Construction - Environmental and Social Management Plan

Walvis Bay Waterfront Pty Ltd

PREPARED FOR

March 2018

ECC DOCUMENT CONTROL: ECC-41-54-REP-28-A

DOCUMENT FOR GOVERNMENT APPROVAL

TITLE AND APPROVAL PAGE

Project Name:	ECC-41-54-REP-28-A Construction - Environmental and Social Management Plan
Client Name:	Walvis Bay Waterfront Pty Ltd
Ministry Reference:	MET Scope of environmental impact assessment for proposed project of Walvis Bay Waterfront Project, Walvis Bay, Erongo Region
Status of Report:	Document for Government Approval
Date of issue:	16th March 2018
Review Period:	

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DEFINITIONS AND ABBREVIATIONS

EAP	Environmental Assessment Practitioner
ECC	Environmental Compliance Consultancy
ESIA	Environmental and Social Impact Assessment
EMA	Environmental Management Act
ESMP	Environmental and Social Management Plan
I&AP	Interested and affected parties
PPE	Personnel Protective Equipment
QCPs	Construction quality control points
SAIEA	Southern African Institute of Environmental Assessment

1. INTRODUCTION

1.1. PROJECT BACKGROUND

Walvis Bay Waterfront Properties (Pty) Ltd, a joint venture between Afrikuumba and the Municipality of Walvis Bay is proposing to construct a waterfront development on the east side of the mouth of Walvis Bay Lagoon, west of the town centre. The Walvis Bay Waterfront proposal (the proposed project) is a mixture of both marine and land based developments, providing new residential, commercial and tourism facilities, as well as a marina and canal.

The land based development is proposed to be developed on two adjoining plots of land to the east of popular Esplanade Drive (the road running parallel to the lagoon). The marine development will utilise land between Esplanade Drive and the coastline (currently the Road Reserve – see Figure 1), and will occupy an off-shore area up to and around The Raft Restaurant (Lagoon Water Area).

The area of land is currently occupied by a cricket oval and club house, swimming pool, tennis and jukskei courts. These sporting facilities will be relocated; the sites are presented in Figure 1. The cricket oval will be relocated to a soccer field surrounded by a residential area in Kuisebmund, and the swimming pool, tennis and jukskei courts will be located to the Jan Wilken site, the central sporting stadium in Walvis Bay located in the centre of town.

Figure 1 Proposed project location

1.2. ENVIRONMENTAL REGULATORY REQUIREMENTS

The proposed project is considered as a Listed Activity as set out in the Environmental Management Act, 2007 (Act No. 7 of 2007) and the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011) gazetted under the Environmental Management Act, (EMA), 2007 (Act No. 7 of 2007) (referred to herein as the EIA Regulations). As a Listed Activity an application for an Environmental Clearance Certificate is required. An Environmental and Social Impact Assessment (ESIA) report and Environmental and Social Management Plan (ESMP) are required as part of the Environmental Clearance Certificate application, as well as to support the decision-making process. This report presents part of the ESMP (see Section 1.3) and has been undertaken in accordance with the requirements of the Environmental Management Act, 2007 and associated Regulations.

1.3. Purpose of this Report

The series of Environment and Social Management Plans (ESMP) are tools to be used by the proponent to ensure potential environment and social impacts and risk are managed. The ESMP for the project is a series of three documents, one for each phase of the project:

- Site Preparation and Construction (Titled: Construction – ESMP)
- Operations ESMP Operations (Titled: Operations – ESMP)
- Decommissioning and Reinstatement (Titled: Decommissioning –ESMP)

By having individual ESMPs specific to phases, the application of the plan and the management of environmental risks shall be more effective and easier to implement. **This report is the ESMP for the Site Preparation and Construction phase of the proposed project.**

The proposed project has three defined sites, as well as road improvements. This Construction-ESMP is applicable for each site/construction works within the scope of the project.

The purpose of this Construction-ESMP is to provide a management framework for the planning and implementation of construction activities and provides construction standards and operating arrangements so that potential environmental and social impacts of the proposed project are mitigated, prevented and minimised as far as reasonable practicable, and that statutory requirements and other legal obligations are fulfilled. This Construction-ESMP also presents protocols and procedures, and roles and responsibilities to ensure the management arrangements are appropriately and effectively implemented.

This Construction-ESMP forms an appendix to the ESIA report; therefore, the ESIA report should be referred to for further information on the construction of the proposed project, assessment methodology, applicable legislation and assessment findings.

This Construction-ESMP is a live document and shall be reviewed at predetermined intervals, and/or updated when the scope of works alters, or when further data / information can be added. All personal working on the proposed project will be legally required to comply with the standards set out in this Construction-ESMPs.

1.4. Management of this Construction ESMP

Walvis Bay Waterfront Properties (Pty) Ltd (the proponent) will hold the Environmental Clearance Certificate for the development and shall be responsible for the implementation and management of this Construction-ESMP.

Prior to the construction works commencing for either Phase 1 or Phase 2, this Construction-ESMP shall be reviewed, amended as required and approved ready for implementation.

The implementation and management of this Construction-ESMP and thus the monitoring of compliance shall be undertaken through daily duties and activities, weekly and monthly inspections (see Sections2.2 and 4). Regular meetings between designated roles and parties shall occur (see Sections 3.2 and 3.3) to ensure that any environmental issues, lessons learnt or required amendments to this Construction-ESMP is appropriately reported and recorded. The findings of these meetings shall be taken forward and considered during the annual review. This formal annual review shall occur every year from the day of implementation and a summary report shall be produced. The following shall be considered during the review:

- The review shall include an evaluation of the operations effectiveness of implementing this Construction-ESMP, of environmental procedures, processes, forms, checklists and any other documents;

- The summary report shall include a review of all review findings, including the independent review (Refer to Section 4.2.2);
- The review shall include an evaluation of environmental incidents and community complaints, and actions taken to rectify or address these events; and
- This Constructions-ESMP shall be amended as required based on the outcomes of the review.

This Construction-ESMP shall be circulated to all contractors and shall be made available on the proponent's website.

A list of required supporting plans, permits, registers or documents are provided in Annex A.

1.5. Limitations, Uncertainties and Assumptions of this Construction-ESMP

This Construction-ESMP does not include measures for compliance with statutory occupational health and safety requirements. This will be provided in the safety management plan to be developed by the proponent.

Where there is any conflict between the provisions of this Construction-ESMP and any contractor's obligations under their respective contracts, including statutory requirements (such as licences, project approval conditions, permits, standards, guidelines and relevant laws), the contract and statutory requirements are to take precedence.

The information contained in this Construction-ESMP has been based on the project description as provided in the ESIA report. Where the design or construction methods alter, this Construction-ESMP may require updating and potential further assessment undertaken.

1.6. Environmental Consultancy

Environmental Compliance Consultancy (ECC), a Namibian consultancy registration number 2013/11401, has prepared this Construction-ESMP on behalf of Walvis Bay Waterfront Properties (Pty) Ltd. ECC operates exclusively in the environmental, social, health and safety fields for clients across Southern Africa, in the public and private sector. ECC is independent to the proponent and has no vested or financial interested in the proposed project.

1.7. Structure of this Construction-ESMP

The following structure has been adopted for this Report:

- Chapter 1 – Introduction
- Chapter 2 – Project Management and Personnel
- Chapter 3 – Communications and Training
- Chapter 4 – Compliance and Enforcement
- Chapter 5 – General Conduct and Site Management
- Chapter 6 – Register of Environmental Risks and Issues
- Annex A – Document checklist
- Annex B – Contact Details Template
- Annex C – Complaints Register
- Annex D – Daily / Weekly Inspection Report
- Annex E – Monthly Compliance Report
- Annex F – Template Waste Management Plan
- Annex G – Monitoring Plan

2. PROJECT MANAGEMENT AND PERSONNEL

2.1. Walvis Bay Waterfront Properties (Pty) Ltd

Walvis Bay Waterfront Properties (Pty) Ltd (the proponent) will hold the Environmental Clearance Certificate for the development and shall be responsible for the implementation and management of this Construction-ESMP across the project for the life time of the construction phase. The proponent shall provide a Project Team to oversee and undertake the construction works, which shall be composed of the proponent's personnel, contractors and consultants.

2.2. Organisational Structure, Roles and Responsibilities

The proponent shall be responsible for:

- Ensuring all members of the Project Team, including contractors and consultants comply with the procedures set out in this Construction-ESMP
- Ensuring that all persons are provided with sufficient training, supervision and instruction to fulfil this requirement; and
- Ensuring that any persons allocated specific environmental responsibilities are notified of their appointment and confirm that their responsibilities are clearly understood.

Contractors shall be responsible for ensuring and demonstrating that all personnel employed by them are compliant with this Construction-ESMP, as listed above.

The key personnel and environmental responsibilities of each role during the construction works are summarised in Table 1. The contact details of key personnel shall be recorded in Annex A. This register shall be displayed on site and shall be reviewed and updated regularly to ensure all details are correct.

Table 1 – Key Roles and Responsibilities

ROLE	RESPONSIBILITY & DUTIES
Walvis Bay Waterfront Properties (Pty) Ltd Management Team	– Overall responsibility for the implementation and management of this Construction-ESMP. – Ensure Environmental Policy is communicated throughout the proposed project. – Responsible for providing the required resources to complete the required tasks and to facilitate company corporate support. Resources being financial, technical and includes external resources.
Project Manager	– Appointed by the proponent. – Responsible for overseeing the construction works, day to day activities, and compliance with this Construction-ESMP, in addition: – Ensuring the construction contractor/s are aware of the commitments made in this Construction-ESMP and any other relevant regulatory requirements and that construction will be undertaken in compliance with these; – Ensuring there are adequate resources are made available for implementation of this Construction-ESMP; – Conducting project meetings regularly during the construction period to review actions arising from previous inspections, current status of tasks and schedule of upcoming tasks; – Arranging an independent audit to assess the proponents level of compliance to this Construction-ESMP;

ROLE	RESPONSIBILITY & DUTIES
	– Ensuring all employees and contractors participate in a Site Induction process prior to commencing work on the project; – Maintain up to date register of employees who have completed the Site Induction; and – Report any non-compliance or accidents to the Regulatory Authority.
Environment and Social Manager	– Experience in the field and management of large construction projects, the Environment and Social Manager will be appointed by the proponent, who will be available, as required for the following: – Being the principal contact point in relation to environmental performance of the project; – Reporting environmental performance to the Site Manager and PM; – Reports incidents to Project Manager. – Reviewing environmental management content of method statements; – Providing guidance for the site team in dealing with environmental matters, including legal and statutory requirements affecting the works; – Being responsible for all environmental management plans and environmental monitoring, and production of associated reports/records; – Being responsible for providing a response to environment-related complaints received from the public or other stakeholders; – Ensuring that best environmental practice is undertaken throughout the duration of the construction period; – Undertaking routine checks of the construction site and activities; – Provisioning of environmental awareness/management training and inductions; – Timely distribution of any relevant environmental documentation, including revisions to this ESMP, to all construction managers and contractors; – Liaise with specialists such as Mr Louw during piling and dredging operations; and the Namibian Dolphin project.
Site Manager	Appointed to manage the performance of the construction activities and manage any contractors. Responsible for the implementation of this Construction-ESMP and ensuring all construction activities are compliant with this Construction-ESMP, as well as: – Overseeing daily onsite activities; – Managing the preparation and implementation of method statements for certain activities, and ensuring the Environmental and Social Manager reviews all method statements and the relevant environmental protocols are incorporated; – Reporting any non-compliance or accidents to the PM and Environment and Social Manager; – Ensuring that all staff have attend a site induction session before commencement of any work on site and that they are adequately informed of the requirements of this Construction-ESMP; – Ensuring that all contract workers, sub-contractors and visitors to the site are conversant with the requirements of this ESMP, relevant to their roles on site and adhere to this ESMP at all times; and – Receiving, responding to and recording complaints.

