

REPORT

Central Térmica de Temane Project - Ecosystem Services Impact Assessment

Moz Power Invest, S.A. and Sasol New Energy Holdings (Pty) Ltd

Submitted to:

Ministry of Land, Environment and Rural Development (MITADER)

Submitted by:

Golder Associados Moçambique Limitada

6th Floor, Millenium Park Building, Vlademir Lenine Avenue No 174

Maputo, Moçambique

+258 21 301 292 Golder Associados Moçambique Limitada

6th Floor, Millenium Park Building, Vlademir Lenine Avenue No 174

Maputo, Moçambique

+258 21 301 292

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Executive Summary

Introduction

In order to address the growing electricity demand faced by Mozambique and to improve power quality, grid stability and flexibility in the system, Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE). MPI's shareholding will be comprised of Electricidade de Moçambique, E.P (EDM) and Temane Energy Consortium (Pty) Ltd (TEC) is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. The proposed CTT project will draw gas from either the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF) or from an alternative gas source.

The proposed Power Plant site is thus located in close proximity to the existing CPF, in the Temane/Mangugumete area, Inhassoro District, Inhambane Province of Mozambique. Proposed project components that are likely to impact terrestrial ecology includes, *inter alia*; the development of the Power Plant site (20 ha) and a 25 km transmission line; the establishment of a beach landing site; and, the upgrade of road access route. This document presents an ecosystem services impact assessment for these proposed project components.

Ecosystem services are the benefits that people and/or a project (the beneficiaries) obtain from ecosystems; consisting of all the natural products and processes that contribute directly and indirectly to human well-being, as well as the personal and social enjoyment derived from nature.

Study Methods

The ecosystem services that the Project could impact (Type I) were identified by first defining which ecosystems could be affected, determining the ecosystem services supplied by and demanded from those ecosystems, and identifying the beneficiaries who use those services supplied by the ecosystems that could be affected. Ecosystem services that the Project depends upon (Type II) were also identified. This was done by reviewing a suite of social, ecological and biophysical baseline reports and impact assessments that have been conducted for the Project.

Following this, a prioritisation of ecosystem services was undertaken and potential impacts on priority ecosystem services were identified and then assessed for significance.

Main Findings

Five Priority Type I ecosystem services were identified, namely 1) Food - Subsistence Crops, 2) Food – Sea and, 3) River Fisheries; 4) Biomass fuel (wood and charcoal); and, 5) Fresh water supply. Potential impacts on these priority ecosystems that were identified and assessed for significance both before- and after mitigation included:

- Vegetation clearance and soil removal in preparation for construction (land-take);
- Disruption of coastal fishing activities;
- Contamination/pollution of surface water due to construction activities;
- Abstraction of ground water from boreholes;
- Contamination/pollution of ground- and surface water resources; and
- Population influx.

The rating of these impacts during the construction, operational and closure phases indicates that before mitigation, they mostly have a moderate significance.

With the implementation of appropriate mitigation measures however, their significance can be reduced to low. It is therefore important that the mitigation measures outlined in this report and indeed all relevant associated impact assessments, are incorporated into the CTT project's overall environmental management programme.

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APPENDIX A

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Results of Prioritisation Exercise for Type II Ecosystem Services

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Document Limitation

1.0 INTRODUCTION

The Mozambican economy is one of the fastest growing economies on the African continent with electricity demand increasing by approximately 6-8% annually. In order to address the growing electricity demand faced by Mozambique and to improve power quality, grid stability and flexibility in the system, Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique and Sasol New Energy Holdings (Pty) Ltd (SNE) in a joint development agreement is proposing the construction and operation of a gas to power facility, known as the Central Térmica de Temane (CTT) project. MPI's shareholding will be comprised of EDM and Temane Energy Consortium (Pty) Ltd (TEC). The joint development partners of MPI and SNE will hereafter be referred to as the Proponent. The Proponent propose to develop the CTT, a 450MW natural gas fired power plant.

The proposed CTT project will draw gas from the Sasol Exploration and Production International (SEPI) gas well field via the phase 1 development of the PSA License area, covering gas deposits in the Temane and Pande well fields in the Inhassoro District and the existing Central Processing Facility (CPF). Consequently, the CTT site is in close proximity to the CPF. The preferred location for the CTT is approximately 500 m south of the CPF. The CPF, and the proposed site of the CTT project, is located in the Temane/Mangugumete area, Inhassoro District, Inhambane Province, Mozambique; and approximately 40 km northwest of the town of Vilanculos. The Govuro River lies 8 km east of the proposed CTT site. The estimated footprint of the CTT power plant is approximately 20 ha (see Figure 1).

Associated infrastructure and facilities for the CTT project will include:

- 1) Electricity transmission line (400 kV) and servitude; from the proposed power plant to the proposed Vilanculos substation over a total length of 25 km running generally south to a future Vilanculos substation. [Note: the development of the substation falls outside the battery limits of the project scope as it is part of independent infrastructure authorised separately (although separately authorised, the transmission line will be covered by the Project ESMP, and the Vilanculos substation is covered under the Temane Transmission Project (TTP) Environmental and Social Management Plans). Environmental authorisation for this substation was obtained under the STE/CESUL project. (MICOA Ref: 75/MICOA/12 of 22nd May 2012)];
- 2) Piped water from one or more borehole(s) located either on site at the power plant or from a borehole located on the eastern bank of the Govuro River (this option will require a water pipeline approximately 11km in length);
- 3) Access road; over a total length of 3 km, which will follow the proposed water pipeline to the northeast of the CTT to connect to the existing Temane CPF access road;
- 4) Gas pipeline and servitude; over a total length of 2 km, which will start from the CPF high pressure compressor and run south on the western side of the CPF to connect to the power plant;
- 5) Additional nominal widening of the servitude for vehicle turning points at points to be identified along these linear servitudes;
- 6) A construction camp and contractor laydown areas will be established adjacent to the CTT power plant footprint; and
- 7) Transshipment and barging of equipment to a temporary beach landing site and associated logistics camp and laydown area for the purposes of safe handling and delivery of large oversized and heavy equipment and infrastructure to build the CTT. The transshipment consists of a vessel anchoring for only approximately 1-2 days with periods of up to 3-4 months between shipments over a maximum 15 month period early in the construction phase, in order to offload heavy materials to a barge for beach landing. There are 3 beach landing site options, namely SETA, Maritima and Briza Mar (Figure 7). The SETA site is considered to be

the preferred beach landing site for environmental and other reasons; it therefore shall be selected unless it is found to be not feasible for any reason; and

- 8) Temporary bridges and access roads or upgrading and reinforcement of existing bridges and roads across sections of the Govuro River where existing bridges are not able to bear the weight of the equipment loads that need to be transported from the beach landing site to the CTT site. Some new sections of road may need to be developed where existing roads are inaccessible or inadequate to allow for the safe transport of equipment to the CTT site. The northern transport route via R241 and EN1 is considered as the preferred transport route (Figure 8) on terrestrial impacts; however, until the final anchor point is selected, and the barge route confirmed, the marine factors may still have an impact on which is deemed the overall preferable route.

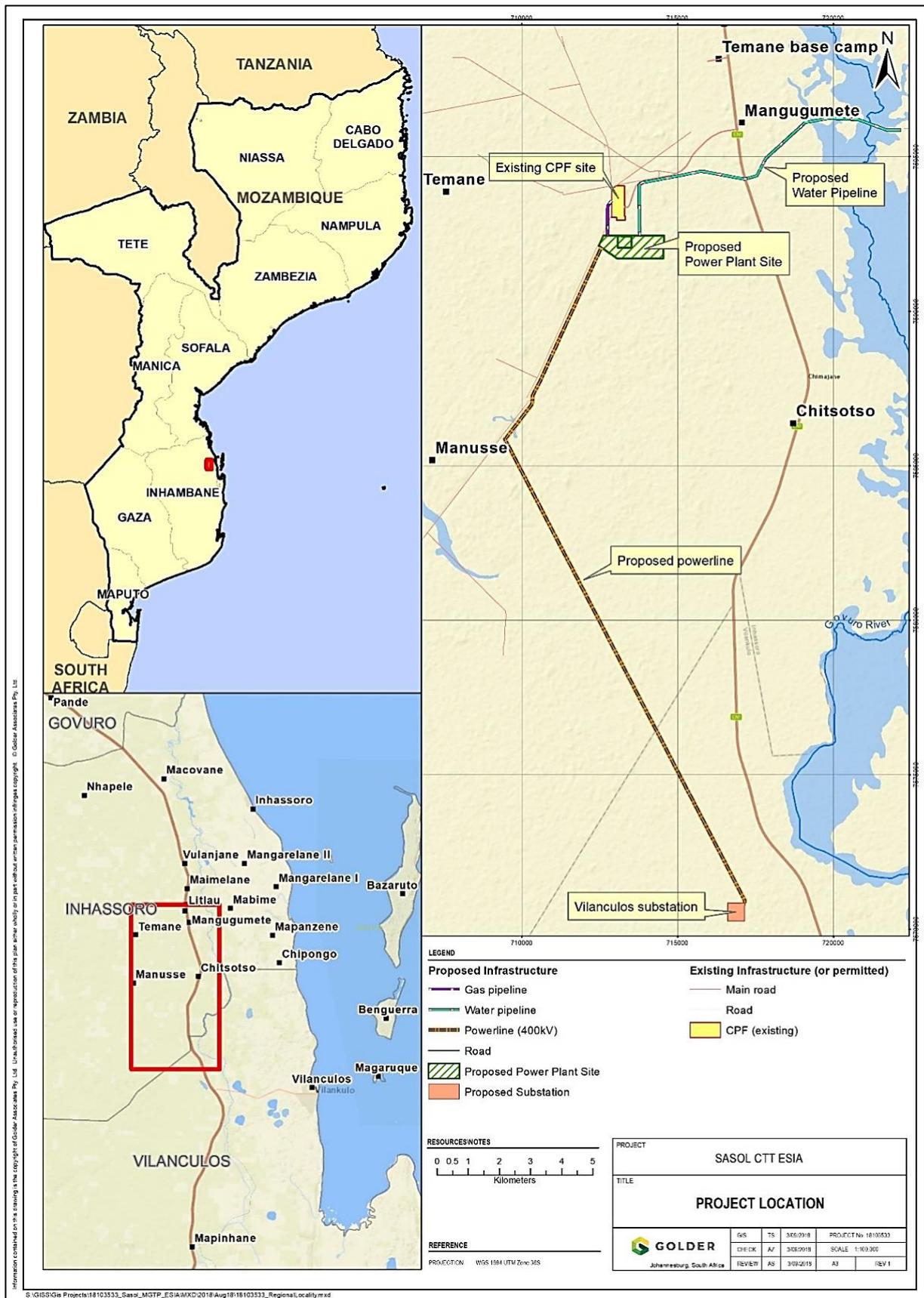


Figure 1: Project Location

2.0 DESCRIPTION OF THE KEY PROJECT COMPONENTS

The CTT project will produce electricity from natural gas in a power plant located 500 m south of the CPF. The project will consist of the construction and operation of the following main components:

- Gas to Power Plant with generation capacity of 450 MW (examples are shown in Figure 2);
- Gas pipeline (± 2 km) that will feed the Power Plant with natural gas from the CPF;
- 400 kV Electrical transmission line (± 25 km) with a servitude that will include a fire break (vegetation control) and a maintenance road to the Vilanculos substation. The transmission line will have a partial protection zone (PPZ) of 100m width. The transmission line servitude will fall inside the PPZ;
- Water supply pipeline to one or more borehole(s) located either on site or at borehole located east of the Govuro River;
- Surfaced access road to the CTT site and gravel maintenance roads within the transmission line and pipeline servitudes;
- Temporary beach landing structures at Inhassoro for the purposes of delivery of equipment and infrastructure to build the power plant. This will include transshipment and barging activities to bring equipment to the beach landing site for approximately 1-2 days with up to 3-4 months between shipments over a period of approximately 8-15 months;
- Construction camp and contractor laydown areas adjacent to the CTT power plant site; and
- Temporary bridge structures across Govuro River and tributaries, as well possible new roads and/or road upgrades to allow equipment to be safely transported to site during construction.



Figure 2: Examples of gas to power plant sites (source: www.industcards.com and www.wartsila.com)

The final selection of technology that will form part of the power generation component of the CTT project has not been determined at this stage. The two power generation technology options that are currently being evaluated are:

- Combined Cycle Gas Turbine (CCGT); and
- Open Cycle Gas Engines (OCGE).

Please refer to Chapter 4 of the main ESIA document for further details on the technology option.

At this early stage in the project a provisional layout of infrastructure footprints, including the proposed linear alignments is also indicated in Figure 1. A conceptual layout of the CTT plant site is shown below in Figure 3.

