SCIENTIFIC AQUATIC SERVICES

FRESHWATER ECOSYSTEM ASSESSMENT

AS PART OF THE ENVIRONMENTAL AUTHORISATION PROCESS FOR THE PROPOSED GOVE-CHIPINDO-CUVANGO-JAMBA TRANSMISSION LINE PROJECT, ANGOLA.

Prepared for:	SRK Consulting (SA) (Pty) Ltd.
Report author:	N. Lushozi (Pri.Sci. Nat) Dr. M. Ross (Pr. Sci. Nat)
Report reviewers:	S. van Staden (Pr.Sci.Nat)
Report Reference:	SAS 24-1055
Submission Date:	September 2024
Amended Date:	June 2024 September 2024

Part of the SAS Environmental Group of Companies

Website: http://www.sasenvironmental.co.za

Project Naming Clarification:

The Gove-Chipindo-Cuvango-Jamba Transmission Line Project was referred to as the Cassinga Electrical Power Supply Project during the ESIA process and stakeholder engagement.

EXECUTIVE SUMMARY

Scientific Aquatic Services (Pty) Ltd. (SAS) was appointed by SRK Consulting (South Africa) to conduct a freshwater ecosystem assessment as part of the environmental authorisation (EA) process for the Gove-Chipindo-Cuvango-Jamba Transmission Line Project (*referred to as the Cassinga Electrical Power Supply Project during the ESIA process and stakeholder engagement*) (the Project). The proposed powerline project is located South of the centre of Angola, namely, in the provinces of Huila and Huambo. The proposed powerline extends for about 170 km, crossing six municipalities which include Jamba, Kuvango, Dongo, Galangue, Chipindo and Kalima.

During the assessment conducted over a period of five (5) days in April 2024, identified drainage systems comprised four primary hydrogeomorphic (HGM) types: rivers with associated riparian vegetation and in some cases with associated floodplains, valley bottom wetlands (both channelled and unchannelled), and what are referred to locally (in Angola) as 'dambos' – the latter being characterised by relatively even topography and situated in low-lying areas. The ecological integrity of the freshwater ecosystems was largely intact due to the remote geographic location of the proposed powerline infrastructure. Ecological modifiers include freshwater crossings, subsistence cultivation activities, impoundments including large dams such as the Gove dam and Cuandeja Dam and impacts associated with use of some of the freshwater ecosystems for domestic needs. Despite these impacts, in terms of ecological services, the freshwater ecosystems are considered important for local communities in terms of provision of water for domestic use, these systems are also a drinking source for cattle and are able to provide good habitat essential for biodiversity maintenance. In addition, the valley bottom wetland systems were utilised for subsistence farming.

A dry season survey was undertaken during July 2024, where all the watercourses and freshwater ecosystem resources identified during the wet season survey were re-assessed to evaluate the influence of seasonality on the systems. It was noted that the surface water ecosystems are generally strongly influenced by seasonality, with many of the minor watercourses, valley bottom wetland units and other isolated wetland features no longer supported persistent surface waters. Seasonal variability is a natural process of the habitat units. None of the wetlands and watercourses were shown to suffer a decline in ecological integrity.

The proposed powerline will cross the freshwater systems, however, given the spatial footprint of the infrastructure such as the powerline supporting pylons and proposed substations, the extent of modification is anticipated to be low. During the planning phase, it must be ensured that the powerline support pylons are spanned appropriately to avoid direct encroachment within the freshwater ecosystems. This is critical for maintenance of ecological functionality as well as for the longevity and protection of the proposed infrastructure.

In terms of the proposed access roads, the layout indicates that some proposed new roads will traverse the delineated freshwater ecosystems, and this will result in a medium impact. Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are low to limit. The medium impact significance is particularly likely to occur during the construction phase of the project where increased vehicle movement will be taking place, resulting in increased dust generation, smothering of freshwater habitat and potential proliferation of alien and invasive species. Beyond the construction phase, the proposed freshwater crossings will also result in a cumulative loss of freshwater habitat and therefore it is important that suitable mitigation measures are implemented to manage significant loss of freshwater habitat during construction of the proposed new access roads and associated crossings.

In conclusion, given that the project has the potential to limit direct impacts on the freshwater ecosystems which reduces the overall impact significance of the project and that the project is considered essential for human livelihoods including socio-economic development and more broadly, for sustainable development for local communities in the areas which form part of the project, it is the opinion of the specialist that the project be considered in a positively for

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater system.
Delineation (of a wetland):	To determine the outer boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Endorheic	As it relates to a depression wetland: inward-draining with no transport of water into downstream systems via subsurface or surface flow. Water leaves via evapotranspiration and infiltration only.
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurrences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface
Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Wetland:	The Ramsar Convention, formally known as the Convention on Wetlands of International Importance, defines wetlands as follows: • Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (use to be defined in relevant sections)
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMC	Ecological Management Class
EMP	Environmental Management Program
EWR	Ecological Water Requirements
ESIA	Environmental and Social Impact Assessment
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GPS	Global Positioning System
HGM	Hydrogeomorphic
IFC	International Finance Corporation
kV	kilovolt
m	Metre
MAP	Mean Annual Precipitation
NIMEA	Ministry of Energy and Water
OHL	Overhead Line
PES	Present Ecological State
MVAs	Megavolt-amperes
RMO	Resource Management Objective
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services
SQR	Sub quaternary catchment reach
WMS	Water Management System

1 INTRODUCTION

1.1 Background and Project Description

Scientific Aquatic Services (Pty) Ltd. (SAS) was appointed by SRK Consulting (South Africa) to conduct a freshwater ecosystem assessment as part of the environmental authorisation (EA) process for the Gove-Chipindo-Cuvango-Jamba Transmission Line Project (*referred to as the Cassinga Electrical Power Supply Project during the ESIA process and stakeholder engagement*) (the Project). The proposed powerline project is located South of the centre of Angola, in the provinces of Huila and Huambo. The proposed powerline extends for approximately 170 km, crossing six municipalities which include Jamba, Kuvango, Dongo, Galangue, Chipindo and Kalima. The detailed project description is provided the section below.

1.1.1 Project description[1]

The main works will be carried out largely in Huila Province near the Gove Hydro Dam (Huambo) and extend for 135 km with an OHL 220 kV to Cuvango, where a new 220/30 kV substation will be built. A new 220/30 kV substation will also be built for distribution in Chipindo along with the construction of an OHL 220 kV from Cuvango to Jamba, with an approximate length of 35 km. A new 220/30 kV – 20 MVA substation will be constructed in Jamba. In addition, the infrastructure associated with the electrification of villages at Chipindo, Cuvango and Jamba will be constructed.

The Republic of Angola, through its Ministry of Energy and Water (MINEA), is embarking on a significant enhancement of its electrical infrastructure with the proposed Project, aiming to boost electric power supply across various communities within the Province of Huíla. The Project is structured around the establishment of a new 220 kV Overhead Line (OHL) network, extending from Gove to Cuvango, and further branching out to Chipindo and Jamba. This network includes the construction of new substations in Chipindo, Cuvango, and Jamba, each equipped with a capacity of 220/30 kV - 20 MVA, to efficiently distribute the generated power to these villages. Furthermore, the Project includes the laying down of medium voltage overhead lines for distribution, along with the necessary low voltage network, public lighting, and home connections within the communities of Chipindo, Cuvango, and Jamba. The overarching goal is to create a robust and reliable electric power supply system that not only

[1] Obtained from memorandum document provided by the EAP titled: Memo: Cassinga Electrical Power Supply Project ESIA: Project Description. Dated: 5th April 2024.

caters to the current demands but is also scalable to accommodate future expansions, including the prospective OHL 220 kV interconnection to Cuchi/Menongue.

An estimated power demand of 80 MW has been calculated for the proposed Project, with an additional 10 MW anticipated for local community demands. This projection underscores the critical nature of the project in addressing the power needs of the region, fostering economic growth, and improving the quality of life for its residents.

Transmission lines and towers

Transmission line conductors are strung on in-line suspension towers and bend (strain) towers. The structures proposed to be used for the majority of the 220 kV Transmission line are metallic towers type Y, adequate to the angle of the OHL. These towers are approximately 50 m in height and a total footprint area of 80 m x 50 m is required for each tower. The average span between two towers is 400 m.

The cross-rope suspension tower is typically used along the straight section of the servitude, while the self-supporting angle towers and inline strain towers are used where there is a bend in the powerline alignment. Angle towers are cumbersome and more steel-intensive than suspension towers, making them more visually intrusive and costly to construct. Therefore, transmission line routes are planned with as few bends as possible.

New Substations

A substation is a key part of the electrical generation, transmission and distribution system, where voltage is transformed from high to low or the reverse using transformers. The project will comprise the supply, installation, testing, commissioning and operation of three 220/30 kV substations in accordance with MINEA and IEC standards. The construction of the new substations will be in accordance with the plan and the single line schemes that will be presented at a later stage, based on relevant guideline schemes. The design of the Chipindo, Cuvango and Jamba 220/30 kV substations is based on MINEA Technical Specifications and IEC Standards. At the 220 kV level, the single busbar configuration was implemented, and the width of each 220 kV Bay Line is 15 m.

Overhead powerline infrastructure

OHL infrastructure refers to the network of towers, poles, conductors and equipment used to transmit and distribute electrical power through aerial cables. The OHL infrastructure for the Project will be constructed in two stages.

Stage 1: Gove – Chipindo – Cuvango

The Gove – Chipindo – Cuvango section of the OHL will comprise the following components:

- High Voltage Transmission Line, between Gove Hydro and New Cuvango 220/30 kV Substation, energized 220 kV single circuit, for a distance of appx 135 km;
- Metallic Towers type Y, adequate to the angle of the OHL;
- Three-Phase OHL 220 kV bundled conductor "YEW" Cable 479 mm^2 (2 by phase); and
- Two Guard Wires will be installed, one conventional "Guinea" and another type "OPGW" with 24 Optical Fibres.

Stage 2: Cuvango – Jamba

The Cuvango – Jamba section of the OHL will comprise the following components:

- High Voltage Transmission Line, between New Substation at Cuvango and New Jamba 220/30kV Substation, energized 220 kV single circuit, for distance of appx 35 km;
- Metallic Towers type Y, adequate to the angle of the OHL;
- Three-Phase OHL 220 kV, bundled conductor "YEW" Cable 479 mm2 (2 by phase); and
- Two Guard Wires will be installed, one conventional "Guinea" and another type "OPGW" with 24 Optical Fibres.

Electrification of community homes and public lighting

The electrification of Chipindo, Cuvango and Jamba requires several infrastructure components. The installation of these components within each community will establish a medium and low voltage network to supply grid electricity to approximately 1 000 homes in each community, including public lighting.

1.1.2 Purpose of the report

The purpose of this report is to define the ecology of the area in terms of freshwater ecosystems characteristics, including mapping of the freshwater ecosystems, discuss key ecological drivers and to define the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), as well as the socio-cultural and ecological service provision of the freshwater ecosystems utilising current industry "best practice" assessment methods in order to ascertain what, if any, impact the activities will have on the freshwater ecosystems associated with the proposed powerline project.

The objective of the study is to provide detailed information when considering the existing activities in the vicinity of the freshwater ecosystems, to ensure the ongoing functioning of the ecosystem such that local and regional conservation requirements and the provision of

ecological services in the local area are supported while considering the need for sustainable economic development.

An impact assessment provided by the Environmental Assessment Practitioner (EAP) was applied to determine the significance of the perceived impacts associated with the proposed powerline project on the receiving environment. In addition, mitigatory measures were developed, which aim to minimise the perceived impacts associated with the proposed activities, followed by an assessment of the significance of the impacts post-mitigation. This report, after consideration and a description of the ecological integrity of proposed powerline project, must guide the EAP and relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed infrastructure from a freshwater ecosystem management point of view.

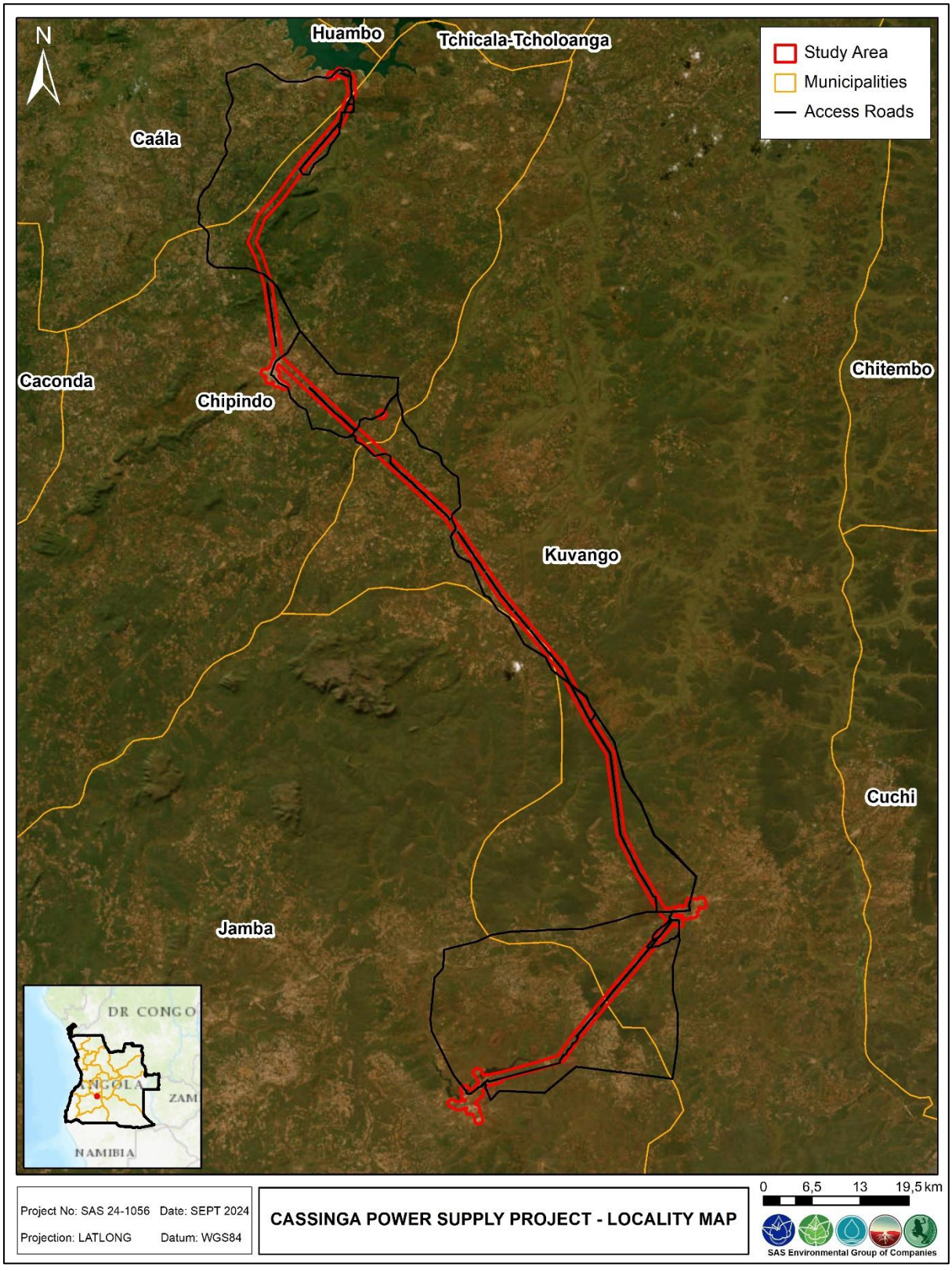


Figure 1: Digital satellite image depicting the location of the study and investigation areas associated with the proposed powerline project in relation to the surrounding environment.

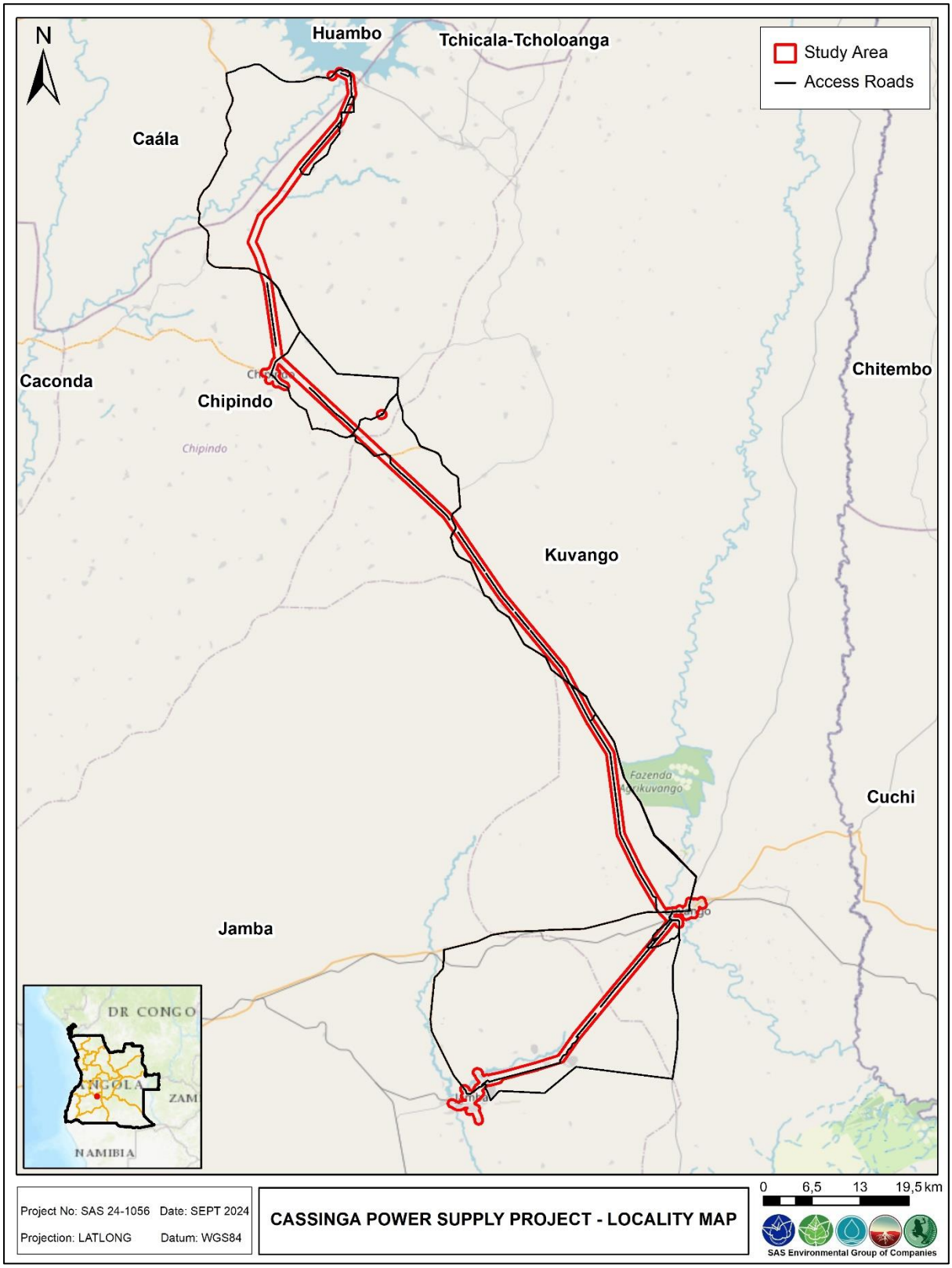


Figure 2: The study and investigation areas associated with the proposed powerline project depicted on a topographical map in relation to the surrounding area.

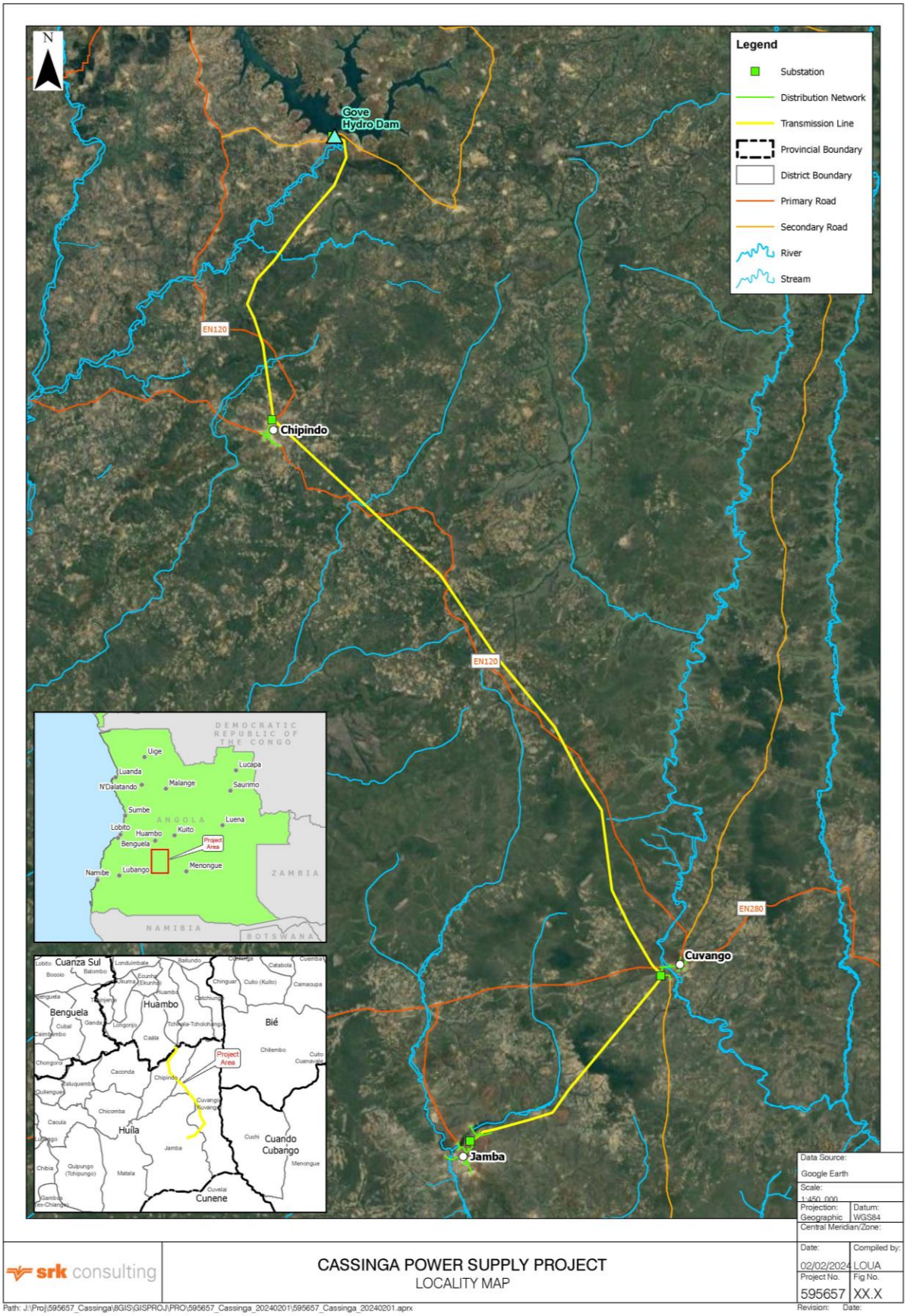


Figure 3: Location of the proposed 220 kV OHL and the towns it will supply with electricity.

