Xaris Walvis Bay Power Plant and Gas Supply Facility

Environmental Impact Assessment Marine Components

Enviro Dynamics
Environmental Management Consultants

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PROJECT NAME	Proposed Xaris Walvis Bay Power Plant and Gas Supply Facility
STAGE OF REPORT	Draft Marine Components EIA Report – for client review
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EXECUTIVE SUMMARY

INTRODUCTION

Xaris Energy Namibia (Pty) Ltd (the proponent) is intending to construct and manage an Open Cycle Gas Turbine (OCGT) Power Plant on 40 hectares of land in Walvis Bay, Namibia. The power plant initially will be sized to be able to yield 300MW of base load power to the national grid of Namibia.

This EIA assesses the marine components of the project that will supply natural gas to the Power Plant namely:

- Dredging work by widening the port entrance channel to the new Tanker Berth for the import and export of petroleum products in the port of Walvis Bay (Botha, Hooks, & Fauls, 2013).
- Dredging work and berth construction work at a new gas terminal for a Floating Storage Regasification Unit (FSRU) and a Liquid Natural Gas (LNG) carrier in a double banking (side-by-side) configuration during refuelling.
- Construction of a trestle gas pipeline from the FSRU to the land based port premises(please refer to the locality plan overleaf) (Figure A).

The operational activities that will take place in this marine environment are:

- Direct transfer of LNG form the LNG carrier to the FSRU every six weeks approximately.
- Storage of the LNG and regasification of the LNG to natural gas on board of the FSRU.
- Pumping of the natural gas from the FSRU via the trestle jetty pipeline to the shore based control station.

The marine components EIA and EMP are subject to:

- The Environmental Management Act (2007) and it's Regulations (2012).
- Relevant Namibian and international maritime legislation and conventions.
- Relevant noise and atmospheric pollution guidelines and best practices.
- Relevant local and international marine pollution legislation and regulations.
- Relevant Namibian labour, public health, and hazards legislation
- Relevant Equator and IFC Standards and guidelines to qualify for international lender funding.

In addition the EIA relies directly on the EIA for the New Tanker Berth for the import and export of petroleum products in the port of Walvis Bay (Botha, Hooks, & Fauls, 2013) content and requirements for dredging. This is due to the fact that the entire marine component falls within the study area of this EIA that already has environmental clearance.

The marine environment in the project area has the following significant features:

- The sea floor consists of silts/clays to sandy material that may contain Hydrogen Sulphide H_2S.
- The benthic ecology is common.
- Marine birds that migrate or hunt may be influenced by the activities of the FSRU and light sources.
- Activity within the port area is set to increase significantly if all the planned port expansions are implemented.
- The Walvis Bay Lagoon (Ramsar Site) is a considerable distance from the project area but still within the same bay.

Public consultation followed the guidelines of IFC and Namibian law. Three meetings were held in Windhoek and Walvis Bay and were well attended. A significant amount of comments were received and considered all three EIAs of the overall project.

The impact assessment showed that there are no impacts that rate high or that cannot be managed to acceptable levels. The impacts cover the fields of:

- Marine pollution.
- Marine biodiversity.
- Noise and air pollution as well as other minor disturbances.
- Impact on birds.
- Economic and social impacts.
- Health and safety.

The following cumulative impacts are of concern although the project itself will add a minor contribution only:

- Excessive build-up of spoil material by dredging activities managed by the port.
- Increased Shipping activity in the port limits as well as the bay area.

It is recommended that the marine component of the Walvis Bay Gas Fired Power Plant and Gas Supply Facility receive Environmental Clearance on condition:

- That the EMP be implemented through the life cycle of the project and be audited annually.
- Relevant IFC standards and guidelines be implemented and the resulting management plans be audited annually.

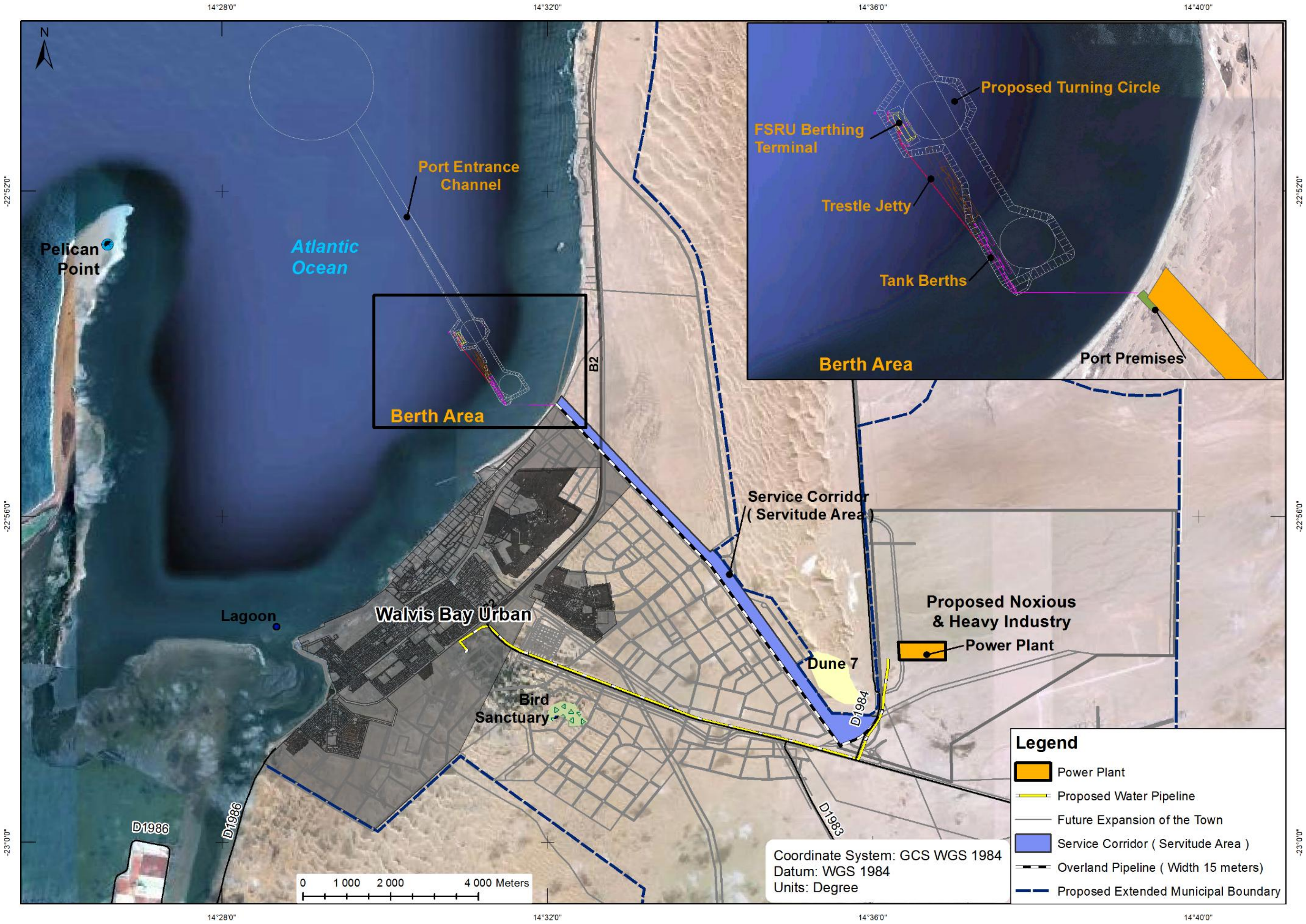

Figure A: Locality of the proposed overall project

TABLE OF CONTENTS

EXECUTIVE SUMMARY ii

TABLE OF CONTENTS v

LIST OF TABLES AND FIGURES viii

LIST OF APPENDICES ix

ABBREVIATIONS AND ACRONYMS x

1 BACKGROUND 1

1.1 Introduction 1

1.2 Project Location 2

1.3 Terms of Reference 2

1.4 Need and Desirability 2

1.5 Methodology 4

2 PROJECT DESCRIPTION 6

2.1 Overall Project Overview 6

2.2 Fuel Selection 7

2.2.1 Properties of Natural Gas 7

2.2.2 Carbon Emissions 8

2.2.3 Natural Gas Markets 9

2.2.4 Compatibility with Kudu Gas 10

2.3 Key Project Components 11

2.4 Berthing of the FSRU and Transport of the Gas along a Trestle Jetty to the Port Premises 12

2.4.1 The Floating Storage Regasification Unit 12

2.4.2 FSRU and LNG Carrier Processes 13

2.4.3 LNG Transfer 14

2.4.4 Gas Liquefaction Process 15

2.4.5 Vapour, boil-off Gas Control and Ship Emissions 15

2.4.6 Ballast Water System 16

2.5 Berth, Jetty and Jetty Approach facilities 16

2.5.1 Berthing System 16

2.5.2 The Trestle Jetty 18

2.5.3 Jetty Control Room 18

2.5.4 GasPort 18

2.6 Dredging 21

2.7 Construction Cost, Period and Resources 21

3 LEGAL AND REGULATORY REQUIREMENTS 23

3.1 Introduction 23

3.2 Listed Activities that require Environmental Clearance 23

3.3 Regulatory Documents relevant to the Project Environment 24

3.4 IFC Standards that guide the Marine Components EIA 26

3.5 Conclusion and Application 30

4 THE RECEIVING ENVIRONMENT 31

4.1 Overview Walvis Bay Environment 31

4.2 Overview of Project Environment 33

4.3 Description of Environment Surrounding Floating Storage Regasification Unit and Trestle Jetty 34

4.3.1 Summary Description of Physical and Social Environment 34

4.3.2 Biological Marine Environment 40

4.3.3 Birds 41

4.4 Conclusion 41

5 PUBLIC CONSULTATION PROCESS 45

5.1 Introduction 45

5.2 Previous Consultation and Public Participation 46

5.3 Current Consultation and Public Participation 46

5.3.1 The Interested and Affected Parties (I&APs) 46

5.3.2 Methodology 47

5.4 Public Feedback 53

5.5 Public Concern 53

6 ALTERNATIVES 56

6.1 Overview 56

6.2 Alternative Activity 56

6.2.1 The '*no-go*' Alternative 56

6.2.2 Alternative Fuel Sources 57

6.3 Alternative Locations 63

6.3.1 FSRU Mooring Location 63

6.4 Alternative Technologies and Design 64

6.4.1 Land-based LNG Terminal vs. FSRU 64

6.4.2 Open vs. Closed Loop Regasification Systems 67

6.4.3 Subsea vs. Trestle Jetty 71

6.4.4 Dredging and Discharge Process Alternatives 72

6.5 Conclusion 73

7 IMPACT ASSESSMENT 74

7.1 Introduction 74

7.1.1 Methodology 74

7.2 Conclusion 90

8 CONCLUSIONS AND RECOMMENDATIONS 91

8.1 Context 91

8.2 Conclusion from the Marine Components EIA 91

8.3 Recommendation 92

9 REFERENCES 93

LIST OF TABLES AND FIGURES

Tables

Table 1: Summary of listed activities 23

Table 2: Regulatory documents guiding the EIA 24

Table 3: Relevant IFC performance standards 27

Table 4: Summary weather statistics for Walvis Bay 31

Table 5: Summary description of key environmental features pertaining to the FSRU and Trestle Jetty 34

Table 6: Description of environmental sensitivities pertaining to this project component environment 41

Table 7: Identification of Interested and Affected Parties 47

Table 8: Notifications placed in the press 48

Table 9 Summary of the meeting conducted at national, regional and local level 51

Table 10: A comparison of the risk factors between heavy fuel oil (HFO) and Liquefied Natural Gas (LNG). 58

Table 11: A comparison of the risk factors associated with possible mooring locations for the FSRU within the Walvis Bay Port area. 63

Table 12: A comparison of the risk factors associated with the construction of a land-based LNG terminal and an offshore FSRU. 64

Table 13: A comparison of the risk factors associated with the operation of a open loop vs. a closed loop regasification system. 68

Table 14: A comparison of the risk factors associated with the transport of gas through a subsea pipeline or in a pipeline along a trestle jetty. 71

Table 15: Description of criteria used to define the significance of the impacts. 75

Table 16: Impact assessment 77

Figures

Figure 1: EIA components of the greater project 3

Figure 2: The Environmental Assessment Process 5

Figure 3: Components of raw natural gas (source: www.naturalgas.org) 7
Figure 4: Carbon footprint of various fuels in power generation (Xaris Energy (Pty) Ltd)). 9
Figure 5: Global LNG supply market predictions. 10
Figure 6: Key project components and technologies. 11
Figure 7: An example of an FSRU. 13
Figure 8: Transfer of LNG from carrier vessel to FSRU using cryogenic hoses. 14
Figure 9: Schematic diagram of the vessel configuration in the berthing area (bouble banking). 17
Figure 10: A simulation of how the vessel will be navigated to the Berth. 17
Figure 11: An example of a trestle jetty. 18
Figure 12: Location of the berthing area of the FSRU and LNGC. 20
Figure 13: Sandy beach at proposed project site and view to port 37
Figure 14: Marine environment context 38
Figure 15: Walvis Bay sensitivity map 39
Figure 16: Schematic representation of the West Coast intertidal beach zonation (Pulfrich, 2012). Species commonly occurring on the central Namibian beaches are listed. 40
Figure 18: Photo plate: Public and Authorities Meetings in Walvis Bay 50

LIST OF APPENDICES

Appendix A	Environmental Management Plan
Appendix B	Pubic Consultation Proces
Appendix C	Legal Framework
Appendix D	Specialist Reports

ABBREVIATIONS AND ACRONYMS

Ballast	Material in ship to steady it
Barg	Pressure in bars above ambient or atmospheric pressure
Benthic	Ecological region at the lowest level of a body of water such as an ocean or a lake, including the sediment surface and some sub-surface layers
BID	Background Information Document
CAGR	Compounded Annual Growth Rate
Class	Pressure rating of the typical pipe
Cryogenic	Functioning under very low temperatures
DEA	Department Environmental Affairs
Double-hulled	Two ship hulls inside of each other to protect as safety feature
Double banking	When cships anchor side-by-side in order to be able to transfer materials directly
EC	Environmental Commissioner
EIA	Environmental Impact Assessment
EMA	Environmental Management Act, No 7 of 1997
EMP	Environmental Management Plan
FSRU	Floating Storaging Regasification Unit
IAP	Interested and Affected Party
IFC	International Finance Corporation
Liquefaction	Process of liquefying or making liquid
LNG	Liquid Natural Gas

LNGC	Liquid Natural Gas Carrier
MET	Ministry of Environment and Tourism
Met-ocean	An abbreviation of the two words "Meteorology" and "Oceanography". The term is often used in the offshore industry to describe the physical environment say near an offshore platform
MTPA	Metric Tons per Annum
MMTPA	Million Metric Tons per Annum
MW	Mega Watt
NSA	National Statistics Agency
Open-loop shell-and-tube vaporization (STV)	Chamber containing loops of pipes that circulated heated medium (water in order to heat and vapourise a target medium(NG to natural gas) in the chamber
OEM	Original Equipment Manufacturer
Piston effect	Pressure fluctuations inside pipes as liquid pushes air/gas in front of it
Propulsion	Effort made to move something
SAPP	Southern African Power Pool
SEA	Strategic Environmental Assessment
SSV	Safety Shutoff Valve
STS	Ship to Ship Transfer
Trestle jetty	Suspended facility on light columns
WBM	Walvis Bay Municipality
WBTC	Walvis Bay Town Council

1 BACKGROUND

This chapter aims to introduce the proposed project and Environmental Impact Assessment (EIA), providing a brief overview of the key processes while laying the background for the more detailed discussions to follow in the next chapter.

1.1 INTRODUCTION

Xaris Energy (Pty) Ltd, a Namibian company, intends to develop, construct, operate and maintain a Natural Gas import and regasification terminal in the Port of Walvis Bay SADC Gateway area. The degasified gas will be used as fuel for a 300 MW open cycle gas fired power plant approximately 12 km east of the port. The development will comprise the following components:

- Floating Storage Regasification Unit (FSRU),
- Light marine trestle (trestle jetty) and overland pipelines for transporting the gas,
- Open cycle gas turbine power plant and water purification plant.

Due to time constraints and to secure flexibility in applying for environmental clearance, the proponent has opted to treat the major components of the project as separate EIAs and EMP's, with a combined public participation process. Each EIA component is mentioned below.

This document has been prepared as **EIA 1** as underlined:

- **EIA 1**: Ship based processes on-board the FSRU including berthing area of the FSRU and transport of the gas from the ship along a trestle jetty to the port premises (including associated dredging activities);
- **EIA 2**: Overland pipeline from the port premises to the power plant (including the port premises);
- **EIA 3**: Power plant including purification plant for the refinement of semi-purified effluent from the Walvis Bay municipal waste water treatment plant.

1.2 PROJECT LOCATION

Xaris intends constructing and managing a ***Floating Storage and Regasification Unit and trestle infrastructure in the Walvis Bay port*** to supply an Open Cycle Gas Turbine (OCGT) power plant within the proposed heavy industrial zone of the Walvis Bay Municipality, just east of Dune 7 and in the Dorob National Park (**Figure 1**).

1.3 TERMS OF REFERENCE

The EIA had been conducted in terms of the requirements as stipulated in the Environmental Management Act, EMA and its regulations (2012), which serve as EIA guidelines. The scope of work relates only to the proposed marine activities. During the assessment consideration had been given to the receiving environment (baseline description of the environment); alternatives to and within the proposed project as well as the legal framework.

A public participation process was followed in accordance with the EMA and based on the results thereof, integrated with above mentioned considerations, the Impact assessment section and related Environmental Management Plan (EMP) has been drafted.

1.4 NEED AND DESIRABILITY

Namibia is currently a net importer of power from the Southern African Power Pool (SAPP). In the short and medium term this supply pool is severely constrained due to pressure from demand growth in the region and lack of expansion to the required infrastructure to support this. Namibia is expected to face a supply deficit by mid-2016 when key contracts with neighbouring suppliers expire and therefore requires the development of base load generation capacity that will allow the country to move toward an acceptable level of autonomy from its neighbours.

