



REPORT

Central Térmica de Temane Project - Marine and Coastal Ecology Study

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

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Executive Summary

Moz Power Invest, S.A. (MPI), a company to be incorporated under the laws of Mozambique, together with 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. During the CTT construction phase, large heavy equipment and materials will need to be brought in by a ship which will dock in the port of Beira. Equipment and materials will 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 constructed of gabions, rock and gravel) at the town of Inhassoro. A maximum of 10 barge movements will be required to complete the delivery of the large infrastructure components to the temporary jetty over an expected 10-month period. The expected towing operations will take ± 22 hours (one way), traveling at an average speed of 12 - 13 km per hour until the Bazaruto Bay area is reached (near the Save river mouth), where speeds will be reduced to < 5 km per hour in line with the construction Environmental and Social Management Plan (c-ESMP). This report presents a description of the baseline marine ecology environment and an assessment of the potential impacts of the barging activities from the port of Beira to Inhassoro where the temporary jetty will be constructed for the offloading of heavy equipment for the power plant.

The CTT project could potentially affect marine biodiversity in three main ways; loss and disturbance of marine and coastal ecosystems of concern; loss and disturbance of fauna species of conservation concern, and creation of barriers to movement and collision risk for fauna species of concern. The construction and operation of the temporary jetty will cause minor land cover changes through vegetation clearance, and changes in local hydrodynamics, the effects of which will impact primary dune and sandy beach habitat. The movement of the barge from Beira to Inhassoro could pose a collision risk to marine mammal species of concern, and cause temporary loss or disturbance of natural habitats, particularly in near-shore shallower waters. These potential impacts will be very transient and with the application of the recommended mitigation measures (such as route alignment, speed limits and marine mammal observers), can be avoided or minimised to a point of low-negligible significance. The possible creation of a transient barrier to movement of individuals of Dugong between southern and northern feeding grounds within the Study Area, as a result of increased vessel traffic/noise in the final approach to the temporary jetty, was also considered, and found to be of low significance due to the low number of barge movements, and their spread over the course of 12-18 months. Although no significant residual impacts on species or ecosystems of concern are expected, the potential cumulative impacts on Dugong as a result of population influx throughout the lifetime of the Project and associated increase risk of accidental bycatch in fishing gear may be difficult to mitigate, and further measures may be required through the development of a biodiversity action plan (BAP) that investigates the feasibility of additional conservation measures at the municipal/government level and potential expansion of reserves and/or community engagement to ensure no net loss of Dugong in the Study Area. Furthermore, it is noted that although no significant Project impacts on the Endangered Indian Ocean humpback dolphin are anticipated prior to or after mitigation, net gain is still required by IFC for this critical habitat-triggering species in the Study Area. The Project Biodiversity Action Plan will therefore include actions that could be implemented on-the-ground to achieve net gain for Indian Ocean humpback dolphin, such as community engagement to mitigate marine mammal hunting and bycatch through the promotion of community-based ecotourism, local protection and enforcement, and social outreach campaigns.

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APPENDICES

APPENDIX A

Remote Satellite Imagery Classification - GTI, 2020

APPENDIX B

Document Limitations

ACRONYMS

Acronym	Description
ADI	Areas of Direct Influence
All	Areas of Indirect Influence
BANP	Bazaruto Archipelago National Park
BOD	Biological Oxygen Demand
CGGT	Combined Cycle Gas Turbine
CH	Critical Habitat
CITES	Convention on International Trade in Endangered Species
COD	Chemical oxygen demand
CORDIO	Coral Reef Degradation in Indian Ocean
CPF	Central Processing Facility
CR	Critically Endangered
CTT	Central Térmica de Temane
DD	Data Deficient
DOC	Dissolved organic carbon
DNAIA	National Directorate of Environmental Impact Assessment
EN	Endangered
ES	Ecosystem Services
EQT	Environmental Quality Target
ESIA	Environmental and Social Impact Assessment
EWT	Endangered Wildlife Trust
FSO	Floating, Storage and Offloading unit
GN	Guidance Note
IUCN	International Union for the Conservation of Nature
LC	Least Concern
IFC	International Finance Corporation
NTU	Nephelometric Turbidity Unit

Acronym	Description
OCGE	Open Cycle Gas Engines
MITADER	Ministry of Land, Environment and Rural Development (Ministério da Terra, Ambiente e Desenvolvimento Rural)
MPI	Moz Power Invest, S.A.
NT	Near Threatened
PAR	Photosynthetic Active Radiation
PS	Performance Standard
PSU	Practical Salinity Unit
SEPI	SASOL Exploration Production International
SNE	SASOL New Energy Holdings (Pty) Ltd
SP	Significance Points
TEC	Temane Energy Consortium (Pty) Ltd
VU	Vulnerable
WWF	World Wide Fund for Nature

1.0 INTRODUCTION

Golder Associates Africa (Golder) was appointed by Globeleq to conduct an environmental baseline study and environmental and social impact assessment (ESIA) of the proposed construction and operation of a natural gas fired power plant with capacity of up to 450MW, known as the Central Térmica de Temane (CTT) project (the Project). The ESIA was publicly disclosed in April 2019 and submitted to the environmental authorities in June 2019.

Due to the limitations in the bridge infrastructures in Mozambique, preventing the heavy equipment from being transported by road, the construction phase activities of the Project had initially evaluated options for the transshipment of heavy and oversized equipment and infrastructure components at anchorage sites in Bazaruto Bay, where the components would be transferred from a cargo ship to a barge for delivery to a temporary jetty at Inhassoro. The proposed anchorage points were located within the boundary of Bazaruto Archipelago National Park (BANP), which, as a protected area, qualifies as Critical Habitat according to the lender requirements of the International Finance Corporation's (IFC) Performance Standard 6 – Conservation of Biodiversity and Living Natural Resources. The results of the assessment of the impacts associated with the transshipment activities and use of the anchorage points predicted a significant negative residual impact on the BANP marine habitat, with mitigation measures focussed on avoiding any activities within the BANP boundary being recommended in order to avoid any loss or degradation of Critical Habitat.

As a result, the Sponsors conducted additional technical studies that successfully identified an alternative to anchoring within the Park boundaries, and therefore the previously studied anchorage points in the BANP will no longer be used. Heavy and oversized equipment and infrastructure components will now be transported to Beira Port (or another viable port), where they will be loaded onto a barge and then transferred to the temporary jetty at Inhassoro. This notwithstanding, there remains a risk that the barge movements could affect seagrass beds and coral reef habitat (classified as 'natural habitat' following IFC PS6) in the shallow water in and around the BANP, as well as species of concern. The Sponsors committed to updating the Marine Ecology Impact Assessment from the CTT ESIA, to address the alternative barge route.

Since the baseline assessment for the impact assessment was a desk-top study, an update of the existing baseline using supplementary primary data on seagrass beds and coral reef was done to inform the fine-scale routing of the barge as it approaches the temporary jetty, to avoid any significant impacts on natural habitats. The generated data has been shared with BANP who in turn provided more up to date information on dugong and dolphin abundance and distribution in the Bazaruto Archipelago area.

This document presents the updated Marine Ecology Impact Assessment for the CTT Project, including the updated baseline characterisation, and incorporating additional environmental action plan items as necessary for inclusion in the overall Project Biodiversity Action Plan (BAP). It relates to item #11b required as part of the sponsor (World Bank) proposed Environmental and Social Action Plan (ESAP).

2.0 PROJECT OVERVIEW

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 Electricidade de Moçambique (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 proposes to develop the CTT, a natural gas fired power plant of a power output in the range of 420-450MW.

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 Production Sharing Agreement (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 CTT site is approximately 500 m south of the CPF. The CPF, and the 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 CTT site. The estimated footprint of the CTT power plant is approximately 20 ha, with 10 ha for the power plant location and 10 ha for the temporary installations during construction (see Figure 1).

In addition to the power plant, infrastructure and facilities for the CTT project will also include:

- 1) Electricity transmission line (400 kV) and servitude; a total length of 25.5 km running generally south from the proposed power plant to a future Vilanculos substation. [Note: the development of the Vilanculos substation falls outside the CTT project scope as it is part of independent infrastructure authorised separately. The 25.5 km transmission line will be covered by the Project ESMP, while the Vilanculos substation is covered under the permitting process of 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 at the power plant site;
- 3) Two (2) New access roads; over a total length of 1,4 km:
 - a. to the north of the CTT to connect to the existing Temane CPF access road;
 - b. to the east of CTT, to be used as a secondary access during construction.
- 4) Gas pipeline and servitude; over a total length of approximately 2 km, which will start from the proposed LPG plant and run south on the eastern 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 (though within the existing secured land parcel (DUAT)); and
- 7) Transshipment at the port of Beira and barging of equipment to a temporary jetty in Inhassoro and associated laydown area for the purposes of safe handling and delivery of large oversized and heavy equipment to build the CTT. The shipment of equipment to and the transshipment of equipment at the Port of Beira does not form part of this study. The assessment will focus on the barging component, whereby equipment will be barged from the Port of Beira down to the Bazaruto Bay in order to offload materials at the temporary jetty. There are two temporary jetty site options, namely SETA and Maritima (Figure 7), though the Maritima site is considered to be the preferred temporary jetty site for environmental and technical (gradient for safe transportation of heavy equipment) considerations; the ESIA however showed that there was no significant difference between selecting either of these sites; and
- 8) Temporary reinforcement of an existing bridge and road (R241) across the Govuro River will be required where the existing bridge is not able to bear the weight of the equipment loads that need to be transported from the temporary jetty site to the CTT site. Alternatively, a temporary bridge can be built alongside the existing bridge, with new temporary access roads off the R241 road.

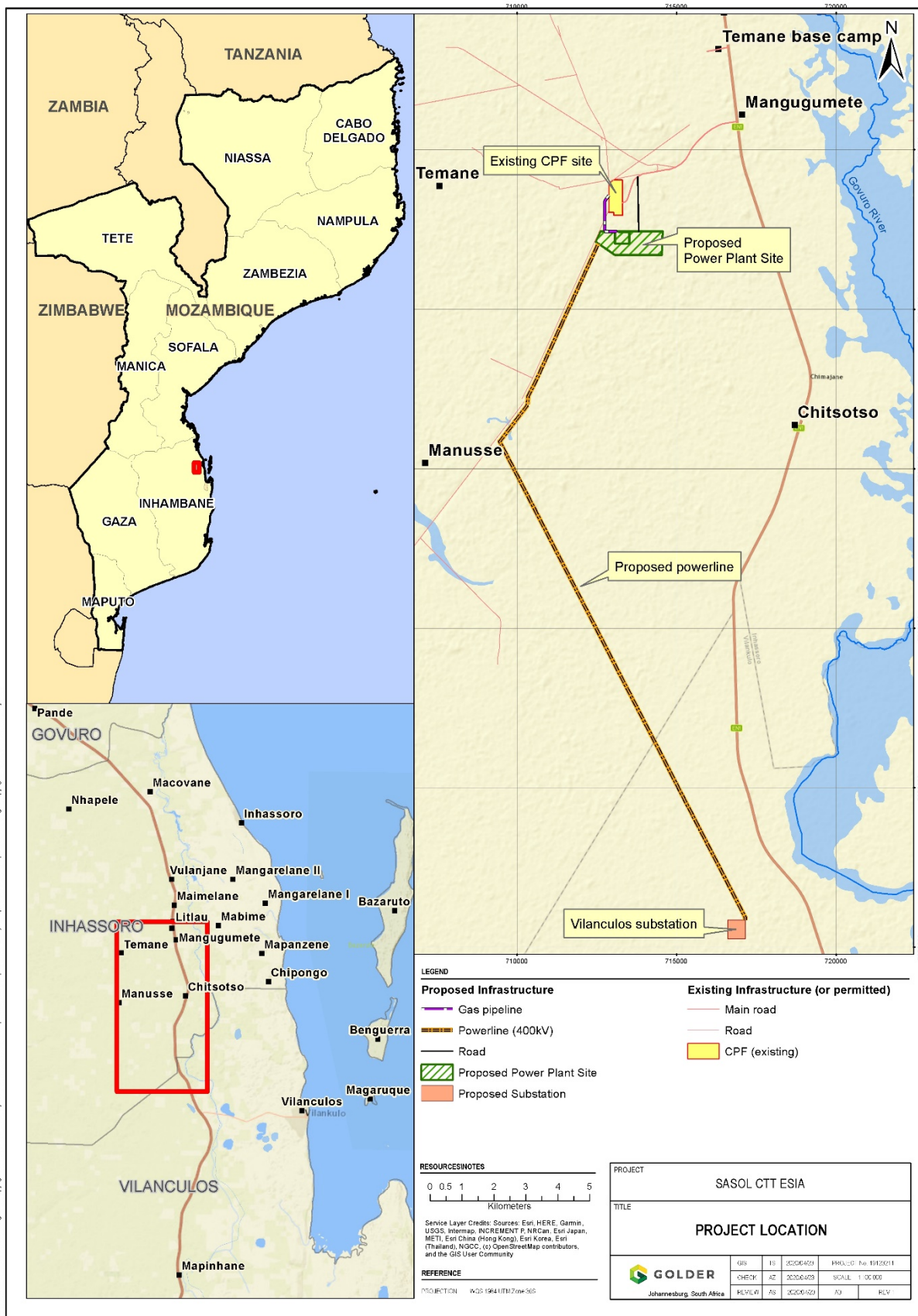


Figure 1: Project Location

3.0 DESCRIPTION OF THE KEY PROJECT COMPONENTS

The CTT project will produce electricity from natural gas in a power plant located 500m 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 a power output in the range 420-450MW;
- Gas pipeline (± 2 km) that will feed the Power Plant with natural gas from the proposed LPG facility;
- 400kV 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 at the power plant site;
- access roads to the CTT site (1 paved, and one gravel finished), and gravel maintenance roads within the transmission line and pipeline servitudes;
- Temporary jetty structures at Inhassoro town for the purposes of delivery of heavy and oversized equipment and infrastructure to build the power plant. This will include barging activities to bring equipment to the temporary jetty site (10 trips over a period of approximately 12 - 15 months); and
- Construction camp and contractor laydown areas adjacent to the CTT power plant site, within the DUAT area; and
- Temporary reinforcing bridge structures across Govuro River and tributaries, as well as possible new roads and/or road upgrades to allow equipment to be safely transported to site during construction.



Figure 2: Example of combined cycle gas turbines plant (source: www.industcards.com)

The technology selected for CTT project is the Combined Cycle Gas Turbine (CCGT). 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 indicated in Figure 1. A conceptual layout of the CTT plant site is shown below in Figure 3.

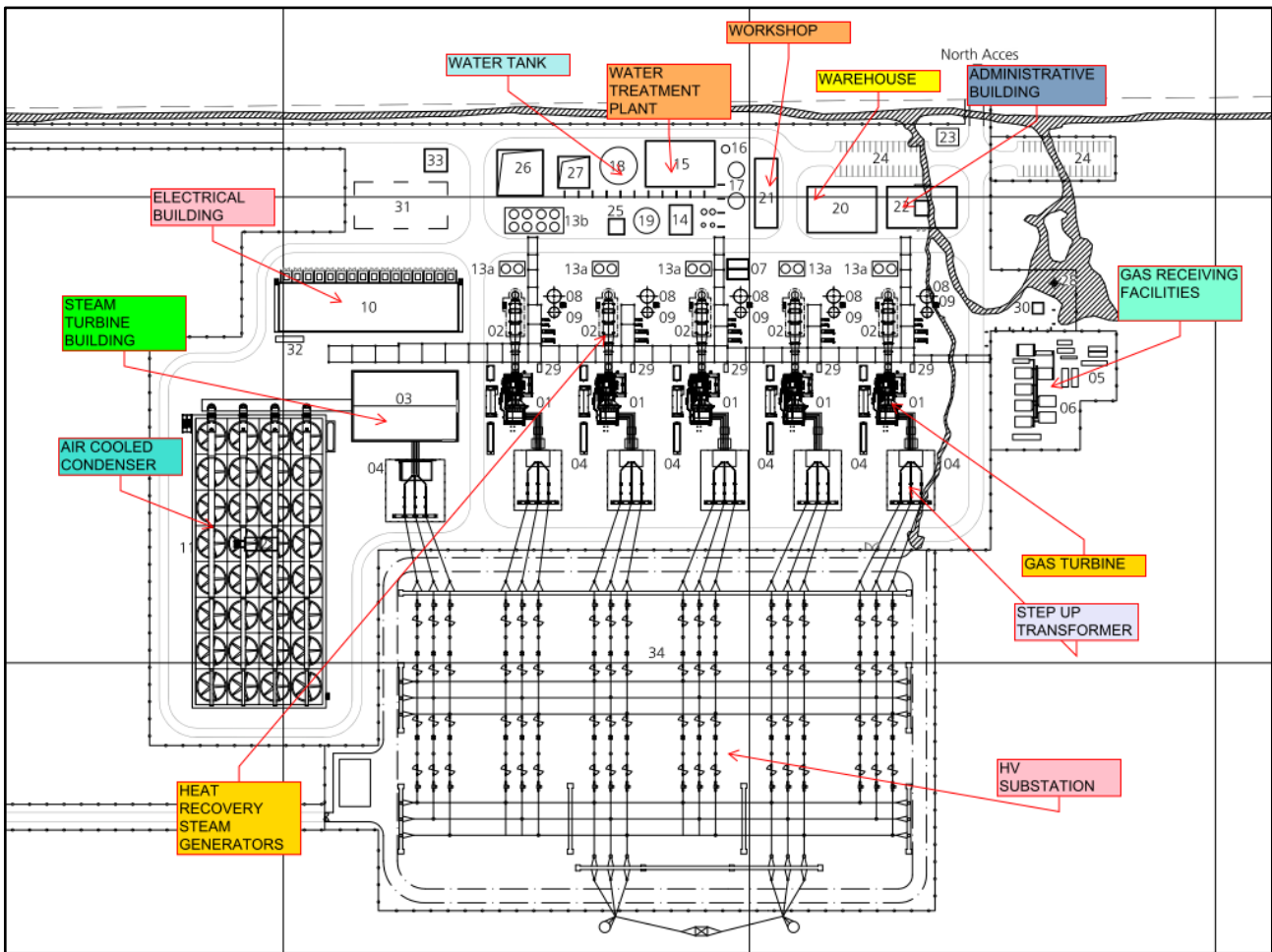


Figure 3: Conceptual layout of CTT plant site

3.1 Ancillary Infrastructure

The CTT project will also include the following infrastructure:

- Maintenance facilities, admin building and other buildings;
- Telecommunications and security;
- Water 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
- Temporary jetty laydown.

The heavy equipment and pre-fabricated over-sized components of the power plant will be brought in by ship to the Port of Beira and transferred by barge to the temporary jetty on the beach at Inhassoro. The equipment will be offloaded from the barge 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 jetty site, offloading and transporting of large heavy equipment by road to site.

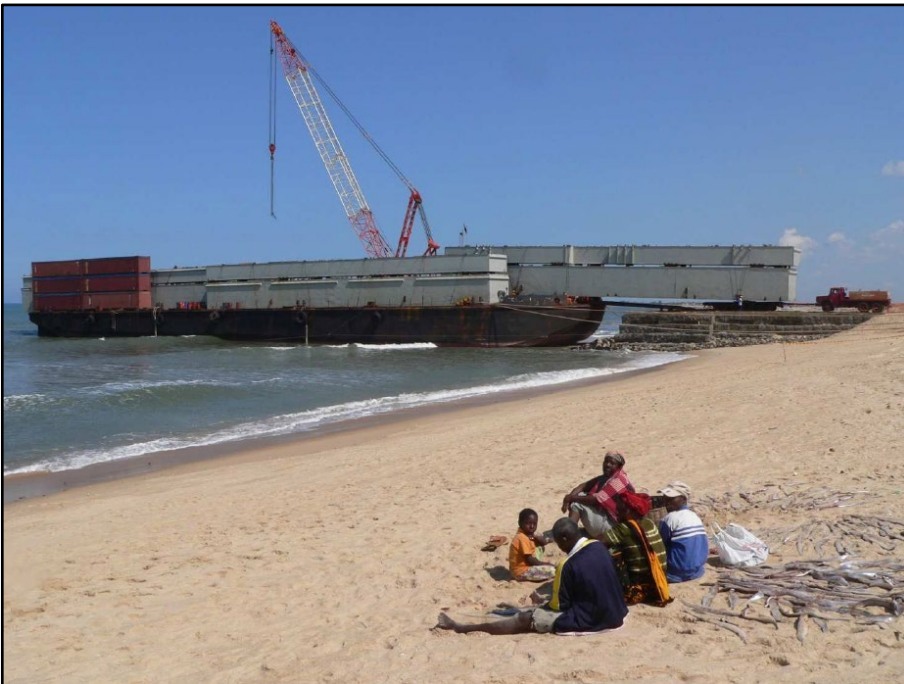


Figure 4: Typical temporary jetty with barge offloading heavy equipment (source: Comarco)



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)

3.2 Temporary Jetty and Land Transportation Route

As part of the CTT construction phase, large heavy equipment and materials will need to be brought in by sea. Equipment and materials would be shipped to the Port of Beira and then transferred to a barge capable of moving on the high tide into very shallow water to where the temporary jetty will be located. A temporary off-loading jetty will be constructed to enable the equipment to be unloaded during low tide, when the barge will rest on the sand. Once loaded, the draught of the barge will be approximately 2 m so that it can navigate safely into shallow coastal waters where the temporary jetty will be located.

Currently, the Maritima temporary jetty site is the preferred temporary jetty location from a technical perspective and is similar to the Seta site option in terms of environmental and social impacts. Once offloaded at the temporary jetty, equipment will then be taken by road, connecting to the R241 in Inhassoro and then the EN1 road, where after it will travel then via the existing CPF access road to the CTT site located near the CPF. Figure 7 indicates the temporary jetty site at Maritima. The alternative nearby site of Seta is still being considered as a potential back-up option.

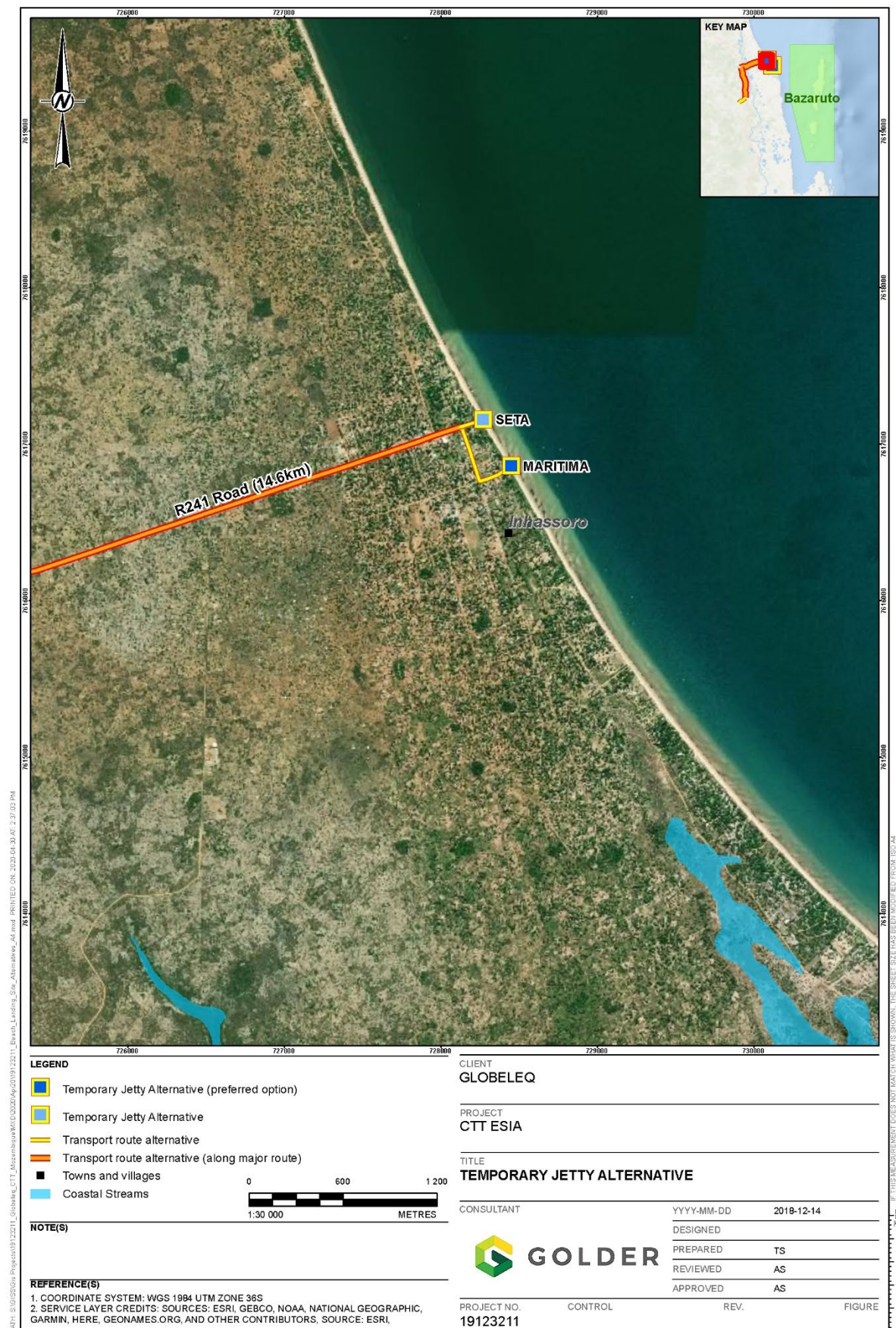


Figure 7: Maritima and SETA temporary jetty sites and route at Inhassoro

3.3 Barging Route

Transporting heavy and over-sized loads by road was investigated either via Beira or from Maputo to the CTT site. Both of the possible options for road transportation - from the Port of Beira (475 km) and the second from Maputo (750 km) - were considered fatally flawed due to infrastructural constraints at two bridges. The Save River bridge and the Limpopo Bridge along the EN1 have 35 and 48 tonne limits respectively. These bridges are unable to support the required loads, and it is not feasible to strengthen the bridges. Due to the size of the rivers they cross, by-passing is also not possible. Based on this, it was found that the road transport option was not feasible, and that equipment would need to be delivered via sea (barging) to a temporary jetty in the vicinity of Inhassoro.

Heavy and oversized equipment and infrastructure components will be manufactured abroad and will be brought into Mozambique via a large vessel docking at the Port of Beira. The equipment will be offloaded at Beira and onto the barge, directly onto the trailers (Figure 8 and Figure 9). The barge will begin its journey at Beira Port and cross the Sofala Bank being towed by a tugboat on its way to the temporary jetty site at Inhassoro (Figure 7). A maximum of 10 barge movements will be required to complete the delivery of the large infrastructure components to the temporary jetty, after which the jetty will be dismantled and rehabilitated. Towing of the barge from Beira to Inhassoro will be completed by a tug boat; it is estimated that each of the expected towing operations will take ± 22 hours (one way), traveling at an average speed of 12 - 13 km per hour until the Bazaruto Bay area is reached (near the Save river mouth), where speeds will be reduced to < 5 km per hour in line with the construction Environmental and Social Management Plan (c-ESMP).

The initial Project description considered an option whereby the trans-shipment vessel could be anchored north-west or west of Bazaruto Island inside Bazaruto Archipelago National Park (BANP). Two anchorage locations were identified on existing maritime maps, and are understood to be historical anchor sites, first used by the Portuguese more than 100 years ago. The locations were subsequently marked on international navigation maps by British Admiralty. These two points may have been used as anchorage locations in the past by trans-shipment vessels for off-loading of equipment. During the ESIA, and in consultation with the Bazaruto Archipelago National Park (BANP), this option was found not to be feasible since these points are now included in the defined boundaries of the BANP, and thus equipment will now be transferred directly from the Port of Beira, thereby avoiding the BANP completely (Figure 10 and Figure 11).



Figure 8: Equipment being offloaded onto a barge while docked in a port



Figure 9: Equipment (Transformer) being loaded directly onto trailers on the barge

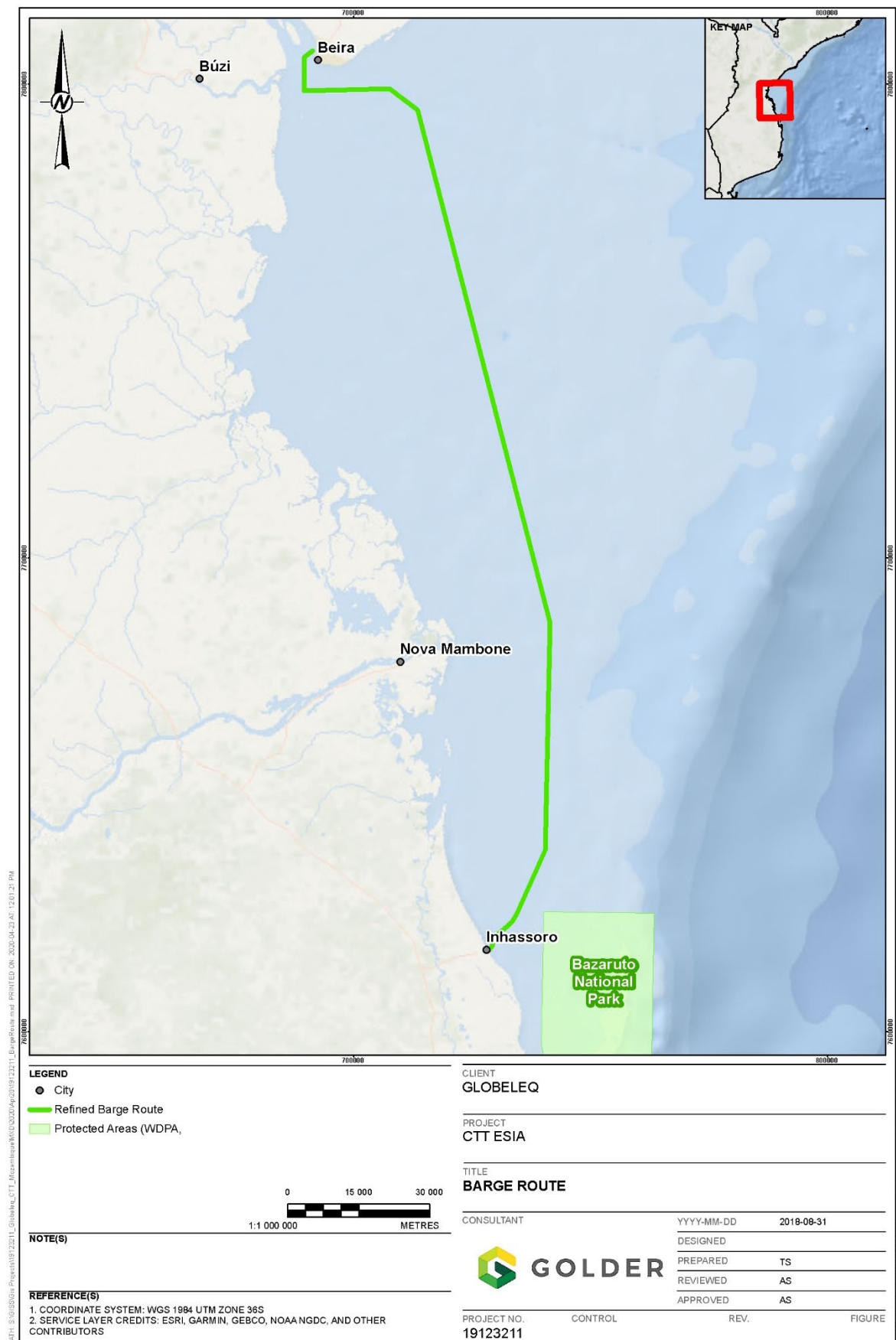


Figure 11: Barge route between Port of Beira and Inhassoro temporary jetty site

3.4 Barging Description

The barge will be positioned alongside the cargo-carrying vessel in the Port of Beira. The cargo or equipment will be trans-shipped onto the barge, using the cranes mounted on the cargo/ship, before it is manoeuvred out of the port.