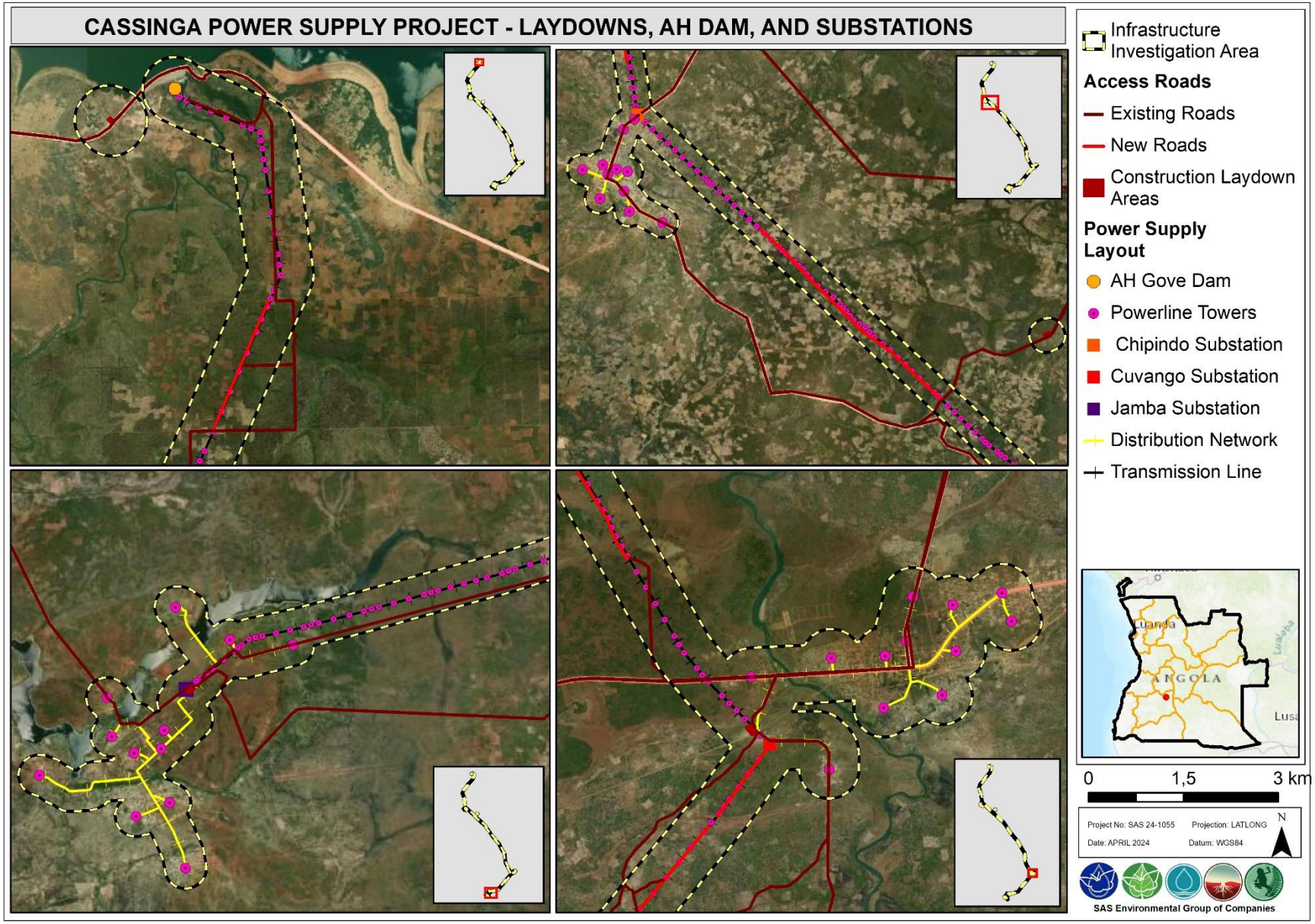


Figure 4: Digital satellite image depicting the location of the substation infrastructure associated with the proposed powerline project in relation to the surrounding environment.

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The delineation and mapping of freshwater features as presented in this report are regarded as a best estimate of the outer boundaries based on the site conditions present at the time of assessment;
- Due to access constraints pertaining to access roads and terrain, some freshwater ecosystems could not be accessed at the proposed crossing points associated with the proposed powerline. Therefore, verification points for some freshwater ecosystems were located at points as close to the freshwater ecosystem crossing as possible to be verified and, where necessary, the conditions at the exact point required were inferred or extrapolated. The observations made are deemed sufficient to ensure that informed decision making can be undertaken;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required, the freshwater ecosystems will need to be surveyed and pegged according to surveying principles and with land survey equipment;
- Given the extensive agricultural activities as well as other anthropogenic disturbances within the assessment footprint, the zonation of the freshwater ecosystems has been altered and, in some areas, augmented over time. To mitigate this limitation, satellite imagery over time was used to verify boundaries using time-series imagery. Despite this, the delineations as presented in this report are regarded as a best estimate of the boundaries based on the site conditions present, as observed during the site assessment and are deemed appropriately accurate to guide the authorisation process;
- Wetland, riparian and terrestrial ecosystem zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the freshwater ecosystem boundary may occur. In the absence of protocols developed specifically for Angolan wetland systems, “best practice” methods developed for the African continent (such as the various wetland assessment tools developed in South Africa), were utilised and adapted where necessary in order to ensure the most appropriate and accurate characterisation of the resources. For the purpose of this assessment, the DWAF (2008) method followed is considered sufficient to provide similar results;
- It is important to note that although all data sources used to provide background information on the sensitivity of the assessed areas provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely

accurate indication of the focus area's actual site characteristics at the scale required to inform the environmental authorisation processes. Field assessments are conducted in order verify these findings and provide more accurate information about on-site conditions;

- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. A more reliable assessment of the biota would require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions. However, it is expected that the existing activities have been accurately assessed and considered, based on the field observations and the consideration of existing studies and monitoring data in terms of aquatic, riparian and wetland ecology.

1.3 Structure of this Report

This report forms part of a suite of reports produced for the purposes of providing freshwater and aquatic ecological investigation of the study area as provided by the proponent. This report specifically deals with the freshwater and aquatic ecological components of the study. The following structure is applicable to this report:

Section 1: Introduction

Provides an introduction, purpose of the study, and assumptions and limitations.

Section 2: Key legislative frameworks and lender requirements

Provides key legislative requirements including national legislative frameworks and the general approach to the ESIA considering both nationally and relevant international standards.

Section 3: Assessment Approach

Provides scope of work, summaries of the relevant methodology and definitions applicable to this report, a description of the sensitivity mapping and the risk assessment approach.

Section 4: Project activities posing potential impacts

Provides description of the project aspects that are likely to result in impacts on freshwater ecosystems within the development footprint.

Section 5: Results of the background assessment and baseline results from the field investigation

This section reports the following:

a) A background study of relevant international and national datasets (such as the Freshwater Ecoregions of the World and the World Database on Protected Areas); and

b) A description and delineation of all freshwater ecosystems associated with the proposed powerline project according to the Department of Water Affairs and Forestry (DWAF)[2] (2008) "A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". All features are mapped according to their ecological sensitivity;

- The classification of the freshwater ecosystems according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- A high-level discussion of the Ecostatus of the freshwater ecosystems, encompassing aspects such as impacts on the hydraulic regimes, geomorphological processes, water quality and habitat and biota of the freshwater ecosystems; and
- A high-level summary of the goods and services provision of the freshwater ecosystems to the surrounding communities.

Section 6: Identification of key issues

Provides a brief description of potential impacts (direct, indirect and cumulative) for the construction, operation and decommissioning phases of the project.

Section 7: Permit requirements/ as well as regulated areas for development in terms of guidelines or protocols under national or international legislation

Provides information on any licenses required under Angolan Legislation, as well as applicable guidelines or protocols under national or international legislation.

Section 8: Impact Statement and Proposed Management Measures

Provides a brief impact statement of the anticipated impacts associated with the proposed project, and guidelines for managing such impacts. The impact assessment provided by the EAP (SRK) is used to quantitatively assess potential impacts on freshwater ecosystems. In addition, the IFC Good Practice Handbook on Cumulative Impact Assessments (2013) is used as a high-level guide to determine cumulative impacts.

Section 9: Recommendations for Environmental and Social Management Plan (ESMP)

[2] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

Provides monitoring recommendations for each of the management actions presented in assessment of impacts.

Section 10: Conclusion and impact statement

Summarises key impact assessment findings and recommendations based on the risk assessment outcomes. In addition, this provides an impact statement based on freshwater specialist findings.

2 KEY LEGISLATIVE REQUIREMENTS, NATIONAL AND INTERNATIONAL GUIDELINES

The following legislation was taken into consideration during the assessment. The following section has been compiled from the online data resources and previous studies conducted in Angola:

- The Constitution of the Republic of Angola (2010);
- The General Environmental Law No. 5/98;
- Decree No.117/20 on General Regulation for Environmental Impact Assessment and Environmental Licensing Procedure;
- Water Law No. 6/02;
- Presidential Decree No. 26/20 (National Biodiversity Strategy and Action Plan 2019-2025);
- Presidential Decree No. 194/11 on Liability on Environmental Damage;
- Presidential Decree No. 261/11 on Water Quality;
- Presidential Decree No. 190/12 on Waste Management;
- Presidential Decree No. 82/14, approves the Regulation on the General Use of Water Resources,

The following subsection focuses on the Good International Industry Practice (GIIP) standards:

- International Finance Corporation (IFC) Environmental Health and Safety Guidelines and Performance Standards (2007).
    - **Performance Standard 1**: Assessment and Management of Environmental and Social Risks and Impacts - Underscores the importance of managing environmental and social performance throughout the life of a project.
    - **Performance Standard 3**: Resource Efficiency and Pollution Prevention - Recognizes that increased economic activity and urbanization 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.
    - **Performance Standard 4**: Community Health, Safety, and Security - Recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts.
    - **Performance Standard 5**: Land Acquisition and Involuntary Resettlement - Recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land.

- **Performance Standard 6**: Biodiversity Conservation and Sustainable Management of Living Natural Resources - Recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.

- Equator Principles (The Equator Principles Association, 2011):
  - The Equator Principles aim to ensure that all companies that apply to the Equator Principles Financial Institution (EPFI) for capital are utilising natural resources responsibly and with focus on sustainability of their operations. The Equator Principles further aim to ensure that any development projects in foreign countries are managed to the same level as they would be in a more developed country, or the country of origin in which the development corporation is based.

3 ASSESSMENT APPROACH AND METHODOLOGY

3.1 Scope of Work

Specific outcomes in terms of this report are outlined below:

- A background study of relevant international and national datasets (such as the Freshwater Ecoregions of the World and the World Database on Protected Areas) was undertaken to aid in defining the PES and EIS of the freshwater ecosystems;
- A description and delineation of all freshwater ecosystems associated with the MR201 according to the Department of Water Affairs and Forestry (DWAF)[3] (2008) "A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". All features are mapped according to their ecological sensitivity;
- The classification of the freshwater ecosystems according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- A high-level discussion of the ecological integrity of the freshwater ecosystems, encompassing aspects such as impacts on the hydraulic regimes, geomorphological processes, water quality and habitat and biota of the freshwater ecosystem;
- A high-level summary of the goods and services provision of the watercourses to the surrounding communities;

[3] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

- The Ecoservices of the freshwater ecosystems were assessed according to "A technique for rapidly assessing ecosystem services supplied by wetlands" (Kotze *et al*., 2020);
- The SRK impact assessment methodology was applied to identify potential impacts that may affect the identified freshwater ecosystems as a result of the activities associated with the proposed powerline project and aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented going forward to assist in minimising the impact on the receiving environment.

3.2 Freshwater Ecosystem Definition

Wetlands are defined by the Ramsar Commission as "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*". As per this definition, a wetland also contains "*riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands*" (Article 2.1, Ramsar Commission). These "riparian zones of habitats" includes vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas.

Wetlands of Angola, according to the Food and Agriculture Organization of the United Nations (FAO) are divided into marine, estuarine, riverine, lacustrine, and palustrine systems. These wetlands are found in five hydrographic zones of the Zaire, Cuanza, Zambezi, Cunene, and Cubango basins. According to FAO, of the total land area of the country of 1 246 700 km^2, wetlands occupy approximately 5 750 km^2 of the land area (4.6%), however no systematic inventory of wetlands has been carried out in Angola. These wetlands occur in the form of sponges, dambos, floodplains, and various types of coastal wetlands, defined as follows:

- Swamps – these are vast, usually inundated, depressions that consist essentially of floating vegetation and wet peaty land;
- Floodplains – these are zones along major river systems that are low-lying and are seasonally flooded; and
- Dambos – these are seasonally or permanently wet grassy valleys, depressions, or seepage zones on slopes which are polygenetic in origin. They can be defined as a wide and low lying gently sloping treeless grass covered depression, which is seasonally waterlogged by seepage from surrounding high ground assisted by rainfall and has water tables for most part of the year in the upper 50-100 cm of the soil profile from which they drain into streams; and

- Valley bottoms – these are characterised by their location on valley floors and the absence of characteristic floodplain features. Dominant water inputs to these wetlands are from the river channel flowing through the wetland, either as surface flow resulting from flooding or as sub surface flow, and/or from adjacent valley-side slopes (as overland flow or interflow). In Angola, valley bottom wetlands have always supported small-scale (largely subsistence) agriculture. Flood recession agriculture on riverside fields called "Nakas" is practised (locally used term). Most of the soils found in these valley bottoms are hydromorphic.

According to RAMSAR, wetlands as defined above are areas which support vegetation, known as “riparian vegetation”, occurring within the area between the water body and the surrounding higher lying areas. These “riparian zones of habitats” include vegetation, known as “riparian vegetation”, occurring within the area between the water body and the surrounding higher lying areas. Ramsar does not provide a definition of riparian habitat, thus, since riparian habitat is sometimes associated with watercourses and is considered an integral part of a watercourse, the extent of riparian vegetation was included in the delineations presented in this report.

In order to further refine the definition of wetland and riparian habitat, the definitions as provided in neighbouring countries’ legislation were also consulted. In this regard, South Africa’s National Water Act, 1998 (Act 36 of 1998) provides a detailed definition of both wetland and riparian habitat, as follows:

Wetland means-
“Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.”

Riparian habitat includes-
“The physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas”.

For the purposes of this report, the terms “watercourse” and “drainage systems” comprise both wetlands (including swamps, sponges, floodplains, and dambos as defined above) as well as

rivers with an associated riparian zone. Where it is necessary to distinguish between such features, the specific term is utilized.

3.3 Delineation of Freshwater Ecosystems

Taking the definitions above (Section 2.2) for wetland and riparian habitat into consideration, the delineation of the various watercourses (which includes dambos/wetlands and rivers) were initially undertaken using desktop methods, making use of historical and current digital satellite imagery, and was based on identifying features displaying a diversity of digital signatures. In this regard, specific mention is made of the following:

- Vegetation associated with wetlands and riparian zones: a distinct increase in density as well as shrub size near flow paths;
- Hue: with water flow paths often showing as white/grey or black and outcrops or bare soils displaying varying chroma created by varying vegetation cover, geology and soil conditions; and
- Texture: with areas displaying various textures, created by varying vegetation cover and soil conditions.

These delineations were subsequently verified and, where necessary, refined, during the site assessment undertaken in April 2024.

3.4 Characterisation of Freshwater Ecosystems

Factors influencing the habitat integrity of the freshwater ecosystems identified during the field surveys were noted, and the functioning, ecological and socio-cultural goods and services (Ecoservices) provided by the various features was assessed. In the absence of protocols developed specifically for Angolan wetland systems, “best practice” methods developed for the African continent (such as the various wetland assessment tools developed in South Africa), were utilised and adapted where necessary to ensure the most appropriate and accurate characterisation of the resources. Whilst detailed assessments of the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and goods and services provision were not undertaken, the methods referred to above were utilised as a guideline to gauge the ecostatus of the drainage systems.

In addition to the delineation of the freshwater ecosystems, field observation of the systems was undertaken at as many points of interest as possible, to define the following important aspects of the wetland ecology:

- Wetland characterisation and classification was undertaken according to the method of Ollis *et al.,* (2013);

- The ecostatus of the freshwater ecosystems, encompassing aspects such as hydraulic connectivity and regimes, geomorphological processes, water quality, habitat and biota. In assessing the ecostatus, impacts to the aforementioned aspects are taken into consideration; and
- Provision of goods and services of the freshwater ecosystems to the surrounding communities, including ecological service provision which may not necessarily be of direct benefit to humans but is crucial to the ongoing ecological functioning of the environment as a whole.

3.5 Sensitivity Mapping

All freshwater ecosystems associated with the proposed powerline were delineated using desk based methods, the delineations were ground-truthed in the field at certain pre-selected points, where possible, with the use of a Global Positioning System (GPS). Geographic Information System (GIS) software was used to project these features onto digital satellite imagery and topographic maps. Where necessary ground truthing of digital satellite imagery was used to refine the delineations developed using desk-based methods.

The sensitivity (setback) maps in Section 7 should be used to guide the design and layout of the proposed powerline project, particularly the placement of laydown areas, powerline towers and any access roads to construction sites. Due to the extent and complex hydraulic connectivity of these drainage systems, the extent of the study area, and nature of the terrain preventing access to much of the study area, it was not feasible to access nor assess each system individually. Therefore, extrapolation of the extent of the features was undertaken by comparing data verified *in-situ* to high resolution digital satellite imagery to map features across the study area. Despite this, the observations made are deemed sufficient to ensure that informed decision making can be undertaken.

3.6 Impact Assessment and Recommendations

Following the completion of the assessment, an impact assessment as provided by the EAP was applied (please refer to Appendix D for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed powerline project. These recommendations also include general ‘best practice’ management measures, which apply to proposed powerline project as a whole, and which are presented in Appendix F. Mitigation measures have been developed to address issues in all phases throughout the life of the proposed powerline project including construction, operation and rehabilitation. The detailed site-specific mitigation measures are outlined in Section 6 of this report.

3.7 Assessment of Ecosystem Services

Ecosystem services are defined as the benefits that people derive from ecosystems. These services are crucial for maintaining the well-being of humans and the health of the environment. They encompass a wide range of processes and functions that ecosystems provide, which can be broadly categorized into provisioning, regulating, supporting, and cultural services.

Regarding Type I and Type II ecosystem services, the IFC categorizes them as follows:

- **Type I Ecosystem Services**: These are direct benefits derived from ecosystems that can be quantified and often have direct economic value. Examples include provisioning services like food, water, and raw materials, which can be directly measured and sold in markets; and
- **Type II Ecosystem Services:** These are more indirect benefits that ecosystems provide, which might not have a straightforward economic value or may not be directly measurable. They include regulating services such as climate regulation, water purification, and pollination, as well as supporting services like soil formation and nutrient cycling. While these services are essential for maintaining ecosystem health and functionality, their economic value can be more complex to quantify and often requires broader valuation methods.

4 PROPOSED ACTIVITIES POSING POTENTIAL IMPACTS TO FRESHWATER ECOSYSTEMS

The below table presents activities associated with the proposed powerline project that will potentially pose impacts to the freshwater ecosystems within the development footprint during the construction and operation phases of the project. In addition to the activities, the following considerations were made:

- The activities relating to the proposed powerline project are all highly site specific, although activities such as clearing of vegetation along the powerline corridor route may result in a cumulative impacts;
- While the operation of the powerline and associated infrastructure will be a permanent activity, the construction thereof is envisioned to take approximately two (2) years to complete; and
- It is highly recommended that the proponent make provision for small-scale rehabilitation of the areas of the freshwater ecosystems which may be directly impacted upon by construction activities. The area must preferably be rehabilitated to

conditions as close as possible to the “preconstruction” state, and where feasible, these rehabilitation efforts must seek to improve site conditions.

Table 1: List of activities associated with the proposed powerline project.

Proposed Activity	Activity Description
Construction Phase	
Site preparation prior to construction activities including clearing of vegetation within the development footprint.	The site preparation will take place prior to any construction activities associated with the project. This phase generally includes planning for infrastructure, access and site camps layouts. In addition, site preparation includes clearing vegetation for servitudes and substation platforms, access paths construction and the establishment of temporary construction camps and laydown areas for materials and equipment.
Groundbreaking activities for construction of the support structures and spanning of the proposed powerline.	This phase includes earthworks such as digging the ground/excavating for the construction of structural foundations, particularly for powerline support structures including levelling the site to the required elevation. Spanning/stringing of the powerline involves hanging conductors (wires) between transmission towers or utility poles to create an electrical pathway for transmitting power.
Construction activities associated with the erection of new substations	This activity includes earthworks and excavations associated with the construction of new substations for power distribution and the construction of foundations including construction for management of stormwater infrastructure within the footprint of the substation.
Transportation of infrastructure and storage of equipment.	This activity generally involves the movement of vehicles and personnel throughout the construction areas associated with the powerline project. In addition, it includes the stockpiling of powerline/substation material within the development footprint.
Operation Phase	
Operation and maintenance of the powerline infrastructure including substations and access route.	This activity includes the operation and maintenance of the powerline infrastructure including powerline servitude. Other general activities include management of vegetation within the servitude during routine maintenance or during operational failure.
Rehabilitation within disturbance areas associated with the proposed powerline.	This activity includes the rehabilitation of areas that were disturbed during the construction phase of the powerline and associated infrastructure. This includes levelling, revegetation of cleared areas and removal of any rubble within construction footprint following construction activities.

5 FRESHWATER ECOSYSTEM ASSESSMENT

5.1 Results: Freshwater Desktop Analysis

The following section contains data accessed as part of the desktop assessment. It is important to note that although all data sources used provide useful and often verifiable high-quality data, the various databases do not always provide an entirely accurate indication of the site specific biodiversity characteristics.

5.1.1 World Database on protected areas

According to the World Database on Protected Areas (UNEP-WCMC, 2024), the proposed powerline and investigation area are not associated with a protected area.

5.1.2 Aquatic Ecoregion

According to the WWF FEOW (Freshwater Ecoregions of the World, http://www.feow.org/ecoregions/) classification, the entire extent of the proposed powerline and associated investigation area is located within the Zambezian Headwaters Ecoregion (reference number 555).

5.1.3 Zambezian Headwaters

The major Upper Zambezi tributaries in the ecoregion are the Lungwebungu, the Luanginga, the Cuando, the Luena, the Dongwe, and the Kabompo Rivers (Bell-Cross 1972). The major tributary of the Kafue is the Lunga River. The Okavango tributaries: the Cubango and the Cuito, arise on the plateau of central Angola, and the Cunene River (1200 km long) arises in west-central Angola. The Cunene's flow is disrupted by a series of rapids and by the 122 m high Ruacana Falls, located at the divide between the rim of the continental plateau and the Atlantic coastal slope (Roberts, 1975).

5.1.4 Boundaries

The fast-flowing Zambezian headwater streams contribute to two major sub-Saharan rivers: the Zambezi and the Okavango. The ecoregion extends from the Okavango catchment in the west to the headwaters of the Kafue River in the east and includes the headwaters of the Upper Zambezi River. The majority of the rivers drain the interior of Angola, but parts of the upper Zambezi and the upper Kafue flow through northern Zambia. The headwaters of the Zambezi share a common watershed divide with the Congo River Basin to the northeast, and with the headwaters of the Cuanza and other westward draining rivers of Angola to the northwest.

5.1.5 Freshwater Habitats

The rivers of this ecoregion are permanent and characterized by steep gradients in places. However, these rivers are unlike many mountain headwaters in that high gradient zones are discontinuous (Allanson *et al.,* 1990).

5.1.6 Endangered and vulnerable fish species

The tables below list fish species are considered at risk of becoming extinct in the absence of conservation efforts and species considered vulnerable (Ministry of the Environment, 2018). Although the database lists a number of other fish species considered vulnerable or at risk of extinction, these fish species were mostly marine rather than freshwater species.

Table A: List of species that are considered vulnerable.

Species	Common name	Family	Status	Habitat
Ethmalosa fimbriata	*Bonga Shad*	Dorosomatidae	VU	Marine, brackish
Arnoglossus capensis	Cape Scaldfish	Bothidae	VU	Marine

Neither of these species are relevant to the proposed development due to geographical distributions that do not coincide with the study area and habitat limitations.

Additional species according to International Union for Conservation of Nature (2024) include *Threespot tilapia* (VU) and *Oreochromis macrochir* (VU). According to the database, the *Oreochromis macrochir* species occurs in the upper Zambezi, as well as the Kafue, Okavango and Cunene Rivers. Occasionally also recorded from the Middle Zambezi. The *Threespot tilapia mainly occurs* in the Upper Zambezi, Okavango and Kafue Rivers, as well as the upper Kasai, Lake Bangweulu and the Chambeshi River. It has also been collected from the Revue River in Mozambique (Buzi system), far to the east of its natural distribution and it is possible that this is a relict population.

These two species, based on habitat availability and distribution ranges, may be located within the study area. It is important that all mitigation measures as stated in this report are implemented in order to mitigate potential impacts.