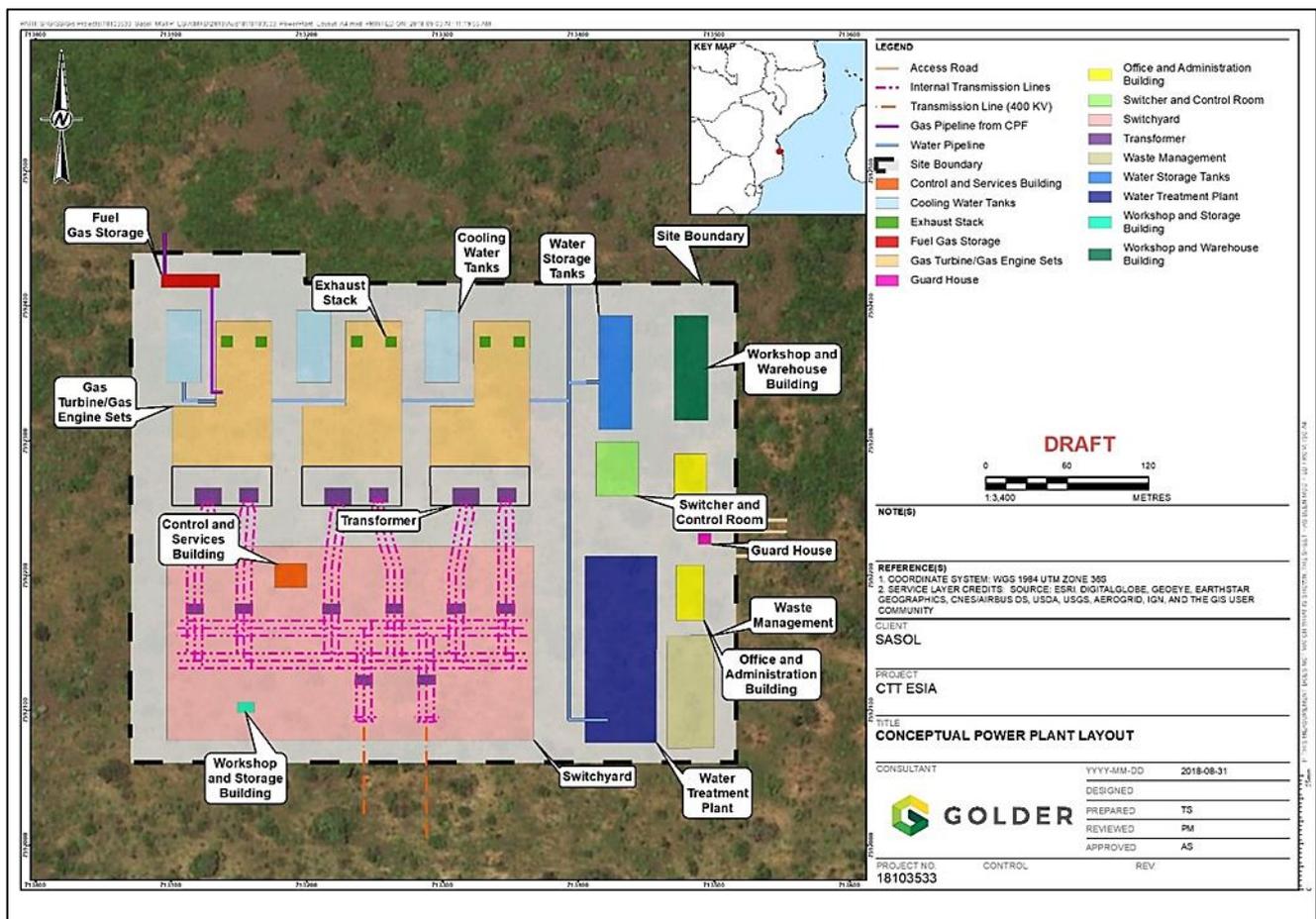


Figure 3: Conceptual layout of CTT plant site

2.1 Ancillary Infrastructure

The CTT project will also include the following infrastructure:

- Maintenance facilities, admin building and other buildings;
- Telecommunications and security;
- Waste (solid and effluent) treatment and/or handling and disposal by third party;
- Site preparation, civil works and infrastructure development for the complete plant;
- Construction camp (including housing/accommodation for construction workers); and
- Beach landing laydown area and logistics camp.

The heavy equipment and pre-fabricated components of the power plant will be brought in by ship and transferred by barge and landed on the beach near Inhassoro. The equipment and components will be brought to site by special heavy vehicles capable of handling abnormally heavy and large dimension loads. Figure 4, Figure 5 and Figure 6 show examples of the activities involved with a temporary beach landing site, offloading and transporting of large heavy equipment by road to site.

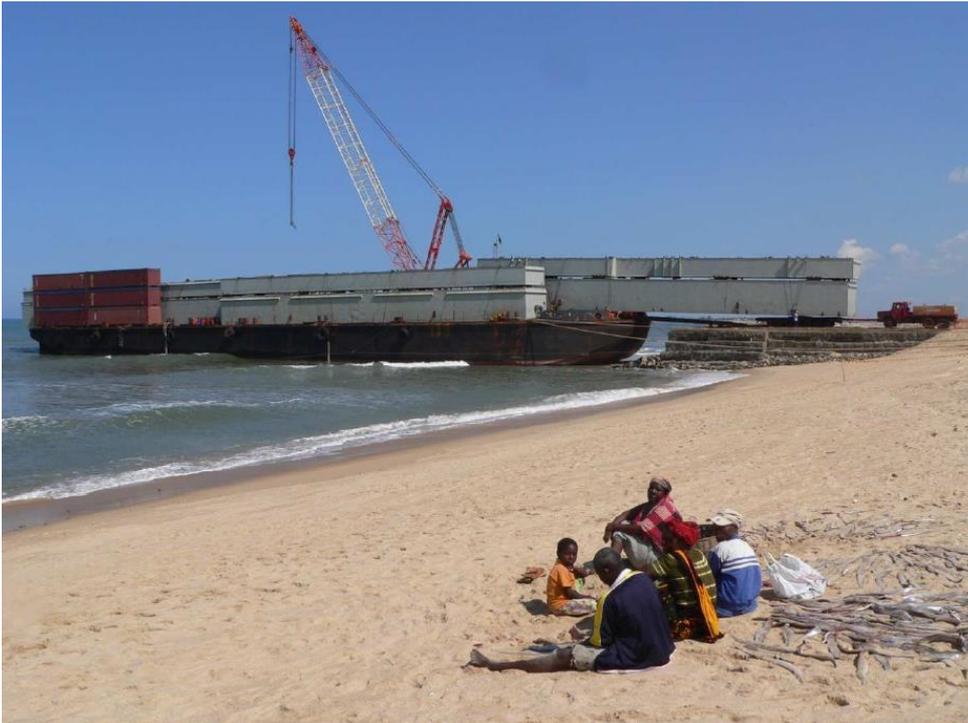


Figure 4: Typical beach landing site with barge offloading heavy equipment (source: Comarco)



Figure 5: Example of large equipment being offloaded from a barge. Note the levels of the ramp, the barge and the jetty (source: SUBTECH)



Figure 6: Heavy haulage truck with 16-axle hydraulic trailer transporting a 360 ton generator (source: ALE)

2.2 Water and Electricity Consumption

The type, origin and quantity of water and energy consumption are still to be determined based on the selected technology to construct and operate the CTT plant. At this stage it is known that water will be sourced from existing boreholes located on site or east of the Govuro River for either of the technology options below:

- Gas Engine: ± 12 m³/day; or
- Gas Turbine (Dry-Cooling): $\pm 120 - 240$ m³/day.

2.3 Temporary Beach Landing Site and Transportation Route Alternative

As part of the CTT construction phase it was considered that large heavy equipment and materials would need to be brought in by a ship which would remain anchored at sea off the coast of Inhassoro. Equipment and materials would be transferred to a barge capable of moving on the high tide into very shallow water adjacent to the beach to discharge its cargo onto a temporary off-loading jetty (typically containers filled with sand) near the town of Inhassoro. As the tide changes, the barge rests on the beach and off-loading of the equipment commences.

Currently, the SETA beach landing site is the preferred beach landing site together with the road route option to be used in transporting equipment and materials along the R241 then the EN1 then via the existing CPF access road to the CTT site near the CPF. Figure 7 and Figure 8 indicate the beach landing site and route transportation option. The alternative beach landing sites of Maritima and Briza Mar are still being evaluated as potential options, as well as the southern transport route, which would also require road upgrades and a temporary bridge construction across the Govuro at the position of the existing pipe bridge. As part of the transportation route, the Govuro River bridge may need to be upgraded/strengthened to accommodate the abnormal vehicle loads. Alternatively, a temporary bypass bridge will be constructed adjacent to the existing bridge.

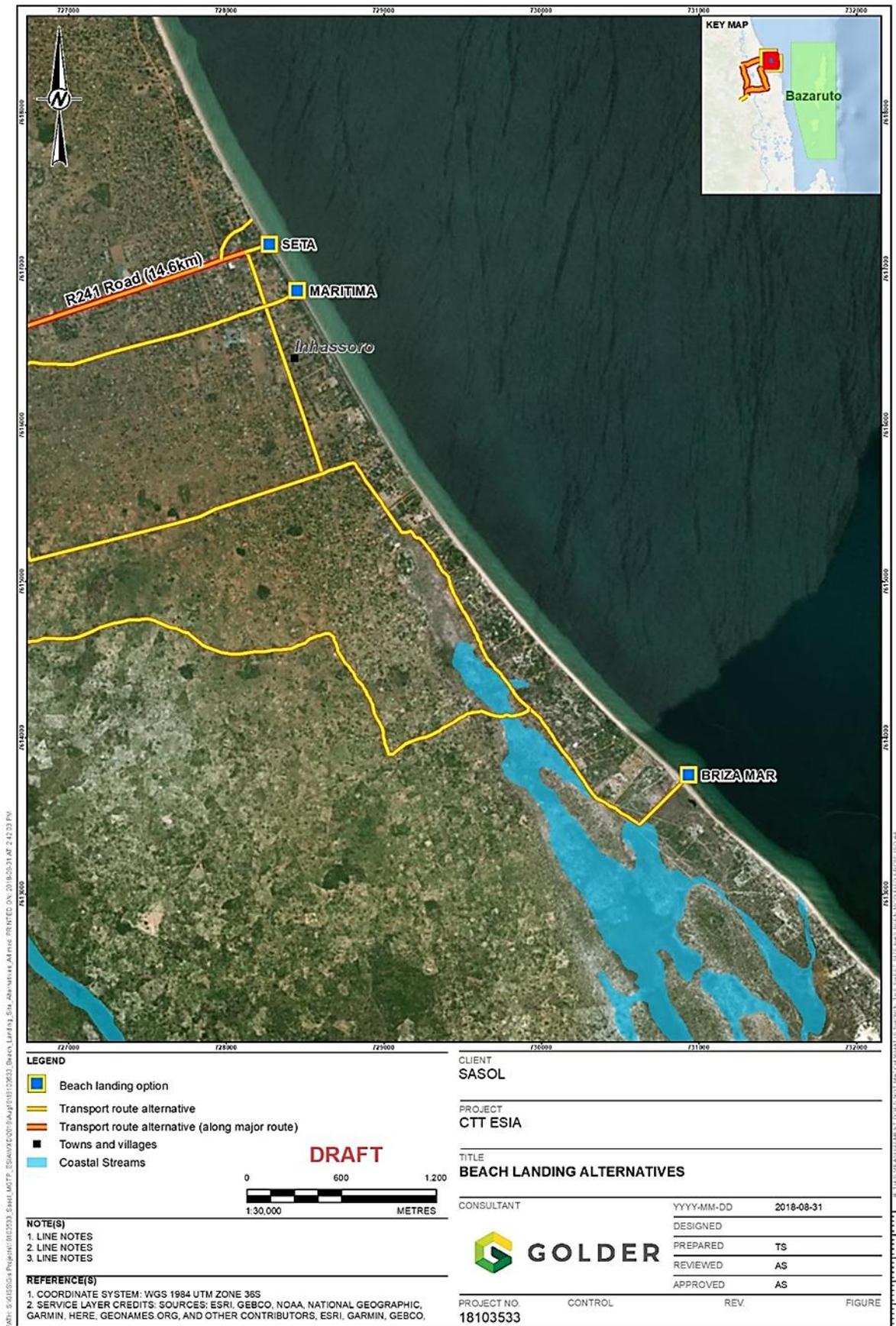


Figure 7: The three beach landing site options and route options at Inhassoro

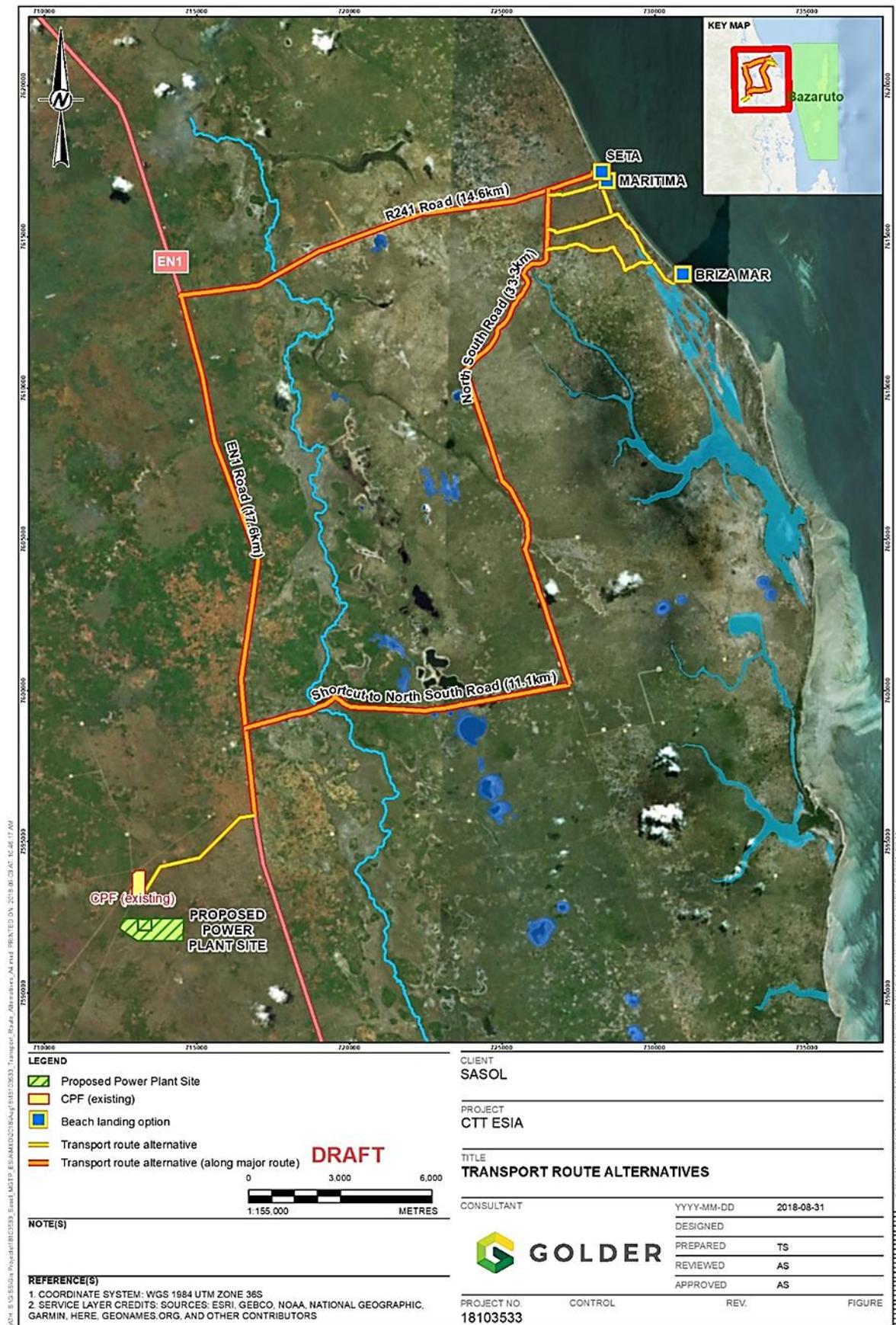


Figure 8: The two main transportation route alternatives from the beach landing sites to the CTT site

