOCATION	TIMING / PHASE	RESPONSIBLE PARTY: SURVEILLANCE / IMPLEMENTATION & FREQUENCY	RESPONSIBLE PARTY: MONITORING ACTIVITIES & FREQUENCY	PROGRESS INDICATOR	CONSULTATION	COST ESTIMATE
						Reuse Initiatives		
Inappropriate management and disposal of hazardous waste leading to contamination of natural environment	ECO Auditing / Visual Inspection	Active work sites	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Safe storage and secondary containment Spill kits MSDS or SDS (Environmental File) Awareness (signs and training registers) Proof of Disposal at licensed facility[26]		Refer to a) and b)
	ECO Auditing / Visual Inspection	Dam and support infrastructure	Operation	Appointed Managing Entity	EHS Manager (Monthly) ECO (Quarterly)			Refer to A) and B)
Increased dust emissions	ECO Auditing / Visual Inspection	Active work sites	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Complaints Register	CLO	Refer to a) and b)
Altered noise profile	ECO Auditing / Visual Inspection	Active work sites	Construction	EPC Contractor	EHS Manager (Daily) ECO (Monthly)	Complaints Register Proof of community notification of blasting activities (Environmental File)	CLO	Refer to a) and b)
Disturbance of archaeological / heritage sites and graves	ECO Auditing / Visual Inspection	Identified sites of significance Excavation areas	Pre-construction Construction	EPC Contractor Independent Heritage Specialist (As required)	EHS Manager (Daily) ECO (Monthly)	Sites projected by fencing (30m buffer) Chance Find Procedure	Inner Council	Refer to a) and b) **g) Heritage Specialist Construction Advisory Services**: € 5 350
Deterioration / loss of access to archaeological / heritage sites and graves	ECO Auditing / Visual Inspection of protection maintenance	Rock Art site and Masibekela refuge cave Identified chiefs' and community's burial sites	Operation	Appointed Managing Entity / DWA	ECO (Quarterly) National Heritage Authority	Preservation of rock art (fencing, plaques and access control notices) Maintained community access	Inner Council	Refer to A) and B)
Physical and economic displacement: relocation of approximately 210 households and the loss of over 700 assets	Implementation of the RAP and LRP	Affected households and PAPs	Construction Post-Construction Operation	DWA *Livelihood Restoration Specialist*	CLO / Grievance Officer (Ongoing) ECO (Monthly)	Proof of Resettlement / Compensation Implementation of LRP Initiatives and List of Beneficiaries	Inner Council / Resettlement Working Group	Refer to b) and e) **h) CLO during Construction: EPC Project Cost** **E) CLO Monthly Salary first three years of Operation:** € 1250 x 36 = € 45 000 **RAP and LRP costs to be assigned following completion of RAP and LRP – costs to include independent M&E specialist to monitor RAP and**

[26] Cost of disposal to be borne by contractor

IMPACT	MONITORING MEASURE	LOCATION	TIMING / PHASE	RESPONSIBLE PARTY		PROGRESS INDICATOR	CONSULTATION	COST ESTIMATE
				SURVEILLANCE / IMPLEMENTATION & FREQUENCY	MONITORING ACTIVITIES & FREQUENCY			
								LRP implementation for at least 5 years
Loss of plant resources used by the community	Implementation of the RAP and LRP	Affected households and PAPs	Pre-Construction Construction	DWA	CLO / Grievance Officer (Ongoing) ECO (Monthly)	Community nurseries supplying rehabilitation efforts	Inner Council / NGOs	Refer to b) and h) **Community nursery projects to be undertaken by relevant NGO**[27]
Creation of local employment opportunities	ECO to ensure construction staff are sourced locally	Local community (directly and indirect affected)	Pre-Construction Construction	DWA EPC Contractor	CLO / Grievance Officer (As required) ECO (Monthly)	Number of household members with direct project employment. Employment records. Labour Recruitment Policy and Guidelines	Inner Council	Refer to b) and h)
Community impacts due to influx of Workers	ECO auditing of community and worker training and support and provision of adequate services / facilities.	Local community Local community (directly and indirect affected)	Pre-Construction Construction Operation	DWA	CLO / Grievance Officer (As required) ECO (Monthly / Quarterly)	Proof of training and awareness raising (socio-cultural profiles, gender based violence, STDs etc.) Provision of health care facilities for staff and local labour Grievance Redress Mechanism (GRM) Grievance Register Skills development and capacity building programme (including programmes for enhancement of agricultural production amongst PAPs)	Inner Council CLO Community (project access, sensitising)	Refer to b) and B) and h) and E)
Increased safety risks to people and animals	ECO Auditing / Visual Inspection	Active work sites Community settlement areas in close proximity to roads	Pre-Construction Construction	EPC Contractor	CLO / Grievance Officer (As required) ECO (Monthly)	Emergency Response Plan Signage Restricted access to active sites Road Safety Measures Grievance Register Reinstatement of temporary community disruption	Inner Council CLO Community (sensitising and awareness)	Refer to b) and h)