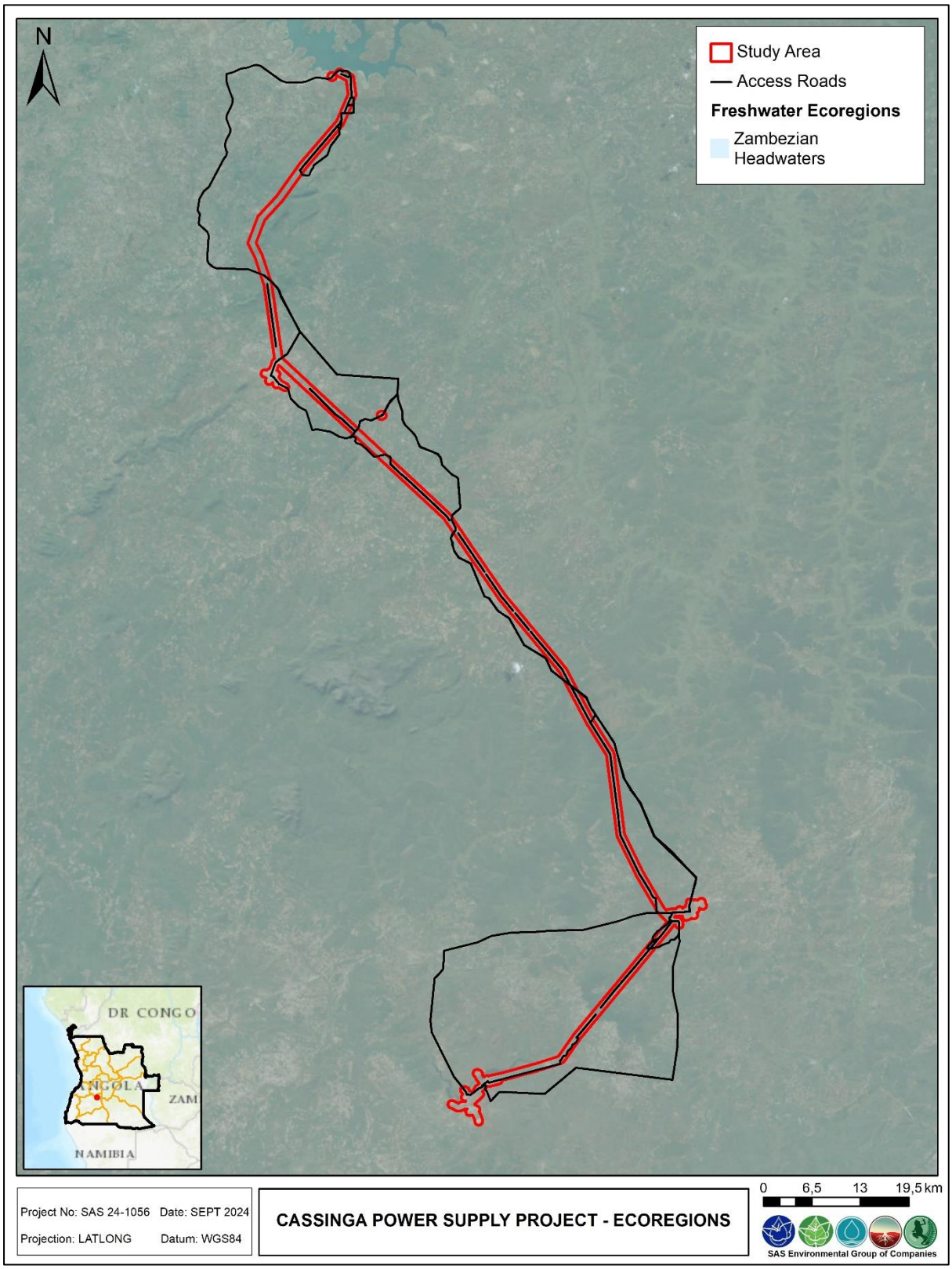


Figure 5: Aquatic Ecoregion associated with the proposed powerline investigation area (INHR, 2016).

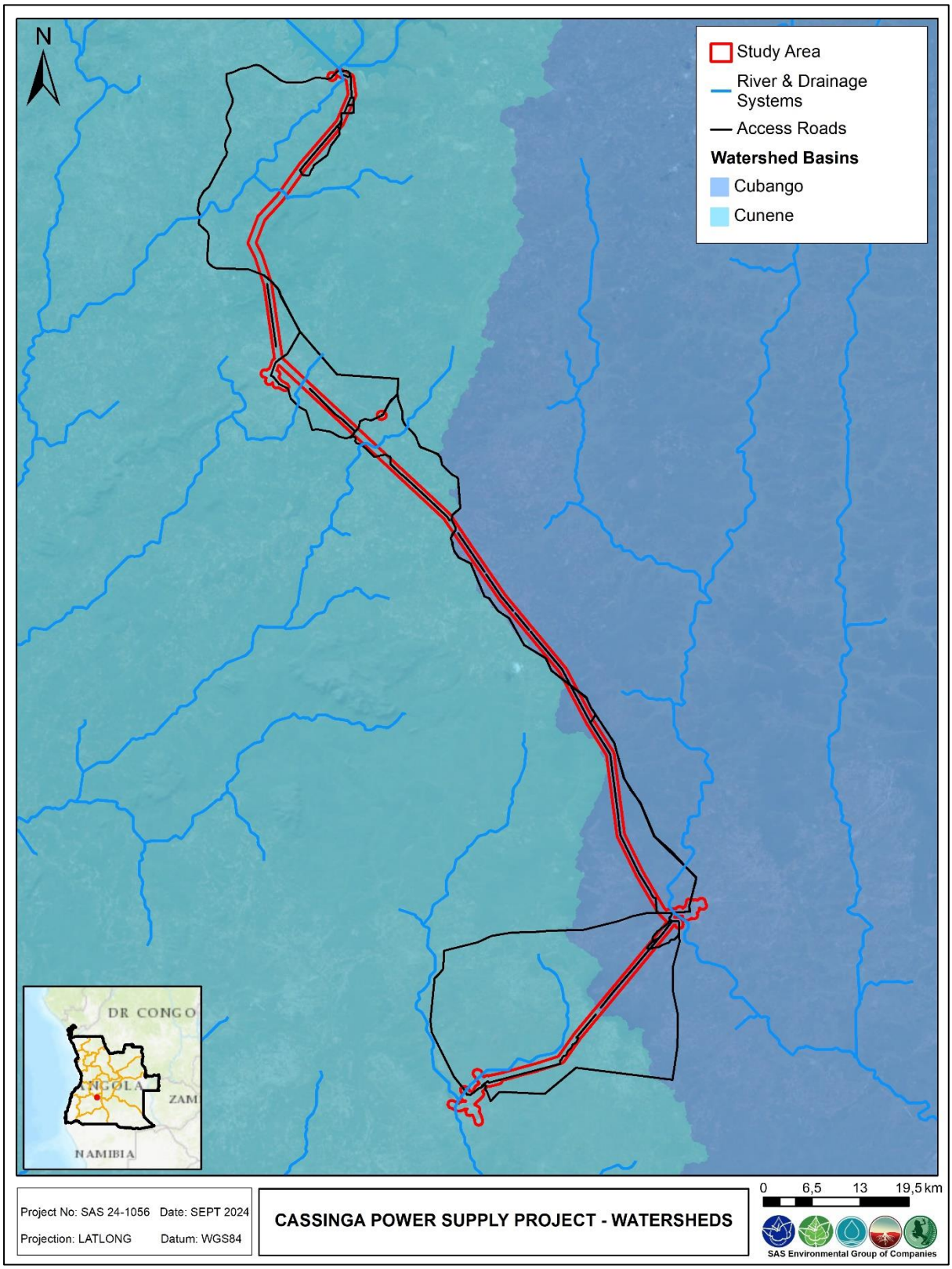


Figure 6: Basins, rivers and drainage systems associated with the proposed powerline and investigation areas

5.2 Results: Freshwater Ecosystem Assessment

5.2.1 Delineation of freshwater ecosystems

Figures 8 to 13 below depict the position of the various wetland systems within the study area based on the combination of delineation methods employed i.e. digital satellite imagery and field verification. During the field assessment, the following indicators were used to delineate the boundaries of the watercourses:

- Terrain units were used as the primary indicator, as the terrain of the study area has well-defined low-lying areas where water is likely to collect and/or move through the landscape;
- Soil morphological characteristics (Figure 7) typically associated with wetland conditions, such as gleying or mottling were used to determine the presence of soils that are associated with prolonged and frequent saturation, as well as variation in the depth of the saturated soil zone within 50 cm of the soil surface. This indicator was used to identify gleyed soils where the soil is a greyish/greenish/bluish colour due to the leaching out of iron;

Figure 7: Representative photographs of soil samples within dambo wetland systems, illustrating typical soil morphological characteristics including mottling (right) and gleying (left) associated with a fluctuating water table.

- Vegetation was utilised in conjunction with terrain as the secondary indicator, where feasible. Due to the transformation in some areas, particularly around the cultivated/historically cultivated areas, the vegetation indicator was not always reliable. Despite this, in some of the dambo systems, various sedge species, orchids, and graminoid species adapted to moist conditions were identified.

5.2.2 Freshwater ecosystem definition and characterisation

In preparation for the field assessment, aerial photographs, digital satellite imagery and available wetland databases were used to identify areas of interest at a desktop level. All possible measures were undertaken to ensure all freshwater ecosystems which may be affected by the proposed powerline were identified, delineated and assessed. During the site assessment conducted over five days April 2024, numerous extensive drainage systems were identified within the study area, many of which are interlinked and extend far beyond the boundaries of the study area.

The identified freshwater ecosystems were classified using the guidelines provided by Ollis *et al*., (2013) (please refer to Appendix A) but taking into consideration the descriptions of wetlands commonly used in Angola as outlined in Section 3.1 of this report. At a high level, these watercourses were classified as Inland Systems falling within the Zambezian Headwaters Aquatic Ecoregions. The identified drainage systems comprised four primary hydrogeomorphic (HGM) types: rivers with associated riparian vegetation and in some cases with associated floodplains, valley bottom wetlands (both channelled and unchannelled), and what are referred to locally (in Angola) as 'dambos' – the latter being characterised by relatively even topography and situated in low-lying areas.

Table 2: Summary of the Classification system for the various freshwater ecosystems identified within the study area (*Ollis, 2013)*.

Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit
Ecoregion: The study area falls within the Zambezian Headwater Aquatic Ecoregion	**Valley floor:** The typically gently sloping, lowest surface of a valley	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
		Floodplain wetland: the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
		Channelled Valley Bottom: a valley-bottom wetland with a river channel running through it. **Unchannelled Valley Bottom:** a valley-bottom wetland without a river channel running through it.
	Plain: an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land	**Dambo –** seasonally or permanently wet grassy valleys, depressions, or seepage zones on slopes which are polygenetic in origin. They can be defined as a wide and low lying gently sloping treeless grass covered depression, which is seasonally waterlogged by seepage from surrounding high ground assisted by rainfall and has water tables for most part of the year in the upper 50-100 cm of the soil profile from which they drain into streams.

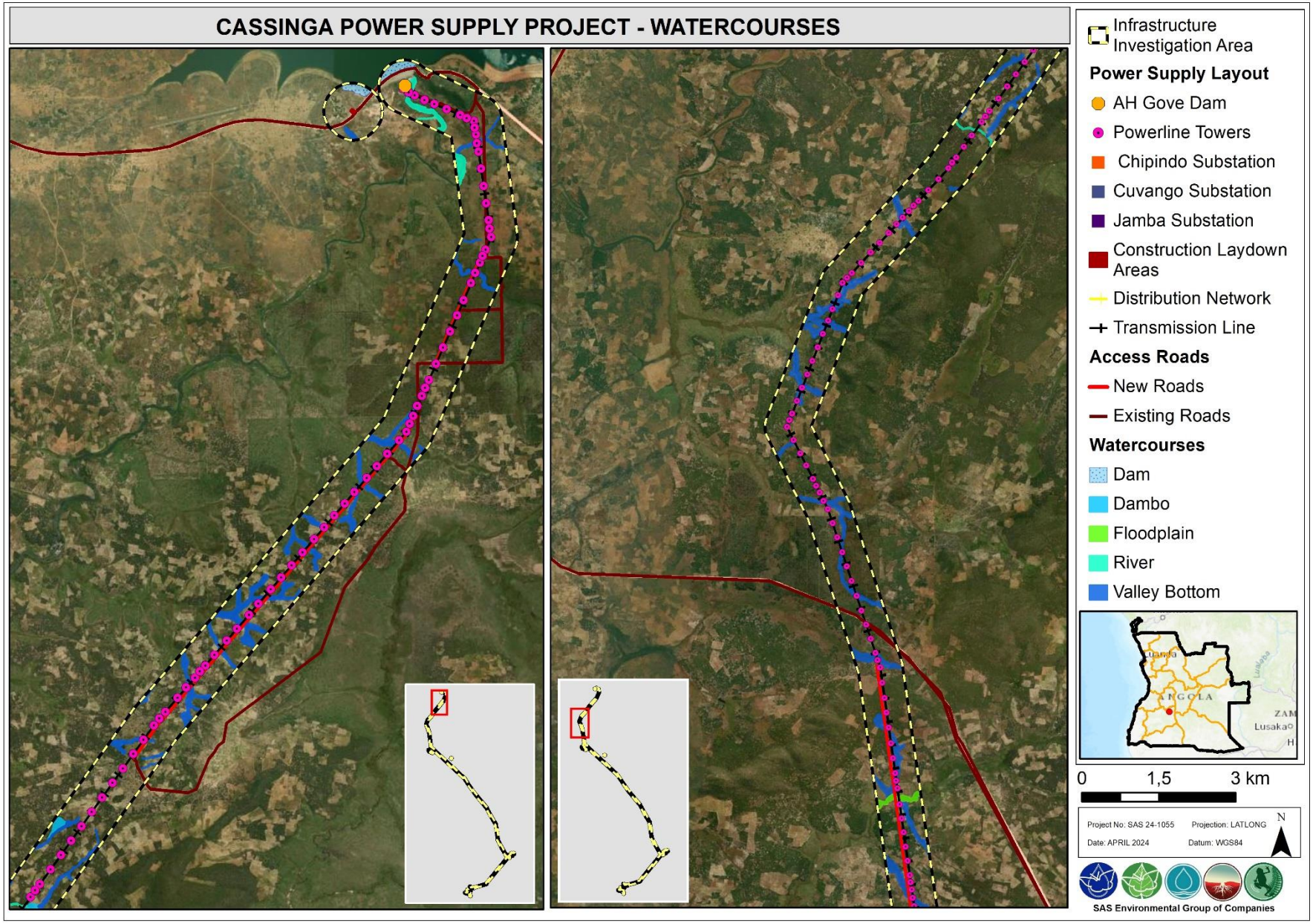


Figure 8: The location of the delineated freshwater ecosystems (northern) associated with the proposed powerline project.

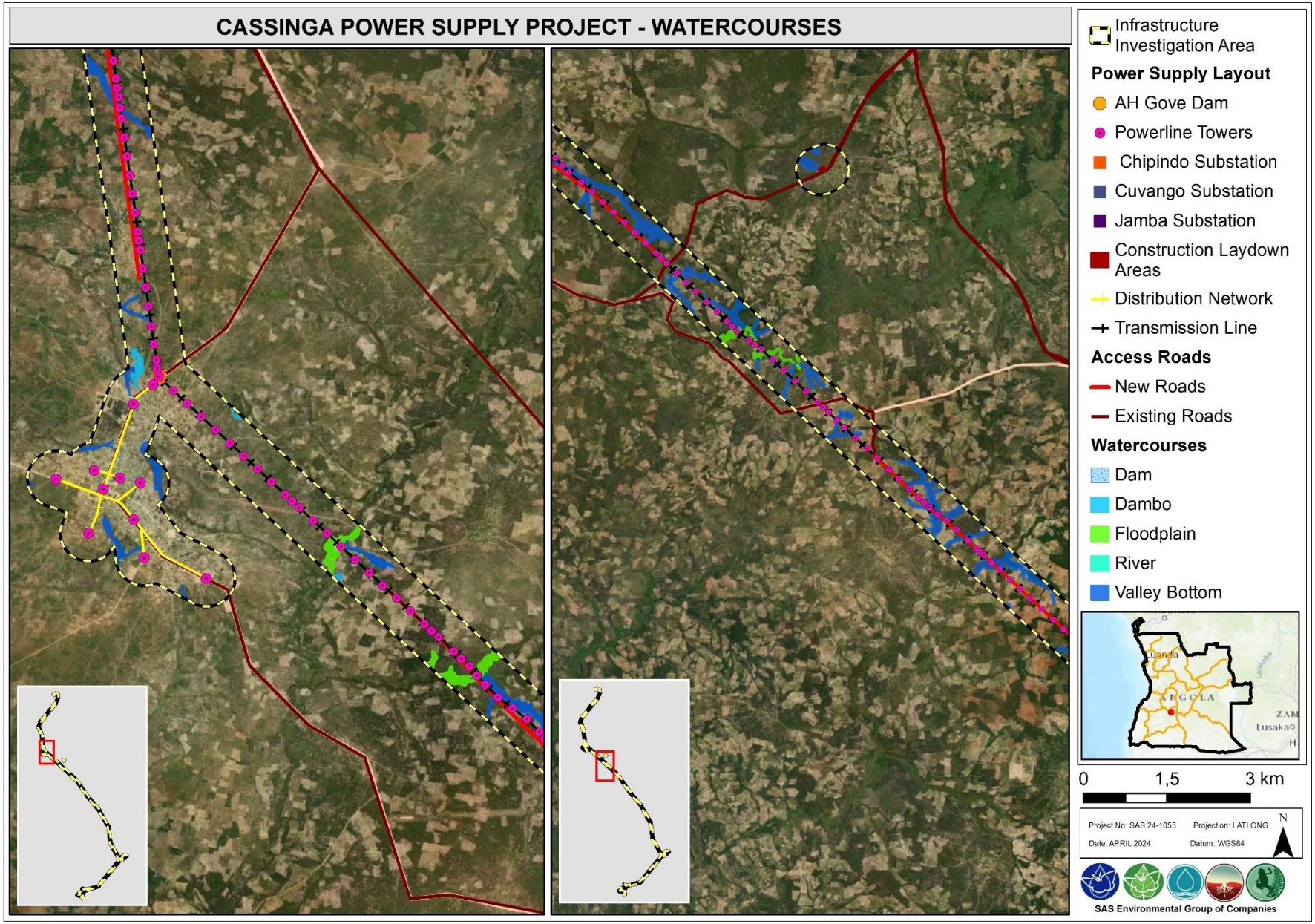


Figure 9: The location of the delineated freshwater ecosystems (northern to central) associated with the proposed powerline project.

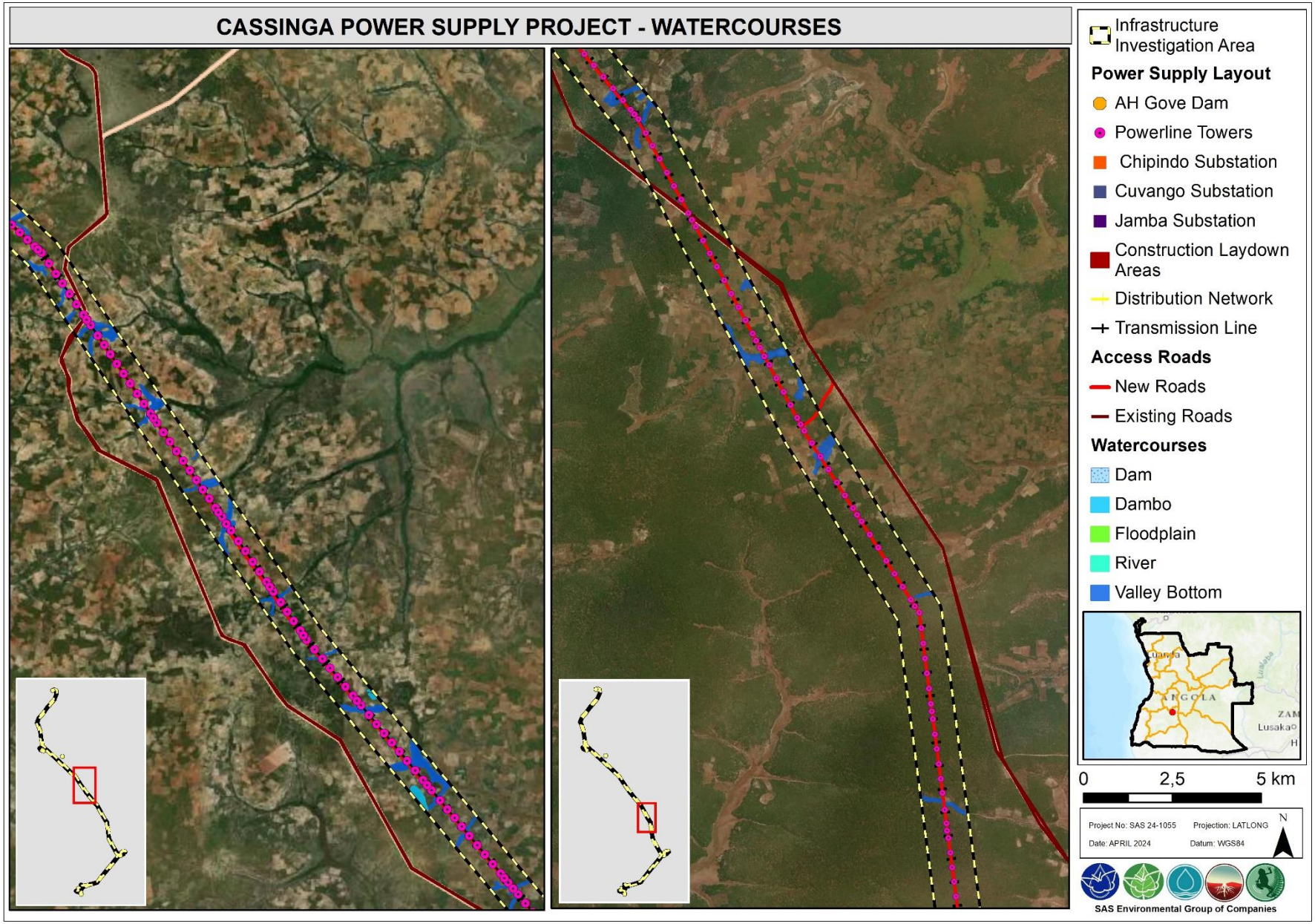


Figure 10: The location of the delineated freshwater ecosystems (central to southern) associated with the proposed powerline project.

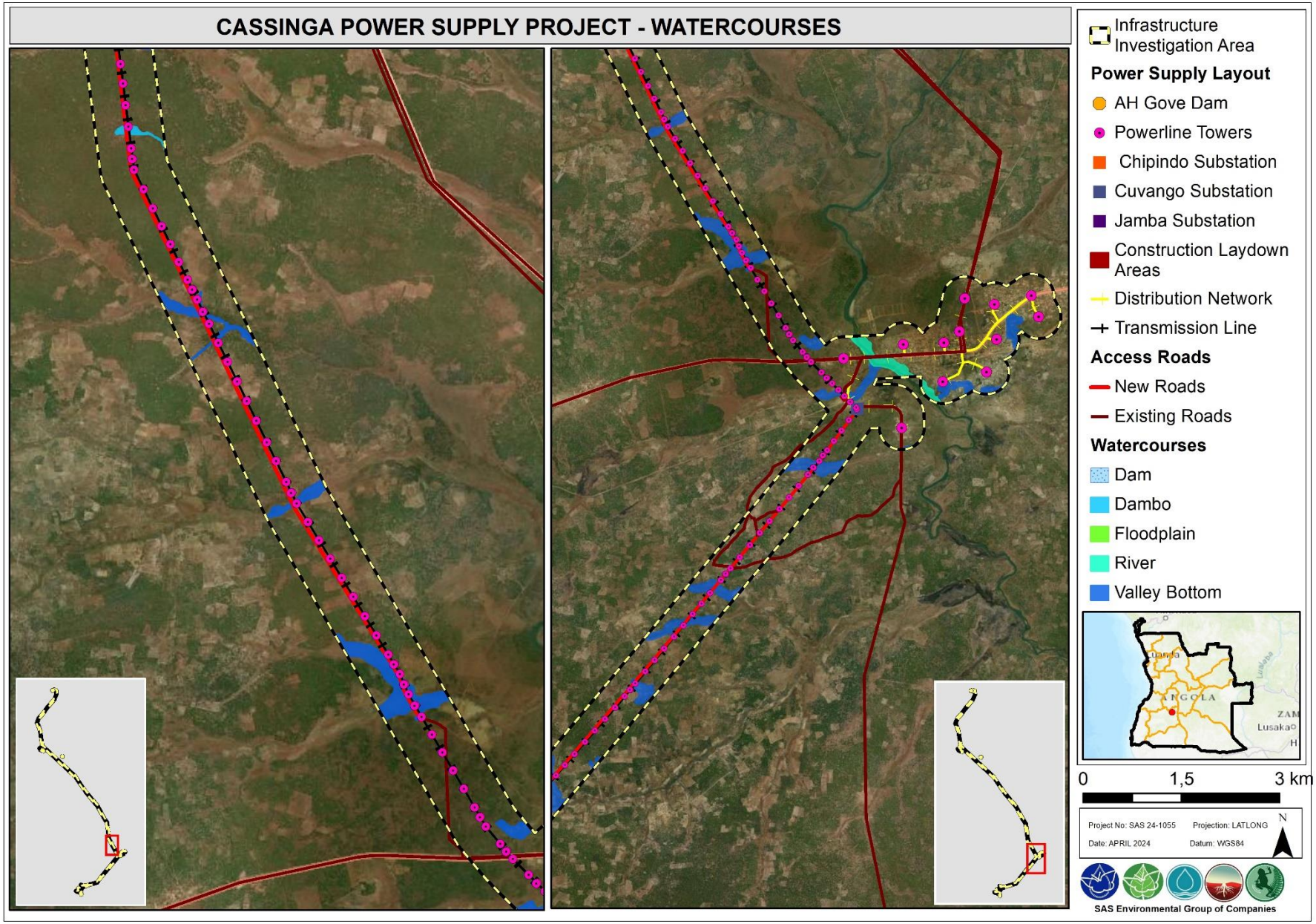


Figure 11: The location of the delineated freshwater ecosystems (southern) associated with the proposed powerline project.

