Chapter 10

Introduction to Impact Assessment and Mitigation

CONTENTS

10 INTRODUCTION TO IMPACT ASSESSMENT AND MITIGATION

10.1 INTRODUCTION

This chapter provides an overview of the approach used for assessing impacts and determining mitigation. The impact assessment comprised the following main activities:

- analysis of baseline data and identification of baseline sensitivities;
- consideration of stakeholder concerns raised during the EPDA (scoping) Phase;
- identification of potential significant impacts;
- development and refinement of mitigation measures (mitigation workshops and meetings were held with the Project's Engineering Team and contractors to ensure the proposed mitigation measures were practical and implementable);
- revision of the Project layout, based on baseline sensitivities and inputs from environmental and social specialists; and
- evaluation of the significance of residual (post-mitigation) impacts. A wide range of different measures to mitigate impacts have been identified in the EIA Report and the Project is committed to their implementation, success and continuous improvement (see *Chapter 17*).

10.2 PREDICTION AND EVALUATION OF IMPACTS

Chapters 11 to *15* identify and assess the potential impacts and risks associated with Project activities during the construction and operation phases. A screening process was conducted by specialists to identify those impacts that were not considered to be significant and which did not warrant further assessment. The impacts assessed in the following chapters were those deemed to be important for decision making.

These impacts were assessed in accordance with the methodology and assessment criteria detailed in *Chapter 3* and summarised below.

10.2.1 *Impact Prediction*

There are a number of ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the Project component or by the execution of a Project-related activity. There are a number of ways that impacts may be described and quantified, including:

- nature of impact: positive or negative;
- type of impact: direct, indirect or cumulative;
- duration of impact: temporary, short term, medium term, long term or permanent; and
- scale of impact: onsite, local, regional, national or international/ transboundary.

The types of impacts and terminology used in the assessment are outlined in *Table 10.1*.

Table 10.1 Defining the Nature of the Impact

Term	Definition
Nature of Impact	
Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Type of Impact	
Direct impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (eg between occupation of a site and the pre-existing habitats, or 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 (eg in-migration for employment placing a demand on resources). Indirect impacts can also be referred to as induced or secondary impacts.
Cumulative impact	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

This EIA considers routine and non-routine events that may lead to potential impacts. Non-routine events generally relate to accidents or unplanned events (such as oil/fuel spills, emergency flaring or venting of gas, etc) that may result in adverse impacts. In these cases, the probability of the event occurring needs to be considered.

10.2.2 Assessing Significance

For the purposes of this EIA, the following definition has been adopted: *'An impact is significant if, in isolation or in combination with other impacts, it should be taken into account in the decision-making process.'*

It is generally accepted that significance is a function of the magnitude of the impact and the likelihood of the impact occurring. It is widely accepted that impact magnitude (or severity) is a function of the extent, duration and intensity of the impact.

The criteria used to determine significance are summarised in *Table 10.2* (1). The prediction takes account of mitigation measures that are already an integral part of design.

Table 10.2 Significance Criteria

Impact Magnitude – the Degree of Change Brought About in the Environment	
Extent	**Onsite:** impacts that are limited to the direct area of disturbance and immediate surrounds. **Local:** impacts that affect an area in a radius of up to 10km around the site. **Regional:** impacts that affect regionally important environmental resources or are experienced at a regional scale, as determined by administrative boundaries or habitat type/ecosystem. **National:** impacts that affect nationally important environmental resources, or affect an area that is nationally important, or that have macro-economic consequences. **Transboundary/international:** impacts that affect internationally important resources, such as areas protected by international conventions.
Duration	**Temporary:** impacts are predicted to be of short duration and intermittent/occasional (typically less than one year). **Short term:** impacts that are predicted to last between one and five years. **Medium term:** impacts that are predicted to last between five and 10 years. **Long term:** impacts that will last longer than 10 years and cease when the Project stops operating. **Permanent:** impacts that cause a permanent change in the affected receptor or resource (eg removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Intensity(2)	BIOPHYSICAL ENVIRONMENT: *Intensity can be considered in terms of the sensitivity of the biodiversity receptor (ie habitats, species or communities).* **Negligible:** the impact on the environment is not detectable. **Low:** the impact affects the environment in such a way that natural functions and processes are not materially affected. **Medium:** where the affected environment is altered but natural functions and processes continue, albeit in a modified way. **High:** where natural functions or processes are altered to the extent that they will temporarily or permanently cease. ***Where appropriate, national and/or international standards are to be used as a measure intensity of the impact.*** SOCIO-ECONOMIC ENVIRONMENT: *Intensity can be considered in terms of the ability of project-affected people/communities to adapt to changes brought about by the project.*

(1) In some cases, specialists have slightly modified the means of assessing significance based on what is most appropriate to their subject matter. Where this is the case, it has been clearly outlined.
(2) The frequency of the activity causing the impact also has a bearing on the intensity of the impact, ie the more frequent the activity, the higher the intensity.