3.0 WHAT ARE ECOSYSTEM SERVICES?

Ecosystem services are **the benefits that people and/or a project (the beneficiaries) obtain from ecosystems**; consisting of all the natural products and processes that contribute directly and indirectly to human well-being, as well as the personal and social enjoyment derived from nature (IFC PS6, 2012; Landsberg *et al.*, 2013). The benefits gained can either be physical or psychological, and can be obtained actively or passively, directly or indirectly.

Ecosystem services include goods or products obtained from ecosystems (provisioning services) such as fresh water, wild foods and timber; control of natural processes (regulating services), such as flood control, erosion protection and climate regulation; and social, non-material benefits (cultural services) such as spiritual values, and recreational and aesthetic enjoyment. These services are underpinned by natural processes (supporting services) such as nutrient cycling, habitat provision and primary production (Landsberg *et al.*, 2013) (IPIECA, 2011).

The benefits of ecosystems are passed on at many levels, and to many different beneficiaries. Examples of the levels at which ecosystem services are supplied/demanded include:

- Local scale: ecosystem services may be the basis for rural livelihoods and subsistence; particularly for the poor; for example, artisanal fishing provides both cash income and food for low-income families;
- Regional scale: the provision of water to communities and businesses from a forested watershed; and
- Global scale: ecosystems regulate climate and act as a reservoir of biodiversity that underpins biological production of all types, including agriculture.

3.1 Ecosystem Services and the International Finance Corporation

The International Finance Corporation's (IFC) Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6) (IFC PS6, 2012), and its Guidance Notes (IFC GN6, 2012) - defines ecosystem services as **the benefits that people, including businesses, derive from ecosystems**. The WBG Op4.03 PS 6 / IFC define two types of priority ecosystem services:

- **Type I Ecosystem Services:** Ecosystem Services on which the Project operations are most likely to have an impact and, therefore, which result in adverse impacts to **affected communities** (beneficiaries); and
- **Type II Ecosystem Services:** Ecosystem Services on which **the Project** is directly dependent for its operations, for example, water.

Although ecosystem services are largely addressed by IFC PS 6, the assessment of ecosystem services is spread throughout the environmental and social Performance Standards (PS) because the potential effects of a project on ecosystem services relates to all aspects of peoples' relationship with the environment, including health and safety risks, land ownership or usage, and cultural heritage.

3.2 Regional Ecosystem Services Overview

Regional Ecosystem Characterisation

The study area falls within Swahilian/Maputaland Regional Transitional Zone (De Castro and Brits, 2014). As the name suggests, this area is defined by a botanical transition, containing elements of both the Swahilian Regional Centre of Endemism, which extends from the north, and the Maputaland-Pondoland Regional Mosaic which extends from the south (De Castro and Brits, 2014). The study area is dominated by three main landscape units, namely Southern Coastal Plains, Govuro Floodplain and Western Plains (Golder, 2017). The topography of the study area ranges from flat to undulating (De Castro and Brits, 2014).

A low, north-south trending dune ridge runs between the coast and the Govuro River, and acts as a natural watershed. The Govuro River lies at 13 m above sea level (m.a.s.l.). Land to the west of the river rises to 58 m.a.s.l, while that to the south rises to 68 m.a.s.l. (De Castro and Brits, 2014).

The regional climate is tropical humid and defined by rainy, hot summer periods (December to March) and fresh winter periods (June to August). Mean annual rainfall is between 800 to 1 000 mm, with February generally experiencing the most rain (164 mm), and July the lowest (18.8 mm). Mean annual temperature is 24°C (De Castro and Brits, 2014). Soils to the east of the Govuro River are of marine origin and are characteristically deep aeolian sands, and range in colour from white to brown (De Castro and Brits, 2014). The clay content of soils to the west of the river is appreciably higher than those to the east. These soils are generally brown to red-brown sandy loams (De Castro and Brits, 2014).

Preface of Ecosystem Services

In their 2005 study on the relationship between poverty and ecosystem services in Mozambique Wong, Roy and Duraiappah (2005) indicated that at the time 70% of the country's population lived in rural areas. A significant proportion of these people will rely, at the very least in part, on the provision of ecosystem services. This is true for Inhambane Province, in which the Project site is located.

Wong, Roy and Duraiappah (2005) identified four stressed ecosystem services in Inhambane Province, namely biodiversity, food provision, water supply, and fuel (energy resources). These authors highlight the vulnerability of these services and the people that depend on them to the vagaries of drought, and they emphasise the importance of better managing ecosystem services.

4.0 SCOPE OF WORK

In determining the requirements of the Ecosystem Service Review and Impact Assessment for the Project, reference was made to the international guidance document 'Weaving Ecosystem Services into Impact Assessment' (Landsberg *et al.*, 2013), appropriate Mozambique legislation and guidelines, as well as international standards and guidelines. National policy and international standards pertaining to the Project are detailed in section 6.0.

The ecosystem services impact assessment concentrates on assessing predicted changes in ecosystems and ecosystem function, and physical and aesthetic changes in the landscape; and the concomitant effects that these changes will have on ecosystem service supply and demand within the same area.

4.1 Objectives

The aim of this Ecosystem Services Review and Impact Assessment is to:

- Identify priority ecosystem services and goods currently supplied in the context of the area in which the Project will be located;
- Qualify the relationship between ecosystem services, the ecosystems that provide them, and the condition of those systems, and the current drivers of change of those systems;
- Identify beneficiaries of the services, that is, the Project and/or the people who benefit from the goods and services supplied, and their level of dependence on the ecosystem services;
- Identify potential impacts on priority ecosystem services arising from the Project and propose mitigation measures; and
- Identify any necessary additional areas of investigation.

4.2 Scope

This assessment is informed by the data gathered as part of several other assessments conducted for the Project, including the biodiversity, cultural heritage and social, surface water and ground water studies. In order to address the above objectives, the scope of the ecosystem services report is as follows:

- Establish the capacity of ecosystems to supply identified services, and the current demand for ecosystem services in the project area;
- Existing pressures and threats on the supply and demand and how the project may contribute to those existing pressures and threats will be identified;
- Impacts and demands on the priority ecosystem services will be assessed; and
- Mitigation and management measures for identified impacts will be recommended for inclusion in the Project's EMP.

5.0 APPROACH AND METHODS

For the purposes of this assessment, the definitions of ecosystem services were based on those developed by the *Millennium Ecosystem Assessment* (MA, 2005), and expanded upon in Landsberg *et al.* (2013) (Table 1). These definitions were chosen to keep consistency with the IFC's Performance Standards, and because they are widely recognised.

Ideally, the Project should maintain the value and functionality of priority ecosystem services to those beneficiaries directly dependent upon them, through direct management control. As such, ecosystem services whose beneficiaries are at the global scale, are not covered by this assessment; the focus is on ecosystem services whose beneficiaries could be directly or indirectly affected by the project on local and regional scales.

Table 1: Ecosystems services categories (MA, 2005; Landsberg *et al.*, 2013)

Broad categories	Definition
Provisioning services	Supporting human needs e.g., traditional hunting grounds, medicinal plants and minerals, water sources, fishing grounds, fire wood.
Cultural services	Aesthetic, spiritual, recreational and other cultural values e.g., sacred sites, recreation, sense of place.
Regulating services	Control of the natural environment e.g., maintenance of key ecological processes, protected areas, habitat of special value, groundwater recharge, catchments.
Supporting services	Natural processes essential to resilience, and functioning of ecosystems. e.g., primary production.

An understanding of the ecosystems and ecosystem processes occurring in the Project's area of influence is important, as it enables an understanding of how those processes affect the supply and demand of the ecosystem services, and the value the ecosystem services eventually offer to beneficiaries (i.e. ecosystem service **supply**). A conceptual ecosystem services flow path illustrating these supply linkages, using the photosynthesis process and the functions, services and benefits that flow from it as an example, is shown in Figure 9.

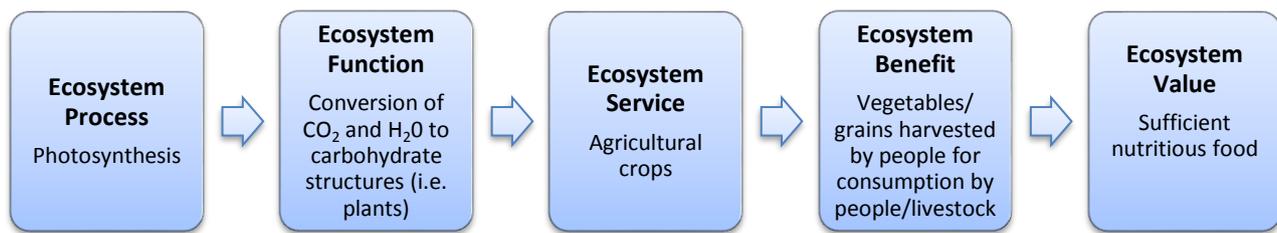


Figure 9: Ecosystem service supply - the flow of ecosystem services to beneficiaries

Given that the assessment of ecosystem services is also concerned with the social aspects of the benefits of services (i.e. ecosystem service **demand**), the assessment of ecosystem services relied upon data gathered during the stakeholder engagement/community consultation processes carried out as part of the social impact assessment study and the archaeological and cultural heritage assessment, specifically, as well as additional studies – refer to the relevant studies listed in section 5.2.

No specific ecosystem services stakeholder engagement processes were undertaken as part of the study. The ecosystem services assessment relies on the relevant data gathered from the social, biological and physical components of the various other baseline studies for the ESIA.

The approach taken to conducting the ecosystem services review is based on the method put forward by Landsberg *et al.* (2013). The method was adapted to preclude additional baseline data gathering for priority ecosystem services, other than that conducted as part of the social impact assessment and the archaeological and cultural heritage assessment

5.1 Study Area

The principal direct source of effects on ecosystem services typically arises from loss in extent of ecosystems supplying services within the Project footprint. This can occur via site clearance (vegetation clearing), ground works (construction) and the physical presence of Project infrastructure (operation). In addition, the scale at which impacts on ecosystem services are expected to manifest, typically extend beyond the Project footprint, considering the distribution of settlements that benefit from such services that will be affected by the Project.

This assessment therefore focuses on ecosystems at the local and regional scales to the Project:

- **Local Scale** – Areas potentially directly affected by Project activities and new infrastructure (refer to infrastructure maps in Figure 7 and Figure 8; and
- **Regional Scale** – Aligns with the area assessed as part of the Socio-Cultural Area of Influence – shown Figure 10. It includes both rural and urban villages, settlements and towns, as well as associated coastal areas. The proposed CTT project could affect 12 villages and communities, as well as certain businesses and fishing activities in Inhassoro Town.