ROLE	RESPONSIBILITY & DUTIES
Construction workers	Responsible for being compliant with this Construction-ESMP throughout the construction works, in addition to: – Ensuring they have undertaken a site induction and are conversant with the requirements of this Construction-ESMP; – Ensuring appropriate briefings for certain activities have been provided and fully understood; – Adherence to this Construction-ESMP at all times; and – Reporting of any operations and conditions that deviate from the Construction-ESMP or any non-compliant issues or accidents to the Environment and Social Manager, and Site Manager. – Ensuring all task and methods statements are signed off by Environment and Social Manager and PM prior to undertaking activities
Independent Environmental Consultants / Nominated expert	A specialist consultant who will act in an advisory capacity on request from the proponent, Site Manager and Environment and Social Manager. Responsible for: – Ensuring they have undertaken a site induction and are conversant with the requirements of this Construction-ESMP; – Liaise closely with the Environment and Social Manager throughout their work on site; – Reporting any issues of concerns to the Environment and Social Manager, PM or Site Manager as soon as the issue arises, and take appropriate action as they deem necessary in line with this Construction-ESMP; – Record any issues or concerns and submit a written report to the Environment and Social Manager and PM; – Adherence to this Construction-ESMP at all times; – Reporting of any operations and conditions that deviate from the Construction-ESMP or any non-compliant issues or accidents to the Site Manager; – Monthly audits and inspections during construction; and – Annual audit of compliance.

2.3. CONTRACTORS

Any contractors hired during the construction works would need to be compliant with this Construction-ESMP, and would be responsible for the following:

- Undertaking construction activities in accordance with this Construction-ESMP as well as relevant policies, procedures, management plans, statutory requirements, and contract requirements;
- Implementing appropriate environmental and safety management measures;
- Reporting of environmental issues, including actual or potential environmental incidents and hazards, to the Site Manager or PM; and
- Ensuring appropriate corrective or remedial action is taken to address all environmental hazards and incidents reported by employees and subcontractors.

2.4. Employment

The proponent and all contractors shall comply with the requirements of the Republic of Namibia Regulations for Labour, Health and Safety, and any amendments to these regulations. During operations, the following shall be complied with:

- In liaison with local government and community authorities the Contractor shall ensure that local people have access to information about job opportunities and are considered first for construction contract employment positions;
- The number of job opportunities shall be made known together with the associated skills and qualifications. The maximum length of time the job is likely to last for shall be clearly indicated;
- Foreign workers with no proof of permanent legal residence shall not be hired; and
- Every effort shall be made to recruit from the pool of unemployed workers living in Walvis Bay.

Additional employment principals shall be developed and included to this Construction-ESMP to ensure a robust employment policy is implemented across the proposed project.

3. COMMUNICATIONS AND TRAINING

3.1. Introduction

The proposed project will involve various construction activities in both the marine environment and on land, both of which have sensitive receptors that are likely to be affected by construction works. It is therefore imperative that all workers and the local community are regularly liaised with to communicate aspects such as the scheduling of certain activities; safety and environmental restrictions and risks with certain activities; updates to the progress of construction works; and certain site environmental issues or concerns to be aware of.

3.2. Communications: Internal

3.2.1. Environmental Communications

The PM, Site Manager, and Environment and Social Manager, shall communicate site wide environmental issues through the following means:

- Site induction (see section 3.5.1);
- Emails;
- Environmental posters and site notices;
- Method Statement and Risk Assessment briefings (see section 5.2);
- Audits and site inspections;
- Toolbox talks, including instruction on incident response procedures; and
- Key project specific environmental issues briefings.

This Construction-ESMP shall be distributed to the project team, including contractors and sub-contractors, to ensure that the environmental requirements are communicated effectively. Key activities and environmentally sensitive operations shall also be briefed to workers and contractors.

3.2.2. Meetings

During the construction phase, internal communication between the management team shall include regular progress meetings (e.g. monthly), covering:

- Training undertaken;
- Progress reports;
- Inspections, audits and non-conformance;
- Complaints received;
- Visits by external bodies and the outcome or feedback from such visits; and
- Objective / target achievement, including reporting on environmental performance.

3.3. Communications: External

3.3.1. Community

The Environment and Social Manager shall represent the proposed project and shall liaise with the local communities and stakeholders regarding the construction works. The following communications shall be undertaken during the construction phase. This list is not limited and may develop over time depending on community feedback and requests.

- Clear contact details of the proponent and Environment and Social Manager circulated around the community, should there be any questions, concerns or complaints;
- Quarterly project updates to local residents through notice boards / news-letter / meetings to keep the local community up to date with progress and any new operations to be carried out;
- Quarterly environmental forums reporting environment and social performance to multi stakeholder forum including government, local council, neighbours and stakeholders; this group of representatives will then report back to their respective associations;
- Early warnings of noisy construction works through notices, what's app / group text alerts, door-to-door engagement and letter dropping for surrounding residents; and
- Flyers circulated around the community with information detailing available alternative sporting facilities for the duration of when the existing ones and replacements ones are unavailable.

This Construction-ESMP will be published on ECC and the proponent's website.

3.3.2. Other Stakeholders

During the construction works, communication will be required with external parties. Communication may take the form of scheduled meetings, site visits and written correspondence. The key stakeholders who shall be communicated with include, but are not limited to:

- Walvis Bay Municipality;
- The Namibian Dolphin Project (Dr Simon Elwen);
- Namport; and
- Ministry of Environment and Tourism, Ministry of Fisheries, Marine Resources or other government stakeholders.

3.4. Complaints Handling and Recording

Complaints shall be directed to a dedicated email address and nominated phone number, the details of which shall be circulated to the local community and displayed on notice boards. Any complaints received verbally by any personnel on the project site shall be recorded by the receiver, including the name and contact details of the complainant, date and time of the complaint, and the nature of complaint. The information shall be given to the Environmental and Social Manager who is overall responsible for the management of complaints, and will provide a written response to the complainant. The Environment and Social Manager shall inform the Site Manager of issues, concerns or complaints.

The Environment and Social Manager shall maintain a complaint's register (see Annex C for a template) that will detail the name and contact details of the complainant, date and time of the complaint, nature of complaint, action taken to resolve issues, and date of complaint handover. The Environment and Social Manager shall be responsible for nominating the correct personnel to co-ordinate and resolve the issue.

The Environment and Social Manager shall inform the Municipality of this complaints register, its location and the person responsible to ensure that local community or the general public are aware and know about the complaints register.

The workforce shall be informed about the complaints register, its location and the person responsible, in order to refer local residents or the general public who wish to lodge a complaint.

The complainant shall be informed in writing of the results of the investigation and action to be taken to rectify or address the matter(s). Where no action is taken, the reasons why are to be recorded in the register.

The complaints register shall be kept for the duration of the project and will be available for government or public review upon request.

3.5. Training and Awareness

All personnel working on the construction site shall be competent to perform tasks that have the potential to cause an environmental impact. Competence is defined in terms of appropriate education, training and experience.

3.5.1. Site Induction

All personnel involved in the proposed project will be inducted to site with specific environment and social awareness training, and health and safety issues concerning the construction works. The environment and social awareness training will ensure that staff are familiar with the principles of this Construction-ESMP, the environment and social aspects and impacts associated with their activities, the procedures in place to control these impacts and the consequences of departure from these procedures.

The PM shall ensure a register of completed training is maintained and issued to the Environment and Social Manager monthly or when there are additions. The training may be provided annually, as a refresher or when certain components may change over time.

The Site Induction should include, but not limited to the following:

- A general site-specific induction that outlines:
  - What is meant by "environment" and "social";
  - Why the environment needs to be protected and conserved;
  - How construction activities can impact on the environment;
  - What can be done to mitigate against such impacts;
- The inductee's role and responsibilities with respect to implementing the Construction-ESMP;
- The environmental impacts and social responsibilities associated with the inductee's working activities;
- The site environmental rules;
- Details of how to deal with, and who to contact if environmental problems should they occur;
- Basic spill response and briefing on use of al location of spill kits;
- The potential consequences of non-compliance with this Construction-ESMP and relevant statutory requirements; and
- The role of responsible people for the proposed project.

3.5.2. Specialist Briefings

Additional environment and social briefings may be delivered to specific personnel allocated with environmental responsibilities or to employees on specific environmental risks applicable to specific activities and mitigation measures required.

Specialist consultants, such as Mr Alan Louw and the Namibian Dolphin Project, may be brought in to provide additional advice on specific activities.

4. REPORTING, COMPLIANCE AND ENFORCEMENT

4.1. ENVIRONMENTAL PERMITS

Prior to construction works, all permits will be obtained. The following environmental permits will be in place prior to applicable activities being undertaken:

- Approximately two 22,000 litre fuel tanks will be on site during construction, therefore the project will require a licence and certificate to store and dispense fuel under the Petroleum Products and Energy Act (Act 13 of 1990) and associated amendments and regulations.
- An existing building that is to be demolished on the site has been identified to contain asbestos cement roofing material. In terms of Section 5 of the Atmospheric Pollution Prevention Ordinance 11 of 1976, any person carrying out a “scheduled process” within a “controlled area” has to obtain a registration certificate from the administering authority, in this case the Department of Health. The removal of this material will be completed by a licenced and registered contractor specialising in asbestos removal.

A check list of permits, approvals, forms, registers and documents that are required prior to specific construction activities is provided in Annex A.

4.2. ENVIRONMENTAL PERFORMANCE MANAGEMENT

4.2.1. SUMMARY OF ENVIRONMENTAL RISKS AND MITIGATION MEASURES

Chapter 6 provides a Register of Environmental Risks and Issues, which identifies mitigation and monitoring measures, as well as roles responsible. This register will be subject to regular review by the Environment and Social Manager together with the Site Manager, and updated when necessary.

This register will be used to undertake weekly and monthly inspections by the PM, Site Manager and Environment and Social Manager (see next section) to ensure the project is compliant with this Construction-ESMP.

4.2.2. ENVIRONMENTAL INSPECTIONS & COMPLIANCE MONITORING

4.2.2.1. DAILY COMPLIANCE MONITORING

A copy of this Construction-ESMPs shall be on site throughout the construction works and shall be available upon request. It is the responsibility of the PM and Site Manager to ensure this Construction-ESMP is complied with through their daily roles.

Daily inspections will be undertaken by the Site Manager (or nominated site supervisor) and a weekly report shall be prepared (see Annex D for a template which shall be developed prior to construction). Any environmental problems or risks identified shall be notified to the Environment and Social Manager and actioned as soon as is reasonably practicable.

4.2.2.2. MONTHLY COMPLIANCE MONITORING

Monthly inspections shall be undertaken by the Environment and Social Manager to check that the standards and procedures set out in this Construction-ESMP are being complied with and pollution control measures are in place and working correctly. Monthly Compliance Reports shall be produced (see Annex E for a template which shall be completed prior to construction commenced). This report shall be completed by the Environment and Social Manager and issued to the PM and Site Manager who will review and discuss any issues with the Environment and Social Manager. The report shall contain a brief description of any areas of non-conformance with the contract specification, the reason for the non-conformance, the responsible party, the result (consequence), the corrective action taken and any necessary follow up measures required.

4.2.2.3. Inspection of Plant and Equipment

All plant and equipment performing an environmental function shall be well maintained and serviced in line with their specification. A register of all plant and equipment under the responsibility of the Contractor shall be maintained and serviced as and when required. This register shall be reviewed monthly to ensure all checks and services for plant and equipment have been undertaken. The register shall include, but not limited to the following:

- Piece of plant and equipment;
- Make and Model;
- Frequency of required service and scheduled dates;
- Dates of last inspection, maintenance and/or test;
- Notes of any issues or concerns; and
- Responsible person.

4.2.2.4. Annual Compliance Monitoring

An independent annual audit shall be undertaken to review operations and compliance over the last 12 months. All monthly reports shall be reviewed, identifying any trends or significant areas of concern, as well as measures implemented to manage / resolve the environment or social issue. All complaints or comments and actions taken shall be reviewed. Compliance and legislative changes shall be reviewed, and lessons learnt shall be captured. This Construction-ESMP shall be amended as required, and follow up training, awareness or updates shall be provided across the project.