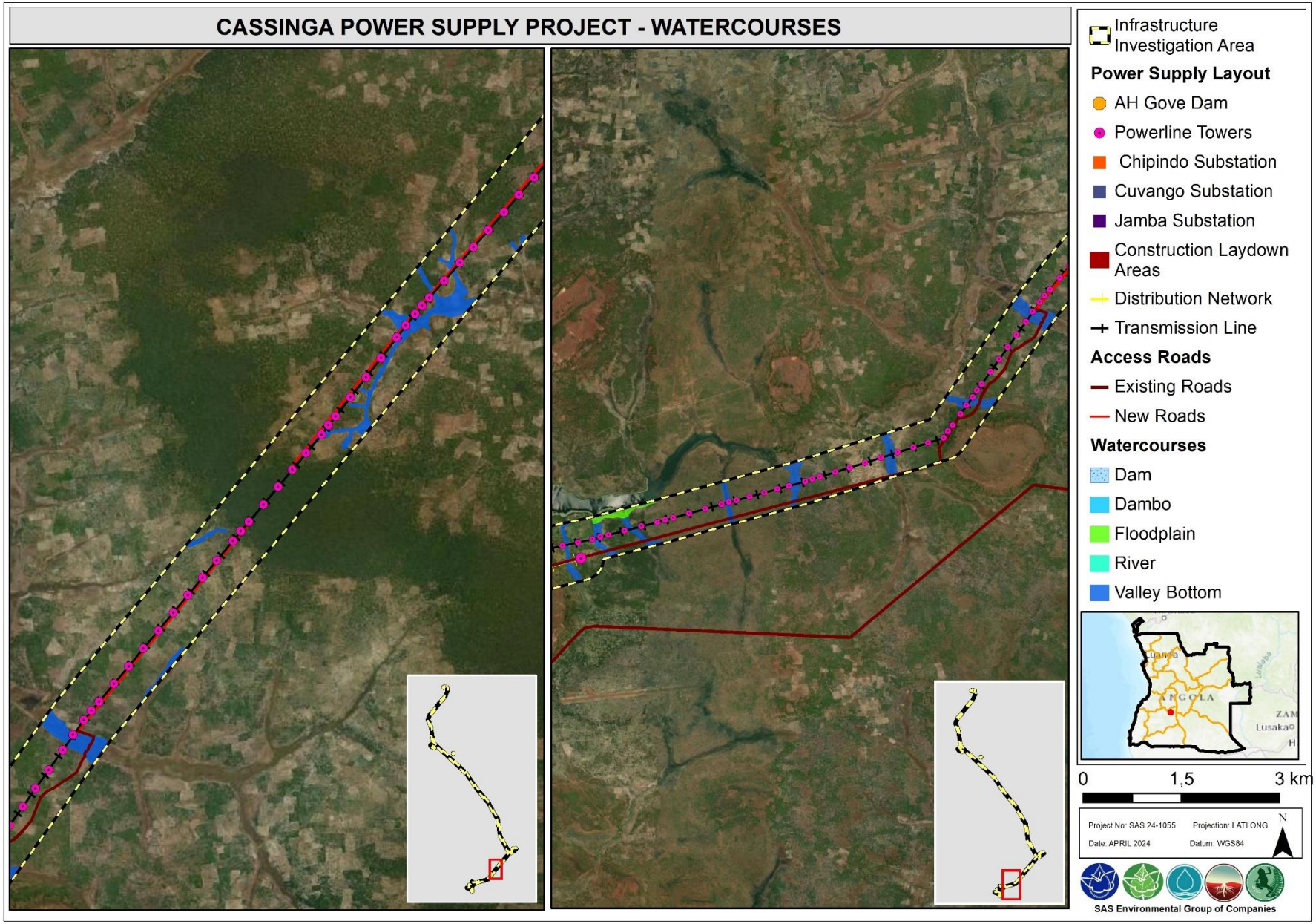


Figure 12: The location of the delineated freshwater ecosystems (southern) associated with the proposed powerline project.

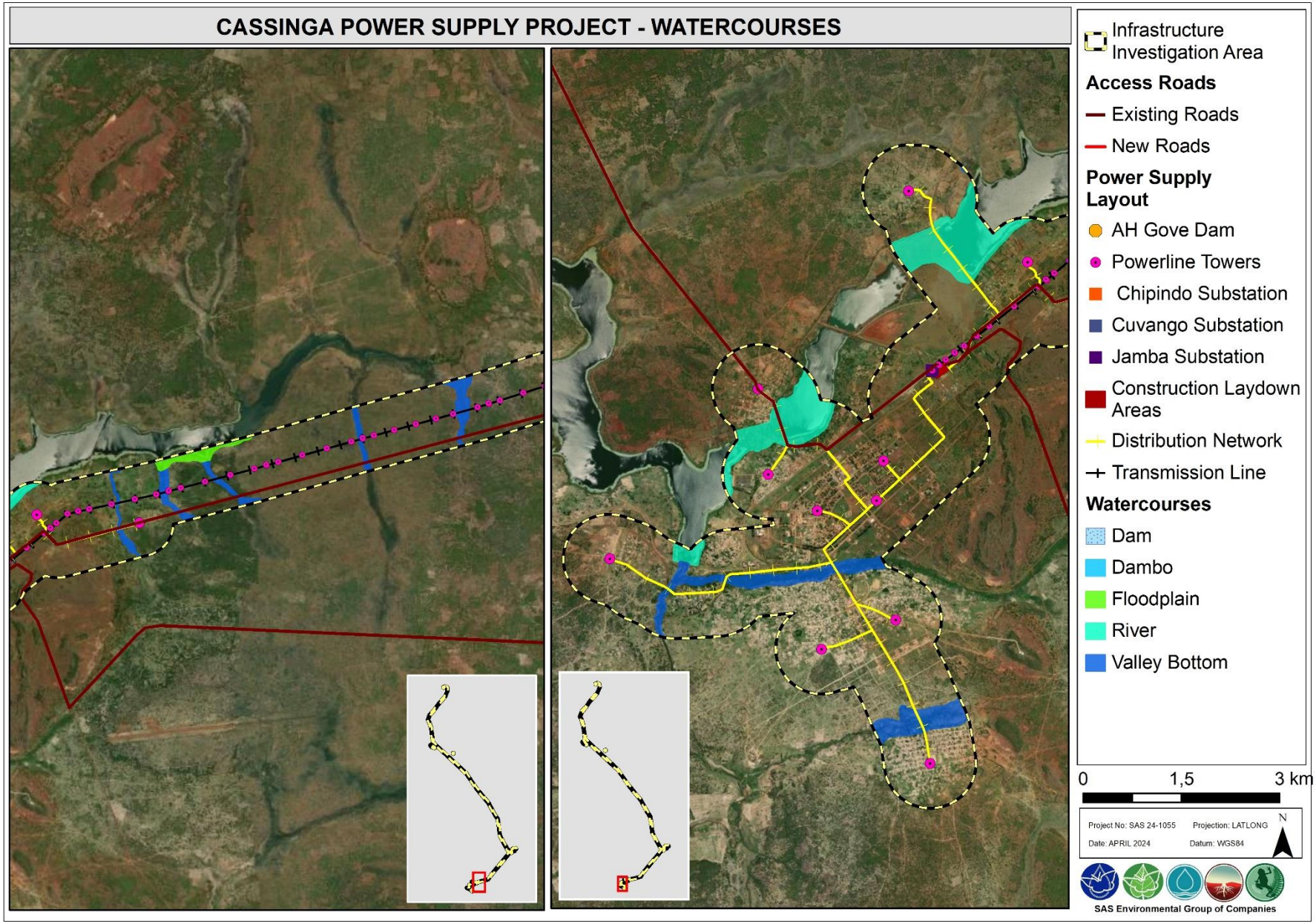


Figure 13: The location of the delineated freshwater ecosystems (southern) associated with the proposed powerline project.

5.2.3 Freshwater Ecosystem Analysis and Discussion

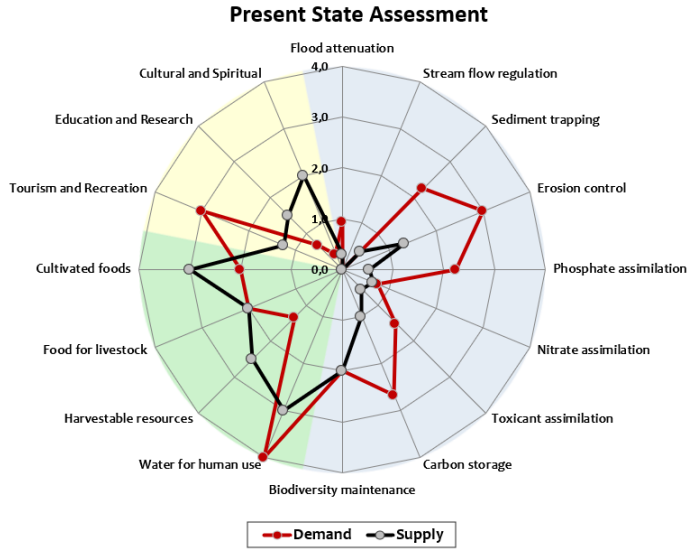
Whilst there were distinct differences between the different HGM types (e.g. between the rivers with associated riparian zones and rivers with an associated floodplain), it was noted during the site assessment that conditions were largely homogenous within each group of the various drainage systems. Therefore, having been subjected to similar anthropogenic impacts (cultivation, cattle trampling and instream crossings), the ecoservice provision, hydrological regime, geomorphological characteristics, water quality and habitat of these systems were assessed in a combined fashion.

For the purposes of this report, the freshwater ecosystems were discussed in terms of system type (e.g. river, channelled valley bottom, dambo), key characteristics, ecostatus including ecological integrity, sensitivity and importance, and in terms of goods and services provision. The latter is considered of particular importance in the context of the rural setting of the study area.

The dashboard style reports below summarise the findings of the field verification in terms of relevant aspects (hydrology, geomorphology and vegetation components) of wetland and riparian ecology. These dashboard reports aim to present all the pertinent facts pertaining to each system in as concise and visually appealing a manner as possible and in as limited a space as possible and preferably on one page.

Table 3: Summary of the assessment of the rivers identified during the field assessment. The rivers include the Cunene River (associated with Gove dam), Cubango River (located in Cuvango) and Cuandeja River (located in Jamba) associated with the proposed powerline project.

Photograph notes: Representative photographs of the, A - Cunene River (associated with Gove dam), B - Cubango River (located in Cuvango) and C - Cuandeja River (located in Jamba). These are the larger river systems within the investigation area and the floodplains and valley bottom systems identified form tributaries or headwaters of these larger river systems. Due to the homogeneity of these river and similarities in terms of ecological service provision, they are discussed in a combined fashion and referred to as "riverine systems".



Watercourse characteristics relating to (PES and EIS) discussions:

- **Hydraulic regime**

The hydraulic regime of the assessed riverine systems has been altered by various road crossings which have in some reaches channelised the flow, presence of impoundments such as the Gove dam and Cuandeja Dam which alter the natural delivery of flows and sediments to downstream reaches of the system, although these impacts are not considered significant given the volumes flowing downstream of the infrastructure.

- **Geomorphology and sediment balance**

Some evidence of moderate incision were observed along the assessed reaches at the time of the assessment. This was particularly along areas where vegetation clearing had taken place along crossing points and along areas that are utilised by communities for access into wood harvesting area. In addition, the presence of instream river crossings (including low-level bridges and low-level causeways) and impoundments has also resulted in reduction in the delivery of sediment to downstream reaches due to reduction in the stream velocity along these crossings which reduces the rivers' ability to carry sediment.

- **Water quality**

In situ water quality parameters were measured during the low flow period.

<table>
<tr><td>Goods and Services Provision</td><td>The riverine systems are of high importance in the different areas they flow through for direct ecological services to communities as a source for water for consumption, watering of cattle, recreational activities and for fishing. During the assessment local communities were observed fishing in the rivers and also observed to be making use of the river as a source for bathing as well as washing clothes.</td><td colspan="2">pH: 6.53
Oxygen content: 7.68 mg/ℓ
Oxygen saturation: 93.6%
Temperature: 17.07° C
Electroconductivity: 5.8 mS/m
Total dissolved solids: 29 ppm

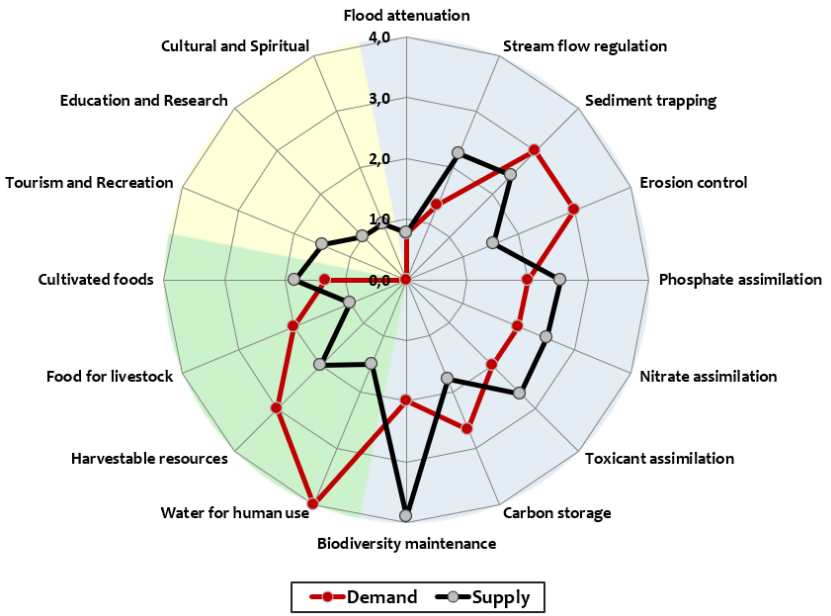
None of these values would pose a limitation to supporting aquatic biota.

➢ Habitat and biota
The rivers provide suitable habitat breeding habitat as well a good migratory corridor for fish and other aquatic biota. Furthermore, they are also important for biodiversity maintenance for avifaunal species. As noted in the PES discussion, vegetation clearing has occurred in some areas, but where clearing has not occurred, the floral species composition and structure remains largely natural. This feature remained unchanged during the low flow survey.</td></tr>
<tr><td>Ecostatus discussion</td><td>Although not formally assessed, the riverine systems are considered to be of moderate to high ecological integrity. Clearing of vegetation has occurred in some accommodate crop cultivation, although this is not at a significant scale. The remaining vegetation comprised indigenous woody species representative of the vegetation throughout the study area and greater surrounds. The impoundments including crossings noted above will have had an impact on the hydraulic regime of the system. Measured water qualities at different reaches measured significantly low electrical conductivity indicated limited impacts in terms of dissolved salts.</td><td>Extent of modification anticipated</td><td>The extent of modification of the riverine systems due to the development of the powerline and associated infrastructure is considered low given the limited extent of the footprint of the pylons and substations. This means that clearing of vegetation will be localised, minimising the potential significant impacts from incision and soil erosion. In addition, it must be ensured that the powerline pylons avoid direct encroachment on the delineated freshwater ecosystem. This is critical for maintenance of ecological functionality as well the longevity of the proposed infrastructure. Additional impacts are anticipated as a result of the clearing of vegetation along the powerline servitude.</td></tr>
<tr><td colspan="4">Consideration of Integrated Environmental Management and Sustainable Development principles:</td></tr>
<tr><td colspan="4">It is recommended that general ‘best practice’ mitigation measures to avoid direct impacts including edge effects be implemented throughout the construction and operation phases of the project. Overall, given that the project has the potential to limit direct impacts on the rivers and that the project is considered essential for human livelihoods including socio-economic development and more broadly, for sustainable development. Therefore, it is the opinion of the specialist that the project be considered in a positively for authorisation.</td></tr>
</table>

Table 4: Summary of the assessment of the valley bottom systems associated with the proposed powerline project.

Photograph notes: Various channelled and unchannelled valley bottom wetland systems noted during the site assessment. Significant rainfall was received during the week of the field work resulting in standing ponds observed at the time.

Photograph notes: Various channelled and unchannelled valley bottom wetland systems noted during the dry season site assessment. The surface water ecosystems, especially the valley bottom wetland units are strongly seasonal.



Goods and Services Provision	The valley bottom systems are considered to provide important ecological services to the rural communities within the assessed areas. Where surface flows were present, local communities were seen utilising the systems for collection of water for drinking, washing of clothes and these were also used extensively as a source of water for cattle. In addition, the valley bottom wetland systems were utilised for subsistence farming. These systems are also considered important for maintenance of biodiversity and habitat provision, and also for the recharge of larger riverine systems. Thus, retention of habitat and hydraulic connectivity is critically important.

Watercourse characteristics relating to ecostatus discussion:

a) Hydraulic regime

Few informal road crossings impeding flow and resulting in the accumulation of snagged debris (e.g. branches, grass stalks etc.) within the valley bottom system are considered the modifier of the ecological integrity of these systems. Despite the observed woody vegetation that has encroached some portions of these systems, impacts from water reductions were considered low. Similarly, there were limited water reduction activities observed within the assessed reaches, and therefore the hydraulic regime is deemed to be in a largely natural state.

b) Geomorphology and sediment balance

The sediment balance within the valley bottom systems has been impacted by presence of informal road crossings that impede flows and result in sediment deposition upgradient of the crossing point. Over time, this has the potential to result in changes in the vegetation community as the sediment layer creates conditions conducive for the establishment of species that are favour growth in sedimented environments. In addition, disturbance associated with agricultural activities and vegetation removal have also contributed to increased sediment inputs and altered distribution of sediment within the wetland.

c) Water quality

Water quality parameters, where measured, indicated that aside from turbidity observed within some of the valley bottom systems, water quality is relatively unimpaired. This is as anticipated due to the remote geographic setting and the fact that the rivers are more regularly utilised for domestic purposes. Increased nutrients are expected due to increased faecal matter from domestic livestock. Water quality parameters were measured during the high flow survey as follows:
EC – 12.5 mS/m; pH – 7.44 and temperature – 22.1˚C; based on this single assessment, this indicated no limitations for supporting aquatic biota in terms of the measured *in-situ* parameters.

Low flow survey results:
EC: 3.8 mS/m
TDS: 19 ppm
pH: 6.77
Temperature: 12.84° C
Oxygen content: 7.78 mg/ℓ
Oxygen saturation: 88.4%

The measured in situ water quality from the low flow survey indicate that the surface waters remain low in dissolved salts (salinity levels), indicating good water quality. The remaining parameters fall within guideline water quality ranges and are therefore not a limiting factor to supporting aquatic/wetland biota.

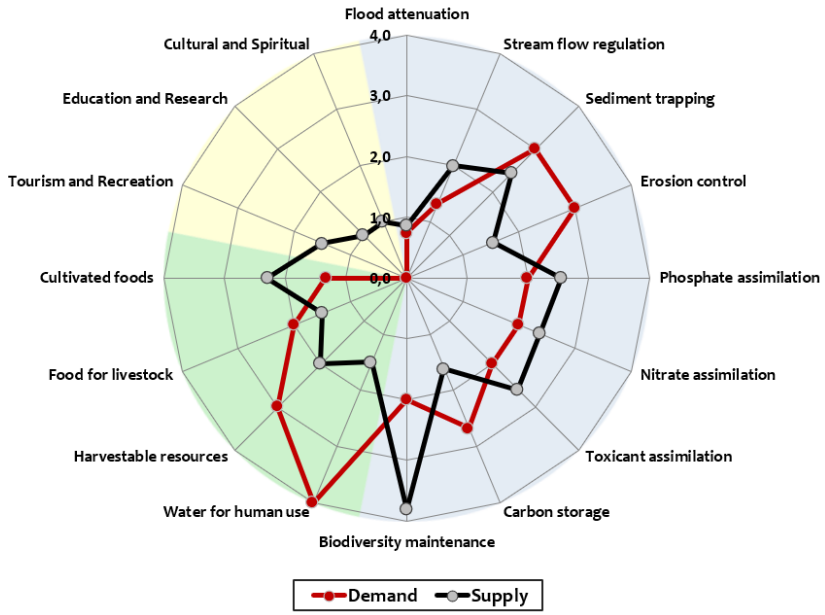
d) Habitat and biota

The vegetation within the valley bottom systems was considered to be largely intact with the exception of areas which have been cleared due to cultivation activities and areas where vegetation has been cleared for creation of

		walking paths for water collection although this is not severe. Species indicative of disturbance or alien and invasives species were predominantly observed along the side of the road/within the road reserve.	
Ecostatus discussion	The hydraulic regime of the valley bottom systems was impacted by presence of various crossings which hydraulic connectivity as observed in some reaches where culverts were not sufficient to convey flow to downstream reaches, resulting in flows ponding upgradient of the valley bottom crossings. Other impacts on the systems include disturbances within the edge of the valley bottom systems from agricultural activities and encroachment by woody species. Despite this, the ecological integrity of the valley bottom systems was considered largely natural with no significant modifiers observed. Observations from the dry season survey reiterated these findings.	**Extent of modification anticipated**	The proposed powerline will cross the delineated valley bottom systems, however given the limited spatial footprint of the infrastructure such as the supporting pylons and proposed substations, the extent of modification is anticipated to be low. Potential impacts from clearing of vegetation, ground-breaking and construction of surface infrastructure can be localised by ensuring that operational and non-operational areas are clearly demarcated prior to any site preparation/construction activities and ensuring that sediment control devices are installed prior to any activities within the site. In terms of the proposed access roads, the layout indicates that some proposed new roads will traverse the valley bottom wetland systems, and this will result in a medium impact. Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are at the lowest.
Consideration of Integrated Environmental Management and Sustainable Development principles:			
It is recommended that general 'best practice' mitigation measures to avoid edge effects be implemented throughout the construction and operation phases of the project. In terms of the layout of the powerline infrastructure, it must be ensured that the powerline pylons are spanned appropriately to avoid direct encroachment within the valley bottom systems, this is critical for maintenance of ecological functionality as well the longevity and protection of the proposed infrastructure as the infrastructure. The layout indicates that some proposed new roads will traverse the valley bottom wetland systems, and this will result in a medium impact. Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are at the lowest. It is further recommended that formal crossing infrastructure be used where roads cross over/through watercourses. These must be designed in such a way that the natural flow of water is not hindered. For roads that cross wider valley bottom wetland units, multiple culvert pipes/drains must be used so that the flow of water is spread across the width of the watercourse and not restricted to a single flow path, which will cause siltation at the upstream side and erosion at the downstream end. Overall, given that the project has the potential to limit direct impacts on the freshwater ecosystems and that the project is considered essential for human livelihoods including socio-economic development and more broadly, for sustainable development. Therefore, it is the opinion of the specialist that the project be considered in a positively for authorisation.		

Table 5: Summary of the assessment of the dambos and floodplain wetland systems associated with the proposed powerline project.