[27] DWA to engage with NGOs

8.3.2 SUMMARY OF MONITORING COSTS

The monitoring costs outlined in **Table 8-1** are summarised in **Table 8-2**. These costs essentially cover the pre-construction, construction, post construction and 3 years of operation.

Table 8-2: Summary of Monitoring Plan Costs

MONITORING PLAN COST ITEM	BUDGET COST (EURO)	BUDGET COST (EMALANGENI)[28]
CONSTRUCTION AND POST-CONSTRUCTION		
a) EHS during construction and post-construction	EPC Project Cost	EPC Project Cost
b) ECO Monthly Construction Monitoring[29]	€ 79 200	1 346 400
c) Construction Quarterly Biomonitoring[30]	€ 29 520	501 840
d) Construction Water Quality Monitoring[31]	€ 21 600	367 200
e) ECO Monthly Post-Construction Monitoring[32]	€ 6 600	112 200
f) Labour cost for post construction control of the alien invasive species	€ 24 000	408 000
g) Heritage Specialist Construction Advisory Services	€ 5 648	96 000
h) CLO during Construction	EPC Project Cost	EPC Project Cost
i) Community nursery projects to be undertaken by relevant NGO[33]	TBD	TBD
Subtotal	**166 568**	**2 831 640**
OPERATION		
A) EHS: Facility	Internal Staff Cost	Internal Staff Cost
B) ECO Quarterly Operational Monitoring[34]	€ 34 320	583 440
C) First year of operation Biomonitoring	€ 4 920	83 640
D) Monthly Operational Water Quality Monitoring	€ 21 600	367 200
E) CLO Monthly Salary first three years of Operation	€ 45 000	765 000
Subtotal	**105 840**	**1 799 280**
Total:	**€ 248 408**	**4 222 920**

28 Currency exchange calculated at a rate of 17:1
29 Based on proposed construction period of 3 years
30 Based on proposed construction period of 3 years
31 Cost of analysis - based on 2 monitoring runs per month during construction (cost of hydrologist excluded)
32 Based on assumed pre-construction period of 3 months
33 DWA to engage with NGOs
34 Based on monitoring for first 3 years of operation on quarterly basis after which the authority / lender will reassess required frequency

8.3.3 WATER QUALITY

SAMPLING LOCATIONS AND FREQUENCY

The objective of the monitoring programme is to ascertain the impacts of the proposed dam on the receiving water environment during both construction and operational phase. Should upstream impacts be identified the monitoring programme may need to be expanded on to qualify potential source zones within the broader basin. It is recommended that sampling be undertake upstream and downstream of the proposed dam along the Lusushwana River at the following locations (**Table 8-3** and **Figure 8-1**).