A check list of permits, approvals, forms, registers and documents that are required prior to certain construction activities is provided in Annex A. This checklist shall be used to ensure compliance with this Construction-ESMP, and shall be updated particularly with any required Method Statements.

4.3. Reporting

There will be a requirement to ensure that any incident is reported to the proponent's Management Team. In the event of any environmental issue, failure of plant and equipment that perform an environmental function or accident, the reporting structure presented in Figure 2.

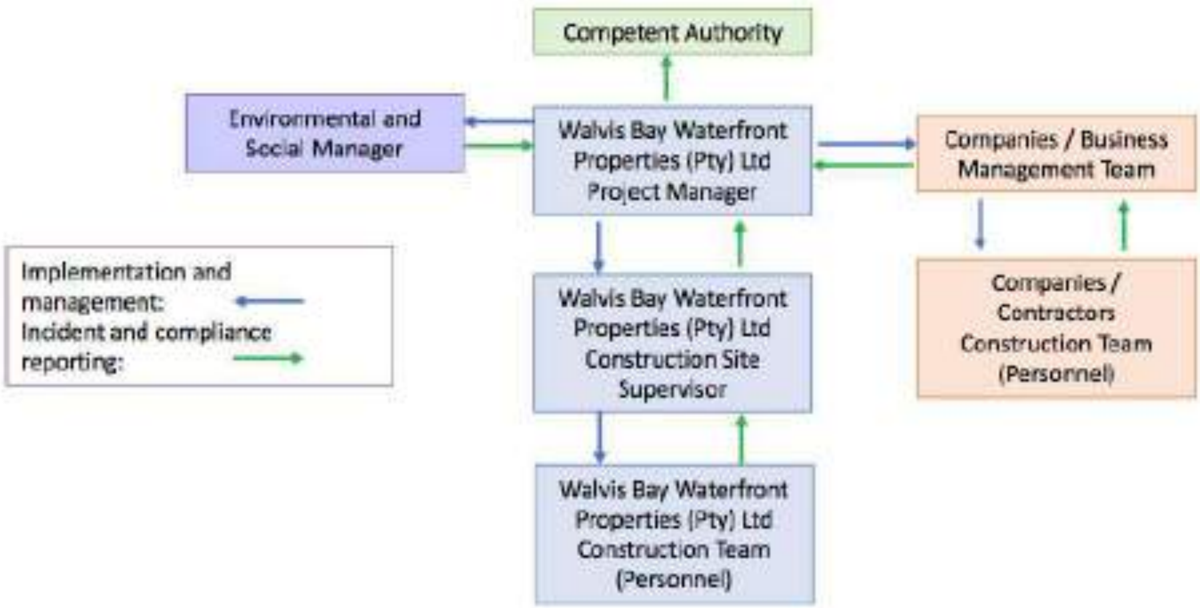

Figure 2 – Reporting Structure overview

4.3.1. Non-compliance

Where it has been identified that works are not compliant with this Construction-ESMP, the proponent shall employ corrective actions so that the works return to being compliant as soon as possible. In instances where the requirements of the Construction-ESMP are not upheld, a Non-Conformance and Corrective Action Notice shall be produced. The Notice shall be generated during the inspections conducted by the Supervisors, the Site Manager, Environment and Social Manager or external third-party audits. The Site Manager will be responsible for ensuring a corrective action plan is established and implemented to address the identified shortcoming.

A non-compliance event / situation is considered if:

- There is evidence of contravention of this Construction-ESMP and associated indicators or objectives;
- The Site Manager and/or Contractor have failed to comply with corrective or other instructions issued by the Environmental Manager or qualified authority; or
- The Site Manager and Contractor fail to respond to complaints from the public.

Works will be stopped in the event of a non-compliance, until corrective action(s) has been completed.

A Compliance Report will be produced each month, as discussed previously.

4.3.2. Disciplinary Action

This Construction-ESMP is a legally binding document and non-compliance with it shall result in disciplinary action being taken against the perpetrator/s. Such action may take the form of (but is not limited to):

- Fines / penalties;

- Legal action;
- Monetary penalties imposed by the proponent on the contractor;
- Withdrawal of license/s; and
- Suspension of work.

The disciplinary action shall be determined according to the nature and extend of the transgression / non-compliance, and penalties are to be weighed against the severity of the incident.

4.4. Control of Records

A range of environmental records, for example waste management records are required and specified throughout this Construction-ESMP. A summary of requirements is provided in Annex A.

Environmental records shall be maintained, either in hard copy or electronic format and shall be readily identifiable, retrievable and protected against damage, deterioration or loss.

5. CONSTRUCTION ENVIRONMENTAL MANAGEMENT

5.1. Objectives and Targets

Environmental objectives for the construction works are as follows:

- Zero pollution incidents;
- Minimise waste sent to landfill or being burnt;
- Minimise disruption to residents (and therefore complaints); and
- Protect marine biodiversity.

Procedures for monitoring construction processes against the project environmental objectives will be proposed by the Contractor and agreed with the PM.

5.2. Method Statements and Risk Assessments

Method Statements and Risk Assessments shall be produced for specific activities prior to works commencing, and shall include environmental protection and mitigation measures, as well as emergency preparedness appropriate to the activity covered. The Site Manager will draft each one and the PM and Environment and Social Manager will review, providing advise where necessary.

Method Statement briefings shall be provided before personnel carry out key activities for the first time.

Method Statements shall be produced for a range of activities, including, but not limited to:

- Worker campsite (see section 5.5);
- Establishment and set up of Construction site (see section 5.6);
- Removal, management and reinstatement of palm trees (see section 5.7);
- Clearance of grass, vegetation, topsoil and subsoil (see section 5.7);
- Community nuisances and hazards (see section 5.10);
- Surface water run-off, groundwater and silt management (see section 5.14.1);
- Dredging works (see section 5.11);
- Marina Wall construction works (piling and rock dropping) (see section 5.11); and
- Handling and disposal of Asbestos (see section 5.14.2).

5.3. Construction Quality Control Points

Construction quality control points (QCPs) shall be identified in the project schedule prior to construction activities commencing. QCPs are required to control project risks, including environmental and social, during specific activities, and to allow for stringent monitoring and accountability to reduce risk within activities. At QCPS, sign off is required upon completion of a construction activity to allow the following activity to commence. This sign off shall be undertaken by the identified responsible personnel.

A QCP system will be in place for the construction phase. QCPs shall be identified and implemented for the construction phase by incorporating them into the method statements and must include the key responsibility personnel that will sign off and or witness each quality control point (critical). QCPs have been incorporated into the environmental monitoring plan Annex G.

5.4. Project Close

All QCPs shall be closed before project close and signed off.

5.5. Worker Campsite and Management

The site to be used to accommodate workers will be an area that minimises the potential for social and environmental impacts, as well as public nuisances. The campsite shall be within the town limits of Walvis Bay and the proponent and contractor will prepare a Method Statement for the set-up and operations which will contain, but is not limited to the following details:

- Site location and layout;
- Preparatory works
- Fencing;
- Waste management (which will comply with the project's waste management principals – see section 0);
- Water supply;
- Management of infectious dieses (e.g. HIV)
- Sewerage management; and
- Site reinstatement.

The campsite will have defined rules that shall be communicated in a Site Induction to all workers staying in the camp during. Workers who do not comply to these rules shall be disciplined accordingly in line with predetermined agreements set out by the Site Manager prior to construction works. Rules will include, but are not limited to the following.

- No visits from local people to the campsite will be allowed unless approved by the Site Manager;
- The campsite shall be kept clean at all times to minimise visual impact, odours and pests, and waste management measures must be adhered to at all times;
- Workers shall not harvest firewood from the site or surrounding areas;
- No alcohol or drugs permitted on the construction camp site
- Workers must make use of the facilities and equipment provided for them; no ad hoc alternatives shall be allowed, for example fires for cooking outside of designated areas or using the bush as a toilet;

The campsite will be reinstated back to its original condition upon completion of the construction works. This shall be undertaken in line with an approved Method Statement.

5.6. Establishment and Management of Construction Site

A Method Statement will be produced setting out how the site will be established and managed, and will include but not limited to the following information.

The construction site shall be established to minimise impacts on the environment and society, and shall include the following considerations:

- Site boundary fence (made of material to reduce noise and visual impacts (e.g. hoarding) and at least 2m high) to be established as soon as possible to prevent windblown litter or waste, to reduce dusts being blown off site and reduce visual impacts on local residents;
- Provide access routes / points onto site at a suitable location to avoid impacts on local residents (on Atlantic Street);

- Plant and equipment shall be brought onto site as and when required, and shall follow designated routes and access points;
- Plant and equipment shall be stored in specific areas taking into consideration impacts on local residents (e.g. start-up of equipment and noise levels);
- A construction office area (construction site office, toilets and other welfare facilities, and the storage of small plant and equipment) will be set up in a suitable location to avoid impacts on local residents;
- Waste collection area and material storage areas shall be located in areas with least impact (visual and other nuisances) to the local residents;
- Lighting shall only be used when necessary and will be designed to minimise spillage of light, and orientated away from residential properties;
- Construction site office located away from residential properties;

A 'good housekeeping' policy shall be adopted across the construction site, which will include the following requirements:

- No fires on site;
- Considerate behaviour of all site staff;
- Maintenance of staff welfare facilities;
- Removal of food waste and other rubbish at frequent intervals;
- No littering or discard of random solid waste; and
- Maintenance of road cleanliness surrounding the site.

5.7. Vegetation Clearance and Topsoil and Subsoil Strip

Vegetation shall only be cleared on the construction site and where possible, established trees along the perimeter of the construction site shall remain in situ, with a clear exclusion zone around each one to protect the roots during construction. This exclusion zone should be approximately two metres from the trunk of the tree.

Where possible, palm trees will be removed and stored until reinstatement. Trees shall be removed, stored and reinstated by a specialist contractor. A Method Statement for this activity shall be prepared.

The area has large areas of grass, which shall be removed and transferred to the Kuisebmond site for reuse on the cricket oval. Any vegetation cleared and not reused will be taken to a suitable site for composting where possible. Topsoil and subsoil shall be stripped and separated where possible for reuse in the community or taken to a suitable site for reuse.

A Method Statement for the clearance of grass, vegetation, topsoil and subsoil shall be prepared.

5.8. Archaeological Remains

The ESIA has determined that there is a low probability to cause a significant environmental impact on cultural heritage; however, there is a risk that during construction undiscovered archaeological remains may be uncovered. In the event of this occurrence, the following measures shall be applied:

- Works to cease, area to be demarcated with appropriate tape by the site supervisor, and the Site Manger to be informed;
- Site Manager to visit the site and determine whether work can proceed without damage to findings, mark exclusions boundary and inform the Environment and Social Manager with the GPS position if possible;

- Environmental and Social Manager to inspect the site and determine if and specialist is required to determine significance;
- Environment and Social Manager / Archaeological Specialist to evaluate the significance of the remains and identify appropriate action, for example, record and remove; relocate or leave in situ (depending on the nature and value of the remains);
- Inform the police if the remains are human; and
- Obtain appropriate clearance or approval from the competent authority, if required, and recover and remove the remains to the National Museum or National Forensic Laboratory as direct.

5.9. Solid Waste Management

The EMA (2007), Section 3, paragraph (i) states that waste must be reduced, re-used and recycled where possible, therefore in accordance with the Act, waste generated on site will be managed and dealt with in accordance with a Waste Management Plan. This Plan will be produced prior to construction activities commencing and will include the following information:

- Describe each waste type expected to be produced during construction activities;
- Estimate the quantity of each waste type;
- Identify the waste management action proposed for each waste stream, including re-using, recycling, recovery and disposal;
- Designated areas to collect and separate waste; and
- Identify waste carrier and waste Disposal Company.

A draft Waste Management Plan template is provided in Annex F. This shall be drafted prior to construction works, and shall be updated on a regular basis to ensure all waste and disposal route are identified. The aim of the Waste Management Plan is to achieve sustainable waste management. Their main purpose is to outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. In addition, it will also outline any potential economical and investment requirements for the treatment and / or disposal of waste.