Once the barge has been loaded, the tugboat will be connected to it in an assisting configuration (alongside it) shown in Figure 12 below. The barge may then be released from the main vessel. The barge-tug combination will then be manoeuvred out of the port into clear waters before the tugboat changes to a towage configuration (Figure 13). Once the tugboat has exited the Port of Beira and has changed to the towage configuration, the voyage to Inhassoro may commence. The barge will be unmanned during towage, with personnel only boarding the barge by means of a small work boat under certain circumstances.

During towage, the barge-tug combination adheres to international maritime rules. These rules require that the combination is regarded as having restricted ability to manoeuvre; consequently, it must show certain ‘day shapes’ (these are maritime signals displayed or hung in a prescribed manner to indicate a vessel's operational status) and navigation lights during day and night respectively. These show ships and other vessels/boats in the vicinity that the combination has restricted ability to manoeuvre and that it will maintain its course and speed. Other vessels are required to keep clear and should not pass between the tug and barge (risk of breaking the tow line).

The tug master may also, by radio, issue a navigation warning to nearby ships, warning them of the combination. When ships receive such a warning, they will immediately be on the lookout for the combination. Additionally, when other ships see the combination on their radars, it will be apparent that the two blips’ are moving together, making the combination identifiable even before it is sighted.



Figure 12: Tugboat in assisting configuration

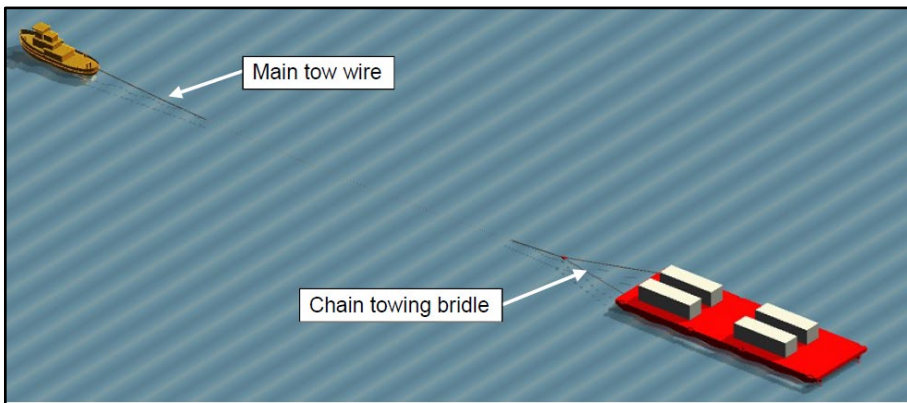


Figure 13: Barge and tugboat in towing configuration

A flat-deck and flat-bottom barge with the following specifications has been recommended for use (Table 1). This type of barge facilitates the navigation in shallow waters (with a minimal draft) and the construction of the temporary jetty high enough up the beach (above the low-tide mark) that the barge is entirely beached on its flat bottom during a large part of the tidal range, allowing for shorter barging and safer unloading operations (Figure 14).

Table 1: Barge specifications (ALE, 2019)

Aspect	Specification
Deadweight	2000 t
Overall length	55 m
Breadth	17 m
Fully laden draught (± 1800 tons)	2.9 m
Expected laden draught (± 600 tons)	2.0 m
Laden freeboard	0.8 m
Light draught	0.7 m
Light freeboard	3.0 m
TPC*	8.7 t

* TPC = Tonnes per centimetre immersion



Figure 14: Flat deck and bottom barge



Figure 15: Typical tugboat



Figure 16: Barge being towed by tugboat

Should the barge utilise an assisted tugboat (Figure 15), the required tide height will be least 2.6 m to approach the jetty. Without the tugboat, the tide height could be lower. Once the tugboat and barge reach a point approximately 1 km offshore of Maritima (proposed jetty location within Inhassoro town), there are two options for the barge's final beach approach.

Option 1

The tugboat (see Table 2) will disconnect its tow line from the barge and attach itself to the barge. The tug’s stern will overhang the barge so that its propellers and rudders are in clear water. The change-over operation will take place in open water at least one nautical mile (1.85 km) offshore, allowing the barge to drift during this relatively lengthy operation. A work boat (see Table 2) will then attach to the barge near the bow, and the barging combination (Figure 17) will proceed to the temporary jetty at a slow speed (<5 km per hour), using both the tugboat and the work boat to steer the barge against the prevailing weather, sea conditions, current, and tide.

Table 2: Tugboat and work boat specifications (ALE, 2019)

Vessel	Aspect	Specification
Tugboat	Draught	3.0 m
	Propellers	2x fixed pitch
	Rudders	2
Work boat	Draught	1.2 m
	Propellers	≤1x fixed pitch, or preferably a Hamilton Jet propulsion unit as it does not have an exposed rudder or propeller.
	Rudders	≤1

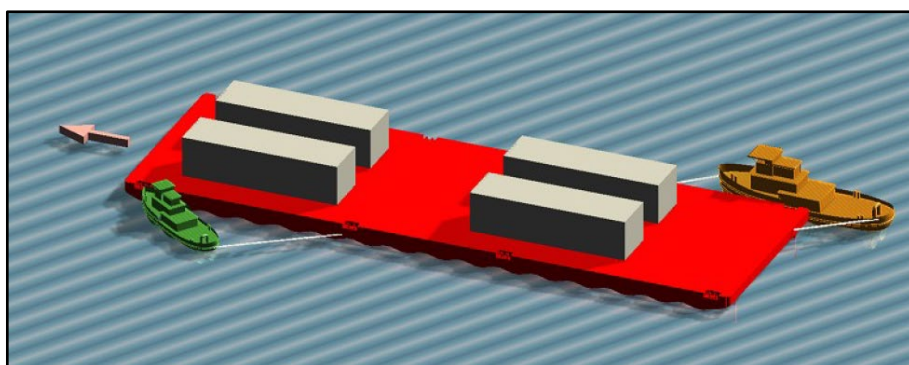


Figure 17: Barging combination

Once within 75 metres of the temporary jetty, a light line (rope) will be sent ashore (by air-powered gun). This line will have a towing cable attached to its end; the onshore crew will pull the tow cable ashore using the light line. The tow cable will then be attached to a winch, which will pull the barge to the temporary jetty. Depending on weather and sea conditions, it might be possible to detach the tugboat once the tow cable is attached to the barge.

Option 2

A cable-based mooring system (E-Bos) (Figure 18) could be used instead of the barging combination depicted in Figure 17. This option has been introduced as a measure to mitigate potential impacts of the tugboat and its propellers in the shallow waters.

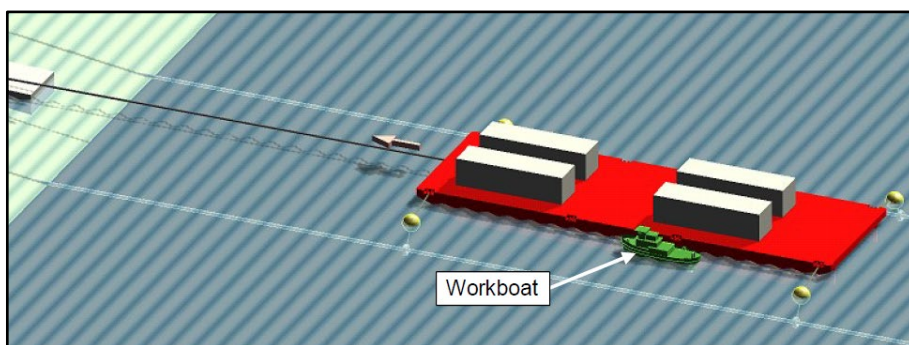


Figure 18: Cable-based mooring system

This system involves the laying of two steel wire ropes (about 60 to 75 mm diameter) from the temporary jetty site to ± 1 km offshore. The shore-side ends of the main wire ropes are anchored on the beach while the seaside ends of the wire ropes are anchored to the seabed by means of a series of specialised anchors (Figure 19). An anchor handling boat will be used to deploy the wires and anchors and will return at the end of the project to retrieve the system. A diver can assist during deployment to ensure that anchors are not located on sensitive substrates. Unlike a convention anchor, no dragging will be required over great distances, as this modern anchor embeds itself almost immediately due to its design. The seaside ends of the mooring ropes are attached to buoys that float at the mooring position about one kilometre offshore.

The main wire ropes lie on the seabed for the duration of the barging activities and have two smaller mooring steel wire ropes attached to it by large shackles; these mooring ropes can thus slide along the main wires. Using the tugboat, the barge is manoeuvred into position such that two buoys lie to each side of the barge. The mooring wire ropes are retrieved and secured on each side of the bow and stern of the barge. These form the barge moorings while it approaches the beach head. The workboat will then nudge the barge towards the shore while it is guided by the two main steel wire ropes. Once within 75 m of the temporary jetty, a light line (rope) is sent ashore (this is done by air-powered gun). The onshore crew will attach a towing cable to the line before the barge pulls it aboard using one of its winches. Once the towing cable is attached to the barge, it will be pulled toward the jetty.



Figure 19: Modern drag-embedded anchor

Barge Mooring

Once the barge has successfully manoeuvred into position on the high tide, it will be secured by mooring cables or ropes (Figure 20). During low tide, the barge will rest on the beach and the equipment can be safely off-loaded via a ramp connecting to the temporary jetty (Figure 21). Equipment will be pulled onto the jetty and as such no crane will be required to lift equipment.

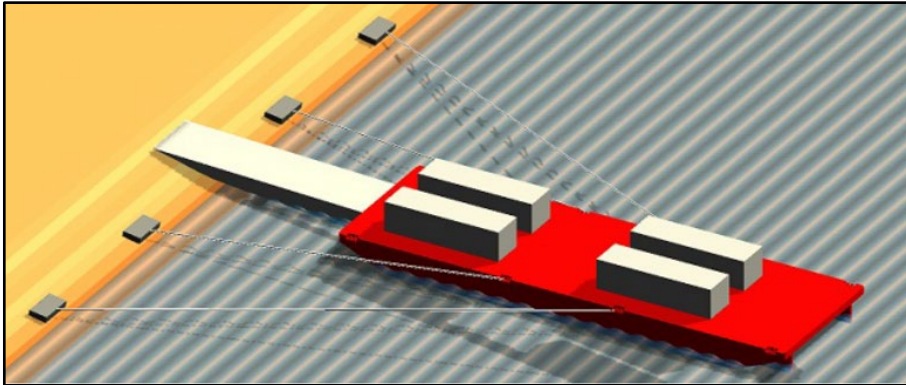


Figure 20: Barge moored at jetty while afloat during high tide

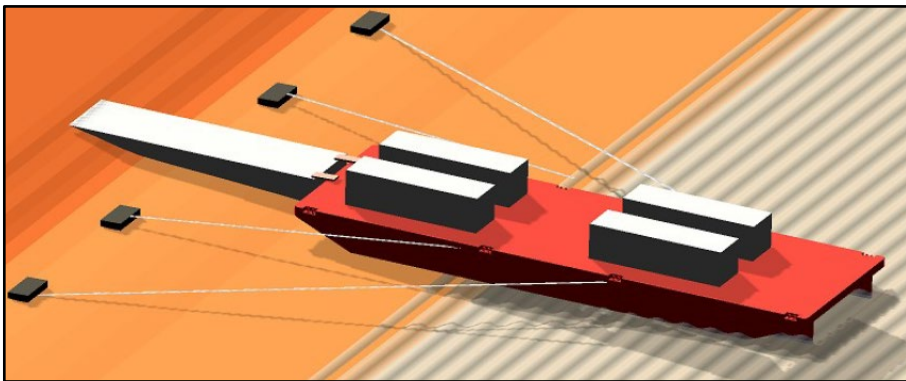


Figure 21: Barge secured and resting on sand during low tide ready for off-loading

3.5 Temporary Jetty Site

The Maritima site is preferred from an environmental and social point of view as well as for technical reasons. The SETA site was previously used as the temporary jetty when the Sasol CPF was constructed and is therefore also still a viable option for the temporary jetty as the environmental and social impacts are very similar between Maritima and SETA. Both Maritima and SETA sites are currently transformed and will result in very little disturbance to the local Inhassoro community and businesses as both have sufficient width in their approaches to the beach (8-10m wide) and it is not envisaged that any additional land will be required. The proposed beach access route is via lands owned by the local authority, and is an existing public access road to the beach. The two temporary jetty site options are illustrated below in Figure 22 and Figure 23. The locations of these temporary jetty sites are shown in Figure 7.



Figure 22: SETA, access to the temporary jetty site



Figure 23: Maritima, access to the temporary jetty site

3.5.1 Temporary Jetty Construction

To facilitate the transportation of the heavy materials from the barge onto the heavy vehicles, a temporary jetty will be constructed. The duration for the construction and removal of the temporary jetty is anticipated to be 3 months.

The jetty will likely be constructed using gabions, rocks, geotextiles and gravel. An option using containers was also considered, however the use of gabions, rocks, geotextiles and gravel is the preferred method for construction.

Gabions

This option entails the construction of the temporary jetty using gabions or rocks to form the main construction of the temporary jetty and by filling these in with sand, aggregate and rocks. The foundation of the jetty can be stabilised using geotextiles if required. The exterior of the jetty is then covered by rocks to protect against scouring.

Containers

There are two options as to how the jetty can be orientated using containers:

- Option 1 will have nine containers arranged as four (4) containers on either side and one (1) in the front. This configuration allows the jetty to be narrow (+/-14 m) and long (+/-100 m); and
- Option 2 will be made up of six (6) containers arranged as two (2) containers on either side and two (2) next to each other in the front. This configuration allows the jetty to be shorter (+/-80 m) and wider (+/-20 m).

Both options will have sandbags placed on the sides to reduce scouring with a row of sugar bags and final gravel surface will be placed on top of the containers to create a level road surface.



Figure 24: Construction of a temporary jetty using gravel, sandbags and rocks to armour



Figure 25: Example of a temporary jetty (gabions) during offloading from barge, with barge lying on the sand bed.

The final design of the jetty will be dependent on the EPC contractor appointment and the barge that is finally chosen for this project.

When not in use the jetty will allow for pedestrian and vehicle crossings. Refer to Figure 26, Figure 27 and Figure 28 below for conceptual illustrations of the jetty. The chosen temporary jetty site for the CTT project will only be required for 12 months during the construction phase of the CTT project. As per section 2.9.1 of the ESIA report, the temporary jetty will be removed after beach landing activities are complete. During the ESIA public consultation process, it was explained to stakeholders (locals and government representatives) that the temporary jetty would not be left in place. Since it will be designed and built as a temporary structure, and without adequate maintenance continuing after the beach landing activities are completed, it would pose a safety risk to locals or other users if it were simply left in place. This position was accepted by stakeholders, and no further comments or requests were received regarding the matter.

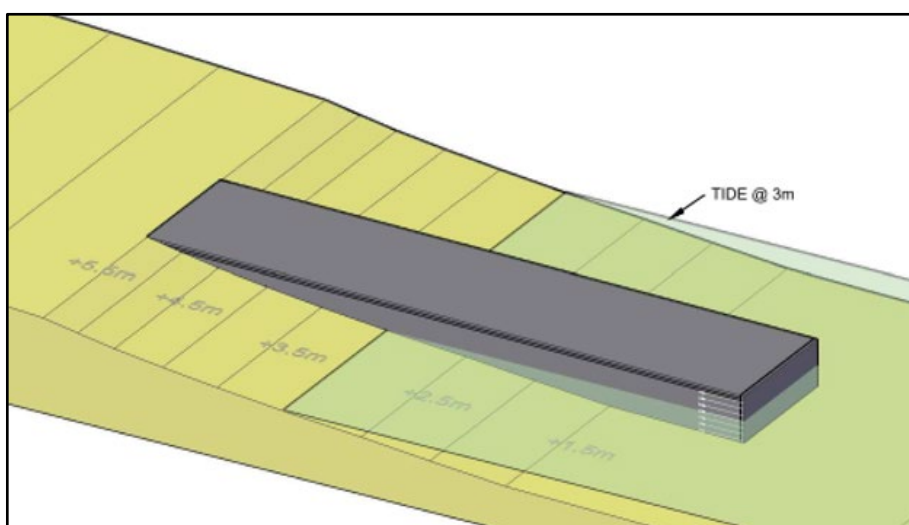


Figure 26: Isometric view of temporary jetty during high tide achieving 3m depth for barge



Figure 27: Aerial view of temporary jetty superimposed at the Maritima site

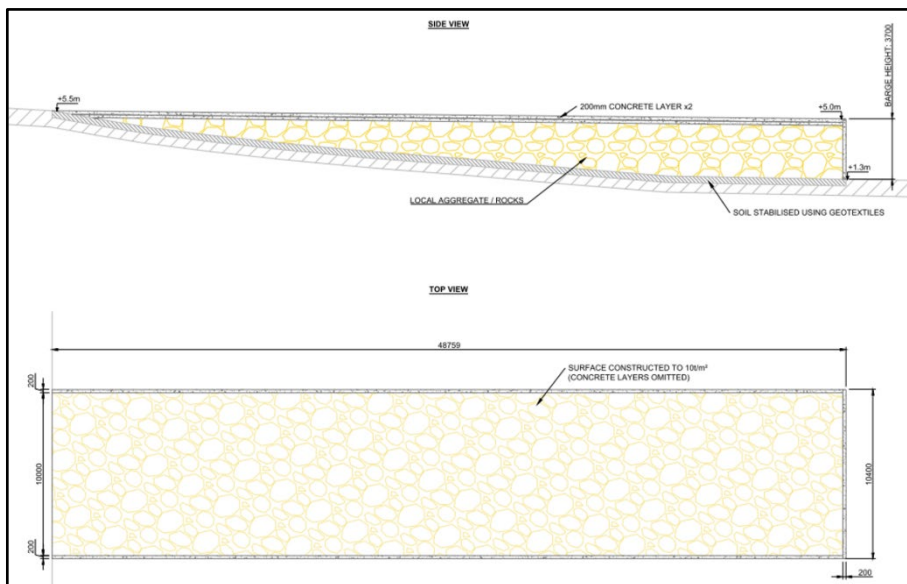


Figure 28: Side view and top view of the temporary jetty dimensions and construction

The temporary jetty will be surfaced by a compacted gravel or suitable aggregate/concrete. The section of track between the temporary jetty and the tar road is approximately 200m in length and will require grading and surfacing to allow for safe transport of the equipment. This section is also referred to as the approach road and is shown below (Figure 29) with a white arrow indicating the route to be taken by trucks transporting loads as they exit the temporary jetty and move towards the main tar road.

There are some minor overhead obstructions on this access road at the junction with the tar road such as telephone wires and electricity cables. These will need to be temporarily lifted so that the loads can pass safely beneath. The relevant authorities will be notified, and the necessary approvals will be sought prior to lifting or moving any overhead wires/cables or supporting poles.



Figure 29: View of the junction of Maritima approach road and tar road. Note overhead telephone and electricity cables.

3.5.2 Temporary Jetty Operation

The temporary jetty is only expected to be used during daylight hours as far as possible (tide dependant). The offloading operations will typically involve the equipment being drive directly off the barge and onto the temporary jetty (Figure 30). From here the equipment will be driven directly to the CTT site following all requirements set out in the Abnormal Loads Transportation Sub-Plan (Figure 31). Given the time between each shipment (up to 3 to 4 months) the equipment at the jetty will demobilize after each load has departed and need to be mobilized again for each incoming load.

A temporary laydown will likely be required where the loads can be staged once offloaded from the barge. As well as other equipment that will need to be stored from time to time. The road transport vehicles can then load the staged equipment one by one for transport to the CTT site.



Figure 30: Equipment mounted on self-propelled modular transporter being driven off the barge at temporary jetty



Figure 31: Equipment being transported by truck on a trailers to its destination

4.0 LEGISLATION

A review of national and international law, policies, agreements and standards pertaining to marine and coastal biodiversity in Mozambique was conducted. These included Mozambican national law and policies, and international conventions and treaties to which Mozambique is a signatory.

The proposed project has been determined as 'Category A' in terms of Mozambique's environmental law (Decree No. 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.

This document represents the Marine Ecology Impact Assessment undertaken to support the ESIA. This study is undertaken in terms of the national Mozambican Law for the Protection, Conservation and Sustainable Use of Biological Diversity (Law 16/2014, amended 2017) and Regulations for Protection of the Marine and Coastal Environment (Decree No. 45/2006) as well as the World Bank Group standards for conservation of biodiversity and ecosystem services (IFC 2012, 2019). The relevant legislation and policies are summarised in the subsections below, highlighting the relevant legislative and policy requirements that must be met to satisfy in-country biodiversity protection objectives, and achieve the desired biodiversity outcomes.

4.1 National Legislation and Policy

Mozambican legislation makes provision for the protection of the marine and coastal environment through the following instruments.

- **Regulation for Pollution Prevention and Protection of the Marine and Coastal Environment (Decree No. 45/2006):** provides for the prevention of marine pollution and environmental protection of marine and coastal areas to protect marine and fresh water ecosystems. The hunting of sea turtles, including the taking or destroying of their eggs is prohibited. Activities that disrupt ecosystems and habitats and normal development of sea turtles are also prohibited. Sanctions for illegal activity are prescribed, including disturbance of turtle nesting beaches.
- **Regulations for Recreational and Sports Fishing (Decree No. 51/99):** includes a list of protected marine species including the sea mammals (dugongs, whales and dolphins), sea turtles, and some species of fish, bivalves and gastropods. However, the list of marine protected species is currently applicable only to recreational and sports fishing, and does not account for capture of these species, either targeted or as by-catch, by both subsistence and commercial fisheries.
- **Decree No. 12/2002 approving the Regulation on Forestry and Wildlife:** The Forestry and Wildlife Regulation establishes the basic principles and norms for the protection, conservation and sustainable utilization of forest and wildlife resources under an integrated management framework for the economic and social development of the country. Chapter IV, articles 43 (5) and 44 (1a) fully protect the species listed in Annex II, which includes all five species of marine turtle found in Mozambique and sets fines for illegal hunting of marine turtles and dugongs. Furthermore, article 44 (1d) restricts the hunting of any other animal that may be declared as protected by a law or convention.
- **General Regulation of Maritime Fishing (Decree 43/2003):** Requires that the use of turtle excluder devices is mandatory for all trawler fishing boats aided by a motor.
- **Decree 5/2003 – Centre for Sustainable Development of Coastal Zones:** the mandate of the centre is to coordinate and promote studies, provide technical assistance, and develop capacity in

microenvironment coastal, marine and lacustrine management activities, and to formulate legislation that promotes the development of coastal zones.

- **Fisheries Law (Decree 22/2003):** this instrument regulates the fisheries sector; however, some aspects are not in conformity with international law, such as delimitation of fishing boundaries and continental shelves, prohibition of over-night fishing, and the compulsory requirement for migration permits for foreign crews fishing in Mozambican waters (Perreira *et al.*, 2014).
- **Law for the Protection, Conservation and Sustainable Use of Biological Diversity (Law 16/2014, amended 2017):** this law defines two categories of Conservation Area:
 - i) **Total Conservation Areas** which includes Integral National Reserves, National Parks, Cultural and Natural Monuments. Only indirect (non-consumptive) use of natural resources may be allowed in these areas; and
 - ii) **Sustainable Use Conservation Areas** which includes Special Reserves, Environmental Protection Areas, Official Game Reserves, Community Conservation Areas, Sanctuaries, Game Farms, and Municipal Ecological Parks. The primary aim of these areas is conservation, with integrated management which may permit sustainable utilisation/extraction of resources, subject to an approved management plan.
- **National Strategy and Action Plan of Biological Diversity of Mozambique (2015-2035):** National policy and plans for nature conservation in Mozambique are laid out in this Action Plan. Its objectives include the promotion of the sustainable use of marine and fisheries resources, improvement in the systems of enforcement and application of legislation on fauna conservation, and the promotion of sustainable development in areas adjacent to conservation protection areas, through use of effective management plans for development.
- **Regulation Establishing the Legal Regime for the Use of the National Maritime Space (Decree No. 21/2017, 24 May):** Applicable to the maritime space and to all private and public activities and uses and establish the guidelines for (among others) the regime applicable to the titles for private use of maritime space, to licenses to build on the strip along the maritime coast and islands, bays and estuaries (is measured from the maximum high tide line to 100m inland mark). Article 12 refers that the Situation Plan (part of the requirements) is supported by an environmental declaration, under the EIA legislation, and can also be subject to a SEA, as well as to public consultation. It also states that the right of private use of the maritime space is granted through a Concession, License or Permit. The issuance of a Title for Private Use of Maritime Space (Título Privativo de Utilização do Espaço Marítimo – TUPEM), binds the title holder to effective use and to guarantee the adoption of measures aiming to maintain the good status of the marine environment and to, after extinction of the rights, the reinstatement of the environmental conditions which have been altered.
- **Regulation on the Marine Scientific Research Decree No. 30/2019, dated 19 April:** Establish the rules applicable to all marine scientific research to be conducted in the national maritime space and are applicable to the work undertaken for scientific purposes, including oceanographic and limnological studies, and geophysical prospection, using vessels, aircrafts and other means, through sampling, recording, filming, a probe/rig or other. Environmental Baseline surveys, geotechnical surveys are also included. It is applicable to all research (the definition of research is unclear and broad) related to living and non-living resources, including hydrocarbon and other marine mineral resources surveys and prospection activities

4.2 International Conventions and Policies

In addition to complying with national Mozambican legislation, the CTT project is also obliged to ensure that its operations comply with International Conventions to which the Republic of Mozambique is a signatory. Several

conventions and agreements have been identified which relate to marine and coastal environments; these include:

- **Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, 1985:** The convention commits its signatories to take all appropriate measures to prevent, reduce and combat marine pollution, establish Specially Protected Areas to protect and preserve rare or fragile marine ecosystems and species, conduct environmental impact assessments, and cooperate in scientific research, monitoring and data exchange with the Contracting Parties.
- **International Convention for the Prevention of Pollution from Ships (MARPOL 73/78):** The MARPOL convention sets out requirements for the management of ballast water, bilge water and other potential sources of ship-based pollution.
- **Convention on the Conservation of Migratory Species of Wild Animals, 1979:** The Convention on Migratory Species (CMS), also known as the Bonn Convention, aims to conserve terrestrial, aquatic and avian migratory species throughout their range. The CMS brings together the signatory States through which migratory animals pass, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range.
- **Protocol for the Fisheries of the SADC, 2001:** commits member states to support national initiatives taken and international conventions for the sustainable use and protection of the living aquatic resources and aquatic environment of the region. In signing the Protocol, Member States agree to harmonise their domestic legislation with particular reference to fisheries and the management shared resources, to take adequate measure to optimise fisheries law enforcement resources and thus protect aquaculture and the aquatic environment and safeguard the livelihood of fishing communities.
- **The Convention on Wetlands (Ramsar Convention) 1975:** the Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
- **Convention on Biological Diversity (CBD), 1992:** Under the convention, each contracting party is expected to develop national strategies, plans or programs for the conservation and sustainable use of Biological diversity, such as National Biodiversity Action Plans
- **Convention on International Trade in Endangered Species (CITES), 1973:** an international agreement between governments, to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Mozambique is a signatory since 1981.
 - CITES Appendix I lists species that are the most endangered among CITES-listed animals and plants and prohibits international trade in specimens of these species except when the purpose of the import is not commercial.
 - CITES Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled; international trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate.
 - CITES Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation; international trade in specimens of species listed in this Appendix is allowed only on presentation of the appropriate permits or certificates.

4.3 International Best Practise Guidance and Policies

The International Finance Corporation's (IFC) Performance Standards have become globally recognised as a benchmark for environmental and social risk management in the private sector. In addition to compliance with national Mozambican legislation, and international legislation to which Mozambique is a signatory, the Project must also achieve the financing requirements set out in the IFC's Performance Standards. At the project financing level, the management of biodiversity is addressed by Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012). Performance Standard 6 (PS6) and the associated Guidance Note 6 (GN6) (IFC, 2019) relates to:

- The protection and conservation of biodiversity;
- Maintenance of ecosystem services; and
- Sustainable management of living natural resources.

The requirements set out in PS6 have been guided by the Convention on Biological Diversity (see Section 3.2). PS6's main priority is that the Project should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimise impacts and restore biodiversity and ecosystem services should be implemented. However, when a project occurs in critical habitat (CH) supporting exceptional biodiversity value, a net gain in biodiversity value is required.

PS6 sets specific biodiversity protection and conservation standards relating to potential project impact. The specific requirements are separated according to the following categories:

- **Modified Habitat:** areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. PS6 relates to areas of modified habitat that have significant biodiversity value, and requires that impacts on such biodiversity must be minimised, and mitigation measures implemented as appropriate.
- **Natural Habitat:** viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. In such areas, the conservation outcome required by PS6 is no-net-loss of biodiversity value achieved using the "like-for-like" or better principle of biodiversity offsets, where feasible.
- **Critical Habitat:** areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. When a project occurs in critical habitat (CH) supporting exceptional biodiversity value, a net gain in biodiversity value is required by PS6. This is achievable through appropriate biodiversity offsets.
- **Legally Protected and Internationally Recognised Areas:** such areas often have high biodiversity value; when this is the case these areas are likely to qualify as Critical Habitat and as such the conservation outcome required by PS6 is also a net gain in biodiversity value, as well as obtaining the relevant legal permits, following standard governmental regulatory procedures, and engagement of affected communities and other stakeholders.
- **Invasive Alien Species:** the development project should not intentionally introduce any new alien species (unless carried out within the appropriate regulatory permits) and should not deliberate any alien species with a high risk of invasive behaviour under any circumstance. PS6 requires that any introduction of alien

species be the subject of a risk assessment for potential invasive behaviour, and that the project should implement measures to avoid the potential for accidental or unintended introductions.

- **Management of Ecosystem Services:** where a project is likely to adversely impact ecosystem services (ES), an ecosystem service review to identify Priority ES is required. Priority ecosystem services are (i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities; and/or (ii) those services on which the project is directly dependent for its operations (e.g., water). If adverse impacts on Priority ES are unavoidable, these must be minimised and mitigation measures that aim to maintain the value and functionality of priority services implemented. With respect to impacts on Priority ES on which the project depends, impacts on ecosystem services should be minimised and measures that increase resource efficiency of their operations implemented.