Impact Magnitude – the Degree of Change Brought About in the Environment	
	Negligible: there is no perceptible change to people's livelihoods. **Low:** people/communities are able to adapt with relative ease and maintain pre-impact livelihoods. **Medium:** people/communities are able to adapt with some difficulty and maintain pre-impact livelihoods, but only with a degree of support. **High:** affected people/communities will not be able to adapt to changes and continue to maintain pre-impact livelihoods.
Impact Likelihood – the Likelihood that an Impact will Occur	
Unlikely	The impact is unlikely, but may occur at some time during normal operating conditions.
Likely	The impact is likely to occur at some time during normal operating conditions.
Definite	The impact will occur at some time during normal operating conditions.

Once a rating was determined for magnitude and likelihood, the risk matrix in *Table 10.3* was used to determine the impact significance for positive or negative impacts.

Table 10.3 Impact Significance

SIGNIFICANCE RATING				
	LIKELIHOOD	Unlikely	Likely	Definite
MAGNI-TUDE	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Minor	Minor
	Medium	Minor	Moderate	Moderate
	High	Moderate	Major	Major

Table 10.4 outlines the various definitions for significance of an impact and is based on the significance rating matrix.

Table 10.4 Significance Definitions

Significance Definitions	
Negligible significance	An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background levels.
Minor significance	An impact of minor significance is one 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/vulnerability/importance.
Moderate significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is ALARP. This does not necessarily mean that moderate impacts have to be reduced to minor impacts, but that moderate impacts are being managed effectively and efficiently.

Significance Definitions	
Major significance	An impact of major significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resources/receptors. A goal of the EIA process is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects, there may be major residual impacts after all practicable mitigation options have been exhausted (ie ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.

Once the significance of the impact has been determined, it is important to qualify the degree of confidence in the assessment. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact. Degree of confidence can be expressed as Low, Medium or High.

10.2.3 Structure of Impact Assessment Chapters

Discussion of impacts is divided into offshore environmental, onshore environmental and socio-economic categories (*Chapters 11, 12* and *13* respectively), as outlined in *Table 10.5*.

The offshore impact assessment chapter (*Chapter 11)* addresses the deep offshore and near shore (within Palma Bay) marine impacts. The onshore impact assessment chapter (*Chapter 12)* discusses impacts on the terrestrial environment. The socio-economic chapter (*Chapter 13*) considers impacts to the socio-economic receptors, both onshore (eg communities) and offshore (eg shipping and navigation).

Unplanned events arising from non- routine Project activities are assessed separately in *Chapter 14*. Cumulative impacts are assessed in *Chapter 15*.

Table 10.5 Structure of the Impact Assessment Chapters

Chapter	Receptor/ Resource
Chapter 11 – Offshore and Near Shore Environmental Impact Assessment	
	Offshore marine ecology
	Near Shore marine ecology
Chapter 12 – Onshore Environmental Impact Assessment	
	Air quality
	GHG Emissions/ Climate change
	Noise
	Landscape, seascape and visual
	Waste
	Soils
	Hydrology
	Groundwater
	Surface water ecology
	Vegetation

Chapter	Receptor/ Resource
	Herpetofauna Avifauna Mammals
Chapter 13 – Socio-economic Impact Assessment	
	Social (Physical and economic displacement, tourism, PIIM, economy) Community health Shipping and navigation Archaeology
Chapter 14 –Unplanned, Non-routine Events	
	All relevant environmental and socio-economic resources/receptors
Chapter 15 – Cumulative Impacts	
	All relevant environmental and socio-economic resources/receptors

The assessment of impacts on a resource/receptor resulting from a Project activity is described in a systematic manner under three subheadings.