The following waste management measures will be followed:

- Waste will be collected, separated and stored in a designated area which will be appropriately fenced and signposted to keep out unauthorised people and animals;
- Waste collection containers will be of an appropriate design to ensure that no waste can escape, and will be labelled with waste type (e.g. wood, metals, building rubble, garden waste, domestic waste);
- Waste storage areas shall be kept clean and tidy at all times;
- Bins shall be emptied regularly to avoid pests and bad odours; and
- No burning will be allowed on site.

Portable toilets / toilet facilities will be provided for the construction workforce. These will be emptied and maintained regularly by a suitable and reputable sanitation contractor.

Any hazardous material and wastes (including medical waste, if necessary) shall be managed in a safe and responsible manner so as to prevent contamination of soils, pollution of water and/or harm to people or animals as a result of the use of these materials. Hazardous and non-hazardous waste shall be stored separately at all times.

5.10. Community Nuisances and Hazards

Tall personnel shall respect the property and rights of local inhabitants at all times and shall treat all such persons with courtesy. A Method Statement will be produced detailing the specific measures that are to be implemented to manage nuisances and hazards to the community. Measures are detailed in these next sections that shall be included in the Method Statement.

5.10.1. Dust Control

Dust control measures shall be used along the roads around and approaching the site, to reduce detrimental impacts to the local community and general public, as well as the marine environment. Control measures to be considered and implemented include the following:

- Use of water bowsers to dampen dust in dry conditions;
- Erect a site boundary closed fence (not mesh) as soon as possible;
- Avoid stockpiling on site, and if soil or sand is stockpiled, cover and limit height to 2m;
- Avoid undertaking activities that will generate dust / disturb the ground during high winds;
- Use of temporary stabilizing measures such as chemical soil binders;
- Re-instating areas cleared of vegetation as soon as is practically possible;
- Cover excavated / dredged material during transportation to Industrial Zone 14; and
- Limiting vehicle speeds in areas in proximity to dwellings and other habitation.

5.10.2. Noise Control

Noise should shall be minimised as much as possible during construction works. The following measures shall be applied:

- Erect a site boundary fence (hoarding fence is preferable, at least 2m high) as soon as possible;
- Limit working hours to 7am to 6pm weekdays and 7am until 1pm on Saturday;
- Undertake noisy activities between 8am and 5pm during weekdays;
- Inform local residents of scheduling and duration of noisy activities through notices, what's app or group text notifications, door-to-door knocking or letter dropping (responsibility of the Environment and Social Manager);
- Regular maintenance and servicing of vehicles, plant and equipment;
- Use hydraulic plant in preference to pneumatic plant where possible;
- Minimise the multiple use of noisy plant and equipment;
- All plant to be shut down or throttled back between periods of use;
- Implement engineering controls where necessary, e.g. silencers;
- Acoustic enclosures may be required for fixed plant such as generators, depending on the siting on the construction site.

The Contractor shall comply with the World Health Organization guidelines (http://apps.who.int/iris/handle/10665/66217) for the management of community noise.

5.10.3. Private Means of Access

Access shall be maintained at all times to residential properties and businesses. Where required, banksman shall aid private vehicles accessing properties and halt construction traffic. A Traffic Management Plan (see Section 5.11) shall be implemented prior to and during construction.

5.11. Construction Traffic

The Traffic Management Plan documents designated routes to and from the construction site for all construction vehicles, as well as identifying site entrances/exits. Where there are exceptions to the defined routes, approval from the Site Manager shall be obtained before the journey.

The Site Manager shall ensure this plan is completed and signed off by the Environmental and Social Manager prior to construction works commence, and shall ensure compliance. Personnel deviating from the designated or approved routes will be appropriately disciplined.

5.12. Risks to the Marine Environment

The proposed project will undertake various construction activities that could cause impacts to the marine environment. A Method Statement shall be prepared prior to any construction activities in or next to the sea, including piling, dredging, construction of the marina wall, removal of the road and ground excavations.

The Method Statement shall include measures to avoid and minimise impacts, and set out any monitoring requirements, which shall include, but not limited to the following:

- Dredging works to be undertaken on the outgoing tide and to avoid strong trade winds;
- Limit activities to the specified area, schedule and for the planned durations;
- Engage the Namibian Dolphin Project to conduct Hydrophone monitoring prior to and during construction activities to determine presence of animals;
- Do not undertake activities until marine mammals have left the area;
- Ensure a Marine Mammal Observer is available to observe and identify presence of animals prior to works and to cease works if dolphins are within the predetermined safe zones;
- Ensure Mr Alan Louw or his nominated representative is present to oversee all dredging activities;
- Use soft-start and ramp-up operations; and
- Maintain and clean all plant and equipment used in the marine environment.

Construction activities including removal of road surfaces and ground excavation will be undertaken along the coastline. Measures shall be taken to avoid surface water run-off entering the sea without prior filtration or treatment, and to ensure lose ground does not enter the sea. The management of surface water run-off and activities next to the sea shall be defined within the Method Statement.

5.13. Environmental Monitoring

Monitoring during operations shall be undertaken to ensure the impacts on society and the environment are minimised and to evaluate how effective the environmental management has been, over an extended period of time. A preliminary environment and social monitoring plan is attached as Annex G.

5.14. Pollution Control and Contingency Plan

5.14.1. Surface Water Run-off, Groundwater and Silt Management

All construction operations on site shall be carried out in a manner to minimise the production and discharge of silty run-off. In particular, where any dewatering or pumping of groundwater has to be carried out, a Method Statement will be produced setting out any required temporary drainage and the methods of collection and disposal of the waters. The Environmental and Social Manager shall sign off this Method Statement.

Specific ground excavation activities and other construction activities shall be avoided during heavy rainfall events to minimise silt laden surface runoff entering the marine environment. Suitable drainage shall be employed to prevent surface water entering the marine environment without treatment and filtration.

5.14.2. Handling and Disposal of Asbestos

One of the existing buildings on site has asbestos in the roof material. A registration certificate (see section 4.1) shall be obtained by a qualified asbestos removal contractor who will remove the material in line with legal requirements. The removal of this contaminated material will produce hazardous waste, which will be disposed of at the hazardous waste disposal site.

5.14.3. Storage of Fuels, Oils and Chemicals

Approximately two 22,000 litre fuel tanks will be on site during construction, and potentially other substances such as oils and chemicals. The Contractor shall comply with all applicable Namibian laws, regulations, permit and approval conditions and requirements relevant to the storage, use, and proper disposal of hydrocarbons (see section 4.1).

Where fuels, oils or chemicals are stored on the construction site, the following should be applied:

- Fuel storage tanks should be sited in a location specified and approved by the Site Manager and should be enclosed with a security fence with a lockable gate;
- Any fuel tank or container should be on a flat area, at least 100m from residential properties and the sea;
- The container shall be stored on an impervious base, be bunded and capable of containing at least 110% of the total capacity of the storage container;
- The bund should be made of impermeable material;
- Signs indicating 'no smoking' 'no naked flames' and 'danger' will be provided in appropriate languages, and will conform to a recognised standard;
- The capacity of the tank and the product within the tank shall be displayed;
- All personnel handling fuel, oil or chemicals shall be supplied with the correct personnel protective equipment (PPE).

5.14.4. Handling of Fuel, Oil and Chemicals

The Site Manager shall take all reasonable precautions to prevent fuel, oil and chemical spills during the course of construction. To this end, the Site Manager shall ensure that:

- All necessary approvals are in place prior to bringing fuel, oil or chemicals on to site;
- All fuel, oil and chemical deliveries will be supervised by a responsible person, who will be trained to deal with any spills;
- All mobile plant shall be refuelled in a designated area on an impermeable surface and away from drains. A spill kit will be located at each refuelling point. Where it is impractical to refuel within a bunded area, a drip tray will be available to catch any spills caused by over fuelling;

- Storage tank levels will be checked before delivery to prevent overfilling and delivering the wrong product;
- Regular audits are performed to verify that no leaking or defective equipment is brought onto site;
- Any oils or lubricants discharged during routine vehicle servicing on site are captured using drip trays, containers or other appropriate containment measures;
- Equipment is maintained regularly to ensure that no fuel, oil or hydraulic leaks occur
- All vehicles or equipment that are used in close proximity to the sea shall be cleaned of oil, grease and other contaminants damaging to marine life; and
- Any fuelling or repairs shall be carried out in designated areas more than 100m away from the coastline and shall be supervised by personnel familiar with spill containment and clean up procedures.

The Site Manager shall ensure that there is sufficient absorbent material and spill kits available on site to manage accidental spills. The location of and instructions on how to use this equipment shall be included in the Site Induction, and nominated personnel will be appropriately trained to use spill kits. The Site Environmental Emergency Plan (see section 5.16), will have detailed instructions on how to respond to spills.

Any accidental spillages of fuels and oils, or other hazardous substances, shall be cleaned up immediately and be reported Site Manager. The following responses shall be undertaken:

- Minor spill: Only diesel and oil, with no human injury, contamination to water bodies or other environmental receptors. Contain and clean up the spill using available spill kit. Report to the Site Manager and Environment and Social Manager, supplying the following information:
    - Date, time, and location;
    - Substance spilled and quantity; and
    - Actions taken, and any future remediation required.
- Major Spill: Resulting in human injury or/and environmental contamination and water body contamination. Contain the spill if possible and report the spill to the Site Manager, who shall then alert the appropriate emergency services (see Table 2). In addition to the above information for a minor spill, the Site Manager shall also be informed of any immediate dangers, e.g. fire, explosion, release of chemical fumes.

5.14.5. Cement delivery

Pre-made concrete will be delivered to the site in a cement agitator truck and shall be delivered to a specific designated area that require cement for construction. In the event of a cement spill the above-mentioned spill response procedure will be enacted.

5.15. Fire Prevention

The Site Manager shall take all necessary precautions to prevent the ignition and spread of fires caused either deliberately or accidentally as a result of the work being performed.

The Site Manager shall prepare a Fire Prevention Plan for fire prevention and emergency management. The Plan shall include, but shall not be limited to, the following:

- Potential sources of fire risk;
- Procedures to be followed to control an accidental fire;
- Identification and location of fire-fighting equipment that will be maintained on site and deployed in the event of an emergency.

The Site Induction will include a briefing of the risks and potential consequences of starting fires. Employees shall also be warned of the risks of careless disposal of burning cigarette butts.

The Site Manager shall provide fire-fighting equipment at specified localities on the site to meet any emergency resulting from a fire. The location of this equipment will be included in the Site Induction and within the Site Manager, as well as clearly marked on signs around the site.

5.16. Environmental Emergency Plan

An Environmental Emergency Plan will be prepared prior to construction and communicated to all members of the project team including sub-contractors and Emergency Services. The aim of the plan is to set out measures that shall be implemented during an environmental emergency. The plan shall detail controls for aspects such as:

- Site drainage controls;
- Fuel handling procedures;
- Incident notification procedures;
- Pollution control equipment requirements; and
- Procedures for the control of dust and mud; and
- Protection measures of water body (the sea) from chemical spills or sediment laden run off.

Responsible staff will be trained in emergency procedures to form an Emergency Team, so that these procedures can be implemented swiftly and effectively. Periodic testing of emergency procedures will be undertaken by the Site Manager. The Environment and Social Manager will observe the test and produce a report on the results. Any corrective actions are taken forward for review and approval.

Should an emergency incident occur, the Environment and Social Manager will be notified immediately. The emergency response will be co-ordinated by the Site Manager.

Protective measures, mitigation, clean up and remediation actions will be identified from the evaluation and shall be put into place, having regard for the sensitivities of the environment. A record of the emergency incident will be drafted by the PM which will include the nature of the corrective action undertaken.

The Site Manager and PM shall investigate the cause of all incidents and must provide written results of the investigation and recommendations on how to prevent a recurrence of such incidents.

5.17. Environmental Emergency and Response Contacts

The Environment and Social Manager will be the primary contact person in the event of an environmental emergency. As discussed in Section 2.2, the Environment and Social Manager has the authority and independence to request reasonable steps be taken to avoid or minimise unintended or adverse environmental impacts, and failing the effectiveness of such steps, to direct that relevant actions be ceased immediately should an adverse environmental impact be anticipated.