4.3.1 Critical Habitat

As stated above, critical habitat (CH) consists of areas with high biodiversity value. Habitats supporting unique, irreplaceable and extremely vulnerable biodiversity features are likely to constitute CH and such features can be identified under baseline conditions at the ecological scales appropriate for their designation (PS 6, IFC 2012). It is possible to identify critical habitat using the five primary criteria provided in GN53 of Guidance Note 6 (IFC, 2019). The criteria and the identification process are described in Table 3.

Table 3: Critical Habitat identification criteria

Criterion	Definition	Identification Process / Thresholds
1	Habitat of significant importance to Critically Endangered (CR) and/or Endangered (EN) species.	<p>Species status to be searched on the IUCN Red List of Threatened Species for all observed and potential flora and fauna species in the Study Area. Any observed and potential CR or EN species to be screened and assessed against thresholds for Criterion 1:</p> <ul style="list-style-type: none"> a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species ($\geq 0.5\%$ of the global population AND ≥ 5 reproductive units GN16 of a CR or EN species). b) Areas that support globally important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a). c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

Criterion	Definition	Identification Process / Thresholds
2	Habitat of significant importance to endemic and/or restricted-range species	<p>The global extent of occurrence (EEO) for all observed and potential species to be defined. Extent of occurrence data can be obtained from the IUCN Red List of Threatened Species (IUCN 2020). For marine systems, restricted-range species are provisionally being considered those with an EEO of less than 100,000 km². For coastal, riverine, and other aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the distance between occupied locations furthest apart). Any area of habitat significant importance for endemic and/or restricted-range species will be screened and assessed against the threshold for Criterion 2:</p> <p>a) Areas that regularly hold $\geq 10\%$ of the global population size AND ≥ 10 reproductive units of a species.</p>
3	Habitat supporting globally significant concentrations of migratory species and/or congregatory species	<p>Any observed and potential migratory or congregatory species to be screened and assessed against thresholds for Criterion 3:</p> <p>a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle.</p> <p>b) Areas that predictably support ≥ 10 percent of the global population of a species during periods of environmental stress.</p>
4	Highly threatened and/or unique ecosystems	<p>Highly threatened or unique ecosystems are those (i) that are at risk of significantly decreasing in area or quality; (ii) with a small spatial extent; and/or (iii) containing unique assemblages of species including assemblages or concentrations of biome-restricted species (GN 90, IFC PS6, 2012b). Any documented or potential highly threatened and/or unique ecosystems will be screened and assessed against the thresholds of Criterion 4:</p> <p>a) Areas representing $\geq 5\%$ of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN.</p> <p>b) Other areas not yet assessed by IUCN but determined to be of high priority for conservation by regional or national systematic conservation planning.</p>

Criterion	Definition	Identification Process / Thresholds
5	Areas associated with key evolutionary processes	The structural attributes of a region can influence the evolutionary processes that give rise to regional configurations of species and ecological properties, such as the presence of genetically unique populations or sub-populations that may be of special conservation concern, given their distinct evolutionary history (GN 81, IFC PS 6, 2019).

Where insufficient data exists to address the thresholds for CH criteria, suitable field survey programmes must be conducted to gather sufficient data to properly ascertain whether CH is present.

5.0 APPROACH AND METHODOLOGY

5.1 Scope of study

Temporary jetty sites and associated laydown areas will be required for handling and delivery of the large heavy equipment and infrastructure required to build the CTT Project. In addition, the barging route from the Port of Beira into the Bazaruto Bay, where heavy equipment will be transferred from a barge to the chosen temporary jetty location. At this stage two temporary jetty site options are still being considered, with a third being excluded during the technical feasibility and ESIA assessment.

A baseline description of the coastal and marine environment in the vicinity of the temporary jetty sites is necessary to inform the Environmental and Social Impact Assessment process. Therefore, the objective of this study is to assess the impact of the temporary jetty and barging activities on marine and coastal species of concern (Dugong, Turtles, Indian Ocean Humpback Dolphin), natural habitats (seagrass beds, coral), and ecosystem services. The full scope of the study as set out in the Terms of Reference document for the Project (Golder, 2015; Golder 2020) is outlined in Table 4.

Table 4: Scope of marine ecology study as defined in the ToR (Golder, 2020, 2015)

Objectives	Project Phase	Methodology
To assess the impact of the temporary jetty and barging activity on marine ecology; in particular species of concern and natural habitats	Construction Operation	<p><u>Baseline</u></p> <ul style="list-style-type: none"> Review existing literature available Updated marine ecology baseline description incorporating results of satellite image classification to map extent of seagrass and coral, to inform the final approach route to the temporary jetty Include additional desktop data on marine water quality, where available Include ecosystem services review for the Study Area Baseline reporting <p><u>Impact Assessment</u></p> <ul style="list-style-type: none"> Assessment of the predicted impacts of temporary jetty construction and operation, and barging activity, on marine fauna species of concern (dugong, turtles, Indian Ocean Humpback Dolphin), and natural habitats (seagrass and coral).

Objectives	Project Phase	Methodology
		<ul style="list-style-type: none"> • Marine ecology impact assessment report • Recommend mitigation measures in order to establish a baseline against which to monitor • Peer review by recognised expert

5.2 Engagements with BANP

During the baseline assessment and impact assessment phases of this study, the following interactions between BANP, Globeleq and Golder were noted (Table 5).

Table 5: Project interactions with BANP

Date	Location	Engagement
10 February 2015	Hotel SETA, Inhassoro	Public Participation meeting during scoping (EPDA) phase of ESIA process (BANP attended)
10 February 2015	Hotel SETA, Inhassoro	Focus Group Meeting (FGM) – Tourism/Conservation with BANP, Tourism operators and related bodies
Various	Telephone calls	To remind stakeholders (incl BANP) to submit comments should they wish as part of PP process
16 January 2019	Hotel SETA, Inhassoro	Public Participation meeting during impact assessment phase of ESIA process (BANP attended)
Various	Telephone calls	To remind stakeholders (incl BANP) to submit comments should they wish as part of PP process
17 April 2019	BANP Offices, Vilanculos	Globeleq and Golder attended a workshop with BANP to update them on the progress with Technical work streams and options being explored to mitigate potential marine impacts from anchorage sites, barging etc
14 October 2019	Conference call	Globeleq and Golder held a call with BANP to understand their research efforts (seagrass and dugong), and some of the studies planned as part of the post ESIA activities as well updating BANP on technical aspects of the project as they are refined
24 January 2020	Conference call	Globeleq and Golder held a call with BANP to align on Marine Study update and the terms of reference, with inputs from BANP
13 February 2020	BANP Offices, Vilanculos	Lenders team (IFC, DFC, WBG & RHDHV), as well as Golder and Globeleq met with BANP as part of Lenders site visit
9 April 2020	E-mail	BANP shared their report on aerial surveys conducted in 2019 with Globeleq and Golder
17 April 2020	Conference call	Golder and Globeleq presented outputs of the Spatial Mapping exercise and provided update on the way forward with Marine Study update
22 April 2020	Online	Globeleq shared Spatial Mapping data with BANP

In addition to the engagements with BANP, other key stakeholders such as WWF and EWT were consulted during the course of the ESIA process and participated in the stakeholder engagement process. Research data was also shared between EWT and Golder during the ESIA process.

5.3 Study Area

The Study Area was based on the spatial extent of the footprint of the proposed temporary jetty sites, the proposed barging route, and an associated buffer zone within which potential direct and indirect effects to coastal and marine species and ecosystems could occur. The proposed barging route extends from the Port of Beira, south over the Sofala Bank and into the Bazaruto Bay.

The Study Area therefore incorporates the footprints of the two temporary jetty site options, and a +10 km buffer surrounding the potential barge routes between the Port of Beira and the temporary jettys, within which direct and indirect effects from the barging activity and the development and operation of the temporary jetty was considered most likely. Since this area overlaps with the marine area enclosed by the Bazaruto Archipelago / Cabo São Sebastião and the mainland, and Bazaruto Archipelago National Park, these were also included in the Study Area to take into account any potential effects on marine species of concern; in particular, Dugong (*Dugong dugon*).

Access into the Port of Beira is through the dredged Mancuti Channel. Ships are required to anchor east of the outer channel while they wait for the Port Authorities berthing instructions. For the purpose of this study, the final approach through the Mancuti Channel is excluded as this is a narrow shipping lane under the control of the Ports authority, with a high volume of regulated traffic in a narrow passage. The Study Area is shown in Figure 32.



Figure 32: Marine Ecology Study Area

5.4 Desktop review of available information

The baseline of marine and coastal ecology was determined through a detailed review of existing baseline studies (e.g. Guissamulo, 2016; EWT, 2015; Findlay *et al.*, 2006; Guissamulo, 2006; Masquine & Torres, 2006) previously conducted on behalf of SASOL within the Study Area. Additional information relevant to the Study Area was sourced through online searches and interrogation of available databases such as the IUCN Red List, the Catalogue of Life, and Species Plus. Relevant information was then collated to aid in identifying any important marine and coastal biodiversity features that exist within the Study Area.

5.5 Remote Satellite Imagery Classification

A satellite imagery classification exercise using remote sensing techniques was done in March 2020 to derive a preliminary delineation of the extent of seagrass beds and coral outcrops within the shallower waters of Bazaruto Bay. A combination of ESA Sentinel 2 satellite imagery (10 m resolution) from October 2019, and AIRBUS Pleiades satellite imagery (1 m resolution) from 2018/2019 were used for the classification (Figure 40).

Sentinel imagery was used in the areas of deeper water along the northern section of the barging route, where any interface between the barge and workboat and underwater features of concern (i.e. seagrass and coral outcrops) was less likely. The higher resolution Pleiades imagery was used for the southern extent of the Study Area, being the shallower, near-shore area being traversed by the barge on its approach to the temporary jetty site, where natural habitats such as coral outcrop and seagrass beds are likely to be encountered. The finer detail in the southern area was also of interest for the proposes of contributing to the marine biodiversity dataset being used by BANP for conservation management purposes.

All mapping was completed as a desk-top only interpretation and classification process. No field verification of the classified output has yet been completed due to the travel restrictions under Mozambique's National Lockdown as a result of the Covid19 pandemic.

5.6 Ecosystem Services

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 6). These definitions were chosen to ensure consistency with the IFC's Performance Standards which are the lenders requirements.

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 6: Ecosystems services categories (after 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, firewood.
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 33.

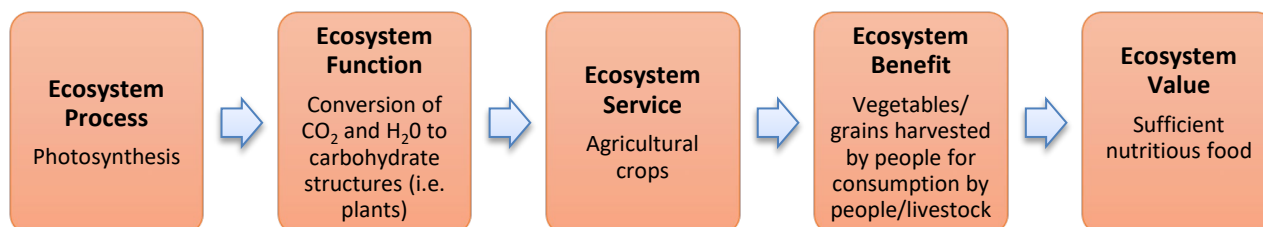


Figure 33: Ecosystem service supply - the flow of ecosystem services to beneficiaries

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 baseline and impact assessment study (Golder Associates Africa, 2018). No specific ecosystem services stakeholder engagement processes were undertaken as part of the study. Other information for the ecosystem services assessment was gathered from the various specialist inputs to the baseline for the ESIA, during the Desktop Review (Section 5.4).

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.

5.6.1 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).

This was done by means of reviewing the results of the other baseline social, ecological and biophysical assessments conducted for this ESIA (listed below) to obtain data for identifying which ecosystem services are relevant to the Project:

- i) Marine baseline report (Golder Associates Africa, 18103533-321205-25);
- iii) Cultural Heritage Baseline (Golder Associates Africa, 18103533-321152-20);
- iv) Social Baseline (Golder Associates Africa, 18103533-320927-5);
- v) Tourism Baseline (Golder Associates Africa, 18103533-321022-15); and
- vi) Stakeholder Engagement Plan (18103533-320925-3).

Available publications, reports and data relating to ecosystem services, tourism and biological resource use in the greater Bazaruto Bay /Archipelago and Sofala Bay, up to the Port of Beira, were also reviewed to characterise Type I ecosystem service supply and demand in the Study Area.

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, they are listed in Section 6.1 for reference, but are not included in the impact assessment.

5.6.2 Step 2: Prioritisation of Ecosystem Services

Priority ecosystem services 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.*, 2014). Since provisioning services, regulating services, and cultural services are all underpinned by the natural processes categorised as 'supporting services' (nutrient cycling, habitat provision and primary production), only the former three services were considered for prioritisation for impact assessment.

5.7 Impact Assessment Methodology and Rating Criteria

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.

Intensity / 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.

Scale/Geographic extent 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).

Impact significance will be rated using the scoring system shown in Table 7 below. The significance of impacts is assessed for the three main phases of the project: i) construction ii) operations iii) decommissioning. 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 8.

Table 7: Scoring system for evaluating impacts

Impact Magnitude			Impact Probability
Severity	Duration	Extent	
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:

SP (significance points) = (severity + duration + extent) x 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 8.

Table 8: 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

Value	Significance	Comment
		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 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 9 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 (All).

- 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. This area aligns with the Study Area defined for the marine ecology assessment.
- 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. The All area aligns with the STUDY AREA defined for the marine ecology assessment (See Section 5.3)

Table 9: 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 MARINE AND COASTAL BASELINE

The Mozambican coastline is characterised by a wide diversity of habitats including sandy beaches, sand dunes, coral reefs, estuaries, bays, seagrass beds and mangrove forests, which in parts support pristine ecosystems, high biological diversity, high endemism, and endangered species (Pereira *et al.*, 2014). The following sections describe the physico-chemical context of the Study Area, and known ecosystems and fauna in terms of distribution, conservation status, and existing pressures/drivers of change.

6.1 Marine and Coastal Oceanography

Data on marine and coastal oceanography in the Study Area was provided by the proponent, consisting of text and figures extracted from relevant sections of the Sasol Offshore Block 16 & 19 Exploration ESIA conducted by ERM (2006) with additional studies commissioned in 2008. These data are reproduced without modification in the subsections that follow.

6.1.1 Bathymetry

Bazaruto Bay and the adjacent marine area to the north is a typical nearshore shallow water system with an average water depth of approximately 10 m. Two distinct basins can be identified in this bay, one located in the northern end, just north of Santa Carolina Island and another located in the middle section of the bay, in-between the Bazaruto and Benguerua Islands. The two basins are linked by a series of channels, which are regarded as flood- and ebb-tide deltas. These two basins and associated channels comprise the deeper areas of the bay with a maximum depth for southern basin of 24 m and 33 m for the northern basin. The remaining southern section of the bay is comprised of vast areas of tidal flats that often dry out during spring low tides.

The northern basin which is the deepest area of the bay is also the main connection to the open sea. Depth contours in this basin are irregular with numerous reefs occurring throughout the basin. The area north of the bay, exhibits a regular depth gradient up to depths of 50 m, despite the regular occurrence of reefs in the region. From the 50 m isobath, there is a sharp increase in water depth. The 1,000 m isobath is located very close to the coast, approximately 25 miles off the coast.

The Sofala Bank is the continental shelf off central Mozambique, extending approximately 500 km from 17° S to 21° S (CM *et al.*, 2016). The shelf has an average reported depth of between 20 m and 30m and is approximately 150 km wide, after which it drops into the Mozambique channel where depths of approximate 3000 m are reached (CM *et al.*, 2016; Siteo *et al.*, 2014). In the context of the project, the Sofala Bank extends from the Save River in a northerly direction to Angoche, with its widest section in proximity to the Port of Beira. The bottom topography on the Sofala Bank consists predominantly of fine gravel and sand sediments from Zambezi River and other rivers which discharge onto the bank (CM *et al.*, 2016).

6.1.2 Spatial and temporal variability of physio-chemical regime of water masses

The physio-chemical characteristics of the water masses of Bazaruto Bay and the adjacent nearshore area north of the Bay, exhibit spatial and temporal variability. In the dry season (May to October), the bay is characterised by water of marine nature. Salinity in this period varies between 35 to 36 PSU and there is little spatial gradient. In the rainy season, the bay is more estuarine, exhibiting greater salinity gradient and lower overall average salinity when compared to the dry season. In the rainy season, salinities levels varies between 35 and 33 PSU (Figure 34).

In the early rainy season (November to December), water with a very high salinity (37 to 40 PSU) occur in the nearshore area north of the bay, in the vicinity of the Govuro River mouth. This phenomenon is only temporary.

It is in the late rainy season that most spatial variability of salinity is observed. A stable salinity gradient is observed throughout the rainy season in the bay, with the lowest salinities being observed in the western side of the bay and the highest in the east (Figure 34). While the western side tends to be more estuarine showing larger temporal variability, the eastern side is more marine in nature, varying little in its physio-chemical status.

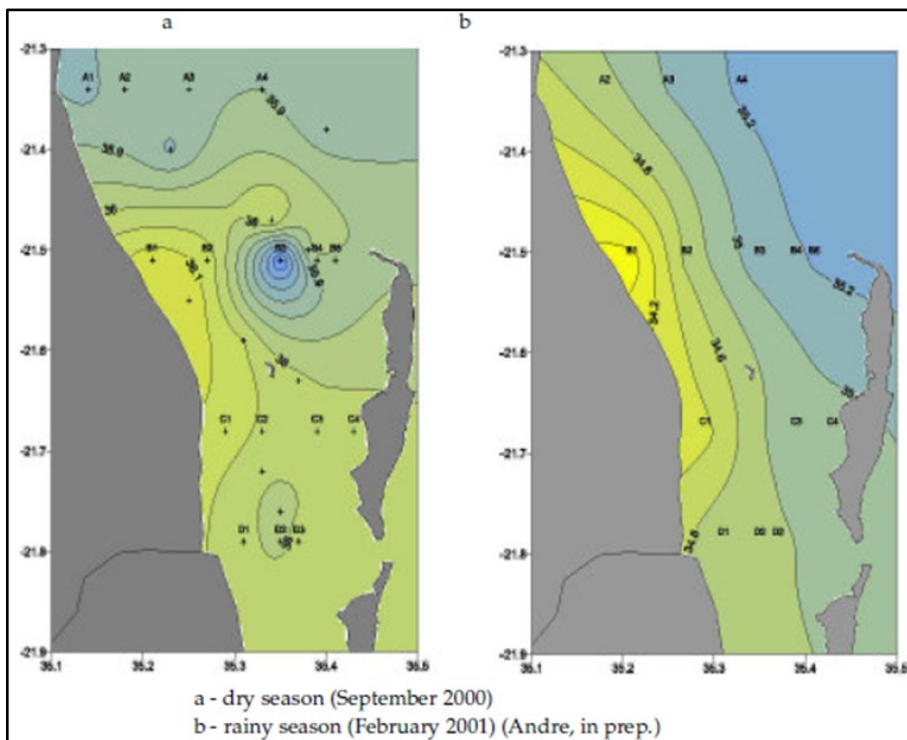


Figure 34: Spatial distribution of surface salinity in two distinct seasons (ERM, 2017)

6.1.3 Water Circulation

Distinct circulation patterns are recognised for the shelf, open ocean and Bazaruto Bay. The circulation of the open ocean adjacent to the Bazaruto Archipelago is governed by the Mozambique Channel circulation system which is comprised of a series of intermittent large-scale eddies drifting southward (see Figure 35). Surface currents associated with this circulation system are known to flow southward throughout the year, with flow speed varying with seasons. According to Admiralty (1995), this current is predominantly southwards and is strongest in summer (October to February), attaining speeds of up to 2 m during this period and 1.3 m at other times during the year.

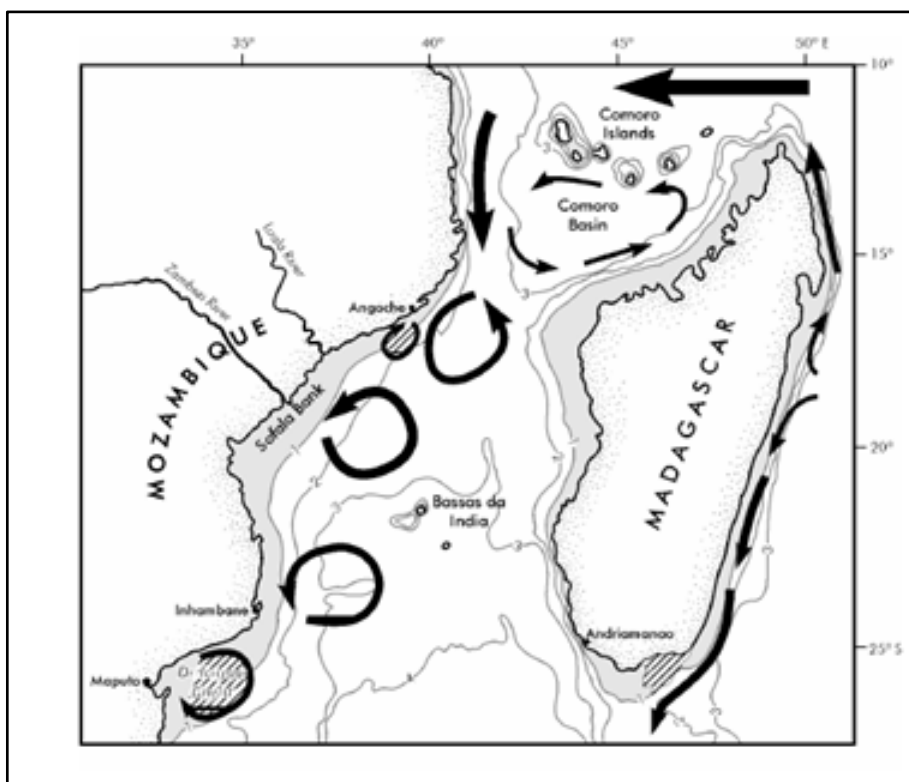


Figure 35: Bathymetry of the Mozambique Channel and the continental shelf off Madagascar in km (after Simpson 1974) with the major circulatory features indicated. Shaded areas are shallower than 1 km; hatched areas denote upwelling (after Lutjeharms, 2007)

The shelf circulation is considered to be a direct result of the Mozambique circulation (Lutjeharms, 2007). The average drift patterns at the sea surface, nevertheless, indicate a strong movement poleward along the eastern shelf of Mozambique (Saetre, 1985). This is also supported by recent salinity distribution map data for the region south of the Sofala bank, just north of Bazaruto, where salinity cells drifting southward are evident. (Figure 36).

However, for the inshore region of Bazaruto Archipelago, currents are known to be highly variable in both speed and direction and are wave-driven and consistent with the wave patterns of this region. In the bay, the main feature of circulation is the occurrence of strong tidal currents that drive water into the bay during the flood phase of the dies and move water out the bay during the ebb tide (Figure 37).

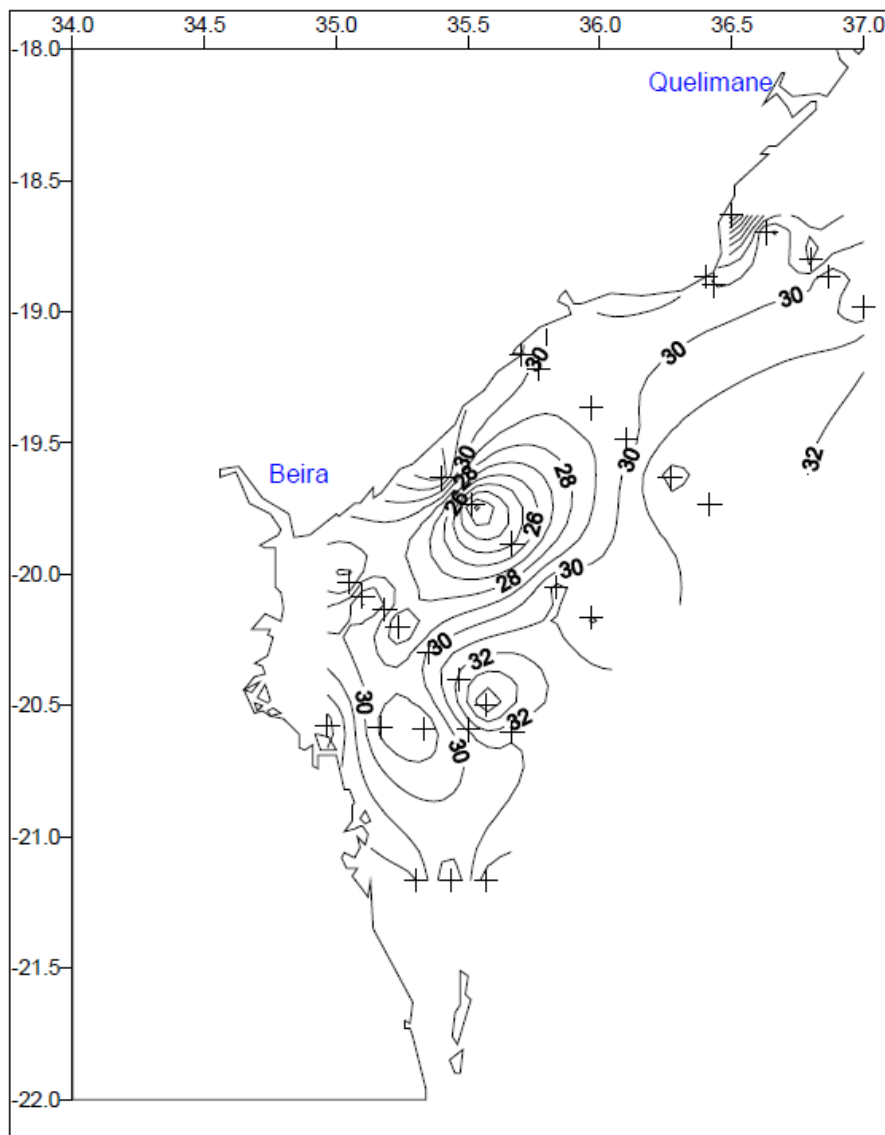


Figure 36: Spatial distribution of salinity in the Sofala Bank (PSU)

The offshore region is dominated by the Mozambique current comprising a number of large-scale eddies (Saetre and Jorge da Silva, 1984). The surface currents in the offshore region flow southwards throughout the year (>50% occurrence at an average speed of approximately 0.6 m) with slightly stronger southwards flows occurring in the November to April period compared to the May to October period (Saetre, 1985). Notes on the Admiralty predominantly southwards and is strongest in summer (October to February), attaining speeds of up to 2 m during this period and 1.3 m at other times during the year.

Within the archipelago the water temperature ranges from 23°C in winter to 28°C in summer and the salinity ranges from 35.4 PSU in winter to 34.7 PSU in summer (Dutton and Zolho, 1990).

The tides are semi-diurnal. The open littoral of the Bazaruto Archipelago experiences low and high tides some 40 minutes ahead of Durban while the tides on the inner bay (north-eastern Bazaruto) are lagged and coincide more or less with those at Durban (Dutton and Zolho, 1990). The mean spring tidal range is approximately 3 m during normal spring tides, increasing to approximately 4.4 m during equinoctial spring tides (measured at 4.39 m during the equinox of 9 March 1989). The tidal range at spring high tide produces strong tidal currents in the channels between the islands that have transported vast quantities of sand to form extensive flood- and

ebb tide deltas. These strong tidal flows also maintain the deep channels on the landward side of the islands and transport sand across the tidal flats.

The offshore wave patterns are dominated by waves from a south-easterly sector. These observations are based on Voluntary Observing Ship swell observations in a block 21°30'-22°30'S; 35° – 36°E) and for the period 1968 to 1998. The highest waves are observed to come from the south during summer. The local wind-driven waves, like the local winds, are from the southeast sector.

Wave action is restricted to the seaward side of the islands and prevents the formation of extensive tidal flats in that area. The alignment of the small half-heart bays on the seaward side of the islands indicates a dominant littoral drift towards the north, consistent with both the offshore and local wind-driven wave climate. Sand transported northwards has been deposited at the northern end of Bazaruto Island to form extensive spit clearly visible on charts of the area. The back-barrier area is sheltered from direct wave action and this produces tranquil low wave conditions (Dutton and Zolho, 1990).

The islands are composed of mainly unconsolidated quartz sand with a minor carbonate component derived from the skeletons of marine organisms. The islands, composed of beach rock and sand dunes, are highly susceptible to movement caused by wind and wave action (Reina, 1998). The presence of beach rock around the island profoundly influences wave refraction patterns.

According to Mark Wood Consultants, (2001), the tidal range at spring highs, produces strong tidal currents in the channels between the islands that have transported vast quantities of sand to form extensive flood- and ebb tide deltas. These strong tidal flows also are known to maintain the deep channels on the landward side of the islands and transport sand across the tidal flats.

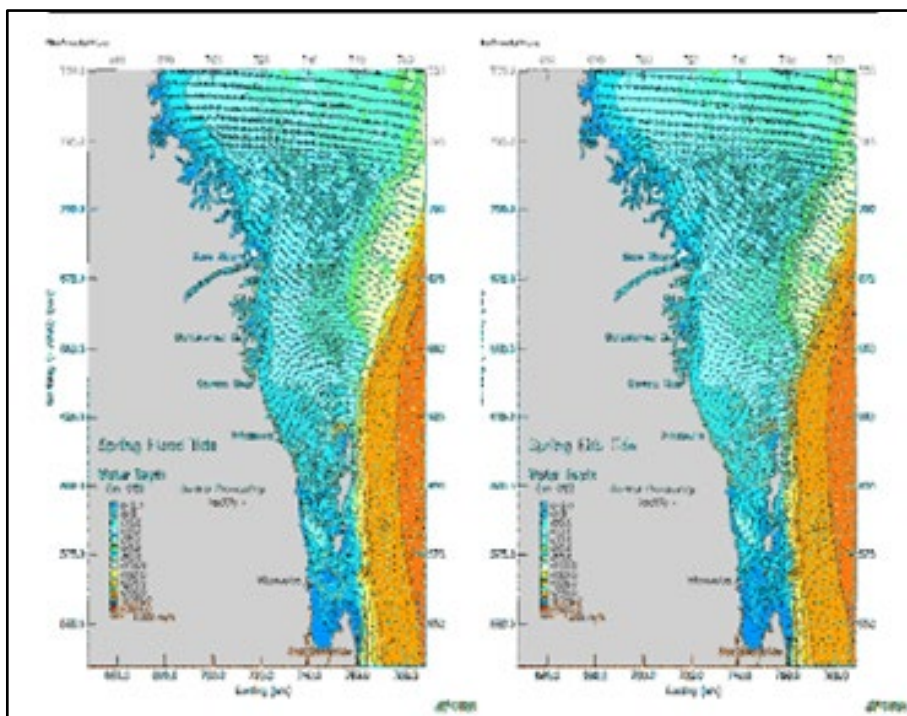


Figure 37: Modelled tidal currents of Bazaruto Bay and adjacent Shelf areas

6.1.4 Water Quality

Physicochemical surveys of water quality in Bazaruto Bay were carried out in November-December 2015 for the EIA process for the Sasol Pipeline and offshore Floating, Storage and Offloading unit (FSO) Project (ERM, 2016). Results of these surveys relevant to the current Study Area are presented in the following sections.