Photograph notes: Various dambo systems noted during the site assessment. Significant rainfall was received during the week of the field work resulting in standing ponds observed at the time of the assessment.



Watercourse characteristics relating to ecostatus discussion:

a) Hydraulic regime

Few informal road crossings impeding flow and resulting in the accumulation of natural debris within the wetland system are considered the most prominent modifier of the ecological integrity of these systems. Some areas are also largely dominated by cultivation, which has resulted in disturbance of soil in the catchment and altered the natural distribution and retention of water in the landscape due to presence of various artificial drainage channels related to agricultural activities.

b) Geomorphology and sediment balance

Sediment laden runoff has likely increased over time within some of the wetland systems due to catchment wide activities (soil disturbances related to cultivation and vegetation clearing). The sediment balance has also been impacted by presence of inform road crossings which impede flows and result in sediment deposition upgradient of the crossing point. Over time, this has the potential to result in changes in the vegetation community as the sediment layer creates conditions that are suitable for establishment of reeds.

c) Water quality

In-situ water quality parameters, where measured, indicated water quality is relatively unimpaired. Water quality parameters were measured as follows, EC – 12.5 mS/m; pH – 7.44 and temperature – 22.1˚C. This is as anticipated due to the remote geographic setting and the fact that the rivers are more regularly utilised for domestic purposes.

<table>
<tr><td>Ecostatus discussion</td><td>The dambo systems were observed to be with no major impacts. The primary modifiers noted were impacts to the vegetation, primarily as a result of some cultivation activities, trampling by domestic livestock and footpaths used during water collection/wood harvesting. The resulting reduction in natural vegetation cover has led to encroachment by floral species associated with disturbance, however this is not considered to be significant.</td><td colspan="2">d) Habitat and biota
The vegetation was considered largely intact with the exception of areas which have been cleared due to cultivation activities and areas where vegetation has been cleared for creation of walking paths for water collection although this is not severe. The presence of encroacher and alien species indicative of disturbance was noted, these included Bidens pilosa and Tagetes minuta.</td></tr>
<tr><td>Goods and Services Provision</td><td>The valley bottom systems are considered to provide important ecological services to the rural communities within the assessed areas. Where surface flows were present, local communities were seen utilising the systems for collection of water for drinking, washing of clothes and these were also used extensively as a source of water for cattle. In addition, the valley bottom wetland systems were utilised for subsistence farming. These systems are also considered important for maintenance of biodiversity and habitat provision, and also for the recharge of larger riverine systems. Thus, retention of habitat and hydraulic connectivity is critically important.</td><td>Extent of modification anticipated</td><td>The proposed powerline will cross the delineated dambos, however given the spatial footprint of the infrastructure such as the supporting pylons and proposed substations, the extent of modification is anticipated to be low. Potential impacts from clearing of vegetation, ground-breaking and construction of surface infrastructure can be localised by ensuring that operational and non-operational areas are clearly demarcated prior to any site preparation/construction activities and ensuring that sediment control devices are installed prior to any activities within the site.

In terms of the proposed access roads, the layout indicates that some proposed new roads will traverse the valley bottom wetland systems, and this will result in a medium impact. Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are low.</td></tr>
<tr><td colspan="4">Consideration of Integrated Environmental Management and Sustainable Development principles:</td></tr>
<tr><td colspan="4">It is recommended that general ‘best practice’ mitigation measures to avoid edge effects be implemented throughout the construction and operation phases of the project. In terms of the layout of the infrastructure, it must be ensured that the powerline pylons are spanned appropriately to avoid direct encroachment, this is critical for maintenance of ecological functionality as well the longevity and protection of the proposed infrastructure as the infrastructure. In terms of the layout of the infrastructure, it must be ensured that the powerline pylons are spanned appropriately to avoid direct encroachment within the valley bottom systems, this is critical for maintenance of ecological functionality as well the longevity and protection of the proposed infrastructure as the infrastructure.

The layout indicates that some proposed new roads will traverse the dambos and floodplain systems, and this will result in a medium impact. Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are at the lowest.</td></tr>
</table>

6 IDENTIFICATION OF POTENTIAL IMPACTS

The below table (Table 6) presents potential impacts on freshwater ecosystems associated with the construction and operation phases of the proposed powerline project. There are four key ecological impacts on freshwater ecosystems that are anticipated:

- Loss of freshwater ecosystem habitat and ecological structure;
- Changes to the socio-cultural and service provision;
- Impacts on the hydrology and sediment balance of the freshwater ecosystems; and
- Impacts on water quality within the freshwater ecosystems.

Table 6: List of the anticipated potential impacts on freshwater ecosystems associated with the construction and operation phases of the proposed powerline project.

Construction and Operation Phase	
Loss of Habitat and Ecological Structure	Some loss or degradation of freshwater habitat has occurred as a result of subsistence agriculture, particularly in the shallow dambo areas which are commonly utilised for cultivation of crops by local communities. Construction of powerline infrastructure may lead to further alterations to habitat and ecological structure, primarily through vegetation losses necessitated during pre-construction preparation, but also potentially by impeding or altering the movement of water through the landscape.
Changes to Ecological and Socio-cultural Service Provision	The loss or alteration of freshwater habitat and ecological structure as a result of the various activities discussed above (Section 4), particularly during pre-construction and construction phases, will inevitably lead to changes in the ability or capacity of the freshwater ecosystems to provision certain ecological services, such as sediment trapping, flood attenuation and assimilation of excess nutrients. Changes in socio-cultural service provision are less likely to occur given that the proposed powerline infrastructure can avoid direct encroachment on the freshwater ecosystems.
Hydrological Function and Sediment Balance	Impacts on hydraulic and geomorphological regimes may result in altered extents (hydroperiod) of freshwater ecosystems, as well as changes to floral assemblages. The presence of instream man-made structures such bridge crossings has the potential to result in changes in the delivery of flows and sediment to downstream reaches of the freshwater ecosystems. Instream structures have the potential to result in sediment deposition upstream and potential desiccation of freshwater habitat downstream if hydraulic connectivity is not sufficiently maintained.
Impacts on Water Quality	During the construction phase, increased vehicular activity and increased human presence carries the potential for direct and indirect impacts on water quality. Spills from vehicles and construction machinery, disturbances to soils and hygiene requirements of construction personnel are amongst potential impacts which may adversely affect water quality with specific mention of Suspended solids, oil and grease spills and contamination with human waste.
Consideration of Cumulative Impacts	
Impacts to downstream water users	The runoff generated from construction sites can contain sediment, chemical contaminants, and other pollutants such as oil and diesel, which has the potential to impact on water quality in nearby rivers and wetlands, and affect the use of the water for downstream users. However, given the nature of the proposed development, this impact is not considered severe, particularly in terms of risk of chemical contamination.
Habitat Fragmentation	The construction of powerline infrastructure includes the clearing of vegetation within the powerline servitude. These activities have the potential to result in the loss of freshwater habitat where crossings are required and fragmentation of freshwater habitat.

7 LEGISLATIVE REQUIREMENTS AND BUFFER ZONE RECOMMENDATIONS

7.1 Consideration of Buffer Zones

Presidential Decree No. 82/14, approves the Regulation on the General Use of Water Resources:

This decree applies to surface water and groundwater, namely watercourses, lakes, lagoons, swamps, springs, reservoirs, estuarine areas and other water bodies, without prejudice to the respective watercourse bed, riverbanks and surroundings.

Article 109(2) establishes that holders of rights to use water resources shall in general be prohibited from:

(e) Carry out any activities in the water protection zones."

Article 110 establishes that proponents shall consider a 200 m buffer zone as follows: "areas of protection of water resources, the water course beds, riverbanks and water courses adjacent zones of up to a distance of 200 metres".

In addition to the above recommended buffer zone, based on the specialist's prior experience in neighbouring SADC countries consideration was given to regional guidelines. A 30 m buffer is often stipulated by the Zimbabwean Environmental Management Agency, while in South Africa, legislation stipulates a 32 m development setback around wetlands and rivers.

Therefore, the precautionary principle, which is considered an important component in Integrated Environmental Management, was applied and a 32 m buffer is therefore recommended as a setback for the non-linear components of the proposed projects (e.g., support pylons positions) and for any linear developments running parallel to the freshwater systems. This may not always be practical to implement however, in which case the Preliminary Guidelines for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries (Macfarlane *et al.*, 2015) was applied. Although developed primarily with the South African context in mind, the tool focuses on ecological processes and is flexible enough to allow for regional adaptation and application. On that basis, a 10 m buffer is considered the minimum for all non-permanent infrastructure during the construction phase where a wider buffer cannot be implemented. The recommended buffer areas are depicted in Figure 14 - 19 in relation to the proposed infrastructure footprint. These should be taken into consideration during future planning to ensure that no infrastructure is unnecessarily placed within watercourses or proximity thereof.

7.2 IFC Performance Standards on Environmental and Social Sustainability

The International Finance Corporations (IFC) Sustainability Framework articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The sustainability framework comprises IFC's Policy and Performance standards on Environmental and Social Sustainability, and IFC's Access to Information Policy. The IFC Performance Standards (PS) are designed to assist the proponent in designing and implementing a project in a manner where risks and impacts associated with the project are identified and mitigated to ensure the project is completed sustainably. The applicant deemed it necessary that the environmental assessment had to consider, were applicable and/or include the Equator Principles as well as Performance Standards 1,3,4,6 and 8. For a detailed description of the Performance Standards please see Appendix B.

In the context of the freshwater assessment the following IFC Performance Standards are applicable:

- Performance Standard 1 (IFC PS1) – Assessment and Management of Environmental and Social Risks and Impacts; and
- Performance Standard 6 (IFC PS6) – Biodiversity Conservation and Sustainable Management of Living Natural Resources.

IFC PS1 is applicable to all projects which pose potential risk and may have an impact on the receiving environment. IFC PS1 (2012) states that should the host country have legislative control for the management of the environment that overlaps with the guidelines of the IFC standards, the more stringent measure should be implemented for the project. The objectives of IFC PS1 (2012), where applicable to the freshwater assessment, are summarised as follows:

- The identification and quantification of environmental risks and impacts associated with the proposed powerline project, as well as the identification of -mitigation measures to be implemented at the site to minimise or avoid said risks and impacts (Please see Sections 4 and 6 for the risks and mitigation measures pertaining to the proposed powerline project);
- To encourage and ensure that the proponent runs the project as sustainably as possible using efficient and effective environmental management plans; and
- To ensure that relevant stakeholders (e.g. local communities, government, etc.) are aware of the project and their respective communications and queries are responded to and managed effectively.

IFC PS6 recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The objectives of IFC PS6 are:

- To protect and conserve biodiversity;
- To maintain the benefits from ecosystem services; and
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

In a development context, IFC PS 6 states that the proponent (a developer) must not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified habitat;
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation;
- Any conversion or degradation is mitigated according to the mitigation hierarchy; and
- The IFC PS 6 stipulates that in areas of natural habitat, mitigation measures will be designed to achieve no nett loss of biodiversity where feasible. No nett loss of biodiversity is defined in the PS as:
    - the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimise the project's impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale.

Appropriate actions to ensure no nett loss of biodiversity include:

- Avoiding impacts on biodiversity through the identification and protection of set-asides;
- Implementing measures to minimise habitat fragmentation, such as biological corridors;
- Restoring habitats during operations and/or after operations; and
- Implementing biodiversity offsets.

The proposed powerline project has the potential to avoid direct impacts on the freshwater ecosystems by ensuring sufficient spanning of powerline support structures. This will ensure a no nett loss of freshwater biodiversity and largely avoiding potential impacts in line with the mitigation hierarchy. Given that the project is linear infrastructure, the crossing of the freshwater ecosystems will take place and development of access roads into the construction sites would result in a series of direct and indirect impacts on the freshwater ecosystems, especially considering that there is no road footprint at some of the crossing locations.

However, a series of mitigation measures to reduce or negate negative impacts have been stipulated (refer to Section 6) which will only result in impacts of low magnitude.

The freshwater ecosystems associated with the proposed powerline project were also categorised according to the relevant IFC defined habitat categories. For a detailed discussion on the habitat categories please see Appendix J.

The freshwater ecosystems fall within the **natural habitat category** as the freshwater ecosystems are "*composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition*". The proponent will not significantly convert or degrade the natural habitats as the direct impacts on the freshwater ecosystems have the potential to be largely been avoided, as per the mitigation hierarchy, and effective mitigation measures to prevent direct or indirect impacts have been stipulated (Section 8 and Appendix F) to ensure no nett loss of aquatic biodiversity occurs.