Table 8-3: Proposed Sampling Locations

POINT	LATITUDE	LONGITUDE	FREQUENCY	RATIONALE
SW5	-26.4025°	31.1003°	**Construction Phase:** Bi-Monthly **Operational Phase:** Monthly for 12 months	This is upstream of the proposed dam inundation area, and also downstream of the existing Luphohlo Dam along the Lusushwana River. The effects of the Luphohlo Dam would be included in the results.
SW7	-26.4286°	31.1123°	**Construction Phase:** Bi-Monthly **Operational Phase:** Monthly for 12 months	This point is after the confluence of the Nondvo and Lusushwana Rivers. Sampling at this location would factor in the effects of the Nondvo River.
SW8	-26.4279°	31.1170°	**Construction Phase:** Bi-Monthly **Operational Phase:** Monthly for 12 months	This point is located immediately downstream of the proposed dam wall. A sample here would provide an indication of the impacts that the proposed dam would have on the Lusushwana River.
SW9	-26.4460°	31.1241°	**Construction Phase:** Bi-Monthly **Operational Phase:** Monthly for 12 months	This point is located approximately 2.4 km downstream of the proposed dam wall, along the Lusushwana River. A sample here would provide an indication as to how the environment would react to the proposed dam.
SW10	-26.4446°	31.1881°	**Construction Phase:** Bi-Monthly **Operational Phase:** Monthly for 12 months after the initiation of dam discharge	This point is located approximately 9.75 km downstream of the proposed dam wall, along the Lusushwana River. A sample here would provide an indication as to how the environment would react to the proposed dam, prior to the river passing through a semi-urban area.

SAMPLING METHODOLOGY

The water quality samples will be collected directly into laboratory-supplied sample containers. Water samples will be obtained from at least 10cm below the water surface wherever possible, with the bottle opening facing upstream. Sample containers will be kept closed and in a clean condition up to the point of sampling.

Monitoring will be undertaken according to WHO Guidelines for Drinking-Water Quality (2008), ensuring that the potential for cross contamination is minimised.

For each sampling point, the temperature, pH and electrical conductivity will be measured *in-situ* using a calibrated multi-parameter probe, and recorded. This information, as well as the physical and environmental information of each sampling point (e.g. visual, olfactory observations and flow conditions) will be recorded on designated field data sheets.

On each sample, the following will be recorded to ensure proper identification:

— Site Name;

— Sample Location and Sample Type; and
— Sample Date and Time.

Post sampling, all samples will be stored in a temperature controlled cooler box (below 4ºC), which is kept sealed and dust-free, until samples are dispatched to a suitably accredited laboratory for analysis.

ANALYTICAL PROGRAMME

It is recommended that the analytical suite follow the schedule as outlined in the Water Quality Objectives as outlined in Water Pollution Control Regulations (2010) for monitoring of water quality (**Table: 8-4)**. As stated within the IFC/World Bank (2007) General EHS Guidelines Section 3: Community Health and Safety, in the absence of local standards for other pollutants, the analytical programme will be in accordance with the WHO (2011) Guidelines for Drinking-Water Quality.

Table: 8-4 Proposed Project Water Quality Guidelines

PHYSIC-CHEMICAL PARAMETERS	STANDARD/OBJECTIVE
Dissolved oxygen	minimum of 4 mg/l (surface water only)
pH	minimum 6.5 and maximum 8.5
EC	1800 µS/cm maximum
Turbidity	5 Nephelometric units (NTU) maximum
Hardness	1000 mg/l maximum (as calcium carbonate)
Chemical oxygen demand	10 mg oxygen/l maximum
Biological oxygen demand	5 mg oxygen/l maximum
Nitrate	10 mg N/l (as nitrogen) maximum
Nitrite	0.2-3 mg N/l (as nitrogen) maximum
Ammonia	0.6 mg N/l maximum
Fluoride	1.0 mg/l maximum
Iron	1 mg/l maximum
Manganese	0.5 mg/l maximum
Mercury	0.001 mg/l maximum
Cadmium	0.003 mg/l maximum
Aluminium	0.2 mg/l maximum
Total Coliforms	1 - 10 per 100 ml maximum
Faecal Coliforms	1 - 10 per 100 ml maximum
Zinc*	3 ug/l maximum
Phosphates*	0.1 mg/l maximum

PHYSIC-CHEMICAL PARAMETERS	STANDARD/OBJECTIVE
*Added in based on land uses within the Lusushwana River Basin	

DATA REPORTING

A factual and interpretive report will be drafted in accordance with the monitoring reporting requirements stipulated in the Water Quality Objectives as outlined in Water Pollution Control Regulations (2010). The report will include a description of the methodologies followed, the analytical results obtained and associated interpretation in line with the defined water quality guidelines. A database of the result will be developed in order to gain an understanding of the impacts during the construction and operation phases through a trend analysis.