Water Column Characteristics

Offshore water within the Study Area was found to be well mixed, as expected for an open coastal region. Water temperatures averaged 26.6°C and an average salinity of 35.2 PSU throughout the water column was recorded. Turbidity values of < 0.6 NTU were recorded, which compare well to the turbidity values collected from the water samples at comparative depths (all < 1 NTU). These values are very low and represent clear water, also indicated by the high photosynthetic active radiation (PAR) values with depth. The 1 percent level of the incident light at the surface, which is the lowest light level required for photosynthesis to occur, reached the bottom of the water column, indicating a well-mixed, clear water column. The mean pH of all sites at the three depths was 8.14 which agrees with the accepted average pH of the global surface ocean of 8.1.

Heavy Metal Content

Heavy metal analysis was conducted on the water samples collected at three depths (surface, mid and bottom). Measured concentrations were compared to environmental quality targets (EQTs) recommended for coastal waters in the region (UNEP/CSIR 2009). Heavy metals were generally present in the offshore water column in low concentrations, with most not exceeding the recommended EQTs. Cadmium, chromium and mercury were below the detection level of the analyses (<1 µg/l) at all sites, and majority of the remaining metals were present at natural levels, as is expected for a well-mixed offshore region, with relatively little anthropogenic impact. The concentration of copper and lead were the only exceptions, where the EQTs were exceeded at selected depths at several sites. It was not possible to determine the source(s) of the observed elevated concentrations from the survey data.

Dissolved Organic Carbon

Dissolved organic carbon (DOC, a direct estimate of labile organic matter in the water column and thus a proxy for estimating BOD and COD) concentrations were generally found to be low in the area surrounding the proposed FSO location, with concentrations being below detection limits at majority of the sites.

Oil and Grease

In the absence of natural seeps, the concentrations of oil and grease can be considered gross indicators of hydrocarbon pollution in the water body. Typical sources of offshore oil and grease include spills and pollution from ships/tankers and spills from offshore platforms and pipelines. Concentrations in the collected water samples showed that levels varied both spatially and with depth. The concentrations range from < 3 mg/l (detection level of the analysis) to a maximum of 45 mg/l at the bottom depth of the FSO site. It was not possible to determine the source(s) of the observed elevated concentrations from the survey data.

Nutrients

Concentrations of total Kjeldahl nitrogen, nitrate, nitrite and phosphorus were found to be below the detection limit of the analyses used at all depths at all sites. The low values of these nutrients in the area could act as a limiting factor for the growth of phytoplankton.

Hydrocarbons and Aromatic Compounds

Both the total petroleum hydrocarbons and polyaromatic hydrocarbons were found to be below the detection levels of the analyses at all sites. This is expected for a well flushed area that is not close to any sources of anthropogenic contamination.

Low concentrations of naphthalene were detected in marine sediment samples. Concentrations at all measuring points were below the screening levels for significant human or ecological impact. Without a longer dataset the possible source is uncertain. Further research into activities in the upstream catchment would be necessary in order to establish a source.

6.2 Satellite Imagery Classification

The results of the satellite imagery classification of Bazaruto Bay are shown on Figure 40. Full details and descriptions for each of the mapped 'landcover' categories are provided in APPENDIX A.

The following key outcomes of the satellite imagery classification exercise are noted:

- Reef possible/likely: Areas of potential coral reef were identified to the north west of the BANP boundary; these can be easily avoided by adjusting the proposed barge route corridor. These areas are discussed in more detail in Section 6.3.1.
- Seagrass possible: Areas where seagrass occurs in deeper water (approx. 5 m) ('sea grass likely') were identified in a band extending roughly in north to south direction, approximately two km from shore. These can be largely avoided by adjusting the proposed barge route corridor. These areas are discussed in more detail in Section 6.3.2.
- Seagrass likely: A darker seabed feature approximately 500 m in width, and commencing 200 m offshore, was tentatively identified as seagrass. This feature is discussed in more detail in Section 6.3.2.

6.3 Marine and Coastal Ecosystems

The Mozambican coastline can broadly be classified into three ecoregions from north to south, each supporting a variety of marine ecosystems; the East African Coral Coast; the Bight of Sofala/Swamp Coast; and Delagoa (Spalding *et al.*, 2007). The Study Area lies between Bazaruto Bay and the port of Beira, in an area of overlap between the coral, swamp and parabolic coastal dune marine ecosystems known as the Delagoa Bioregion (Figure 38), and includes aspects of each.

Bazaruto Bay is sheltered from high energy wave action by the Bazaruto Archipelago and Cabo São Sebastião, conditions which have supported the development of sandy tidal flats and associated seagrass meadows. The sea-ward side of the Bazaruto Archipelago is characterised by parabolic dune systems, consisting of steep and tall (up to 120 m) vegetated dunes, often backed by salt lakes and closed salt lagoons. Bazaruto Archipelago is a transitional ecosystem, where both tropical coral reef and submerged rocky reef occur offshore (Perreira *et al.*, 2014).

The Bight of Sofala / Swamp Coast is characterised by extensive mangrove swamps and coastal wetlands. The continental shelf is wide along this section of the coastline, reaching up to 140 km near Beira. The ecoregion is driven by the numerous rivers (24) that drain into the ocean. These rivers support extensive mangroves, coastal swamps, and tidal estuaries (Perreira *et al.*, 2014). The Save and Pungwe Rivers are the largest rivers discharging in proximity to the Study Area. As a result of the rivers draining into the Sofala Bay, turbid waters are common, limiting the growth of corals in this region (Muthiga *et al.*, 1998). The turbidity is also likely to be negatively correlated with the presence of seagrass, which needs light to penetrate to the seabed for growth.

The specific ecosystems that are present within the Study Area are discussed in the sections that follow.

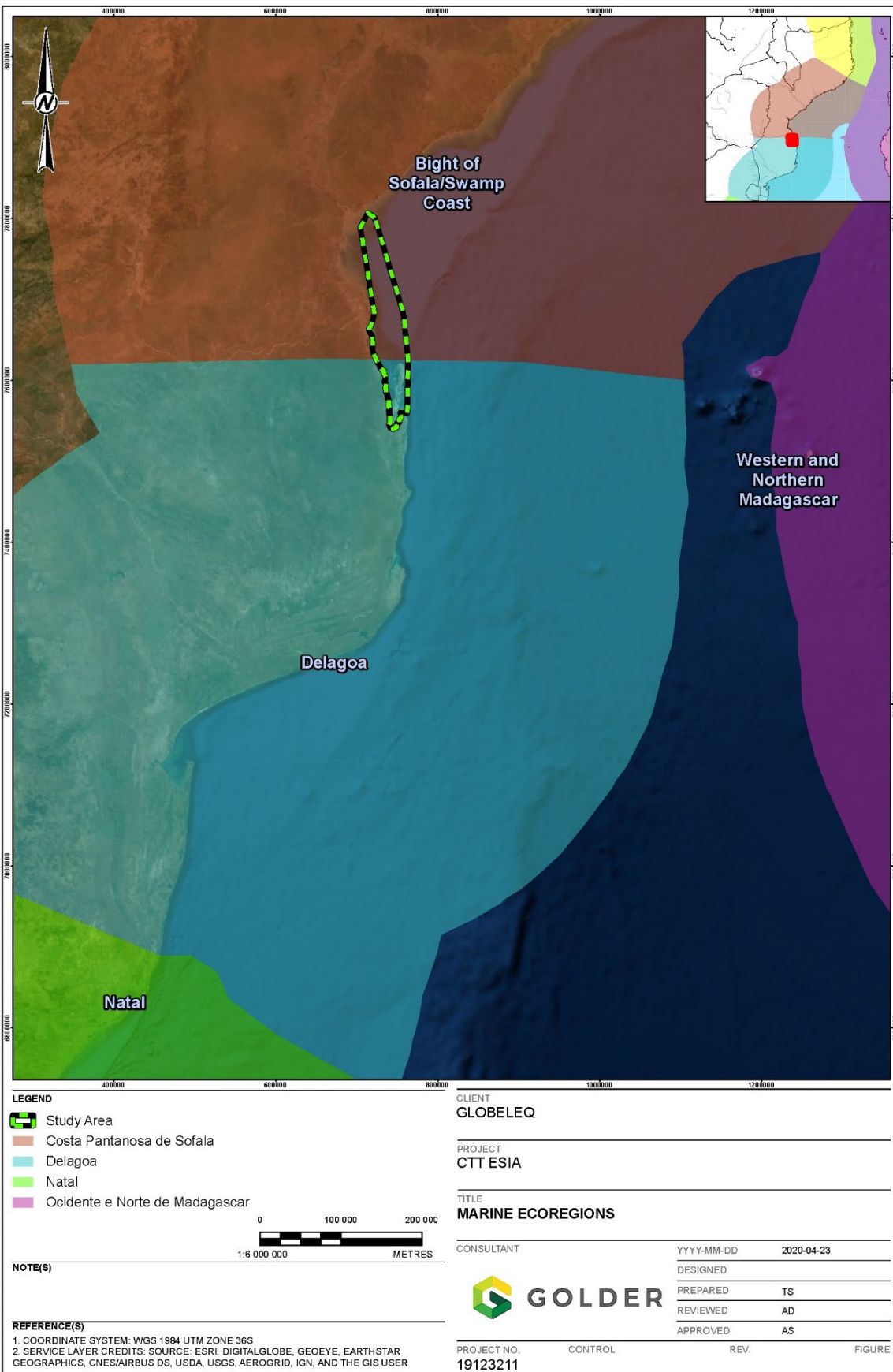


Figure 38: Marine ecoregions in the Study Area

6.3.1 Coral Reefs

Coral reef systems are distributed throughout the Study Area, the largest of which are located off the coast north of Inhassoro (Findlay *et al.*, 2006). The satellite imagery classification exercise identified several possible/likely areas of coral outcrop amounting to 9.49 km² in extent; to the south of the final approach route to the temporary jetty, and west of BANP. These features are likely to be those described by Findlay *et al.* (2006).

The species diversity, extent and condition of the majority of the mapped offshore and coastal reefs has not yet been ground-truthed due to COVID-19 health and safety restrictions. A potentially similar system - Two-Mile reef off the south coast of Bazaruto Island - has been monitored since 1999, as part of the CORDIO (Coral Reef Degradation in Indian Ocean) regional program to monitor coral condition and the impact of bleaching¹. This reef is dominated by massive hard corals (mainly Porites and Faviids) followed by branching/tabular corals (Acropora) (Pereira *et al.*, 2008). The condition of Two-Mile reef has been previously assessed as good (Findlay *et al.*, 2006), despite pressures including increased populations of coral-feeding crown-of-thorns starfish (*Acanthaster planci*), and illegal fishing practises. The most recent available monitoring results indicate that 16.7% of this reef was affected by bleaching which occurred during a widespread bleaching event in early 2005 (Pereira *et al.*, 2008). No recent results to indicate whether the reef has recovered or further deteriorated since then were available at the time of writing.

6.3.2 Seagrass Beds

In Bazaruto Bay, seagrass beds associated with the sand tidal flats typically occur in shallow and subsidiary waters of less than 5 m depth (Bandeira *et al.*, 2008). The most common seagrass species in the Study Area are *Halodule uninevis*, *Halophyla ovalis* and *Thalassondendron ciliatum* (Guissamulo, 2006).

Within the Study Area, extensive seagrass beds were previously identified off the shoreline where temporary jetty sites Maritima and Seta are located (Guissamulo, 2006), with much smaller seagrass beds located in the near shore environment south from Inhassoro to Vilanculos, and along the western shore of Bazaruto Island (Figure 39). Seagrass beds are dynamic systems, typically shifting in response to physical disturbances during cyclone events. As expected, the results of the recent satellite imagery classification indicate a significant shift in the extent of seagrass beds off the Inhassoro shore (Figure 40), compared to the areas mapped in 2006 (Figure 39).

Expert review of the satellite imagery classification suggests that the thick band of possible seagrass identified approximately 200 m offshore is likely to consist of an algae bed interspersed with bare rock and seagrass, most likely *Zostera capensis* (Dr Vic Cockroft, pers. comm.). As such, this area is expected to have limited importance for dugong, which do not have a preference for sparsely distributed *Zostera* sp., instead consuming seagrass in proportion to their availability, with biomass being the primary determining factor, and species composition influencing consumption to a lesser degree (Tol *et al.*, 2016); i.e. larger, denser seagrass meadows with high available biomass are preferred.

The importance of seagrass beds in the Bazaruto Bay area is related to their importance as a food source for the populations of green turtle (*Chelonia mydas*) and dugong (*Dugong dugon*) that are resident in the area (Perreira *et al.*, 2014). The seagrass meadows of the tidal flats in Bazaruto Bay are known to support the largest remaining populations of dugong in the Western Indian Ocean (Findlay *et al.*, 2011; Perreira *et al.*, 2014). In addition, seagrass meadows act as a shelter and nursing areas for several juvenile fish species and have importance as fishing grounds for the subsistence (artisanal) beach seine fisheries within the Study Area. Erosion of river systems that discharge into Bazaruto Bay as a result of damming and agricultural intensification are anticipated to increase sediment loading of waters, which could affect seagrass beds through smothering

¹ When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn completely white (National Oceanic and Atmospheric Administration, 2015).

(Pereira *et al.* 2014). This effect is already evident in the northern area of the Study Area, where the turbidity of the sea water due to sediment discharged by the Save, Buzi and Pungwe rivers precludes the growth of sea grass beds, and dugong presence, in this area.

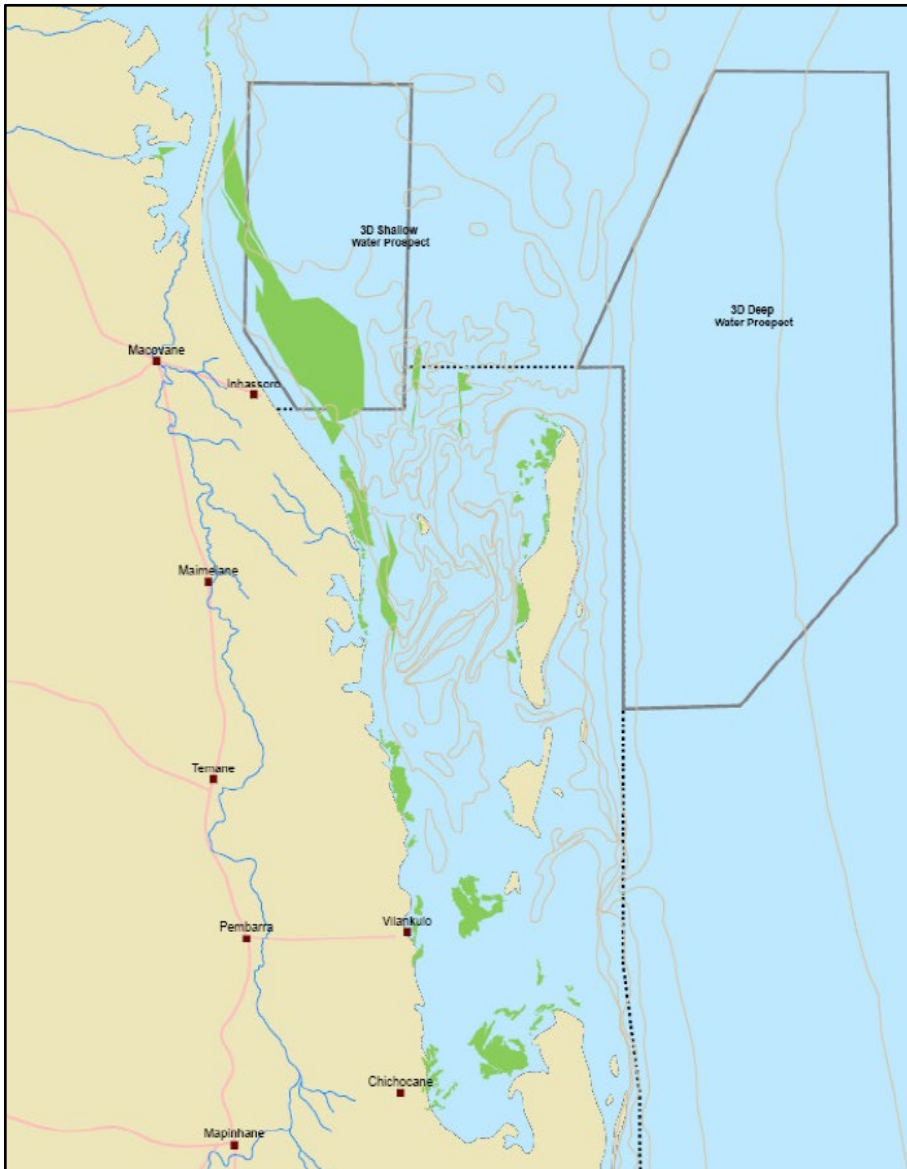


Figure 39: Seagrass beds (green areas) within Bazaruto Bay (Guissamulo, 2006)

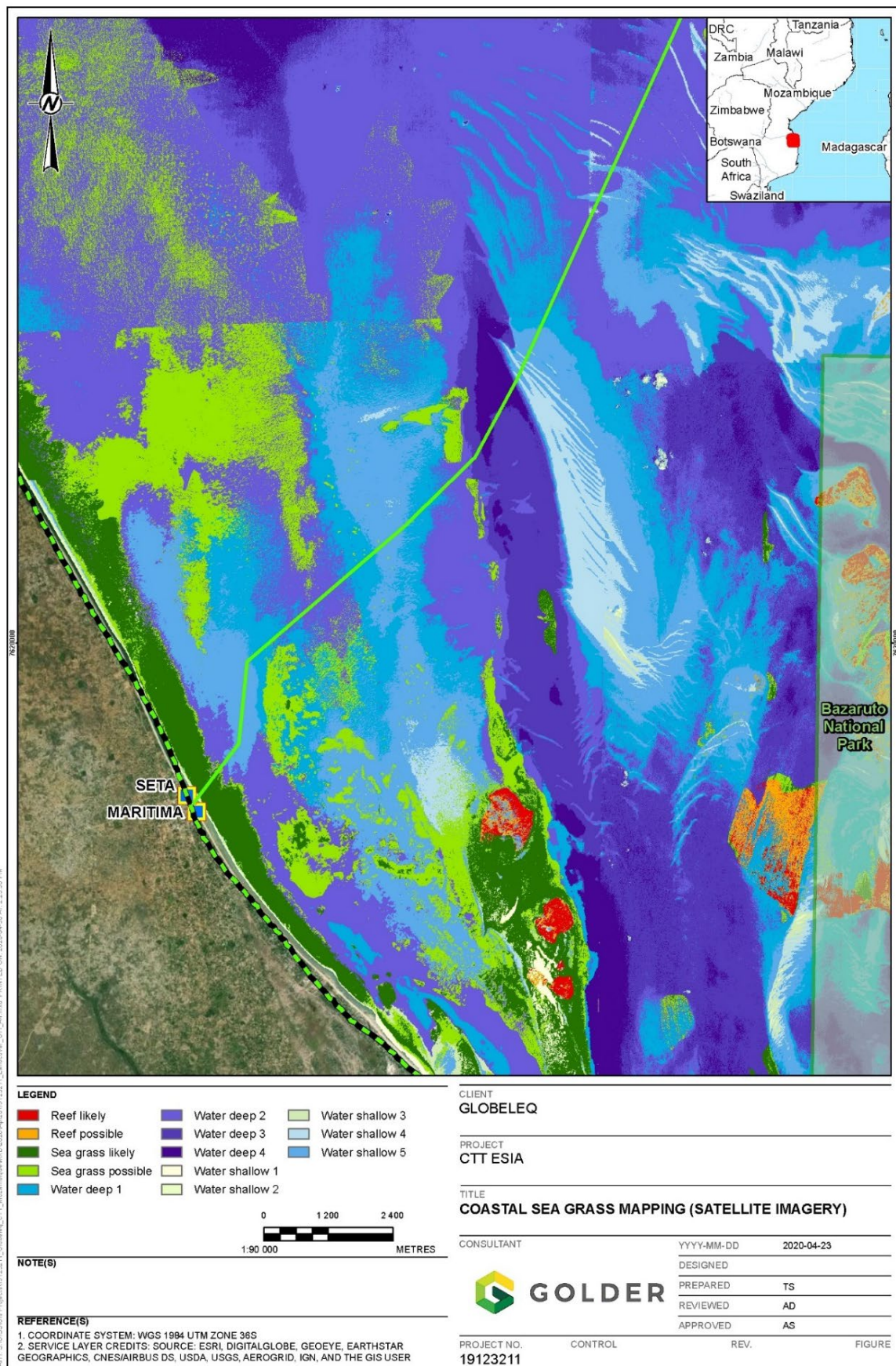


Figure 40: Satellite Imagery Classification Results (GTI, 2020)

6.3.3 Mangroves

Mozambique contains the second highest area of mangrove forest within the Western Indian Ocean (Spalding *et al.*, 2007). The Sofala coast has an almost continuous fringe of well-developed mangrove forests, with the Zambezi River Delta being the second biggest continuous mangrove extent in Africa, covering approximately 37 000 ha (Fatoyinbo *et al.*, 2018; Shapiro *et al.*, 2015).

Mangroves play an important role in the retention of marine sediment and stabilisation of coastlines (Perreira *et al.*, 2014). The sediments and sheltered waters of mangrove forests support a huge variety of invertebrates, phytoplankton, zooplankton, juvenile fish and shrimps (Perreira *et al.*, 2014) and therefore are crucial in support of higher-trophic level species such as birds and commercial fish species. They are particularly important during juvenile growth stages of commercial prawns that are harvested in open waters, as they provide a nutrient-rich environment and shelter from tides and predation for juvenile fish and marine invertebrates. Other ecosystem services provided by mangrove forests in Mozambique include supply of construction material and firewood; and climate regulation through carbon storage. An assessment conducted by Siteo *et al.*, (2014), looking at the biomass and carbon stocks of the Sofala Bay Mangrove forests, showed that the average total carbon storage of Sofala Bay mangrove was 218.5 Mg·ha⁻¹, of which around 73% are stored in the soil.

Current pressures on Mozambican mangrove systems include clearance for agricultural purposes and salt extraction, harvest of accessible mangrove forests for firewood/charcoal production, accidental oil spills (Perreira *et al.*, 2014), and upstream dams (e.g. Cahora-Bassa dam) which reduce the flow of freshwater and associated nutrients to mangrove systems, resulting in their shrinkage (Bandeira *et al.*, 2012).

Mangroves associated with river and stream mouths are concentrated in the Mangarelane area of the Study Area, approximately 20 km south of the proposed temporary jetty sites (Findlay *et al.*, 2006). Five species dominate within the Study Area, including red mangrove (*Rhizophora mucronata*), see Figure 41 below, black mangrove (*Bruguiera gymnorhiza*), Indian mangrove (*Ceriops tagal*), white mangrove (*Avicennia marina*), and *Sonneratia alba* (Findlay *et al.*, 2006).

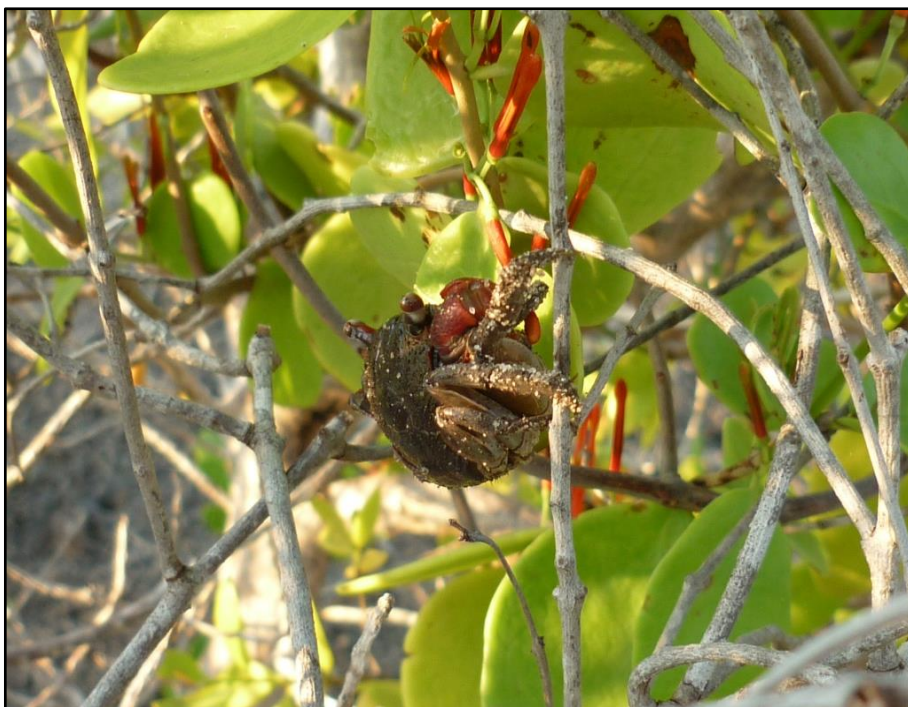


Figure 41: Crab species in red mangrove, Mangarelane area (Golder Associates, 2015)

6.3.4 Primary Dunes and Sandy Beaches

Sandy beaches occur along most of the coast of the mainland between Cabo São Sebastião and Bartolomeu Dias Point, and make up most of the east and west coasts of the islands of Bazaruto Archipelago (Findlay *et al.*, 2006). Sandy beaches are extensive within Bazaruto Bay, within which the Study Area lies. These beaches sometimes extend to form sand/mud banks and are backed by sparsely vegetated dunes. The dunes are subject to strong erosion pressure, both natural (wind/rain/sand accretion) and anthropogenic (unplanned development on dunes) in nature (Findlay *et al.*, 2006). Sandy beaches and dunes in the region have an important role as nesting habitat for marine turtles (Perreira *et al.*, 2014). Both loggerhead and leatherback turtle nests have been recorded on the eastern coast of Bazaruto Island, and at the sandy beaches of the mainland coastline north of Inhassoro, especially in areas of small dunes and weak erosion (Findlay *et al.*, 2006). The distribution and number of nests along the coastline within the Study Area is unknown; however suitable habitat may be present 10-15 km south of Inhassoro where dune systems are evident, and the beaches of the Bazaruto Archipelago islands constitute important nesting sites for turtles (Fernandes *et al.*, 2017).

The beach where the temporary jetty is located is not considered an important turtle nesting area, most likely due to the absence of dunes, and reduced availability of suitable nesting habitat as a result of urban coastal development, and high levels of human activity on the beach itself.

6.4 Marine and Coastal Fauna

The Bazaruto Archipelago and its coastal waters is a marine protected area (MPA) and National Park, which supports the most viable dugong population in East Africa (UNEP, 2014) as well as turtles, dolphins and marlin. The proposed temporary jetty locations are located north and south of Inhassoro town on the mainland coast, outside the National Park.

A description of the marine fauna expected to occur in the Study Area is provided in the following sections, using baseline studies previously completed for Sasol's seismic exploration area within which the Study Area lies, and available published and unpublished information.

6.4.1 Plankton

There are few data available for phytoplankton and zooplankton within the Study Area. In Mozambique the most phytoplankton-productive waters are found near the coast, due to the influence of river discharges and upwelling, while the warmer offshore waters support a lower plankton biomass (Perreira *et al.*, 2014). The Inhassoro area experiences high nutrient loading due to outflows from the Save River where the sediment inputs cause elevated turbidity, thereby influencing primary production along the coast (Findlay *et al.*, 2006). Therefore, the Study Area is likely to support productive planktonic communities due to the presence of river/estuarine systems.

The Delagoa marine ecoregion, within which the Study Area is located, is a transitional zone between the oligotrophic warm waters of the subtropics, and the more productive waters of the sub-Antarctic zone (Spalding *et al.*, 2007). This mixing of waters results in an area of planktonic upwelling that is an important feeding ground for some migratory animals such as whales, whale shark (*Rhincodon typus*) and sea birds (Perreira *et al.*, 2014).

6.4.2 Invertebrates

There is limited available information on marine invertebrates of Mozambique, particularly species that are not harvested for commercial reasons. Most available information is focussed on molluscan fauna, many of which are harvested for food purposes or for their shells.

The invertebrate species discussed in the following sections have not yet been assessed by the IUCN Red List (IUCN, 2014); therefore, their conservation status is currently unknown.

Molluscs

Over 500 species of mollusc are known from the Bazaruto Archipelago alone (Everett *et al.*, 2008) six of which are endemic (Perreira *et al.*, 2014).

Some species of marine mollusc on the Mozambique coast have important 'ecosystem engineer' roles. For example, giant triton (*Charonia tritonis*) is one of the few predators of crown-of-thorns starfish (*Acanthaster planci*). Giant triton is heavily exploited for sale as a souvenir; large-scale removal of giant triton can allow crown-of-thorns starfish to proliferate, which can result in coral reef collapse (Perreira *et al.*, 2014). Other species such as sea slugs are thought to be very diverse but greatly understudied, with a recent study (Tibirică, 2013) contributing over 100 new records for Mozambique as well as a number of undescribed species.

Relevant coastal habitats within the Study Area that provide habitat for molluscan species include beaches, rocky intertidal areas and mangrove forests:

- Sandy beaches in the Bazaruto archipelago are inhabited by various gastropods capable of trapping water inside their shells to prevent desiccation during low tide, such as the periwinkle species *Nodilittorina natalensis* and *Littoraria glabrata*, and the nerite (*Nerita plicata*) (Everett *et al.*, 2008).
- In rocky intertidal areas, species present include black rock oyster (*Crassostrea cuccullata*), grazing snail (*Planaxis sulcatus*), mussel (*Parviperna nucleus*), whelk (*Thais savignyi*), limpet (*Cellana capensis*) and the predatory black mulberry shell (*Morula granulata*) (Everett *et al.*, 2008).
- Mangrove forest provides specialised habitat for several molluscan species, including mangrove creeper (*Cerithidea decollata*), mangrove periwinkle (*Littoraria scabra*, *Littoraria intermedia*), a creeping snail (*Terebralia palustris*), and oysters (*Crassostrea forskhalii*).

Six endemic species of gastropod (*Conus pennaceus*, *Epitonium pteroen*, *E. repandior*, *Fusiaphera eva*, *Thracia anchoralis*, *Limatula vermicola*) are known from the Bazaruto Archipelago (BirdLife International, 2018).

Crustaceans

Mangroves are particularly important as a nursery for juvenile stages of penaeid prawn, including the Indian white prawn (*Fenneropenaeus indicus*) and brown prawn (*Metapenaeus monoceros*), prior to their migration to deep open waters. These species are crucial to the Mozambican prawn fishing industry, accounting for 90% of the total catch (Findlay *et al.*, 2006). Their conservation status has not yet been assessed by the IUCN Red List (IUCN, 2018). Nursery habitat (mangroves) for these species is present within the Study Area.