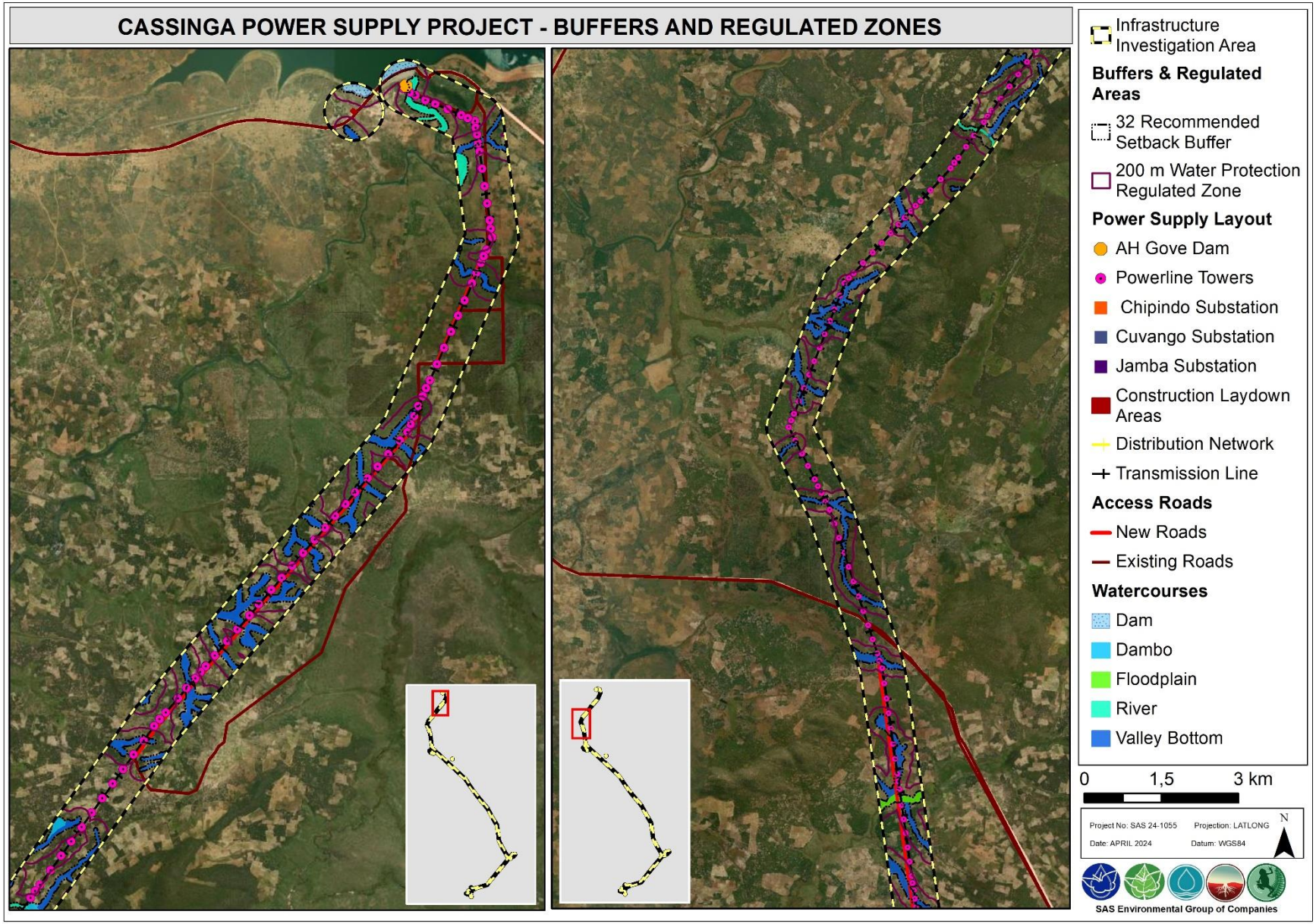


Figure 14: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

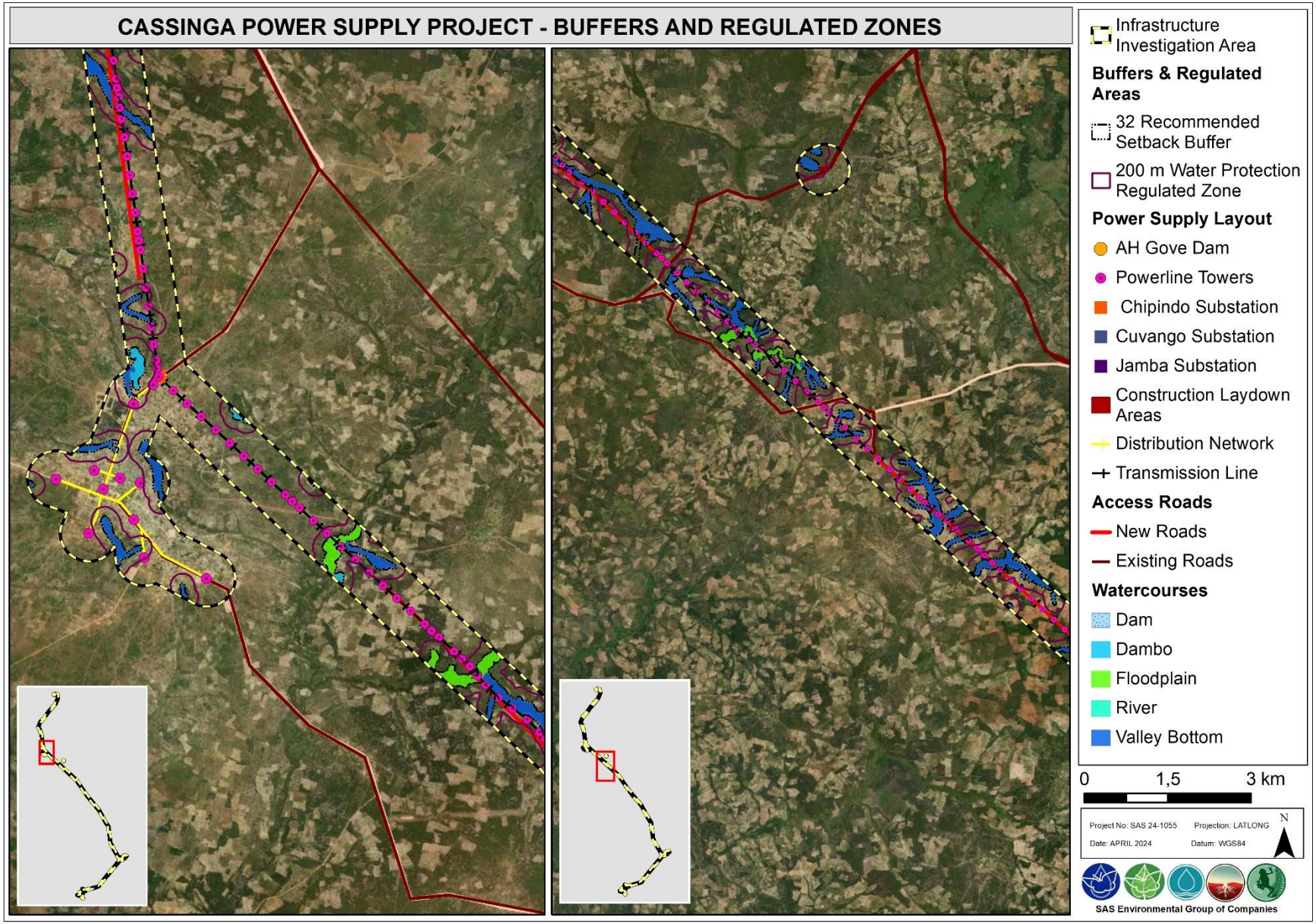


Figure 15: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

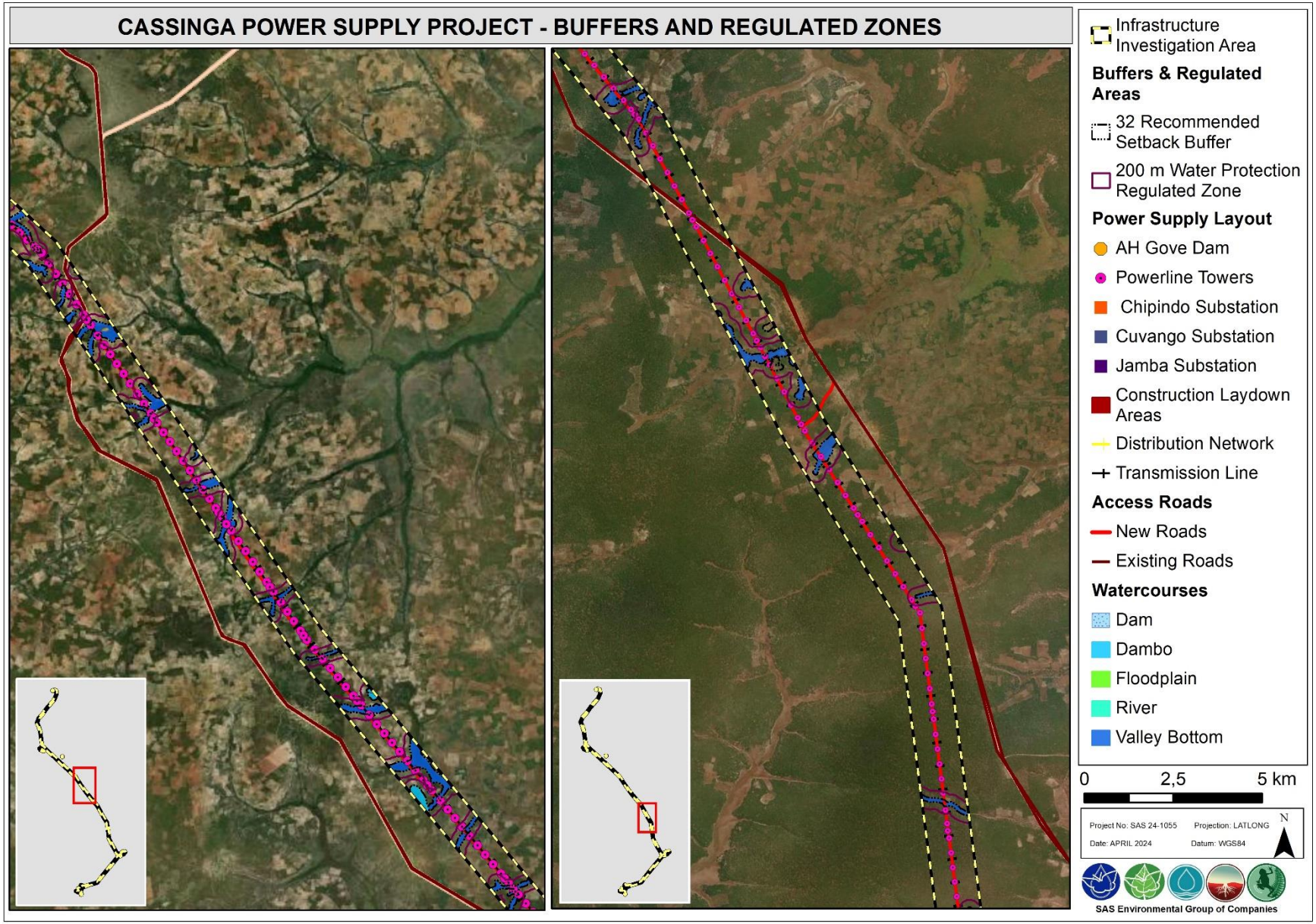


Figure 16: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

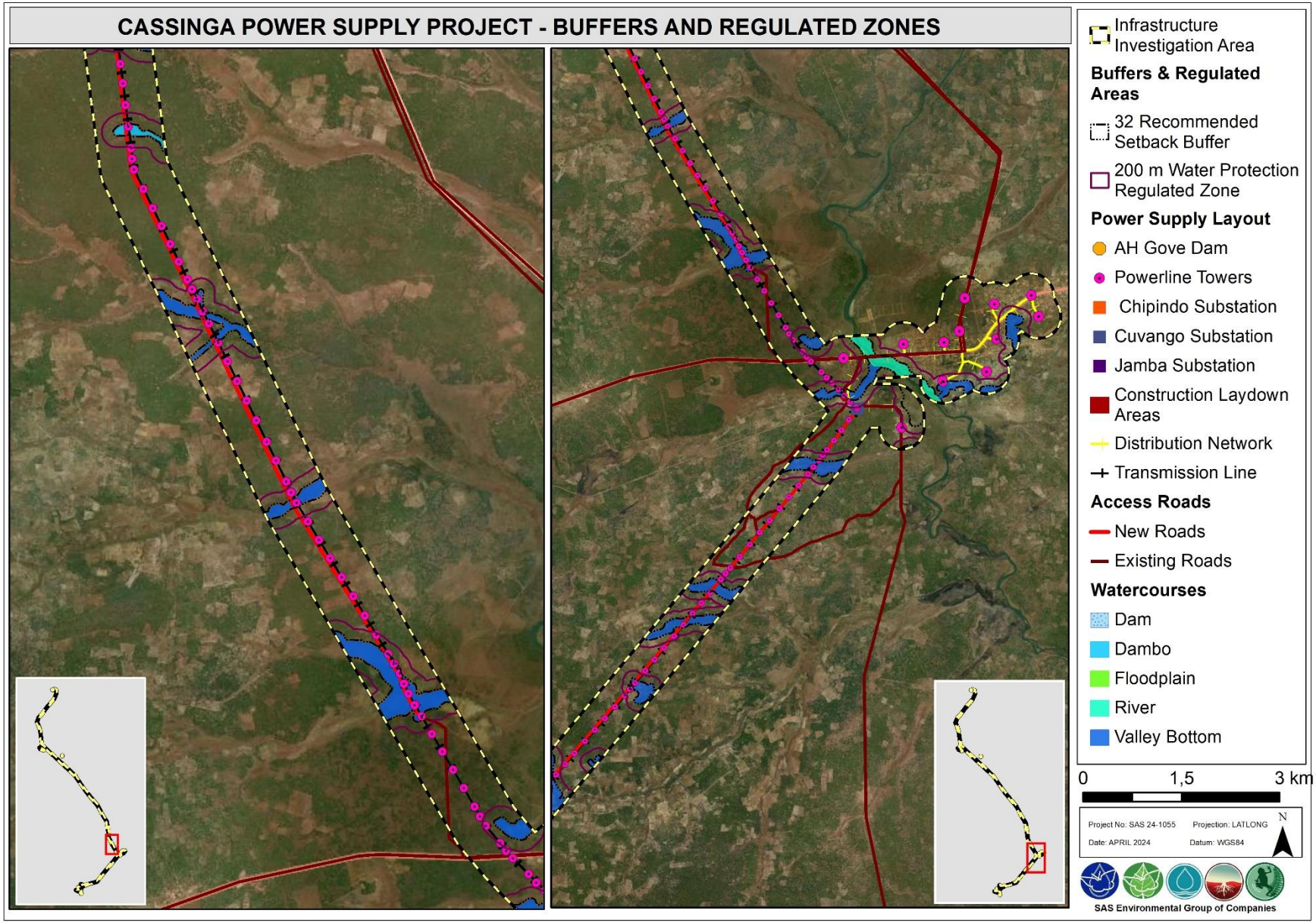


Figure 17: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

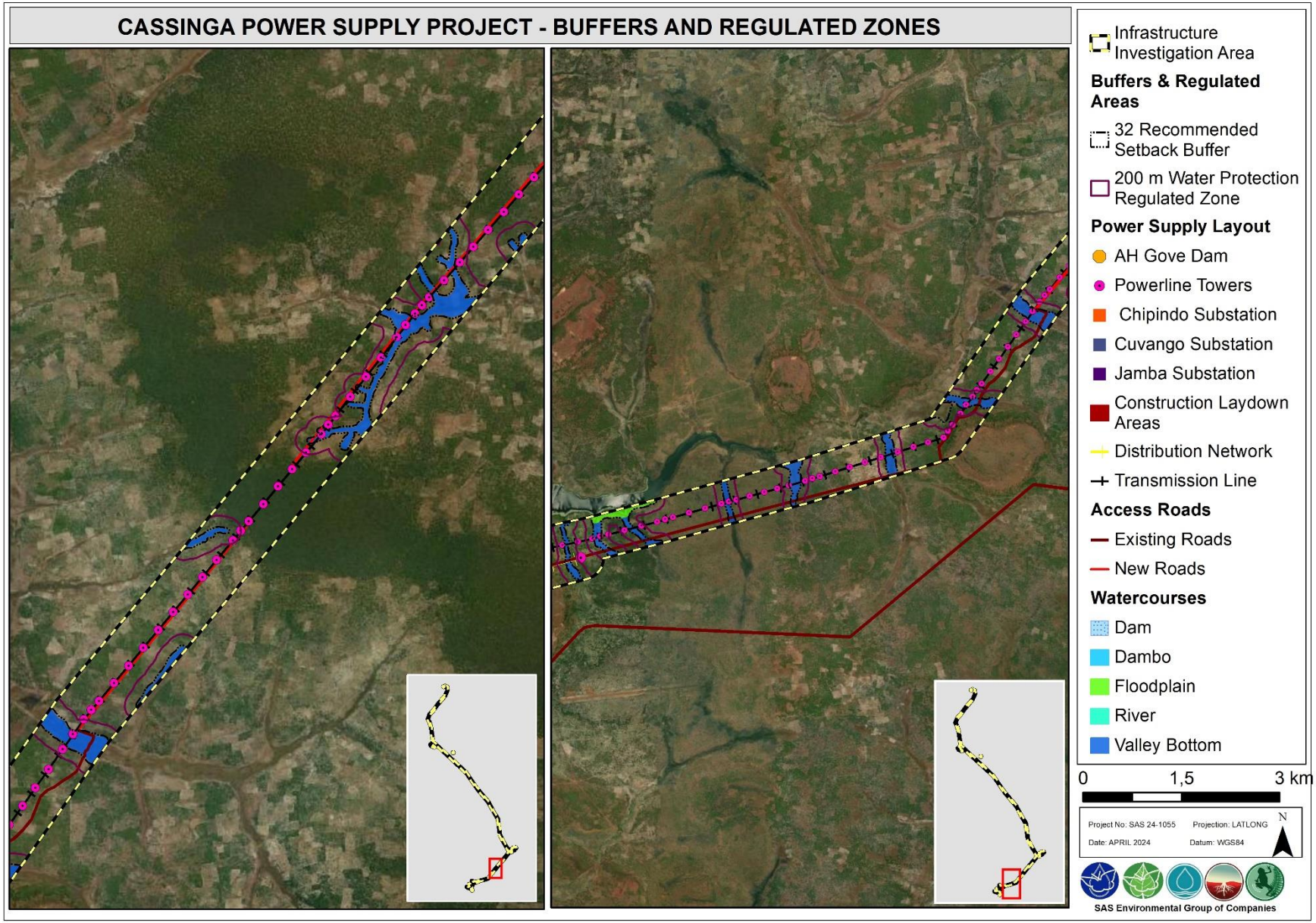


Figure 18: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

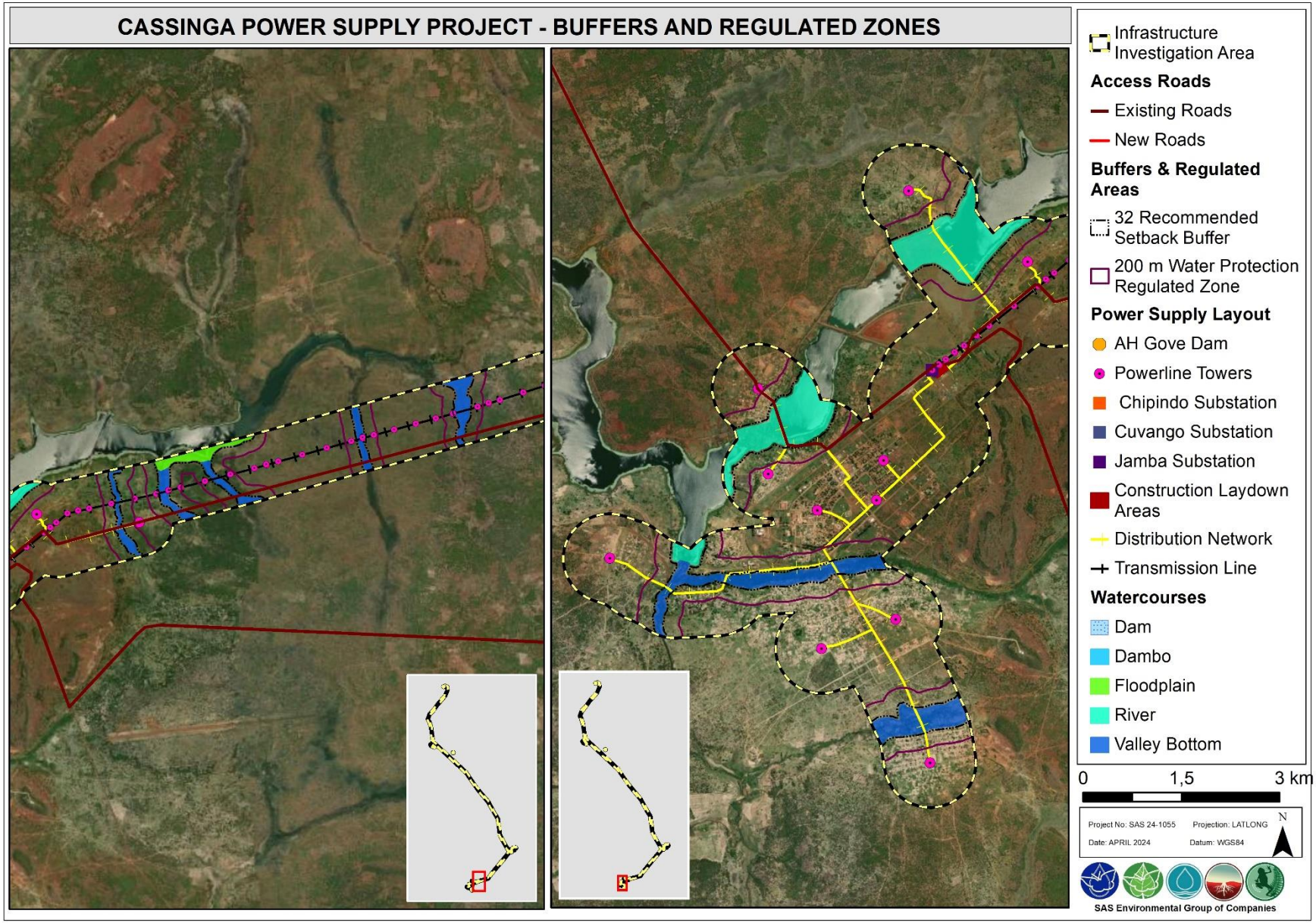


Figure 19: The location of the delineated freshwater systems including buffer zones associated with the proposed powerline project.

8 IMPACT ASSESSMENT

This section presents the impact assessment conducted for the proposed activities associated with the construction of the proposed powerline and associated infrastructure.

8.1 Assessment of impacts using the assessment methodology provided by the EAP

Identified impacts are described in terms of the nature of the impact, receptor sensitivity and the significance of the predicted environmental change (*with and without mitigation*). The assessment of the identified impacts is based on determining the following aspects: impact probability, duration, extent, consequence, and loss of the resource. The impact rating system considers the confidence level that can be placed on the successful implementation of mitigation.

Table 7: Summary of the impact assessment conducted for the proposed powerline project activities for the pre-construction phase.

ACTIVITY 1: Site preparation prior to commencement of construction.								
Impact Summary: ➢ Removal of vegetation leading to increased bare areas and changes in runoff in the landscape; ➢ Smothering of freshwater habitat due to dust generated from cleared areas; and ➢ Miscellaneous activities by construction personnel.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Major (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is essential; ➢ As far as possible, existing roads must be utilised to gain access to sites; ➢ All vegetation cleared as part of the site clearing activities (specifically where large areas need to be cleared) should be appropriately stockpiled in a small areas. Vegetation which is suitable for use in reinstatement may be temporarily stockpiled, outside of delineated freshwater systems, Plant material suitable for use as firewood or which would normally be harvested by communities may be given to the community. No Alien or Invasive Plants (AIPs) may be donated to the local communities to limit spread; ➢ Freshwater systems situated downgradient and within 32 m of any construction site must be protected by means of construction of a silt trap, erected along the boundary of the freshwater system. Silt traps must be monitored closely, and accumulated sediment removed as regularly as required, preferably by hand if feasible. Removal with machinery may take place provided that no indiscriminate movement of machinery occurs within freshwater systems; ➢ Contractor laydown areas, and material storage facilities to remain within the designated contractor camp and batching plant footprint; and ➢ No vegetation may be removed from any delineated freshwater system or directly adjacent thereof where no infrastructure is planned, as this provides a natural buffer zone around the freshwater systems which disperse surface runoff into the freshwater systems, and thus prevents sedimentation and erosion thereof.							
After management	Minor	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 8: Construction activities associated with the development of construction camps/laydown areas.

ACTIVITY 2: Site preparation prior to commencement of construction.								
Impact Summary: ➢ Increased bare areas and changes in runoff in the landscape; ➢ Generation of dust in the cleared areas and smothering of freshwater habitat; and ➢ Miscellaneous activities by construction personnel.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Major (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ All development footprint areas to remain as small as possible and vegetation clearing to be limited to what is essential; ➢ Suitable procedures for the disposal of construction waste and hazardous materials must be developed; ➢ Containment systems to prevent contamination of groundwater and surface water such as drip trays must be installed; ➢ All vegetation cleared as part of the site clearing activities (specifically where large areas need to be cleared) should be appropriately stockpiled in a small areas. Vegetation which is suitable for use in reinstatement may be temporarily stockpiled, outside of delineated freshwater systems. Any plant material suitable for use as firewood or which would normally be harvested by communities may be given to the community; and								

➢ No Alien or Invasive Plants (AIPs) may be donated to the local communities to limit spread.								
After management	Minor	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 9: Summary of the impact assessment conducted for the proposed powerline project activities for construction phase.

ACTIVITY 3: Groundbreaking activities for construction of the support structures and spanning of the proposed powerline over freshwater ecosystems including preparation of the 'right of way' (servitude).								
Impact Summary: ➢ Smothering of freshwater habitat due to dust generated from cleared areas; ➢ Increase in bare areas including changes in runoff patterns in the landscape; ➢ Proliferation of alien and invasive species within the freshwater habitat; ➢ Increased erosion and sedimentation of the freshwater systems; ➢ Alteration of surface water quality from concrete casting; and ➢ Disturbance to aquatic biota								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before Management	Major (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ Careful planning of pylons for the powerlines must take place, ensuring that as far as practical (considering any restrictions relating to spanning of freshwater ecosystems) pylons are not placed within 10m of the delineated edge of the freshwater systems, to minimise potential loss of vegetation, erosion or sedimentation of the freshwater system during construction works; ➢ During excavation activities, the topsoil and vegetation must be stockpiled separately from other material outside of the delineated freshwater system; ➢ Excavation of pits the pylons within close proximity to a freshwater system may cause excessive sediment to enter into the freshwater systems, specifically if works are undertaken during the rainy months. As such, during excavation of the foundations, soil must be stockpiled upgradient of the excavated pit. Mixture of the lower and upper layers of the excavated soil should be kept to a minimum. Excess soil as a result of bulking must be spread evenly in the landscape given that the excavated pits are to be filled with concrete. Alternatively excess soil must be used in rehabilitation processes of adjacent areas, immediately after installation of the pylon; ➢ Excavated materials must not be contaminated, and it should be ensured that the minimum surface area is taken up by any stockpiled materials. The mixture of the lower and upper layers of the excavated soil should be kept to a minimum, so as for later use as backfill material after construction has commenced; ➢ All exposed excavated soil stockpiles should be protected from wind using suitable geo-textile or by not stockpiling more than 3 m tall and removing or infilling of stockpiled soils; ➢ Suitable drainage must be insured along the hardstand areas to ensure that water does not pond on the hardstand or does not drain in a concentrated manner into the freshwater systems for towers that are associated with watercourses and/or wetlands. This must be incorporated into the stormwater management plan and be overseen by a freshwater ecologist. Rehabilitation of the construction footprint areas: ➢ Rehabilitation measures around areas where construction took place must be developed and implemented. Implementation must be overseen by a suitably qualified Environmental Site Officer with freshwater and biodiversity resource management experience and the ESO must sign off the rehabilitation before the relevant contractors leave site; ➢ Ensure that soils are replaced in the correct layers, ripped and re-reprofiled, and that vegetation is restored to a point where succession will lead to the same conditions as the pre-mining state as a minimum; ➢ The construction areas should regularly be inspected for alien and invasive vegetation species which might have established due to the construction activity related disturbances.								
After management	Minor	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 10: Construction activities associated with the development of infrastructure of new substations.

ACTIVITY 4: Construction activities associated with the development of infrastructure of new substations.								
Impact Summary: ➢ Increased soil erosion and formation of preferential flow paths in the landscape; ➢ Sedimentation of the freshwater system due to disturbance in the landscape resulting in changes in the instream substrate; ➢ Smothering of freshwater habitat due to dust generated from cleared areas; ➢ Changes in flow, pattern and timing due to increased impermeable surfaces; ➢ Loss of foraging and breeding habitat and faunal migratory corridors; and ➢ Proliferation of alien and invasive species within the freshwater habitat.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Moderate (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ Silt/sediment traps are to be used during the construction phase, to limit additional sediment associated with construction activities from reaching the freshwater habitat; ➢ Design of infrastructure should be environmentally and structurally sound and all possible precautions taken to prevent contamination of surface and resources present; ➢ Adequate stormwater management must be incorporated into the design of the substation infrastructure in order to prevent erosion and the associated sedimentation of the freshwater habitat. In this regard special mention is made of: o Sheet runoff from cleared areas, paved surfaces and/or access roads needs to be curtailed; o Runoff from paved surfaces should be slowed down by the strategic placement of berms; and o All overburden stockpiles and waste stockpiles must have berms and/catchment paddocks at their toe to contain runoff from the facilities. ➢ Erosion arising as a consequence of the development of surface infrastructure must be remedied immediately and included as part of an ongoing rehabilitation plan; ➢ Where construction activities have taken place, footprint areas must be monitored for alien and invasive vegetation encroachment and all alien vegetation/weeds must be removed according to a suitable alien vegetation control plan; ➢ If any solid materials do enter the freshwater environment, if deemed safe, they should be immediately removed and disposed at a registered waste disposal facility. Material that may be re-used must be re-used and material that will not be re-used must be disposed of; **Control measures specific to concrete works:** ➢ Fresh concrete and cement mortar must not be mixed near the freshwater ecosystems. Mixing of cement may be done within the construction camp, however, may not be mixed on bare soil, and must be within a lined, bound or bunded portable mixer. Consideration must be taken to use ready mix concrete. The designated concrete mixing areas must be approved by the ECO; ➢ No mixed concrete shall be deposited directly onto the ground within the freshwater ecosystems (outside of the designated area). A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited whilst it awaits placing; ➢ A washout area should be designated outside of the freshwater ecosystems, and wash water should be treated on-site or discharged to a suitable sanitation system; ➢ Cement bags must be disposed of in the demarcated hazardous waste receptacles and the used bags must be disposed of through the hazardous substance waste stream; and ➢ Spilled or excess concrete must be disposed of at a suitable landfill site. Chain of custody documentation must be provided. Rehabilitation measures of the construction footprint areas as outlined in Activity 2 must be implemented in a phased manner shortly after the construction activities.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 11: Construction activities associated with the development of access roads.

ACTIVITY 5: Construction activities associated with the development of access roads.								
➢ Impact Summary: ➢ Potential temporary in-channel diversion of the freshwater crossing to allow for excavations for road crossing to take place; ➢ Loss of freshwater habitat and ecological structure resulting in impacts on biota; ➢ Altered runoff patterns and alteration to flow patterns, leading to increased erosion and sedimentation of the freshwater system; ➢ Disturbances of soils leading to increased alien vegetation proliferation, and in turn to further altered riverine habitat; and ➢ Increased risk of pollution of surface water which may affect the freshwater ecosystem, leading to impaired water quality including an altered pH regime, salinisation of soils and increased contaminants in the freshwater ecosystems.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Major (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ General construction mitigation measures outlined for Activity 1 and 2 (site preparation activities) for clearing of vegetation, management of spills, waste, and usage of storage facilities are considered applicable; ➢ **It is highly recommended that all construction and site clearing should ideally take place during the period when flows are low (outside of the rainfall season) in order to minimise impacts on the freshwater ecosystems as well those downstream as a result of the construction activities;** ➢ Implementation of erosion and sediment control measures must be implemented to prevent excessive sedimentation during construction; ➢ Sandbags should be used to create a coffer dam around the construction area, if applicable (for temporary diversion), which can then be dewatered. Water must be diverted into the downstream reach of the freshwater ecosystem around the coffer area and allowed to always flow to the downstream reach; ➢ Any diversion for construction activities must mimic natural flow patterns and maintain sediment transport; and ➢ All alien and invasive vegetation species, debris and litter removed from the road reserve must be removed from site.								
After management	Moderate (-)	Short term	Local	Medium	Possible	**Medium**	– ve	Medium

Table 12: Operation of the proposed surface infrastructure (OHPL and powerline servitudes).

ACTIVITY 6: Operation of the proposed linear infrastructure (OHPL and powerline corridors).								
Impact Summary: ➢ Changes in flow, pattern and timing due to increased impermeable surfaces; and ➢ Altered drainage patterns, potentially leading to the formation of preferential flow paths and/or concentrated flows.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Minor (-)	Medium term	Site	Low	Definite	**Low**	– ve	Medium
Essential management measures: ➢ An emergency plan must be developed to manage any infrastructure failure, which may impact on the freshwater ecosystems should any fault necessitate usage of heavy machinery and clearing of vegetation to access site; ➢ The powerline servitude must be monitored for alien and invasive vegetation encroachment and all alien vegetation/weeds must be removed according to a suitable alien vegetation control plan. Annual follow up should be undertaken for at least 3 years post construction; and								

➢ Disturbances within the footprint area should be limited to what is essential for long-term maintenance in-line with the mitigation measures presented herein.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 13: Operation of the proposed surface infrastructure (substations).

ACTIVITY 7: Operation of the proposed surface infrastructure (substations).								
Impact Summary: ➢ Increased impermeable surfaces due to the presence of surface infrastructure (substations); ➢ Potential indiscriminate movement of vehicles within the riverine systems for perimeter inspections/ maintenance.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Minor (-)	Medium term	Site	Low	Definite	**Low**	– ve	Medium
Essential management measures: ➢ Rehabilitation measures around areas where construction took place must be developed and implemented. Implementation must be overseen by a suitably qualified Environmental Site Officer with freshwater and biodiversity resource management experience and the ESO must sign off the rehabilitation before the relevant contractors leave site; ➢ Ensure that soils are replaced in the correct layers, ripped and re-reprofiled, and that vegetation is restored to a point where succession will lead to the same conditions as the pre-mining state as a minimum; ➢ It must be ensured that regular inspections of all stormwater infrastructure are conducted. During the inspection data must be recorded and kept for the purposes of tracking and reporting; ➢ Bare areas should be revegetated within suitable indigenous vegetation species.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 14: Operation of the proposed new accessed roads.

ACTIVITY 8: Operation of the proposed new accessed roads.								
Impact Summary: ➢ Altered timing and pattern of flows within the catchment; ➢ Change in freshwater hydroperiod and changes in flood peaks; and ➢ Potential desiccation of downstream reaches of freshwater ecosystems due to blocked culverts.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Moderate (-)	Short term	Local	Medium	Possible	**Medium**	– ve	Medium
Essential management measures: ➢ Regular inspection of the access roads and associated culverts must be done in order to ensure structural stability during the operation of the road; ➢ Where culverts are proposed, spots for the build-up of debris and excess sediment must be identified and when necessary, debris/excess sediment must be removed by hand. This is particularly important following heavy rainfall events since any blockages may result in back-flooding of the freshwater ecosystems systems; ➢ Any erosion or gully formation must be identified on an ongoing basis and re-profiled and revegetated accordingly; and ➢ Any litter from maintenance activities must be cleared from the site and discarded at suitable registered facility.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

Table 15: Decommissioning of infrastructure associated with the proposed powerline project.