The precision of the sampling and analysis will be assessed through a comparison of the original and duplicate sample analytical results. This will be done through a quality assurance/quality control programme (i.e. obtain the percentage variance of the duplicated sample).

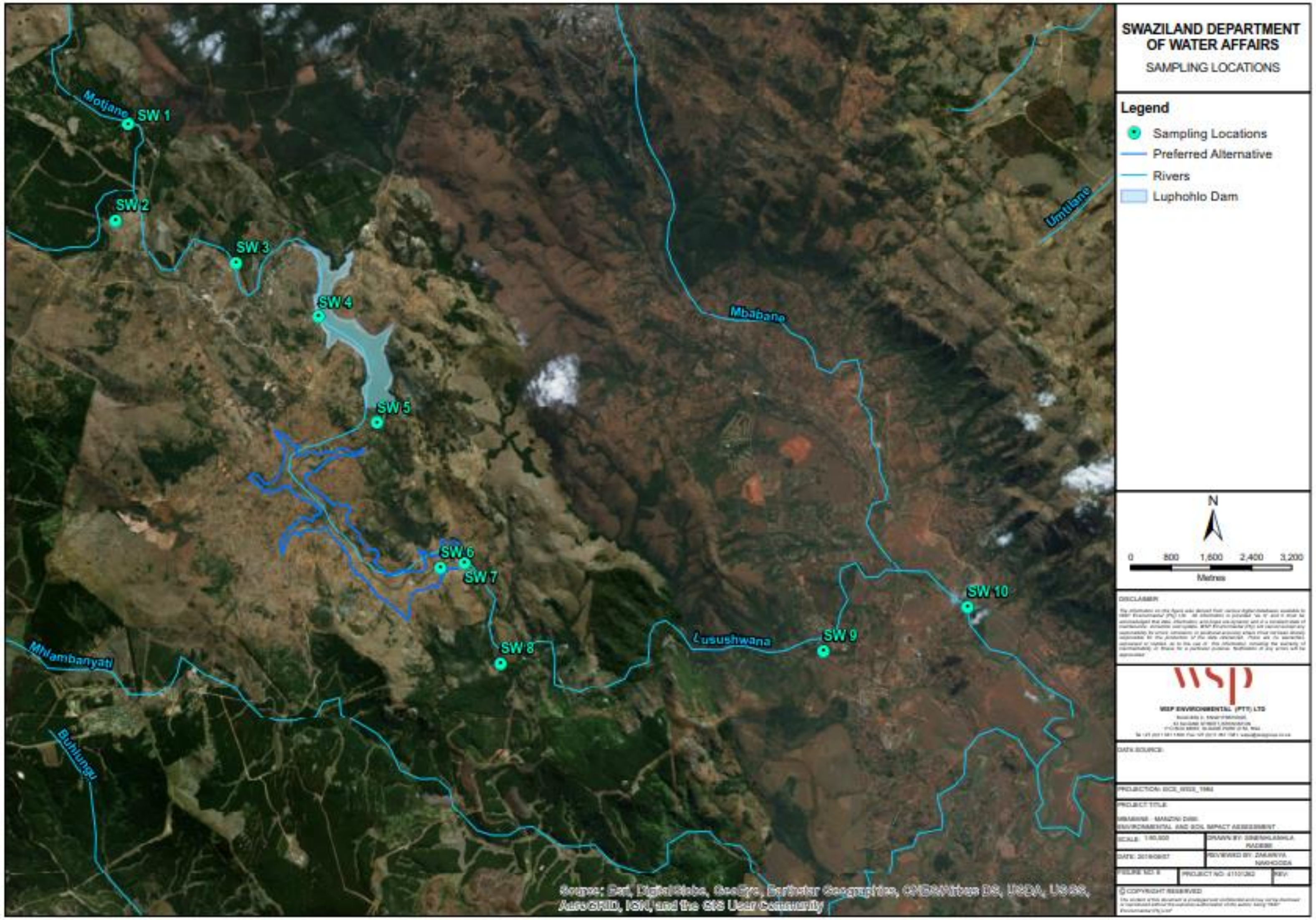

Figure 8-1: Reference Map for Water Quality Sampling Locations (WSP, 2019)