It is for this reason that NamPower has called for tenders to supply short-term critical energy until the Kudu gas power project starts functioning in 2018 and conjunction with thereafter. Xaris have embarked on the development of a suitable power generation project that not only addresses the NamPower and country requirements. The project will improve the reliability and stability of the power supply system to meet the power shortage in the country. The project also makes provision for the incorporation of fuel from the Kudu gas project that may become available within the region and therefore further enhances the overall value and future capability of the Project.

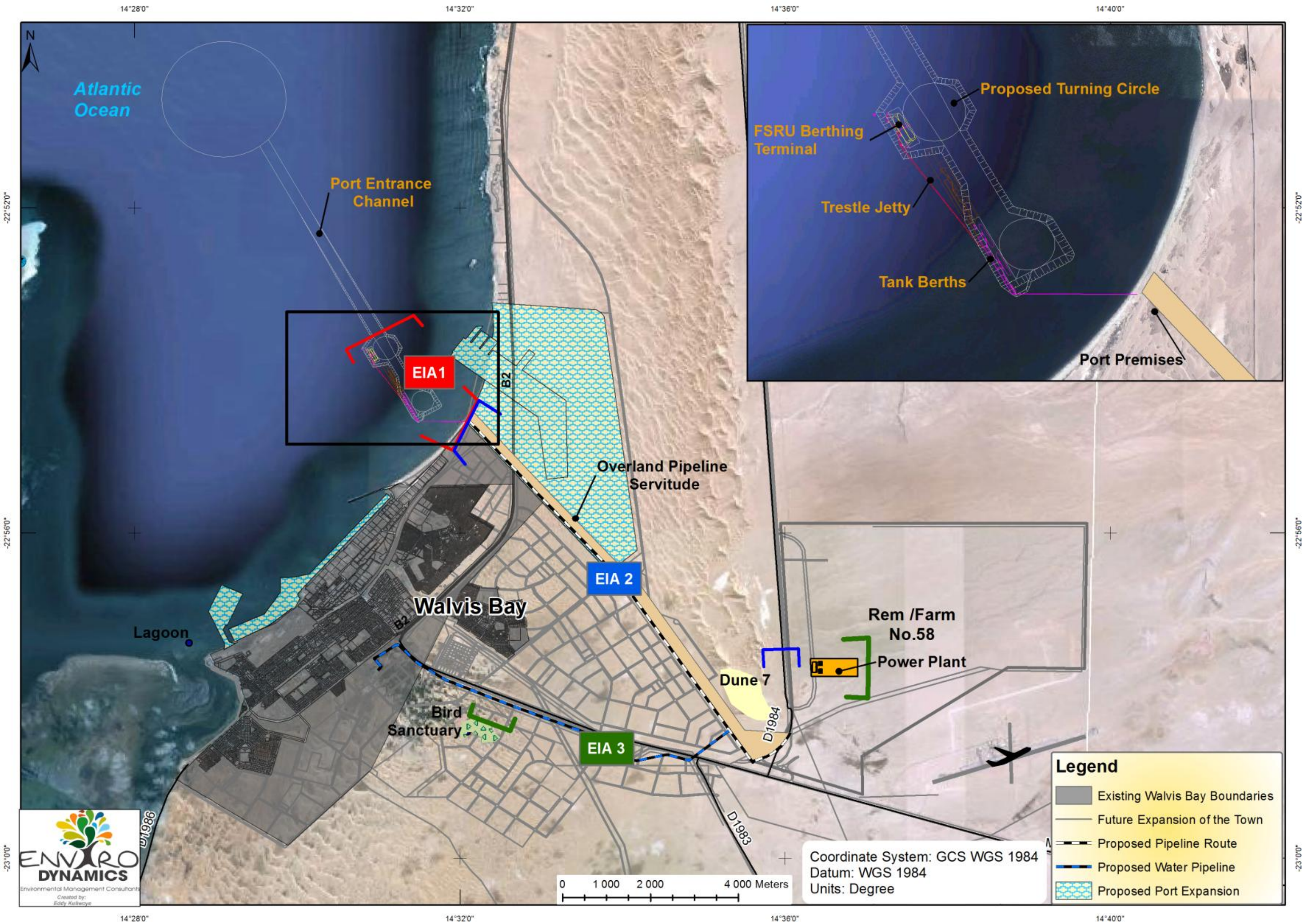

Figure 1: **EIA components of the greater project**

1.5 METHODOLOGY

The usual procedure for conducting an Environmental Assessment is described in **Figure 2** below. The procedure is based on the requirements of the EMA. The EIA team is responsible for coordinating the process as an independent entity from the project proponent.

An Environmental Impact Assessment (EIA) process was conducted and completed in 2014 with the intention to apply for Environmental Clearance (EC). The client decided to appoint Enviro Dynamics to continue with the application for EC and comply with lender requirements in 2015 by a second round of public consultation, additional specialist studies and compiling three separate Environmental Assessment Report (each including its own Environmental Management Plan (EMP).

During the inception / internal scoping meeting it was decided to continue immediately with a full Environmental Impact Assessment (EIA) due to the historical environmental assessment process (Scoping) which had been conducted. This approach was submitted to the Directorate of Environmental Affairs

Existing EIAs and EMPs with environmental clearance in the bay environment, specialist reports, previously conducted, and new specialist studies were considered during the compilation of this report. These reports include:

- Specialist investigations of air quality and noise impact assessment.
- Health Impact Assessment.
- EIA and EMP for the New Tanker Berth for the import and export of petroleum products in the port of Walvis Bay.
- Namport port dredging EMP.
- EIA for the strategic expansion of the Walvis Bay Container Terminal.
- SEA for the NAMPORT SADEC Gateway Port in Walvis Bay.

The EIA and EMP for the New Tanker Berth for the import and export of petroleum products in the port of Walvis Bay (Botha, Hooks, & Fauls, 2013).

- is located in the exact same area as the proposed project with
- exactly the same processes.

Using the same content and applying the same impact assessment with the same mitigation measures for the dredging and construction work was discussed with the Directorate of Environmental Affairs which approved of the process.

Therefore the

- dredging and trestle construction process proposed,

- the impacts considered and
- the mitigation measures proposed

in this EIA and it's EMP will correlate directly with or improve upon the content of the EIA and EMP for the New Tanker Berth for the import and export of petroleum products in the port of Walvis Bay (Botha, Hooks, & Fauls, 2013).

This EIA therefore followed the steps described in **Figure 2** except for the report that is usually produced at the end of the Scoping Phase. The proceedings required for the Scoping Report have been fully incorporated in this final EIA Report.

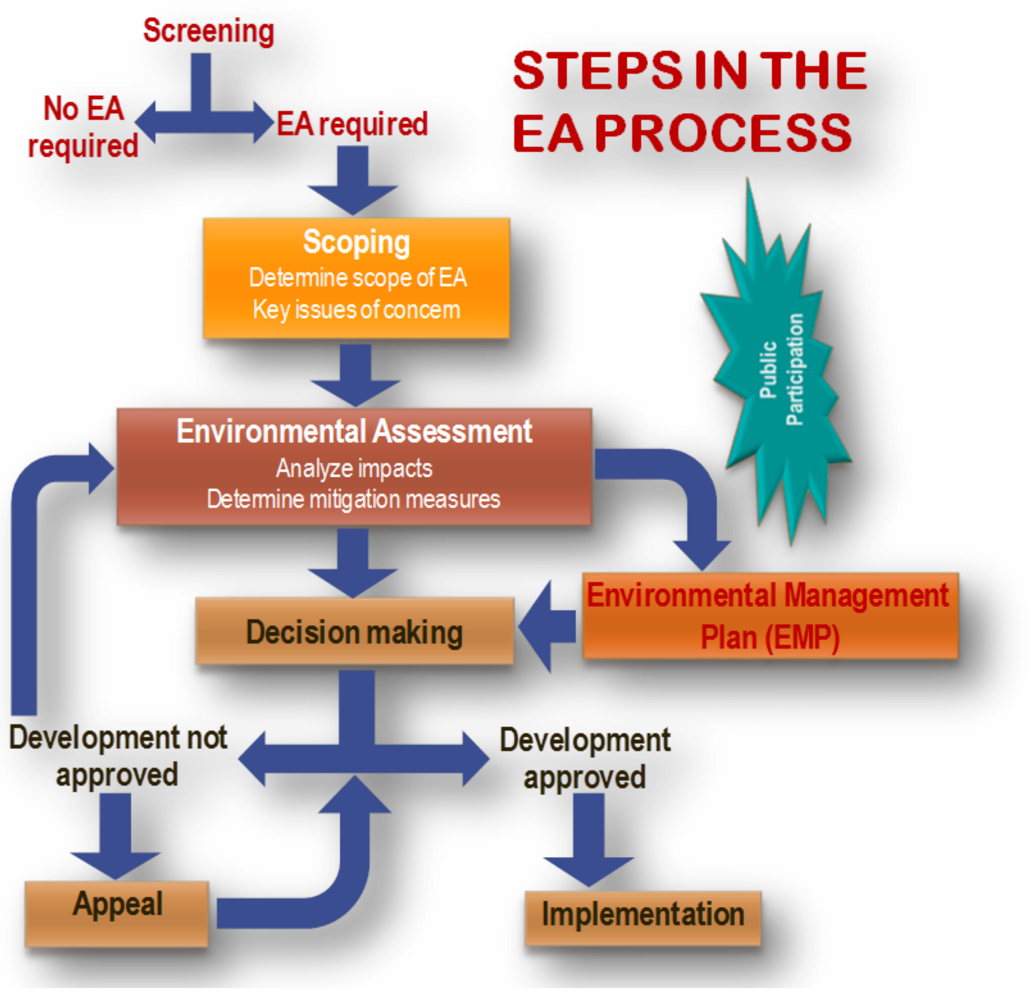

Figure 2: The Environmental Assessment Process

2 PROJECT DESCRIPTION

Xaris provided a project description, which has been detailed below. This includes a brief overall project description followed by a specific project component description. The purpose of Section 2 is to glean aspects of the project that may potentially affect the social and biophysical environment.

2.1 OVERALL PROJECT OVERVIEW

From receiving the Liquid Natural Gas (LNG) by means of Carrier (LNGC) vessels to generating up to 300 MW of electricity, the following processes are applied:

- Liquid Natural Gas is transferred from the LNGC vessel to a permanently moored FSRU located approximately 2.4 km from the shore within the Port of Walvis Bay SADC Gateway area
- Steam from the FSRU boilers is used to heat sea water circulated through the shell-and-tube vaporizers in the on board regasification plant. This increase in the temperature of the LNG results in the LNG to change from liquid to gaseous form.
- The gas is then conveyed to shore via a trestle pipeline to the control station on land. A subsurface pipeline of 12.5 km conveys the gas further to the power plant in the proposed heavy industrial area behind Dune 7 ((Xaris Energy (Pty) Ltd)).

In terms of land acquisition and required approvals Xaris Energy has secured or is in the process of securing the following:

- The proposed site for the power plant: The Walvis Bay Municipality has approved a resolution to conclude a lease agreement with a purchase option for the site as soon as possible. This is structured as a tri-partite agreement including government as signatory until the site is fully transferred to the Council.
- The proclamation of the heavy industrial zone and rezoning of the allocated land: In progress
- Way leaves for the port premises (on land), gas and water pipelines: Negotiations with Namport, Walvis Bay Municipality, Roads Authority, Government and NamPower respectively in progress.
- A Port Usage Agreement: Negotiations with Namport in progress for the usage of the marine area in the Port (i.e. not including dry land).

2.2 FUEL SELECTION

2.2.1 Properties of Natural Gas

Natural gas is a fossil fuel that is found in porous geological reserves beneath the earth's surface. In a gas state it consists of a blend of combustible hydrocarbon and non-hydrocarbon gases including methane, ethane, propane, butane, and pentane
(**Figure 3**).

Chemical Properties listed in order of abundance.

Methane (CH_4)	70-90%
Ethane (C_2H_6)	
Propane (C_3H_8)	0-20%
Butane (C_4H_{10})	
Carbon Dioxide (CO_2)	0-8%
Oxygen (O_2)	0-0.2%
Nitrogen (N_2)	0-0.5%
Hydrogen Sulfide (H_2S)	0-0.5%
Rare Gases Ar, He, Ne, Xe	trace

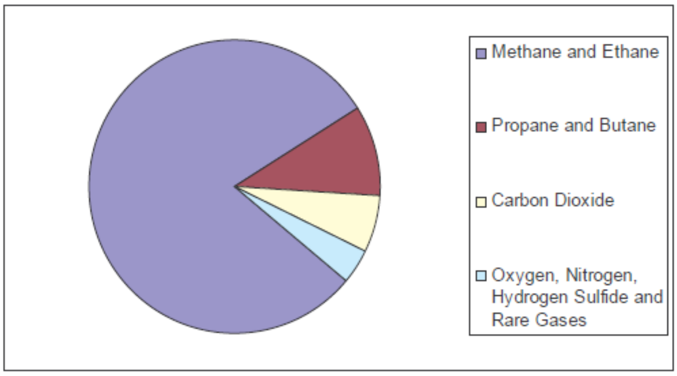

Figure 3: Components of raw natural gas (source: www.naturalgas.org)

When chilled to extremely low temperatures (-162 °C), the gas liquefies and has a 600 fold reduction in volume. This allows for the effective storage and transportation of a fuel with a much higher energy density (Chan, Hartline, Hurley, & Struzziery, 2004).

A typical liquefaction consists of the following processes:

- The gas is extracted and transported to a processing plant.
- It is purified by removing any condensates such as water, oil, mud, as well as other gases such as CO_2 and H_2S.
- Trace amounts of mercury is removed from the gas stream to prevent mercury from reacting with aluminium in the cryogenic heat exchangers.
- The gas is then cooled down in stages until it is liquefied.
- Natural Gas is finally stored in storage tanks and can be loaded and shipped.
- The natural gas liquefaction process inherently produces a product with reduced contaminants due to the phase change of the gas.
- Typical regasification is achieved through heating the liquid natural gas so that it expand and changes form from liquid back to gas (original state).

Natural Gas has the following properties which makes it the ideal fuel source:

- It is odourless, colourless, non-corrosive and dissipates when spilled.
- The propagation speed of its flame is approximately 40 cm/second which is why it is called a "lazy flame". A large amount of energy is stored in Natural gas which makes it a good fuel source but because of the slow propagation speed, the energy in Natural Gas cannot be released rapidly enough to create an explosion in an unconfined space.
- Natural gas can only burn if the concentration ratio of Natural Gas to air is within the flammable range of 5 percent to 15 percent. For Natural Gas to burn, it must first vaporize (return to a gaseous state), then mix with air in the proper proportions and then be ignited. If a leak occurs in the storage containers or pipeline, Natural Gas vaporizes rapidly, turning into a gas (methane plus trace gases), and mixing with air. Only if this mixture is within the flammable range (temperature)will there be a risk of ignition, but not explosion.
- When burning, the reaction yields carbon dioxide and water. All free carbon is consumed which is why it does not create black smoke.
- No chemicals or high pressures are used in the regasification or liquefaction process of Natural Gas.
- Because Natural Gas is lighter than water it will not mixed when spilled in water. It will float on top until it evaporates, leaving no residue behind.

2.2.2 Carbon Emissions

The carbon content of Natural Gas is typically between 60-70% and hence the products of natural gas combustion contain less Carbon Dioxide than fuels with higher carbon content. As illustrated in **Figure 4** for an equivalent amount of heat, burning natural gas produces about 30 percent less carbon dioxide than burning petroleum and about 45 percent less than burning coal (Xaris Energy (Pty) Ltd).

Natural gas typically has low sulphur levels (0.05 to 0.18% by mass) and therefore emissions of SO_x from natural gas combustion are low. Because natural gas is a gaseous fuel, filterable Particulate Matter (PM) emissions are also typically low. NO_x emissions are controlled by the use of Dry Low NO_x technologies and or turbine water injection.

Natural gas exists as a vapour at normal conditions and therefore any potential loss of gas would result in air emissions (Xaris Energy (Pty) Ltd,). Gas loss would typically be detected by pipeline pressure drop, in which case the pipeline will be shut off from the supply and investigated to ensure no further loss of product and reduced environmental impact. Natural gas has a very limited risk of soil and groundwater pollution.

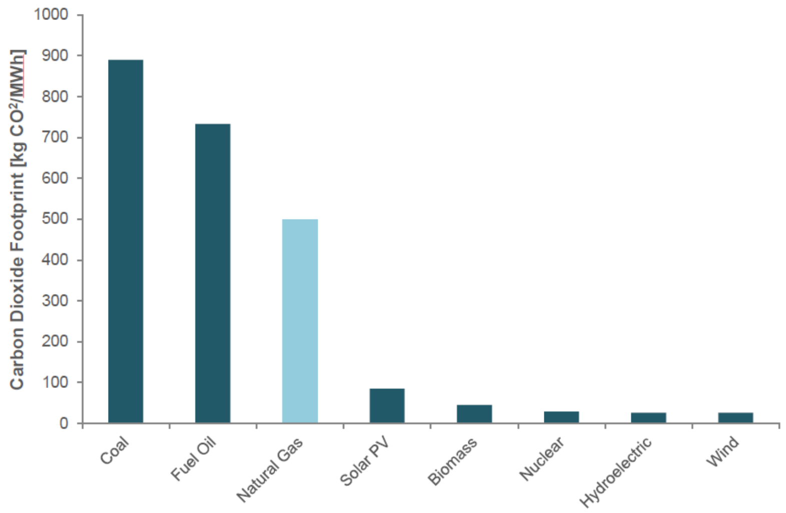

Figure 4: **Carbon footprint of various fuels in power generation (Xaris Energy (Pty) Ltd)).**

2.2.3 Natural Gas Markets

World trade in Natural Gas has more than tripled over the last 15 years, moving from an annual trade of 66 million metric tons per annum (MTPA) in 1997 to 240 MTPA in 2013 (Xaris Energy (Pty) Ltd,).

The Natural Gas market has been regionally split into the Atlantic Basin and Pacific Basin Markets. The Atlantic Basin is historically dominated by European buyers and the Pacific Basin dominated by Japanese and Korean buyers. The highest portion of global imports are attributed to the Pacific Basin (181.50 MMTPA) whereas the Atlantic Basin imports account for 62.05MMTPA (**Figure 5**).

Projections over the years 2015 to 2021 period indicate that supply will grow with a compounded annual growth rate ("CAGR") of 8.7%, from 264 MTPA in 2015 to 436 MTPA.