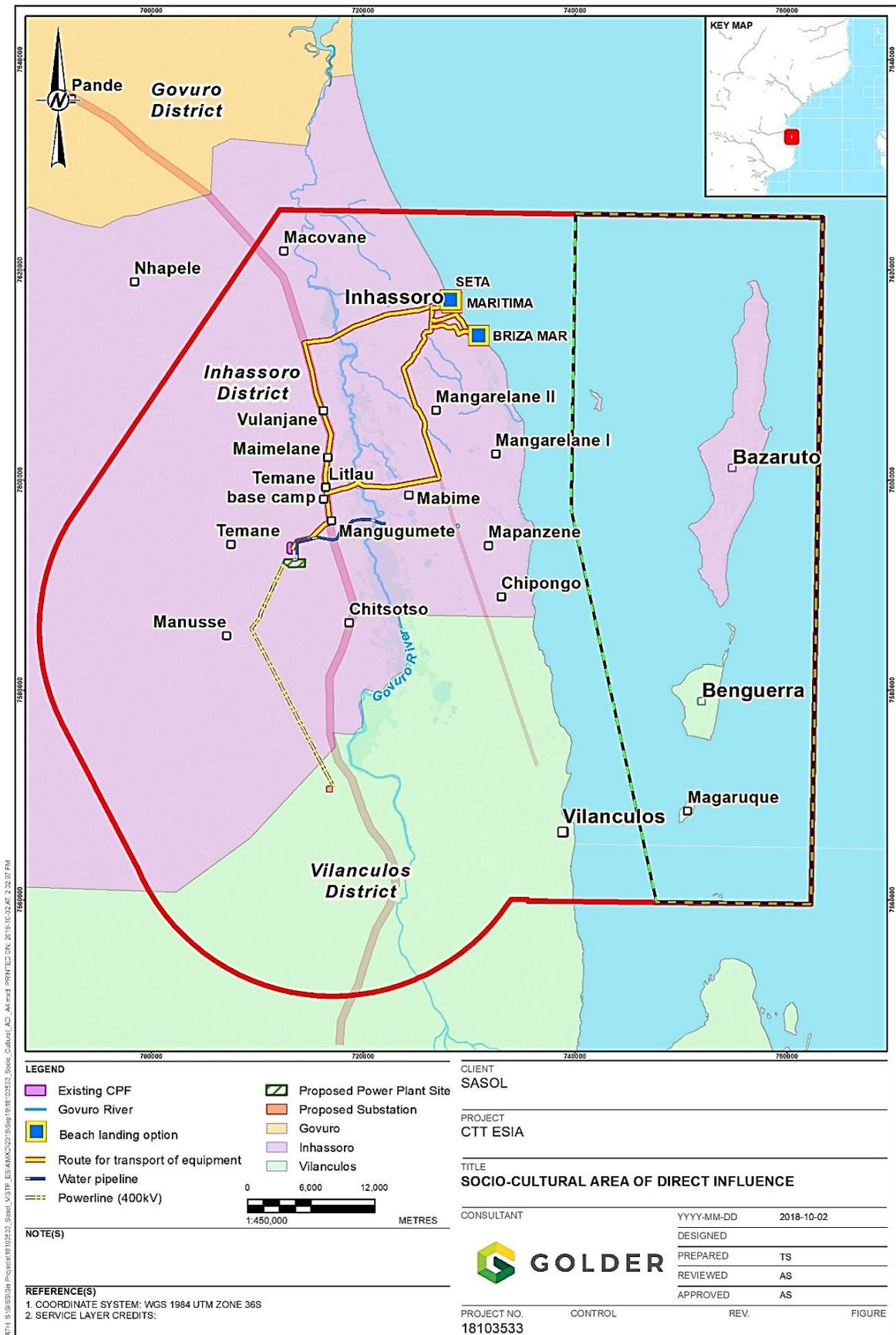


Figure 10: Extent of the Area of Influence used for the Socio-Cultural Impact Assessment

5.2 Step 1: Identification of Ecosystem Services Relevant to the Project

The ecosystem services that the Project could impact (Type I) were identified by first defining which ecosystems could be affected, determining the ecosystem services supplied by and demanded from those ecosystems, and identifying the beneficiaries who use those services supplied by the ecosystems that could be affected, as per Step 1 of the guidance provided in (Landsberg *et al.*, 2013). The ecosystem services that the Project depends upon (Type II) were also identified.

The ecosystem service review method outlined in (Landsberg *et al.*, 2013) was adapted to preclude additional baseline data gathering for priority ecosystem services once the initial ecosystem services list was refined. Instead, data on the use of priority ecosystem services was collated from the baseline social, biodiversity and surface water studies and the Project description, to determine how ecosystem services currently contribute to beneficiaries' livelihoods, health, safety or culture.

This was done by means of reviewing a variety of social, ecological and biophysical assessments, including, *inter alia*:

- The Social Impact Assessment Report. Golder (2018), Report No. 18103533-32027-5;
- The Cultural Heritage Impact Assessment Report. Golder (2018), Report No. 18103533-321152-20;
- The Terrestrial Ecology Impact Assessment Report. Golder (2018), Report No. 18103533-320312-1;
- The Aquatic Biodiversity Report. Golder (2018), Report No. 18103533-320976-10;
- The Surface Water Report. Golder (2018), Report No. 18103533-321064-16;
- The Hydrogeological Specialist report. Golder (2018), Report No. 18103533-321064-17; and
- The Tourism Impact Assessment. Golder (2018), Report No. 18103533-321022-15.

Unless otherwise indicated, baseline information presented in this report has been summarized from the above listed works.

The ecosystem services that the Project depends upon (Type II) were also identified. As Type II ecosystem services relate to Project *operational performance*, but not Project impact, these are listed in section 8.2 for reference but are not included in the impact assessment.

5.3 Step 2: Prioritisation of Ecosystems Services

Priority ecosystem services, upon which the impact assessment was focused, were selected from the list of relevant ecosystem services generated in Step 1. Priority ecosystem services are:

- Services for which Project impacts could affect beneficiaries' livelihoods, health, safety or culture (Type I); and
- Services that could prevent the Project from achieving operational performance i.e. impact the Project (Type II).

The ecosystem service prioritisation exercise was carried out systematically, using the WRI Impact Scoping tool, and current guidance regarding conducting an Ecosystem Services Review (Landsberg *et al.*, 2013).

5.4 Step 3: Assessing Project Impacts on Priority Ecosystem Services

The impact assessment process was aligned with the World Resources Institute (WRI) approach (Landsberg *et al.*, 2013), consisting of a combination of the WRI approach to assessment of Project impact on priority ecosystem services and thereby assessment of impact on beneficiaries (Figure 11); and the prescribed impact assessment method being used for the ESIA (ref. section 5.4.1).

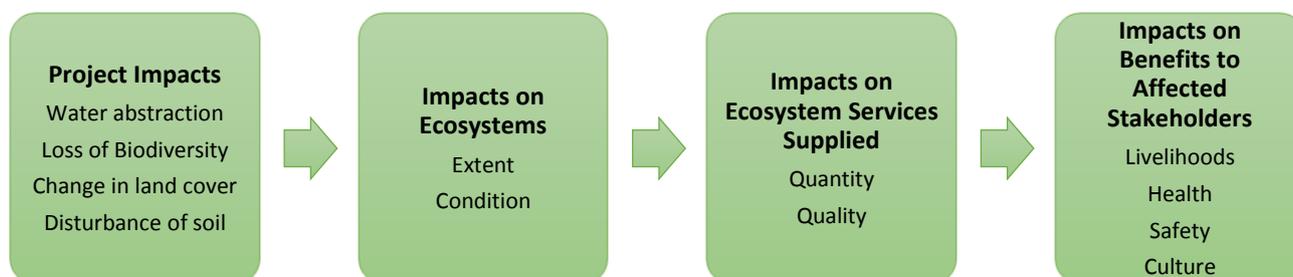


Figure 11: How assessment of Project impacts on ecosystems leads to assessing impacts on beneficiaries of ecosystem services (Landsberg *et al.*, 2013)

5.4.1 Assessing Significance of Project Impacts on Affected Priority Ecosystem Services

Potential impacts are assessed according to the direction, intensity (or severity), duration, extent and probability of occurrence of the impact. These criteria are discussed in more detail below:

- **Direction of an impact** may be positive, neutral or negative with respect to the particular impact. A positive impact is one which is considered to represent an improvement on the baseline or introduces a positive change. A negative impact is an impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor;
- **Severity** is a measure of the degree of change in a measurement or analysis (e.g. the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none, negligible, low, moderate or high. The categorisation of the impact intensity may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment). The specialist study must attempt to quantify the intensity and outline the rationale used. Appropriate, widely-recognised standards are used as a measure of the level of impact;
- **Duration** refers to the length of time over which an environmental impact may occur: i.e. transient (less than 1 year), short-term (1 to 5 years), medium term (6 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project) or permanent;
- **Extent/Scale** refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international. The reference is not only to physical extent but may include extent in a more abstract sense, such as an impact with regional policy implications which occurs at local level;
- **Probability of occurrence** is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur); and
- **Impact significance** will be rated using the scoring system shown in Table 2 below. The significance of impacts is assessed for the two main phases of the project: 1) construction 2) operations.

While a somewhat subjective term, it is generally accepted that significance is a function of the magnitude of the impact and the likelihood (probability) of the impact occurring. Impact magnitude is a function of the extent, duration and severity of the impact, as shown in Table 2.

Table 2: Scoring system for evaluating impacts

Severity	Duration	Extent	Probability
10 (Very high/don't know)	5 (Permanent)	5 (International)	5 (Definite/don't know)
8 (High)	4 (Long-term – longer than 15 years and impact ceases after closure of activity)	4 (National)	4 (Highly probable)
6 (Moderate)	3 (Medium-term- 6 to 15 years)	3 (Regional)	3 (Medium probability)
4 (Low)	2 (Short-term - 1 to 5 years)	2 (Local)	2 (Low probability)
2 (Minor)	1 (Transient – less than 1 year)	1 (Site)	1 (Improbable)
1 (None)			0 (None)

After ranking these criteria for each impact, a significance rating was calculated using the following formula:

$$\text{SP (significance points)} = (\text{severity} + \text{duration} + \text{extent}) \times \text{probability.}$$

The maximum value is 100 significance points (SP). The potential environmental impacts were then rated as of High (SP >75), Moderate (SP 46 – 75), Low (SP ≤15 - 45) or Negligible (SP < 15) significance, both with and without mitigation measures in accordance with Table 3.

Table 3: Impact significance rating

Value	Significance	Comment
SP >75	Indicates high environmental significance	Where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. Impacts of high significance would typically influence the decision to proceed with the project.
SP 46 - 75	Indicates moderate environmental significance	Where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value. Such an impact is unlikely to have an influence on the decision. Impacts may justify significant modification of the project design or alternative mitigation.
SP 15 - 45	Indicates low environmental significance	Where an effect will be experienced, but the impact magnitude is small and is within accepted standards, and/or the receptor is of low sensitivity/value or the probability of impact is extremely low. Such an impact is unlikely to have an influence on the decision although impact should still be reduced as low as possible, particularly when approaching moderate significance.
SP < 15	Indicates negligible environmental significance	Where a resource or receptor will not be affected in any material way by a particular activity or the predicted effect is deemed to be

Value	Significance	Comment
		imperceptible or is indistinguishable from natural background levels. No mitigation is required.
+	Positive impact	Where positive consequences / effects are likely.

In addition to the above rating criteria, the terminology used in this assessment to describe impacts arising from the current project are outlined in Table 4 below. In order to fully examine the potential changes that the project might produce, the project area can be divided into Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII):

- Direct impacts are defined as changes that are caused by activities related to the project and they occur at the same time and place where the activities are carried out i.e. within the ADI; and
- Indirect impacts are those changes that are caused by project-related activities but are felt later in time and outside the ADI. The secondary indirect impacts are those which are as a result of activities outside of the ADI.

Table 4: Types of impact

Term for Impact Nature	Definition
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (i.e. between an effluent discharge and receiving water quality).
Indirect impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (i.e., pollution of water placing a demand on additional water resources).
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned activities) to affect the same resources and/or receptors as the Project.

6.0 LEGISLATIVE AND POLICY CONTEXT

6.1 Applicable Mozambique Legislation and Policy

The proposed project has been determined as 'Category A' in terms of Mozambique's environmental law (Decree 54/2015 of 31 December, which has been in force since April 2016). For 'Category A' projects, an Environmental and Social Impact Assessment (ESIA) must be prepared by independent consultants as a basis for whether or not environmental authorisation of the project is to be granted, and if so, under what conditions. The final decision maker is the Ministry of Land, Environment and Rural Development (Ministério da Terra, Ambiente e Desenvolvimento Rural (MITADER) through the National Directorate of Environmental Impact Assessment (DNAIA). MITADER consults with other relevant government departments prior to making a decision. The ecosystem services study was undertaken in line with Mozambique environmental legislation, specifically:

The Environment Law (Law 20/97 of 1 October)

The Environment Act (Law 20/1997 of 1 October) specifies that all public and private activities, with the potential to influence the environment, must be preceded by an Environmental Impact Assessment (EIA) to obtaining an

Environmental Licence. This Law is based on the precautionary principle that focuses on preventing the occurrence of significant or irreversible negative environmental or social impacts, regardless of the existence of scientific certainty about the occurrence of such impacts on the environment. The process of EIAs are regulated by Decree 56/2010 as well as the requirements in the general EIA regulations published under Decree 45/2004 as amended in Decree 42/2008 and by the Ministerial Decree 129/2006 and Decree 130/2006 which sets out principles for the compilation of ESIA studies and public participation process during the ESIA process.

The Ecosystem Services Impact Assessment falls within the Environmental Framework Law under specific clauses (article 10, 2) which state the need to perform a “socio-economic description of the [affected] location,” “identification and evaluation of the activity’s fatal issues” and “indication of the activity’s potential environmental impacts”.

Corporate Social Responsibility

In 2014, the GoM promulgated the “Corporate Social Responsibility (CSR) Policy for the Mineral Resources Extractive Industry” (GoM, 2014). This policy also applies to companies operating in the oil and gas sector in Mozambique. The policy aims, *inter alia*, to establish guidelines for the extractive industry on poverty reduction. It defines the framework to develop realistic and practical CSR programmes and aims to ensure alignment between government and corporate development plans ultimately aligning CSR initiatives in the extractive industry in Mozambique to international best practices. The policy is based on the CSR best practices as set out in ISO 26000¹. It emphasises that companies bear the responsibility of contributing towards sustainable development, including health and wellbeing of society, where their activities and decisions have an impact society and the environment (GoM, 2014:7).

On social investment and local development, the CSR policy objective is to promote the sustainable and integrated development of communities. Companies in the extractives industry need to meet these objectives through:

- Ensuring that communities’ views are considered in the decision-making processes;
- Establishing in writing signed plans and agreements on local investment that will mitigate negative impacts resulting from exploration and pre-feasibility activities;
- Establishing Local Development Agreements (LDAs) with the participation of communities for the operational phase; and
- Ensuring communities’ participation in decision-making for closure regarding environmental restoration, land backfilling, social reintegration of the workforce; as well as harmonisation between restoration Programmes and LDA.