Cephalopods

Although these are typically offshore species of deep waters, some cephalopod species may occur within the Study Area.

Deep channels near shore inside Bazaruto Archipelago provide habitat for some (normally deep-water dwelling) juvenile squid species including diamondback squid (*Thysanouteuthis rhombus*) and Indian squid (*Loligo duvauceli*), which are thought to be attracted to seagrass beds for feeding opportunities and shelter (Findlay *et al.*, 2006). The cuttlefish *Sepia pharaonis* appears to be common in shallow waters, as it dominates the catches of the beach seine fishery in the coast of Vilankulo and Inhassoro district (Findlay *et al.*, 2006). The presence of these species in the Study Area was confirmed during the Golder site visit; squid and cuttlefish were brought ashore at Inhassoro from Bazaruto Bay by fishermen (Figure 42).



Figure 42: Squid and cuttlefish caught in Bazaruto Bay (Golder Associates Africa, February 2015).

6.4.3 Seahorses

There are at least 30 species of pipefish recorded in Mozambique, however it is likely that this number is underestimated (Perreira *et al.*, 2014). Seahorses and pipefish are subject to overexploitation for souvenirs, traditional medicinal purposes, and the aquarium market (Perreira *et al.* 2014; Project Seahorse, 2003). CITES lists five species of seahorse in Mozambican waters as protected (Table 10).

Table 10: CITES-listed seahorse species in Mozambican waters

Scientific name	Common Name	Conservation Status (IUCN, 2020)
<i>Hippocampus borboniensis</i> ,	Réunion seahorse	NE
<i>Hippocampus camelopardalis</i>	Giraffe seahorse	DD
<i>Hippocampus fuscus</i>	Sea pony	NE
<i>Hippocampus histrix</i>	Spiny seahorse	VU
<i>Hippocampus kuda</i>	Spotted seahorse	VU

All of these species are associated with seagrass habitats (Aylesworth, 2014; Project Seahorse, 2003a, 2003b, 2003c; Wiswedel, 2012), therefore they could potentially occur within the Study Area. The entire seahorse genus *Hippocampus* spp. was listed in Appendix II of CITES in November 2002 (Project Seahorse, 2003).

6.4.4 Fish (excluding Sharks and Rays)

Fish diversity and population composition will vary according to habitat type within the Study Area. Fish species expected to be present within the Study Area largely consist of species associated with seagrass beds and shallow waters, as well as some juvenile stages of deep water and pelagic fishes.

Shallow-water coastal species expected to occur within the Study Area are listed in Table 11.

Table 11: Shallow-water coastal species expected in the Study Area (Findlay et al., 2006)

Scientific name	Common Name	Conservation Status (IUCN, 2020)
<i>Aeoliscus punctulatus</i>	Speckled shrimpfish	DD
<i>Amblygaster sirm</i>	Spotted sardinella	LC
<i>Carangoides ferdau</i>	Blue trevally	LC
<i>Cheilopogon cyanopterus</i>	Margined flyingfish	LC
<i>Chirocentrus dorab</i>	Dorab wolf herring	LC
<i>Fistularia commersonii</i>	Bluespotted cornetfish	LC
<i>Hemiramphus far</i>	Black-barred halfbeak	NE
<i>Strongylura leiura</i>	Banded needlefish	NE
<i>Tylosurus crocodilus crocodilus</i>	Hound needlefish	LC

Juvenile stages of deep water pelagic species that may also occur include Indian scad (*Decapterus russelli* – LC), *Scomberoides tol*, *Selar crumenophthalmus*, *Carangoides dinema*, kawakawa (*Euthynnus affinis* – LC), *Rastreliger kanagurta* and *Herklotsichthys quadrimaculatus* (Findlay et al., 2006). Other species likely to be present include the mangrove and estuarine fish species flathead mullet (*Mugil cephalus* - LC), yellowtail barracuda (*Sphyræna flavicauda* - NE), and bonefish (*Albula vulpes* - NT) (Findlay et al., 2006). The diversity of fish species taken by the local capture fishery is illustrated in Figure 43.

**Figure 43: Capture fisheries observed during site visit (Golder Associates Africa, 2015)**

6.4.5 Sharks and Rays

Sharks and rays recorded in Bazaruto National Park include black tip reef shark (*Carcharhinus melanopterus* – NA), white tip reef shark (*Triaenodon obesus* – NA), blackfin shark (*Carcharhinus limbatus* – NA), dusky shark (*Carcharhinus obscurus* - VU), Zambezi shark (*Carcharhinus leucas* - NA), Java shark (*Carcharhinus amboinensis* - DD), blue stingray (*Dasyatis chrysonota* - LC), and whale shark (*Rhincodon typus* - VU) (Everett *et al.*, 2008). The conservation status of several of these is unknown (not assessed - NA) as they have not yet been assessed by the IUCN Red List of Threatened Species (IUCN, 2014). The oceanographic characteristics of the Inhambane area create favourable conditions for aggregations of resident and transient reef manta ray (*Manta alfredi* – VU), giant manta ray (*Manta birostris* - VU) and whale sharks (*Rhincodon typus* - EN) (Perreira *et al.*, 2014).

Little information exists on the presence or distribution of sharks and rays within the Study Area. Aerial surveys conducted in 2001 (Mackie, 2001) recorded no whale sharks between the Save River estuary and Bazaruto (within which the Study Area lies), possibly because the survey was conducted over shallow water of <10 m depth (Mackie, 2001); by comparison, sightings of whale shark were made in the open sea between Pomene and Bazaruto Island (Findlay *et al.*, 2006). The species is known to occur in both coastal and pelagic waters (Pierce & Norman, 2016) and therefore could occur within the Study Area.

Dusky shark (*C. obscurus*) has a patchy distribution in tropical and warm temperate seas, being highly migratory (Musick *et al.*, 2009). Population decline in several areas of its range are attributed to entanglement in shark-protection beach nets, fisheries bycatch, and targeted fishing - its fins are highly prized for the shark fin trade (Musick *et al.*, 2009). Although recorded in Bazaruto National Park (Everett *et al.*, 2008), no information on frequency of occurrence or distribution is available.

Blue stingray (*D. chrysonota*) is often found in shallow bays and sheltered sandy beaches in summer, moving offshore to deeper waters of up to about 100 m depth in winter (Smale, 2009); it is likely to be present within the Study Area.

6.4.6 Avifauna

Bazaruto Archipelago is a designated Important Bird Area (IBA) (BirdLife International, 2015). A total of more than 180 bird species have been recorded for Bazaruto Archipelago, which is an important stopover for different species of migrating birds, particularly Palaearctic waders which are attracted by the extensive sand flats on the leeward shores of the islands (CSIR, 2001).

The number of waterbirds present during the austral summer regularly exceeds 20,000 (BirdLife International, 2015). The largest congregations in southern Africa of bar-tailed godwit (*Limosa lapponica*) and crab-plover (*Dromas ardeola*) have been observed within the IBA. Flocks of American flamingo (*Phoenicopterus ruber*), which arrive from breeding grounds in Botswana and disperse along the east coast of Africa, are present in the archipelago during mid-winter (BirdLife International, 2015). Rare birds observed in the marshes of San Sebastião include long-toed lapwing (*Vanellus crassirostris*) and rufous-bellied heron (*Butorides rufiventris*) (BirdLife International, 2015); however, these are not listed as threatened (i.e. Critically Endangered, Endangered, or Vulnerable) by the IUCN Red List of Threatened Species (IUCN, 2020).

6.4.7 Cetaceans

The combination of shallow, plankton-rich waters in Bazaruto Bay, and nearby oceanic conditions, provides highly suitable conditions for cetaceans (whales and dolphins) in the greater Bazaruto area (Everett *et al.*, 2008). At least three species of whale and six species of dolphin occur in the area, and thus may occur in the Study Area.

Whale species include southern right whale (*Eubalaena australis*), humpback whale (*Megaptera novaeangliae*) and minke whale (*Balaenoptera acutorostrata*). These typically occur on the seaward side of Bazaruto

Archipelago, the shallow waters of the leeward side not being deep enough for them. Minke whale and southern right whale are resident in the area, whilst humpback whales migrate along the coasts of Natal, southern Madagascar and Mozambique, passing Bazaruto Archipelago between September and November on their annual migration to Madagascar (CSIR, 2001).

Four species of dolphins are resident in coastal waters of the area; Indian Ocean Humpback Dolphin (*Sousa plumbea* - EN), Indo-Pacific bottlenose dolphin (*Tursiops aduncus* - DD), spinner dolphin (*Stenella longirostris* - DD) and spotted dolphin (*Stenella attenuata* - LC) (Perreira *et al.*, 2014). Other species that are present in the Study Area (Findlay *et al.*, 2006) include common dolphin (*Delphinus delphis* - LC), and bottlenose dolphin (*Tursiops truncatus* - LC). All of these species may occur within the Study Area. Recent aerial surveys conducted in Bazaruto Bay counted 241 individuals, found primarily to the north and west of BANP (Gaylard and Mònico, 2020).

6.4.8 Dugong

Dugong (*Dugong dugon*), is listed as Vulnerable on the IUCN Red List of Threatened Species (Marsh & Soltzick, 2019) because of population declines across its entire range. The declines have arisen from threats including gill netting (which entangles them as bycatch), overexploitation through subsistence hunting, and agricultural pollution resulting in sedimentation of seagrass beds and consequent habitat loss (Marsh & Soltzick, 2019). They are also listed on Appendix I of the Convention on International Trade in Endangered Species (CITES) which prohibits trade of this species or its parts. The dugong population of Bazaruto Bay is the largest population of dugongs in the Western Indian Ocean (Marsh & Soltzick, 2019).

The IUCN assessment of dugong conservation status makes reference to a (non-IUCN) assessment of the East African population as Endangered (Marsh *et al.*, 2011); however this book was not available for the literature review and the basis of the assessment is unclear. What is currently known, is that ten dugong surveys conducted during 2018 showed a population still in the range of that previously estimated (Vic Cockcroft, pers. comm) during 2008/09 (Findlay *et al.*, 2012). Surveys conducted in 2019 estimated a population of 170-193 individuals (Gaylard and Mònico, 2020); however, the survey methods were not comparable and as such that population estimate is not comparable to the previous estimates. Although the status of the dugong population in Bazaruto Bay is in the process of being reviewed (Vic Cockcroft, pers. comm), since the most recent comparable population estimate suggests the population size has remained relatively constant over the 10 years between counts, and in the context of the significant levels of recruitment indicated during the 2019 survey (Gaylard and Mònico, 2020), the VU threat status was retained for dugong for the purposes of this study.

Dugong presence and movements are closely linked to the presence and extent of seagrass beds, which form its primary food source (Guissamulo, 2006). Dugongs have been estimated to spend 72% of their time within 3 m from the sea surface (Chilvers *et al.*, 2004). Surveys offshore of Bazaruto Island have showed that dugongs move to the offshore areas during low tide to escape the risk of stranding; this information has prompted the proposal of an area north of Bazaruto Archipelago National Park as an additional dugong protection area (WWF & UNEP 2004).

Dugongs are relatively slow-moving, swimming at speeds of approximately 10 km/h, but can reach speeds of 22 – 25 km/h in short bursts if disturbed (e.g. pursued by boat) (Marsh *et al.* 1981 and Cockcroft *personal communication*, 2020)

2006 Baseline Survey

An aerial field survey of dugong in Sasol's offshore exploration blocks 16 & 19, within which the Study Area lies, was previously undertaken in March/April 2006 (Guissamulo, 2006). The survey gathered primary data on dugong numbers/movements in the area to the north of Bazaruto National Park, and the extent of sea grass beds to the north of Bazaruto. Dugong presence within the Study Area based on the data gathered in Guissamulo's study is shown in Figure 44. Dugong was observed singly, in pairs and less frequently in

aggregations, at distances varying from 500 m to 10 km from shore. Most sightings were concentrated between Bazaruto Bay and Vilanculos, with 54 of a total 79 dugong recorded in this area (Guissamulo, 2006).

Overall, during Guissamulo's survey, dugong were most common in the area north of the Santa Carolina Island and west of the northern tip of the Bazaruo Island, an area which the barging route crosses. (Figure 44). Dugong were observed to sometimes form large aggregations, for reasons speculated to be either for social behaviours, or due to presence of deeper water during low tide conditions when access to seagrass feeding areas was restricted. These aggregations were observed both within Bazaruto Bay, and up to 10 km offshore (Guissamulo, 2006).

2015 Supplementary Data

Additional shapefile data provided by the Endangered Wildlife Trust (EWT, 2015) on dugong presence and patterns of distribution in the Bazaruto Bay area, shows the areas where sightings of dugong have been concentrated during their survey work (Figure 45, Figure 46). The figures illustrate the areas (isopleths) within which 100%, 95% and 90% of adult dugong sightings (Figure 45) and calf sightings (Figure 46) have been observed by EWT during 2012-2014; these areas may be considered as being of greater importance for dugong conservation within the Study Area.

2016 Baseline Survey

An aerial survey of dugong in Bazaruto Bay was carried out in April 2016 for the EIA process for the Sasol Pipeline and offshore Floating, Storage and Offloading unit (FSO) Project (Guissamulo, 2016), which updated the distribution and abundance estimates made previously (Guissamulo, 2006), and characterised the Study Area's importance for dugongs. Observed group sizes ranged from solitary individuals to groups of 11 individuals, 20% of which included calves (Guissamulo, 2016). Groups with calves were observed at four key locations, notably in the north eastern area of Bazaruto Bay between Bazaruto Bay and north of Santa Carolina Island, which lies within the Study Area.

2019 Aerial Survey

An aerial survey of dugong's within the greater Bazaruto Archipelago National Park and northwards along the coast was undertaken in a fixed-winged aircraft and helicopter between 15 - 22 June 2019, excluding 20 June due to bad weather (Gaylard and Mònico, 2020). The survey counted 170 dugongs in 96 separate observations; the population size for dugongs in this region was estimated to be 170 - 193 individuals (Gaylard and Mònico, 2020). At least 9.7% of the dugongs observed were either sub-adults or juveniles, indicating that significant recruitment (the process by which new individuals are added to a population) is taking place; and suggesting that if the dugong population is declining, it is likely to be due to adult mortalities rather than through lack of recruitment (Gaylard and Mònico, 2020).

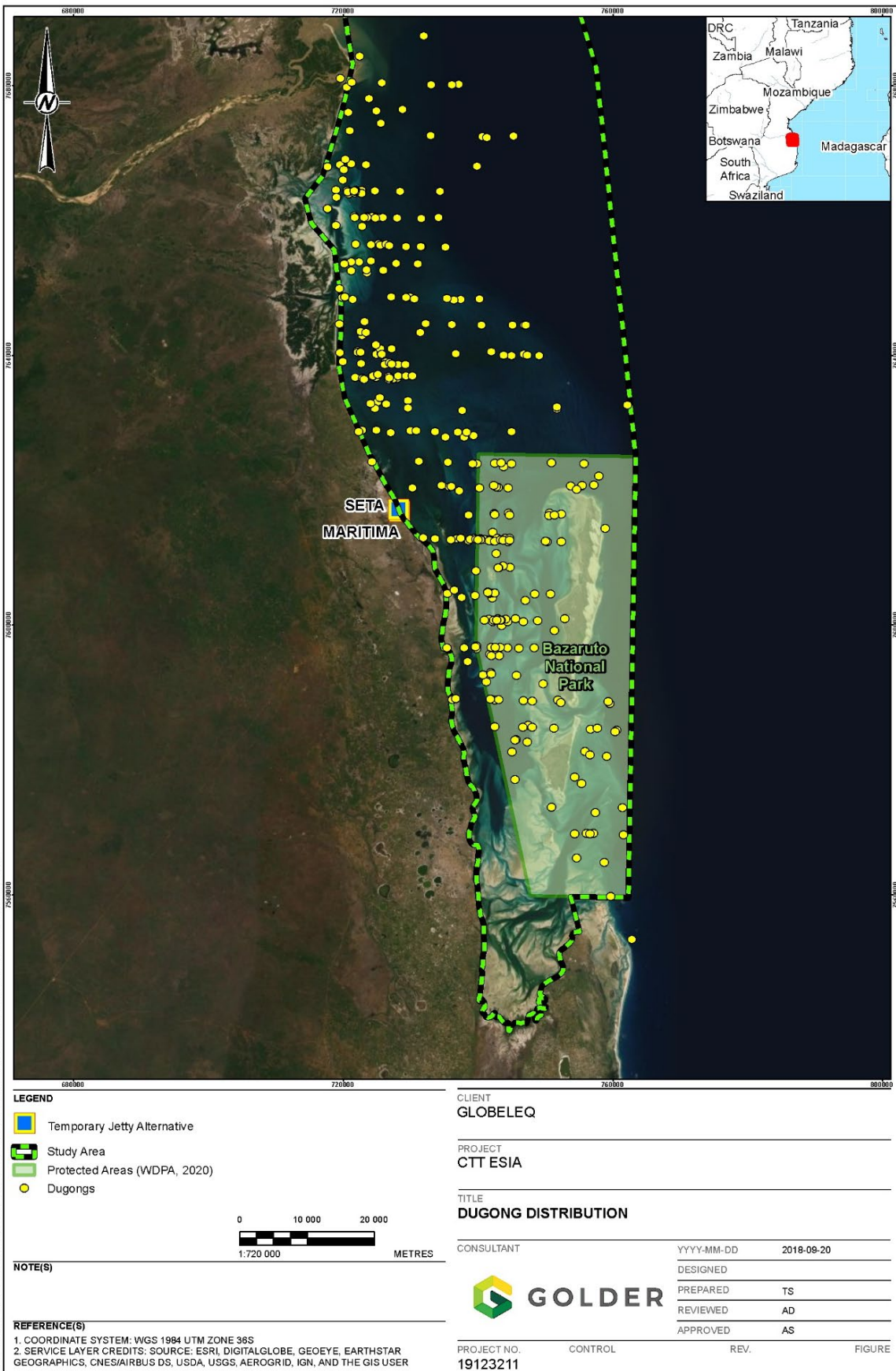


Figure 44: Dugong distribution in relation to the Study Area (Guissamulo, 2006)

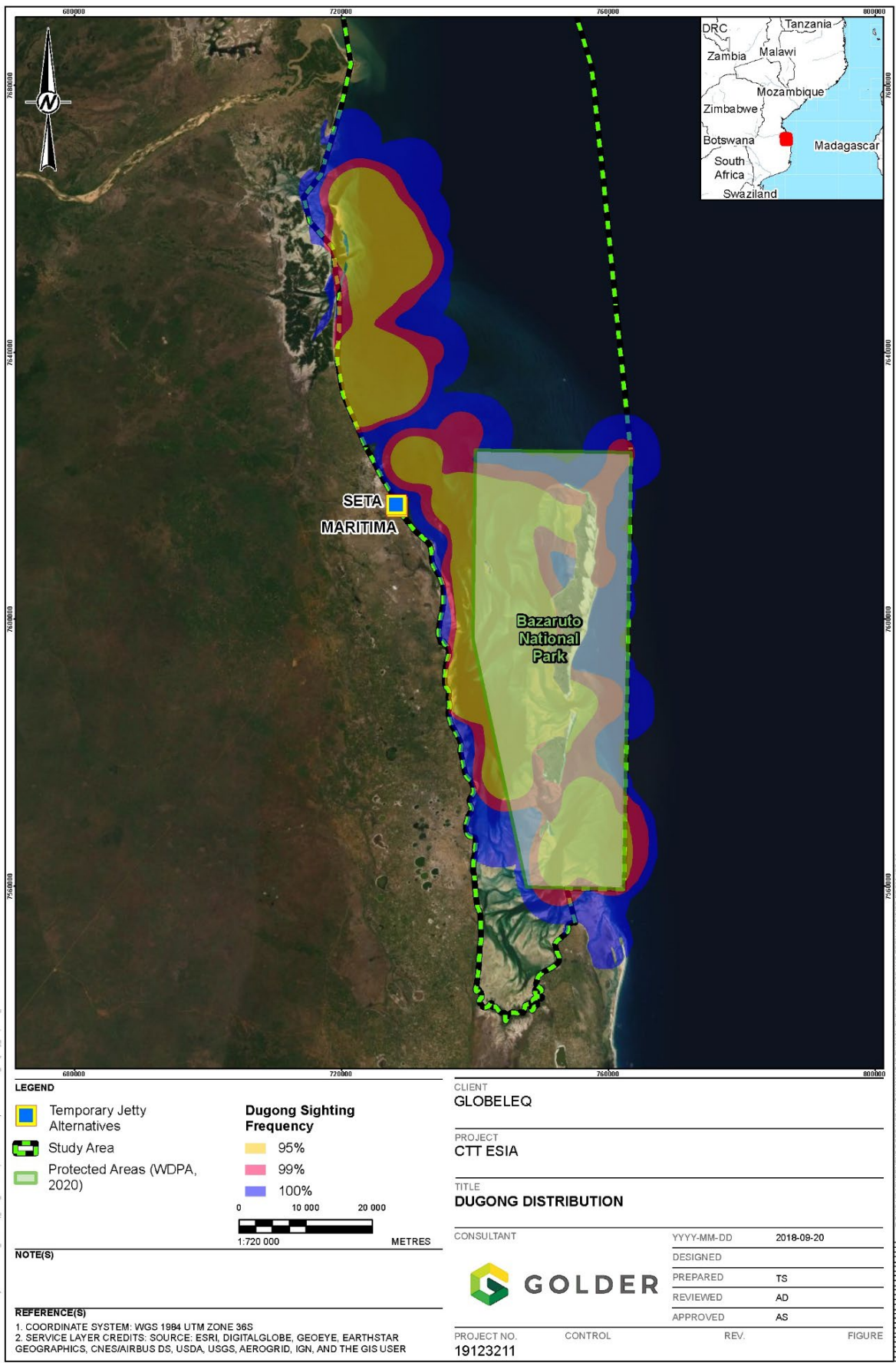


Figure 45: Adult dugong distribution 2012-2014 (EWT, 2015)

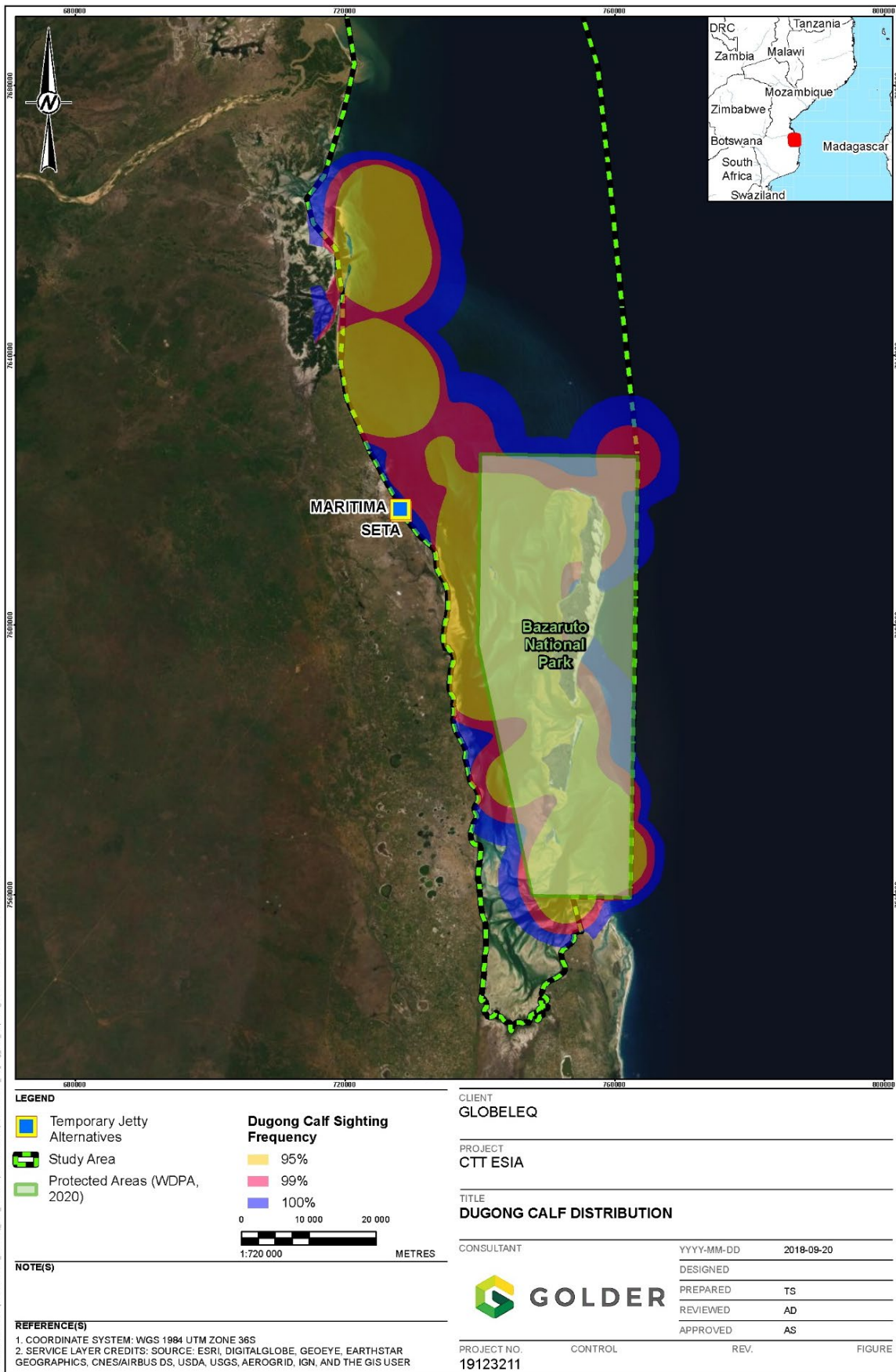


Figure 46: Breeding dugong distribution 2012-2014 (EWT, 2015)

6.4.9 Sea Turtles

Five species of marine turtles occur in Mozambique, the loggerhead (*Caretta caretta*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and olive ridley (*Lepidochelys olivacea*). Observations of the olive ridley turtle are largely confined to the northern region; the other four have been observed along the entire Mozambican coast (Perreira *et al.*, 2014).

A total of 1,876 turtles were observed during aerial surveys of Bazaruto Bay conducted in 2020 (Gaylard and Mónico, 2020). Turtle sightings were widespread throughout the bay, but concentrated off the shore of Inhassoro to such a degree that they were counted as groups (Gaylard and Mónico, 2020). Loggerhead and leatherback turtle nests have been recorded on the eastern coast of Bazaruto Island, and at the sandy beaches of the mainland coastline north of Inhassoro, especially in areas of small dunes and weak erosion (Findlay *et al.*, 2006). The distribution and number of nests along the coastline within the Study Area is unknown; however suitable habitat may be present 10-15 km south of Inhassoro where dune systems are evident. Loggerhead turtle is listed as Endangered (Marine Turtle Specialist Group 1996) and leatherback turtle is listed as Vulnerable (Wallace *et al.*, 2013) by the IUCN Red list of threatened species.

While the hunting of marine reptiles is prohibited by law, butchered adult green turtles were previously found on the foreshore at the mouth of the Nhangonzo coastal stream (Avis *et al.* 2015).

6.4.10 Seals

Two seal species (crab eater seal *Lobodon carcinophaga*, cape fur seal *Arctocephalus pusillus*) have been recorded in Mozambican waters; however, these are incidental records - Mozambican coastal waters are outside their normal distribution ranges (southern coast of South Africa and Antarctic respectively (Findlay *et al.*, 2006). Seals are therefore not expected to occur in significant numbers within the Study Area.

6.5 Protected Areas and Species

Several marine and coastal ecosystems and species are protected by Mozambican law, or as a result of obligations on the Mozambican government as signatories to various international conventions (ref. Section 4.0). In addition, GN95 of the IFC PS6 guidance notes (IFC, 2019) require that Projects potentially affecting protected areas comply are subject to the mitigation requirements for natural or critical habitat, depending on the qualifying biodiversity values present in the legally protected or internationally recognised area. Protected areas and species that are present within the Study Area are summarised in the following paragraphs.

6.5.1 Protected Areas

6.5.1.1 Nationally Designated Areas

Bazaruto Archipelago National Park

As mentioned throughout this report, Bazaruto Archipelago National Park lies within the Study Area. Designated in 1971, it was the first official National Park of Mozambique, and initially comprised the three southernmost islands Bangué, Magaruque and Benguerua, together with a contiguous sea area extending 5 kilometres to the West and to the 100 m line of bathymetry to the East (WWF, 2010). The protected area was then extended in 2002, to include the remaining islands of the archipelago (i.e. Bazaruto and Santa Carolina), and was renamed as the Bazaruto Archipelago National Park, with a total area of 1,430 km² (WWF, 2010; Perreira *et al.*, 2014).

The Nhamabue area at the Govuro River Estuary to the north of Inhassoro and Save River holds about 60 percent of the dugong population of the entire greater Bazaruto Archipelago and has been proposed as a sanctuary which could be managed as part of the Bazaruto Archipelago National Park (Guissamulo, 2016).

Bazaruto Archipelago Important Bird Area

Bazaruto Archipelago Important Bird Area (IBA) consists of the islands of Bazaruto, Santa Carolina, Benguerra and Margaruque, and also the San Sebastião peninsula on the mainland – overlapping in part with the National Park. The most important habitat for birds is the extensive intertidal flats which connect the islands, as the site is designated as an IBA due to its importance as wintering ground for large numbers of non-breeding migratory waders from the Palearctic (BirdLife International, 2015).

6.5.1.2 Protected Habitats

Primary dunes and sandy beaches are prominent habitats, especially from Bazaruto southwards, where these play an important role as nesting habitat for marine turtles. The Forestry and Wildlife Regulations offer total protection to all five species of marine turtles, which extends to their nesting sites. If nesting sites occur within the Study Area, these beach areas will be subject to the requirements of the Forestry and Wildlife Regulations.

In addition, the Regulation for the prevention of marine pollution further protects beach systems where turtles are present, describing beaches as “fundamental habitats for the normal development of marine turtles”. It requires that infrastructure development apply for special licenses, prohibits driving on the beach and makes provisions for heavy fines for violations.

6.5.2 Nationally Protected Species

Several nationally-protected faunal species occur within the Study Area, which will be closely considered during the assessment of potential project impacts:

- All turtle species are protected under national legislation so that the killing of marine turtles and possession of their eggs is an offence (Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]). This regulation prescribes a fine of MT 25,000 (approximately US\$ 1,000) for the illegal hunting of marine turtles;
- All cetacean species are protected under national legislation (Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]); and
- Dugong is protected under national legislation (Annex II, Forest and Wildlife Regulations [Decree 12/2002 of 6 June 2002]). This regulation prescribes a fine of MT 50,000,000 (approximately US\$ 722,500) for the illegal hunting of this species.

6.5.3 Marine Species of Conservation Concern

Two marine mammal species of concern are found in the coastal waters of the Study Area; Dugong, and Indian Ocean Humpback Dolphin.