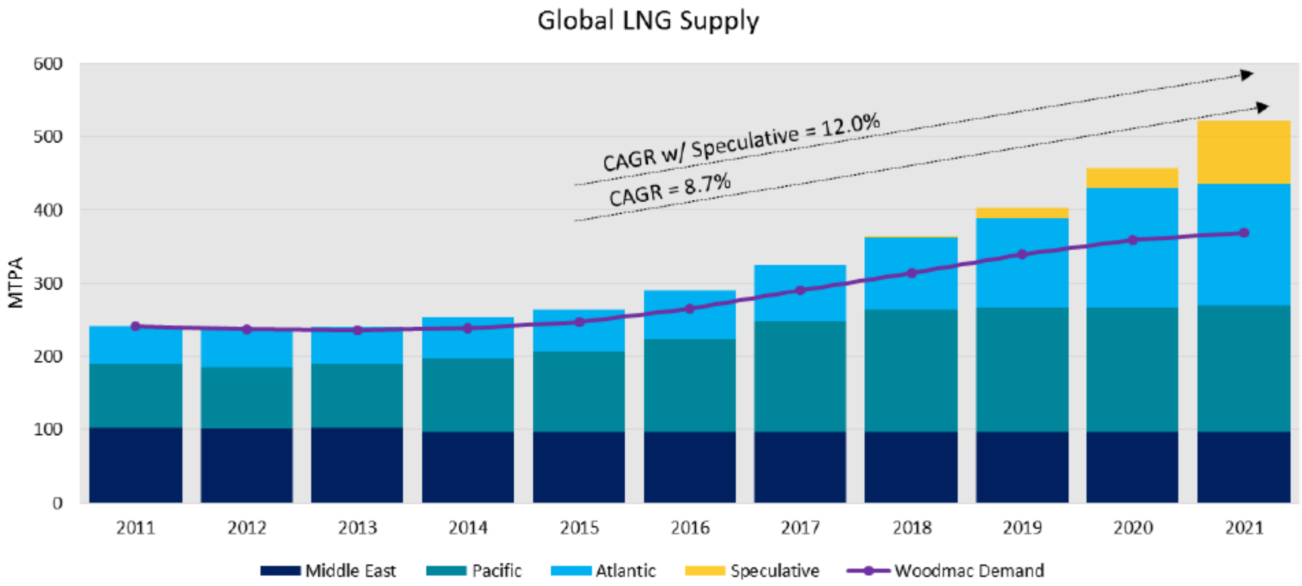

Figure 5: Global LNG supply market predictions.

2.2.4 Compatibility with Kudu Gas

The selected technologies fully support the development of the Kudu gas field as the Power Plant is flexible with respect to the proposed load factor. This means that once the Kudu gas project becomes operational, liquefied gas from the Kudu gas field can be supplied to the FSRU for use at the power plant. Furthermore any future gas infrastructural development in the region would seamlessly integrate with gas supply from the Kudu Fields.

The skills developed and utilised in the construction and operation of the plant, as well as the FSRU, overland and marine gas pipeline, will be invaluable in the development of skills for the Kudu gas field and any future Power Plant Projects.

2.3 KEY PROJECT COMPONENTS

This project will consist of the following components (**Figure 6**):

- Ship based processes on board the FSRU, berthing infrastructure to safely moor the FSRU and LNGC for regasification and transport of the gas from the ship along a trestle jetty to the port premises (including associated dredging activities);
- Overland pipelines for transporting the gas to the power plant
- Open cycle gas turbine power plant and water treatment plant.

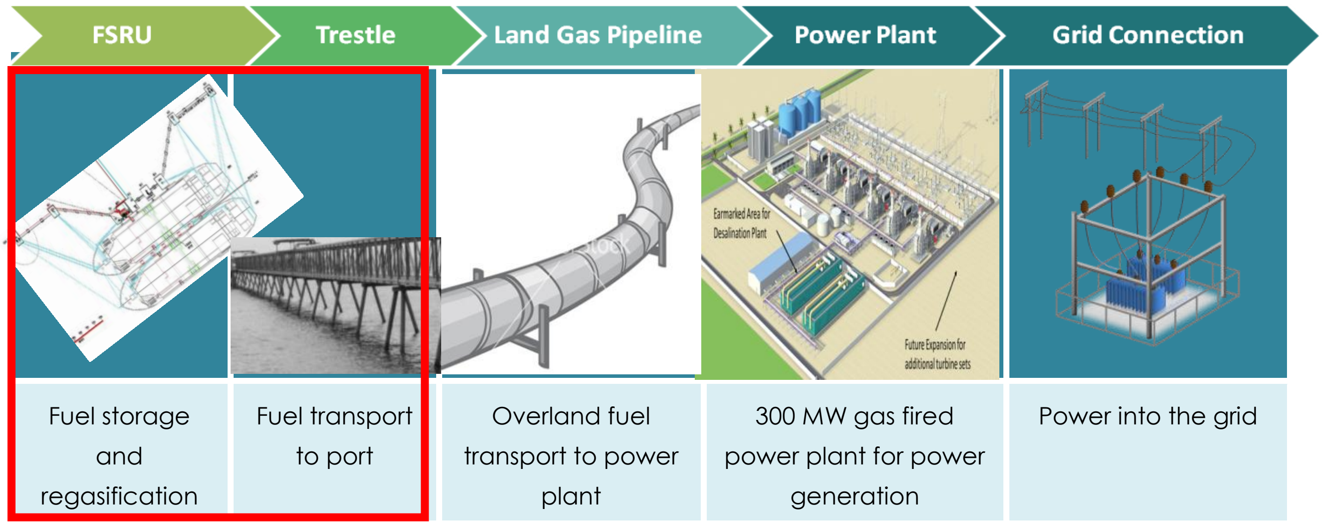

Figure 6: Key project components and technologies.

The subject of this study is highlighted in Figure 6 above.

The next section provides more information on the Ship based processes on-board the FSRU, berthing infrastructure to safely moor the FSRU and LNGC for regasification and transport of the gas from the ship along a trestle jetty to the port premises (including associated dredging activities).

2.4 BERTHING OF THE FSRU AND TRANSPORT OF THE GAS ALONG A TRESTLE JETTY TO THE PORT PREMISES

Xaris Energy (Pty) Ltd intends to utilise a Floating Storage and Regasification Unit (FSRU) that includes all the facilities and functions for the storage, regasification and metering of LNG. Once regasified, the gas will be transported along a trestle jetty to the port premises for use as fuel at the power plant. The floating storage solution, avoids the construction of expensive land-based import terminal and provides for major schedule benefits. This solution is also flexible for future expansion.

2.4.1 The Floating Storage Regasification Unit

The FSRU would be provided by the Original Equipment Manufacturer (OEM) and supplier, Excelerate Energy, and would remain moored in place at a nearshore berthing jetty connected to the gas port in a single berth or buoy configuration.

The FRSU will have a length of approximately 300 m and breadth of 45 m, with a draft of approximately 12 m and a nominal cargo capacity in the range of 138,000 to 152,000 m³ (**Figure 7**). Power required for operations and propulsion would be generated on-board.

The FSRU will include the following structures/facilities:

- LNG storage tanks
- Emergency vent system
- Shell-and-tube vaporization (STV) system for vaporization of LNG
- Living quarters to accommodate 30 permanent crew members' permanent needs.

The vessel is double-hulled and is designed with primary and secondary cargo containment systems to prevent leaks or ruptures in the unlikely event of a grounding or collision. The primary and secondary cargo containment systems are protected by the outer and inner hulls and separated from the inner hull by more than six feet of void space or water ballast.

What is the draft of a vessel?

It is the vertical distance between the waterline and the bottom of the hull, with the thickness of the hull included. Draft determines the minimum depth of water a ship or boat can safely navigate.

The LNGC and FSRU are equipped with emergency shutdown systems that significantly diminish the risk of an accidental release of LNG. On board fire and gas detection and firefighting systems automatically activate in case of fire. Special ship-operating procedures, crew training, and high standards of ship maintenance further contribute to safety.

2.4.2 FSRU and LNG Carrier Processes

Conventional LNG carriers will resupply the FSRU with LNG as needed. Each carrier will have nominal cargo capacities in the range of 127,000 m^3 to 177,000 m^3. To facilitate LNG transfer between the LNG Carrier (LNGC) and the FSRU the LNGC will be moored alongside the FSRU in a "double banking" (side by side) arrangement to enable a direct Ship to Ship Transfer (STS) of LNG.

Figure 7: An example of an FSRU.

The FSRU vaporization of LNG will utilize

- six high-pressure LNG pumps configured for operational flexibility and
- six high Pressure vaporisers, using shell and tube heat exchangers.
- The LNG is therefore pressurised (min 75 barg) and heated indirectly by heated water to a pre-determined gas temperature and pressure.

With this configuration, the FSRU will have a regasification capacity of up to 589,935m3/h, operating in the closed-loop operation (gas is used to heat HP Vaporizers). The FSRU vaporizer system is designed to operate between 75.0 and 104.0 barg.

The process is run via the FSRU Integrated Automated System (IAS) and protected via the Emergency Shutdown System.

The FSRU is fitted with two high-pressure gas connections: one on the port and the other on the starboard side. Gas from the FSRU is provided to the trestle pipeline by connecting one of these connections to a high-pressure manifold linked to the trestle pipeline.

The anticipated throughput at the facility has been defined as a maximum of 1,400 000 m^3 of LNG per annum, with carriers resupplying LNG to the FSRU every 40--60 days.

2.4.3 LNG Transfer

LNG provided from the carrier vessels will arrive fully cooled before transferring it to the FSRU. High pressure, low temperature carbon steel jetty approach pipe work will convey the gas from the jetty to the shore side. The pressure and temperature of the gas will be monitored at the jetty using controlled systems. A valve will be provided to shut off the flow of gas if the pressure (or temperature) exceeds the prescribed safe working parameters of the pipe work and downstream systems.

During this transfer cryogenic flexible hoses are used to resupply the FSRU with LNG at flow rates up to 6,000m^3/h for peak periods (but typical flow rates are in the order of 3,000 to 4,500m^3/hr). Six liquid hoses, and two vapour hoses are connected between the FSRU and the LNGC. The liquid hoses are each capable of transferring up to 1,000m^3/h. The LNGC cargo transfer pumps will be utilized in the transfer of liquid to the FSRU.

Figure 8: Transfer of LNG from carrier vessel to FSRU using cryogenic hoses.

2.4.4 Gas Liquefaction Process

The liquefaction of gas will be carried out at the supply loading facility. Prior to liquefaction, gas is pre-treated to remove components and impurities which would otherwise interfere with the liquefaction process. As such, the composition and characteristics of regasified LNG will normally meet Gas Network Entry Conditions (done during liquefaction process) for sulphur, hydrogen sulphide, carbon dioxide and water content without requiring additional treatment at the Terminal.

Table 1: Example LNG and Re-gas Composition and characteristics

COMPONENT	LEAN LNG (MOL %)	RICH LNG (MOL %)
Methane	96.09	89.75
Ethane	3.40	6.33
Propane	0.39	2.26
I-Butane	0.04	0.40
N-Butane	0.03	0.61
I-Pentane	0.00	0.02
N-Pentane	0.00	0.01
Hexane	0.04	0.00
Nitrogen	0.01	0.62
Carbon Dioxide	0.00	0.00
	100.00	**100.00**
Molecular Weight (kg/kmol)	**16.69**	**18.10**

The above liquefaction process will occur abroad at the respective loading facility of the LNG cargo

2.4.5 Vapour, boil-off Gas Control and Ship Emissions

For LNG to remain a liquid, it must be kept at temperatures below -162˚C on board the carrier vessels. Despite efficient insulation, ambient heat will inevitably warm and vaporize the LNG. The vapours created by this heating process are called "boil-off".

The FSRU and LNGC operators will actively manage boil off gas arising from the transfer. The LNGC operator will receive vapour from the FSRU and have the capability to manage the boil off gas using gas burning and/or re-liquefaction. The vapour and boil off gas will be managed within the operating limits specified for the LNGC and FSRU cargo tanks and no other boil off gas management facilities will be provided at the GasPort.

Vapour displaced by the loading of the FSRU cargo tanks will be returned to the LNGC to counter the "piston effect" caused by the LNG transfer. Some boil off gas will be used for electrical power generation and ship services and any surplus vapour burnt in the FSRU or LNGC boilers. Steam surplus to the requirements for heating and ship board power generation will be removed via steam "dump" valves to the open atmosphere.

The specialist impact study on air pollution (Valsamakis, 2015) makes the statement that the emmisions at the FSRU is negligible due to the closed, controlled system applied in the regassifying process.

2.4.6 Ballast Water System

The FSRU will have a water ballast system in order to maintain its draft, trim and stability during loading and regasification. The FSRU will discharge ballast water during LNG offloading from the carrier and will take on ballast water to offset the hourly vaporization rate of up to 2,500 m3/hr.

2.5 BERTH, JETTY AND JETTY APPROACH FACILITIES

The berthing and jetty facilities will be designed to facilitate the safe berthing and mooring of the FSRU and the LNGC and to receive gas from the FSRU. The jetty approach facilities will be designed to convey the gas to the onshore port premises. The light weight trestle shall be separate and run parallel to the planned oil tanker berth trestle – up to 40m spacing between the two trestles.

2.5.1 Berthing System

The jetty has been designed to accommodate vessels with a carrying capacity of between 138,000 to 151,000 m^3. The berth pocket will be approximately 370 m long, 60 m wide and 15.5 m deep.

For this project a single berth jetty, LNG off-take using side-by-side mooring (**Figure 9**) is considered. This configuration requires the transfer of LNG from the carrier vessel onto the FSRU using a side-by-side transfer. The LNGC berths alongside the FSRU and

LNG is transferred using flexible Ship-to-Ship Transfer Hoses on the FSRU. A second set of high pressure loading arms and piping then transfers the gas from the FSRU to the jetty and into a trestle jetty pipeline.

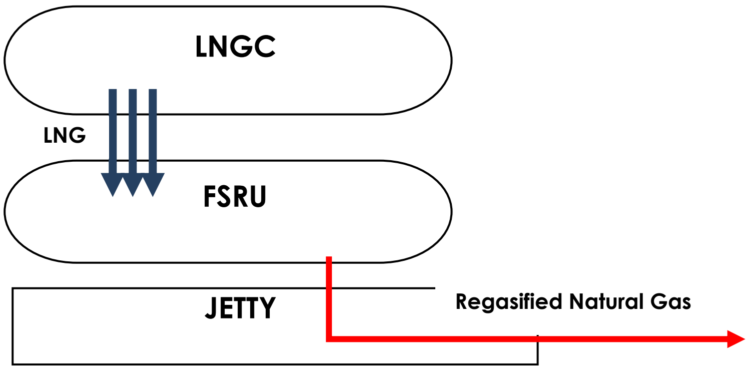

Figure 9: Schematic diagram of the vessel configuration in the berthing area (bouble banking).

The Berthing system will provide the facilities for the vessel to dock, and will include functions for met-ocean monitoring and mooring hook load monitoring. It will be equipped with a central computer system that allows the operator to monitor and supervise critical docking characteristics of its berth, including hook load, ship approach and met-ocean data and will interface with the Ship-to-Shore Link (SSL) system linked to a control panel in the port premises to hook load and met-ocean data to the ship while the vessel is docked.

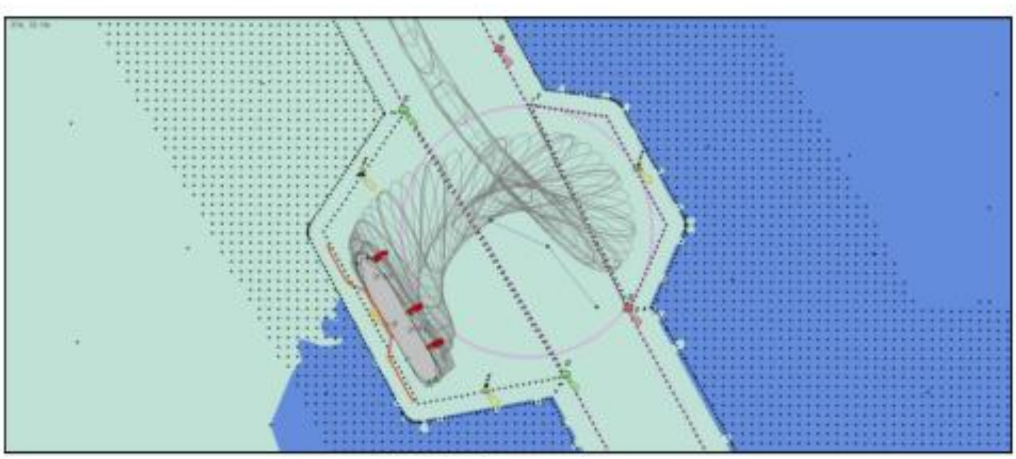

Figure 10: A simulation of how the vessel will be navigated to the Berth.

2.5.2 The Trestle Jetty

The Trestle Jetty will be a fixed structure of reinforced concrete deck on piles or alternative as agreed with NamPort (**Figure 11**). Each foundation will consist of two steel piles of 1.016m diameter. The two piles will have a combined approximate disturbed footprint of 14.2m^2 (if the disturbance diameter is 3m). The span between foundations is 15m maximum. It is expected that there will be at least 354 piles. The resulting disturbed seabed footprint is 2,515m^2.

It will consist of:

- A "Sea island" including Breasting Dolphins, Mooring Dolphins, Loading Platform, Walkways, Quick Release Hooks, Fenders, Navigational Aids, Utilities, Gangway
- Trestle & related pipelines from FSRU to Port Station via a light trestle structure.

Figure 11: An example of a trestle jetty.

2.5.3 Jetty Control Room

A GasPort Control Room (GCR) will be provided to house operator work stations, the Plant Control System (PCS) as well as emergency shutdown, fire and gas detection and communication systems.

2.5.4 GasPort

The proposed GasPort includes a jetty-mounted, articulated, high-pressure gas-offloading arm which will be used to convey high pressure re-gasified LNG from the FSRU high pressure manifold to the jetty pipeline.

Low Temperature, Carbon Steel pipeline works (Class 900) (incorporated immediately downstream of the arm) will provide isolation capability in the gas operations in the event of an emergency or unexpected change in temperature or pressure which would exceed design parameters.