The Land Law (Law 19/97 of 1 October) and Land Law Regulations (Decree 66/1998 of 8 December)

A number of policies and legislation governs land matters in Mozambique.

These include the Constitution of the Republic of Mozambique (2004), the National Land Policy (Resolution 10/1995 of 17 October), the Land Law (Law 19/1997 of 1 October) and the Land Law Regulations² (Decree 66/1998 of 8 December) with its Technical Annex. The Constitution establishes that, among other things, land in Mozambique is the property of the state, that it may not be sold, mortgaged or otherwise alienated and that the right to use and benefit from land is conferred by the state and the conditions for such are determined by

¹ ISO 26000 provides guidance on how business and organisations can operate in a socially responsible way. This means acting in an ethical and transparent way that contributes to the health and welfare of society.

² The Land Regulations apply only to land matters in rural areas.

the state. The land use right conferred by the state through the Land Law is known as a “right to use and benefit from land”.

The Land Law recognises the legitimacy of customary law. People who occupy and use land in rural areas, individually or as part of a community³ and in accordance with customary norms and practices, such as inheritance from their ancestors, are deemed to have legal rights to use and occupy the land in question (Article 12). This constitutes a right to use and benefit from land through “occupation”. They may apply for official title to the land (Article 13), but the lack of registration or title does not prejudice their land rights.

Other than the requirement of the Land Law that compensation should be paid when land is expropriated in the public interest; there is no specific legislation governing compensation (including physical relocation) of those people or communities whose rights to use and benefit from land are cancelled or negatively impacted on. The legislation does not cover issues related to compensation such as principles, forms, eligibility, valuation, adequacy, procedures, timing and responsibilities⁴.

Law 10/1988, of 22 December, Law on the Protection of Cultural Heritage

The Law on the Protection of Cultural Heritage (1988) was established to ensure the legal protection of material and immaterial assets of Mozambican cultural heritage. For the purposes of the law, Cultural Heritage is defined as “the set of material and immaterial assets created or integrated by the Mozambican people throughout history, with relevance to the definition of the Mozambican cultural identity”. The law qualifies all cultural heritage assets discovered in Mozambican territory as State property.

Article 10 of The Law on the Protection of Cultural Heritage (1988) outlines the cultural heritage assets that are considered as inalienable property of the State, namely, archaeological localities and objects, rock paintings, and buildings or other structures that are representative of the pre-colonial societies, such as stone walls, “zimbabwes”, “aringas”, mining centres and centres of power, population settlements, trading hubs and worship sites. Localities with special ecological characteristics are also included in the list of cultural assets (Article 3.4.c). Article 13 defines that, in the event of discovery of any places, buildings, objects or documents susceptible of being classified as cultural heritage assets, the closest administrative authorities must be informed

The Law on Forest and Wildlife (Law 10/99 of 7 July) - Articles 11 and 13

The Law on the Protection of Forests and Wildlife (Decree 12/2002), makes provision for the existence of ‘Zones of Use’ and of ‘Historical-Cultural Value’, for purposes of protecting forests with a religious interest and other sites of historical importance and cultural use, in line with the traditional norms and practices of the various communities.

6.2 Other Pertinent Mozambican Legislation:

- Ministerial Diploma No. 180/2004, dated September 15 – Quality of Water for Human Consumption; and
- Regulation on Environmental Quality Standards and Effluent Emission - Decree 18/2004 of 2 June – Appendices III, IV and VI, as well as Article 12.

³ The Land Law has its own specific definition for a local community. This is “a grouping of families and individuals living in a territorial area equal or inferior to a locality, with the aim of safeguarding common interests through the protection of residential and agricultural areas (be they in use or fallow), forests, places of cultural importance, grazing lands, water resources and expansion areas”.

⁴ The introduction of the Territorial Planning Law (Law 19/2007 of 18 July) provides a structure which, in the absence of specific legislation governing compensation for expropriation, is likely to be applied to calculations in the future. This legislation provides for compensation for the sacrifice of acquired rights. The rights to be compensated for include the loss of tangible and intangible assets, damage to social cohesion and the loss of productive assets.

6.3 IFC Performance Standards 2012

At the project financing level, the assessment and management of ecosystem services is largely dealt with in PS 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC PS6, 2012); however, elements of PS 1, 3, 4, 5, 7 and 8 are also relevant to ES assessment. Relevant parts of the PS are briefly summarised as follows.

PS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS 6 directly relates to the four types of ecosystem services, as one of the three major objectives of PS 6 is to maintain the benefits of ecosystem services. It establishes objectives and requirements to avoid, minimise and, where residual impacts remain, compensate/offset for risks and impacts to ecosystem services within a project's area of influence. It puts an onus on project developers (the 'client') to carry out a systematic review (including participation of beneficiaries) of all ecosystem services a project will impact, or is dependent upon, to identify priority ecosystem services, and avoid, minimise, and mitigate impacts on priority ecosystem services for which a client has direct management control or significant influence.

PS 1 – Assessment and Management of Environmental and Social Risks and Impacts

This PS requires that all reasonably expected risks and impacts related to ecosystem services are identified, and broader definition of a project's area of influence be used. Indirect project impacts on ecosystem services upon which beneficiaries' livelihoods are dependent should be included in the assessment.

PS 4 – Community Health, Safety and Security

This PS establishes the requirement for the assessment of impacts on priority ecosystem services that may result in adverse health and safety risks to beneficiaries.

PS 5 – Land Acquisition and Involuntary Resettlement

PS5 relates to project situations where restrictions on land use, access to natural resources, and use of natural resources, such as aquatic resources, timber products and fresh water, impact affected beneficiaries of ecosystem services. The client must assess impacts on, and compensate for, loss of provisioning ecosystem services resulting from land acquisition and involuntary resettlement.

PS 7 – Indigenous Peoples

PS7 addresses impacts on lands and natural resources that may be subject to traditional ownership, or under customary use. Such use may be seasonal/cyclical, and may be ceremonial, cultural, or economic in nature. PS7 requires that adverse impacts on affected Communities of Indigenous Peoples should be avoided where possible; or otherwise be subject to appropriate application of the mitigation hierarchy to minimise adverse impacts.

PS8 – Cultural Heritage

PS8 deals with the protection of tangible and intangible Cultural Heritage, and sets out requirements for avoidance, or the application of an appropriate mitigation hierarchy to minimise adverse impacts.

When replicable cultural heritage is removed, and avoidance is not possible, restoration measures including the maintenance of ecosystem services required to support the cultural heritage must be taken, either in situ or in a different location. Non-replicable cultural heritage should not be removed unless several specific conditions are met. The Project should not remove or significantly alter or damage critical cultural heritage.

Project Relevance

In the case of its direct investments (including project and corporate finance provided through financial intermediaries), the IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. Together, the Performance Standards establish standards that the Project is to meet throughout the life of an investment by a lender (such as IFC/World Bank as an example). As stated above, Performance Standards 1, 4, 5, 6, 7 and 8 have components that directly relate to ecosystem services and maintenance of their supply despite project impact. Therefore, in order to secure Project funding, the Project must demonstrate that it is in compliance with the requirements of each of the above-mentioned applicable performance standards. In the case of the CTT project, PS 7 – Indigenous Peoples does not find application.

7.0 STEP 1: IDENTIFICATION OF ECOSYSTEM SERVICES RELEVANT TO THE PROJECT

7.1 Vegetation Communities Providing Ecosystem Services

A mapping exercise conducted by Golder (2015a) identified six primary vegetation groups consisting of 33 vegetation communities in the region – a vegetation community map is presented in Figure 12. Of the primary vegetation groups, the following are relevant to this study, namely:

- Open and Closed Woodland (incl. dense woodland, low mid-dense woodland and tall mid-dense woodland mapping habitats),
- Low Thicket (incl. non-intact thicket mosaic mapping habitat);
- Tall Forest/Tall Thicket, and
- Permanent and Seasonal Wetlands.

The provision of terrestrial and freshwater aquatic ecosystem services identified for this study is linked to these broad vegetation groups.

In this section we provide a synthesis of information on vegetation groups as they relate to the provision of ecosystem service. Where vegetation communities such as the Open and Closed Woodland, Low Thicket and Tall Forest/Tall Thicket vegetation groups render the same or very similar ecosystems services, they are discussed together:

7.1.1 Open and Closed Woodland, Low Thicket and Tall Forest/Tall Thicket

These vegetation groups are essentially savanna habitat-type formations, and generally characterised by both woody and grass components, the relative abundance and structure of which, are highly variable. In the study area the Open and Closed Woodland group is particularly widespread and dominant, occurring on both the eastern and western sides of the Govuro River. Conversely, Low Thickets and Tall Forest/Tall Thicket occur in small, scattered patches embedded within Open and Closed Woodland.

These vegetation groups are important for supplying various ecosystem provisioning services. They are generally in good ecological condition, although localised disturbances are present, and typically associated with some form of natural resource exploitation. Prominent ecosystem services associated with these vegetation groups include:

- Subsistence crop production. Vegetation is cleared and then burnt to provide an ash garden for crop growing.
- Wood from trees is collected for use as biofuels (fire wood and charcoal production) and for building material;
- Tall grasses are collected and used for roof thatching; and
- Woodland habitat is important foraging (grazing and browsing) habitats for domestic livestock, including cattle, sheep and goats;
 - These habitats typically have a rich faunal community and will be important hunting areas for bush meat. We note however, that hunting has reduced game populations significantly and it is likely that prey species are present only in remote areas; and
 - These habitats also provide various other non-timber forest products, including wild fruits and medicinal plants.

7.1.2 Permanent and Seasonal Wetlands (incl. Govuro River)

The most prominent drainage feature in the study area is the Govuro River, which flows from the south to north, entering the Indian Ocean to the north of Inhassoro. There are also several smaller streams, wetland and natural pans/depressions present in the region. Riparian and wetland habitats are critically important in rendering both provisioning and regulating ecosystem services. Some of the more prominent ecosystem services provided by these ecosystems include:

- Enriched soils along wetland and river margins are commonly used for growing subsistence crops;
- The river is a source of water for drinking and washing;
- Wetland vegetation, such as the extensive reed and grass beds along the Govuro River floodplain, plays an important role in filtering and purifying water, and regulating stream flow;
- Wetland vegetation, particularly the abundant lawn grasses, are an important grazing resource for domestic livestock;
- Wine made from the oil harvested from the *Hyphaene* palm, which is a common species growing along the Govuro River floodplain;
- Wetland vegetation, particularly tall reeds and sedges, are also widely harvested and used as building material; and
- Fishing in rivers (Govuro) and other inland streams by members of local communities is common.

7.2 Coastal Resources off Inhassoro

Coastal villages utilise the beach area for communal sea fishing, while off-shore fishing from small fishing boats using line and hook or nets is also a common livelihood activity. Fish that are caught are sold at local markets and form an important part of the diet of local households.

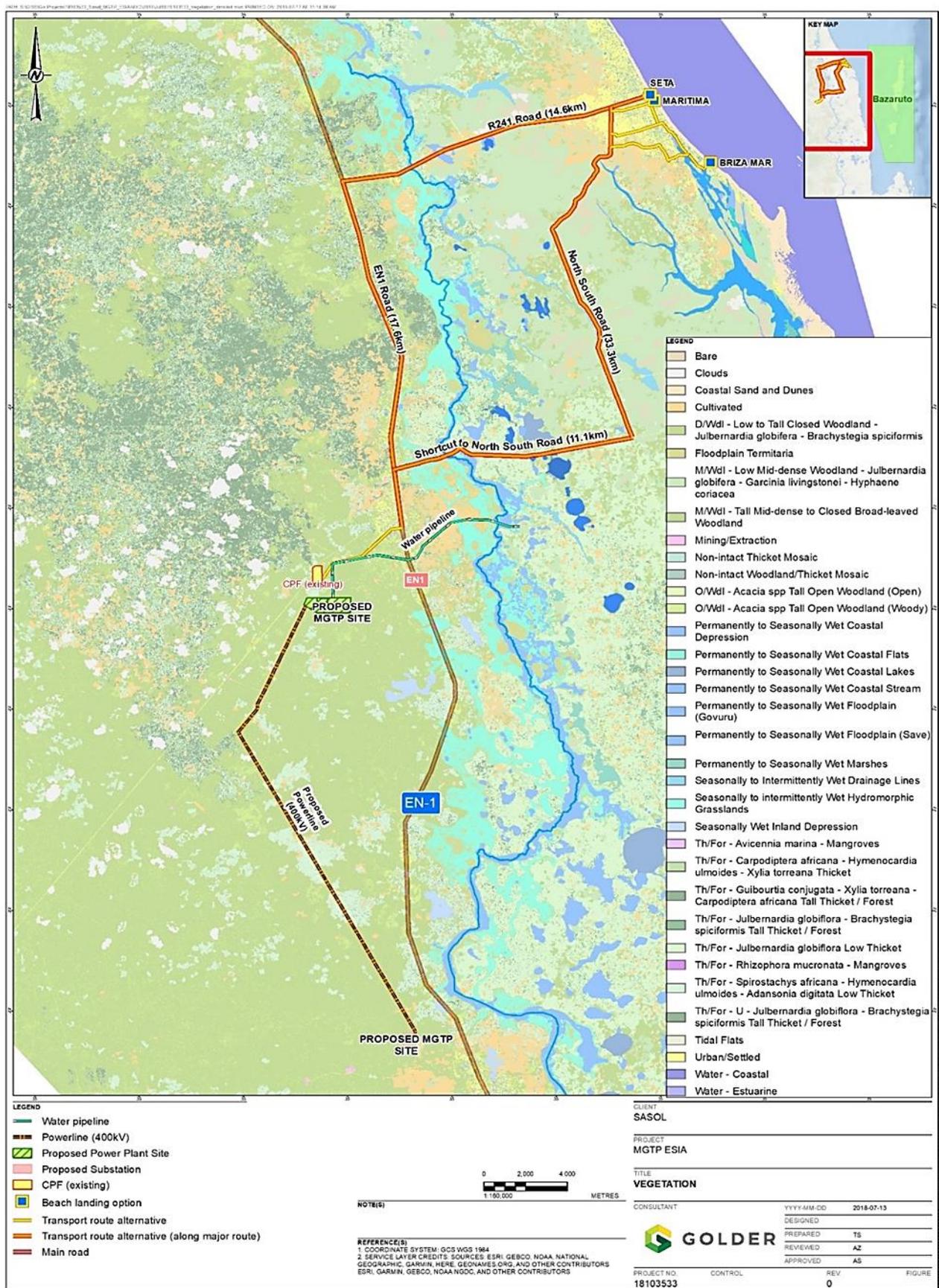


Figure 12: Vegetation communities associated with the proposed Project (from Golder, 2015a)

7.3 Faunal Communities Providing Ecosystem Services

Terrestrial Faunal Communities

Historically, the region had a rich faunal assemblage, with literature indicating that up to 109 mammal, 63 reptile, 29 amphibian and over 250 bird species potentially occurring in the region (Golder, 2015).