The dugong population in the area (the Bazaruto Archipelago region), is considered the largest and last viable population in the Western Indian Ocean region, from Cabo de São Sebastião in the south to the Save River mouth in the north (Findlay *et al.* 2011; Allen 2013; Samoilys *et al.* 2015). Most recent population estimates, which should be considered cautiously as different methodologies were used at varying levels of detail, vary between 359, 463 and 852 dugongs for the Greater Bazaruto Area (Findlay *et al.*, 2011; Provancha & Stolen, 2008; Guissamulo *et al.*, 2016, respectively). Dugongs use the entire inshore waters depending on the availability of forage and disturbance. Their distribution is closely related to the location of the seagrass meadows between 1 and 5 m deep that they utilise for grazing (Guissamulo, 2006). Pressures from anthropogenic disturbances, causing reductions in available seagrass beds for foraging, is the main cause for classifying the East African dugong population as endangered on the IUCN Red List (Allen, 2013).

The Indian Ocean Humpback Dolphin (*S. plumbea*) is resident in the coastal waters of the Study Area. It occurs in shallow waters typically less than 25 m in depth; correspondingly, most of the population occurs within 500 m to 2 km of the coastline (Plon *et al.*, 2016). The most recent available count data indicated a population of

ca. 60 in the Bazaruto Archipelago (Guissamulo and Cockcroft, 1997). The use by Indian Ocean Humpback Dolphins of this habitat elevates the exposure of the animals to a variety of threats, including organic and chemical pollution from land-based runoff causing food web and water quality changes, noise pollution, boat disturbance, climate change, and mortality via entanglement in fishing gear; the latter of which is considered to be the greatest threat to this species' survival (Braulik *et al.*, 2017; Plon *et al.*, 2016).

Bull shark (*Carcharhinus leucas*), which is classified as Near Threatened, and smalltooth sawfin (*Pristis microdon*), which is Critically Endangered (CR), are expected to occur within the Study Area (Golder, 2017). Whale shark (*R. typus*), which is Endangered (EN), could also occur.

In addition, all five Western Indian Ocean (WIO) marine turtle species have been reported to occur in or near the Study Area (Costa *et al.*, 2007). These species utilise the seagrass beds and coral reefs in the region for foraging, and the beaches, particularly on the east coast of Bazaruto Island, for nesting (Hughes 1971; Costa *et al.* 2007; Videira *et al.* 2008; Pereira and Videira 2009). Five species nest on the beaches of Bazaruto Archipelago and São Sebastião Peninsula (Olive Ridley awaits further confirmation) during the October-March period. Some of these species may nest on the sandy beaches of the Study Area, with special reference to the Nhamábuê area (north of Inhassoro) where beaches are considered suitable for nesting. It is likely that loggerhead turtles' nest in this beach (ERM & IMPACTO, 2016), but Marshall *et al.* (2015) consider the area a suitable nesting ground for green and leatherback turtles as well.

Marine turtles are the only threatened reptiles reported to occur in the estuarine and coastal habitats of the Study Area. These are briefly discussed in Table 6-10. All five species of marine turtles are protected from hunting by the Forest and Wildlife Law (Decree 12/2002 of 6 June) and its eggs and habitats by the Regulation on Pollution Prevention and Protection of the Marine and Coastal Environment (Decree 45/2006 of 30 November). Apart from these, one other threatened species (Zambezi Soft-shelled Terrapin - *Cycloderma frenatum*) may be present in the Study Area, confined to the Save River and the Govuro River estuaries (Golder, 2015a). This species is mostly found in northern Mozambique, with the Save River marking the southern extent of its range. Hence, these six species are the main reptile species of conservation concern for the estuarine and coastal area (Table 12).

Table 12: Reptile species of conservation concern associated with estuarine and coastal habitats in Study Area

Species	Common name	Conservation status (IUCN, 2020)	Likelihood in Study Area	Notes
<i>Chelonia mydas</i>	Green turtle	Endangered	Confirmed	Recorded on the seagrasses north of Inhassoro, an important foraging ground (ERM & IMPACTO, 2016). May also nest in the Study Area.
<i>Eretmochelys imbricata</i>	Hawksbill turtle	Critically Endangered	High	Observed near the Study Area (ex. Santa Carolina Island). May also occur on shallow waters of Study Area.
<i>Lepidochelys olivacea</i>	Olive Ridley turtle	Vulnerable	High	Observed in Bazaruto Archipelago and São Sebastião Peninsula). May occasionally visit the Study Area.

Species	Common name	Conservation status (IUCN, 2020)	Likelihood in Study Area	Notes
<i>Caretta caretta</i>	Loggerhead turtle	Vulnerable *Near-threatened (South West Indian Ocean subpopulation)	Confirmed	Observed in Bazaruto Archipelago and São Sebastião Peninsula). May also nest in the Study Area.
<i>Dermochelys coriacea</i>	Leatherback turtle	Vulnerable *Critically Endangered (Southwest Indian Ocean subpopulation);	High	Recorded near the Study Area ERM & IMPACTO (2016). May occasionally visit the Study Area and possibly nest here.
<i>Cycloderma frenatum</i>	Zambezi Soft-shelled Terrapin	Endangered	Low	Mainly found in northern Mozambique as far south as the Save River and may occur in the Save and Govuro River estuaries.

7.0 ECOSYSTEM SERVICES

This section presents a summary of the relevant information on services supplied by marine and coastal ecosystems, distilled from the biodiversity, surface water, ground water, social, cultural heritage, soil baseline reports, and satellite imagery classification, in order to put the Study Area's capacity to supply provisioning, supporting, regulating, and cultural and spiritual ecosystem services in context.

The ecosystem services supplied within the Study Area are listed according to the supplying ecosystem in Table 13. These ecosystem services are supplied by ecosystems that may have a loss in extent and/or condition because 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 identified (Table 13), and fall into the following categories:

- **Local:**
 - Artisanal fishers utilising Bazaruto Bay;
 - Inhassoro-based consumers of artisanal fish haul;
 - Inhassoro and Bazaruto-based guest houses and tour operators;
 - Residents of Bazaruto Bay coastal area.
- **Regional:**
 - Guest houses and tour operators in the Bazaruto Archipelago;
 - Offshore Artisanal fishermen;
 - Commercial fisheries (trawling and longliners);

- Coastal residents located between Beira and Bazaruto.
- **Beyond Regional:**
 - International tourists

Table 13: Ecosystem services supplied in the Study Area, and beneficiaries of those services

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
Provisioning			
Capture fisheries – artisanal	Coastal	Wild fish captured through seine netting, hand lining and other non-industrial methods	Local
Capture fisheries - industrial	Marine	Wild fish captured through trawling and other non-farming methods	Regional
Biomass fuel	Mangrove	Fuelwood and charcoal	Regional
Biological raw materials – ornamental resources	Coastal	The collection of shells and corals for jewellery and ornaments is a common practice in tourist areas, where such items can be sold. Local markets are evidence of this with crafts for sale.	Local
Traditional medicines	Coastal	Use of shells in traditional medicine practises was observed in some coastal villages (Social baseline)	Local
Regulating			
Erosion control	Mangrove, coral reef, seagrass beds	Coral reefs, mangroves and sea grass beds reduce loss of land and beaches due to waves and storms. Mangroves are known to reduce the height and energy of wind and swell waves passing through them, thus reducing their ability to cause erosion (Spalding <i>et al.</i> , 2014)	Local Regional
Regulation of water timing and flow	Mangrove	Mangrove systems retain water, which can decrease flooding - reducing the need for engineered coastal protection infrastructure	Local Regional

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
Water purification and waste treatment	Mangrove	Mangroves play an important role in the filtration and decomposition of organic wastes and pollutants in water	Local Regional
Cultural			
Ethical and spiritual	Coastal	A sacred pool site is situated on the coast approximately 20 m south of Chipongo (Vilankulo)	Local Regional
Recreation and ecotourism	Coastal, marine	Livelihoods based on provision of recreational/ecotourism opportunities	Local Regional
		Recreational opportunities (fishing, wildlife appreciation)	Beyond Regional
Supporting			
Habitat	Seagrass, mangroves	These habitats form important nurseries for breeding fish, and support foraging faunal species e.g. dugong	Local Regional Beyond Regional
Nutrient cycling	Marine, coastal	Flow of nutrients (e.g., nitrogen, sulphur, phosphorus, carbon) through ecosystems – e.g. transfer of nitrogen from plants to seabed, oceans to atmosphere, atmosphere to plants	Local Regional Beyond Regional
Primary production	Seagrass, mangroves,	Algae and plants transform sunlight and nutrients into biomass, forming the base of the food chain in aquatic ecosystems	Local Regional Beyond Regional

Ecosystem Service	Ecosystem Type	Definition of Service	Beneficiaries
Water cycling	Marine, coastal	Flow of water through ecosystems in its solid, liquid, or gaseous forms – from oceans to air, air to rain, rain to oceans	Local Regional Beyond Regional

7.1 Priority ecosystem services

Priority ecosystem services are (i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities; and/or (ii) those services on which the project is directly dependent for its operations (e.g., social license to operate).

Two priority Type I ES according to potential project impact were identified:

- **Food – Capture fisheries:** barge movements may temporarily affect local artisanal fishers' ability to fish in Bazaruto Bay;
- **Recreation and Tourism:** barge movements and the presence of the temporary jetty may temporarily affect the ability of local and regional tour operators to work in Bazaruto Bay.

As mentioned previously (Section 5.6) Type II ecosystem services are not included in the impact assessment, which deals with Type I Priority ecosystem services, i.e. those that may be impacted by the Project, only.

7.1.1 Food – Capture Fisheries

The fisheries sector in Mozambique is characterized by its economic diversity, supporting three main types of fisheries: artisanal, semi-industrial and industrial fisheries. Sports line-fishing also takes place and has increased in popularity (see Section 7.1.2 Recreation and Ecotourism).

Artisanal Fishers

The capture fisheries ecosystem service is only considered as a priority ecosystem service for local beneficiaries, i.e. the artisanal fishers in Bazaruto Bay whose livelihoods depend on it, and the local residents who are reliant on that fish as a food resource. Since the barge movements are not expected to impinge on commercial fishing sector in any meaningful way, the ecosystem service in the context of commercial fisheries is not discussed in further detail.

Artisanal fishery methods used in the Study Area include the use of beach seines, gillnets and handlines. Fishing in deeper waters of Bazaruto Bay also takes place, focussing on the capture of diamondback squid (*Thysanouteuthis rhombus*) and Indian squid (*Loligo duvauceli*), which are thought to be attracted to seagrass beds for feeding opportunities and shelter (Findlay *et al.*, 2006).

Artisanal fisheries provide income to a large proportion of economically active people in the Mangarelane, Mapanzene and Chipongo, coastal regions, where most men are practising fishers and where fishing is the main source of family income either in cash or goods (Figure 47). When beach seine fishing is not practised in the closed season, most fishers pursue other forms of income generation (ERM/Consultec, 2009).



Figure 47: Seine netting off the beach at Inhassoro

Crabs, lobsters, bivalves and sea cucumbers are collected by the use of simple snorkelling gear and pot traps (Figure 48). Harvesting normally takes place on flats, reefs and in mangroves and estuaries.

Informal traders dominate the trade of these products. Processing is usually smoking or sun drying but a small portion is sold fresh, mainly in cities or villages. Prices vary considerably by site, and they may increase two to three times in the urban markets.



Figure 48: Lobster harvesting in Inhassoro



Figure 49: Sale of fish at the local market, beach trading and squid and cuttlefish caught in Bazaruto Bay.

During the low tide, locals traverse the exposed sand banks to collect crabs and sand worms (Figure 50).

These are primarily collected to use as bait for fishing within the bay.

Although the temporary jetty will cover a portion of the sand bank, the area covered will be very small in relation to the area used for collection.



Figure 50: Sand worms collected at low tide in Inhassoro

Commercial Fisheries

Industrial and semi-industrial fishing activities along the coast can be divided into nearshore operations and deep-water operators. Nearshore operations typically target shrimps by means of trawling, while deep-water operators comprise of purse sein and longlines targeting larger pelagic species. The semi-industrial fisheries vessels are mostly ice carriers, making short trips and not venturing far from the shore due to the characteristics of the vessels (i.e. limited capacity to store and process fish products)

Industrial fishing is carried out especially in the central part of the country (Sofala Bank) (Figure 52), mainly through joint ventures between the Government of Mozambique and foreign fishing companies. The Sofala Bay is traditionally an important shrimp fishing area in Mozambique. The rivers and estuaries draining into the Sofala Bay support a commercial fishery of various prawn species.

Total marine fishery capture production in Mozambique in 2017 was estimated at 232 300 tonnes (FAO, 2019). Agriculture, forestry and fishing together contribute 24.52% of Mozambique's GDP (World Bank, 2018) (Figure 51).

The total annual production of the industrial and semi-industrial sectors was estimated at 19 524 tonnes in 2003 (MIP, 2004); noting that shallow water shrimp contributed 39 percent of the total value of industrial fisheries. Other important products were tuna (38 percent), deep shrimp (seven percent) and fish (five percent) (Table 1) (MIP, 2004). As control on the tuna fisheries is limited, the Government considers the shallow-water shrimp, deep-water shrimp, and fish the most important resources captured in industrial fisheries.

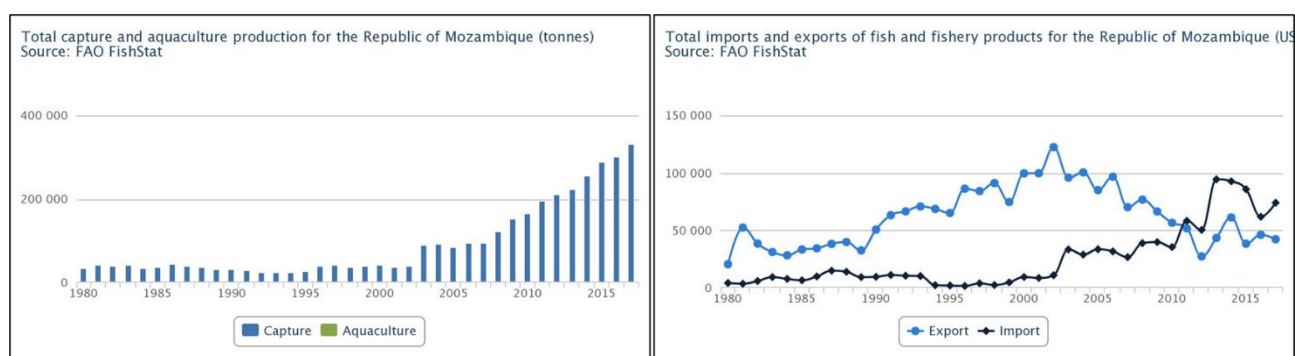


Figure 51: Total capture and aquaculture production (tonnes) and total imports and exports of fish and fishery products (US\$ 1000) for the Republic of Mozambique

As an example, the Pescanova Group have their Pescamar fleet of more than 30 vessels based out of the Port of Beira, such operations as the specialising in the capture of various prawn species, mainly tiger prawn, banana prawn, Guinea shrimp, western king prawn and giant tiger prawn (<http://www.nuevapescanova.com/en/>) (Figure 34). Furthermore, the Afritex Ventures Group has one of their longline fishing companies (Pescamoz LDA) based in Beira. The fleet of vessels focuses on fresh Tuna, Swordfish and Mahi mahi (<http://afritexventures.com/>) (Figure 53).

Based on the frequency of the barging activities (approximately 10 trips over 8 months), and the proposed vessels being used, it is not expected that capture fisheries within the Study Area would be negatively impacted – therefore industrial scale capture fisheries **were not considered a Type I priority ecosystem service** for impact assessment.



Figure 53: Examples of commercial fisheries. (photos taken from Afritex Ventures and Pescanova Group for illustrative purposes only)

7.1.2 Recreation and ecotourism

Inhassoro lies directly west of the northern point of the Bazaruto Archipelago with Santa Carolina Island in clear view between Bazaruto and the mainland. The town is located on the sea front stretched over a distance of approximately 6 km with the main tourist accommodation facilities in a band extending approximately 5 km south of the R241 (main road in Inhassoro) to 1 km north along the beach, facing east. Inhassoro town has developed into a popular tourist venue for both holiday and fishing enthusiasts due to the scenic and tranquil environment, recreational and game fishing opportunities, snorkelling, scuba diving and wind surfing. It is clear that the Inhassoro hospitality industry is dependent on the scenic environment and recreational facilities related to the ocean. Some of the accommodation facilities have their own boats and experienced fishermen to accompany guests on fishing expeditions. The Bazaruto Archipelago, considered one of East Africa's best and certainly Mozambique's premier fishing destination, is in close proximity. The islands cater for upmarket tourists and many facilities overlook the sea channel between Inhassoro and the island. The tourism industry is limited between the Bazaruto Archipelago and Beira.

Many of the local beneficiaries of this ecosystem service are reliant on recreation and ecotourism opportunities for livelihood generation. There is a potential for the barge movements to impinge on some accommodation provider/boat operator's ability to launch/operate while the movements are ongoing, which could potentially temporarily affect the livelihoods of those operators. The ES was considered a Type I priority ES for these beneficiaries and as such was brought forward for impact assessment.

Although much of the tourist accommodation on Bazaruto Island is located on the west coast of the island and is west-facing (e.g. Pestana Bazaruto Lodge Hotel on the northern end of the island and Anantara Bazaruto Island Resort and Spa approximately in the centre of the island), the barge movements are considered unlikely

to have any impact on the livelihoods of the operators of these upmarket facilities. The ES was therefore not considered a Type I priority ES for these beneficiaries.

Tourists availing of the recreational opportunities provided by the ecosystems of the Study Area are unlikely to suffer impacts on their wellbeing as a result of the barge movements. Any visual effects of the presence of the barge will be temporary and not significantly different to the visual presence and noise generated by existing boat traffic; no significant effects on the value of the recreational experience are anticipated. The ES was not considered a Type I priority ES for these beneficiaries.

7.2 Baseline Conclusion

The Study Area is characterised by a diversity of habitats including sandy beaches, sand dunes, coral reefs, estuaries, bays, seagrass beds and mangrove forests, which support a rich marine and coastal flora and fauna, some of which are of significant conservation concern.

Of note is the presence of dugong within the Study Area; the dugong population of the Bazaruto Archipelago is the largest population in the Western Indian Ocean and thus is of significant conservation importance. Other species of conservation concern that occur within the Study Area include Indo-Pacific bottlenose dolphin and spinner dolphin, both of which are Data Deficient; and the Endangered loggerhead turtle and Vulnerable leatherback turtle, seahorses, whale shark, reef manta ray and giant manta ray; all of which are of international conservation concern.

Dugong presence and movements are closely linked to the presence and extent of seagrass beds. Within the Study Area, the most extensive bed of seagrass is located off the shoreline where the temporary jetty options Maritima and Seta are located (Guissamulo, 2006). At low tide, dugong move from these areas into deeper waters to avoid stranding on the tidal flats where the seagrass occurs. Barges loaded with heavy equipment will sail to the temporary jetty sites on the high tide; at low tide the barge will reach the temporary jetty site and be off-loaded. Barges sailing on the high tide may present a collision risk to dugong; in addition, barge movements in shallow waters at the temporary jetty sites could disturb the seabed and any nearby seagrass beds. Scheduling of barge sailing to take place during high tides only, and selection of appropriate barge sailing routes to avoid important coral outcrop and seagrass bed locations, will be critical in minimising the potential for any impacts on species and habitats of conservation concern, and protected areas.

Two Type I priority ES were identified in the Study Area; capture fisheries for artisanal fishers, and recreation and ecotourism for local beneficiaries of that service. The assessment of potential Project impacts on these ES and their beneficiaries and development of appropriate mitigation strategies is key in avoiding any negative impacts on the livelihoods and/or wellbeing of the beneficiaries of these services

8.0 CRITICAL HABITAT SCREENING

8.1 Study Area

Marine and coastal ecosystems and species to be assessed for Critical Habitat (CH) were screened using the Study Area that was defined for the current baseline description (Section 5.2). CH was only identified and mapped at this scale as potential direct and indirect project effects are expected to be limited to this spatial extent.

8.2 Species Triggers of CH

A list of 1,974 marine and coastal species with potential to occur within the Study Area was derived from the IUCN Red List for Mozambique (IUCN, 2018), with the following habitat filters applied:

- Marine Neritic
- Marine Deep Benthic
- Marine Coastal/Supratidal
- Marine Oceanic
- Marine Intertidal
- Artificial/Aquatic & Marine

In order to refine the list to include only species of conservation concern with potential to trigger Critical Habitat criteria, species that were categorised as CR or EN on the IUCN Red List (Criterion 1), known endemic species (Criterion 2) and/or species listed on Appendix I or II of the Convention on Migratory Species (Criterion 3) were shortlisted. 112 marine and coastal faunal species with potential to trigger Critical Habitat designation on the basis of Criterion 1-3 were identified (Appendix A) and are discussed in greater detail according to trigger criteria overleaf.

8.2.1 Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species

Twenty-three CR and EN species potentially occur in the marine and coastal habitats of the Study Area. Most of these are not expected to occur in concentrations sufficient to trigger the quantitative thresholds for Critical Habitat designation.

Indian Ocean Humpback Dolphin (*Sousa plumbea* - EN) is resident in the coastal waters of the Study Area (Braulik *et al.*, 2017; Perreira *et al.*, 2014). Although the numbers of the dolphin currently present in Bazaruto Bay are unknown, the most recent available count data indicated a population of ca. 60 in the Bazaruto Archipelago (Guissamulo and Cockcroft, 1997). Research indicates that the species occurs in groups of less than 100, and the global population numbers in the tens of thousands (Braulik *et al.*, 2017). The global population is therefore assumed to be between 10 000 to 90 000 individuals. The quantitative threshold for the designation of CH under criterion 1 is areas that support $\geq 0.5\%$ of the global population AND ≥ 5 reproductive units of a CR or EN species; which is assumed to be 50 to 450 individuals. The presence of 50 individuals in Bazaruto Bay is possible, therefore the Study Area has been mapped as potential CH for Indian Ocean Humpback Dolphin (Figure 54) taking a precautionary approach.

The presence of individuals of beach-nesting turtles (Green Turtle, Hawksbill Turtle) is likely to be restricted to the ocean-facing sand dunes on Bazaruto Island, which is not expected to constitute a globally important concentration of these species or trigger the quantitative thresholds of criterion 1.

Table 14: Critically Endangered and Endangered Species confirmed/with potential to occur in the STUDY AREA

Class	Common name	Scientific name	IUCN	CMS	CITES
ACTINOPTERYGII	Giant Wrasse	<i>Cheilinus undulatus</i>	EN		II
HOLOTHUROIDEA	Golden Sandfish	<i>Holothuria lessoni</i>	EN		
HOLOTHUROIDEA	Black Teatfish	<i>Holothuria nobilis</i>	EN		
HOLOTHUROIDEA	Golden Sandfish, Sandfish	<i>Holothuria scabra</i>	EN		
ACTINOPTERYGII	Sibayi Goby	<i>Silhouettea sibayi</i>	EN		
HOLOTHUROIDEA	Prickly Redfish	<i>Thelenota ananas</i>	EN		
CHONDRICHTHYES	Ornate Eagle Ray	<i>Aetomylaeus vespertilio</i>	EN		
CHONDRICHTHYES	Pelagic Thresher	<i>Alopias pelagicus</i>	EN	II	II
CHONDRICHTHYES	Honeycomb Izak Catshark	<i>Holohalaelurus favus</i>	EN		
CHONDRICHTHYES	Whitespotted Izak Catshark	<i>Holohalaelurus punctatus</i>	EN		

Class	Common name	Scientific name	IUCN	CMS	CITES
CHONDRICHTHYES	Shortfin Mako	<i>Isurus oxyrinchus</i>	EN	II	-
CHONDRICHTHYES	Largetooth Sawfish	<i>Pristis pristis</i>	CR		I
CHONDRICHTHYES	Whale Shark	<i>Rhincodon typus</i>	EN	I/II	II
CHONDRICHTHYES	Great Hammerhead	<i>Sphyrna mokarran</i>	CR		
CHONDRICHTHYES	Zebra Shark	<i>Stegostoma fasciatum</i>	EN		
REPTILIA	Green Turtle	<i>Chelonia mydas</i>	EN	I/II	I
REPTILIA	Hawksbill Turtle	<i>Eretmochelys imbricata</i>	CR	I/II	I
AVES	Madagascar Pond-heron	<i>Ardeola idae</i>	EN		
AVES	Cape Gannet	<i>Morus capensis</i>	EN		
AVES	African Penguin	<i>Spheniscus demersus</i>	EN	II	II
AVES	Indian Yellow-nosed Albatross	<i>Thalassarche carteri</i>	EN		
MAMMALIA	Blue Whale	<i>Balaenoptera musculus</i>	EN	I	I
MAMMALIA	Indian Ocean Humpback Dolphin	<i>Sousa plumbea</i>	EN		I

8.2.2 Criterion 2: Endemic and/or restricted-range species

Six endemic gastropods from the Bazaruto Archipelago are known to occur within the Study Area (BirdLife International, 2018). The presence of these endemic species triggers CH under Criterion 2, as the Bazaruto Archipelago supports $\geq 10\%$ of the global population size and ≥ 10 (all) reproductive units of these species (Figure 55).

The known extent of occurrence (EOO) of Indian Ocean Humpback Dolphin is 54,000 km² which puts it firmly in the restricted-range category (EOO of < 100,000 km² for marine species). Although the numbers of this species within the Study Area are not known, it is unlikely that the Study Area regularly holds $\geq 10\%$ of the global population size (1,000 – 9,000 individuals), although ≥ 10 reproductive units could potentially be present.

Table 15: Endemic/ restricted-range species occurring within the Study Area

Class	Common name	Scientific name	IUCN	CMS	CITES
GASTROPODA	Feathered Cone	<i>Conus pennaceus</i>	LC	-	-
GASTROPODA	-	<i>Epitonium pteroem</i>	NE	-	-
GASTROPODA	-	<i>Epitonium repandior</i>	NE	-	-
GASTROPODA	-	<i>Fusiaphera eva</i>	NE	-	-

Class	Common name	Scientific name	IUCN	CMS	CITES
GASTROPODA	-	<i>Limulata vermicola</i>	NE	-	-
GASTROPODA	-	<i>Thracia anchoralis</i>	NE	-	-

8.2.3 Criterion 3: Migratory and/or congregatory species

Seventy-seven migratory/congregatory faunal species could potentially occur in the Study Area (Table 16), including six shark/ray species, three sea turtles, 57 bird species, and 11 mammals (cetaceans).

Critical Habitat under Criterion 3 is triggered by congregations of migratory bird species associated with Bazaruto Archipelago IBA in the Study Area (Figure 55). Bazaruto Archipelago IBA, which lies within the Study Area, constitutes Critical Habitat on the basis of BirdLife International's Criterion A4² (which is aligned with the quantitative threshold for Critical Habitat designation under criterion 3) for congregations of the following species; Grey Plover *Pluvialis squatarola*, Lesser Sandplover *Charadrius mongolus*, Sanderling *Calidris alba*, Little Tern *Sternula albifrons*, Common Tern *Sterna hirundo*, and Lesser Crested Tern *Thalasseus bengalensis* (BirdLife International, 2018). BANP IBA has therefore been mapped as CH under Criterion 3 in the Study Area (Figure 55).

Although the seagrass beds of the Study Area support dugong (*D. dugon*) for both grazing and breeding purposes, the current population estimate of between 170 and 193 individuals (Gaylard and Monico, 2020) does not trigger the thresholds for Critical Habitat designation under Criterion 3 i.e. areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle, since the global population has been estimated in the tens of thousands (Marsh and Sobtzick, 2019). The Study Area is therefore also considered unlikely to support ≥ 10 percent of the global population of a species during periods of environmental stress. No critical habitat has therefore been mapped for this species on this basis.

Table 16: Migratory/congregatory species potentially occurring within the study area

Class	Common name	Scientific name	IUCN	CMS	CITES
CHONDRICHTHYES	Pelagic Thresher	<i>Alopias pelagicus</i>	EN	II	II
CHONDRICHTHYES	Common Thresher Shark	<i>Alopias vulpinus</i>	VU	II	-
CHONDRICHTHYES	Silky Shark	<i>Carcharhinus falciformis</i>	VU	II	II
CHONDRICHTHYES	Great White Shark	<i>Carcharodon carcharias</i>	VU	I/II	II
CHONDRICHTHYES	Shortfin Mako	<i>Isurus oxyrinchus</i>	EN	II	-
CHONDRICHTHYES	Longhorned Pygmy Devil Ray	<i>Mobula eregoodootenkee</i>	NT	I/II	II
REPTILIA	Loggerhead Turtle	<i>Caretta caretta</i>	VU	I/II	I

² BirdLife International Criterion A4, Congregations: The site is known or thought to hold congregations of $\geq 1\%$ of the global population of one or more species on a regular or predictable basis. This criterion can be applied to seasonal (breeding, wintering or migratory) congregations of any waterbird, seabird or terrestrial bird species. Sites can qualify whether thresholds are exceeded simultaneously or cumulatively, within a limited period.