8.3.4 AQUATIC ECOSYSTEMS

The results of the Critical Habitat Assessment indicated that the considered riverine Discrete Management Unit (DMU) did not exceed any thresholds for the classification, and therefore the riverine habitat within the DMU of this study would not constitute Critical Habitat (CH). However, the health of the riverine habitat and ecosystem functioning will be monitored with reference to the parameters outlined in **Table 8-5.** The sampling locations are illustrated as the “S” points shown in yellow on **Figure** 8-2.

Table 8-5: Recommended Riverine Aquatic Biomonitoring (The Biodiversity Company, 2019)

METHOD	DURATION	KEY PERFORMANCE INDICATOR
Construction Phase		
SASS5	Construction (Quarterly)	No significant difference (*p<0.05*) in SASS5 score or ASPT between up and downstream monitoring points
Fish Observations	Construction (Quarterly)	*Chiloglanis anoterus* will always be located downstream of the impoundment (FROC = 5.0)
Water Quality Monitoring	Construction Phase (Bi-monthly sampling)	*Direct Comparison between up and downstream river reaches will not result significant* (*p<0.05*) changes in parameters between every 4 sample sets. Further comparison to DWAF (1996) for Aquatic Ecosystems[35] can be made.
Operation Phase		
SASS5	Operation (every 3 months over 6 month period) (i.e. 2 monitoring runs)	No significant difference (*p<0.05*) in SASS5 score or ASPT between monitoring surveys that can be attributed to impacts from the proposed discharge
Fish Observations	Operation (every 3 months over 6 month period) (i.e. 2 monitoring runs)	*Chiloglanis anoterus* will always be located downstream of the impoundment (FROC = 5.0)
Water Quality Monitoring	Operation (Monthly for 12 months after completion of the construction phase)	*Direct Comparison between up and downstream river reaches will not result significant* (*p<0.05*) changes in parameters between every 4 sample sets for Aquatic Ecosystems can be made.

[35] South African Aquatic Ecosystems Standards (DWS, South African Water Quality Guidelines, 1996)