In the event of an incident that requires the emergency services, the services that should be contacted are listed in Table 2.

Table 2 - Emergency Services contact telephone numbers

AMBULANCE	POLICE	FIRE BRIGADE	SEA RESCUE	NAMPORT FIRE AND PORT CONTROL
+264 81 129 3875	+264 64 - 219 000, +264 64 – 219036 064 219 048 219 048	+264 81 122 0833 or 081 122 0888	208 2221 or 081 129 6295	208 2221 or 208 2265

For large-scale spills and other significant environmental incidents, the fire services shall be contacted as required and the Ministry of Environment and Tourism (MET) office informed of the incident (telephone +264 61 284 2111). All correspondence with MET should be undertaken by the PM as guided by the Environment and Social Manager.

For the clean-up of smaller spills, the relevant Material Safety Data Sheet (MSDS) should be obtained online and be consulted to determine the appropriate clean-up procedure. Basic spill response training will be provided as part of the site environmental induction, spill response equipment, including relevant MSDS copies, will be provided in areas where potentially environmentally hazardous chemicals may be used.

All environmental incidents, regardless of their size or significance, should be recorded and reported to either the PM or the Environment and Social Manager.

6. REGISTER OF ENVIRONMENTAL RISKS AND ISSUES

6.1. INTRODUCTION

An environmental review of the proposed project has been completed to identify all the commitments and agreements made within the ESIA report. From this, a schedule of environmental commitments and risks has been produced, which details deliverables including measures identified for the prevention of pollution or damage to the environment during the construction phase.

Table 3 – Environmental Risks and Issues, Mitigation and Monitoring Measures

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
1.1	Worker Campsite: Set-up	– Loss of vegetation – Visual impacts – Increased noise levels – Pests and odours	– Avoid removing vegetation. – Suitable fencing around the site. – Appropriate siting to take into consideration existing residents. – Enforcement of QCPs.	– Site Manager to oversee the set-up of the campsite. – Final check by the Site Manager and Environment and Social Manager once site is established.	– Duration of set-up – Final one-off check	– Site Manager – Environment and Social Manager
1.2	Worker Campsite: Operations	– Visual impacts – Increased noise levels – Pests and odours	– Appropriate waste collection points and waste management, and the site to be kept clean at all times. – Appropriate sewerage management. – No unauthorised visitors. – Implementation of Method Statement and campsite rules.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Weekly – Monthly	– Site Manager – Environment and Social Manager
1.3	Worker Campsite: Reinstatement	– Soil degradation – Litter.	– Implementation of Method Statement. – Disturb any compacted soil. – Ensure waste is removed from site and site is reinstated back to its original condition. – Enforcement of QCPs.	– Site Manager to oversee the removal and reinstatement of the campsite area. – Final check by the Site Manager and Environment and Social Manager once site is reinstated.	– Duration of reinstatement – Final one-off check	– Site Manager – Environment and Social Manager
2.1	Establishment and Management of Construction site	– Noise and dust. – Residential visual amenity. – Community severance.	– Installation of a site boundary made of hoarding and at least 2m high. – Designated access routes and points.	– Daily visual observations. – Site Manager to oversee the set-up of the site. – Weekly checks by the Site Manager and weekly reports.	– Duration of set-up – Final one-off check	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			– Bring plant and equipment as and when required. – Suitable siting of construction office, waste collection area, and storage area for plant and equipment. – Downward lighting. – Application of good housekeeping. – Enforcement of QCPs.	– Monthly Checks by the Environment and Social Manager and monthly reports.		
2.2	Site preparation: Removal of vegetation	– Loss of established vegetation, in particular palm trees and grass. – Potential nests – disturbance to birds	– Reuse of grass on other sites where sports facilities will be relocated. Where not possible, offer to local residents for reuse on their properties. – Removal and reinstatement of palm trees as soon as practicable, using a suitably qualified specialist, ensuring root protection zone is identified and managed. – Suitably qualified personnel to remove, store and reinstate trees, at the most suitable time of the year. – Any relocation of nests must be agreed with the Environment and Social Manager. – No animals or birds may be	– Oversee work – Liaise with specialist during storage	– Duration of works	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			collected, caught, consumed or removed from site by the Contractor or their personnel on site. – Application of Method statement. – Enforcement of QCPs.			
2.3	Site preparation: Removal of top soil	– Loss of fertile soil (topsoil and subsoil)	– Recover, store and reuse for final landscaping. – Separate topsoil and sub soil – Appropriately store the soil in line with best practice to avoid degradation (e.g. store for no more than 12 months and in piles not exceeding 2m high, cover to protect from wind). – Application of Method statement. – Enforcement of QCPs.	– Weekly checks of any stored soil to minimise degradation and suitable storage arrangements.	– Duration of works – Weekly checks	– Site Manager – Environment and Social Manager
2.4	Site preparation and excavation	– Disturbance / damage of undiscovered archaeological remains	– Site Manager or appropriate person to oversee all ground excavation works. – In the event of a discovery, works to cease until advice from specialist is obtained.	– N/A	–	– Site Manager
2.5	Site preparation and excavation	– Silty surface run-off during rainfall events or through disturbing	– Suitable site drainage to avoid silty water entering the marine environment.	– Daily inspections of the site to be undertaken to detect any signs of silty surface water run-off entering marine	– Daily	– Site Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		groundwater, entering marine environment and increase suspended solids or polluting water		environment.		
3.1	General construction activities: Generation of waste	– Generation of waste, odours and pests	– Application of Waste Management Plan. – Waste to be collected, separated and stored in appropriately marked areas / containers (e.g. wood, metals, building rubble, garden waste, domestic waste). – Waste storage areas shall be appropriately signed, well maintained and good housekeeping will be applied. – Waste will be disposed of to designated, licensed and appropriate facilities, which will be identified in the Waste Management Plan. – No waste to be burnt on site. – Site induction and training of staff.	– Operate in accordance with the Waste Management Plan. – Update the Waste Management Plant as and when required. – Daily and weekly checks of waste collection area. – Monthly checks of nominated waste disposal routes	– Daily – Weekly	– Site Manager – Environment and Social Manager
4.1	Operating plant and equipment	– Local Community: – Reduced local air quality (vehicle emissions)	– Avoid idling of plant and equipment (turn off when not in use) – Minimise the multiple use of	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social	– Daily – Weekly – Monthly	– Site Manager and Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		– Increase in local noise levels	noisy plant and equipment. – Where possible, position nosy plant and equipment away from residential and commercial properties. – Vehicles to be in good working order and well maintained and serviced in accordance with specific requirements. – Select equipment with lower sound power levels. – Site boundary fence – hoarding. – Contractor should be required to guarantee optimised equipment design noise levels. Implement engineering controls (e.g. silencers) in order to limit noise levels. – Notice to surrounding community of when noisy activities are to be undertaken. – Site Induction	Manager and monthly reports.		
4.2	Operating plant and equipment	– Construction Workers: Reduced local air quality – Increase in local noise levels	– Appropriate PPE – face masks if required, ear plugs – Site Induction	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports. – Noise monitoring	– Daily – Weekly – Monthly – Quarterly – Annual	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
5.1	General construction works: excavation and moving / transporting material	– Local Community and marine environment impacts through increased dust and deposition	– Application of dust suppression measures e.g. dampening areas. – Closed site boundary fence. – Avoid certain activities during high winds. – Avoid overfilling excavated material in trucks. – Cover excavated / dredged material during transportation to Industrial Zone 14. – Limit vehicle speeds – Avoid stockpiling – Site Induction	– Daily visual observations. – Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
5.2	General construction works: Tall infrastructure	– Impacts to resident's visual amenity. – Collision risk for birds in flight	– Avoid high masts and cranes. – If required, keep on site for the specific activity and remove as soon as works are complete – If lighting is required, use flashing lights of colours rather than white, and avoid the use of flood lights. – Site boundary fence – hoarding, to be erected as soon as practicable.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
5.3	General construction activities: lighting	– Residential amenity	– Lighting shall only be used when necessary and will be designed to minimise spillage of light, and orientated away from residential properties	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
				reports.		
6	Construction traffic	– Increase traffic volumes, noise and community severance.	– Construction traffic to follow designated routes, as per Traffic Management Plan. – Construction vehicles to enter and exit site at designated locations. – Avoid construction traffic during peak times (7.30 – 9.30, 12.30 – 13.30 and 16:00 – 17:00) – No parking or idling on roads, and implement traffic management to avoid vehicles queuing on roads entering the site. – Traffic calming measures to direct flow of traffic to and from the site. – Use of banksmen to manage heavy vehicles enter and exit the site.	– Regularly review Traffic Management Plan – Undertake spot checks to ensure construction traffic is following designated route. – Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports. – Noise monitoring	– Daily – Weekly – Monthly – Quarterly – Annual	– Site Manager – Environment and Social Manager
7	Rerouting existing services	– Suspended services and disruption	– Prior notice of the scheduling of suspended services. Avoid sensitive times (weekends). – Enforcement of QCPs.	– Regular community engagement	– Duration of works	– Site Manager – Environment and Social Manager
8	Closure of Esplanade Road	– Loss of access road. Traffic disruption and diversion to	– Early notice about road closure through notices and signs on and around Esplanade Drive.	– Regular community engagement	– Duration of works	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		alternative roads, altering traffic baseline	– Enforcement of QCPs.			
9	Road Upgrades: Potential diversions required and/or temporary road closures	– Increased community severance, reduced access to private properties, increase traffic on usually quiet roads.	– Appropriate signs for diversions. – Early notice about road works through notices and signs on the road to be upgraded. – Enforcement of QCPs.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
10.1	Marine Construction Works: Dredging, piling and rock placing	– Increase suspended solids: reduce water quality, affect aquatic life (fish move away from area, causing dolphins and other mammals to move away) and reduce sunlight in water column – Change in Bathymetry	– Undertake activities on outgoing tide only. – Limit works during certain conditions, e.g. when trade winds are strong – Activities limited to those agreed with Municipality. – Mr Alan Louw to oversee dredging activities. – Use soft-starts and ramp up operations. – Avoid piling and dredging between June and September. – Enforcement of QCPs.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports. – Mr Louw over-see all works. – Liaise with the Dolphin Project prior to and during works who will undertake hydrophone monitoring. – Turbidity and water quality monitoring throughout construction. – Sediment samples before construction activities. – Bathymetric survey.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
10.2	Marine Construction	– Increase noise and vibration: marine	– Use soft-starts and ramp up operations.	– Weekly checks by the Site Manager and weekly reports.	– Daily – Weekly	– Site Manager – Environment and