With regard to mammals, we note that as a consequence of long-term and widespread hunting, several species are probably locally extirpated. These are likely to include many of the large ungulates that are typically highly sought after as bush meat, including Kudu (*Tragelaphus strepsiceros*) and Impala (*Aepyceros melampus*), as well as many other smaller taxa such as *inter alia*; Aardvark (*Orycteropus afer*) and Porcupine (*Hystrix africaeaustralis*).

Table 5 provides a list of terrestrial mammal species that have been recorded in the region, and that are known to be favoured bush-meat prey species. Several of these taxa may still persist in remote and isolated areas of natural habitat and will be hunted for bush meat by local communities. Unlike in other African countries, large primates (e.g. Vervet Monkey *Cercopithecus pygerythrus* and Chacma Baboon *Papio ursinus*) are not considered a food source by local communities (Pers. Obs. 2018).

The region's bird community is also likely to be important source of food. It is expected that both hunting, as well as egg collecting are taking place. Although no direct evidence of the use of herpetofauna (reptiles and amphibians) as a meat source was recorded, we note that some of these species may have natural resource value. Insects, such as caterpillars, are also likely to form part of the traditional diets of communities. Insects are extremely nutritious, offering high protein, fat and micronutrients content. They may therefore be an important dietary supplement.

Aquatic and Marine Faunal Communities

Fishing is a major livelihood activity in the project area (see photo in Figure 13). Coastal villages use beach areas to launch fishing boats. Fishing in the Govuro River and the scattered inland pans is also a common practice in the study area.

The Dugong (*Dugong dugon*) is a large marine mammal and is known to be eaten by local communities whenever one is intentionally or unintentionally killed, and washes up onto local beaches (Guissamulo, 2016). Moreover, five marine turtle species are known to occur off the coast (Table 5), and have been recorded being killed and eaten by local communities (read Marine Impact Assessment).

Table 5: Prominent large faunal taxa that are known or likely to be hunted for meat

	Family	Species Name	Common Name
Terrestrial Faunal Taxa	Hystricidae	<i>Hystrix africaeaustralis</i>	Porcupine
	Pedetidae	<i>Pedetes capensis</i>	Springhare
	Thryonomyidae	<i>Thryonomys swinderianus</i>	Greater Cane Rat
	Mantidae	<i>Manis temminckii</i>	Pangolin
	Orycteropodidae	<i>Orycteropus afer</i>	Aardvark
	Hippopotamidae	<i>Hippopotamus amphibius</i>	Hippopotamus
	Suidae	<i>Potamochoerus larvatus</i>	Bushpig
	Bovidae	<i>Tragelaphus angasii</i>	Nyala

	Family	Species Name	Common Name
		<i>Neotragus moschatus</i>	Suni
		<i>Tragelaphus scriptus</i>	Bushbuck
		<i>Cephalophus natalensis</i>	Red Duiker
		<i>Aepyceros melampus</i>	Impala
		<i>Sylvicapra grimmia</i>	Common Duiker
		<i>Raphicerus campestris</i>	Steenbok
Large Marine Faunal Taxa (excl. fish)	Dugongidae	<i>Dugong dugon</i>	Dugong
	Cheloniidae	<i>Chelonia mydas</i>	Green turtle
		<i>Eretmochelys imbricata</i>	Hawksbill Sea Turtle
		<i>Lepidochelys olivacea</i>	Olive Ridley Turtle
		<i>Caretta caretta</i>	Loggerhead Turtle
	Dermochelyidae	<i>Dermochelys coriacea</i>	Leatherback Turtle



Figure 13: Locally caught fish being sold along the EN1

7.4 Water Resources

The Plant site is situated in the Inhambane Province, within the Govuro River catchment. The Govuro River is approximately 8 km to the east of the proposed project site –see Figure 14. The total Govuro River catchment area was estimated to be 11 169 km². Based on recordings at a flow station close to its source, the average annual flow of the Govuro River is 121 Mm³/yr.

The Govuro River meanders for a distance of ~248 km from its origin in the lake land near the town of Pomene at the point (Ponta de Barra Falsa), to its mouth at Bartholomew Diaz Point, 130 km north of Vilanculos. The river flows in a predominantly northerly direction, parallel to the coastline and due to its proximity to the coast.

A wide variety of aquatic and wetland habitats are present in the eastern Govuro area. These areas are considered sensitive habitats. In this area several seasonal streams occur in the rainy season, which feed the coastal lakes and the wetlands. Due to the seasonality of the surface water resources, groundwater is the main source of water in the project area.



Figure 14: The Govuro River is a much-used source of water for drinking, cooking, clothes washing and bathing

7.5 Project Water Demand

The Surface Water Impact Assessment indicates that the proposed CTT Project will require cooling water, demineralised water and potable water. Water will be sourced from local boreholes and treated accordingly. Two boreholes (T9 and W5A) are currently being considered. Borehole T9 is in an alluvial aquifer, delivers good quality water similar to the quality of the Govuro River, but is located about 12 km from the site on the east bank of the Govuro River. Borehole W5A is in the vicinity of the CPF, approximately 2 km from the proposed CTT site, and delivers water from the karst aquifer. Rainwater will also be harvested and used during the rainy season.

Particular water use requirements/demands:

- Cooling of gas engines/gas turbines will require treated and filtered water of stringent water quality;
- Fire water system must meet the required provisions relating to design, operation, maintenance, pumping, storage and installations;
- Potable water must also be made available via the raw water treatment plant to meet required human consumption specifications;
- Service water must be available once weekly, to wash down floors to be drawn off prior to fire water tank;
- Demineralised water will be used for the cooling in the gas and steam turbine; and
- Water cooling will be used as an alternate when air cooling is not possible.

Both the Surface Water and Geohydrology Impact Assessments highlighted possible impacts on groundwater availability and baseflow of the Govuro River as a result of proposed Project water abstraction.

7.6 Other Water Users

The main source of water for local communities is groundwater, obtained from wells with a hand pump (Figure 15). Piped water accounted for a very small fraction of the water source. Seasonal streams that occur in the rainy season in the Govuro area are used by local communities for consumption and agriculture.



Figure 15: Hand pumps have been installed close to some villages to provide drinking water to local communities

7.7 Socio-Economic Setting

The Project is located in the Temane/Mangungumete area of the Inhassoro District of Inhambane Province, Mozambique. The Project area incorporates 12 villages and communities, as well as the proposed beach landing sites in Inhassoro Town. The Inhassoro District has 51 193 inhabitants, with an average population density of 8.3 inhabitants per km² and an average family size of six members.

There are primary and secondary schools in Inhassoro main village. Almost half of the respondents had finished primary school and about a third with no type of formal education. The houses in the project area are made mainly of local and mixed materials with houses located in district centres built of conventional materials.

More than half the respondents in the area use pit latrines with no slab. Subsistence agriculture is the principal economic activity for inland communities, followed by livestock breeding. Charcoal production is the most lucrative natural resource use in the project area. Fishing from the sea provides food and income to a large proportion of economically active people in the coastal villages around the project area. These livelihood strategies are discussed in more detail below:

7.7.1 Food Security and Diet

7.7.1.1 Subsistence Agriculture

Cultivated plants (incl. grains) or agricultural products harvested for human or animal consumption are recognised as an important ecosystem service (IFC GN6, 2012; Landsberg *et al.*, 2013). Various crops are grown on both a subsistence and commercial basis. Subsistence farming is by far the most common form of agriculture and features prominently throughout the area. A shifting/semi-permanent farming method is practiced, with patches of woodland cleared and typically burnt to create an ash garden. The resulting ash is incorporated into soil at the onset of the rainy season and provides additional nutrients for crop growth. Crop fields are generally about 0.96 ha large. Maize, cassava, ground nuts and cowpeas are common crop plants. Other common crops include potatoes, millet and sweet potatoes. Depending on productivity, each plot is cultivated for a couple of years (sometimes up to four) before being abandoned in favour of a new plot. Refer to Figure 16 to Figure 18.



Figure 16: Small-scale subsistence crop fields are common throughout the region (This one included a combination of maize and cassava)



Figure 17: Maize is a common crop (These cobs have been harvested and left to dry. They will later be ground to make porridge)



Figure 18: Cassava is another commonly grown crop

7.7.1.2 Fruits, Vegetables and Other Produce

Several forms of fresh produce were observed for sale at a road side stall including mangos, Marula⁵ fruits, pumpkins, paw paws, chilli peppers and nuts (Figure 19 and Figure 20). These will be grown in homestead gardens and adjacent farming plots or harvested locally. Evidence of palm sap collecting for the making of wine, from *Hyphaene* and *Phoenix* plants, was also observed close to the Govuro River (Figure 21). Villages also collect wild fruits and berries in the resource areas around their communities as a dietary supplement.



Figure 19: An assortment of fruits and vegetables for sale at a road side vendor



Figure 20: Harvested nuts



Figure 21: Evidence of palm sap harvesting to be used for palm wine

7.7.2 Natural Resource Use

Biological Materials

The use of various plant materials for building huts, granaries, livestock pens and various other rural infrastructure is common throughout the region, and one of the main forms of ecosystem goods. Common uses of plant material observed during the field inspection are discussed below:

- Tall woody grasses from the genera *Hyparrhenia* and *Hyperthelia*, as well as reeds and sedges are cut at the end of the growing season, dried, and used for thatching roofs and as walling material for huts and granaries (Figure 22). It was also noted that grass bundles are stacked at the side of major roads and sold commercially (Figure 23);

⁵ *Sclerocarya birrea* subsp. *caffra*

- Wood from local trees of varying sizes is harvested and used as props and supports in huts and other village infrastructure (Figure 24); and
- A number of tree species in the region, such as *inter alia*; *Pterocarpus angolensis* and *Azelia quanzensis*, are highly sought after for their timber. Although no actual timber felling was observed during the field inspection, numerous trucks transporting felled trees were observed driving south along the EN1. It is believed that these were harvested further in the interior (west and north of the project area) and are being transported to Maputo for export.

Non-Biological Raw Materials

The use of non-biological material was also noted during the field inspection. Common materials included rocks and sand that are sold for use as building material (Figure 25 and Figure 26).

Rocks are quarried and then transported to road-side chipping yards where they are broken in smaller, and differently sized rocks and pebbles using hammers and picks. These are then sold as a building aggregate. Sand for building is also quarried at local sites. Sand is loaded directly onto waiting vehicles and transported to nearby towns.



Figure 22: Local women cutting thatching grass



Figure 23: Piled thatching grass bundles, ready for sale



Figure 24: Hut built out of local sourced natural material including, thatching grass, wood and reeds



Figure 25: Rocks quarried locally, are sold for the building industry



Figure 26: Sand quarry, photographed during the field visit

7.7.3 Livestock Husbandry

The keeping of livestock for domestic or commercial consumption or use is recognised a provisioning ecosystem service (Landsberg *et al.*, 2013). Despite the abundance of available rangeland for grazing, domestic livestock numbers in the study area do not appear to be large. Animals were observed only occasionally during the field inspection, including cattle and goats (Figure 27 and Figure 28). Livestock herds that are present depend on being able to access a variety of grazing resources during the different seasons to meet their nutritional requirements. They will also need ready access to reliable water sources. The keeping of poultry seems to be more common in the study area, with numerous chickens observed.



Figure 27: Grazing cattle, photographed to the west of the Govuro River



Figure 28: Goats, photographed to the east of the Govuro River

7.8 Cultural Heritage Context

The Inhassoro District is considered to have high archaeological potential due to its strategic setting along coastal trade routes (both inland and along the shoreline) and the Govuro and Save Rivers. During archaeological surveys, a total of 15 archaeological sites were identified in the study area and surrounds. These include one stone age site (containing lithic artefacts), one early Iron Age Site and six Late Iron Age Sites. No archaeological evidence was recovered in the CTT project-related areas.

Based on community consultation, 45 burial and cemetery sites identified in the study area, with a number of these recorded along the main EN1 Road. Six sites of cultural importance ‘sacred places’ were in the cultural heritage study area. These include sites comprising sacred trees, sacred forests and a sacred pool. Sacred trees and forests are typically associated with ancient burial grounds (e.g. the Chipongo Baobab) and cemeteries (e.g. Mangugumete and Chitsotso). The two scared pools are linked to the burial of stillborn babies. Two other sacred places noted in the Heritage Report include an abandoned spiritual centre and a site dedicated to male circumcision.