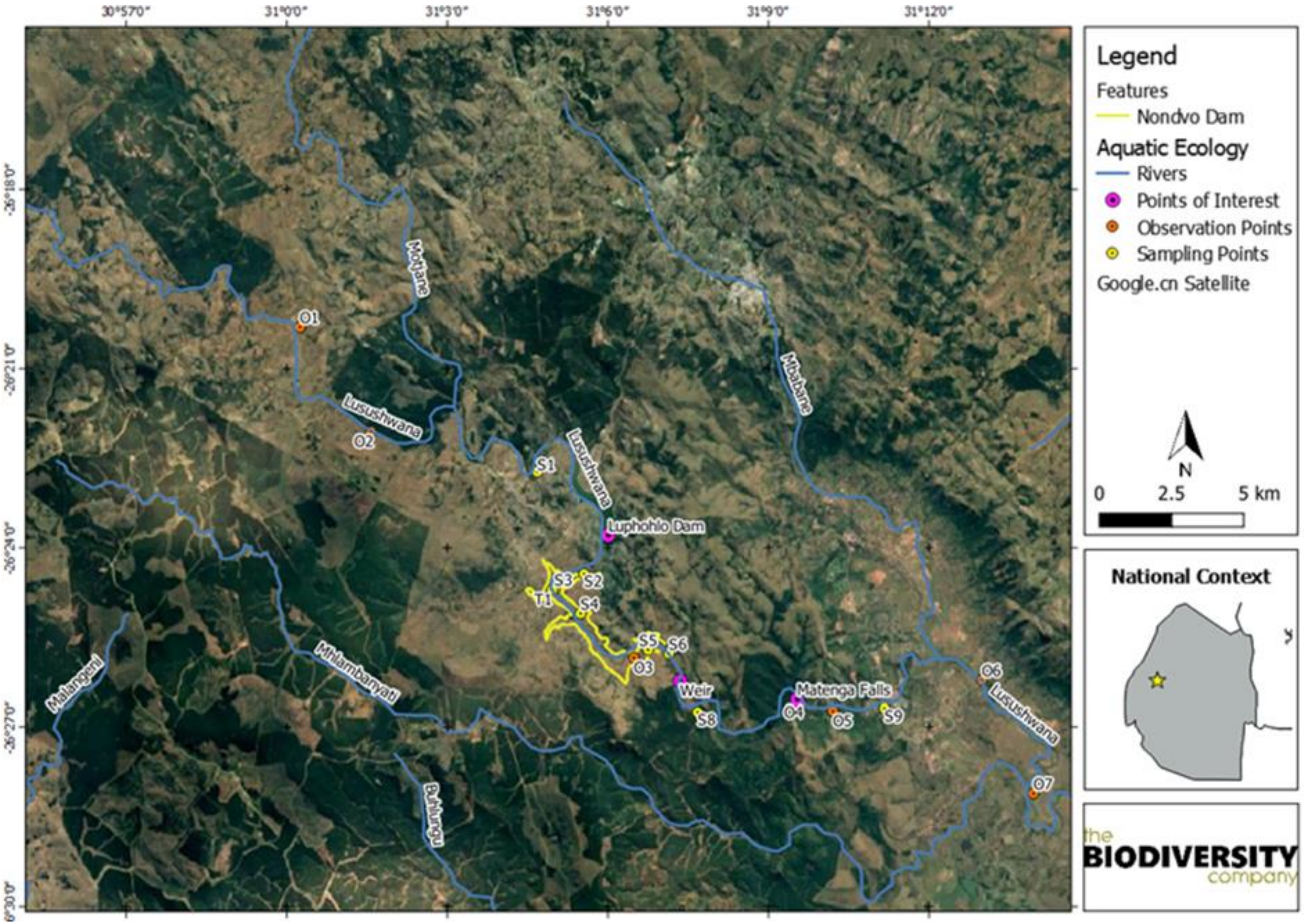

Figure 8-2: **Reference Map for Riverine Aquatic Biomonitoring Sampling Locations (The Biodiversity Company, 2019)**

9 PUBLIC CONSULTATION AND DISCLOSURE

Consultation facilitated by the Community Participation Liaison Officer (CPLO) and Community Liaison Officer CLO will be required for the successful implementation of measures stipulated within the ESMP, including:

- Implementation of LRP initiatives.
- Grievance Mechanisms.
- Initiatives to ensure employment opportunities benefit local communities during both construction and operational phases (database of the economically active population in liaison with community representative and district authorities; and local publication and announcements on job and training opportunities).
- Community health and safety; and ensuring community accessibility during construction for the households that won't be relocated.
- Feedback between the contractor and the community on concerns raised, unintended impacts and monitoring results.

The Stakeholder Engagement Plan (**SEP**) includes more detail on target groups, appropriate consultative processes, consultation frequency, reporting methods and disclosure procedures.

10 CONCLUSION AND RECOMMENDATIONS

The impact assessment carried out and mitigation measures recommended have been done with reference to both national legislation and regulations; as well as key lender requirements and guidelines – principally, the AfDB IESIA Guidelines (AfDB 2009; 2015).

The ESMP represents the project’s commitment to address and manage the potential negative and enhance the positive impacts associated with the bulk water supply infrastructure. The key intent of the ESMP is to ensure that the environmental and social objectives of the project are met, and it is based on the various components of the project throughout design, construction and operational phases.

The ESMP makes recommendation for capacity building and assigns responsibilities for the implementation of enhancement and mitigation measures as well as the completion of the monitoring programs.