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
	Works: Dredging, piling and rock placing	mammals will avoid areas – Impact to bird life	– Marine Mammal Observer to observe and identify presence of animals prior to works and to cease works if dolphins are within the predetermined safe zones. – Avoid piling and dredging between June and September. – Limit activities to prescribed durations. – Enforcement of QCPs.	– Monthly Checks by the Environment and Social Manager and monthly reports. – Mr Louw over-see all works. – Engage the Namibian Dolphin Project to conduct Hydrophone monitoring prior to and during construction activities to determine presence of animals. – Avian Monitoring (support the existing bird monitoring programme led by Mr. Peter Bridgeford)	– Monthly – Throughout construction phase – Bi Annual	Social Manager
10.3	Marine Construction Works: Dredging, piling and rock placing	– Generation of contaminated dredged material	– Sample dredged material to ensure waste disposal route is appropriate. – Limit dredging to specific areas and during outgoing tides. – Enforcement of QCPs.	– Regular sampling of material	– Duration of works	– Site Manager
10.4	Marine Construction Works: Dredging, piling and rock placing	– Disruption of sea floor causing sulphur eruptions leading to reduced water quality and bad odours	– Limit dredging to specific areas and during outgoing tides. – Enforcement of QCPs.	– Weekly checks by the Site Manager, in particular to notice fouls smells. Associated weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Project Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
10.5	Marine Construction Works: Dredging, piling and rock placing	– Integrity of the Raft Restaurant from vibrations	– Further investigations into the integrity of the structure prior to piling and other marine construction activities. – A pre-construction survey will be conducted and recorded, including a photographic report. This will be signed off by both the proponent and the owners of the Raft. – Enforcement of QCPs.	– Regular visual checks during marine construction works.	– Daily	– Site Manager
10.6	Marine Construction Works: General activities	– Loss of fuel or oil (loss of containment or leaks), contaminating marine environment	– Maintenance of vehicles. – Spill kits suitable for marine environment to be located near activities, and staff trained to handle spills.	– Regular visual checks during marine construction works. – Weekly checks by the Site Manager, in particular to notice fouls smells. Associated weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager
10.7	Marine Construction Works: General activities	– Direct and indirect impacts to marine mammals and other wildlife (disturbance, injury or mortality)	– Observation of the presence of marine environment for mammals and other wildlife in the area. Hold off on any operations until wildlife has moved from the area. – Avoid certain times of the year – dredging activities shall be	– Observation of the presence of marine environment for mammals and other wildlife in the area by the MMO - surveys of entire Lagoon and surrounding the project – Continual liaising with The Dolphin Project.	– Daily – Weekly – Monthly – During construction phase – Bi Annual	– Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			undertaken in winter months, from May to August to minimise impacts on sensitive feeding seasons – Marine works will avoid sensitive marine mammal breeding times and should be minimised between June to September. – Implement Method Statement. – Enforcement of QCPs.	– Hydrophone monitoring. – Avian Monitoring		
10.8	Marine Construction Works: General activities	– Visual intrusion and noise impacts on the Raft Restaurant	– Install a visual screen as soon as practical to block construction view and attenuate noise. – Construction works to stick to schedule. – Enforcement of QCPs.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
10.9	Marine Construction Works: General activities	– Litter entering the marine environment: entangling animals, suffocating animals, animals consuming litter. – Scavenger birds dominating the area.	– Good site housekeeping. – Bins on and surrounding the site, which are regularly emptied. – Nominated person to undertake litter picking regularly. – Avoid food waste being thrown into the environment.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports. – Avian Monitoring.	– Daily – Weekly – Monthly – Bi Annual	– Site Manager – Environment and Social Manager
10.10	Marine Construction Works: Lighting	– Increased lighting: reduced local resident's amenity; – Impacts on birds and	– No night time working	– Avian Monitoring	– Bi Annual	– Site Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		other marine wildlife				
11	Removal of road and ground excavation works in close proximity to the sea	– Silt laden effluent entering the marine environment and increasing suspended solids, causing impacts on marine life and water quality.	– Implement suitable drainage. – Avoid undertaking specific activities during rainfall events. – Install silt fencing is required. – Sequencing of construction works e.g. construct marina first to provide an enclosed working area and contain sediment run off. – Enforcement of QCPs.	– Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
12	Dewatering / pumping of groundwater	– Discharge of silty water to the environment – marine impacts – Potential spread of contamination	– Application of Method Statement – Filter any groundwater prior to discharge to the marine environment. – Suitable bunding and storage of oils, fuels and chemicals. – Maintenance of plant and equipment. – Any water discharged shall meet accepted water quality standards. – Enforcement of QCPs.	– Sampling of any water to be discharged to the marine environment. – Weekly checks by the Site Manager and weekly reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
13	Excavation during rainfall events	– Silt laden surface water entering the marine environment, increasing	– Suitable drainage to prevent surface water entering the marine environment without treatment and filtration. – Avoid specific activities during	– Daily checks, weekly checks and reports by the Site Manager. – Monthly Checks by the Environment and Social	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		suspended solids and reducing water quality and potential impacting marine life.	high rainfall events.	Manager and monthly reports.		
14.1	Demolition activities: An existing building that is to be demolished on the site has been identified to contain asbestos cement roofing material.	– Handling and disposal of asbestos – loss of containment / spread of contamination.	– Implementation of the Method Statement for the handling and disposal of asbestos. Approved registration certificate from the Department of Health. – Removal of this material to be completed by a licenced and registered contractor specialising in asbestos removal. – Asbestos waste shall be separated for safe disposal and disposed of to an appropriate disposal site in accordance with the Waste Management Plan. – Enforcement of QCPs.	– Daily checks, weekly checks and reports by the Site Manager. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
14.2	Demolition activities	– Septic tank waste - loss of containment / spread of contamination	– All contents of tanks to be emptied and disposed of appropriately, prior to removing and disposing of tanks. – Enforcement of QCPs.	– Daily checks, weekly checks and reports. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
15.1	Storage of fuel and oils	– Loss of containment, causing ground contamination	– Licence and certificate to store and dispense fuel. – Stored in a lockable area, on a	– Tanks and containers to be checked daily. – Weekly checks and reports by	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			flat impermeable area, with a bund that is capable of storing 110% of stored capacity. – Libelled tanks and containers. – Any hazardous chemicals, liquids or materials to be stored on site to be in suitable storage containers, in lockable store with appropriate bunding, with an inventory. – Appropriate safety signs around storage area, e.g. no smoking. – Appropriate PPE to personnel. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works.	the Site Manager. – Monthly Checks by the Environment and Social Manager and monthly reports.		
15.2	Delivery of fuel and oil	– Loss of containment, causing ground contamination	– All deliveries to be supervised. – Refuel in designated area, on impermeable surface away from drains, residential properties and the sea. Spill kits to be located at nominated locations around site. – Drip trays used where required. – Storage tanks to be checked prior to delivery (level and correct tank). – Regular checks and servicing of	– Audits of vehicles to ensure maintained and not defective. – Daily and Weekly checks and reports by the Site Manager. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			storage containers and regular maintenance and servicing of plant and equipment. – Good house-keeping – clean vehicles regularly. – Spill kits to be located around site. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works.			
15.3	Use and maintenance of plant and equipment: Spills of fuels, oils or chemicals	– Loss of containment, causing localised ground contamination	– Spill kits in designated areas around site. – Contain and clean up spill in accordance with emergency procedures. – Report spill as soon as possible. – All plant and material to be well maintained and have appropriate containment (drip trays). – Maintenance activities of large plant and equipment shall be undertaken off site. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works.	– Daily checks of bunds and regular checks of inventories by the Site Manager. – Daily and weekly site inspections and production of report. –	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			– Suitable PPE and equipment when handling hazardous chemicals, liquids and materials.			
15.4	Delivery of cement	– Loss of containment, causing ground contamination	– Any spills of cement shall be cleared up as soon as spill occurs.	– Site Manager to oversee all deliveries.	– Duration of delivery	– Site Manager
16	General construction activities: Energy use	– Use of resources	– Turn off plant and equipment when not in use. – Regular maintenance of plant and equipment. – Minimise / optimise workforce travel. – Source materials locally. – Source sustainable material where possible. – Apply waste hierarchy and reuse and recycle.	– Weekly checks and reports by the Site Manager. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
17	General construction activities: Material use	– Use of resources	– Source materials locally to reduce transportation. – Source sustainable material where possible. – Apply waste hierarchy and reuse and recycle. material where possible	– Weekly checks and reports by the Site Manager. – Monthly Checks by the Environment and Social Manager and monthly reports.	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager
18	Vehicle movements on site	– Hazards to workers (collisions leading to injuries)	– Clearly marked areas around site for worker and vehicle access. – Speed limit of 40km/hr. – Site induction and training of staff.	– Weekly checks to ensure areas are clearly marked and reports by the Site Manager. – Monthly Checks by the Environment and Social	– Daily – Weekly – Monthly	– Site Manager – Environment and Social Manager

REF NO.	ACTIVITY	RISKS AND POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			– Reversing of vehicles overseen with appropriate warnings (lights / sounds).	Manager and monthly reports.		

7. IMPLEMENTATION OF THE CONSTRUCTION-ESMP

This Construction-ESMP:

A. Has been prepared pursuant to a contract with the proponent;

B. Has been prepared on the basis of information provided to ECC up to January 2018;

C. Is for the sole use of the proponent, for the sole purpose of an ESMP;

D. Must not be used (1) by any person other than the proponent or (2) for a purpose other than an ESMP; and

E. Must not be copied without the prior written permission of ECC.

ECC has prepared the ESMP on the basis of information provided by the proponent, specialist reports and the ESIA. These have been independently reviewed and verified by the Southern African Institute of Environmental Assessment (SAIEA).

Construction – ESMP Annexes

Walvis Bay Waterfront Pty Ltd

PREPARED FOR

March 2018

DOCUMENT FOR GOVERNMENT APPROVAL

Contents

ANNEX A: DOCUMENT CHECK LIST

DOCUMENT	PURPOSE	REQUIRED BEFORE REQUIRED UPDATES	OWNER
Contact Details	Register of key construction personnel and their contact details, and emergency numbers.	Prior to construction. Checked monthly to ensure it is up to date	Site Manager
Site Induction Register	Register of all personnel working on site and when they undertook training.	Monthly	Site Manager
Complaints Register	Name and contact details of the complainant, date and time of the complaint, nature of complaint, action taken to resolve issues, and date of complaint handover. See Annex C	Prior to construction. Amended when complaint received or when complaint resolved.	Environmental and Social Manager
Environmental Permits: 1. Consumer Installation licence and certificate 2. Registration Certificate	Approval from competent authority to undertake specific activities: 1. Consumer Installation licence and certificate to be obtained under the Petroleum Products and Energy Act (Act 13 of 1990) and associated amendments and regulations, for the storage of two 22,000 litre fuel tanks. 2. Registration certificate from the administering authority (the Department of Health) to approve the removal of this asbestos, under Section 5 of the Atmospheric Pollution Prevention Ordinance 11 of 1976	Prior to certain activities. Annually.	Environmental and Social Manager
Weekly Compliance Report	Checklist of what should be checked on site and any non-compliance or concerns on site to be recorded, and resolution logged. See Annex D.	Completed checklist prior to construction commenced. Weekly	Site Manager
Monthly Compliance Report	The report shall contain a brief description of any areas of non-conformance with the contract specification, the reason for the non-conformance, the responsible party, the result (consequence), the corrective action taken and any necessary follow up measures required. See Annex E.	- Monthly.	Environmental and Social Manager
Plant and Equipment Register	Register of all plant and equipment on site, including the following information: – Piece of plant and equipment; – Make and Model; – Frequency of required service and scheduled dates; – Dates of last maintenance and test; and – Notes of any issues or concerns.	Completed checklist prior to construction commenced. Monthly.	Operations Manager
Method Statements	Each method statement to be listed in this table and the frequency of use to be included. Reviews of Method Statements shall occur to	Monthly	Site Manager

DOCUMENT	PURPOSE	REQUIRED BEFORE REQUIRED UPDATES	OWNER
	ensure lessons are learnt.		
Waste Management Plan	Outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. Outline any potential economical and investment requirements for the treatment and / or disposal of waste. See Annex F.	Monthly	Environment and Social Manager
Traffic Management Plan	To document designated routes for construction vehicles to and from the site, and access points. Any traffic calming measures. Specific times when construction traffic should avoid journeys.	Before construction works commences. Monthly.	Site Manager.
Fire Prevention Plan	Fire and emergency management measures, and pollution incident response management plan requirements. Identifies and concentrates on potential incidents and emergencies that could occur on the proposed project site, and describes the general policy and approach that should be followed when dealing with an emergency or incident, such as fire, explosion, spills and traffic accidents. – The development, site plans and maps; – Incident identification and notification process; – Emergency contact details; – Emergency response procedures; and – Training requirements.	Monthly	Site Manager
Environmental Emergency Plan	Set out measures that shall be implemented during an environmental emergency, including but not limited to: – site drainage controls; – fuel handling procedures; – incident notification procedures; – pollution control equipment requirements; and – procedures for the control of dust and mud; and – protection measures of water body (the sea) from chemical spills or sediment laden run off.	Prior to construction. Monthly.	Site Manager

ANNEX B: TEMPLATE CONTACT DETAILS

ROLE	NAME	CONTACT DETAILS
Project Manager		
Site Manager		
Environment and Social Manager		
Ministry of Environment and Tourism		
Ministry of Fisheries and Marine Resource		
Namibian Dolphin Project		
Namport		
Walvis Bay Ambulance		
Walvis Bay Police		
Walvis Bay Sea Rescue		
Namport fire and port control		