In addition, gas loss would typically be detected by pipeline pressure drop, in which case the pipeline will be shut-off from the supply to ensure no further loss of product and reduced environmental impact.

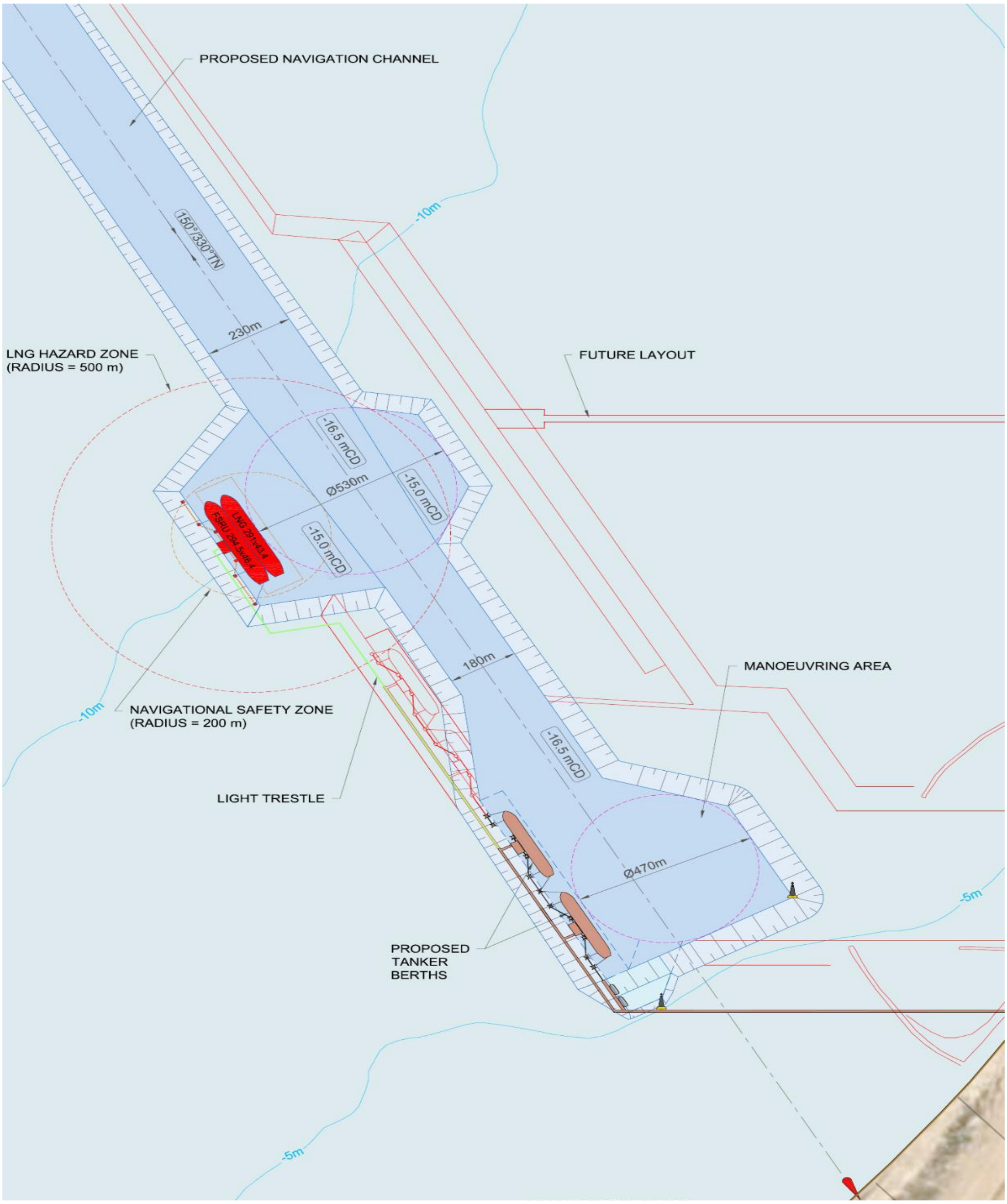

Figure 12: Location of the berthing area of the FSRU and LNGC.

2.6 DREDGING

Dredging works are required in order to safely accommodate the manoeuvring of the FSRU and LNGC vessels. It includes the following:

- A portion from the beginning of the navigation channel to the south eastern edge of the turning circle, situated in the proximity of the -10 m CD contour.
- Widening of the planned entrance channel for the LNG berthing purposes from 180 m to 230 m from channel entrance to the LNG berthing terminal as per NamPort requirements.
- Dredging of the FSRU and LNG vessels berthing pockets and a 265m radius (530m diameter) turning circle opposite the berthing pocket.

The scope of work related to marine works is based on the following:

- The depth requirement of:
- -16.5m CD for the entrance channel
- -15.5m CD for the berthing pocket
- -15.0m CD for the turning basin.
- The channel width required is 230 m.
- The minimum length of the berth pocket will be approximately 370 m and 60 m wide.
- H2S protection on the dredgers should be provided if required during dredging.

As recommended in *Update of the EIA for the Capital and Maintenance Dredging of Walvis Bay Harbour* (Geo Pollution Technologies, 2013) (maintenance dredging to be conducted by NamPort) a trailing suction hopper dredger should be utilized for dredging activities. This type of dredger has large, powerful pumps and engines that enable it to suck up sand, clay, sludge and even gravel from ocean floors.

Dredging material will be discarded at the NamPort approved disposal site (X: 444077.507 Y: 7474110.151 (UTM 33S)) according to permitting and EIA requirements.

2.7 CONSTRUCTION COST, PERIOD AND RESOURCES

The overall project construction period for the marine components is 12 -15 months.

The marine components will cost US$ 180 million to construct, US$ 1.2 million/annum to maintain and US$ 269 million/annum to operate (including the FSRU Time Charter Party Agreement). This figure includes anticipated fuel cost for the power plant.

Up to 202 people will participate in the construction process and will be sourced from Namibia if the skill is available. Some specialist skills will have to be imported from the US, South Africa and Turkey (Garanit Koza Energy (GKE)).

3 LEGAL AND REGULATORY REQUIREMENTS

3.1 INTRODUCTION

This chapter informs the reader on:

- The activities that require environmental clearance.
- Legislation that regulates the project environment.
- IFC guidelines that apply to the EIA and the project life cycle.
- IFC performance standards that apply to this project and how it will be incorporated.

3.2 LISTED ACTIVITIES THAT REQUIRE ENVIRONMENTAL CLEARANCE

The Environmental Management Act (Act No. 7 of 2007)(EMA) Government Notice No. 29 of 2012 stipulates which activities have to obtain an Environmental Clearance Certificate in Namibia. In terms of this assessment and proposed line the following activities apply:

Table 1: Summary of listed activities

ANNEX SECTION	ANNEX DESCRIPTION	PROJECT COMPONENT RELEVANT IN THIS EIA
8.10	Reclamation of land from below or above the high water mark of the sea or associated inland waters.	Dredging of berth and channel. Trestle foundation piling.
9.1	The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.	LNG Carrier and FSRU transfer of LNG, storage of LNG, re-gasifying process and pumping of Natural Gas to shore.
9.3	The bulk transportation of dangerous goods using pipeline, funiculars, or conveyors with a throughout capacity of 50 tons or 50 cubic meters or more per day.	Storage of LNG and pumping of natural gas.
9.4	The storage and handling of a dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin, in containers with	LNG Carrier and FSRU storage of LNG

ANNEX SECTION	ANNEX DESCRIPTION	PROJECT COMPONENT RELEVANT IN THIS EIA
	a combined capacity of more than 30 cubic meters at any one location.	
10.1	Construction of a) oil water, gas and petrochemical and other bulk supply pipelines. b) any structure below the high water mark of the sea.	Construction of berth, trestle pipeline and dredging activities

This report has been compiled in support of and Environmental Clearance Application, as mentioned above. **Appendix C** contains a table with all the additional legislation that has been considered during the compilation of this report.

3.3 REGULATORY DOCUMENTS RELEVANT TO THE PROJECT ENVIRONMENT

Table 2 below summarise the key legislation and guidelines that govern the environmental assessment process for this EIA.

Table 2: Regulatory documents guiding the EIA

FIELD	INSTRUMENT AND CONTENTS
Finance	The International Finance Corporation (IFC)
	Equator Principles
Marine	The Benguela Current Commission (BCC)
	UN Convention on the Law of the Sea, 1982 (UNCLOS)
	The Ramsar Convention (RC)
	UN Convention for the Prevention of Marine Pollution from Land-based Sources
	Convention on Biological Diversity Rio de Janeiro (1992)
	United Nations Framework Convention on Climate Change (UNFCCC) (1994)
Noise	South Africa - GNR.154 of January 1992; South Africa - GNR.155 of 10 January 1992; SANS (South African National Standards) 10103:2008; SANS 10328;

FIELD	INSTRUMENT AND CONTENTS
	SANS 10357,
Air	WHO, (2005): WHO Air quality guidelines IFC, (2007): Environmental Health and Safety Guidelines,
Water	South African Water Resources Management Act: Water quality standards World Health Organisation (WHO): Water Quality Standards
Marine Pollution	Territorial Sea and Exclusive Economic Zone of Namibia (No 3 of 1990, amended by Act 30 of 1991
	Dumping at Sea Control Act, N.73 of 1980
	The Marine Resources Act 2000
	Marine Notice No. 2 of 2012 issued by the Ministry of Works and Transport
	Namibian Ports Authority Act 2 of 1994
	Prevention and Combating of Pollution of the Sea by Oil Act (No. 6 of 1981)
	Prevention and Combating of Pollution of the Sea by Oil Amendment Act (No. 24 of 1991)
	Pollution Control and Waste Management Bill:
	Labour Act (1992) and Affirmative Action (Employment) Act 29 of 1998
	Hazardous Substances Ordinance 14 of 1974:
	Public Health Act 36 of 1919:
	Water Act No 54 of 1956 is still in force
	Atmospheric Pollution Prevention Ordinance 11 Of 1976

All materials used during the construction of the marine components of the project should adhere to international standards and requirements for LNG and Natural Gas operations (such as International Finance Corporation requirements and ASME requirements). These have been documented and all specifications should be kept on site.

3.4 IFC STANDARDS THAT GUIDE THE MARINE COMPONENTS EIA

The International Finance Corporation has set a series of performance standards and guidelines to assure accountability to the financing process in terms of the socio-economic and biophysical environment. The relevance of these performance standards to this project is set out below in **Table 3**.

The IFC Guidelines provide a particular focus on:

- Environmental Health and Safety Guidelines for Liquefied Natural Gas (LNG) Facilities (International Finance Corporation, 2007) which covers
- Spill Risk Assessment.
- Spill Prevention and Control Plan.
- Spill Control Response Plan.
- Design and materials selection.
- Waste water, air emissions, noise, and occupational health and safety management (including cold surfaces, hazardous substances, fire and H2S emissions).
- Environmental Health and Safety Guidelines for Shipping (International Finance Corporation, 2007) which covers:
- Spill Prevention Procedures for gas/LNG transfer.
- Emergency plans when LNG is accidentally released.
- Noxious Fluids Spill prevention Plan.
- Removal or reduction of tributyltin, copper and biocides from antifouling hull paint.
- Ballast and waste water, air emissions, waste, noise, and occupational health and safety management (see above).
- Environmental Health and Safety Guidelines for Ports and Harbors (International Finance Corporation, 2007), which is managed under the Namport authority management plans.

Table 3: Relevant IFC performance standards

PERFORMANCE STANDARD	FOCUS AREA AND DESCRIPTION	RELEVANCE AND REQUIREMENTS SET
1: Social and Environmental Assessment and Management Systems:	Emphasizes "*the importance of managing social and environmental performance throughout the life of a project*". The management process of "*plan, implement, check and act entails the thorough assessment of potential social and environmental impacts and risks from the early stages of project development and provides order and consistency for mitigation and managing these on an ongoing basis*".	Limited relevance that is likely only to indirectly enhance long-term socio-economic conditions. Establish and maintain a Social and Environmental Management System that is applicable to the size and nature of the project. Require Social and Environmental Assessment, relevant Management Plan, organizational capacity, training, community engagement, monitoring and reporting
2: Labour and Working Conditions	Acknowledges "*that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers*". A "*sound worker-management relationship is a key ingredient to the sustainability of the enterprise*".	Adopt a human resources policy appropriate to the project size that sets out its approach to managing employees in consistence with the IFC requirements
3: Pollution Prevention and Abatement	Recognizes "*that increased industrial activity and urbanization often generate increased levels of pollution to air, water and land that may threaten people and the environment at the local, regional and global level*". Outlines "*a project approach*" towards "*pollution prevention and abatement*" in line with	Managed through the Social and Environmental Management Systems and must be incorporated therein.

PERFORMANCE STANDARD	FOCUS AREA AND DESCRIPTION	RELEVANCE AND REQUIREMENTS SET
	"internationally disseminated technologies and practices".	
4: Community Health, Safety and Security	*"acknowledges the public authorities' role in promoting the health, safety and security of the public",* *"addresses the clients responsibility to avoid or minimize the risks and impacts to community health, safety and security that may arise from project activities".*	Managed through the Social and Environmental Management Systems and must be incorporated therein. Entails adherence to Environmental Health and Safety Guidelines for: Liquefied Natural Gas (LNG) Facilities Shipping Ports and Harbors
5: Land Acquisition and Involuntary Resettlement	Recognizes that "project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood1) as a result of project-related land acquisition and/or restrictions on land use.	The Project site is situated within the Dorob National Park and planned heavy industry zone. The marine facilities is situated in the Port of Walvis Bay SADC Gateway approved port zone. The project does not entail land acquisition or resettlement of communities. This Performance Standard is thus not applicable to this Project.
6: Biodiversity Conservation and Sustainable Natural Resource Management	Recognizes *"that protecting and conserving biodiversity and its ability to change and evolve, is fundamental to sustainable development".* This Performance Standard *"reflects the objectives of the Convention on Biological Diversity to conserve*	Managed through the Social and Environmental Management Systems and must be incorporated therein. The habitat is considered as modified by existing human activities. This includes the area of channel and berth dredging and

PERFORMANCE STANDARD	FOCUS AREA AND DESCRIPTION	RELEVANCE AND REQUIREMENTS SET
	biological diversity and promote use of renewable natural resources in a sustainable manner".	foundation piling.
7: Indigenous Peoples	Recognizes that Indigenous People ("*social groups with identities that are distinct from dominant groups in national societies*") are often among the most "*marginalized and vulnerable segments of the population*". Indigenous People are exposed to "*different types of risks and severity of impacts than other communities including loss of identity, cultural and natural resource-based livelihoods*", etc. On the other hand development projects "*may create opportunities for Indigenous People to participate in and benefit from project-related activities that may help them fulfil their aspiration for economic and social development.*	No relevance to the project for there is no indigenous people affected by the project.
8:_Cultural Heritage	"*recognizes the importance of cultural heritage for current and future generations*".	Managed through the Social and Environmental Management Systems and must be incorporated therein.

3.5 CONCLUSION AND APPLICATION

These IFC standards and guidelines as well as the Equator Principles will be used through the impact assessment process and the development of the EMP to

- assure the project complies to international environmental best practice and
- assure improvements on the project design, implementation and operations are continually considered and applied.

4 THE RECEIVING ENVIRONMENT

The information outlined below has been sourced from primary data (site visits conducted) and secondary literary sources. Previous assessment work was conducted in the area and Mendelsohn, et al. (2009). The social environmental description has been sourced from the Walvis Bay Integrated Urban Spatial Development Framework (Urban Dynamics Africa, 2012).

The structure of this receiving environment chapter is as follows. First a broad overview description of the Walvis Bay Townlands is provided, followed by an overview of the overall project area and finally a description of the environment directly affected by the individual project component is provided. This chapter also includes sensitivities of key environmental features affected by the Port Premises and Natural Gas Pipeline as well as the potential impacts associated with these effects (**Table 6**).

4.1 OVERVIEW WALVIS BAY ENVIRONMENT

Walvis Bay is located within the central coastal region of Namibia. This environment has been (and continues to be) shaped by a combination of large scale ocean and atmospheric conditions, namely the northward flowing cold Benguela ocean current and the South Atlantic Anticyclone respectively.

Weather conditions in and around Walvis Bay are unique and are driven by the large scale features mentioned above. The main features include low radiation and sunshine levels, low temperatures, low rainfall, but frequent fog and strong and frequent winds (see **Table 4** below).

Table 4: Summary weather statistics for Walvis Bay

VARIABLE	VALUE	VARIABLE	VALUE
Ave. annual temperature (°C)	<16	Prevailing wind direction	South-west
Fog frequency (days/year)	50-100	Ave. wind speeds (m/s)	2-4
Ave. annual rainfall (mm)	<50	Radiation (kWh/m^2/day)	<5.4
Humidity (%) summer & winter	>90 & 65	Sunlight (hours/day)	<5

The cold Benguela ocean current is a major driver of marine life. Winds driven by the South Atlantic Anticyclone cause the offshore movement of surface water and gives rise to flow of colder nutrient rich water from the ocean depths. This phenomenon is known as upwelling and is responsible for the abundance of fish and other marine resources. Several upwelling cells occur along the Namibian coastline, one of which is located adjacent to Walvis Bay's coastline.

A coastal spit is a landform that develops as a result of sediment deposition as sediment is transported along the coast. A coastal spit (terminating at Pelican Point) provides protection for Walvis Bay from turbulent conditions in the Atlantic Ocean. This southernmost portion of this sheltered area (i.e. the lagoon) is a biodiversity hotspot demonstrated by its declaration as a Wetland of International Importance (Ramsar Site) (see **Figure 14**).

The Walvis Bay environment consists of several key physical geographical features. Dune fields (coastal, inland, vegetated and unvegetated) are one such prominent feature, most notably the Namib Sand Sea located to the south of the townlands. A major ephemeral river – Kuiseb River (and its delta) is another prominent feature and forms the boundary between sand sea to the south and the gravel plains to the north. The lower reaches of the Kuiseb River are underlain by a productive groundwater reserve (aquifers) that supplies Walvis Bay's potable water needs. An artificial wetland has developed overtime from the overflow of Walvis Bay's treated wastewater. The unique biophysical configuration of the Walvis Bay environment and the coastal Namib in general, gives rise to high levels of species endemism and biodiversity (see **Figure 15**).