- **Impact assessment**: the Project activities that give rise to potential impacts are identified and the magnitude, likelihood and significance of the impacts on the receptor or resource assessed without the implementation of mitigation or enhancement measures.

- **Mitigation measures**: the key mitigation or enhancement measures that the Project has agreed to are defined here. These measures described how negative impacts can be avoided, minimised, remedied or compensated and how positive impacts can be enhanced.

- **Residual impacts:** an assessment of the significance of the impacts following the implementation of the recommended mitigation or enhancement measures is provided here.

The assessment exercise was supported by technical studies (eg to quantify noise and air quality impacts through modelling). Where relevant, standards or guidelines are used to determine the acceptability of impacts and gaps in knowledge are made clear. A wide range of different measures to mitigate impacts have been identified in the EIA Report and the Project is committed to their implementation, success and continuous improvement (see *Chapter 17*).

10.3 *INTEGRATION AND MITIGATION WORKSHOPS*

Mitigation measures recommended by the EIA Team (including the various environmental and socio-economic specialists) were agreed with the Project, and residual impacts were determined based on the assumption that these agreed mitigation measures will be implemented by the Project or the Project's contractors. Mitigation measures (in particular, measures that resulted in a change to the design layout of the Project) were developed and verified as feasible through a series of mitigation workshops involving key personnel from the EIA Team, AMA1 and potential FEED Contractors. In addition, several meetings were held between the Engineering Team and some specialists to refine and finalise mitigation measures, including the incorporation of avoidance wherever possible in the Project design.

The objectives of each of the workshops and ad hoc meetings, as well as a list of attendees (by team), are presented in *Table 10.6*.

The three workshops took place over an eight-month period, starting from the time that specialist baseline findings became available, through various updates and changes to the Project description, and lasting through the completion of the specialist reports. The workshops focused on two main areas:

- mitigation, management and monitoring measures proposed by the EIA Team, and agreement of these with AMA1; and
- discussion of certain key issues and how the Project planned to deal with these, such as:
    - ecologically sensitive areas within Afungi Project Site and the technical feasibility of revising the Onshore Project Footprint Area to avoid sensitive areas;
    - possible techniques for bringing the pipelines from offshore, through Palma Bay to the Afungi Project Site to avoid or minimise impacts to sensitive and important marine biotopes (eg coral and seagrass);
    - options for the disposal of dredge material;
    - waste management practices; and
    - exclusion zones in the near shore to minimise impacts to transportation routes along the coast.

Table 10.6 Integration and Mitigation Workshops/Meetings

Dates	Objectives of Workshop or Meeting	Attendees (Representatives from)
Integration Workshop: 25–26 January 2012	• Facilitate integration between specialists. • Obtain a thorough understanding of the base case Project description through direct interaction with the Engineering Team. • Obtain a better understanding of the affected environment (baseline) and key sensitivities across all specialist studies.	• ERM and Impacto EIA Project Management Team • Environment and social specialists involved in the EIA • Project Engineering Team (Offshore and Onshore) • INP representative

Dates	Objectives of Workshop or Meeting	Attendees (Representatives from)
Integration and Mitigation Workshop: 12–13 July 2012	• Understand specialist findings/ recommendations; in particular, key impacts, proposed mitigation, monitoring and management measures. • Align/integrate specialists. • Workshop mitigation, monitoring and management measures with all present.	• ERM and Impacto EIA Project Management Team • Environment and social specialists involved in the EIA • Project Engineering Team (Offshore and Onshore)
Mitigation Workshop: 28–29 August 2012	• Discuss and agree on possible mitigation measures with FEED Contractors and AMA1 to allow EIA Team to finalise the impact assessment chapters and Environmental Management Plan (EMP).	• ERM and Impacto EIA Project Management Team • Key environment and social specialists involved in the EIA • Project Engineering Team (Offshore and Onshore) • Onshore FEED Contractors • Near Shore infrastructure design engineers
Ad hoc meetings: June 2012 to September 2012	• Discuss and agree on proposed mitigation measures.	• Environment and social specialists involved in the EIA • Project Engineering Team

The outcomes of the workshops provided the basis for both the mitigation measures described in the following chapters and the Environmental and Social Management Plan (ESMP) in *Annex D*. These workshops also influenced the Project design iteratively, with the feedback from the EIA specialists incorporated into the Project layout and design in real time (described in *Section 10.4* below).