7.9 Existing Pressures and Threats to Ecosystem Service supply

Across the study area, subsistence agriculture and woodland clearing for biofuels are probably the main drivers of habitat modification.

- Slash and burn agriculture is the dominant form of farming practiced. Fields are created by clearing and burning indigenous vegetation. Crops are then grown for several years before nutrient levels are depleted, and fields are abandoned in favour of newly created field; and
- Wood plant material is a valuable source of natural fuel and used for charcoal production and for firewood. Select large trees are felled, cut up into suitable size-lengths and then either bundled and used/sold as fire wood, or combusted in mud kilns to produce charcoal;

The biophysical outcome of both these livelihood activities (agriculture and charcoal production) is a landscape characterised by a patch-work mosaic comprising cultivated fields, fallow open fields, recovering / regenerating habitat patches, and areas of undisturbed natural habitat.

The conversion of natural woodland habitat to a disturbed shrubland type form over large spatial scales will potentially impact the ecological integrity and functioning of local ecosystems, which may threaten the supply of various ecosystem services.

7.10 Which Ecosystem Services could the Project Impact? And Which Beneficiaries Are Potentially Affected?

The ecosystem services supplied within the Study Area are listed according to vegetation group in Table 6. These ecosystem services are supplied by ecosystems that are likely to have a loss in extent and/or condition as a result of the Project, and thus could potentially be impacted by the Project.

The beneficiaries who use those services supplied by the ecosystems that could be affected by the Project were also identified (Table 6), and fall into the following categories:

- **Site-based (Type I):**
 - Subsistence farmers and charcoal producers.
- **Local (Type I):**
 - Residents of villages and towns (Inhassoro) in the study area.
- **Regional:**
 - Downstream water users; and
 - Regional consumers.

In addition, the Project itself is a Type II beneficiary of ecosystem services within the study area:

- The Project is dependent on the abstraction of groundwater from boreholes for its operation; and
- The Project is dependent on a social licence to operate.

Table 6: Ecosystem Services that the project could potentially impact and beneficiaries of those services

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
<i>Provisioning</i>			
Food	Open and Closed Woodland Low Thicket Permanent and Seasonal Wetlands	Subsistence food crops (cassava, maize), fruits and vegetables (pumpkins, paw paws, chilli peppers and nuts)	Site-based and local subsistence farmers Local consumers
	Open and Closed Woodland Low Thicket Permanent and Seasonal Wetlands	Foraging/grazing resources for Livestock (e.g. cattle, sheep and goats)	Site-based subsistence farmers Local subsistence farmers. Local consumers
	Open and Closed Woodland Low Thicket Tall Forest / Tall Thicket	Wild foods, including bush meat and wild fruits.	Site-based communities Local communities
	Permanent and Seasonal Wetlands	Capture Fisheries – fishing for freshwater fish in the Govuro River and inland pans.	Residents of Site-based communities Residents of Local communities Regional consumers
	Coastal	Capture Fisheries – fishing for sea fish off the Inhassoro coast	Residents of Local communities Regional consumers
Medicinal Plants	Open and Closed Woodland Low Thicket Tall Forest/Tall Thicket	Availability of traditional medicines	Residents of Local communities
Biomass Fuel	Open and Closed Woodland Low Thicket Tall Forest/Tall Thicket	Fuelwood and charcoal	Residents of Site-based communities Residents of Local communities Regional consumers

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
Biological raw materials	Open and Closed Woodland Tall Forest/Tall Thicket	Construction materials for traditionally-built homes	Residents of Site-based communities Residents of Local communities
Fresh water	River Wetland/pans Shallow aquifers	Water for consumption is taken from groundwater well (hand pumps) and from Govuro River. Tributaries from Govuro surface water may also be used by residents of local communities.	Residents of Site-based communities Residents of Local communities Regional downstream users
	River Wetlands Shallow aquifers	Water sourced from a borehole either located on site or via a water pipeline to be positioned on the eastern bank of the Govuro River for the Project.	The Project
<i>Regulating</i>			
Regulation of air quality	Open and Closed Woodland Low Thicket Permanent and Seasonal Wetlands	Leaves of trees, shrubs and forbs trap air pollutants, especially near industrial and urban areas, and along roadsides	Residents of Site-based communities Residents of Local communities
Regulation of water flow patterns	Open and Closed Woodland Low Thicket Permanent and Seasonal Wetlands	Sandy soils along with terrestrial vegetation facilitates water penetration and aquifer recharge. Reeds and sedges contribute to reduced flooding frequency	Residents of Site-based communities Residents of Local communities Regional downstream users
Water purification	Permanent and Seasonal Wetlands	Vegetation in the Govuro River floodplain and in other wetland areas has a role in dilution, decomposition and partial water purification.	Residents of Site-based communities Residents of Local communities Regional downstream users
Erosion control	Open and Closed Woodland Low Thicket Tall Forest/Tall Thicket Permanent and Seasonal Wetlands	All vegetation cover within the study area reduces soil loss and prevents erosion	Residents and subsistence crop farmers of Site-based communities Residents of Local communities

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
Pollination	Open and Closed Woodland Low Thicket Tall Forest / Tall Thicket Permanent and Seasonal Wetlands	Subsistence agriculture is reliant on pollination by bees for fruit and vegetable growth.	Site-based subsistence farmers Local subsistence farmers

8.0 STEP 2: ECOSYSTEM SERVICE PRIORITISATION

8.1 Prioritisation of Type I Ecosystem Services

Ecosystem services were prioritised according to project impact by answering the three key advanced by Landsberg *et al.* (2013):

- 9) Could the Project affect the ability of others to benefit from this ecosystem service?
- 10) Is the ecosystem service important to beneficiaries' livelihoods, health, safety or culture?
- 11) Do beneficiaries have viable alternatives to this ecosystem service?

The full results of the prioritisation exercise for Type I ES are detailed in APPENDIX A. Five Priority Type I ES according to Project Impact were identified:

- **Food - Subsistence Crops:** Direct land-take, declaring of servitudes and Project-associated population influx may increase pressure on available space for growing subsistence crops for local beneficiaries, who rely on the crops for their staple diet;
- **Food – Sea Fisheries:** Potential temporal disruption of sea fishing activities due to ship movement and off-loading at the selected beach landing site, may potentially reduce overall catch yield for local sea fishermen;
- **Food – River Fisheries:** Potential project impacts on water quality in the Govuro River may affect fisheries, including subsistence-scale fishing within the study area, and downstream users;
- **Biomass fuel (wood and charcoal):** Land-take and Project-associated population influx may increase pressure on supply of wood biomass for local beneficiaries; and
- **Fresh water supply:** The quality of fresh water for drinking may be compromised by potential accidental spillages and leaks from vehicles and machinery working or traversing in close proximity to water sources. Quality of fresh water for drinking may be compromised by abstraction for Project processes.

8.2 Prioritisation of Type II Ecosystem Services

Type II ES were prioritised according to project dependence (operational risks to project performance) by answering the two key questions put forward by Landsberg *et al.* (2013):

- 1) Could this ecosystem service change in ways that could affect operational performance?
- 2) Does the Project have viable alternatives to this ecosystem service?

The full results of the prioritisation exercise for Type II ES are detailed in APPENDIX B. One priority Type II ES according to operational risk to Project performance was identified.

The Project itself is a Type II beneficiary of ecosystem services within the study area:

- **Fresh water supply:** The Project is reliant on the quality and quantity of freshwater remaining constant throughout its lifetime in order to maintain its operational feasibility.

As noted above, ecosystem services on which the Project depends on are highlighted in this document and included for completeness, but are not included in the impact assessment, which deals with Type I ecosystem services, i.e. those that may be impacted by the Project, only.

9.0 STEP 3: ASSESSMENT OF PROJECT IMPACT ON TYPE I PRIORITY ECOSYSTEM SERVICES

The priority ES are generally tied to land cover types and associated loss to the Project footprint (especially provisioning and regulating ES), or the presence of the Project in the landscape (cultural ES), which will be in effect for the lifetime of the Project, from construction through to closure.

However, some potential impacts on ES are considered specific to a particular Project phase (for example, 'regulation of water flows and timing' is more likely to be affected during the operational phase of the Project as a result of the physical presence of the Project), therefore the impact assessment is separated into construction/operation/decommissioning phases and grouped by Project impact. Some priority ES may potentially be affected during several project phases e.g. wild foods.

The impact severity ratings presented in the impact analysis summary sections are based on the anticipated impacts on ES, both before and after specific mitigation measures have been applied. Mitigation measures provided include those from specialist studies that are specific to potential impacts on the supply of ES, and suggested additional mitigation measures based on guidance provided for major infrastructure project impacts and dependencies on ES (IPIECA, 2011).

During the Environmental Impact Study (EIS) process, issues and impacts were identified through community consultation, professional experience, and by referencing previous environmental assessments and IFC guidance notes. Key potential impacts on Priority ES that have been identified for detailed assessment are outlined in Table 7.

In sections 9.1 through to 9.3 we discuss impact characterisation for the construction, operational and decommissioning/closure phases. Rating calculation are presented in Table 8. Recommended mitigation measures are detailed in section 9.4.

Table 7: Key Potential Impacts on Priority Ecosystem Services

Project Phase	Project Impact	Priority ES Potentially Affected
Construction	1) Vegetation clearance and soil removal in preparation for construction (land-take)	Food – subsistence crops
	2) Disruption of coastal fishing activities	Food – coastal fisheries
	3) Contamination/pollution of surface water due to construction activities	Freshwater supply Food – river fisheries
Operation	4) Abstraction of ground water from boreholes	Freshwater supply
	5) Contamination/pollution of ground- and surface water resources	Freshwater supply
	6) Population influx	Biomass fuels (charcoal and fire wood) Food – fisheries
Decommissioning and Closure	7) Contamination/pollution of ground and surface water resources	Freshwater supply

9.1 Construction Phase

9.1.1 Impact 1: Vegetation Clearance and Soil Removal in Preparation for Construction

9.1.1.1 Food – Subsistence Crops

Land take for the proposed Project may result in the loss/disturbance of approximately nine hectares of cultivated land. The value of this ecosystem service is considered Very High as food crops are essential for subsistence and may constitute the only real opportunity of livelihood generation for beneficiaries within the study area. This notwithstanding, we note that the availability of viable alternative areas for crop growing is probably high, as there are extensive areas of similar habitat adjacent to proposed Project footprint areas, which will be readily accessible. There may however, be an associated opportunity cost concerning the clearing of new crop fields to replace those lost/disturbed by Project activities.

The severity of the loss of ecosystems supporting subsistence crops is considered high, and the extent will be the site, as most of the beneficiaries are likely to occur in villages within the immediate vicinity. The duration of impact will, in most cases, be permanent. This impact is thus rated of moderate significance before mitigation. Mitigation measures, including compensation as per the resettlement action plan, can be implemented to reduce impact severity, which will reduce overall impact significance to **low**.

9.1.2 Impact 2: Disruption of Coastal Fishing Activities

9.1.2.1 Food – Coastal Fisheries

Offshore fishing is a prominent livelihood strategy of many local people. The value of coastal fish to affected beneficiaries is therefore high. The conveying of Project infrastructure by ship to Inhassoro and the subsequent off-loading using barges of the machinery and equipment at the selected beach landing site may cause the temporal disruption of fishing activities. The social impact assessment predicts that this may reduce fish quantity for household consumption and sale.

The magnitude of this impact is anticipated to be moderate. It will be restricted to the construction phase and therefore has a short duration. Conveying and offloading activities will be restricted to one landing site, so the extent of the impact will local. The overall impact is rated low significance prior to mitigation and can be maintained at a **low** significance with the correct implementation of mitigation measures.

9.1.3 Impact 3: Contamination/pollution of surface water due to construction activities

9.1.3.1 Freshwater supply and food (River Fisheries)

During construction activities associated with the upgrading of the bridge crossing the Govuro River there is a risk of accidental leaks or spills of chemical, fuels and other contaminants (e.g. effluents) directly into the Govuro River. A reduction in water quality caused by pollutants could reduce water quality and affect the supply of freshwater. It could also negatively impact fish populations, causing die-offs, which could impact the supply of fish to local communities.

Prior to mitigation, the severity of this impact is rated as moderate, and the extent will be regional as downstream users may be affected. It will however, be confined to potential incidents occurring during the construction phase, so has a short-term duration. The overall impact risk score prior to mitigation is one of moderate significance.

Provided that the Project adheres to the mitigation measures concerning the maintenance of construction vehicles and machinery, and the handling and storage of fuels, chemicals and other potential contaminants, the intensity of potential impacts and the probability of their occurrence can be reduced, resulting in an after-mitigation impact rating of **low** significance on this ecosystem service and its affected beneficiaries.

9.2 Operational Impacts

9.2.1 Impact 4: Abstraction of Ground Water from Boreholes

9.2.1.1 Freshwater Supply

The proposed Project will rely on the abstraction of water from a borehole to supply the Plant with process water. Excessive extraction may reduce the ground water levels, which may affect the supply of freshwater to communities. This is particularly relevant to communities that rely on hand-pump boreholes or shallow, hand-dug wells for water for drinking, washing and crop irrigation purposes.

The potential effects are considered to be of high severity, and to be potentially regional in extent. Potential impact duration is long term. The overall significance of this impact prior to mitigation is moderate. The application of the recommended mitigation measures, including regular borehole monitoring, can reduce the severity and probability of this impacts, resulting in a **low** significance score post mitigation.