The economy of Walvis Bay is based largely on fishing and aquaculture, tourism, port activities and manufacturing. The Walvis Bay population was estimated at 80 000 in 2012 and with a population growth rate of 4.7% (averaged over the past 16 years) is expected to more than double by 2030 to approximately 180 000 (Urban Dynamics Africa, 2012). Unemployment for the Erongo region is estimated at 30% (Republic of Namibia (RN): National Statistics Agency (NSA), 2011).

The major constraints to the future development of Walvis Bay include the sensitive Kuiseb Delta area to the south and a prominent dune belt to the north, both which fall within the Dorob National Park (**Figure 15**). This national park is a state protected area. Hence, the reasonable growth direction is eastward (inland).

Existing serviced industrial land is scarce and not suitable for noxious industrial activity. In light of this, the Walvis Bay Municipality (WBM) has approved the establishment of a heavy/noxious industrial area to the east of Dune 7, north and west of the Rooikop Airport. This area currently also falls within the Dorob National Park. Hence, ambiguity currently exists regarding the ownership of "Farm 58". The Ministry of Environment and Tourism (MET) and the WBM will need to clarify this matter and the way forward.

The WBM has adopted a new vision for the period 2012-2022. The WBM is aiming to "facilitate the substantial transformation of Walvis Bay from its present status as a small tourism destination and a semi-industrial port town based mainly on fishing, into a modern regional capital and the primary industrial city of Namibia" (Urban Dynamics Africa, 2012). In line with this vision the WBM has plans to expand the harbour and their road network. The establishment of several residential and industrial townships is also planned (**Figure 14**).

4.2 OVERVIEW OF PROJECT ENVIRONMENT

The project-specific receiving terrestrial environment can generally be divided into two components, namely, the coastal and inland dune fields and the gravel plains further inland. The coastal and inland dune fields are located along the fringes of the existing built-up area and as such have been exposed to human activity and the associated habitat degradation. The gravel plains have a unique biologically sensitive soil crust that supports several endemic plant species, most notably lichens. These plains likewise because of their proximity to Walvis Bay's existing built-up area have been subjected to habitat disturbance and degradation.

The project-specific receiving marine environment is located near the northern edge of the sheltered bay area. The area affected by the FSRU (and associated development) and Trestle Jetty is approximately 6.5 km in length stretching from the high water mark approximately 1.5 km north of the current built-up area off-shore in a north-westerly direction (**Figure 14**).

The following table summarises some of the key characteristics Walvis Bay's marine environment.

(For referencing purposes the Chart Datum (CD) for Walvis Bay is 0.966 m below the Walvis Bay official Land Levelling Datum.)

4.3 DESCRIPTION OF ENVIRONMENT SURROUNDING FLOATING STORAGE REGASIFICATION UNIT AND TRESTLE JETTY

4.3.1 Summary Description of Physical and Social Environment

Table 5: Summary description of key environmental features pertaining to the FSRU and Trestle Jetty

BASELINE ENVIRONMENT			
PHYSICAL ENVIRONMENT		SOCIAL ENVIRONMENT	
Tides, currents and waves (CSIR, 2010)	Semi-diurnal tidal cycle, with mean spring tide range of 1.42 m(0.27 – 1.69 m) and mean neap tide range of 0.62 m (0.67 – 1.29 m). Benguela current speed: 0.25 – 0.35 m/s, with a north-west netflow direction (CSIR, 2010). Majority of waves approaching Pelican Point originate from the south. The predominantly wind-forced water circulation within the bay, near the shore in the vicinity of the project site, is northerly (Botha, et al., 2013). The refresh rate of the bay and lagoon is approximately 7 days.	**Infrastructure & Services**	No port facilities are currently in place. The nearest port facilities are located to the south of the proposed site. Plans exist for the expansion of the port area to within the vicinity of the proposed project. A new tanker berth and associated infrastructure are in development for the import and export of petroleum products. A new entrance channel will be dredged.
Features of coastal water	Max. sea surface temp. (Feb) 17.9 °C (Robertson, et al., 2012). Min. sea surface temp. (Aug) 13.4 °C. Total Suspended Solids (TSS) (averaged over 1 749 samples collected between Nov 2012 – Mar 2013) at -	**Ownership of coastal water**	The lagoon area is a declared Wetland of International Importance (Ramsar site) and as such falls under the ownership of the MET (see Figure 14). North of the Ramsar site up until the Port Limit (see

BASELINE ENVIRONMENT			
PHYSICAL ENVIRONMENT		SOCIAL ENVIRONMENT	
	3 m CD approximately 2 km from the proposed site was 3.22 mg/l (Botha, et al., 2013). This figure is well below the recommended low risk scenario. The TSS value was used to determine turbidity, which was recorded at 2.12 NTU. The Chemical Oxygen Water (COD) is an indicator of the how much oxygen is consumed per unit volume of water. Increasing the dead/decaying organic material in a body of water increases the COD. Effluents released into the bay area are limited by the Water Act (54 of 1956) to 75 mg COD/l.		Figure 15) the bay area extending landward up to the High Water Mark is under the ownership of NamPort. Aquacultural proponents have use rights obtained from NamPort to carry out aquacultural activities (see **Figure 14**) adjacent to the east of the Walvis Bay peninsula.
Sea floor Sediment	The depth of the affected area ranges from approx. -20 m CD (Chart Datum, which is the lowest astronomical tide) at the entrance to the navigation channel to approx. -8 m CD at the seaward end of the trestle jetty (Botha, Hooks, & Fauls, 2013). **Composition**: sediment, if categorised according to grain size, is a combination of fine material (silts and clays) to more coarse material (various sands). Proportions of fine and coarse material within sediment varies significantly across the bay area. Fine material contains decaying organics, which results in the accumulation of hydrogen sulphide and methane	**Uses within coastal area**	NamPort undertakes various port activities including transport and storage of a wide variety of commodities. Several aquaculture projects (oyster and mussel farms) exist adjacent to the east of the Walvis Bay peninsula. Tourism activities (catamaran and ship cruises and bird/marine mammal watching) take place within the bay area along the Walvis Bay peninsula. Movement of Namibian Defence Force naval patrol vessels.

BASELINE ENVIRONMENT			
PHYSICAL ENVIRONMENT		SOCIAL ENVIRONMENT	
	gas in the sediment. Furthermore potentially toxic substances (i.e. heavy metals) can accumulate particularly in fine sediment (Botha, et al., 2013). Concentrations of arsenic, cadmium, chromium, copper and nickel (ave. over 15 samples collected adjacent to the proposed berthing area between Dec 2010 and Apr 2011) exceeded BCLME guideline values. However, probable effects are only expected with the concentration of cadmium (Botha, et al., 2013). **Distribution**: in general grain size of sediment increases toward the shoreline (i.e. fines in deeper water and sands near the shoreline).		

Figure 13: **Sandy beach at proposed project site and view to port**

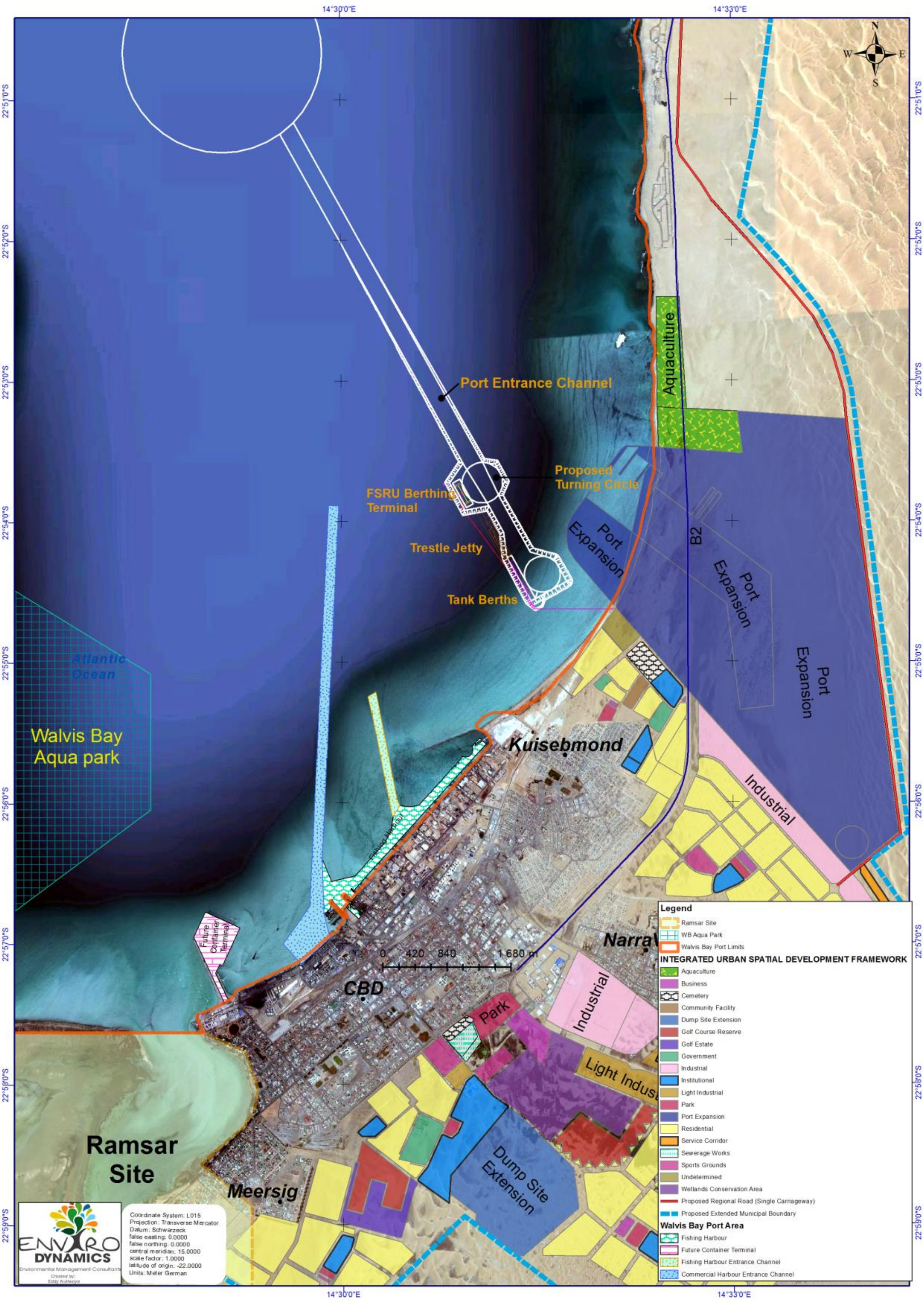

Figure 14: **Marine environment context**

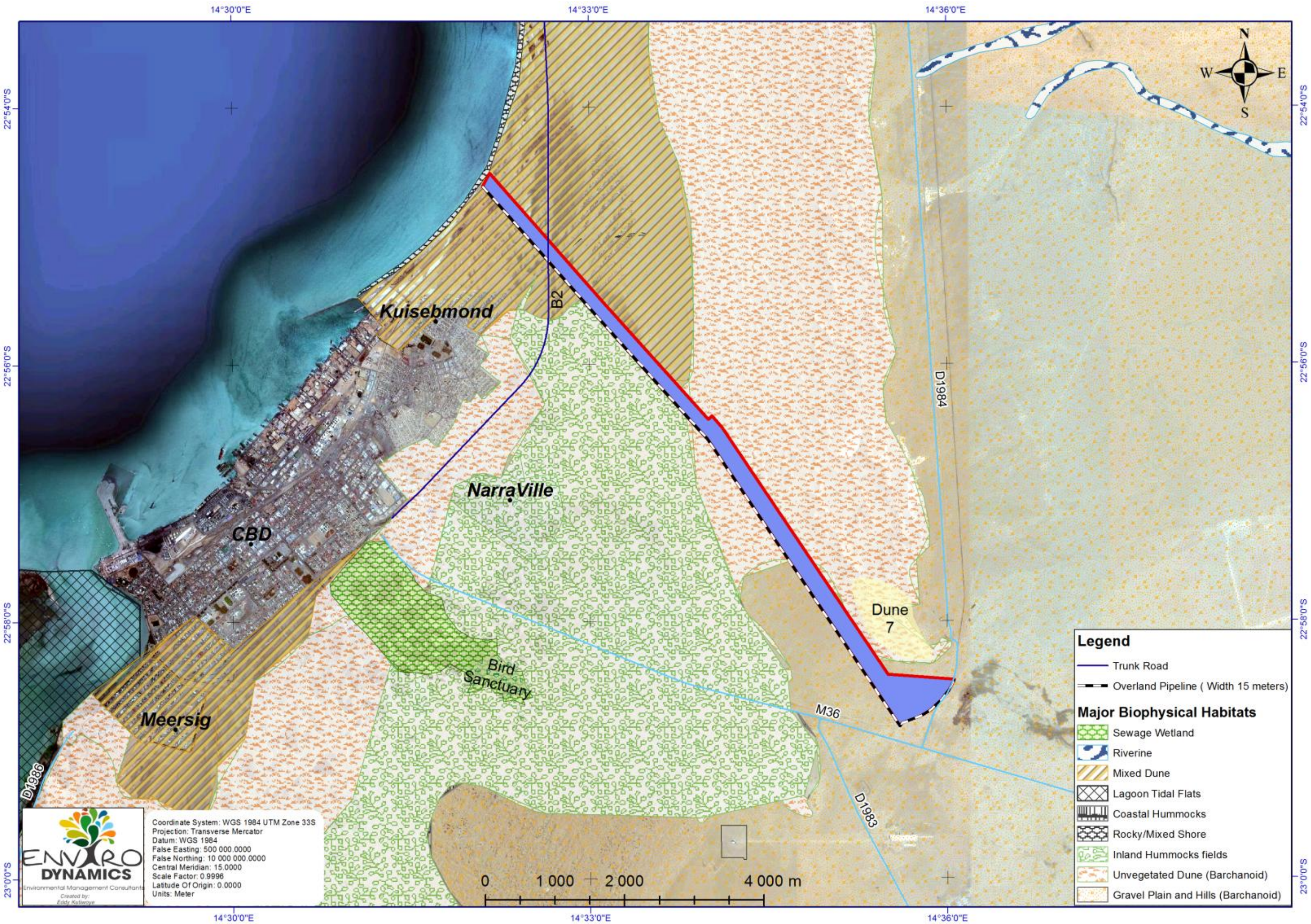

Figure 15: **Walvis Bay sensitivity map**

4.3.2 Biological Marine Environment

Marine biotic communities can be classified according to their respective habitats, namely intertidal (between low and high water marks), subtidal (below low water mark) and pelagic (area between water surface and ocean floor) communities.

The intertidal zone affected by the proposed project is a sandy (as opposed to rocky) environment (see **Figure 13**). A mixture of sandy and rocky environments is located to the north of the project site toward Langstrand (Botha, et al., 2013). The intertidal communities are characterised by relatively low species diversity. These include various invertebrate macro and micro faunal species (**Figure 16**). Species recorded on beaches similar to this one are common along most of the Namibian coastline. The lower intertidal zone is characterised by higher species diversity than the higher intertidal zone owing to the presence of more oxygen.

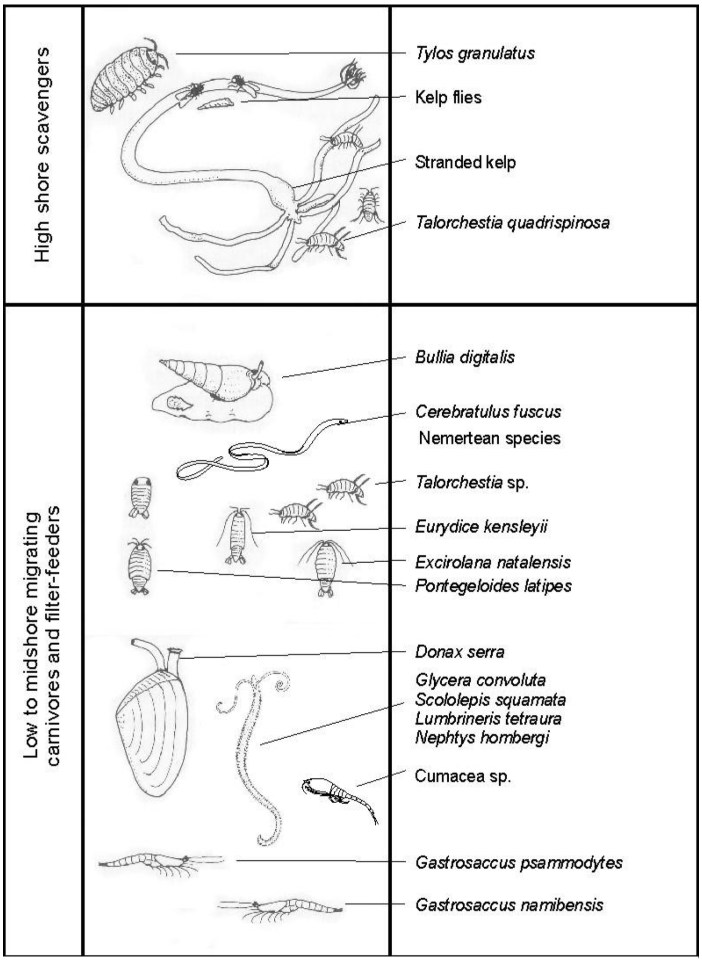

Figure 16: Schematic representation of the West Coast intertidal beach zonation (Pulfrich, 2012). Species commonly occurring on the central Namibian beaches are listed.

In general the benthic species diversity of Walvis Bay is low. The main contributing factor is the relatively low oxygen concentrations in the sediment. Low oxygen conditions result in a diverse mix of anaerobic bacteria. Studies conducted in the area indicate that there is a decrease in species diversity and abundance with a movement off-shore into deeper water.

Pelagic communities in general consist of fish species (e.g. mullet) their predators (marine mammals and turtles) and an abundance of plankton species. Five Cetacean species are known to frequent the Walvis Bay coastal area – three whale and two dolphin species (CSIR, 2010). Whale species include the humpback, southern right and the pygmy right whales. Dolphin species include the heaviside and common bottlenose dolphins. These whale and dolphin species occur mostly to the west of the bay area (CSIR, 2010; Botha, et al., 2013). Cetacean species rely significantly on their hearing for feeding, social communication and orientation. These species are thus sensitive to certain frequencies of sound waves generated by submarine dredging and construction activities (Botha, et al., 2013). These sound waves are suspected of causing health impacts and even death for some of these species.