The integration and mitigation workshops facilitated a robust assessment of impacts and challenging of the feasibility of the proposed mitigation measures. The mitigation measures (or their performance-based objectives) have been agreed to and are an integral part of the Project. The implementation of mitigation measures will be incorporated into the FEED/EPC Contractors' contract requirements, along with proposed monitoring and reporting.

10.4 *REVISIONS TO THE PROJECT LAYOUT*

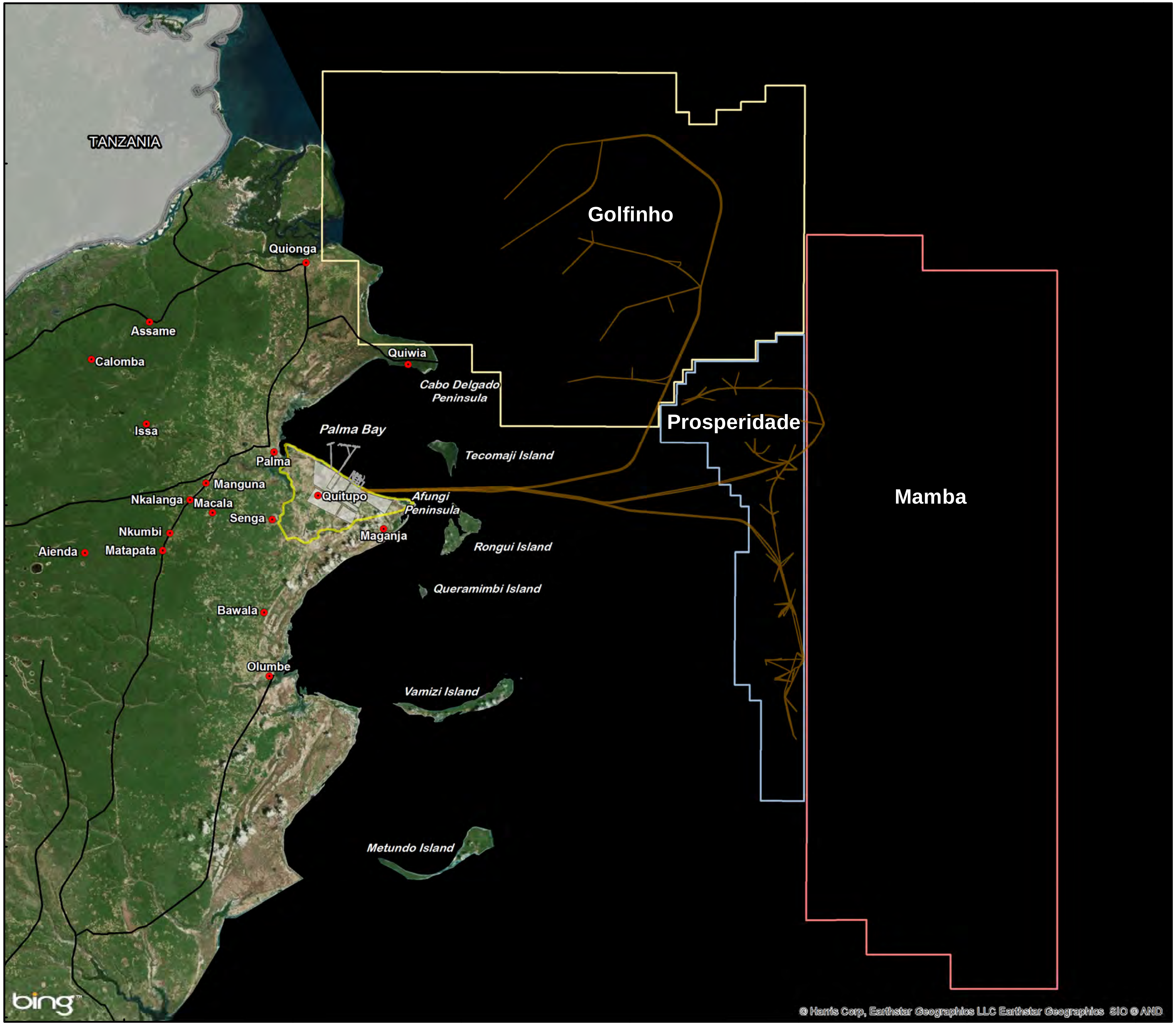
The development of appropriate mitigation measures is a key component of the EIA process. *Chapters 11* to *13* provide detail on the identified impacts and range of mitigation measures. In light of the potential impacts, the EIA Team worked with the Project's Engineering Team to revise the Project layout to avoid and/or minimise a range of potential impacts on the biophysical and socio-economic environment. In light of the ecological value and sensitivity of the region (see *Chapters 6* to *8*), avoiding or minimising impacts through appropriate mitigation is an important consideration. The proposed mitigation through revising/reducing the layout of components of the Project is described here to provide a better understanding of the proposed post-mitigation Project description.