Class	Common name	Scientific name	IUCN	CMS	CITES
REPTILIA	Leatherback	<i>Dermochelys coriacea</i>	VU	I/II	I
REPTILIA	Olive Ridley	<i>Lepidochelys olivacea</i>	VU	I/II	I
AVES	Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	LC	II	-
AVES	Red-billed Teal	<i>Anas erythrorhyncha</i>	LC	II	-
AVES	African Black Duck	<i>Anas sparsa</i>	LC	II	-
AVES	Yellow-billed Duck	<i>Anas undulata</i>	LC	II	-
AVES	Rufous-bellied Heron	<i>Ardeola rufiventris</i>	LC	II	-
AVES	Ruddy Turnstone	<i>Arenaria interpres</i>	LC	II	-
AVES	Sanderling	<i>Calidris alba</i>	LC	II	-
AVES	Curlew Sandpiper	<i>Calidris ferruginea</i>	NT	II	-
AVES	Little Stint	<i>Calidris minuta</i>	LC	II	-
AVES	Caspian Plover	<i>Charadrius asiaticus</i>	LC	II	-
AVES	Common Ringed Plover	<i>Charadrius hiaticula</i>	LC	II	-
AVES	Greater Sandplover	<i>Charadrius leschenaultii</i>	LC	II	-
AVES	White-fronted Plover	<i>Charadrius marginatus</i>	LC	II	-
AVES	Lesser Sandplover	<i>Charadrius mongolus</i>	LC	II	-
AVES	Chestnut-banded Plover	<i>Charadrius pallidus</i>	NT	II	-
AVES	Kittlitz's Plover	<i>Charadrius pecuarius</i>	LC	II	-
AVES	African Three-banded Plover	<i>Charadrius tricollaris</i>	LC	II	-
AVES	White-winged Tern	<i>Chlidonias leucopterus</i>	LC	II	-
AVES	Western Marsh-harrier	<i>Circus aeruginosus</i>	LC	II	II
AVES	White-faced Whistling-duck	<i>Dendrocygna viduata</i>	LC	II	-
AVES	Crab-plover	<i>Dromas ardeola</i>	LC	II	-
AVES	Peregrine Falcon	<i>Falco peregrinus</i>	LC	II	I
AVES	African Snipe	<i>Gallinago nigripennis</i>	LC	II	-
AVES	Rock Pratincole	<i>Glareola nuchalis</i>	LC	II	-

Class	Common name	Scientific name	IUCN	CMS	CITES
AVES	Collared Pratincole	<i>Glareola pratincola</i>	LC	II	-
AVES	African Fish-eagle	<i>Haliaeetus vocifer</i>	LC	II	II
AVES	Black-winged Stilt	<i>Himantopus himantopus</i>	LC	II	-
AVES	Caspian Tern	<i>Hydroprogne caspia</i>	LC	II	-
AVES	Common Little Bittern	<i>Ixobrychus minutus</i>	LC	II	-
AVES	Dwarf Bittern	<i>Ixobrychus sturmii</i>	LC	II	-
AVES	Bat Hawk	<i>Macheiramphus alcinus</i>	LC	II	II
AVES	Black Kite	<i>Milvus migrans</i>	LC	II	II
AVES	Yellow-billed Stork	<i>Mycteria ibis</i>	LC	II	-
AVES	Southern Pochard	<i>Netta erythrophthalma</i>	LC	II	-
AVES	Eurasian Curlew, Curlew	<i>Numenius arquata</i>	NT	II	-
AVES	Whimbrel	<i>Numenius phaeopus</i>	LC	II	-
AVES	Osprey	<i>Pandion haliaetus</i>	LC	II	II
AVES	Great White Pelican	<i>Pelecanus onocrotalus</i>	LC	I/II	-
AVES	Lesser Flamingo	<i>Phoeniconaias minor</i>	NT	II	II
AVES	African Spoonbill	<i>Platalea alba</i>	LC	II	-
AVES	Spur-winged Goose	<i>Plectropterus gambensis</i>	LC	II	-
AVES	Glossy Ibis	<i>Plegadis falcinellus</i>	LC	II	-
AVES	Grey Plover	<i>Pluvialis squatarola</i>	LC	II	-
AVES	Spotted Crake	<i>Porzana porzana</i>	LC	II	-
AVES	Pied Avocet	<i>Recurvirostra avosetta</i>	LC	II	-
AVES	African Skimmer	<i>Rynchops flavirostris</i>	NT	II	-
AVES	African Comb Duck	<i>Sarkidiornis melanotos</i>	LC	II	II
AVES	Little Tern	<i>Sternula albifrons</i>	LC	II	-
AVES	Lesser Crested Tern	<i>Thalasseus bengalensis</i>	LC	II	-
AVES	Greater Crested Tern	<i>Thalasseus bergii</i>	LC	II	-

Class	Common name	Scientific name	IUCN	CMS	CITES
AVES	Wood Sandpiper	<i>Tringa glareola</i>	LC	II	-
AVES	Common Greenshank	<i>Tringa nebularia</i>	LC	II	-
AVES	Green Sandpiper	<i>Tringa ochropus</i>	LC	II	-
AVES	Marsh Sandpiper	<i>Tringa stagnatilis</i>	LC	II	-
AVES	Common Redshank	<i>Tringa totanus</i>	LC	II	-
AVES	White-headed Lapwing	<i>Vanellus albiceps</i>	LC	II	-
AVES	Wattled Lapwing	<i>Vanellus senegallus</i>	LC	II	-
MAMMALIA	Bryde's Whale	<i>Balaenoptera edeni</i>	LC	II	I
MAMMALIA	Dugong	<i>Dugong dugon</i>	VU	II	I
MAMMALIA	Southern Right Whale	<i>Eubalaena australis</i>	LC	I	I
MAMMALIA	Humpback Whale	<i>Megaptera novaeangliae</i>	LC	I	I
MAMMALIA	Killer Whale	<i>Orcinus orca</i>	DD	II	II
MAMMALIA	Sperm Whale	<i>Physeter macrocephalus</i>	VU	I/II	I
MAMMALIA	Pantropical Spotted Dolphin	<i>Stenella attenuata</i>	LC	II	II
MAMMALIA	Striped Dolphin	<i>Stenella coeruleoalba</i>	LC	II	II
MAMMALIA	Spinner Dolphin	<i>Stenella longirostris</i>	DD	II	II
MAMMALIA	Indo-Pacific Bottlenose Dolphin	<i>Tursiops aduncus</i>	NT	II	II
MAMMALIA	Common Bottlenose Dolphin	<i>Tursiops truncatus</i>	LC	I/II	II

8.3 Ecosystem Triggers of CH

Ecosystem triggers of CH within the Study Area are illustrated on Figure 55.

8.3.1 Criterion 4: Highly threatened and/or unique ecosystems

Seagrass beds within the Study Area could qualify on the basis of their support of unique assemblages of species, as well as potentially being at risk of significantly decreasing in area or quality (IFC, 2019); however the mapped extent of seagrass in the Study Area does not trigger the quantitative threshold of $\geq 5\%$ of the global extent of an ecosystem set for Criterion 4.

8.3.2 Criterion 5: Key evolutionary processes

The islands of the Bazaruto Archipelago support at least six species of endemic marine gastropod that are phylogenetically distinct (see Section 8.2.2), and several terrestrial lizard species have been identified as being endemic to the Bazaruto Archipelago, such as *Scelotes duttoni* and *Lygosoma lanceolatum*) (BirdLife

International, 2018; Broadley, 2008). However, *Lygosoma lanceolatum* is a synonym of *Mochlus lanceolatus* – broadley’s Writhing skink, and its mapped distribution includes the northern reach of the mainland San Sebastian Peninsula (Conradie et al., 2019a), *S. duttoni* is known only from Benguera, but further research on this species distribution is required (Conradie et al., 2019b).

However, reptile taxonomy in Africa is continuously changing as modern molecular genetic techniques are applied to differentiate species. As a result, species thought to have restricted distributions can have much more restricted ranges, or vice versa. The species mentioned above have not been assessed by IUCN and their EOO has not been determined, and reptiles in the region remain understudied.

The islands of the Bazaruto Archipelago are relatively young, and peninsular in origin, and are likely not yet old enough for significant speciation or key evolutionary processes to have taken place (Downs and Wirminghaus, 2008). In addition, the islands do not lie very far offshore, and the intervening sea does not pose a great obstacle to colonisation (Downs and Wirminghaus, 2008). Critical habitat was therefore not identified under this Criterion.

8.4 Natural and Modified Habitats

All of the marine and coastal ecosystems of the Study Area; i.e. seagrass beds, coral outcrops, mangroves and primary dunes with sandy beaches are categorised as natural habitats per the definition provided in paragraph 13 of IFC GN6 (IFC, 2019).

The beach habitat adjacent to urban areas (Vilanculos, Inhassoro) of the coastal region of the Study Area is considered modified, primarily due to the transformation of the dune habitat by residential developments, and degradation of the beach tidal zone by fishing activities (particularly seine netting) with concomitant effects on the expected species composition – for example, the beach is not considered important for nesting turtles, compared to nearby undisturbed natural primary dune and sandy beach habitats e.g. on Bazaruto Island, and typical coastal dune vegetation has been lost/degraded.

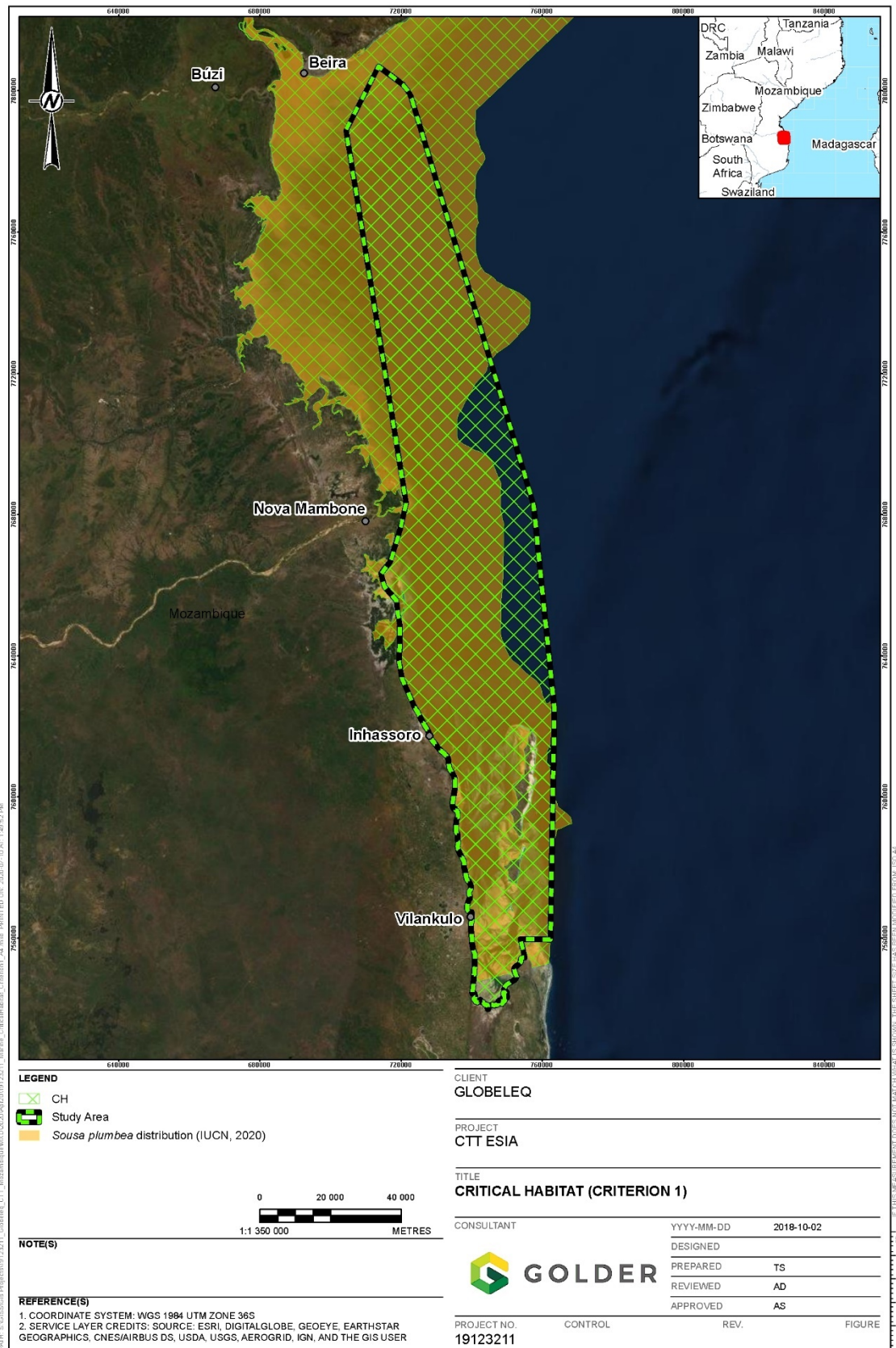


Figure 54: Potential Critical Habitat (Criterion 1)

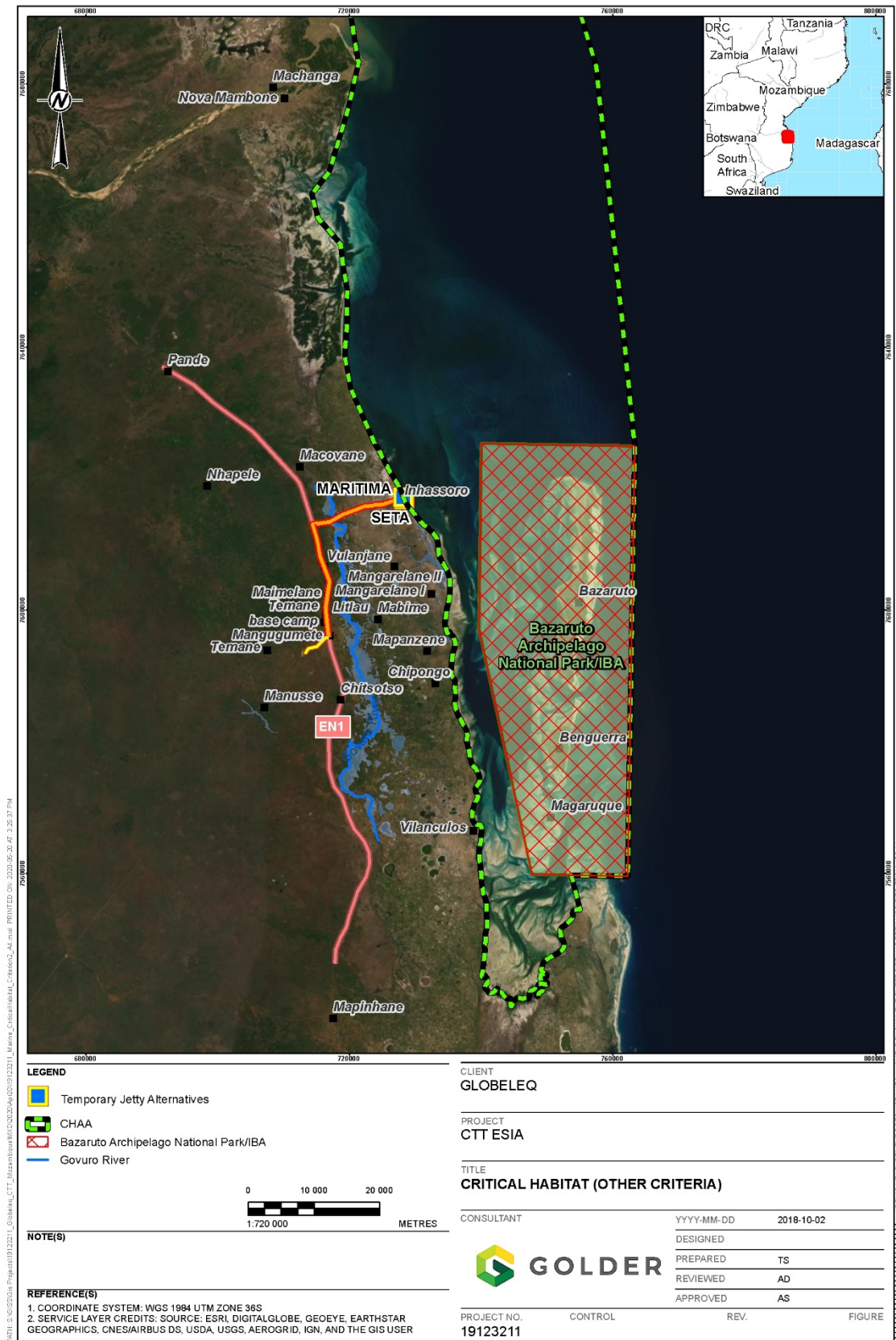


Figure 55: Critical Habitat (Criterion 2)

8.5 Summary

The species and ecosystems for which critical and natural habitat have been identified in the Study Area, are summarised in Table 17.

Table 17: Summary of species triggering critical habitat, and natural habitat in Study Area

Triggering Criterion	Species / ecosystem	Area of critical / natural habitat in study area
1	Indian Ocean Humpback Dolphin	Study area, plus known distribution (IUCN, 2020)
2	Endemic gastropods: <i>Conus pennaceus</i> , <i>Epitonium pteroen</i> , <i>Epitonium repandior</i> , <i>Fusiaphera eva</i> , <i>Limulata vermicola</i> , <i>Thracia anchoralis</i>	Bazaruto Archipelago National Park
3	Congregations of migratory species including: Grey Plover <i>P. squatarola</i> , Lesser Sandplover <i>C. mongolus</i> , Sanderling <i>C. alba</i> , Little Tern <i>S. albifrons</i> , Common Tern <i>S. hirundo</i> , Lesser Crested Tern <i>T. bengalensis</i>	Bazaruto Archipelago IBA
Natural habitat	seagrass beds	A probable possible seagrass bed occurs in deeper water approximately two km from shore
	coral outcrops	A possible outcrop approx. 9.49 km ² in extent occurs to the northwest of BANP boundary
	mangroves	concentrated in the Mangarelane area of the Study Area, approximately 20 km south of the proposed temporary jetty sites
	primary dunes with sandy beaches	All such habitat in the Study Area, with the exception of modified primary dune and sandy beach habitat adjacent to urban areas (Vilanculos, Inhassoro)

9.0 IMPACT ASSESSMENT

9.1 Receptors for Impact Assessment

Receptors for Impact Assessment were selected based on their confirmed presence in the Study Area and capacity to trigger Critical Habitat (species and ecosystems); ecosystems that constitute 'natural' habitat as defined by IFC (2012b); protected ecosystems and nationally-protected species were also included. All selected receptors for impact assessment are summarised in Table 18.

Table 18: Marine ecology receptors for impact assessment

Project Component	Receptors	Reasoning
Temporary jetty	Beach-nesting turtles	Nationally-protected
	Primary dunes and sandy beaches	Nationally-protected
	Seagrass beds	Natural habitat
	Dugong	Nationally-protected
Barge movements	Coral reef	Natural habitat
	Indian Ocean Humpback Dolphin	Nationally-protected, CH triggering
	Dugong	Nationally-protected
	Seagrass beds	Natural habitat
	Capture fisheries (artisanal)	Priority ecosystem service
	Tourism	Priority ecosystem service

9.2 Identified impacts – Temporary Jetty Sites

It should be noted that the temporary jetty site and associated transshipment and barging activities will all take place during the CTT project construction phase. The impacts below are however, separated into the site-specific construction, operational and decommissioning impacts for each of the temporary jetty sites, anchorage points and barging activities, as relevant.

9.2.1 Construction impacts

The construction of the preferred temporary jetty site will involve the construction of a new jetty from the beach into the water (see Figure 7, Figure 32), which will either be 14 m wide x 100 m long (1400 m²), or 20m wide x 80m long (1600 m²). The chosen temporary jetty site will also require some road upgrades from the temporary jetty site along the chosen route to the CTT site. Although the proposed sites are currently or have in the past, been used for beach access, the upgrade of the access roads will result in additional disturbance and loss of primary dune habitat; in addition, the construction of the jetty will result in the loss of a minimum of 1400-1600 m² of sandy beach habitat. In the context of the extent of this habitat in the Study Area, the potential impact could be of moderate intensity, with the loss being medium-term, persisting until such a time as the temporary jetty site has been removed (after 12-15 months) and natural beach formation and sedimentation processes have been resumed. Impacts would be restricted to the extent of the temporary jetty sites, and the impact is considered definite. Prior to mitigation, the significance of the impact of loss of natural primary dune and sandy beach habitat will be moderate. The application of the required mitigation measures reduces the intensity of the impact to low, as well as the probability of the impact occurring, resulting in a residual impact of low significance.

The use of anchors for installation of the cable based mooring system could result in reduction in extent or condition of seagrass beds. In the context of the extent of this habitat in the Study Area, the potential impact would be of low intensity, with the loss being medium-term, persisting until such a time as the temporary jetty site has been removed (after 12-15 months). Impacts would be restricted to the extent of the anchor sites. Prior to mitigation, the significance of the impact of on seagrass beds will be low. The application of the required

mitigation measures further reduces the intensity of the impact, ensuring that the residual impact is of low significance.

Since the proposed sites are already being regularly used for beach access for boats, it is unlikely that these areas are important turtle nest sites due to existing levels of disturbance. Therefore, the likelihood of direct impacts of loss of nest sites, or mortality or injury of nesting turtles or incubating eggs as a result of construction activities (e.g. site clearance, earthworks) is considered low. Should the impact occur, it could be of medium intensity, since loss of individuals of CR or EN beach-nesting turtles (Green Turtle, Hawksbill Turtles), could represent a moderate proportion of the overall population of these species in the Study Area. The duration of the impact would be long-term and would need to be considered at an at least national extent, since the affected species are nationally protected, as well as being of global conservation concern. The application of the required mitigation measures may reduce the intensity of the impact, and the probability of its occurrence, resulting in a residual impact of still low significance, but with a lower score.

Indirect effects to faunal species of concern (nesting turtles, dugong) could occur as a result of noise generated by the presence of people and heavy machinery, and site lighting at night. These disturbances could create a barrier to movement and dispersal of faunal species of conservation concern, particularly nesting turtles, if present. Since the proposed temporary jetty sites are unlikely to constitute important turtle nest sites due to existing levels of disturbance, the likelihood of any impacts on nesting turtle species is considered low. Similarly, any sensory disturbances to dugong as a result of the construction activity is considered unlikely, since they generally do not occur in near shore parts of the Study Area. The impact would be short-term in nature, and would need to be considered at the national extent, since the affected species are nationally protected. The application of the required mitigation measures could reduce the probability of the predicted impacts occurring, resulting in a Project impact of low residual significance.

The hunting of turtles for meat has been noted in the Study Area (see Section 5.3.9). There is a potential that construction workers or influx of people attracted to the construction sites (e.g. people seeking employment or opportunities) could increase hunting pressure on beach-nesting turtles within the Study Area. In many cases, once job/opportunity seekers have arrived and settled, they may stay for indefinite periods of time. Should the impact occur, it could be of high intensity, since loss of individuals of CR or EN beach-nesting turtles (Green Turtle, Hawksbill Turtles) through hunting could affect a high proportion of the overall population of these species in the Study Area. The duration of the impact would be permanent, as opportunity-seekers may remain at/near the sites beyond their operational lifetime, and would need to be considered at an at least national extent, since the affected species are nationally protected, as well as being of global conservation concern. The probability of the impact occurring as predicted is considered high, resulting in an impact of moderate significance prior to mitigation. The application of the required mitigation measures (particularly appropriate population influx management and education programmes) could reduce the intensity of hunting pressure as well as the probability of the predicted impacts for nesting turtles; however the effectiveness of these measures would need to be monitored into the future.

The accidental capture of Dugong as bycatch in nets has been reported by fishers in the Study Area (Guissamulo, 2016). There is a potential that construction workers or people attracted to the construction sites (e.g. people seeking employment or opportunities) could increase fishing pressure in the Study Area, and thus the likelihood of Dugong becoming captured as bycatch. The potential impact could be of moderate intensity, affecting a significant proportion of the overall population of Dugong in the Study Area. The duration of the impact would be permanent, as opportunity-seekers may remain at/near the sites beyond their operational lifetime, and would need to be considered at the national extent, since Dugong are nationally protected. The probability of the impact occurring as predicted is considered high, resulting in an impact of moderate significance prior to mitigation. The application of the required mitigation measures (particularly appropriate population influx management) could reduce the probability of the predicted impacts occurring, resulting in a

Project impact of low residual significance – although it is noted that subsistence/commercial fishing and thus accidental dugong bycatch is likely to continue in the Study Area, despite the project's best efforts.

Required mitigation measures

- New areas of primary dune and beach habitat disturbance and associated vegetation clearance should be minimised wherever possible. Areas proposed for vegetation clearance should be clearly marked and no heavy vehicles should travel beyond the marked works zone.
- Any areas of disturbance along the access track to the temporary jetty should be stabilised and revegetated with appropriate indigenous coastal dune species (e.g. *Scaevola plumieri*, *Carpobrotus dimidiatus*). If present, these should be rescued from affected areas immediately prior to construction activities and maintained in a nursery until rehabilitation work can commence. Alternatively seeds/plugs of local indigenous vegetation could be locally harvested, or sourced from nurseries, and transplanted to the disturbed areas.
- Should the cable mooring system be deployed, a diver should assist in the placement of anchors to avoid or minimise interactions with sensitive habitat such as seagrass beds.
- The Proponent must implement measures to minimise impacts arising from sensory disturbance caused by human presence and mechanical noise generated during construction activity. These should include restrictions in operating hours for heavy machinery, use of low-pitched reverse alerts, and restriction of movement of construction workers and vehicles to demarcated areas where construction will take place. The use of site lighting at night should be avoided; if absolutely necessary for security reasons, directional lighting minimising spillage to adjacent environments should be used.
- Although it is considered highly unlikely that the beach where the temporary jetty will be used by nesting turtles, the construction site should be checked for any evidence of turtle presence early every morning. In the event that a turtle or a turtle nest site is discovered prior to or during construction, the nest site should be demarcated, access restricted, and through the Centro Terra Viva, an appropriate specialist should be brought to site to advise on a suitable plan of action. The presence of any nests must be reported to the Centro Terra Viva which coordinates the national Mozambican turtle monitoring program (Fernandes et al., 2017).
- The Proponent must enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel.
- Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool-box talks.
- Ecological clerk of works (ECOW) to be appointed for duration of construction works.
- The Proponent must enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel.
- The Contractor's Social Officers, in conjunction with the Sponsors HSE Manager and Community Liaison Officer will regularly communicate with stakeholders at the temporary jetty site, as well as District authorities (as well as others where required), so as to keep them informed of planned works and activities at the temporary jetty site. This will include communicating with locals and the community about project progress, awareness as well informing them of the mechanisms in place for communications and lodging grievances via the community grievance mechanism.
- The development of worker and community education programmes by the Proponent and Contractor(s), which focus on the value of conservation of species such as sea turtles and dugong, and the generation

of tourism potential, can contribute to the alleviation of hunting pressure on affected fauna species and reduce local people’s reliance on consumption of bush meat.

- An Influx Management Plan for the Project will be implemented to manage access control, prevent unplanned growth in housing development and promote regional economic development, at the same time reducing pressure on ecosystems of concern and associated species for provision of natural resources.
- The Contractor and Sponsor will ensure that the HSESS Construction Management Plan and its overarching requirements are carried out for the barging, temporary jetty activities and onward road transport of equipment to the CTT site.

Table 19: Temporary jetty sites – construction impacts

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
<i>Loss of protected habitat (primary dunes and sandy beaches)</i>	6	3	1	5	Moderate 50	4	3	1	3	Low 24
<i>Reduction in extent or condition of seagrass beds</i>	2	3	1	4	Low 28	1	3	1	3	Low 15
<i>Direct injury/mortality of nesting turtles/eggs</i>	6	4	5	2	Low 30	4	4	5	1	Low 13
<i>Indirect injury/mortality of nesting turtles/eggs</i>	6	5	5	4	Moderate 64	6	5	5	2	Low 32
<i>Sensory disturbances to turtles and dugong</i>	4	1	2	3	Low 21	2	1	2	2	Low 10
<i>Indirect injury/mortality of Dugong</i>	6	5	4	4	Moderate 68	6	5	4	2	Low 30

9.2.2 Operational impacts

The operation of the temporary jetty site will involve barging of large project components to shore, from where they will be transported via road to a laydown area, and then to the CTT site itself. It is anticipated that a maximum of 3 components could be shipped in a week to the site, thus Option 1 (Gas Turbines) would take 20 weeks (Chapter 2.0, Project Description), suggesting that the temporary jetty site will be used on up to 10 occasions, over the course of a minimum of 20 weeks (5 months), with the actual duration likely to be extended due to the waiting period of up to 3-4 months between some of the shipments. It is likely that the total duration could be between 8-15 months with long periods of no activity.

For each barge shipment, three separate road convoys will be required to transport the project components to site. Typically, one road convoy will use a low load multi-axle trailer, driven by 2 haulers (Figure 56).

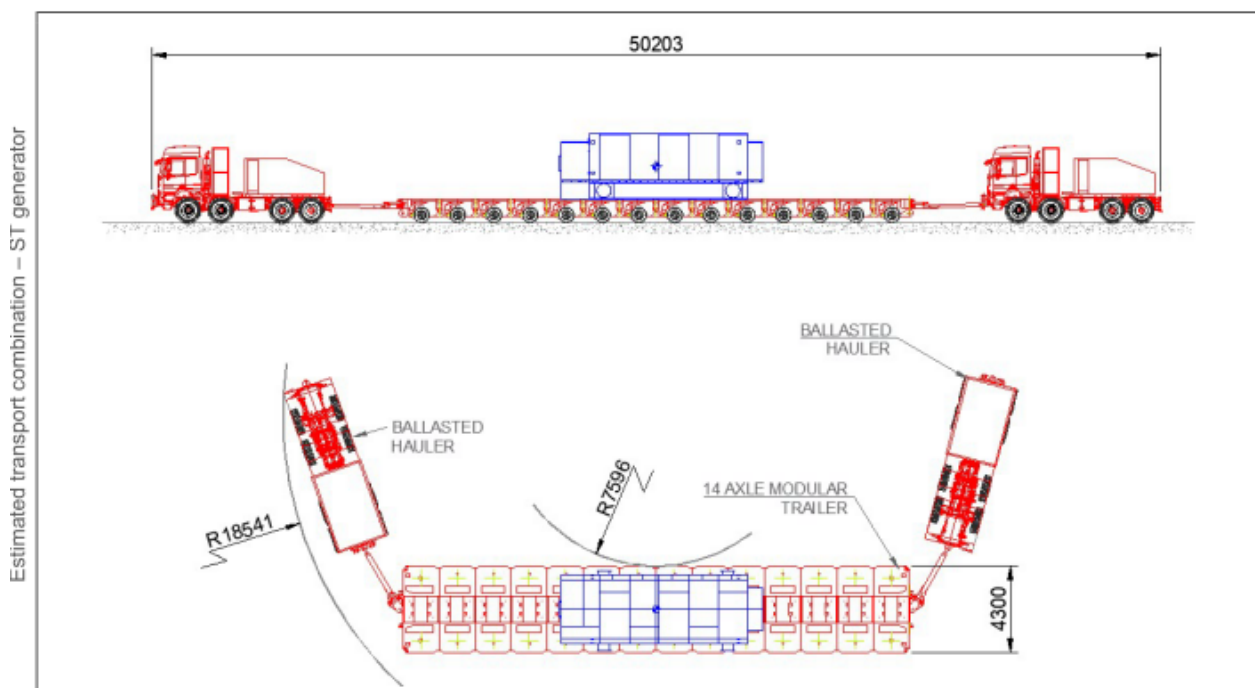


Figure 56: Road convoy details

The operation of the temporary jetty site could cause alteration of local hydrodynamics due to the presence of the jetty, influencing sediment transport, erosion and accretion on Primary dune and sandy beach habitat. The intensity of the potential impact could be moderate, and the duration short-term, persisting for the duration of the use of the temporary jetty. Impacts are likely to affect local sediment transport dynamics, potentially causing sand erosion on the up-shore side of the jetty, and accretion down-shore of the jetty. The application of the required mitigation measures can reduce the intensity of potential impacts as well as the probability of them occurring in the first place, reducing the residual impact to one of low significance.

During operation, deterioration of water quality and benthic sediment as a result of contamination with hydrocarbon fuels, oils and/or lubricants from barges and heavy equipment is probable. The intensity of the potential impact could be moderate, and the duration short-term, persisting for the duration of the use of the temporary jetty. Impacts are likely to affect local water and sediment quality. The application of the required mitigation measures can reduce the intensity of potential impacts as well as the probability of them occurring in the first place, reducing the residual impact to one of low significance.