4.3.3 Birds

The proposed project site is located near two Important Bird Areas (IBAs) namely the stretch of coast immediately north of Walvis Bay and the Walvis Bay Lagoon. Several bird species such as coastal waders, gannets, gulls and cormorants and penguins are found mostly (in some cases exclusively) in coastal marine environments. Their dependence (need to enter water to feed) on these specific habitats makes them vulnerable to hazardous waste spillages, which either directly, or indirectly affect them (food sources). Some of the potentially affected species are included in the International Union for Conservation of Nature Red List of Threatened Species. Cape Gannet (Endangered (E)), African Penguin (E), Crowned Cormorant (Near Threatened (NT)), Bank Cormorant (NT), Cape Cormorant (NT), Hartlaub's Gull (Vulnerable).

4.4 CONCLUSION

Table 6 provide a summary of the marine environmental sensitivities with the potential impact of each that should be considered.

Table 6: Description of environmental sensitivities pertaining to this project component environment

FEATURE	DESCRIPTION	SENSITIVITY	POTENTIAL IMPACT
BIOPHYSICAL			
Marine biodiversity	Sediment with rich organic content will be put in suspension during dredging.	Increase in probability of release of hydrogen sulphur and associated effects on marine biota.	Loss of marine biodiversity.
	Dredging effluent and overflows will increase turbidity within the marine environment.	Reduction in transparency in water and associated reduction in photosynthetic rates and	Loss of marine biodiversity.

FEATURE	DESCRIPTION	SENSITIVITY	POTENTIAL IMPACT
		smothering of organisms.	
	Heavy metals potentially mobilised during dredging may reduce the quality of water in the bay.	Proximity of marine fauna, fish factory water intakes and mariculture activities to site of dredger overflow discharge and intake of heavy metals.	Health impacts on humans and marine species.
	Benthic organisms will be affected by the dredging activities at the proposed berthing area and channel to be widened.	Existence of benthic organisms in the proposed area for dredging.	Loss of benthic marine habitat and biodiversity.
	Benthic and intertidal organisms will be affected by the construction of the trestle jetty foundations.	Existence of benthic and intertidal organisms in the proposed area for the trestle jetty foundations.	Loss of marine biodiversity along trestle jetty foundations.
	Ballast water with potential exotic species will be discharged into the Walvis Bay waters from the FSRU and the LNG carrier.	Proximity of marine biota to discharge point of ballast water.	Loss of marine biodiversity.
	Paint with an anti-fouling agent will be used to paint the hull of the FSRU during routine maintenance.	The constituents of some anti-fouling agents are highly toxic to marine organisms.	Loss of marine biodiversity.
	Submarine noise and vibrations will be generated by dredging and construction activity.	Cetaceans are prone to health impacts from sound waves generated during dredging and construction.	Health impacts on cetaceans.

FEATURE	DESCRIPTION	SENSITIVITY	POTENTIAL IMPACT
Birds	Sources of artificial light are likely to increase with new developments. Many lights are unshielded/point skywards.	Artificial light can cause confusion to birds when navigating at night, especially migrants.	Enhances the potential for collisions. Potential cumulative impact
	Bird species that are dependent on the marine coastal environment must enter the water to feed.	Habitat dependence makes these species indirectly and directly vulnerable to hazardous waste spills.	Bird mortality (freezing) due to spillage.
SOCIAL			
Employment	Jobs will be created both directly and indirectly, both during construction and operational phases.	Significant regional unemployment rate of 30%.	**Positive:** employment creation.
Power supply	300 MW of additional base-load power will be added to the national grid.	Potential shortfall of electricity by 2016 and associated power cuts.	**Positive:** augmentation of national power supply.
National economy	Direct (tax) and indirect (environment conducive to foreign investment) national economic benefits will result from the proposed project once operational.	Need for national economic growth.	**Positive:** contribution to national economy.
Health and safety	Hydrogen sulphide gas might be released during dredging.	Proximity of dredger ship crew to area where toxic gas will be released.	Health impacts.
	Construction labourers will be employed from beyond the town	Increase in disposable income of construction labourers. Increase in	Increased HIV infection rate and associated

FEATURE	DESCRIPTION	SENSITIVITY	POTENTIAL IMPACT
	boundaries. Some will flock to Walvis Bay in seek of employment.	risky sexual activity.	socio-economic impacts

Chapter 7 will consider how the aspects of the project interact and affect each of these sensitivities.

5 PUBLIC CONSULTATION PROCESS

As mentioned in the project description, the pipeline is a component of a greater project. Therefore a joint public participation process was conducted for the project at large. Specific concerns with regards to the pipeline have been highlighted at the end of this chapter. During the public consultation process identified stakeholders were introduced to the project as a whole, allowing them to participate on all three components. This chapter provides a description of how the public consultation process was undertaken by describing:

- the Interested and Affected Parties (I&APs),
- the means of communicating with them,
- common themes resulting from the consultation process.

5.1 INTRODUCTION

Public participation forms an important component of an Environmental Impact Assessment (EIA) as it provides potential I&AP's with a platform whereby they can raise any issues or concerns relevant to the proposed project. This assists the consultant in considering the full spectrum of potential impacts and to what extent further investigations are needed.

In addition, the public participation process also grants I&AP's an opportunity to review and comment on all the documents produced throughout the EIA process. This is done in accordance with both the Namibian Environmental Management Act of 2007, its Regulations (2012), as well as international best practice principles.

The IFC's manual "Doing Better Business through Effective Public Consultation and Disclosure: A Good Practice Manual" provides action oriented guidelines aimed at ensuring that consultation is both effective and meaningful. The guidelines emphasise the need for the project sponsor to ensure that the process of public consultation is accessible to all potentially affected parties, from national to local level. Emphasis is placed on the engagement of local stakeholders, namely people who are likely to experience the day-to-day impacts of a proposed project. On a practical level, the sponsor has to ensure that:

- all stakeholders have access to project information;
- the information provided can be understood;
- the locations for consultation are accessible to all who want to attend; and
- measures are put in place which ensure that vulnerable or minority groups are consulted.

5.2 PREVIOUS CONSULTATION AND PUBLIC PARTICIPATION

To this end Xaris Energy has carried out targeted and specific consultation meetings with key stakeholders of the project. This consultation assisted to develop and guide the project scope in preparation for the project EOI and RFP. It was also aimed at building relationships and to inform national authorities and the relevant interested parties about the project and to allow for the identification of key constraints within the proposed power plant project. This is a continuous process which helps to refine the project, secure the necessary approvals and support and ensure the ultimate success of the project.

As part of the initial EIA (not part of this EIA process), a number of focus group meetings were held during 2014. A public meeting was also arranged to obtain public input and to present the intended development to the public. The public meeting was held on 8 May 2014 at the Pelican Bay Hotel in Walvis Bay. Advertisements about the meeting were placed in the Namib Times and Republikein newspapers respectively over a 2 week period.

I&APs that participated in this EIA process provided valuable inputs and are acknowledged.

5.3 CURRENT CONSULTATION AND PUBLIC PARTICIPATION

Subsequent to a meeting with the DEA, the client decided to repeat the public consultation process which is now part of the new EIA process.

5.3.1 The Interested and Affected Parties (I&APs)

Previously identified stakeholders were informed of the change of Environmental Consultant and were provided with updated project information, whilst inviting them to again provide their comments.

Additional I&AP's (not previously included in the communication) were identified using the existing Enviro Dynamics' stakeholder database and information provided by the proponent.

Notices regarding the project were also placed in various newspapers inviting the public to register as I&AP's. All of this was done in compliance with the following definition of an interested and affected party:

> *"(a) any person, group of persons or organization interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity' (MET, 2010)."* (Environmental Management Act, 2007).

A summary of the stakeholder groups, consisting of authorities and interest groups at national, regional and local level, are presented in **Table 7**. The complete IAP list can be viewed in ***APPENDIX B***.

Table 7: Identification of Interested and Affected Parties

ITEM	LEVEL	DESCRIPTION
STAKEHOLDER DATABASE	NATIONAL	Ministry of Environment and Tourism Ministry of Mines and Energy Ministry of Agriculture, Water and Forestry Ministry of Trade and Industry Ministry of Works and Transport Ministry of Fisheries and Marine Resources Namibia Defence Force / Ministry of Defence
		NamPower NamWater
	REGIONAL	Erongo Regional Authorities
		Namibia Airports Company (NAC) & Directorate Civil Affairs (DCA)
		Erongo RED Roads Authority
	LOCAL	Walvis Bay Municipality Walvis Bay Town Council
		NamPort Tourism Associations Walvis Bay Chamber of Commerce Walvis Bay Corridor Group NGOs Local interest groups e.g. Dolphin group and NACOMA

All individuals, groups, organisations and organs of state registered as I&AP's on the project are kept up to date for the duration of the EIA study.

5.3.2 Methodology

The consultant used various means of contacting the I&APs including telephone calls, faxes, e-mails and published invitations to public meetings in the media (newspaper adverts). These tools are used to inform the largest possible number of people around the project area and the country about the proposed project.

5.3.2.1 Newspapers

Newspaper notices were placed for two consecutive weeks in national (and local) circulars (see **Table 8**). The notice served as an introduction to the project, also indicating its locality, while inviting the public to register as I&AP's (***APPENDIX B***). After the project scope had changed another round of notices were placed in two newspapers indicating the amendment.

Table 8: Notifications placed in the press

DATE	NATIONAL NEWSPAPER	CIRCULATION	INFORMATION SHARED
26 February 2015	Republikein	Afrikaans Newspaper, National	Project introduction, Invitation to public meeting
27 February 2015	Namib Times	English Newspaper, Local	Project introduction, Invitation to public meeting
5 April 2015	Namibian	English Newspaper, National	Project introduction, Invitation to public meeting
6 April 2015	Namib Times	English Newspaper, Local	Project introduction, Invitation to public meeting
9 April 2015	Republikein	Afrikaans Newspaper, National	Amendment to project scope
10 April 2015	Namib Times	English Newspaper, Local	Amendment to project scope

5.3.2.2 Posters

Notices (i.e. Posters) were fixed at conspicuous places and available notice boards throughout Walvis Bay (See ***APPENDIX B***), namely:

- Woermann Brock (Town Centre)
- Walvis Bay Spar
- Walvis Bay Shoprite
- Walvis Bay Municipality
- Woermann Brock (Kuisebmond)
- Shop4Value Kuisebmond
- Immanuel Ruiters Primary School Kuisebmond
- Woermann Brock (Narraville)
- Public Library (Narraville)
- Erongo Region Police Station Head Office in Walvis Bay

These notices were not place at the site (as per regulation) as the location above proved to be more practical in notifying the public. They have a greater visibility and audience to that of the site area which is not visited by such a large portion of the community. The notices provided the following information:

- The application is done in accordance to the Environmental Management Act of 2007 and its regulations;
- The nature and location of the proposed project;
- Where further information can be obtained (inviting them to a public meeting); and
- The contact information of Enviro Dynamics who is responsible for the EIA application.

5.3.2.3 Background Information Document (BID)

A BID containing up to date information of the project was also circulated to all identified stakeholders as well as registered I&AP's via e-mails or fax (***APPENDIX B***). The BID informed them about the proposed project, its locality as well as the public meeting and contact details if they require additional information. When the project scope changed, the BID was updated and re-circulated.

5.3.2.4 Meetings

Meetings were held at national, regional and local levels (**Figure 17**). The following meetings were called and invitations were sent out by fax and e-mail:

- Authority meeting 11 April 2015, 14:00 at Ministry of Mines and Energy Auditorium; Aviation Road; Windhoek.
- Authority meeting 12 April 2015, 14:00 at Town Hall, Walvis Bay Municipality.
- Public consultation meeting 12 April 2015, 18:00 at Emmanuel Ruiters Primary School, Kuisebmond, Walvis Bay.

A Summary of the meeting conducted at national, regional and local level is given in **Table 7**. The meetings' proceedings can be viewed in ***APPENDIX B***.

Figure 17: Photo plate: Public and Authorities Meetings in Walvis Bay

Table 9 Summary of the meeting conducted at national, regional and local level

OBJECTIVES	THE MEETING	MAIN ISSUES RAISED
NATIONAL LEVEL		
To engage with relevant ministries to solicit their ideas and concerns about the project. This was expected to assist the consultant in defining the parameters for the study in terms of issues to explore.	Held on Wednesday, 11 April 2015 in Windhoek at the Ministry of Mines and Energy - Auditorium. 19 attendees including representatives from the Ministry of Mines and Energy, Ministry of Trade and Industry, NamPower, NamWater, Namibia Airports Company, Ministry of Works and Transport and the Walvis Bay Corridor Group.	Air and noise pollution from the power plant. Hydrates in the natural gas pipeline and how this is dealt with. Safety zones and standards for this type of energy project. Land ownership associated with the power plant. Strategic considerations of the project with other projects in the area. Impact of reduced water supply to Birds Paradise. Stack heights and the potential impact on the airport. Tariff and off take prices associated with the project.
REGIONAL LEVEL		
To engage with relevant authorities that have jurisdiction over the area to solicit their ideas and concerns about the project.	Held at the Municipality's Town Hall in Walvis Bay on the 12th of April 2014. 19 people attended including representatives from the Walvis Bay Municipality, Erongo Regional Council, ErongoRED, Namport, Ministry of Fisheries and Marine Resources, Namibian Navy, and the Namibia Airports Company.	Effects of electromagnetic induction from the substation on the airport controls. Impact of the project on existing water sources. Visual impact. Effect on the dolphin communities in the area. Land issues – Municipal land vs. state land. Effect of wind on the buried pipeline. Effect of the permanent temperature inversion layer in the area of Dune 7.

OBJECTIVES	THE MEETING	MAIN ISSUES RAISED
		Impact of reduced water supply to Birds' Paradise. Impacts associated with pipeline failures.
LOCAL LEVEL		
To create a platform whereby the concerns of individuals, groups, or local communities could be conveyed	Held on the 12th of April 2015 at 18h00 at the Immanuel Ruiters Primary School in Kuisebmond, Walvis Bay. 31 people attended, local business owners and representative from the Namibian Dolphin Project, the press and NGOs such as NACOMA, as well as some community members	Effect of corrosive environment on the infrastructure. Consideration of existing SEA and EIAs done for Namport. Close proximity of the natural gas pipeline to communities – potential safety concerns. Seismic activity in the area due to detonations by the military. Existing diesel pipeline from Engen in proximity. Environmental sustainability of Natural Gas and its extraction.

5.4 PUBLIC FEEDBACK

All the comments received on this project are included in the *Issues and Responses Trail* (***APPENDIX B***). These issues have been considered and included in the EIA reports where applicable.

The draft EIA reports will be circulated for one week to all registered stakeholders in April 2015. Comments received on the draft report will be documented in the *Comments and Responses Trail* document. This report will highlight comments raised from the public on the documents and contain statements of how these are addressed and incorporated into the final document. After incorporating the comments, the final version of the document will be submitted to the Directorate of Environmental Affairs for consideration of environmental clearance.

5.5 PUBLIC CONCERN

From the comments submitted to Enviro Dynamics, a number of key issues came to our attention. It is clear that they should be considered at a strategic level for the proposed project. The key concerns are listed below in **Table 8.**

For this particular marine environmental assessment, the relevant issues are highlighted in **bold.**

These issues, as well as the sensitivities identified in the baseline section are collated in ***Section 7*** where the potential impacts related to the sensitivities are further assessed.

Table 8: Summary of marine component issues raised during the consultation process

THEME	POTENTIAL IMPACT	PUBLIC CONCERN
BIOPHYSICAL ENVIRONMENT	Impact on the airport	Stack heights and the potential impact on aviation. Effects of electromagnetic induction from the substation on the airport controls.
	Impact on water sources	Impact of the project on existing water sources.
	Impact on marine ecology	**Lighting impact on birds** **Effect on the dolphin communities in the area.** **Marine water quality, with respect to, dredging, and cold-water discharge from the FSRU.** **Effect of dredging activities on surrounding mariculture projects, water column, etc (cumulative effect)** **Impact on dolphins**
	Impact on land based ecology	Impact of reduced water supply to Birds' Paradise. Positive impact on reduced habitat on bird collisions. Effect of the permanent temperature inversion layer in the area of Dune 7. Environmental sustainability of Natural Gas and its extraction.
	Impact of pollution	Air and noise pollution from the power plant. **Effect of spoil grounds for dredging material on the surrounding environment.**
	Alternatives	Rail to transport the staff
	Local climate	Impact of local climate on the project – corrosion, wind and wind-blown sand.
SOCIO-ECONOMIC ENVIRONMENT	Safety concerns	**Safety zones and standards for this type of energy project.** Seismic activity in the area due to detonations by the military. Existing diesel and other pipelines in proximity. Close proximity of the natural gas pipeline to communities – potential safety concerns. **Safe access for incoming and outgoing oil and Natural Gas tankers that will be discharging to the oil terminal**

THEME	POTENTIAL IMPACT	PUBLIC CONCERN
		and FSRU. **Safety requirements of the trestle and related pipelines from the FSRU and its compatibility with those of the incoming oil terminal pipelines.** **Impacts associated with pipeline failures.** **Fire risk.**
	Land use concerns	Land ownership associated with the power plant. Land issues – Municipal land vs. state land.
	Impact on sense of place	Visual impact.
	Strategic considerations	**Consideration of existing SEA and EIAs done for Namport.** **Strategic considerations of the project with other projects in the area.** **Alignment with existing and planned infrastructure** particularly with the planned new freeway, its intersections and interchanges.
	Decommissioning	**There should be a closure plan for decommissioning.**

The issues raised by the stakeholders will be considered for it's relevance to the project and then carried forward to **Chapter 7** to be incorporates with the baseline sensitivities in the impact assessment.

6 ALTERNATIVES

It is necessary to consider the various elements of the project in terms of alternative approaches in order to assure the optimal selection of processes and materials that will benefit the environment in a deliberate way.