ACTIVITY 9: Decommissioning of infrastructure associated with the proposed powerline project.								
Impact Summary: ➢ Soil erosion and sedimentation of freshwater due to disturbance in the landscape; ➢ Increase in bare areas including changes in runoff patterns in the landscape; ➢ Smothering of freshwater habitat due to dust generated from cleared areas; ➢ Proliferation of alien and invasive species within the freshwater habitat; and ➢ Disturbance to aquatic biota.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Minor (-)	Medium term	Site	Low	Definite	**Low**	– ve	Medium
Essential management measures: ➢ Decommissioning vehicles should be checked for leakages of hydrocarbons prior to commencement of decommissioning and closure; ➢ Vehicles should utilise existing access roads and minimise compaction of adjacent areas; ➢ Disturbed areas adjacent to the decommissioning sites should be revegetated in order to limit potential soil erosion; ➢ Rehabilitation measures around areas where decommissioning took place must be developed and implemented. Implementation must be overseen by a suitably qualified Environmental Site Officer with freshwater and biodiversity resource management experience and the ESO must sign off the rehabilitation before the relevant contractors leave site; ➢ Ensure that soils are replaced in the correct layers where infrastructure has been removed/decommissioned, ripped and re-reprofiled, and that vegetation is restored to a point where succession will lead to the same conditions as the pre-mining state as a minimum; and ➢ Monitor spread of alien and invasive species during the decommissioning phase.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

8.2 Cumulative Impacts

Cumulative impacts are activities and their associated impacts on the past, present and foreseeable future, both spatially and temporally, considered together with the impacts identified in Section 8 above.

Direct and indirect impacts identified within freshwater ecosystems include agricultural activities, various freshwater ecosystem crossings associated with informal roads impacting on the natural hydraulic regime, an increase in alien and invasive species entering the system due to regular disturbance of soil and removal of indigenous vegetation. The disturbances associated with creation of access roads and construction of surface infrastructure in the area will potentially further increase clearing of vegetation, changes to the natural pattern and timing of flows in the landscape and potential incision of freshwater areas, if suitable mitigatory measures are not put into place. Additionally, the fragmentation of habitats and disturbance to freshwater ecosystems can lead to altered water quality, loss of biota, and alter the ecological functions provided by the freshwater ecosystems. Furthermore, the cumulative impacts associated with activities for the powerline construction and operation may exacerbate erosion and sedimentation, threatening the stability of riverbanks and exacerbating the loss of valuable wetland habitats.

Some of the proposed access roads will result in a cumulative loss of freshwater habitat and therefore it is important that suitable mitigation measures are implemented to manage significant loss of freshwater habitat during construction of access roads and associated crossings. Watercourse crossings for vehicular access must be done using formal structures that will not hinder the natural flow of surface waters such as suitably sized culverts. If the watercourse is relatively wide, such as for valley bottom wetland units, then multiple culverts should be used so that the flow of water can be spread across the width of the watercourse. This will promote the flow-through of silt from upstream sources and will also abate the effects of erosion at the downstream side of the culvert drains. Restriction of the flow to a single flow path (i.e., a single culvert) will promote erosion at the downstream side.

Rehabilitation efforts such as alien vegetation management, clearing of construction rubble, ensuring that the pre-construction landscape in terms of surface flows is re-instated and where possible improved must be done to ensure that the cumulative impacts on the system are reduced and the ecological functioning of the systems can be maintained. Additionally, ongoing monitoring and adaptive management strategies are important to address unforeseen impacts and ensure the long-term integrity and resilience of wetlands and rivers which are to be potentially impacted by the proposed powerline development. The table below (Table 16)

summarises the impact significance of the cumulative impacts associated with the proposed powerline development.

Table 16: Summary of impact assessment for cumulative impacts associated with the proposed powerline project.

Cumulative impacts associated with the proposed powerline infrastructure.								
Impact Summary: ➢ Smothering of freshwater habitat and impacts to downgradient freshwater systems; ➢ Proliferation of alien and invasive species and change in freshwater habitat; ➢ Runoff of contaminated water from construction areas to downstream freshwater ecosystems; ➢ Vegetation disturbance along powerline corridor due to maintenance activities; and ➢ Potential indiscriminate movement of vehicles within the riverine systems for perimeter inspections/ maintenance.								
	Magnitude	***Duration***	***Scale***	***Consequence***	***Probability***	***Significance***	***Status***	***Confidence***
Before management	Major (-)	Medium term	Local	Medium	Definite	**Medium**	– ve	Medium
Essential management measures: ➢ Rehabilitation measures around areas where construction took place must be developed and implemented. Implementation must be overseen by a suitably qualified Environmental Site Officer with freshwater and biodiversity resource management experience and the ESO must sign off the rehabilitation before the relevant contractors leave site.								
After management	Minor (-)	Short term	Site	Low	Possible	**Low**	– ve	Medium

If the mitigation measures presented in this document (Section 6) are adequately adhered to during all phases of proposed powerline project, the scale of impact on the Valued Environmental and Social Components (VECs) in the context of freshwater ecosystems will be reduced to acceptable. The monitoring plan to manage cumulative impacts is presented in Section 9 below.

8.3 Impacts on Type I and Type II Ecosystem Services

Ecosystem services regarded as Type I ecosystem include services that directly benefit human well-being, through the provision of tangible goods or services. These may include water quality regulation, flood regulation and maintenance of biodiversity through provision of habitat. Ecosystem services regarded as type II typically are those that support the functioning of the ecosystems and the provision of Type I services. In the context of the proposed powerline and associated infrastructure, the proposed construction activities will result in clearing of vegetation, ground-breaking activities and increase in bare areas, this may result in the increase in erosion rates and impact soil stability within the freshwater ecosystems, therefore impacting on Type II ecosystem services such as erosion control, assimilation of nutrients and toxicants. Potential impacts on the freshwater ecosystems due to construction have the potential to impact on the hydraulic regime of the freshwater ecosystems thereby altering the natural pattern and timing of flows within the systems, this will result in also result

in impacts on Type II ecosystem services such as streamflow regulation, and flood attenuation which is essential for hydrologically connected freshwater ecosystems.

Construction and operation of the powerline infrastructure has the potential to impact on Type I ecosystem services, an example of this is through the cumulative loss of freshwater habitat due to construction particularly of the access roads. This has the potential to result in habitat fragmentation impacting on the wetlands ability to provide habitat and therefore maintain biodiversity. The cumulative loss of freshwater habitat also has the potential to result in decrease in provision of Type I ecosystem services such as opportunities for tourism and recreation due to loss of aesthetic value of the freshwater ecosystems although this is not considered the most significant ecosystem service within the assessed areas. Freshwater ecosystems provide direct services such as provision of water for human use, and for cattle and livestock, impacts associated with groundbreaking activities and increased vehicle movement resulting in dust generation have the potential to result in changes in the water quality regime of the freshwater ecosystems and therefore impacting on the provision of these direct services.

9 PROPOSED MONITORING PROGRAMME

Prudent monitoring must be done in the areas impacted by the construction activities associated with the proposed powerline project. Given that this is a linear infrastructure project, the rehabilitation and monitoring of disturbed areas must be done progressively in-line with the phase approach of the project. This will ensure a continual flow of data, enabling all parties involved to accurately assess and manage the progress of the rehabilitation interventions and any arising issues particularly for the monitoring of biota specific water quality on aquatic resources in the vicinity of the construction activities, monitoring of alien and invasive species, water retention and distribution patterns in the landscape. To ensure the accurate gathering of data, the following techniques and guidelines should be followed (Table 17):

Table 17: Monitoring recommendations for the impacted areas.

Aspect	Monitoring Location	Frequency of sampling	Frequency of Reporting	Report Content	Equipment
Water quality	Immediately upstream and downstream of the freshwater crossings.	Monitoring must take place prior to construction activities along freshwater crossings and after construction is completed.	Water monitoring must be assessed on a two-weekly basis along crossing points that are in an active phase of development during the construction phase and during maintenance in the event of infrastructure failure.	Report must be compiled on a monthly basis for all data collected and include mitigation and management actions that are recommended and that are undertaken.	1. GPS 2. Camera 3. Field Form 4. Handheld multi parameter water quality meter
Freshwater resource (riparian) ecological monitoring	Immediately upstream and downstream of the freshwater crossings. This must also include culverts associated with the proposed crossings.	Monitoring should take place bi-annually during the construction phase along crossing points that are in an active phase of development.	Bi-annual status quo reporting.	Results of the must be compared to the baseline results and any changes in ecological integrity/ecostatus or ecoservice provision must be documented. This can be done by assessing ecological drivers and receptors of the freshwater system. Important aspects include hydrological changes, water quality, soil erosion, and changes in the vegetation composition. In terms of ecoservices, important aspects include use of freshwater ecosystems by locals as source for water, cattle for drinking and various biodiversity for habitat.	1. GPS 2. Camera 3. Field Form
Erosion	Immediately upstream and downstream of the freshwater crossings.	Monitoring of erosion should occur on a weekly basis during construction by the contractor or ECO, and after every major rainstorm. Any erosion should be captured and recorded and reported during the ECO site visit	1. After every major rainstorm and/or flood. 2. Monthly monitoring report compiled by the appointed ECO during the construction phase.	1. Brief indication of the method of assessment; 2. Assumptions and Limitations must be listed; 3. Photos and GPS point locations taken of existing erosion in the freshwater features and adjacent banks must be incorporated into the report. 4. Any erosion observed must be discussed in detail and management recommendations made; and 5. Map indicating where erosion is present. 6. Recommended and undertaken control measures.	1.GPS 2. Camera 3. Field Form 4. Measuring Tape
Alien vegetation control	Immediately upstream and downstream of the freshwater crossings.	Regrowth of alien vegetation should be monitored monthly during the first growing season.	At the end of the first growing season following the completion of construction, and on an on-going monthly basis during operations.	1. Provide a list of species occurring within the study area; 2. Discuss the density of species; 3. Freshwater feature integrity and risk to be discussed; 4. Fixed point photograph (Taking photograph at specific point within priority area to show effect of alien vegetation control); 5. Control measures undertaken to be recorded, and; 6. Assess the necessity of further alien and invasive vegetation control.	1. GPS; 2. Field Form; and 3. Camera

10 IMPACT STATEMENT AND CONCLUSION

Scientific Aquatic Services (Pty) Ltd. (SAS) was appointed by SRK Consulting (South Africa) to conduct a freshwater ecosystem assessment as part of the environmental authorisation (EA) process for the Gove-Chipindo-Cuvango-Jamba Transmission Line Project (*referred to as the Cassinga Electrical Power Supply Project during the ESIA process and stakeholder engagement*) (the Project). During the wet season assessment conducted over a period of five (5) days in April 2024, identified drainage systems comprised four primary hydrogeomorphic (HGM) types: rivers with associated riparian vegetation and in some cases with associated floodplains, valley bottom wetlands (both channelled and unchannelled), and what are referred to locally (in Angola) as 'dambos' – the latter being characterised by relatively even topography and situated in low-lying areas. The ecological integrity of the freshwater ecosystems was largely intact due to the remote geographic location of the proposed powerline infrastructure. Ecological modifiers include freshwater crossings, subsistence cultivation activities, impoundments including large dams such as the Gove dam and Cuandeja Dam and impacts associated with use of some of the freshwater ecosystems for domestic needs. The dry season survey undertaken during July 2024 reiterated the strong seasonal variability of the surface water resource units, especially the valley bottom and dambo wetland units. This does not impact on the overall PES nor ecoservice provision of the units, however.

Despite these impacts, in terms of ecological services, the freshwater ecosystems are considered important for local communities in terms of provision of water for domestic use, these systems are also a drinking source for cattle and are able to provide good habitat essential for biodiversity maintenance. In addition, the valley bottom wetland systems were utilised for subsistence farming.

10.1 Impact Statement

The proposed powerline will cross the freshwater systems, however, given the spatial footprint of the infrastructure such as the powerline supporting pylons and proposed substations, the extent of modification is anticipated to be low. During the planning phase, it must be ensured that the powerline support pylons are spanned appropriately to avoid direct encroachment within the freshwater ecosystems. This is critical for maintenance of ecological functionality as well the longevity and protection of the proposed infrastructure.

In terms of the proposed access roads, the layout indicates that some proposed new roads will traverse the delineated freshwater ecosystems, and this will result in a medium impact.

Therefore, it is recommended that any in-stream construction works associated with the access roads must ideally be done during the winter season where the flows are low to limit. The medium impact significance is particularly likely to occur during the construction phase of the project where increased vehicle movement will be taking place, resulting in increased dust generation, smothering of freshwater habitat and potential proliferation of alien and invasive species. Beyond the construction phase, the proposed freshwater crossings will also result in a cumulative loss of freshwater habitat and therefore it is important that suitable mitigation measures are implemented to manage significant loss of freshwater habitat during construction of the proposed new access roads and associated crossings.

10.2 Conclusion and Specialist Opinion

In conclusion, given that the project has the potential to limit direct impacts on the freshwater ecosystems which reduces the overall impact significance of the project and that the project is considered essential for human livelihoods including socio-economic development and more broadly, for sustainable development for local communities in the areas which form part of the project, it is the opinion of the specialist that the project be considered in a positively for authorisation.

11 REFERENCES

Allanson, B. R.,Hart, R. C.,Keefe, J. H. O.;Robarts, R. D. (1990). "*Inland waters of southern Africa: An ecological perspective*" Dumont, H. J.;Werger, M. J. A. ((Vol. Monographiae Biologicae 64, pp. Kluwer Academic Publishers) as cited by Tweddle, D. 2015. Freshwater Ecosystems of the World (FEOW). Zambezian Headwaters (555). World Wildlife Fund (WWF): The Nature Conservancy (TNC). [online]. URL: http://www.feow.org/ecoregions/details/555

Department of Water Affairs and Forestry (DWAF). 2008. *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas,* prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. X. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2005. *Final draft: A practical field procedure for identification and delineation of wetlands and Riparian areas.*

Department of Water and Sanitation (DWS). 2014. *A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: C2 Compiled by RQIS-RDM: Online available: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx*

IUCN (International Union for Conservation of Nature). 2007. *Oreochromis andersonii*. The IUCN Red List of Threatened Species, Version 2024-2. Available at: https://www.iucnredlist.org [Accessed 6 Feb. 2025].

IUCN (International Union for Conservation of Nature), 2007. *Oreochromis macrochir*. The IUCN Red List of Threatened Species, Version 2024-2. Available at: https://www.iucnredlist.org [Accessed 6 Feb. 2025].

Kleynhans C.J., Thirion C. and Moolman J. 2005. *A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kleynhans C.J., Thirion C., Moolman J, Gaulana L. 2007. *A Level II River Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria

Kotze D.C., Marneweck G.C., Batchelor, A.L., Lindley D.S. and Collins N.B. 2009. *WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands.* WRC Report No TT 339/08, Water Research Commission, Pretoria.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P. and Goge C. 2008. *WET-Health: A technique for rapidly assessing wetland health.* WRC Report No. TT 340/08. Water Research Commission, Pretoria.

Nel, JL, Driver, A., Strydom W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J, Nienaber, S., Van Deventer, H., Swartz, E. & Smith-Adao, L.B. 2011. *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources.* Water Research Commission Report No. TT 500/11, Water Research Commission, Pretoria.

Ollis, D.J., Snaddon, C.D., Job, N.M. & Mbona, N. 2013. *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Rossouw, L., Avenant, M. F., Seaman, M. T., King, J. m., Barker, C. H., du Preez, P. J., Pelser, A. J., Roos, J. C., van Staden, J. J., van Tonder, G. J., and Watson, M. 2005. *Environmental Water Requirements in Non-Perennial Systems.* WRC Report 1414/1/05. Water Research Commission. Pretoria.

Roberts, T. R. (1975). "Geographical distribution of African freshwater fishes" Zool. J. Linn. Soc. 57 pp. 249-319 as cited by Tweddle, D. 2015. Freshwater Ecosystems of the World (FEOW). Zambezian Headwaters (555). World Wildlife Fund (WWF): The Nature Conservancy (TNC). [online]. URL: http://www.feow.org/ecoregions/details/555

Rountree, M.W. and Kotze, D.C. 2013. Appendix A3: Ecological Importance and Sensitivity Assessment. In: Rountree, M. W., Malan, H.L., and Weston, B.C. Eds. *Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)*. WRC Report No. 1788/1/12. Pretoria.

UNEP-WCMC and IUCN. 2024. *Protected Planet: The World Database on Protected Areas (WDPA) and World Database on Other Effective Area-based Conservation Measures* (WD-OECM) [Online], April 2024, Cambridge, UK: UNEP-WCMC and IUCN. Available Here: www.protectedplanet.net.

Van Deventer, H.; Smith-Adao, L.; Mbona, N.; Petersen, C.; Skowno, A.; Collins, N.B.; Grenfell, M.; Job, N.; Lötter, M.; Ollis, D.; Scherman, P.; Sieben, E.; Snaddon, K. 2018. *South African Inventory of Inland Aquatic Ecosystems. South African National Biodiversity Institute, Pretoria. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number* http://hdl.handle.net/20.500.12143/5847.

Van Deventer, H., Smith-Adao, L., Collins, N.B., Grenfell, M., Grundling, A., Grundling, P-L., Impson, D., Job, N., Lötter, M., Ollis, D., Petersen, C., Scherman, P., Sieben, E., Snaddon, K., Tererai, F. & Van der Colff, D. 2019. *South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. CSIR report number CSIR/NRE/ECOS/IR/2019/0004/A. South African National Biodiversity Institute, Pretoria.* http://hdl.handle.net/20.500.12143/6230.

Van Deventer, H., Smith-Adao, L., Mbona, N., Petersen, C., Skowno, A., Collins, N.B., Grenfell, M., Job, N., Lötter, M., Ollis, D., Scherman, P., Sieben, E. & Snaddon, K. *2018. South African National Biodiversity Assessment 2018: Technical Report. Volume 2a: South African Inventory of Inland Aquatic Ecosystems (SAIIAE). Version 3, final released on 3 November 2019. Council for Scientific and Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI): Pretoria, South Africa. Report Number: CSIR report number CSIR/NRE/ECOS/IR/2018/0001/A; SANBI report number* http://hdl.handle.net/20.500.12143/5847.

APPENDIX A – Terms of Use and Indemnity

INDEMNITY AND TERMS OF USE OF THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and SAS and its staff reserve the right to, at their sole discretion, modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although SAS (Pty) Ltd exercises due care and diligence in rendering services and preparing documents, SAS (Pty) Ltd accepts no liability and the client, by receiving this document, indemnifies SAS (Pty) Ltd and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by SAS (Pty) Ltd and by the use of the information contained in this document.

This report must not be altered or added to or used for any other purpose other than that for which it was produced without the prior written consent of the author(s). This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

APPENDIX B – Legislation

LEGISLATIVE REQUIREMENTS

Ministry of Environment (MINAMB)	The Ministry of Environment (MINAMB) is the Ministerial Department responsible to formulate, conduct, supervise, evaluate, and execute the Executive's policy in the field of protection, preservation and conservation of environmental quality, pollution control, areas of conservation and enhancement of natural heritage, as well as the preservation and rational use of mineral resources. MINAMB comprises a set of agencies and services, in particular, the National Directorate for the Prevention and Assessment of Environmental Impacts (Direcção Nacional de Prevenção e Avaliação de Impactes Ambientais (DNPAIA)), which is the service responsible for the conception and implementation of policies and strategies to prevent the incidences of environmental impacts. Depending on the type of project being developed, the EIA report must also be approved by the line ministry. This ensures that the EIA not only addresses the requirements of the Environmental Baseline Law and the Presidential Decree on Environmental Impact Assessment and Environmental Licensing, but also the relevant sectoral legislation. MINAMB also includes a set of bodies and services, in particular the National Directorate for the Prevention and Evaluation of Environmental Impacts (DNPAIA), which is the service responsible for designing and implementing policies and strategies to prevent environmental impact incidences. MINAMB is responsible for the implementation of the Environment Framework Law 5/98, the approval of EIAs under the Presidential Decree 117/20 on Environmental Impact Assessment and Environmental Licensing Procedure, and all associated Regulations
The General Environmental Law No. 5/98	The General Environmental Law (Lei de Bases do Ambiente, LBA) was promulgated in accordance with the Constitutional Law of the Republic of Angola. The purpose of the law is to provide the framework for environmental legislation and regulations; more specifically to define the basic concepts and principles for the protection, preservation and conservation of the Environment, promotion of quality of life and the rational use of natural resources (Article 1). The LBA incorporates international declarations which Angola has ratified and defines citizens' rights and responsibilities. Further, the LBA introduces the concept of legal penalties for illegal activities that have caused damage to the environment. Article 4 includes a number of principles guiding LBA, including a principle in respect of liability: all persons or organisations which through their actions cause harm to the environment, or the degradation, destruction or depletion of national resources, shall be held liable for the same, and shall be required to repair such damage and/or pay compensation for the damage caused. Article 16(1) of LBA stipulates that an Environmental Impact Assessment (EIA), including public consultation (Articles 10 and 32), is mandatory for all undertakings which have an impact on the balance and wellbeing of the environment and society. Article 16(2) states that more specific legislation on EIAs will be developed by the government. An Environmental License is issued on the basis of an EIA/EIS and a license is required before any other license required by law will be granted (Article 17(2)). According to the LBA, MINAMB is responsible for issuing environmental licenses
Decree No.117/20 on General Regulation for Environmental Impact Assessment and Environmental Licensing Procedure.	This decree establishes the standards and procedures that regulate the environmental impact assessment of public and private projects and the environmental licensing procedure for activities that, due to their nature, location or dimension, may cause significant environmental and social impact (Article 1). Applies to all public or private activities that may directly or indirectly influence environmental components (Article 2). This decree revokes the regulations previously in force on these matters (Decree No. 51/04, of 23 July 2004, on EIA, and Decree No. 59/07, of 13 July, on Environmental Licensing), as well as all legislation that contradicts its wording. Chapter II of the decree focuses on EIA, and Chapter III establishes the provisions applicable to Environmental Licensing. Chapter IV sets out the requirements for monitoring the provisions of the decree, the fees to be paid and the fines and accessory penalties applicable to infractions. Article 7 refers to the categorization of the activities and therefore Annexes I to V list the activities that are classified under Category A, B, C, D and E, respectively, and specifies the requirements for each one of those categories. For activities under category A, an EIA is required as well as Terms of Reference (TOR) and an Environmental Pre-Feasibility Study and Scoping (EPDA) (Article 7 and 12); Category B requires an EIA and the preparation of TOR for its elaboration; and Category C will require a Simplified Environmental Study and TOR. At the beginning of an Environmental Impact Assessment procedure, the project owner (in this instance, Soul Rock) must register the proposed activity, under the terms of the applicable legislation in force, in the Integrated Environmental System (SIA). The Ministerial Department that oversees the proposed activity must, within 5 (five) days, after receiving the Environmental Impact Study, issue an opinion on the project to be licensed (Article 6 (3)).