ANNEX C: COMPLAINTS REGISTER TEMPLATE

NAME	CONTACT DETAILS	DATE AND LOCATION OF COMPLAINT	NATURE OF COMPLAINT	ACTION TAKEN TO RESOLVE	NOMINATED PERSON TO RESOLVE ISSUE (Signature)	DATE OF RESOLUTION / CLOSED OUT COMPLAINT

ANNEX D: DAILY/WEEKLY INSPECTION REPORT

INSPECTION DATE: ____

INSPECTION COMPLETED BY: ______________________________________

SUMMARY OF CONSTRUCTION ACTIVITIES OCCURRING:

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CONTRACTORS ON SITE:

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Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
1.1	Worker Campsite: Set-up – Minimise loss of vegetation, keep noise levels as low as possible, screen the site, good house-keeping. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
1.2	Worker Campsite: Operations Keep noise levels as low as possible, screen the site, good house-keeping, waste collection points, sewerage management system, no unauthorized visitors.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
1.3	Worker Campsite: Reinstatement – Disturb any compacted soil. – Ensure waste is removed from site and site is reinstated back to its original condition. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
2.1	Establishment and Management of Construction site – Installation of a site boundary made of hoarding and at least 2m high. – Designated access routes and points. – Bring plant and equipment as and when required. – Suitable siting of construction office, waste collection area, and storage area for plant and equipment. – Downward lighting. – Application of good housekeeping. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
2.2	Site preparation: Removal of vegetation – Reuse of grass on other sites where sports facilities will be relocated. Where not possible, offer to local residents for reuse on their properties. – Removal and reinstatement of palm trees as soon as practicable, using a suitably qualified specialist, ensuring root protection zone is identified and managed. – Suitably qualified personnel to remove, store and reinstate trees, at the most suitable time of the year. – Any relocation of nests must be agreed with the Environment and Social Manager. – No animals or birds may be collected, caught, consumed or removed from site by the Contractor or their personnel on site. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
2.3	Site preparation: Removal of top soil – Recover, store and reuse for final landscaping. – Separate topsoil and sub soil – Appropriately store the soil in line with best practice to avoid degradation (e.g. store for no more than 12 months and in piles not exceeding 2m high, cover to protect from wind). – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
2.4	Site preparation and excavation: Disturbance / damage of undiscovered archaeological remains – Site Manager or appropriate person to oversee all ground excavation works. – In the event of a discovery, works to cease until advice from specialist is obtained.	Site Manager		Yes☐ No☐ N/A☐	
2.5	Site preparation and excavation: Silty surface run-off – Suitable site drainage to avoid silty water entering the marine environment.	Site Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
3.1	General construction activities: Generation of waste – Waste to be collected, separated and stored in appropriately marked areas / containers (e.g. wood, metals, building rubble, garden waste, domestic waste). – Waste storage areas shall be appropriately signed, well maintained and good housekeeping will be applied. – Waste will be disposed of to designated, licensed and appropriate facilities, which will be identified in the Waste Management Plan. – No waste to be burnt on site.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
4.1	Operating plant and equipment – Avoid idling of plant and equipment (turn off when not in use) – Minimise the multiple use of noisy plant and equipment. – Where possible, position nosy plant and equipment away from residential and commercial properties. – Vehicles to be in good working order and well maintained and serviced in accordance with specific requirements. – Select equipment with lower sound power levels. – Site boundary fence – hoarding. – Contractor should be required to guarantee optimised equipment design noise levels. Implement engineering controls (e.g. silencers) in order to limit noise levels. – Notice to surrounding community of when noisy activities are to be undertaken.	Site Manager and Environment and Social Manager		Yes☐ No☐ N/A☐	
4.2	Operating plant and equipment: Impact on workers – Appropriate PPE – face masks if required, ear plugs	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
5.1	General construction works: excavation and moving / transporting material – Application of dust suppression measures e.g. dampening areas. – Closed site boundary fence. – Avoid certain activities during high winds. – Avoid overfilling excavated material in trucks. – Cover excavated / dredged material during transportation to Industrial Zone 14. – Limit vehicle speeds – Avoid stockpiling	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
5.2	General construction works: Tall infrastructure – Avoid high masts and cranes. – If required, keep on site for the specific activity and remove as soon as works are complete – If lighting is required, use flashing lights of colours rather than white, and avoid the use of flood lights. – Site boundary fence – hoarding, to be erected as soon as practicable	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
5.3	General construction activities: lighting: Residential amenity – Lighting shall only be used when necessary and will be designed to minimise spillage of light, and orientated away from residential properties	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
6	Construction traffic: Increase traffic volumes, noise and community severance. – Construction traffic to follow designated routes, as per Traffic Management Plan. – Construction vehicles to enter and exit site at designated locations. – Avoid construction traffic during peak times (7.30 – 9.30, 12.30 – 13.30 and 16:00 – 17:00) – No parking or idling on roads, and implement traffic management to avoid vehicles queuing on roads entering the site. – Traffic calming measures to direct flow of traffic to and from the site. – Use of banksmen to manage heavy vehicles enter and exit the site.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
7	Rerouting existing services – Prior notice of the scheduling of suspended services. Avoid sensitive times (weekends). – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
8	Closure of Esplanade Road: Loss of access road. – Early notice about road closure through notices and signs on and around Esplanade Drive. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
9	Road Upgrades: Potential diversions required and/or temporary road closures – Appropriate signs for diversions. – Early notice about road works through notices and signs on the road to be upgraded – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
10.1	Marine Construction Works: Dredging, piling and rock placing – increase suspended solids. – Undertake activities on outgoing tide only. – Limit works during certain conditions, e.g. when trade winds are strong – Activities limited to those agreed with Municipality. – Mr Alan Louw to oversee dredging activities. – Use soft-starts and ramp up operations. – Avoid piling and dredging between June and September. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
10.2	Marine Construction Works: Dredging, piling and rock placing - Increase noise and vibration – Use soft-starts and ramp up operations. – Marine Mammal Observer to observe and identify presence of animals prior to works and to cease works if dolphins are within the predetermined safe zones. – Avoid piling and dredging between June and September. – Limit activities to prescribed durations. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
10.3	Marine Construction Works: Dredging, piling and rock placing - Generation of contaminated dredge material – Sample dredged material to ensure waste disposal route is appropriate. – Limit dredging to specific areas and during outgoing tides. – Enforcement of QCPs.	Site Manager		Yes☐ No☐ N/A☐	
10.4	Marine Construction Works: Dredging, piling and rock placing - Disruption of sea floor causing sulphur eruptions leading to reduced water quality and bad odours – Limit dredging to specific areas and during outgoing tides. – Enforcement of QCPs	Project Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
10.5	Marine Construction Works: Dredging, piling and rock placing - Integrity of the Raft Restaurant from vibrations – Further investigations into the integrity of the structure prior to piling and other marine construction activities. – Enforcement of QCPs.	Site Manager		Yes☐ No☐ N/A☐	
10.6	Marine Construction Works: General activities - Loss of fuel or oil – Maintenance of vehicles. – Spill kits suitable for marine environment to be located near activities, and staff trained to handle spills.	Site Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
10.7	Marine Construction Works: General activities - Direct and indirect impacts to marine mammals – Observation of the presence of marine environment for mammals and other wildlife in the area. Hold off on any operations until wildlife has moved from the area. – Avoid certain times of the year – dredging activities shall be undertaken in winter months, from May to August to minimise impacts on sensitive feeding seasons – Marine works will avoid sensitive marine mammal breeding times and should be minimised between June to September. – Implement Method Statement. – Enforcement of QCPs.	Environment and Social Manager		Yes☐ No☐ N/A☐	
10.8	Marine Construction Works: General activities - Visual intrusion and noise impacts on the Raft Restaurant – Install a visual screen as soon as practical to block construction view and attenuate noise. – Construction works to stick to schedule. – Enforcement of QCPs	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
10.9	Marine Construction Works: General activities - Litter entering the marine environment – Good site housekeeping. – Bins on and surrounding the site, which are regularly emptied. – Nominated person to undertake litter picking regularly. – Avoid food waste being thrown into the environment.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
10.10	Marine Construction Works: Lighting – No night time working	Site Manager		Yes☐ No☐ N/A☐	
11	Removal of road and ground excavation works in close proximity to the sea – Implement suitable drainage. – Avoid undertaking specific activities during rainfall events. – Install silt fencing is required. – Sequencing of construction works e.g. construct marina first to provide an enclosed working area and contain sediment run off. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
12	Dewatering / pumping of groundwater – Application of Method Statement – Filter any groundwater prior to discharge to the marine environment. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
13	Excavation during rainfall events – Suitable drainage to prevent surface water entering the marine environment without treatment and filtration. – Avoid specific activities during high rainfall events.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
14.1	Demolition activities: An existing building that is to be demolished on the site has been identified to contain asbestos cement roofing material. – Implementation of the Method Statement for the handling and disposal of asbestos. Approved registration certificate from the Department of Health. – Removal of this material to be completed by a licenced and registered contractor specialising in asbestos removal. – Asbestos waste shall be separated for safe disposal and disposed of to an appropriate disposal site in accordance with the Waste Management Plan. – Enforcement of QCPs	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
14.2	Demolition activities – All contents of tanks to be emptied and disposed of appropriately, prior to removing and disposing of tanks. – Enforcement of QCPs.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
15.1	Storage of fuel and oils – Licence and certificate to store and dispense fuel. – Stored in a lockable area, on a flat impermeable area, with a bund that is capable of storing 110% of stored capacity. – Libelled tanks and containers. – Any hazardous chemicals, liquids or materials to be stored on site to be in suitable storage containers, in lockable store with appropriate bunding, with an inventory. – Appropriate safety signs around storage area, e.g. no smoking. – Appropriate PPE to personnel. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
15.2	Delivery of fuel and oil – All deliveries to be supervised. – Refuel in designated area, on impermeable surface away from drains, residential properties and the sea. Spill kits to be located at nominated locations around site. – Drip trays used where required. – Storage tanks to be checked prior to delivery (level and correct tank). – Regular checks and servicing of storage containers and regular maintenance and servicing of plant and equipment. – Good house-keeping – clean vehicles regularly. – Spill kits to be located around site. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
15.3	Use and maintenance of plant and equipment: Spills of fuels, oils or chemicals – Spill kits in designated areas around site. – Contain and clean up spill in accordance with emergency procedures. – Report spill as soon as possible. – All plant and material to be well maintained and have appropriate containment (drip trays). – Maintenance activities of large plant and equipment shall be undertaken off site. – Site Induction and appropriate training of nominated persons. – Site Environmental Emergency Plan – ensure up to date throughout construction works. – Suitable PPE and equipment when handling hazardous chemicals, liquids and materials	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
15.4	Delivery of cement – Any spills of cement shall be cleared up as soon as spill occurs.	Site Manager		Yes☐ No☐ N/A☐	

Ref No.	Item	Responsibility	Construction Activity Status (Underway / Complete)	Compliant	Notes / Action Taken / Corrective Action Required
16	General construction activities: Energy use – Turn off plant and equipment when not in use. – Regular maintenance of plant and equipment. – Minimise / optimise workforce travel. – Source materials locally. – Source sustainable material where possible. – Apply waste hierarchy and reuse and recycle.	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
17	General construction activities: Material use – Source materials locally to reduce transportation. – Source sustainable material where possible. – Apply waste hierarchy and reuse and recycle. material where possible	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	
18	Vehicle movements on site – Clearly marked areas around site for worker and vehicle access. – Speed limit of 40km/hr. – Site induction and training of staff. – Reversing of vehicles overseen with appropriate warnings (lights / sounds).	Site Manager Environment and Social Manager		Yes☐ No☐ N/A☐	

ANNEX E: MONTHLY COMPLIANCE REPORT

INSPECTION DATE: ____

INSPECTION COMPLETED BY: _____________________________________

APPROVED BY: ____

SUMMARY OF CONSTRUCTION ACTIVATES OCCURRING:

CONTRACTORS ON SITE:

NON-CONFORMANCE

AREA OF ACTIVITY:

REASON:

RESPONSIBLE PARTY

RESULT:

CORRECTIVE ACTION TAKEN:

FOLLOW-UP ACTION TO BE TAKEN:

ADDITIONAL COMMENTS:

GOOD PERFORMANCE
Description of activity or action in which contract went beyond compliance towards responsible care for the environment:

ADDITIONAL COMMENTS

ANNEX F: TEMPLATE WASTE MANAGEMENT PLAN

INTRODUCTION

The aim of this Waste Management Plan is to achieve sustainable waste management. The main purpose is to outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. In addition, it also outlines any potential economical and investment requirements for the treatment and / or disposal of waste.