These are considered in terms of

- Alternative activities
- Alternative fuel sources
- Alternative locations
- Alternative technologies and designs

6.1 OVERVIEW

Throughout the course of the project development, decisions are made concerning e.g. the possible locations, the type of technologies and the processes involved in the proposed development. Many of the identified alternatives are not viable due to technical, regulatory, time and economic constraints. This chapter provides a description of the various alternatives associated with the project and how they were considered:

- Alternative activity including the "no-go" alternative;
- Alternative fuel sources;
- Location alternatives for the power plant; and
- Design and technology alternatives.

The preferred alternative has been considered during the assessment of potential impacts (Chapter 8).

6.2 ALTERNATIVE ACTIVITY

6.2.1 The '*no-go*' Alternative

The Proposed Project could potentially:

- assist in ensuring security of power supply,
- reduce Namibia's reliance on electricity imports,
- contribute through the development of gas infrastructure from which various industries can leverage off, and

- result in secondary spin-off benefits such as job creation in construction and operation of the power plant.
- have economic benefits to Namibia in that the electricity can be sold to neighbouring countries.

The '*no-go*' alternative predicts the future scenario that would exist in the absence of this project. Due to the looming electricity supply deficit Namibia is expected to face when key supply contracts with neighbouring regional suppliers expire in 2016 the 'no-go' option is not considered the preferred alternative. The 'no-go' alternative will:

- change the favored conditions of supply to Namibia;
- reduce supply secured and increase supply deficit significantly;
- put Namibia in a position that threatens supply security; and
- cause the wider benefits of the project, such as supply stability and associated benefits to the national economy to not be realized.

By implementing the project the reliability and stability of the national power supply system will be improved to meet the power shortage in the country and possibly contribute to the fast declining Southern African Power Pool (SAPP).

The '*no-go*' alternative is not considered to be a viable alternative.

6.2.2 Alternative Fuel Sources

In many regions of the world (e.g. South America, Central America, the Caribbean region and Southeast Asia), heavy fuel oil is still used as the primary fuel source for power generation. As prices for heavy fuel oil have steadily increased and environmental policies have evolved to promote cleaner power generation alternatives, power generators have sought to use natural gas as an alternative source of fuel (Van Marcke & Dumitrasc, 2013).

In the following table (**Table 10**) a summary between the key risk factors associated with each of these fuel sources (i.e. natural gas and heavy fuel oil) is provided with a description of the preferred alternative for this project.

Table 10: A comparison of the risk factors between heavy fuel oil (HFO) and Liquefied Natural Gas (LNG).

RISK FACTOR	HEAVY FUEL OIL (HFO)	LIQUEFIED NATURAL GAS (LNG)	PREFERRED ALTERNATIVE
SUPPLY OPTIONS AND MARKET CONSIDERATIONS	• Availability of HFO is linked to the abundance of refining activity internationally. • Furthermore the global production outlook for world liquid fuel indicates an average annual production increase of less than 2 percent.	• With the global availability of LNG and the planned production growth in mind, the interest in using LNG as a fuel is growing. • LNG supply is expected to grow with an annual growth rate of 8.7% in the next five years.	• LNG is becoming more popular as a fuel source worldwide.
POWER GENERATION ENVIRONMENTAL PERFORMANCE	• Due to the high Carbon Content of HFO (88%) the combustion products of HFO have a high percentage of Carbon Dioxide. • The sulphur content of HFO results in direct Sulphur Oxide (SOx) emissions varying between 1 and 2 %. • Nitrous oxide (NOx) emissions are generally greater due to a higher percentage of fuel-bound nitrogen. The exhaust gas from HFO fired systems also contains argon.	• The carbon content of Natural Gas is typically between 60-70% and hence the products of natural gas combustion contain less Carbon Dioxide than fuels with higher carbon content. Carbon dioxide emission of 500 kg/MWh as compared to 720 kg/MWh for HFO. • Low sulphur content with levels of 0.05 to 0.18% by mass. • NOx emissions are typically controlled by the use of Dry Low NOx technologies and/or turbine water injection. Natural gas exists as	• Natural Gas is more environmentally friendly.

RISK FACTOR	HEAVY FUEL OIL (HFO)	LIQUEFIED NATURAL GAS (LNG)	PREFERRED ALTERNATIVE
	• HFO spillages or pipe ruptures can greatly impact marine life and terrestrial soil conditions.	a vapour at normal conditions and therefore any potential loss of gas would result in air emissions. • Natural gas has a very limited risk of soil and groundwater pollution.	
PLANT OPERATIONS	• HFO limits the use of available technology since heavy-duty machines are the only suitable contenders. This reduces the modularity of the plant. • The machines require a cool down period on shutdown where diesel fuel reserve is required. • HFO engines require frequent maintenance due to the poor fuel quality, and the units typically have long downtime periods for major overhauls. • The average annual availability of HFO fired plants is typically 88%. Additional	• LNG enables the selection of Aero derivative turbines that improves the modularity of the plant (See Section 1.5.4 below). • Aero derivative turbines provide for flexible operation with high part load efficiency. Start-up and shutdown durations are short and there is no maintenance increase associated with multiple start/stop cycles. • The Aero derivative units have shorter downtimes for overhauls, typically 5 days for engine exchange at major interval of 50,000 hours. The anticipated plant availability for the Aero derivative GE	• HFO can only be used by heavy-duty machines whereas LNG can be used by Aero derivative turbines, which has specific advantages over heavy duty machines.

RISK FACTOR	HEAVY FUEL OIL (HFO)	LIQUEFIED NATURAL GAS (LNG)	PREFERRED ALTERNATIVE
	maintenance penalties as the units have limited stop/start operational capability	LM 6000 is in excess of 97%.	
FUEL DELIVERY LOGISTIC	• Storage of HFO is simpler due to the relative stability of HFO at ambient conditions. • HFO may require heating in order to deliver the fuel. Would require significant investment in storage capacity and associated heating operations. The storage capacity would have to be constructed on land and would therefore require suitable land area for an HFO storage plant. • Once established would further require either piped HFO to the power plant or a road/rail solution. Given the environmental considerations it would not be attractive to pipe HFO over a long	• Historically, high cost and lengthy schedules associated with the establishment of LNG storage capacity have been prohibitive. • The availability of suitable land area close to large ports where LNG carrying vessels are able to dock is also a restriction. The use of FSRU technology significantly improves the financial and schedule benefits of LNG storage for scenario mentioned above. • The final logistic solution of delivering the fuel to the power plant is subject to the same provisions as HFO and the LNG would either have to be re-gasified and piped to the plant or road transported in liquid	• The logistics associated with fuel delivery to the power plant have already been worked out in this case.

RISK FACTOR	HEAVY FUEL OIL (HFO)	LIQUEFIED NATURAL GAS (LNG)	PREFERRED ALTERNATIVE
	distance and a trucking solution is likely the more feasible option. This solution further would raise environmental concerns due to the increased road traffic and the further potential of HFO spillage and management.	state. The use of Natural Gas pipelines is a well-established solution and a marine trestle pipeline followed by a sub-terrain, terrestrial pipeline would be the solution of choice.	
FUTURE COMPATIBILITY WITH KUDU GAS	• An HFO fired power plant would in all likelihood support a switch to Gaseous Fuel if the Kudu gas fields supply network expands to Walvis Bay. • Due to the additional maintenance restraints, the use of HFO is not recommended with highly cyclical operations in which multiple stop starts may be required.	• The FSRU LNG terminal would be able to support integration with the Kudu gas fields as potential floating liquefaction facilities could be used to supply the FSRU with Kudu Gas. • The Gas fired AeroDerivative power plant will not have any associated maintenance penalties due to cyclical operations and would further support any additional power that is realised through the Kudu Fields.	• The Gas fired power plant can be integrated with the Kudu Gas Project so that natural gas can be supplied by the Kudu Gas.
SPIN OFFS AND ADDITIONAL BENEFITS	• The use of HFO would have limited future benefits as the environmental	• The Walvis Bay Port is being expanded and the region will require power and	• Natural Gas can provide additional spin off benefits to

RISK FACTOR	HEAVY FUEL OIL (HFO)	LIQUEFIED NATURAL GAS (LNG)	PREFERRED ALTERNATIVE
	performance, the integration potential with the Kudu Development and the logistical solution of fuel delivery are unlikely to create an expanded HFO market.	water. Natural Gas can provide power for the region. The proposed gas plant, power plant and potential future desalination plant cover three critical utilities in one namely gas, power and water. The results of such a multi beneficial solution will result in increased and faster development within the region. • The proposed LNG storage terminal (Walvis GasPort) will provide for access to gas for other industries in the area including the heavy industrial area. The fishing factories in the area will be able to change to gas as a fuel, saving them money and lessening their environmental impacts.	the development in the region.

Based on the environmental analysis presented above, LNG:

- Has enhanced performance in comparison to HFO.
- Is less expensive.
- Has fewer environmental risk factors.
- Can be incorporated with other projects in the country (i.e. Kudu Gas).
- Ensures plant operational flexibility.
- Provides better power generation technology.

It is for these reasons that natural gas is the fuel of choice for this project.

6.3 ALTERNATIVE LOCATIONS

6.3.1 FSRU Mooring Location

The FSRU mooring location was determined based on the required distance of pipeline and other infrastructure to the onshore facilities, safety exclusion zones for other vessels and costs associated with constructing infrastructure. Once these were considered to satisfaction a suitable location was sought based on the risk factors listed below (**Table 11**):

Table 11: A comparison of the risk factors associated with possible mooring locations for the FSRU within the Walvis Bay Port area.

RISK FACTOR	CURRENT MOORING LOCATION	AN ALTERNATIVE LOCATION
SUFFICIENT WATER DEPTH	• The water at the site of sufficient depth to safely manoeuvre the FSRU and LNGC (between 15 to 20 m deep after dredging).	• Since the proposed site fitted all the requirements, alternative locations for the mooring area were not investigated.
ENVIRONMENTAL AND METOCEAN CONDITIONS	• Environmental conditions at the site are favourable with respect to operating the FSRU facility. The site allows for the required berth availability without additional wave or wind protection (further motion studies are required).	
AVAILABLE INFRASTRUCTURE	• The light trestle jetty, GasPort and berth forms part of the new tanker berth and associated infrastructure for the import and export of petroleum products.	

RISK FACTOR	CURRENT MOORING LOCATION	AN ALTERNATIVE LOCATION
GEOLOGY AND DREDGING POTENTIAL	• The geology is favourable for a dredged channel and piled structures as specified for the layout. Vessel navigation simulation work confirmed that the proposed navigation layout was adequate for safe navigation, even during extreme events.	

The proposed mooring location is the preferred alternative primarily due to the integration potential with the new tanker berth and associated infrastructure for the import and export of petroleum products. In addition to this, the proposed location also has suitable environmental conditions e.g. geology and metocean conditions.

6.4 ALTERNATIVE TECHNOLOGIES AND DESIGN

6.4.1 Land-based LNG Terminal vs. FSRU

The use of natural gas as a power generation fuel requires the establishment of natural gas storage infrastructure. Historically, the preferred natural gas storage method has been to establish regasification terminals onshore. However, the use of Floating Regasification and Storage Units (FSRUs) are becoming more and more prevalent in many countries worldwide.

Table 12 below provides a summary of the key risk factors considered when determining the preferred alternative for the regasification of LNG.

Table 12: A comparison of the risk factors associated with the construction of a land-based LNG terminal and an offshore FSRU.

RISK FACTOR	LAND-BASED LNG TERMINAL	FSRU	PREFERRED ALTERNATIVE
TIME AND COST CONSTRAINTS	• The cost of land-based terminals ranges between \$250 million and \$1 billion. These terminals require three to four years to construct.	• FSRU costs range between \$100 - \$350 million. The projected construction period for the FSRU modifications and supporting	• The FSRU is the preferred alternative since it is more cost effective and requires less time to become operational.

RISK FACTOR	LAND-BASED LNG TERMINAL	FSRU	PREFERRED ALTERNATIVE
		infrastructure is 12-15 months.	
REQUIRED FOOTPRINT	• They require sizeable land areas and deep-water ports. These terminals are most suitable for servicing large power plants/markets that provide base-load capacity.	• Once the berthing are is established, the FSRU requires just the space in the jetty and very little onshore space. It is permanently moored and will only be moved occasionally in case of very bad weather. • Can be incorporated in the planned oil terminal.	• Since the FSRU does not require a large footprint area on land and it is possible to integrate it with the planned oil terminal infrastructure it is the preferred alternative.
TIME TO DEPLOY	• Land based LNG storage facilities typically have a 2-5 year construction period.	• The limited Port infrastructure requirements ensure that floating LNG solutions can be deployed in relatively short time frames to meet market requirements	• The FSRU solution provides for a flexible solution which can be deployed with in the timeframes required by Namibia.
OTHER	• A large structure will be more visible. • Less flexible – the location is fixed for the 25-30 years of the project life and, complex, costly and time consuming to expand if required. • A complex decommissioning plan for the infrastructure is required.	• FSRU is offshore and therefore not seen by most of the public as are unsightly onshore facilities. • More flexible in terms of location selection since it can be moved from location to location. • Simplified decommissioning.	• The FSRU is more flexible, less visible and easier to decommission, therefore it is the preferred alternative.

The use of a FSRU is the preferred alternative because:

- It can be commissioned much quicker than an onshore constructed terminal.
- It is less expensive in the short term.
- It requires a smaller footprint area on land which makes it less visible.
- It is more flexible since it can be moved from location to location.

6.4.2 Open vs. Closed Loop Regasification Systems

Seawater cooling is standard marine practice. The two systems that are typically used are the open and closed loop regasification systems (**Table 13**).

- Open loop regasification system: Relatively warm seawater is drawn in through the FSRU's sea chests. It is used as a heat source and passed through the shell of the shell-and-tube vaporizers, causing the vaporization of the LNG. During this process, the temperature of the seawater is lowered by approximately 7 ˚C.
- Closed loop regasification system: Steam from the FSRU boilers is used to heat sea water circulated through the shell-and-tube vaporizers in the regasification plant. Results in minimal usage of seawater by the FSRU.

Table 13: A comparison of the risk factors associated with the operation of a open loop vs. a closed loop regasification system.

RISK FACTOR	OPEN LOOP REGASIFICATION SYSTEM		CLOSED LOOP REGASIFICATION SYSTEM	PREFERRED ALTERNATIVE
WATER REQUIREMENTS AND COOLING OF SURROUNDING SEAWATER TEMPERATURE	• For support machinery cooling	• 5,000 m³/hr with a temperature rise of +2˚C	• 5,000 m³/hr with a temperature rise of +2˚C	• The closed loop regasification system requires less seawater and since water is not discharged back to the ocean, temperature dispersal in the water column is not a concern and does not require additional specialist studies.
	• For regasification process	• 13,500 m³/hr with a temperature depression of 5.5˚C • 9,000 m³/hr with a temperature of -7.8˚C	• N/A	
USE OF CHEMICALS	• Chemical dosing of the cooling seawater to inhibit fouling by marine growth • Hypochlorite and copper is used for defouling which is discharged into the ocean.		• To prevent marine growth and fouling of the sea water systems aboard the FSRU, chlorine in the form of sodium hypochlorite will be injected into the seawater intake system. The sodium hypochlorite will be produced on the FSRU by an onboard electrolytic generation system that will provide a continuous supply of chlorine for marine growth control. The chlorine rapidly disperses within the	• None of the chemicals used in the closed loop system is discharged back to the environment.

RISK FACTOR	OPEN LOOP REGASIFICATION SYSTEM	CLOSED LOOP REGASIFICATION SYSTEM	PREFERRED ALTERNATIVE
		water piping systems prior to discharge overboard with residual chlorine levels below IFC HSE Guidelines. In the closed loop system chemicals required to maintain the system are not discharged to the environment, only requiring normal make-up maintenance.	
POTENTIAL ENVIRONMENTAL EFFECTS	• The intake of seawater has potential implications for local hydrological flows, sediment suspension and the entrapment of marine organisms. • Discharge of cold water back to the sea has the potential to result in impacts on the local marine ecosystem. • More fuel-efficient because it uses natural heat within the seawater rather than heat derived from the combustion of gas.	• The closed loop system requires more fuel and therefore the associated air emissions are higher.	• The open loop regasification system is more fuel-efficient and could therefore be considered in future provided that the necessary dispersal studies are done to verify that it is to international standards and requirements.

Both systems were considered for this project however, the closed loop cooling system was selected as the preferred alternative for the project because

- Colder water is not discharged to the water column.
- It presents a smaller threat to the surrounding marine environment.
- Chemicals are not discharged to the ocean.

- Lengthy specialist and modeling studies are not required to assess the impact on the surrounding marine environment.

However, due to the significant cost associated with operating the FSRU in the closed loop system, the change to an open loop regasification system may be considered in the future with the required specialist studies done to ensure that the system is operated within the accepted international limits.

6.4.3 Subsea vs. Trestle Jetty

The transport of the re-gasified natural gas from the FSRU to the onshore port premises, require pipeline infrastructure. Traditionally, these pipelines are located either subsea or on a trestle jetty structure. The risks involved with these two alternatives are discussed below (**Table 14**).

Table 14: A comparison of the risk factors associated with the transport of gas through a subsea pipeline or in a pipeline along a trestle jetty.

RISK FACTOR	SUBSEA PIPELINE	TRESTLE JETTY	PREFERRED ALTERNATIVE
APPROVAL FROM PORT AUTHORITIES	• Not within Namport's planning regime. They have explicitly indicated that they will not support this type of design.	• The concept fits in with Namport's planned Oil berth jetty.	• The trestle jetty is the preferred pipeline structure for the port authorities.
GEOTECHNICAL SUITABILITY	• Seabed conditions are not economically suitable for constructing a pipeline subsea.	• Specific recommendations are made in terms of dredging for the new tanker berth and associated infrastructure of the import and export of petroleum products. • This information can be used to guide the construction of the trestle jetty, foundations footprint area.	• Dredging studies have already been done in the area that can be used for this study.
ENVIRONMENTAL IMPACTS	• Disturbance of marine flora and fauna through physical presence of machinery and workers as well as noise • Stirring of the sediment on the sea	• Due to the smaller footprints associated with the jetty foundation structures, the environmental impacts on the marine environment are expected to be	• Due to the short term and local scale impacts associated with the construction of the trestle jetty, it is the preferred alternative.

RISK FACTOR	SUBSEA PIPELINE	TRESTLE JETTY	PREFERRED ALTERNATIVE
	bottom, releasing pollutants into the water column. • Erosion at the point where the pipeline enters the surf zone and beach due to increased turbulence around the structures.	short term and at a local scale. Once the construction activities have seized, the impacts will stabilize.	