9.2.2 Impact 5: Contamination/Pollution of Ground and Surface Water Resources

Both the surface water and geohydrological impact assessment reports identify several potential sources of contamination/pollutants associated with the Plant's operations that may impact local water resources in the event of spills, leaks or incorrect management. These include spills from the evaporation pond and the improper management of discarded sludge from the pond; spills from the first flush pump; discharge from the clean stormwater sump; and the irrigation of effluents into the surrounds.

The potential effects are considered to be of high severity and to be regional in extent. Potential impacts may occur throughout the operational phase and thus the duration is long term. The overall significance of this impact prior to mitigation is moderate. With correct mitigation, as per the recommended measures outlined in the surface water impacts assessment and geohydrology report, this impact can however, be reduced and maintained at a **low** significance.

9.2.3 Impact 6: Population Influx

9.2.3.1 Biomass Fuels (*charcoal and fire wood*)

According to the Social Impact Assessment, the area has already experienced a significant influx of people in search of work and business opportunities. This may accelerate with the expansion of Project operations. An influx of people is likely to increase pressure on locally-sourced resources, such as woody biomass for fire wood and charcoal. This impact may persist throughout all phases of the proposed Project.

Before mitigation, the severity of the potential impact is high. It will be local in extent, but will potentially be permanent in duration, with settled populations likely to remain beyond the operational lifetime of the Plant. The overall impact significance without mitigation moderate.

This impact can be reduced to a **low** significance, with the implementation of appropriate mitigation. An Influx Management Plan is one of the key mitigation measures proposed in the Social Impact Assessment to address the potential effects of Project-driven population influx. It is recommended that this be developed/updated based on regular consultation with the relevant stakeholders.

9.2.3.2 Fisheries

Significant population influx may result in increased pressure on local fisheries. Moreover, the presence of improved beach landing facilities (developed for the Project) may increase the scale and efficiency of local fishing operations, which may further impact the sustainability of fisheries.

The severity of a population influx on fisheries is considered high, and the extent will be the local, as most of the beneficiaries are likely to occur in Inhassoro and surrounding settlements. The duration of impact is permanent. This impact is thus rated of moderate significance before mitigation.

This impact can be reduced to a **low** significance, with mitigation (i.e. the development of the Influx Management Plan, as per the recommendations of the Social Impact Assessment).

9.3 Decommissioning and Closure Phase

9.3.1 Impact 7: Contamination/Pollution of Ground and Surface Water Resources

During the dismantling of project infrastructure there is potential for contaminants that have been stored and used on site during operation, such as sludge, fuels, chemicals effluent to be spilled or leaked into the environment. There is also potential for leaks and spills of hazardous substances from vehicles and machinery used for decommissioning activities.

Similar to the operational phase, the overall significance of this impact prior to mitigation during the decommissioning and closure phase is moderate. With correct mitigation, it can however be reduced to a **low** significance.

Table 8: Impact Rating – Before and After Mitigation

Indicator of potential impact		Pre-mitigation					Post-mitigation				
		Severity	Duration	Geographic Extent	Probability	Significance	Severity	Duration	Geographic Extent	Probability	Significance
Construction Phase											
Vegetation Clearance and Soil Removal in Preparation for Construction		8	5	1	5	70	3	5	1	5	45
Disruption of Coastal Fishing Activities		6	2	2	4	40	4	2	2	3	24
Contamination/pollution of surface water due to construction activities		8	2	3	4	52	6	2	2	2	20
Operational Phase											
Abstraction of Ground Water from Boreholes		8	4	3	4	60	6	4	3	2	26
Contamination/Pollution of Ground and Surface Water Resources		10	4	2	4	64	6	4	2	2	24
Population Influx	Fuel wood and charcoal	8	5	2	4	60	6	5	2	3	39
	Fisheries	8	5	2	4	60	6	5	2	3	39
Decommissioning and Closure Phase											
Contamination/Pollution of Ground and Surface Water Resources		10	4	2	4	64	6	4	2	2	24

9.4 Recommended Mitigation Measures

Recommended mitigation measures to manage the impacts on priority ecosystem services are listed below:

9.4.1 Food – Subsistence Crops

Farmers whose crops will be lost as a result of the Project must be identified and engaged with regarding relocation and/or compensation, as necessary:

- Implement an effective stakeholder engagement process;
- A compensation plan should be developed in consultation with the affected farmers and the authorities and community representatives to specify which assets or livelihood resources will be affected by the project, and how these will be compensated for; and
- Develop and implement a comprehensive influx management plan to limit the extent to which increases in population will impact the availability of crop produce.

9.4.2 Food - Coastal Fisheries

- As per recommendations in the Social Impact Assessment Report, mitigation centres on developing communication, safety and awareness measures (such as educational campaigns) to alert and inform community members, specifically fishermen, about the duration, nature and schedule for the delivery of heavy equipment that will be transhipped and barged to the beach landing site;
- Develop and implement a comprehensive influx management plan, to reduce pressure on fish resources;
- Monitor the use of beach landing sites and prevent use by large-scale commercial fishing operators; and
- The results of monitoring need to be presented in a non-technical manner to affected communities and discussed in an open and participatory forum.

9.4.3 Food – River Fisheries

- Develop a well-designed storm water management plan for the Plant, ensuring the separation of clean and dirty water, and the containment and correct disposal of potentially contaminated water. All wastewater discharged from the site must comply with the appropriate Mozambican and IFC standards;
- Develop protocols to manage the storage and handling of all chemicals and other hazardous substances used on-site during all phases of the proposed project. Protocols should also include provision for the correct clean-up of potential spills and leaks;
- Regularly maintain and service all vehicles and machinery to minimise the potential for leaks and spills of fuels;
- Conduct regular monitoring of water quality in the Govuro River. The results of monitoring need to be presented in a non-technical manner to affected communities and discussed in an open and participatory forum; and
- Develop and implement a comprehensive influx management plan.

9.4.4 Fresh Water Supply

- Develop a well-designed storm water management plan for the Plant, ensuring the separation of clean and dirty water, and the containment and correct disposal of potentially contaminated water. All wastewater discharged from the site must comply with the appropriate Mozambican and IFC standards;

- Develop protocols to manage the storage and handling of all chemicals and other hazardous substances used on-site during all phases of the proposed project. Protocols should also include provision for the correct clean-up of potential spills and leaks;
- Regularly maintain and service all vehicles and machinery to minimise the potential for leaks and spills of fuels;
- Develop protocols to manage the storage and handling of all chemicals and other hazardous substances used during all phases of the proposed project; and
- Conduct regular monitoring of groundwater quantity and quality, as per the Geohydrology Impact Assessment. The results of monitoring need to be presented in a non-technical manner to affected communities and discussed in an open and participatory forum

9.4.5 Biomass Fuels (Fire wood and Charcoal)

- Develop and implement a comprehensive influx management plan.

9.5 Cumulative Impacts

It is anticipated that the Project may affect priority ES, including specifically, subsistence crops, fisheries, freshwater supply (both volume and quality) and the availability of biomass for fuel (fire wood and charcoal).

Following the impact assessment process, it can be seen that predicted Project impacts on most ecosystem services have a low overall risk score post-mitigation, and thus are not expected to contribute significantly to cumulative impacts on ecosystem services. However, we note that potential population influx, driven at least in part, by the proposed Project and auxiliary developments is a phenomenon that is difficult to mitigate, and may place increasing pressure on the provision of local ecosystem services and is therefore expected to contribute to cumulative impacts on potentially all ecosystem services throughout all phases of the Project.

10.0 CONCLUSION

The proposed CTT Project will have impacts that are likely to influence the supply of ecosystem services to communities living in and around the envisaged Project footprint. Impacts are linked to direct project activities, such as; land take, the development of Plant infrastructure, conveying of construction material, and subsequent Plant operations; as well as indirect effects, including most notably, population influx driven by the promise of potential employment.

These impacts will place additional strain on several priority provisioning services, such as subsistence farming output, fisheries, water quality and supply, and the provision of woody plant material for fire wood and charcoal production.

It is thus important that identified impacts are carefully managed. We emphasise the high degree of synergy between proposed mitigation measures advanced by several specialist studies, and those recommended in this study. In line with this, it is important that proposed mitigation measures are proactively implemented during all the relevant phases of the proposed Project. We also recommended that the results of all environmental monitoring, as they relate to the provision of ecosystems services, are regularly presented and discussed with affected communities. Based on the outcomes of public consultation, mechanisms should also be in place to adapt on-site environmental management procedures to address any community concerns and minimise further negative impacts.

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Signature Page

Golder Associados Moçambique Limitada

Andrew Zinn
Terrestrial Ecologist

Aisling Dower
Senior Ecologist

AZ/AD/jep

NUIT 400196265
Directors: G Michau, RGM Heath

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APPENDIX A

**Results of Prioritisation Exercise
for Type I Ecosystem Services**

PRIORITISATION OF ES ACCORDING TO PROJECT IMPACT

Priority Type I ecosystem services are those services for which the answers to questions 1 and 2 are “Yes” or “Unknown”, **and** “No” or “Unknown” to question 3.

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
<i>Provisioning</i>						
Food – Subsistence crops	Local beneficiaries	Income, livelihoods, food intake	Y	Y	Unknown	1
Food – Food for Livestock	Local beneficiaries	Reduced vegetation cover due to Project land-take may reduce grazing/foraging availability, which may limit the ability of people to raise livestock for subsistence and livelihood purposes. Increased demand as a result of population influx could also occur.	N – Reduced vegetation cover resulting from the proposed project is unlikely to push grazing resource beyond a threshold.	n/a	n/a	0

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Food – Wild foods	Local beneficiaries	Reduced bush meat and food plant availability due to reductions in woodland/bush land cover that supports hunted/harvested species	Y – However, loss of habitat is unlikely to negatively affect wild food availability to the extent that local communities are affected	Y	Y	0
Food – Sea fish	Local beneficiaries Regional beneficiaries	Potential temporal disruption of sea fishing activities due to ship movement and off-loading at the selected beach landing site, may potentially reduce overall catch yield for local sea fishermen.	Y	Y	N	1
Food – River fish	Local beneficiaries Regional beneficiaries	Project impacts (chemical leaks and spills) on water quality in rivers and wetlands may affect fisheries downstream, including subsistence-scale fishing within the study area, and downstream users.	Y	Y	N	1

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Medicinal plants	Local beneficiaries	Availability of traditional medicines – those who use them are likely to be reliant on them	Y	Y	Y	0
Biological raw materials – construction of traditional houses	Local beneficiaries	Ability to construct homes and animal shelters	Y	Y	Y	0
Biomass fuel – wood and charcoal	Local beneficiaries Regional beneficiaries	Availability of fuel sources for cooking, fish processing, brick making, and livelihood generation	Y	Y	Uncertain	1
Fresh water	Local beneficiaries Regional beneficiaries	The quality of fresh water for drinking may be compromised by potential accidental spillages and leaks from vehicles and machinery working or traversing in close proximity to water sources. Quality of fresh water for drinking may be compromised by abstraction for Project processes.	Y	Y	N	1

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
<i>Regulating</i>						
Air quality	Local beneficiaries Regional beneficiaries	Project effects on ecosystems that provide this ecosystem service are negligible in the context of available unaffected areas	N	n/a	n/a	0
Water flows and timing	Local beneficiaries	Govuro floodplains may be disturbed, affecting their capacity to supply service.	N – one potential river crossing point may be impacted. Mitigation measures have been developed to limit impacts on riparian habitat.	Y	Y – The Govuro River is characterised by extensive reed beds across much of its length in the study area	0

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Soil stability & erosion control	Local beneficiaries	Vegetation clearance for construction of infrastructure components may reduce the ability of the surrounding soils to withstand erosive forces of winds and floods	N – one potential river crossing point may be impacted. Mitigation measures have been developed to limit impacts on riparian habitat.	n/a	n/a	0
Water purification and waste treatment	Local beneficiaries Regional beneficiaries	Disturbance of Govuro floodplains by proposed infrastructure may impact the integrity of floodplains and their ability to supply this ES	N – one potential river crossing point may be impacted. Mitigation measures have been developed to limit impacts on riparian habitat.	n/a	n/a	0

Cultural

Ecosystem Service	Potentially affected beneficiaries	Potentially affected benefits	1. Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries' livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternative to this ES? (Y/N/?)	Priority ES 1 = Priority 0 = Non-priority
Ethical and spiritual values	Local beneficiaries	Sacred sites and intangible cultural heritage are intrinsically linked with natural ecosystems such as wetlands, rivers and forests, and substantially contribute to beneficiaries' sense of identity	N - project is unlikely to impact site of cultural value	n/a	n/a	0

APPENDIX B

**Results of Prioritisation Exercise
for Type II Ecosystem Services**

PRIORITISATION OF ES ACCORDING TO PROJECT DEPENDENCE

Priority Type II ecosystem services are those services for which the answer to question 1 is “Yes” or “Unknown”, **and** “No” or “Unknown” to question 2.

Ecosystem Service	Potentially affected benefits	1. Could this ecosystem service change in ways that could affect operational performance? (Y/N/?)	2. Does the Project have viable alternatives to this ecosystem service? (Y/N/?)	Priority ES? 1 = Priority 0 = Non-priority
Freshwater supply	The Project is reliant on the groundwater obtained boreholes to maintain its operational feasibility.	Y	N	1
Soil stability and erosion control	Vegetation removal for site clearance could contribute to landform instability surrounding the proposed infrastructure, creating a ‘nick point’ for erosion to take hold. Ongoing soil erosion around the Project infrastructure will be costly for the Project to maintain/address, which could affect the Project Performance.	N – mitigation measures have been developed to control Project impacts on soil stability and erosion	n/a	n/a

APPENDIX C

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Document Limitations

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