	Within a maximum period of 30 (thirty) days from the date of receipt of the documentation, the Ministerial Department responsible for the Environment Sector sends the respective opinion to the competent authority to license or authorize the project (Article 17). Therefore, the project that has received a negative opinion from the Minister responsible for the Environment cannot be given authorization or license (Article 18 (1)). Furthermore, the decision taken by MINAMB can be appealed under the general terms of administrative procedures and litigation (Article 18 (2)). This decree adopts provisions concerning requirements, criteria and administrative procedures related to Environmental Licenses. In terms of Article 26, any activity requiring an EIA must apply for an Environmental License, which the MINAMB issues.
Water Law No. 6/02	Article 10 states that the objective of the State is "to ensure the use of available water for all purposes through its rational and planned use for the sustained development of the national economy" and also to "promote, frame and regulate the use of water for agricultural, livestock, industrial and hydroelectric purposes". The law states that private use of water cannot come before public use: "Common uses, as described in articles 21 and 22, have priority over any private use, so that private use cannot be granted or maintained to the detriment of those". Pursuant to Articles 22 and 24, water uses are classified as (1) common (public) use, which refers to water taken from natural sources without any administrative approval, and (2) private water use, which requires a license. Common (public) water uses have priority over private water uses. Articles 24 and 26 of the Act further clarify private uses that require and do not require a license or concession. The supply of water to the population for human consumption and health needs has priority over other private uses (Article 33(2)). Article 41 (1) establish that private use of water depends on licensing, in which its use does not significantly change the quality and quantity of the water and the environmental balance, in accordance with the Regulation. n.º2 of the same Article states that the following also depends on licensing: a) prospecting, pumping water and use of groundwater, except the activities described line c) of n.º1 of article 26 of this law[1]; b) deposits installation, the crops implantation or plantations and the cut down of trees on the beds and banks of the continuous or discontinuous natural currents and lakes, lagoons and marshes; and c) the extraction of inert materials, such as sand and gravel, from the beds and margins of continuous or discontinuous natural currents and from lakes, lagoons and marshes. In terms of Article 68, Section 1 of the law, "the discharge of wastewater, wastes or other substances, and any activities that cause pollution or degradation of public water, is dependent on authorisation granted by the institution responsible for managing water resources".
Presidential Decree No. 26/20 (National Biodiversity Strategy and Action Plan 2019-2025)	To implement the recommendations from the United Nations Convention on Biological Diversity (UNCBD, ratified by Resolution No. 23/97), the Government approved through Resolution No. 42/06 of 26 July 2006, the National Biodiversity Strategy and Action Plan (NBSAP). However, this Resolution was revoked by Presidential Decree No. 26/20 that approves the National Biodiversity Strategy and Action Plan 2019-2025, an annex of this Presidential Decree. This strategy aims to incorporate measures for the conservation and sustainable use of biological diversity and the fair and equitable distribution of biological resources favouring all Angolans into policies and development programmes. The National Strategy and Action Plan for Biodiversity (NBSAP) of the Republic of Angola was developed to serve as an integrated strategic framework. the conservation and sustainable use of biodiversity can be organized and coordinated to fulfil an Action Plan over seven years (2019-2025).
Presidential Decree No. 194/11 on Liability on Environmental Damage	This decree establishes strict liability for degradation of the environment. Aimed at preventing and repairing environmental damage, the decree establishes that all activities capable of causing damage to the environment (Article 3(1)) are considered liabilities and are subject to regulation under the "polluter pays" principle. According to the decree, any entity responsible for pollution (by act of wilful misconduct or negligence) will be held responsible for cleaning up and restoring the environmental damage. Responsibility will be held for losses and damages caused to the environment by way of compensation for damages and environmental recovery measures. Article 18º informs the right of the public to request intervention when there is concern that environmental damage has taken place. In Article 21º, the Decree also states that any individuals or legal entities which carry out activities that impose environmental risks shall have civil liability insurance
Presidential Decree No. 261/11 on Water Quality	This decree serves as an addition to the national Water Law No. 6/02, dealing specifically with water quality. It establishes the roles within the Angolan governmental administration for overseeing water quality issues and addressing the water quality standards relating to human consumption and waste water. The decree also lists the role of water quality monitoring and the standard parameters for drinking water, surface water and emissions limits for wastewater discharge (in Annex VI). According to item 3 of Article 1, this law also regulates the control standards of wastewater discharge in water bodies and soil to preserve the quality of the aquatic environment and protect public health. Article 13 of Chapter III (Protection of Waters Against Pollution of Discharged Wastewater) defines that the discharge of wastewater from a treatment facility into water and soil requires a license issued by the Ministry of Environment, in which discharge standards for mitigation or prevention of damage are set.

Presidential Decree No. 82/14, approves the Regulation on the General Use of Water Resources	This decree applies to surface water and groundwater, namely watercourses, lakes, lagoons, swamps, springs, reservoirs, estuarine areas and other water bodies, without prejudice to the respective watercourse bed, river banks and surroundings. Article 17 states that the use of water resources for private use need a specific title of use (concession or license). Article 109(2) establishes that holders of rights to use water resources shall in general be prohibited from: "b) Accumulate solid wastes, liquids or any substances in places and conditions that may contaminate or create danger of water resources contamination; c) Carry out any activities that imply or may imply the degradation or pollution of the water resources; d) Make any changes to the regime, flow, quality and use of water resources that may affect the public health, natural resources, the general environment, security and national sovereignty; e) Carry out any activities in the water protection zones." Article 110 establishes that proponents shall consider a 200m buffer zone as follows: "areas of protection of water resources, the water course beds, river banks and water courses adjacent zones of up to a distance of 200 metres". Article 111 defines, as it is forbidden, in the protection zones of the water resources, in terms of the present Diploma and other applicable laws: "d) Install dumps or heaps resulting from mining activity; f) Install pipelines and reservoirs of hydrocarbons or wastewater." Article 119 states that: "without prejudice the provisions of this legal document, the assignment of any permits for the use of water resources, independently of its end, is subject to prior approval by the corresponding environmental impact studies, provided that that the legislation in force to require, by virtue of its nature, size or location, which may have significant environmental and social impacts." Sections I and II from Chapter VIII (Fees) presents the calculations related with the fees to be paid for water abstraction and wastewater discharge. Executive Decree No. 469/15 on the slaughter prohibition in the national territory of protected species of the fauna and wild flora This executive decree establishes a ban on the slaughtering of wild fauna and flora (protected species) on national territory, in order to avoid the illegal hunting and trafficking of valuable objects, activities which, in recent years have assumed high levels, endangering the biodiversity, under the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), assigning to the Ministry of Environment inspectors the responsibility for overseeing and define the regime of sanctions.
International Finance Corporation (IFC) Environmental Health and Safety Guidelines and Performance Standards (2007)	The IFC is a financial services provider which has set out to ensure that their clients act responsibly toward the environment by providing environmental, health and safety guidelines which their clients must follow and apply before lending of finance may take place. ○ **Performance Standard 1**: Assessment and Management of Environmental and Social Risks and Impacts - Underscores the importance of managing environmental and social performance throughout the life of a project. ○ **Performance Standard 3**: Resource Efficiency and Pollution Prevention - Recognizes that increased economic activity and urbanization 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. ○ **Performance Standard 4**: Community Health, Safety, and Security - Recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. ○ **Performance Standard 5**: Land Acquisition and Involuntary Resettlement - Recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. ○ **Performance Standard 6**: Biodiversity Conservation and Sustainable Management of Living Natural Resources - Recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The IFC habitat categories are defined as follows: ***Modified Habitat*** Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. This Performance Standard applies to those areas of modified habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in PS 1. The proponent should minimise impacts on such biodiversity and implement mitigation measures as appropriate. ***Natural Habitat*** Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. The proponent will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

	➢ No other viable alternatives within the region exist for development of the project on modified habitat; ➢ Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and ➢ Any conversion or degradation is mitigated according to the mitigation hierarchy. ➢ In areas of natural habitat, mitigation measures will be designed to achieve no nett loss of biodiversity where feasible. Appropriate actions include: ➢ Avoiding impacts on biodiversity through the identification and protection of set-asides; ➢ Implementing measures to minimise habitat fragmentation, such as biological corridors; ➢ Restoring habitats during operations and/or after operations; and ➢ Implementing biodiversity offsets. ***Critical Habitat*** Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered 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. In areas of critical habitat, the proponent will not implement any project activities unless all of the following are demonstrated: ➢ No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical; ➢ The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values; ➢ The project does not lead to a nett reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and ➢ A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the proponent's management program.

APPENDIX C – Method of Assessment

1. Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion and ecostatus of the larger aquatic system within which the watercourses present or in close proximity of the study area are located. Aspects considered as part of the literature review are discussed in the sections that follow.

2. Wetland Classification System

All areas containing wetland or riparian characteristics that were encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). This method encompasses the broad suite of "wetlands" as defined by the Ramsar Convention and includes all ecosystems that the Ramsar Convention is concerned with.

A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table B1: Classification System for Inland Systems, up to Level 3.

<table>
<tr><th colspan="3">WETLAND / AQUATIC ECOSYSTEM CONTEXT</th></tr>
<tr><td>LEVEL 1:
SYSTEM</td><td>LEVEL 2:
REGIONAL SETTING</td><td>LEVEL 3:
LANDSCAPE UNIT</td></tr>
<tr><td rowspan="4">Inland Systems</td><td rowspan="4">DWA Level 1 Ecoregions
OR
NFEPA WetVeg Groups
OR
Other special framework</td><td>Valley Floor</td></tr>
<tr><td>Slope</td></tr>
<tr><td>Plain</td></tr>
<tr><td>Bench
(Hilltop / Saddle / Shelf)</td></tr>
</table>

Level 1: Inland systems

From the classification system, Inland Systems (Table B1) are defined as **aquatic ecosystems that have no existing connection to the ocean**[4] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included in Level 2 of the classification system is that of the aquatic ecoregion (Table B1). Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

[4] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Table B2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 3: Landscape Setting

At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table B1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table B2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

Taking into consideration the descriptions of wetlands commonly used in Angola. At a high level, the watercourses were classified as Inland Systems falling within the Zambezian Headwaters Aquatic Ecoregions. The identified drainage systems comprised four primary hydrogeomorphic (HGM) types: rivers with associated riparian vegetation and in some cases with associated floodplains, valley bottom wetlands (both channelled and unchannelled), and what are referred to locally (in Angola) as ‘dambos’ – the latter being characterised by relatively even topography and situated in low-lying areas.

Wetland delineation

For the purposes of this investigation, wetland habitat was defined according to the factors associated with the Ramsar Commissions’ definition of a wetland. The extent of the wetland was determined by delineating the wetland based upon the Department of Water and Sanitation (DWS) (formerly DWA / DWAF) guidelines ‘A practical field procedure for the identification and delineation of wetlands and riparian areas’ (DWAF, 2008). This method is regarded as regional best practice adapted from the Ramsar Commissions guidelines and stipulates that consideration be given to four specific wetland indicators to determine the boundary of the wetland. Whilst not developed in the region in which the

investigation area is located, this method is regarded as applicable, relevant and provides an accurate rationale in watercourse mapping in support of the International Finance Corporation standards for rigorous characterisation of watercourses.

These indicators are:

- Densification of riparian vegetation;
- Changes in hue of vegetation;
- Linear connectivity of features to drainage systems;
- Position in the landscape, for example valley floors; and
- Presence of surface water showing up either as black areas or white areas reflecting cloud cover.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF 2005).

The presence of hydric soils as a soil wetness indicator (i.e. examination of redoximorphic features within the soil) are one of the most important factors for identifying wetlands boundaries. The reason being that vegetation (considered to be the primary determining factor) can easily respond to changes in hydrology (e.g. the draining of a wetland), while the soil morphological signatures remain even if the wetland hydrology is altered.

A number of soil forms associated with the permanent zone of the wetland or the seasonal / temporary zones are provided in the guidelines of this method.

One of these are the redoximorphic features, which are the result of the reduction, translocation and oxidation (precipitation) of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 500mm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils, and it can then be considered a wetland. Redoximorphic features typically occur in three types:

- A reduced matrix – i.e. an *in situ* low chroma (soil colour), resulting from the absence of Fe_3^+ ions which are characterised by “grey” colours of the soil matrix.
- Redox depletions - the “grey” (low chroma) bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur; and
- Redox concentrations - Accumulation of iron and manganese oxides (also called mottles).

Once the presence or absence of redoximorphic features within the upper 500mm of the soil profile is identified, that alone is sufficient to identify the soil as being hydric (a wetland soil) or non-hydric (non-wetland soil) (Collins, 2005; DWAF, 2005).

Riparian and wetland zones can be divided into three zones (DWAF 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

Since wetlands have a wetness gradient from the middle of the wetland to the adjacent terrestrial area, vegetation in an untransformed state can be used to support the delineation of a wetland due to plant community adapting to the moisture gradient. Plant communities are assessed, rather than individual indicator species, but the dominant species (hydrophytes or not) in the area are assessed to determine the presence of a wetland.

APPENDIX D – Impact Assessment Methodology

Impact assessment methodology

Potential impacts (direct, indirect, cumulative) will be assessed using information gathered during the baseline assessment in combination with previously collected desktop data and compared with the detailed project description.

Impact significance rating

Practicable management measures will be recommended that avoid, and if avoidance is not possible, then reduce, restore, compensate/offset negative impacts, enhance positive impacts and assist project design. The impact significance rating system is presented in Table D1 and involves the following parts:

- Part A: Defines impact consequence using the three primary impact characteristics of magnitude, spatial scale and duration.
- Part B: Uses the matrix to determine a rating for impact consequence based on the definitions identified in Part A.
- Part C: Uses the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence.

Table D1: Impact significance rating system.

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE ***Use these definitions to define the consequence in Part B***		
Impact characteristics	**Definition**	**Criteria**
MAGNITUDE	Major -	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate -	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor -	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor +	Minor improvement; change not measurable; or threshold never exceeded
	Moderate +	Moderate improvement within or better than the threshold; or no observed reaction
	Major +	Substantial improvement; within or better than the threshold; or favorable publicity
SPATIAL SCALE OR POPULATION	Site	The area that is directly exposed to project facilities (i.e. project footprint)
	Local	The area affected by the project's direct impacts, .e. impacts that result from the direct interaction between project's infrastructures, routine project activities and the receiving environment
	Regional	the wider geographic area affected by the indirect impacts of the project's infrastructures and activities and/or impacts resulting from unforeseen (accidental) project activities, specifically the potential impacts in the unlikely event to occur
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years

PART B: DETERMINING CONSEQUENCE RATING ***Rate consequence based on definition of magnitude, spatial extent and duration***					
			SPATIAL SCALE/ POPULATION		
			Site	**Local**	**Regional**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
			Medium	Medium	High
		Short term	Low	Medium	Medium
PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE					

Use these definitions to define the consequence in Part B					
Impact characteristics	**Definition**		**Criteria**		
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High
PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*					
			CONSEQUENCE		
			Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)		Definite	Medium	Medium	High
		Possible	Low	Medium	High
		Unlikely	Low	Low	Medium

Notes: + denotes a positive impact. Using the matrix, the significance of each described impact is initially rated. This rating assumes the management measures inherent in the project design are in place.

Management recommendations and post management significance

After determining the significance rating, practicable management measures are suggested for each specific impact. The impact description should indicate the significance rating prior to and following mitigation/optimisation. As explained above:

“Recommendations for management should focus on avoidance, and if avoidance is not possible, then to reduce, restore, compensate/offset negative impacts, enhance positive impacts and assist project design.”

The significance of impacts is then re-assessed with assumed management measures in place (“after management”). Specialists also recommend and describe appropriate monitoring and review programs to track the efficacy of management measures.

An example of the table used to report the significance rating for each impact before and after the implementation of mitigation / management measures, and listing these measures, is provided in the table D2 below.

Table D2: Impact significance rating and mitigation measures for the impact.

Activity: XXXX								
Project phase: XXXX								
Impact Summary: XXXXX								
	Magnitude	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+ /-**	**Confidence**
Before Management	*Moderate*	*Long term*	*Site / local*	***Medium***	*Possible*	***Medium***	-	*Medium*
Management Measures:								

APPENDIX E – Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES) AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the Ecoservices for the riverine systems.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0,3	0,9	0,0	Very Low
	Stream flow regulation	-	-	#VALUE!	#VALUE!
	Sediment trapping	0,5	2,3	0,1	Very Low
	Erosion control	1,3	3,0	1,3	Moderately Low
	Phosphate assimilation	0,5	2,3	0,2	Very Low
	Nitrate assimilation	0,7	0,8	0,0	Very Low
	Toxicant assimilation	0,5	1,5	0,0	Very Low
	Carbon storage	1,0	2,7	0,8	Low
	Biodiversity maintenance	2,0	2,0	1,5	Moderately Low
PROVISIONING SERVICES	Water for human use	3,0	4,0	3,5	Very High
	Harvestable resources	2,5	1,3	1,7	Moderately Low
	Food for livestock	2,0	2,0	1,5	Moderately Low
	Cultivated foods	3,0	2,0	2,5	Moderately High
CULTURAL SERVICES	Tourism and Recreation	1,3	3,0	1,3	Low
	Education and Research	1,5	0,7	0,3	Very Low
	Cultural and Spiritual	2,0	0,3	0,7	Very Low

Table E2: Presentation of the results of the Ecoservices for the valley bottom wetland.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0,8	0,0	0,0	Very Low
	Stream flow regulation	1,8	0,3	0,4	Very Low
	Sediment trapping	0,9	1,5	0,1	Very Low
	Erosion control	1,1	2,0	0,6	Very Low
	Phosphate assimilation	0,9	1,5	0,1	Very Low
	Nitrate assimilation	0,8	1,5	0,0	Very Low
	Toxicant assimilation	0,8	1,5	0,1	Very Low
	Carbon storage	1,4	2,7	1,3	Low
	Biodiversity maintenance	1,7	2,0	1,2	Low
PROVISIONING SERVICES	Water for human use	1,5	0,7	0,3	Very Low
	Harvestable resources	1,5	1,3	0,7	Very Low
	Food for livestock	2,0	2,7	1,8	Moderate
	Cultivated foods	2,5	2,0	2,0	Moderate
CULTURAL SERVICES	Tourism and Recreation	0,4	0,0	0,0	Very Low
	Education and Research	0,5	0,0	0,0	Very Low
	Cultural and Spiritual	1,0	0,0	0,0	Very Low

Table E3: Presentation of the results of the Ecoservices for the dambos.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0,6	0,0	0,0	Very Low
	Stream flow regulation	2,0	0,0	0,5	Very Low
	Sediment trapping	1,6	3,0	1,6	Moderately Low
	Erosion control	1,5	1,3	0,7	Very Low
	Phosphate assimilation	1,7	2,0	1,2	Low
	Nitrate assimilation	1,6	2,0	1,1	Low
	Toxicant assimilation	1,7	2,0	1,2	Low
	Carbon storage	1,6	2,7	1,4	Moderately Low
	Biodiversity maintenance	1,6	1,0	0,6	Very Low
PROVISIONING SERVICES	Water for human use	1,5	0,3	0,2	Very Low
	Harvestable resources	0,5	0,3	0,0	Very Low
	Food for livestock	1,5	1,3	0,7	Very Low
	Cultivated foods	2,3	0,0	0,8	Very Low
CULTURAL SERVICES	Tourism and Recreation	0,3	0,0	0,0	Very Low
	Education and Research	0,5	0,0	0,0	Very Low
	Cultural and Spiritual	1,0	0,0	0,0	Very Low

APPENDIX F – Impact Analysis and Mitigation Measures

General construction management and good housekeeping practices

Latent and general impacts which may affect the freshwater ecosystem ecology and biodiversity, will include any activities which take place in close proximity to the proposed servitude that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the freshwater ecosystem identified in this report:

Development footprint

- All development footprint areas should remain as small as possible and should only encroach into the freshwater ecosystem considered absolutely essential;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid freshwater ecosystem areas and be restricted to existing roads along the tarred access road which traverses the freshwater ecosystem;
- Appropriate sanitary facilities must be provided for the life of the repair and maintenance phase and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant standards to prevent leakage;
- No fires should be permitted in or near the construction area; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed areas. Whilst not considered severe at this time, the vegetation component within the freshwater ecosystem environment is already transformed. However, alien invasive species are opportunistic, and where disturbances do occur, they will promulgate; therefore, these species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered within the freshwater ecosystem must take place to comply with applicable legislation; and
- Species specific and area specific eradication recommendations:
    - Footprint areas should be kept as small as possible when removing alien plant species; and
    - No vehicles should be allowed to drive through designated sensitive freshwater ecosystems areas during the eradication of alien and weed species.

Soils

- Sheet runoff from compacted areas should be slowed down by the strategic placement of berms;
- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soils;
- Temporary stockpiling of excavated material from trenches can be retained alongside trenches, as required for backfilling. Any soil to be stockpiled for longer than a month should be moved to a designated stockpile area, as approved by the Environmental Control Officer (ECO);
- All soils compacted during the repair and maintenance phase should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area as well as immediate vicinity of the proposed work area should be removed.

APPENDIX G – Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc (Environmental Management) (University of Johannesburg)
Dr. Matthew Ross	PhD Aquatic Health (University of Johannesburg)
Nqobile Lushozi	MSc (Geoinformatics) (Stellenbosch University)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Physical address:	29 Arterial Road West, Oriel		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	Stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Natural Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health Practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.

Signature of the Specialist

I, Mathew Ross, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.

Signature of the Specialist

I, Nqobile Lushozi, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct.

Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource Discipline Lead, Managing Member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health Practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018
Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy)	2018

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

DEVELOPMENT SECTORS OF EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river sand, clay, fluorspar
2. Linear developments (energy transmission, telecommunication, pipelines, roads)
3. Minerals beneficiation
4. Renewable energy (Hydro, wind and solar)
5. Commercial development
6. Residential development
7. Agriculture
8. Industrial/chemical

KEY SPECIALIST DISCIPLINES

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Environmental and Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions

Freshwater Assessments

- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant Species and Landscape Plans
- Freshwater Offset Plans
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Biodiversity Offset Plan

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF DR MATHEW JAMES ROSS

PERSONAL DETAILS

Position in Company	Discipline Lead, Principal Aquatic Ecologist, Ecologist
Joined SAS Environmental Group of Companies	2024

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist with the South African Council for Natural Scientific Professions (SACNASP): Reg no 005072 (Ecological Sciences & Aquatic Sciences)
Accredited River Health Practitioner by the South African River Health Program (RHP)
Member of the South African Wetland Society (SAWS)
Member of the South African Society for Aquatic Scientists (SASAqS)

EDUCATION

Qualifications

PhD Aquatic Health (University of Johannesburg)	2015
MSc Aquatic Health (University of Johannesburg)	2005
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc Biological Sciences (Zoology & Botany) (University of Johannesburg)	2000

Short Courses

Algal toxicity testing workshop – Environmentek, CSIR.	2003
Grass identification course – Witwatersrand Botanical Gardens	2003
Venomous snake handling and first aid	2003
First Aid – Level 3 – Netcare 911	2004
Advanced 4x4 driving	2001
Soil Classification course with emphasis on wetland delineations (TerraSoil Science)	2009
Advanced grass identification course (Africa Land Use Training)	2010
Qualified as an Advanced Scuba Diver.	2004
Internationally accredited protection dog trainer and trials assailant.	2005

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa –Botswana, Mozambique, Zimbabwe, Zambia, Namibia, Swaziland
Eastern Africa – Tanzania, Uganda, Malawi
West Africa – Ghana, Senegal, Angola, Cameroon, Mali, Burkina Fasso, Sierra Leone
Central Africa – Democratic Republic of the Congo

DEVELOPMENT SECTORS OF EXPERIENCE

1. Renewable energy: Hydropower (run-of-river, pumped storage & dams), solar (floating PV, PV & CSP).
2. Fish migrations assessments and fishpass/fishway design & construction
3. Instream infrastructure: Gauging weirs, abstraction weirs.
4. Ecological Water requirements: DRIFT Modelling experience.

5. Linear developments (energy transmission, telecommunication, pipelines, roads)
6. Water resources sector (wastewater treatment works & water treatment works).
7. Mining sector (various).
8. Industrial, commercial & residential developments.

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans

Aquatic Ecological Assessment and Water Quality Studies

- Fish migrations analysis
- Fishpass/fishway design and development (2D and 3D design modelling)
- Fishway integration and hydraulic modelling
- Habitat Assessment Indices (IHAS, HCR, IHI & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Response Assessment Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological analysis
- Water quality monitoring
- Screening Test
- Riverine Rehabilitation Plans
- Floral Assessments

Biodiversity Assessments

- Floral Assessments
- Faunal Assessments
- Avifaunal Impact Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring

Modelling & Design

- Proficient in GIS modelling and analysis
- Proficient in AutoCAD design and modelling
- Proficient in hydraulic analysis of fishways and other instream infrastructure

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF NQOBILE LUSHOZI

PERSONAL DETAILS

Position in Company	Freshwater Ecologist Wetland and Aquatic Ecology
Joined SAS Environmental Group of Companies	April 2019

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member of the International Affiliation for Impact Assessments (IAIAsa) South Africa
Member of the South African Wetland Society (SAWS)
Member of the South African Council for Natural Scientific Professions (SACNASP Reg No - 124679)

EDUCATION

Qualifications

MSc Geoinformatics (Cum laude) (Stellenbosch University)	2019
BSc (Hons) Environmental Sciences (University of KwaZulu-Natal)	2015
BSc Environmental Sciences (University of KwaZulu-Natal)	2014

Short courses

Tools for Wetland Assessment (Rhodes University)	2020
Grass Identification Course (Africa Land-Use Training)	2021

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North-West, Limpopo, KwaZulu-Natal, Northern Cape, Free State
West Africa – Angola

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans

Aquatic Ecological Assessment and Water Quality Studies

- Toxicological Analysis
- Surface and groundwater quality Monitoring
- Screening Test
- Mass and salt balance determination