10.4.1 *Revisions to the Offshore Project Description*

Changes to the Pipeline Corridor between Rongui and Tecomaji

The proposed pipeline corridor was initially planned to transition from deep to shallow water and pass through the mid-point between the islands of Rongui and Tecomaji. However, the baseline surveys conducted in this area indicated that the proposed pipeline corridor would pass through an area of shallow fringing reefs. In review of the environmental sensitivities, the EIA Team identified a potential alternate route to the south between the islands, closer to Rongui Island, to avoid or minimise damage or disturbance to the fringing reefs. In discussion with the Project's Engineering Team, this alternate route, closer to Rongui Island, was agreed upon. This southern route is depicted in *Figure 10.1*.

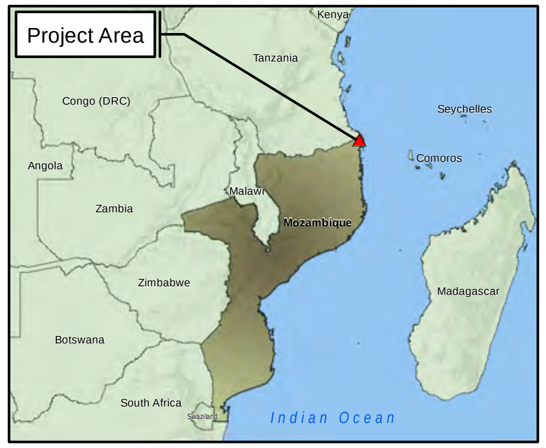
The installation technique or method proposed for the pipeline in this area also presented the possibility of significant environmental impacts. A cutter suction dredger was initially proposed to dredge the channel between the islands of Rongui and Tecomaji. This method would use a rotating cutter head to loosen the carbonaceous rock and grind the material. The environmental concern associated with this was related to the likelihood of creating a large plume of finely ground calcium carbonate, which could potentially result in adverse impacts to the marine ecology within the bay and surrounds. The EIA Team proposed an alternate method that involves fracturing the carbonaceous rock through the use of small controlled underwater explosions to loosen the substrate, and then mechanically excavating the corridor. The Project's Engineering Team agreed that this was a viable option, and will task the dredging contractor with using this method (or similar) instead of dredging. The excavated material may provide beneficial use for armouring the pipeline, while providing a suitable medium to facilitate the recolonisation of coral.



Legend

- Villages / Settlements
- Regional Roads
- Proposed Pipeline Corridor Route
- Cais
- Onshore Layout
- Afungi Project Site
- Prosperidade Gas Field
- Golfinho Gas Field *
- Mamba Gas Field

* Indicative area not yet approved by INP



MAIN MAP SCALE:

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Figure 10.1:
Locality of Pipeline Corridor

CLIENT:

Anadarko Moçambique Área 1, Lda

eni

DATE: Oct 2013	CHECKED: KG	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 400 000

DRAWING: Locality_of_Pipeline_corridor.mxd

REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

Impacto Projectos e Estudos Ambientais

ERM

Projection: UTM Zone 37 S. Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation
AMA1, 2012. Inset Map: Esri Data & Maps

SIZE: A3

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Changes to the Pipeline Corridor within Palma Bay

It was initially proposed to dredge a channel, approximately 300m wide by 5m deep, within Palma Bay to accommodate access by the pipeline installation barge. The dredging of this channel is expected to result in the accumulation of approximately 6.6 million m^3 of dredge material. The environmental impacts associated with this method include the loss of biotopes within the footprint area of the dredge channel, as well as potential increases in turbidity.