Discharge of ballast water could result in the introduction and/or spread of invasive marine algae (e.g. *Acanthophora spicifera*, *Gracilaria salicornia*), which have the potential to substantially alter natural sandy beach or seagrass habitats. The intensity of the potential impact could be high, causing changes to a high proportion of affected ecosystems of concern (sandy beaches, seagrass beds) within the Study Area. The duration of the impact would be permanent and would extend regionally; there is a high likelihood that this impact could occur within the Study Area without appropriate management and mitigation. The application of the required mitigation measures can reduce the probability of the impact occurring in the first place; however, the intensity and likely extent of potential impacts remain the same, resulting in a residual impact of still moderate significance.

During the temporary jetty operations, which will be for a day or two at a time, it is not expected that there will be any impact on neighbouring properties (commercial and some residential) due to the limited extent of the activities. The road transport impacts have already been assessed in the Traffic Impact Assessment (TIA) report

and identified impacts will be managed under the Traffic and Transport Management Sub-Plan and the Abnormal Loads Transport Sub-Plan.

Required mitigation measures

- Monitor erosion and accretion of sands on either side of the jetty and employ appropriately designed engineering measures to prevent any significant impacts on sandy beach habitat upshore and downshore of the jetty where necessary. Designs for engineered measures should be approved by the permitting authority, prior to construction.
- Restore beach landform to its original setting, following removal of the temporary jetty.
- Routes for transfer of heavy equipment should be clearly marked and no heavy vehicles should travel beyond the marked works zone. Transport of the equipment during offloading from the barge and onward road transport to the CTT site will be managed by the Traffic and Transport Management Sub-Plan and the Abnormal Loads Transport Sub-Plan.
- Prohibit access to personnel outside of the defined access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing toolbox talks.
- Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transshipment vessels and heavy equipment are minimised. Daily maintenance and monitoring checks of vessels should be conducted with spill kits available on site. The use of biofuel for barges or tugboats is recommended.
- Frequent monitoring of marine water and sediment quality should be implemented for the duration of transshipment and barging activities, temporary jetty site and the designated barging route between them.
- The barge should be sourced from a low risk country (in terms of ballast water contamination), with reduced risk locations being those in closest proximity to the Study Area (e.g. South Africa, Kenya).
- Strict controls on ballast water management for both barges and transshipment vessels must be enforced by The Proponent, in line with the relevant MARPOL standards (see Section 3.2). High risk ballast water (that coming from ports and coastal waters outside of Bazaruto Bay) should not be discharged by barges and/or transshipment vessels, under any circumstances. Tank-to-tank transfer of ballast water should be enforced for all barges and transshipment vessels associated with the Project, and should be documented and monitored by The Proponent at all times.
- Monitoring for the introduction and/or spread of invasive marine algal and faunal species should be conducted on a regular basis for the duration of barging and transshipment activity.

Table 20: Temporary jetty sites – operational impacts

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	intensity	Duration	Geographic Extent	Probability	Significance	intensity	Duration	Geographic Extent	Probability	Significance
<i>Alteration of hydrodynamics - Loss/ disturbance of natural habitat (primary dunes and sandy beaches)</i>	6	2	2	5	Moderate 50	4	3	1	3	Low 24

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	intensity	Duration	Geographic Extent	Probability	Significance	intensity	Duration	Geographic Extent	Probability	Significance
<i>Compaction from access roads – permanent loss/disturbance of natural habitat (primary dunes and sandy beaches)</i>	4	2	1	5	Low 35	4	2	1	3	Low 24
<i>Water and benthic contamination from petroleum, oils and lubricants (primary dunes and sandy beaches, seagrass beds)</i>	6	2	2	5	Moderate 50	4	2	2	2	Low 16
<i>Ballast discharge – spread of invasive species - Loss/disturbance of natural habitat (primary dunes and sandy beaches, seagrass beds)</i>	8	5	3	4	Moderate 64	8	5	3	3	Moderate 48

9.2.3 Decommissioning impacts

The decommissioning of the temporary jetty site will involve the removal of the jetty structure, leaving a minimum footprint of 1400-1600 m² in the sandy beach habitat zone. Over time, natural hydrodynamic patterns will re-establish and ultimately, the affected area is expected to be restored to a sandy beach habitat, while recognising that the habitat is unlikely to be restored to its exact baseline condition. Disturbances arising during decommissioning will be transient and local, with the significance of predicted impacts expected to be low. The significance of predicted impacts can be further reduced through the application of the required mitigation measures.

The removal of the jetty infrastructure and associated heavy vehicle works is likely to cause some transient water quality and benthic contamination with sediment, and potentially petroleum, oils and lubricants. Following completion of decommissioning, the intensity of the impact is expected to be low, and site based only, resulting in a residual impact of low significance.

Required mitigation measures

- The extent of sandy beach habitat disturbance should be minimised wherever possible. Areas proposed for works should be clearly marked and no heavy vehicles should travel beyond the marked works zone.
- Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks.
- Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transshipment vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels should be conducted, with spill kits available on site.

Table 21: Temporary jetty sites – decommissioning impacts

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	intensity	Duration	Geographic Extent	Probability	Significance	intensity	Duration	Geographic Extent	Probability	Significance
<i>Alteration of hydrodynamics - Loss/disturbance of natural habitat (primary dunes and sandy beaches)</i>	4	1	2	5	Low 35	4	1	1	3	Low 18
<i>Water and benthic contamination from petroleum, oils and lubricants (primary dunes and sandy beaches, seagrass beds)</i>	6	1	2	5	Moderate 45	4	1	1	3	Low 18

9.3 Identified impacts – Barge Movements

Large heavy equipment and components required for the construction of the power plant will be transferred from the transshipment vessel onto a barge inside the Port of Beira. The barge, which is capable of moving on the high tide will navigate by being towed by a tugboat into very shallow water adjacent to the beach to offload its cargo onto the temporary jetty at the preferred temporary jetty site of Maritima. As the tide subsides, the barge rests on the sand and the equipment will be off-loaded.

A maximum of 3 components could be shipped in a week to the site, thus Option 1 (Gas Turbines) would take 20 weeks (Chapter 2.0, Project Description), suggesting that barging will be required on at least 7-10 occasions, over the course of a minimum of 20 weeks (5 months), with the actual duration likely to be extended due to the waiting period of up to 3-4 months between some of the shipments. The actual number of barging movements is not expected to be greater than 7-10 movements, depending on the size of the load that the barges can transport. It is likely that the total duration could be between 12-15 months with long periods of no activity.

9.3.1 Construction impacts

No construction phase impacts are anticipated, other than those already addressed for the temporary jetty.

9.3.2 Operational impacts

The movements of the barges from the Port of Beira to the temporary jetty will cross Dugong habitat north of Bazaruto Archipelago National Park, with the potential to separate some of the largest feeding grounds of the north from other feeding grounds and/or preferred breeding habitats of the south as a result of acoustic and/or physical disturbances, creating barriers to movement for this species. The intensity of the potential impact on Dugong movements could be high and are considered at the national scale given the level of protection assigned to this species in Mozambique; but the impacts will be transient, only occurring at disjunct times of barge movements. The probability of the impact occurring is assessed as being moderate, resulting in an impact of moderate significance prior to mitigation. The application of the required mitigation measures, specifically the presence of a Certified Marine Mammal Observer on all barge movements, reduces the intensity of the potential impact, resulting in a residual impact of low significance.

Barge strikes are possible, as Dugong are slow moving (average 10 kmph, typically 5-8 kmph, short bursts of up to 20 kmph) and are typically concentrated in shallow waters (< 5 m depth) where seagrass beds occur. Barge strikes could also affect the *Endangered* Indian Ocean Humpback Dolphin, which is resident in the coastal waters of the Study Area. The intensity of the potential impact is high, and effects would be long-term, lasting until such a time as Dugong/Indian Ocean Humpback Dolphin recovered from the loss of the affected individuals. The potential effect is assessed at the national scale for nationally-protected Dugong, and at the international scale for the globally *Endangered* Indian Ocean Humpback Dolphin. Prior to mitigation measures being implemented, there is a low probability of barge strike for Dugong; barge strikes are considered improbable for Indian Ocean Humpback Dolphin which is a faster-swimming, more agile species. Impacts on Dugong and Indian Ocean Humpback Dolphin prior to mitigation are Moderate. The strict application of the required mitigation measures, specifically strict speed restrictions of 5km/h such that the boats would be traveling slower than the speeds of the mammals, as well as the presence of a Certified Marine Mammal Observer on all barge movements, further reduces the likelihood of any potential impacts occurring for both species, resulting in residual impacts of low significance.

The barge movements may cause seabed scour in areas of shallower water, which could affect natural habitat including seagrass beds and coral outcrops. The expected laden draught (± 600 tons) of the barge is 2.0 m; Assuming the width of the area of disturbance to be approximately 50 m, a total area of 40 - 60 m² could be affected by the barge as it approaches the shore in waters less than 2.0 m in depth, and seagrass may be present in part of this area; however the barge will be moved to shore during the high-tide to prevent contact with the seabed during barging, therefore no significant scouring effect on the sea floor is anticipated. In the context of the extent of this habitat in the Study Area, the potential impact could be of low intensity, with the loss being short-term for seagrass beds persisting until such a time as the barge movements cease (after approximately 12-15 months) and seagrass beds recover; and medium-term for coral outcrops. Impacts would be at the local extent, and are considered definite. Prior to mitigation, the significance of the impacts on sea grass and coral may be moderate. The application of the required mitigation measures reduces the intensity of the impact to low, as well as the probability of the impact occurring, resulting in a residual impact of low to negligible significance.

The movement of the barge in Bazaruto Bay could hamper the movement of boat-using artisanal fishers in the bay, and when docked, could impinge on the ability of shore-based artisanal fishers to draw in seine nets. This could result in a temporary impact on the livelihoods of affected fishers, and the well-being of people who rely on purchasing that fish from markets for consumption. Similar effects could also be felt by local boat operators providing recreation and ecotourism services (e.g. fishing charters, snorkel/scuba trips) operating out of Inhassoro in particular. The impact on both of the priority ES is expected to be of low intensity, transient and

local in extent, with a moderate probability of occurring, given the few expected barge movements over the course of 12-18 months. An impact of low significance prior to mitigation is predicted for both ES. The application of the recommended mitigation measures will further minimise any potential impacts to low-negligible significance.

Required Mitigation Measures

- Strict speed restrictions must be enforced on barges to protect Dugongs (and Indian Ocean Humpback Dolphin) from vessel collision in Bazaruto Bay. The maximum allowable speed should be < 5 kmph to allow Dugong to move out of the way of oncoming vessels, minimising the risk of collision. This is below the 10 knot speed limit site within the BANP.
 - The rationale for reducing the vessel speed to < 5 kmph (< 2.7 knots) in order to reduce the risk of a harmful collision is based upon research conducted by the Florida Fish and Wildlife Conservation Commission and consultation with Dr Vic Cockcroft (*pers.comm.*). Calleson and Frohlich's (2007) and Laist and Shaw's (2006) papers on manatee considered vessel size and speed, concluding that slower speeds allow biota to detect and respond to the vessels, while the boat operators have more time to see biota and take avoidance actions. It is generally accepted that *minimum wake speed* should be maintained in sensitive areas (not to exceed 3 knots) (Calleson and Frohlich, 2007; Work *et al.*, 2010)
- A Certified Marine Mammal Observer (MMO) must be employed by the Proponent or the Contractor responsible for such activities to observe and monitor all barge and transshipment movements. The MMO should hold a current MMO mitigation training certificate, and have demonstrable ability and experience in identifying the specific SoC (in this case Dugong and Indian Ocean Humpback Dolphin) for which mitigation measures apply. Any sightings of SoC should be documented according to standardised data-collection methods, to prove compliance with mitigation requirements and contribute to scientific databases – e.g. that held by BANP. The MMO will have authority to influence the speed and direction of vessel movements where any potential risks to marine mammals are identified.
- The presence of an MMO on the tug boat/work boat vessels accompanying the barge is compulsory.
- Barges and associated tug boats/work boats must be routed via specific vessel lanes/channels that avoid natural habitats including seagrass beds and coral outcrop. These routes needed to be clearly marked with buoys (no Styrofoam to be used). Ground-truthing the preliminarily mapped extent and condition of seagrass and coral outcrop will be required prior to the commencement of barge movements to inform final route selection.
- Strict controls on ballast water management for both barges and accompanying tug boats/work boats must be enforced by The Proponent, in line with the relevant MARPOL standards. High risk ballast water (that coming from ports and coastal waters outside of Bazaruto Bay) should not be discharged within the Study Area under any circumstances. Tank-to-tank transfer of ballast water should be enforced for all barges and tug boats/work boats associated with the Project and should always be documented and monitored.
- The Contractor's Social Officers, in conjunction with the Sponsors HSE Manager and Community Liaison Officers will need to clearly communicate with local fishers and boat operators launching out of sites in proximity to the temporary jetty locations so that operators can plan trips around the proposed barge movements and avoid any interference if necessary. This will include communicating with locals and the community about project progress, awareness as well informing them of the mechanisms in place for communications and lodging grievances via the community grievance mechanism.

Table 22: Barge and transshipment vessel movements - operational impacts

Indicator of potential impact	Pre-mitigation					Post-mitigation				
	Intensity	Duration	Geographic Extent	Probability	Significance	Intensity	Duration	Geographic Extent	Probability	Significance
Barrier to movement (Dugong)	8	1	4	3	Moderate 52	4	1	4	3	Low 27
Barge collisions causing injury/mortality (Dugong)	8	4	4	2	Moderate 32	4	4	4	1	Low 12
Barge collisions causing injury/mortality (Indian Ocean Humpback Dolphin)	8	4	5	1	Low 17	4	4	5	1	Low 13
Loss/disturbance of natural habitat (seagrass beds)	2	2	2	5	Moderate 30	2	2	1	3	Low 15
Loss/disturbance of natural habitat (coral)	4	3	2	5	Moderate 45	1	3	1	1	Negligible 5
Capture fisheries	4	1	2	3	Low 21	2	1	2	2	Negligible 10
Recreation and ecotourism	4	1	2	3	Low 21	2	1	2	2	Negligible 10

9.3.3 Decommissioning phase impacts

No decommissioning phase impacts are anticipated.

9.4 Cumulative Impacts

The construction and operation of the temporary jetty site and associated barging movements will add to cumulative impacts on species and ecosystems of concern in the Study Area. The potential contribution of the Project to indirect/induced effects, i.e. population influx and increased fishing pressure in Bazaruto Bay, may be more significant for Dugong populations due to increased rates of accidental bycatch, than mitigable direct impacts such as vessel strikes. Although mortality rates have been estimated at two to four individuals a year in the Greater Bazaruto Archipelago (Findlay *et al.*, 2011), the values are likely under-estimated, and the actual rate is likely to be greater. Greater intensity of beach seine netting by the increased population could also result in increased degradation of seagrass habitat, reducing available foraging habitat for dugong (Provancha and Stolen, 2008).

Although residual impacts of low-negligible significance for collision risk to Dugong and Indian Ocean Humpback Dolphin are predicted following implementation of the required mitigation measures, they may still contribute to the cumulative effects of increased boat traffic in Bazaruto Bay that is being generated by the growth of tourism in the area (Murie *et al.*, 2016); the presence of the barges being towed by a tugboat may contribute to increased

acoustic disturbance in the Bay and subsequent deterioration of the quality of habitat for both of these species, although these activities will occur infrequently and last for a short duration.

Similarly, low level residual impacts on marine water and sediment quality at the temporary jetty in the form of small hydrocarbon fuel and lubricating oil leaks may contribute to the overall increased marine pollution loading in the Study Area arising from fishing vessels as well as tourism and recreational vessels (Murie *et al.*, 2016).

The construction of the temporary jetty will add to the increased erosion and deposition of sand on nearby seagrass beds, which is already evident as a result of intensifying land development in the Vilanculos/Inhassoro region for tourism and residential purposes, albeit at a very localised and transient scale.

Application of the recommended Project mitigation measures may reduce the level of contribution of the Project to overall cumulative impacts; however since some low-level residual effects are predicted, despite mitigation (population influx exacerbating fishing pressure and accidental bycatch), the Project could potentially contribute to the existing cumulative impacts in the Study Area.

10.0 ENVIRONMENTAL ACTION PLAN – TEMPORARY JETTY

Table 23: Environmental Action Plan – Temporary Jetty

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
<i>Construction Phase</i>				
Primary dunes and sandy beaches	Loss of protected habitat (primary dunes and sandy beaches)	Land take during construction	<ul style="list-style-type: none"> ■ The construction site should be monitored every morning to check for any evidence of turtle presence. Should a nest be discovered, it should be fenced off, access restricted, and its location reported to the Centro Terra Viva for one of their specialists to advise on the plan of action to be followed. ■ New areas of habitat disturbance and associated vegetation clearance should be minimised wherever possible. Areas proposed for vegetation clearance should be clearly marked and no heavy vehicles should travel beyond the marked works zone. Disturbed areas to be stabilised and planted with indigenous coastal dune species (e.g. <i>Scaevola plumieri</i>, <i>Carpobrotus dimidiatus</i>). ■ Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks. Enforce complete ban on 	<p>The Proponent to instruct construction crew regarding buffer area and produce construction method statement</p> <p>The Proponent to employ ECOW for duration of construction works</p>
Nesting turtles	Direct injury/mortality of nesting turtles/eggs	Site clearance in advance of construction		

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			<p>all wildlife exploitative activities (hunting/trapping/fishing) for all project personnel.</p> <ul style="list-style-type: none"> ■ Operating hours for heavy machinery to be minimised, defined and adhered to. Use of low-pitched reverse alerts, and directional lighting (if necessary) is recommended. ■ The Contractor and Sponsor will ensure that the HSESS Construction Management Plan and its over-arching requirements are carried out for the barging, temporary jetty activities and onward road transport of equipment to the CTT site. ■ Ecological clerk of works (ECOW) to be appointed for duration of construction works. 	

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
<p>Nesting turtles Dugong</p>	<p>Indirect injury/mortality of nesting turtles/eggs Indirect injury/mortality of Dugong</p>	<p>Population influx</p>	<ul style="list-style-type: none"> ■ The Proponent must enforce a complete ban on wildlife harvesting (hunting/trapping/fishing) for all project personnel, including any such activities by any person within the areas under project control. ■ The development of worker and community education programmes by the proponent, which focus on the value of conservation of species including Indian Ocean humpback dolphin, sea turtles and dugong, and the generation of tourism potential, can contribute to the alleviation of hunting pressure on affected fauna species and reduce local people's reliance on consumption of bush meat. ■ An Influx Management Plan for the Project should be implemented to manage access control, prevent unplanned growth in housing development and promote regional economic development, at the same time reducing pressure on ecosystems of concern and associated species for provision of natural resources. 	<p>The Proponent environmental manager</p>
<p>Capture fisheries (artisanal)</p>	<p>Temporary restrictions in ability to seine net,</p>	<p>Barge movements</p>	<ul style="list-style-type: none"> ■ Regular communication with stakeholders, as well as District 	<p>Contractor's Social Officers, in conjunction</p>

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
Ecotourism	launch boats, fish or provide tours		authorities (as well as others where required), to keep them informed of planned works and activities at the temporary jetty site. This will include communicating with locals and the community about project progress, as well informing them of the mechanisms in place for communications and lodging grievances (community grievance mechanism)	with the Sponsors HSE Manager and Community Liaison Officer
<i>Operational Phase</i>				
Primary dunes and sandy beaches	Alteration of hydrodynamics - Loss/ disturbance of natural habitat	Presence of the jetty	<ul style="list-style-type: none"> ■ Routes for transfer of heavy equipment should be clearly marked and no heavy vehicles should travel beyond the marked works zone. Transport of the equipment during offloading from the barge and onward road transport to the CTT site will be managed by the Traffic and Transport Management Sub-Plan and the Abnormal Loads Transport Sub-Plan. ■ Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transshipment vessels and heavy equipment are minimised/eliminated. Daily 	The Proponent environmental manager

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			<p>maintenance and monitoring checks of vessels should be conducted.</p> <ul style="list-style-type: none"> ■ Frequent monitoring of marine water and sediment quality should be implemented for the duration of transshipment and barging activities, focussing on the temporary jetty and the designated barging route. 	
<p>Primary dunes and sandy beaches</p>	<p>Compaction from access roads – permanent loss/ disturbance of natural habitat</p>	<p>Transfer of heavy equipment</p>	<ul style="list-style-type: none"> ■ Routes for transfer of heavy equipment should be clearly marked and no heavy vehicles should travel beyond the marked works zone. ■ Prohibit access to personnel outside of the defined access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks. 	<p>The Proponent environmental manager</p>
<p>Primary dunes and sandy beaches Seagrass beds</p>	<p>Water and benthic contamination from petroleum, oils and lubricants</p>	<p>Barge Transshipment vessel</p>	<ul style="list-style-type: none"> ■ Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, tug noats, work boats and heavy equipment are minimised/eliminated. 	<p>The Proponent environmental manager</p>

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			<ul style="list-style-type: none"> ■ Daily maintenance and monitoring checks of vessels should be conducted. ■ Frequent monitoring of marine water and sediment quality should be implemented for the duration of transshipment and barging activities, focussing on the anchorage point, temporary jetty and the designated barging route 	
<p>Primary dunes and sandy beaches Seagrass beds</p>	<p>Ballast discharge – spread of invasive species - Loss/ disturbance of natural habitat</p>	<p>Barge Transshipment vessel</p>	<ul style="list-style-type: none"> ■ Strict controls on ballast water management for both barges and transshipment vessels must be enforced by The Proponent. ■ High risk ballast water (that coming from ports and coastal waters outside of Bazaruto Bay) should not be discharged within the Study Area under any circumstances. ■ Tank-to-tank transfer of ballast water should be enforced for all barges and vessels associated with the Project, and should be documented and monitored by The Proponent at all times. ■ Monitoring for the introduction and/or spread of invasive marine algal and faunal species should be conducted on a 	<p>The Proponent environmental manager</p> <p>Independent ecologist to be contracted to conduct and document invasive marine species monitoring surveys</p>

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			regular basis for the duration of barging activity	
<i>Decommissioning Phase</i>				
Primary dunes and sandy beaches	Alteration of hydrodynamics - Loss/disturbance of natural habitat	Dismantling of jetty	<ul style="list-style-type: none"> ■ The extent of sandy beach habitat disturbance should be minimised wherever possible. Areas proposed for works should be clearly marked and no heavy vehicles should travel beyond the marked works zone. ■ Prohibit access to personnel outside of the defined project work sites and access roads. Train personnel to understand the sensitivity of the local environment in induction and ongoing tool box talks. ■ It is anticipated that once the rock foundations of the temporary jetty are removed, the beach will quickly level out with tidal movement and no import of sand for rehabilitation of the former temporary jetty site will be required. 	The Proponent to instruct decommissioning crew regarding buffer area and produce work method statement The Proponent to employ ECOW for duration of decommissioning works
Primary dunes and sandy beaches Seagrass beds	Water and benthic contamination	Dismantling of jetty	<ul style="list-style-type: none"> ■ Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transhipment 	The Proponent Environment Manager

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			vessels and heavy equipment are minimised/eliminated. Daily maintenance and monitoring checks of vessels should be conducted. Spill kits to be kept on site and utilised if necessary, in line with the waste management plan.	
Primary dunes and sandy beaches	Invasive species	Dismantling of jetty	<ul style="list-style-type: none"> Some invasive plant species are present in the existing access routes to both of the proposed temporary jetty site. These species should be controlled and removed as part of the site decommissioning works. Disturbed areas to be stabilised and planted with indigenous coastal dune species (e.g. <i>Scaevola plumieri</i>, <i>Carpobrotus dimidiatus</i>). 	The Proponent Environment Manager

11.0 ENVIRONMENTAL ACTION PLAN – BARGE MOVEMENTS

Table 24: Environmental Action Plan – Barge Movements

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
<i>Operational Phase</i>				
Dugong	<i>Collision risk</i>	Barge movements	<ul style="list-style-type: none"> ■ Strict speed restrictions must be enforced on barge vessels in Bazaruto Bay. The maximum allowable speed should be < 5 kmph ■ A Certified Marine Mammal Observer (MMO) must be employed by THE PROPONENT to observe and monitor all barge movements. The MMO will have authority to influence the speed and direction of vessel movements where any potential risks to marine mammals are identified. 	<p>The Proponent to instruct transshipment vessel and barge crews regarding speed limits</p> <p>The Proponent to employ certified MMO for duration of operations</p>
Dugong Indian Ocean Humpback Dolphin	<i>Barge collisions causing injury/mortality</i>	Barge movements		
Seagrass beds	<i>Loss/ disturbance of natural habitat</i>	Barge movements	<ul style="list-style-type: none"> ■ Barges must be routed via specific vessel lanes/channels that avoid potentially important areas of seagrass habitat. 	The Proponent to instruct transshipment vessel and barge crews regarding defined routes
Coral reef Seagrass beds	Water and benthic contamination from petroleum, oils and lubricants	Barge movements	<ul style="list-style-type: none"> ■ Strict controls should be put in place to ensure that leakages of petrol, oils and/or lubricants from barges, transshipment vessels and heavy equipment are minimised/eliminated. 	The Proponent Environment Manager

Aspect	Potential Impact	Impact Source	Detailed Actions	Responsibility
			<p>Daily maintenance and monitoring checks of vessels should be conducted.</p>	
<p>Capture fisheries (artisanal) Ecotourism</p>	<p>Temporary restrictions in ability to seine net, launch boats, fish or provide tours</p>	<p>Barge movements</p>	<ul style="list-style-type: none"> Regular communication with stakeholders, as well as District authorities (as well as others where required), to keep them informed of planned works and activities at the temporary jetty site. This will include communicating with locals and the community about project progress, as well informing them of the mechanisms in place for communications and lodging grievances (community grievance mechanism) 	<p>Contractor's Social Officers, in conjunction with the Sponsors HSE Manager and Community Liaison Officer</p>

12.0 MONITORING PROGRAMME – MARINE ECOSYSTEMS AND SPECIES

Table 25: Monitoring programme – Marine ecosystems and species

Objective	Detailed Actions	Monitoring Location	Frequency	Responsibility
<i>Construction Phase</i>				
Minimise impacts on primary dune and sandy beach habitat	ECOW	Construction site	Daily monitoring during construction	The Proponent to employ ECOW for duration of construction works
Establish baseline extent and condition of seagrass and coral outcrop in Study Area in advance of barging	Ground-truthing surveys to confirm baseline extent and condition of preliminarily mapped seagrass beds and coral outcrops	Within the area of influence of the finalised barging route	Prior to construction	The Proponent to employ independent specialist to establish the baseline
Establish baseline for marine water and sediment quality monitoring	Baseline data gathering for benchmarking of future monitoring - to be conducted prior to construction of temporary jetty. Samples will be analysed for Total Organic Carbon, Hydrocarbons, Metals and Biological Oxygen Demand (BOD) at the temporary jetty site as well as the final approach into shallow water. Water samples (TSS and particulates) will be collected at the temporary jetty site	Within the area of influence of temporary jetty site (to be defined by specialist)	Prior to construction	The Proponent to employ independent specialist to establish the baseline
<i>Operational Phase</i>				

Objective	Detailed Actions	Monitoring Location	Frequency	Responsibility
Maintain acceptable marine water and sediment quality, prevent contamination	Frequent monitoring focussing on the temporary jetty and final approach into shallow water	Temporary jetty and the final approach into shallow water	Marine water and sediment quality monitoring before and after each barge trip	The Proponent Environmental manager
Prevent collisions with Dugong or Indian Humpback Dolphin	Certified Marine Mammal Observer (MMO) to observe and monitor all barge movements. The MMO will have authority to influence the speed and direction of vessel movements where any potential risks to marine mammals are identified	Temporary jetty and the finalised barging route	MMO should be present on all barge movements	The Proponent to employ Certified Marine Mammal Observer (MMO)
<i>Decommissioning Phase</i>				
Minimise impacts on primary dune and sandy beach habitat	ECOW	Temporary jetty	Daily monitoring during decommissioning works	The Proponent to employ ECOW for duration of decommissioning works

13.0 CONCLUSIONS

The project will potentially affect marine biodiversity in three main ways; loss and disturbance of marine and coastal ecosystems of concern; loss and disturbance of fauna species of conservation concern, and creation of barriers to movement and collision risk for fauna species of concern.

The construction of the temporary jetty will cause minor land cover changes through vegetation clearance, and changes in local hydrodynamics, the effects of which will impact primary dune and sandy beach habitat. The main potential direct Project impact is the possible collision risk for Dugong and Indian Ocean Humpback Dolphin during barge movements; however the implementation of the recommended mitigation measures (strict speed limits in Bazaruto Bay and onboard MMO) is anticipated to reduce the risk of any impact occurring to negligible. The potential contribution of the Project to indirect/induced effects, such as population influx and increased fishing pressure in Bazaruto Bay, may be more significant for Dugong populations due to increased rates of accidental bycatch.

It is therefore crucial that the mitigation hierarchy is followed and all efforts to avoid impacts on biodiversity within the project's area of influence are made. Where avoidance of impacts is impossible, application of the recommended mitigation measures is critical in reducing the significance of predicted project impacts.

Appropriate vessel maintenance and management is essential for the prevention of pollution of the marine environment with hydrocarbon fuels, oils and/or lubricants from barges and heavy equipment; of potentially greater importance is the application of strict controls on ballast water management to prevent introductions and/or spread of marine invasive species. The implementation of a Population Influx Management Plan and community and worker education programmes by the Proponent to reduce or prevent turtle hunting and accidental mortality of Dugong as bycatch in the Study Area are important measures in reducing project impact on marine fauna species of conservation concern. The retention of a 250 m buffer zone around Bazaruto Archipelago National Park/IBA is important in preserving the ecological integrity of the protected area and preventing any project-related disturbance in the reserve.

Provided that the recommended mitigation measures are incorporated into the Project's environmental management plan, and are enacted and reported upon to the relevant authority throughout the lifetime of the project, the significance of most predicted impacts on biodiversity and ecosystem services can be reduced to environmentally acceptable levels. Although no significant residual impacts on species or ecosystems of concern are expected, the potential cumulative impacts on Dugong as a result of population influx throughout the lifetime of the Project and associated increase risk of accidental bycatch in fishing gear may be difficult to mitigate. Further conservation measures for Dugong are addressed via the Project biodiversity management sub-plan, which includes additional conservation measures focussing on community engagement and awareness raising activities, and promotion of ecotourism. Furthermore, it is noted that although no significant Project impacts on the Endangered Indian Ocean humpback dolphin are anticipated prior to or after mitigation, net gain is still required for this critical habitat-triggering species in the Study Area. As stipulated in the Project biodiversity management sub-plan, it indicates that a species-specific biodiversity action plan (BAP) will be prepared for Indian Ocean humpback dolphin, outlining conservation measures that could be implemented on-the-ground to achieve net gain for the species, such as community engagement to mitigate marine mammal hunting and bycatch through the promotion of community-based ecotourism, local protection and enforcement, potential expansion of reserves, and social outreach campaigns (Braulik et al, 2017).

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Golder Associados Moçambique Limitada

Aisling Dower
Ecologist

Warren Aken
Ecology Lead

AD/WA/nbh

NUIT 400196265

Directors: G Michau, RGM Heath

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APPENDIX A

**Remote Satellite Imagery
Classification - GTI, 2020**

APPENDIX B

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