The trestle jetty is the preferred alternative, because:

- The port authorities have indicated that they will not give approval for a subsea pipeline.
- Studies associated with the new tanker berth and associated infrastructure of the import and export of petroleum products have already been done which can feed into the current project in terms of dredging activities.
- The impacts associated with the construction of the trestle jetty are expected to be at a local scale and of short duration.

6.4.4 Dredging and Discharge Process Alternatives

The dredging process will be a major impact activity that includes the widening of the proposed channel for the new bulk fuel terminal as well as the berth and turning circle.

The activity will be to the same specifications of the new bulk fuel terminal and will take place in the direct project area covered by its dredging process. It therefore makes sense to apply the same principles of dredging as has been proposed and approve in the EIA for the proposed new Tanker Berth and associated infrastructure in the Port of Walvis Bay (Botha, Hooks, & Fauls, 2013) to minimise the impact of dredging.

According to (Botha, Hooks, & Fauls, 2013) there are three groups of dredgers available:

- Mechanical dredgers that are stationary and haul sediment through the water column mechanically with grabs or buckets.
- Hydraulic dredgers that draw slurry of water and sediments via a pipe to a barge by means of a vacuum process generated by centrifugal pumps.

- Hydrodynamic dredgers that use agitation of water injection to mobilise the sediment and then uses the current to relocate the sediment to a new position.

Although the port of Walvis Bay operates both grab dredgers and the Trailing Suction Hopper Dredgers (which is a hydraulic dredger) the favoured dredged type for the new Tanker Berth and associated infrastructure. The following benefits are considered decisive in the decision to use the Trailing Suction Hopper Dredgers (TSHD):

- The local terrain sediment are ideal for the TSHD as it is sandy to silt.
- The TSHD is mobile, can transport dredged material over considerable distance and can discharge with minimal disturbance of the sediment.
- The TSHD dredging process isolates the sediment in the suction pipe and therefore cause minimal sediment release (turbidity) in the water column if overflow is prohibited or if the overflow process prohibits the discharge of suspended sediment. Both options are readily available. Low turbidity valves on the overflow choke the airflow in the stream and so reduce air in the overflow, which in turn stabilize the flow and dispose suspended sediment faster to the ocean floor.
- Biogenic gas build-up due to sediment containing biological material may reduce the centrifugal pump efficiency. Using de-gassing equipment will eliminate the problem.
- Potential sediment plume can be further reduced by using overflow water discharge in a "green pipe" at the suction head as process water. This assures that suspended sediment is again sucked up into the dredger without spilling.

Sediment plumes are a common problem at the discharge site. Special equipment to reduce the depth distance between the release position and the ocean floor can reduce the plume size. This is preferred even if the discharge takes place over a designated disposal site to reduce the effect of turbidity on ocean life in the affected water column. The duration of the event of turbidity in the water column should be limited as much as possible.

6.5 CONCLUSION

The preferred alternatives are carried forward to the impact assessment in **Chapter 7** and applied to the sensitivities and concerns to determine which impact it will have on the environment.

7 IMPACT ASSESSMENT

7.1 INTRODUCTION

This section provides an assessment of the significance of the potential impacts issues identified by the public and to the sensitivities of the pipeline environment. It is based on the assumption that the project description provided by Xaris is correct and will be implemented as is.

7.1.1 Methodology

Overall approach

The team identified potential impacts of the proposed marine components on the receiving environment. The team was tasked to consider the following when identifying potential impacts:

- The type of effect that the proposed activity will have on the environment;
- What will be affected; and
- How will it be affected?

The sources of risk are, where possible, based on accepted scientific techniques. Failing this, the specialists and project team made a professional judgment based on expertise and experience. All potential impacts that result from the proposed project have been evaluated for the construction, operational and decommissioning phases.

Potential Impacts were identified considering the sensitivities of the social and ecological qualities of the area, as well as the issues raised during public consultation.

The impact assessment methodology is contained in **Table 16** below.

Table 15: Description of criteria used to define the significance of the impacts.

DESCRIPTION	
Nature	Reviews the type of effect that the proposed activity will have on the relevant component of the environment and includes "what will be affected and how?".
Extent	Geographic area. Indicates whether the impact will be within a limited area (on site where dredging/construction is to take place); local (limited to within 15 km of the area); regional (limited to ~100 km radius); national (limited to the in-shore zone of the Namibian ocean); or international (extending beyond Namibia's boarders).
Duration	Whether the impact will be temporary (during construction only), short term (1-5 years), medium term (5-10 years), long term (longer than 10 years, but will cease after operation) or permanent.
Intensity	Establishes whether the magnitude of the impact is destructive or innocuous and whether or not it exceeds set standards, and is described as none (no impact); low (where natural/ social environmental functions and processes are negligibly affected); medium (where the environment continues to function but in a noticeably modified manner); or high (where environmental functions and processes are altered such that they temporarily or permanently cease and/or exceed legal standards/requirements).
Probability	Considers the likelihood of the impact occurring and is described as uncertain, improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of prevention measures).
Significance	Significance is given before and after mitigation. Low if the impact will not have an influence on the decision or require to be significantly accommodated in the project design. Medium if the impact could have an influence on the environment which will require modification of the project design or alternative mitigation (the area can be used, but with deviations or mitigation). High where it could have a "no-go" implication regardless of any possible mitigation (an alternative route should be used).
Status of the impact	A statement of whether the impact is positive (a benefit), negative (a cost), or neutral. Indicate in each case who is likely to benefit and who is likely to bear the costs of each impact.
Degree of Confidence in Predictions	Based on the availability of specialist knowledge and other information.

Mitigation and Enhancement Measures

Where negative impacts have been identified, mitigation objectives have been set, and practical, attainable mitigation measures are recommended that will minimise or eliminate the impacts.

In the case of positive impacts, enhancement measures are recommended for optimising the benefit to be derived.

Table 16 below provides the principle of the mitigation to be applied, but the detailed mitigation is provided in the EMP.

Monitoring

Monitoring requirements with quantifiable standards to assess the effectiveness of mitigation actions have been recommended where appropriate. These must indicate what actions are required, by who, and the timing and frequency thereof.

Monitoring is recommended in **Table 16** as principles, but the detailed recommendations in this regard are contained in the EMP.

The outcome of the impact assessment is presented in the **Table 16** below.

Table 16: Impact assessment

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
MARINE POLLUTION									
Release of hydrogen sulphide (H_2S) (Construction, Maintenance))	Limited area	Temporary	High	Probable	Negative Could affect health of marine species as well as personnel	High	High	Apply existing H_2S procedure of dredging activities in the port (Document Reference number BKI-516-1 0012-3E-H2S-0). This includes continuous monitoring, isolating deck, engine room intake and accommodation intakes from the hopper, closing the aft section of the hopper and circulating air forward to the bow. Other vehicles should pass the dredger more than 100m away	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
								preferably upwind.	
Increase in turbidity due to dredging activity and spoil disposal activity will reduced photosynthetic rates an smother organisms, leading to a loss in various forms of benthic and marine life **(Construction, Maintenance))**	Limited area	Temporary	Low	Probable	Negative. May affect mariculture, benthic organisms and its predators, marine mammals. May affect sea water intakes at the fish factories. May affect marine tourism due to marine mammals and other visible species moving away temporary.	Medium	Medium	Cannot measure turbidity directly therefore measure representative suspended solids. Measure in real time at: Main entrance channel for ships (Buoy 6) At the fairway; Near Bird Island; The 3rd (future) tanker berth (comparative to the Bulk Fuel Terminal study). Use the EMP water sample analysis procedures. Use proposed dredger technology to limit	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
								discharge plume at the disposal site.	
Lowered water quality due to mobilised heavy metals. **(Construction, Maintenance)**	Local	temporary	Low	Low	Negative Unlikely that significant quantities of heavy metal contaminants will be released if existing data prove accurate (Botha, Hooks, & Fauls, 2013).	Medium	Low	Measure contaminants in real time at: Main entrance channel for ships (Buoy 6) At the fairway; Near Bird Island; The 3rd (future) tanker berth (comparative to the Bulk Fuel Terminal study). Use the EMP water sample analysis procedures o	Low
LNG spill may cause freezing of birds caught in the LNG pool. **(Operations)**	Limited area	Temporary	High	Improbable	Negative. Marine hunter species need to enter water and is bound to be	High	Low	Avoid spills. Execute spill procedures immediately to isolate and remove spill.	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
					attracted to fish in the berth vicinity.				
MARINE BIODIVERSITY									
Destruction of benthic marine habitat and loss of biodiversity due to dredging of sediment. **(Construction, Maintenance)**	Limited area	Long term	High	Definite	Negative. The layer of sediment hosting the benthic habitat will be completely removed.	High	Medium/ Low	Minimise the required footprint through design interventions. Improve dredging accuracy by reducing footprint uncertainty and error.	Low
Destruction of benthic marine habitat and loss of biodiversity due construction of the trestle foundations. **(Construction, Maintenance)**	Limited area	Medium term	Medium	Definite	Negative. The layer of sediment hosting the benthic habitat on the foundation footprint will be	High	Medium/ Low	Minimise the required footprint through design interventions. Improve footprint accuracy by reducing footprint uncertainty and error.	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
					completely removed.				
Discharge of ballast water of the dredger or the LNG Carrier may introduce exotic invasive species or disease that may cause loss of marine bio-diversity. **(Operations)**	Regional	undetermined	None to high	Uncertain	Negative. Effect of exotic invasive species or disease can vary significantly	Medium	Med/High	Apply MARPOL/IMO guidelines on ballast water. Discharge all ballast water before entering Namibian Exclusive Economic Zone	Low
Anti-fouling agent in hull paint may reduce water quality and marine organisms **(Operations)**	Local	Long term at the berth	Low	Probable	Negative Contaminants such as tributyltin and copper oxides can affect marine fauna and enter the food chain.	High	Medium	Avoid paint with tributyltin, biocides, copper concentration.	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
NOISE AND OTHER DISTURBANCES									
Submarine noise and vibration caused by dredging and piling activities affect cetaceans in the bay area. **(Construction, Maintenance)**	local	Temporary	Medium to High	Highly probable	Negative. May cause permanent damage to hearing as well as cause change in behaviour patterns that may reduce feeding effectiveness.	High	High	Conduct slow warning starts to warn cetaceans and give them opportunity to move away each time before operations start. Use contractors with reputable records of state of the art and well maintained equipment. Monitor potential movement of cetaceans on approaches to the site and suspend operation if activity occurs.	Med-low
Artificial light as well as low visibility can cause bird strikes in	Limited area	Long term	Low	Probable	Negative. Unshielded or skyward	High	Medium	Face lights down and shield to avoid uncontrolled dispersed	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
migrant birds. **(Operations)**					pointing light can confuse birds.			light source. Monitor bird strikes and review significance of patterns.	
Noise of the berth construction process and the FSRU operations may affect marine mammals **(Construction, Maintenance' Operations)**	Local	Long term	Medium	High	Negative Marine mammal communities may avoid the berthing area permanently. (Botha, Hooks, & Fauls, 2013)	High	Medium	IFC guidelines for noise reduction include: Selecting equipment with lower sound power levels; Installing suitable mufflers on engine exhausts and compressor components; and Installing acoustic enclosures. The intake air ducts and exhaust ducts should be attenuated. Conduct noise	Low
Noise of berth construction process and the FSRU operations may affect human population **(Construction, Maintenance Operations)**	Local	Long term	Medium	High	Negative Human sensitivity receptors are not close enough to be adversely affected and	High	Low		Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
					will not be exposed to excessive noise above ambient noise further than 1,28 km from the FSRU (Williams, 2015).			monitoring at the nearest sensitive receptor community.	
ECONOMIC AND SOCIAL									
Employment Creation during construction and operation. **(Construction, Operation)**	Local	Short to long term	Low	High	Positive for local communities.	High	Low	Local people employed where possible.	Low
Increase in regional and national electricity supply with 300MW to avoid a potential future shortfall by 2016	National to international	Long term	medium	Definite	Positive. Will add 300MW baseline power to the national pool as deemed required by	High	Medium	Maximise the utilisation and price efficiency by optimising the technology used.	High

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
(Operation)					Nampower by mid 2016.				
National economic benefit by means of direct (tax) and indirect (environment conducive to investment). **(Operation)**	national	Long term	Medium	Highly probable	Positive. Contribute to revenue and economic growth stimulation.	High	Low	Optimal pricing to stimulate economic growth and use of electricity produced.	Medium
Health and safety compromised during construction and operation, associated with failures, leakages, spillages. **(Construction, Maintenance, Operation)**	Local	Long term	Low	Improbable	Negative for the local communities.	High	Low to medium	Good communication about the health and safety risks (low) Constant monitoring. Training of staff. Leakage detection. Emergency plan for failures. Other measures in the EMP.	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
Visual impact during construction and operations. (Construction, Operation)	Local	Long term	Medium	High	Negative for the tourists, passersby, local residents.	High	Medium	Use colours on the FSRU that blend with the marine environment.	Low
Increase in foreign and migrant labour may increase the HIV infection rate and associated impacts during construction and operations. (Construction, Maintenance, Operation)	Local	Long term	Low	probable	Negative Increase in the prevalence of HIV/AIDS and other STDs	High	Medium	HIV/AIDS awareness training Relocation of family units to the project.	Low
Sustainability of project due to high maintenance (corrosion effects).	Local	Long term	Medium	Definite	Negative on infrastructure.	High	Medium	Include these matters in the O&M contract. Consider corrosion	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATIO N	MITIGATION/ ENHANCEMENT	POST-MITIGATIO N
(Construction, Maintenance, Operation)								matters in final design.	
HEALTH AND SAFETY									
Conflict with other infrastructure in the area. (Construction, Maintenance, Operation)	Local	Short term	Medium	Probable	Negative Increased risk of compromised safety of both gas and fuel infrastructure	High	Medium	Identify all other infrastructure (Bulk Fuel Terminal) and assure necessary safety zones are adhered to.	Low
Conflict with other activities of the Bulk Fuel Tanker facility. (Construction, Maintenance, Operation)	Local	Long term	Medium to low	Definite	Negative Designated channel transport both the LNG carrier and bulk fuel carriers, causing access conflict.	High	Medium	Effective port management and user access planning between the parties that utilise the channel. Conservative storage reserve management on the FSRU between	Low

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATION	MITIGATION/ ENHANCEMENT	POST-MITIGATION
								refuelling cycles.	
Pipeline failure causing gas release (Operation)	Limited area	Temporary	Low	Improbable	Negative	Medium	Low	Leak detection and control systems will eliminate excessive gas release in case of pipeline failure.	Low
Fire risk (Operation)	Limited area	Temporary	High	Improbable	Negative	Medium	Medium	IFC recommendations include: Safety focus in design. Safe LNG transfer procedure. Fire response plan. Prevent ignition sources. Correctly specify fire detection and suppression equipment and systems.	

POTENTIAL IMPACT	EXTENT	DURATION	INTENSITY	PROBABILITY	STATUS	DEGREE OF CONF.	SIGNIFICANCE		
							PRE-MITIGATIO N	MITIGATION/ ENHANCEMENT	POST-MITIGATIO N
CUMULATIVE IMPACTS									
Build-up of dredge spoil material in the designated spoil areas managed under the Namport EMP	Limited area	Permanen t	Medium	Definite	Negative Sea bed profile and toxicity content of the spoil may change significantly.	Uncert ain	Medium	Conduct a specialised impact assessment to adjust the Namport dredging EMP. Determine new spoil areas that may have less significance / are more contained.	Low
Shipping activity in the bay area and port limits	Local	Long term	Medium	Definite	Neutral. Increases the risks associated with shipping and port activities	High	Medium	Improvement of the port management processes. Improved port communication process	Low

7.2 CONCLUSION

The only potential impact with a high pre-mitigation significance is the release of hydrogen sulphide (H_2S) during dredging. If appropriate on board prevention and monitoring measures are implemented, the significance is reduced to low and therefore acceptable.

The assessment indicates that all potential impacts can be mitigated effectively to reduce the significance of the potential impact to low and therefore acceptable.

The cumulative impact will not significantly increase due to the marine activities of the project, but should the SADC Port realise, both cumulative impact will see dramatic increase, which may lead to unacceptable condition in the bay area, if not addressed. This must be addressed by Namport at a strategic level with an integrated monitoring system.

All health and safety impact mitigation measures must be subjected to the relevant IFC guidelines to assure effective reduction of the risk and impact significance.

Detailed mitigation and enhancement may be found in the Environmental Management Plan.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONTEXT

The project originally carried with it significant complexities that could have significant effects on the social and natural environment. The project is however of national significance and will benefit Namibia both in energy security and economic stimulation.

Therefore the approach to the assessment was to facilitate improvements in especially the marine components in order to eliminate unmanageable risks. This leaves a project of very significant value of which significant impacts are eliminated.

8.2 CONCLUSION FROM THE MARINE COMPONENTS EIA

The environment of the marine project is typical of the bay conditions expected in the remainder of Walvis Bay. Therefore we assume that

- the existing information on the marine conditions and
- the impacts descriptions as well as the prevention and mitigation

can be accurately described from existing EIAs and EMPs of similar activities, and experience gained through them.

The dredging, piling and marine construction process may be of a complex nature but the assessment thereof has been addressed extensively in the EIA for the proposed new Tanker Berth and associated infrastructure in the Port of Walvis Bay (Botha, Hooks, & Fauls, 2013). This EIA draws directly on the assessment of the tanker berth EIA as all the dredging and foundation piling activities takes place in its project area that was evaluated.

The operational activities of the FSRU are however a new process with new potential impacts associated. Therefore new assessments were required in the fields of

- air quality,
- noise and
- health and safety

These studies satisfied the minimum National and IFC standards.

The activities of the marine components of the project will not result in significant impacts and effective design and management principles will reduce all impacts to low in significance.

All of the potential activities and impacts are covered under IFC guidelines, which will standardise the design and implementation process significantly.

8.3 RECOMMENDATION

It is therefore recommended that the marine component of the Walvis Bay Gas Fired Power Plant and Gas Supply Facility receive Environmental Clearance on condition:

- That the EMP be implemented through the life cycle of the project and be audited annually.
- Relevant IFC standards and guidelines be implemented and the resulting management plans be audited annually.

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