The Project is discussing alternative installation methods with FEED Contractors to reduce the likely impacts associated with dredging and backfilling a pipeline corridor within Palma Bay. Considerations include mechanical (rather than dredger) methods to trench the pipe (eg use of a crawler in shallow water, and use of special pipeline trenching barges). The intent of these alternate methodologies is to reduce adverse impact to the coral and seagrass communities. This will be achieved by significantly reducing the expected volume of 6.6 million m^3 of dredge material and minimising the footprint area of the pipeline from an approximately 300m wide corridor to approximately 100m wide.

10.4.2 Revisions to the Onshore Project Layout

Field studies conducted during the Baseline Phase of the EIA identified and mapped sensitive habitats for a variety of vegetation, terrestrial fauna and avian species. Once these species-specific sensitive habitat maps were overlaid (see *Figure 10.2*), it became apparent that certain areas within the Afungi Project Site were more sensitive than others and contributed to the biodiversity of the Study Area. It was determined that most of the species relied heavily on the wetlands within the Onshore Project Footprint Area for the ecological functions they provide (food, water, breeding habitat, etc).

Legend

- Villages / Settlements
- Regional Roads
- Local Roads
- Nearshore Components
- Onshore Layout
- Airstrip
- Afungi Project Site

Sensitivity Rating

- Very High
- High
- Medium-High
- Med
- Low
- 150m Buffer

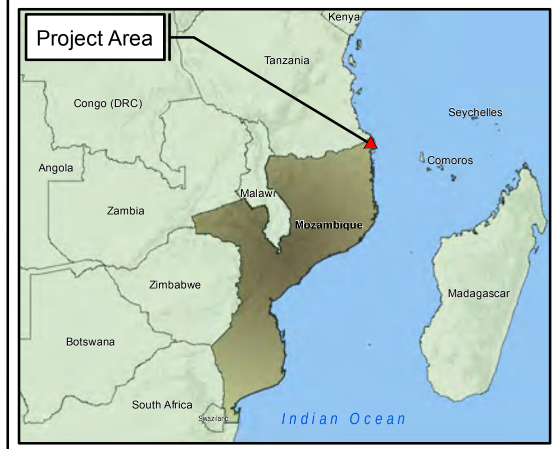

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Figure 10.2:
"Base-Case" Onshore Project Footprint Area Overlaid on Sensitive Areas

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DRAWN: AB	APPROVED: JR	SCALE: 1 : 50 000

DRAWING:
Onshore Project Footprint Area Overlaid on Sensitive Areas.mxd

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ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

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Projection: UTM Zone 37 S, Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
ERM, 2012. Inset Map: Esri Data & Maps

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Once potential mitigation measures were compiled, it became obvious the Project could reduce adverse environmental impacts by revising the Onshore Project Footprint Area. With the above sensitivity map in mind, the Project began to investigate methods to avoid or minimise potential footprint impacts. This was facilitated by a series of interactions held between the EIA and Project Engineering Teams. The EIA Team, in conjunction with AMA1, revised the base case Project layout (*Figure 10.2*) to avoid or minimise impacts on the identified high-sensitivity areas (illustrated in *Figure 10.3*). The potential FEED Contractors were then tasked with determining whether they could design the Project to work within the revised areas. Those Contractors confirmed that they were able to work within the revised layout.