It is expected that should the ESMP be executed effectively, the proposed project will not result in significant impacts (moderate significance post mitigation). For this to be achieved, the ESMP will be integrated into the project's overall planning, design, budget, and implementation. The ESMP provides the required level of detail for mitigation and monitoring measures and its assignment of institutional responsibilities, and cost requirements.

APPENDIX

A

CHANCE FIND PROCEDURE

HERITAGE CHANCE FIND PROCEDURE

PURPOSE

Physical cultural resources / heritage remains are finite, non-renewable and highly susceptible to disturbance. They are managed for their historical, cultural, scientific, and educational value to the general public, and local communities. Heritage sites may be of regional, provincial, national, or international significance. While their true meaning may remain esoteric, identification could lead to presentation, education and benefit to the public.

The purpose of the Chance Find Procedure is to ensure that any heritage resources that may be encountered during implementation of the proposed project are managed in a responsible manner.

SCOPE

The sphere of influence spreads wider than the construction footprint, for social and environmental considerations. Within its footprint, the Project carries the full responsibility within the scope of its ESMP, but outside the footprint DWA operates through social responsibility considerations.

LIMITATIONS

In the first instance, Eswatini does not have easily accessible heritage database that is regularly updated with new findings, nor the resources to develop this within the foreseeable future.

The Government of Eswatini has not yet developed a protocol that can be readily accessed outlining the procedures to be followed on site. The development of the procedures therefore, follows the international good practice and adopts the spirit of the national legislation pertaining to cultural heritage.

PROTOCOL

- Any form of cultural and natural heritage feature identified within a project's sphere of influence shall be documented in consultation with the relevant Authority.
- Encounter with tangible heritage features is likely to occur during site preparation and during construction, for those items that are underground. It is therefore prudent to undertake inspections continuously to prevent negative impacts and also be able to minimise those that are inevitable, including at a later point, enhancement of and/or development of positive heritage impacts for community beneficiation.
- All efforts leading to either in-situ or ex-situ conservation of identified heritage features must be undertaken by DWA, especially those identified within its sphere of influence.
- The approach to documentation, conservation planning and implementation must be undertaken with the involvement of the relevant Authority. This approach does not only deal with negative impacts, but is required also in the case where improvements are required to present identified heritage feature for public consumption.
- In all cases, awareness in the form of leaflets, meetings and workshops, as necessary need to be made to the workforce and the neighbouring community on a regular basis.

HERITAGE DATABASE

- Establish a Heritage Database within the actual and perceived sphere of influence.
- Determine the provenance of each artefact or feature identified.

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- Continuously survey site to identify heritage sites (building remains, artefacts grinding stones, anvils etc.) and graves.
- For every new ground opening the Earth Works team must inform the Environment Manager (EM) so they can survey the site and identify potential heritage sites.
- During the ground opening operations, the Earth Works team following discovery of heritage features, must suspend the activity and report the observation to the EM so they can mount an investigation and determine the next set of action.

MANAGEMENT ACTIONS AND RESPONSE

The following actions are essential for the preservation and protection of cultural resources on site:

- Known heritage sites and graves must be fenced, signposted and/or otherwise cordoned off to maintain or enhance protection from damage until technical evaluation has been sought. If there is an accidentally unearthed heritage item (grave or artefact), earthworks or other intrusive operations, reasonable measures will be implemented to prevent damage to the grave or artefact. Work must be stopped immediately and valuation of the element significance and the next course of action identified in consultation with the site Environmental Manager and relevant Authority
- Artefact must be examined by a suitably qualified specialist. This can be outsourced in liaison with the relevant Authority.
- Post assessment, the specialist must provide a *green light* for work to resume after appropriate action of onsite conservation or removal to a more secure place has been concluded (as per consent of the relevant Authority).

Documentation is followed by an assessment of conservation status for inclusion in a management protocol (i.e. to preserve it in-situ or ex-situ; and the steps to be followed to present it to the public). Often the steps include organisation and participation of the community involved, to encourage long-term custodianship.

Determination of the scale of importance or significance of the heritage resource identified should be based on:

- Impending threat;
- Requirements for development of management plans due to their magnitude and significance;
- In situ or ex-situ conservation;
- Special preservation techniques.