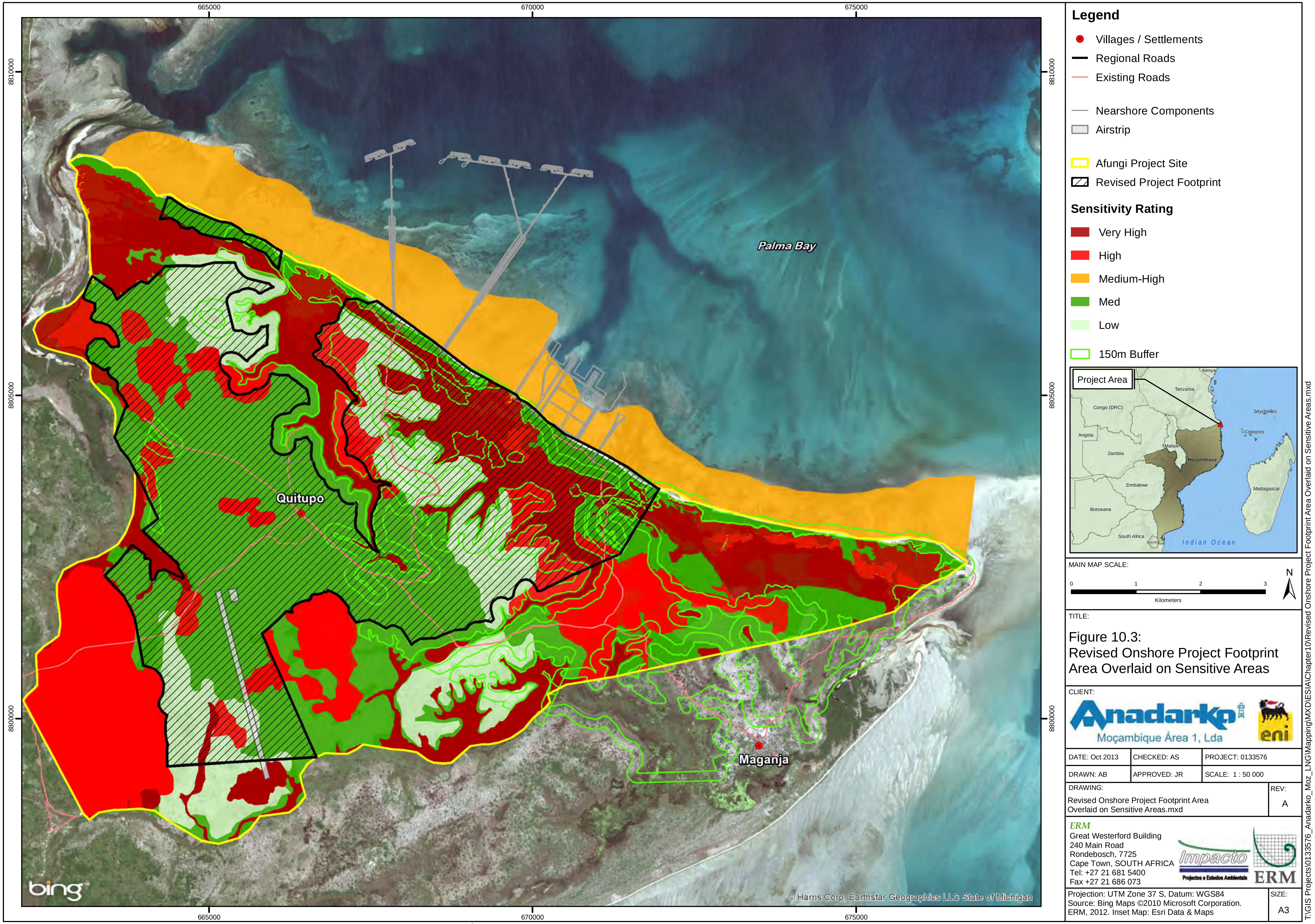
This mitigation exercise enabled the avoidance of some impacts and the minimisation of others to ALARP. The Revised Project Footprint Area effectively reduces the disturbance of areas of High to Very High terrestrial ecological sensitivity from approximately 2,340ha to 1,695ha, thereby avoiding approximately 645ha. *Table 10.7* below provides an overview of the reduced area of disturbance to terrestrial areas with a sensitivity rating of Medium and greater.

***Table 10.7 Approximate Reduction in Disturbance to Sensitive Areas (Figure 10.3*)**

Sensitive Habitat Rating	Vegetation	Herpetofauna	Avian	Mammal
Medium	-2,698ha	-1,098ha	-2,697ha	-1,099ha
Medium–High	N/A	N/A	-112ha	N/A
High	+85ha	-51ha	-103ha	-6ha
Very High	-210ha	-323ha	N/A	N/A
Total reduction in disturbance	**-2,823ha**	**-1,472ha**	**-2,912ha**	**-1,105ha**

Note:
NA indicates that this habitat rating was not observed within the Survey Area.

In addition to the above described reductions, wetlands by their nature are considered to be sensitive ecosystems. The Revised Project Footprint Area reduces the area of disturbance to wetlands and their buffer areas from approximately 2,590ha to approximately 1,643ha, thereby avoiding 947ha in total.



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Villages / Settlements
Regional Roads
Existing Roads
Nearshore Components
Airstrip
Afungi Project Site
Revised Project Footprint
Sensitivity Rating
Very High
High
Medium-High
Med
Low
150m Buffer
Project Area
Kenya
Tanzania
Congo (DRC)
Seychelles
Comoros
Angola
Malawi
Zambia
Mozambique
Zimbabwe
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Botswana
South Africa
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Revised Onshore Project Footprint
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