This Waste Management Plan is a live document and should be updated during the annual review, which is undertaken by the Operational Manager and Environmental and Social Manager.

PRINCIPALS

The following principles should be applied to the management of waste on site:

- The waste hierarchy (avoid, reuse, recycle, recovery, disposal) should be applied for each waste stream, so that the impact on the environment is reduced as much as possible;
- Waste collection area will be identified prior to construction activities, and demarcated and secured with appropriate fencing;
- Bins shall be emptied on a regular basis to avoid pests and bad odours;

Table 1 – Waste Management Roles

ROLE	INDIVIDUAL OR PARTY
Proponent	
Contractor	
Responsible person for the Waste Management Plan	

The following waste management measures shall be followed:

- Waste will be collected, separated and stored in a designated area which will be appropriately fenced and signposted to keep out unauthorised people and animals;
- Waste collection containers will be of an appropriate design to ensure that no waste can escape, and will be labelled with waste type (e.g. wood, metals, building rubble, garden waste, domestic waste);
- Waste storage areas shall be kept clean and tidy at all times;
- Bins shall be emptied regularly to avoid pests and bad odours; and
- No burning will be allowed on site.

Any hazardous material and wastes (including medical waste, if necessary) shall be managed in a safe and responsible manner so as to prevent contamination of soils, pollution of water and/or harm to people or animals as a result of the use of these materials. Hazardous and non-hazardous waste shall be stored separately at all times.

WASTE MANAGEMENT ARRANGEMENTS

The project shall have a dedicated waste collection, sorting and pickup area. This area will be fenced off, clearly signposted and access shall be by those authorised.

The following information shall be provided in this section:

- *Location plan of the dedicated area*
- *Arrangements to appropriately secure and designate the area (fencing, locked gate)*
- *Access arrangements*
- *Drainage arrangements*
- *Set up of the site*
- *Authorised personnel*
- *Any rules or codes of conduct*

Waste Generated

Provide all waste streams, type and quantity, allowing a review to be undertaken and the most appropriate waste disposal options are identified.

Table 2 – Waste Type and Management

WASTE TYPE	ESTIMATED QUANTITY	WASTE MANAGEMENT	WASTE CARRIER INFORMATION AND SITE
Site Clearance			
Vegetation	(example only) 40 palm trees Other bushes and vegetation	Recover, store and replant palm trees Other bushes etc. give away to community or compost	Company Name: Phone No. xxx xxx xxxxx
Tarmac			
Other road products?			
Demolition			
Bricks	$4m^3$	Reuse	Local community
Wood		Separate and reuse or recycle	
Metal		Separate and reuse or recycle	
Asbestos			
Construction			
Packaging and plastic			
Excavated material (onshore)			

WASTE TYPE	ESTIMATED QUANTITY	WASTE MANAGEMENT	WASTE CARRIER INFORMATION AND SITE
Dredged Material	20,000m^3		

ANNEX G: MONITORING PLAN

Item	Rationale	Monitoring Area / Site Description / Details	Frequency	Phase (Construction, Operations, Decommissioning, or All)	Parameters	Quality Control Point
Potential water quality impacts from dredging activities.	Dredging has the potential to smother the seafloor habitat by increase sedimentation. Release of heavy metals can have serious cumulative negative impacts on the marine environment. Release of hydrogen sulphide can cause varying degrees of anoxia resulting in mortalities of marine organisms. Bad odours can also arise as a result of the release of hydrogen sulphide	A. Turbidity & general chemistry (sampling and analysis) of water – Immediately next to the Marina, including the access channel B. Sediment samples – project site, access channel and lagoon entrance	A. Ongoing for the duration of construction. On-line with real time in-stream turbidity meter, data collected at predetermined intervals. B. Before construction commences and prior to dredging activities commencing. Post dredging samples also to be collected.	A. All B. Pre and Post dredging	A. Turbidity & general chemistry of water B. Chemical composition including heavy metals	A. Yes B. Yes

Bathymetric survey	Analysis of the sea floor to determine potential impacts of siltation	Lagoon – survey area used for the ESIA plus area south of the project	Annual	All	Elevations of water level	Yes
Cetacean Monitoring - Hydrophone monitoring	To monitor the movements of dolphin movements in and out of the Lagoon Hydrophones are used to detect dolphin use and changes in use of the Lagoon environment during construction compared to before and after impact	Located near the Raft restaurant (use existing Namibian Dolphin Project monitoring site)	Ongoing during construction	Construction	Hydrophone digital waveform characterisation to select clicks and logs the time, centre frequency, intensity and bandwidth of each cetacean click	Yes

Cetacean Monitoring – Marine Mammal Observation (MMO) monitoring	To monitor the movements of dolphin in and out of the Lagoon during dredging activities	Lagoon area and Mouth of the Lagoon	The MMO should 1) Conduct a survey of the entire Lagoon from the Salt Works to the mouth of the Lagoon daily, prior to any dredging or pile driving, to determine the presence and location of animals in the Lagoon and 2) Keep constant watch during these activities to ensure animals are not approaching into the Lagoon near these activities when they are occurring.	All - Before and during dredging activities	Visual MMO (Dolphins are not in the Lagoon before dredging or pile driving occurs and b) not within 1000m of either activity when they are occurring)	Yes
Avian Monitoring	Disturbance of feeding and roosting shorebirds particularly flamingos by human activity. Participate in bi annual bird counts to determine bird use of the Lagoon and Ramsar area	Ramsar Site	Bi Annual	All	Participate in bi annual bird counts coordinated by Mr Peter Bridgeford.	No

Groundwater – if encountered	To identify/ quantify any water quality impacts associated with dewatering, extraction or contamination from construction works	TBD	Monthly	Construction	Field water quality parameters plus chemical analysis	No
Potable Water (supplied by municipality)	To determine suitability of water for drinking	TBD – Source on site	Annual	Construction and Operations	Potable drinking water suite	No
Noise	Noise monitoring to determine impact of development on residents and surrounds	Specific locations to be determined by a noise specialist. Expected to be along KR Thomas Street, Atlantic Street and 4th Road.	A. Quarterly B. Annual	A. Prior to construction commencing and during construction B. Operations	dB	No
Air Quality	Air quality monitoring to determine impact from development on residents and surrounds	Surrounding residents	Visual observations daily	Construction	Visual nuisance dust leaving the site and implement mitigation measures	Yes

Potential pollution from boats	Monitor and control all boat users of the marina, prohibit boat users entering the Lagoon. Oils or chemicals resulting from accidental spills during refuelling, collisions, cleaning pose a serious threat to the ecological function of the Lagoon including seabirds.	Ensure spill contingency plan is in place: A. Containment boom and spill kits to be on site B. Mock emergency response drills conducted	A. Inspected Monthly B. Bi annual	All	Visual and inspections	No

Operations - Environmental and Social Management Plan

Walvis Bay Waterfront Pty Ltd

PREPARED FOR

March 2018

DOCUMENT FOR GOVERNMENT APPROVAL

TITLE AND APPROVAL PAGE

Project Name:	ECC-41-54-REP-29-A - Operations - Environment and Social Management Plan (Operations-ESMP)
Client Name:	Walvis Bay Waterfront Pty Ltd
Ministry Reference:	MET Scope of environmental impact assessment for proposed project of Walvis Bay Waterfront Project, Walvis Bay, Erongo Region
Status of Report:	Document for Government Approval
Date of issue:	16th March 2018
Review Period:	

Environmental Compliance Consultancy Contact Details:
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Confidentiality

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DEFINITIONS AND ABBREVIATIONS

EAP	Environmental Assessment Practitioner
ECC	Environmental Compliance Consultancy
ESIA	Environmental and Social Impact Assessment
EMA	Environmental Management Act
EMS	Environmental Management System
ESMP	Environmental and Social Management Plan
I&AP	Interested and affected parties
PPE	Personnel Protective Equipment

1. INTRODUCTION

1.1. Project Background

This Operational Environment and Social Management Plan (Operations-ESMP) has been written assuming construction is complete and the project is moving into the operational phase.

Upon completion of the construction phase of the Walvis Bay Waterfront, the project will move into the operational phase. The project site is located at the north end of Esplanade Drive on the east side of the mouth of Walvis Bay Lagoon, west of the town centre, see Figure 1. The project is a mixture of both marine and land based developments, providing the following components, as illustrated in Figure 2:

- Community and sporting facilities – swimming pool, tennis and jukskei courts (located at the Jan Wilken sporting stadium), and cricket grounds (located in Kuisebmund);
- A marina and water canals for leisure craft moorings;
- Public open outdoor spaces;
- An amphitheatre;
- A multipurpose business and conference centre;
- Offices;
- Residential units;
- Two hotels;
- Serviced apartments (managed by the hotel);
- Restaurants;
- Retail space area;
- Parking bays;
- Internal road and pedestrian access routes; and
- Upgrade of existing road intersections.

The cricket ground in Kuisebmund shall be managed by the municipality and the sporting facilities at Jan Wilken shall be managed under the current management arrangements, therefore these facilities are not within the scope of this operations of the Waterfront development and therefore are managed independently to the operational phase and are outside the scope of this report.

The components within the waterfront site shall be leased or purchased by companies and businesses or individuals. The role of Walvis Bay Waterfront Properties (Pty) Ltd is discussed in Section 2.1.

The commencement of operations of the project will be undertaken in two phases: the western side of the development site shall be constructed and thus become operational first. This part of the development includes the marina, hotel and hospitality facilities, residential, commercial and retail spaces, and a conference centre. The second phase is the eastern side of the project, which comprises of residential, hotel and hospitality facilities and a portion of the inner marina (canal). Both phases are illustrated in Figure 2.

Figure 1 - Project location

Figure 2 –Layout

1.2. ENVIRONMENTAL REGULATORY REQUIREMENTS

The project is considered as a Listed Activity as set out in the Environmental Management Act, 2007 (Act No. 7 of 2007) and the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011) gazetted under the Environmental Management Act, (EMA), 2007 (Act No. 7 of 2007) (referred to herein as the EIA Regulations). As a Listed Activity an application for an Environmental Clearance Certificate is required. An Environmental and Social Impact Assessment (ESIA) report and Environmental and Social Management Plan (ESMP) are required as part of the Environmental Clearance Certificate application, as well as to support the decision-making process. This report presents part of the ESMP (see Section 1.3) and has been undertaken in accordance with the requirements of the Environmental Management Act, 2007 and associated Regulations.

1.3. PURPOSE OF THIS REPORT

The series of ESMP are tools to be used by the proponent to ensure potential environment and social impacts and risk are managed. The ESMP for the project is a series of three documents, one for each phase of the project:

- Site Preparation and Construction (Titled: Construction – ESMP)
- Operations ESMP Operations (Titled: Operations – ESMP)
- Decommissioning and Reinstatement (Titled: Decommissioning –ESMP)

By having individual ESMPs specific to phases, the application of the plan and the management of environmental risks shall be more effective and easier to implement. **This report is the ESMP for the Operational phase of the project.**

The purpose of this Operations-ESMP is to provide a management framework for the identification of the management and control of activities with environmental aspects and key risks. It describes how activities will be controlled so that potential environmental and social impacts of the project are prevented and minimised as far as reasonable practicable, and that statutory requirements and other legal obligations are fulfilled. This Operations-ESMP also presents protocols and procedures, roles and responsibilities to ensure the management arrangements are appropriately and effectively implemented.

This Operations-ESMP forms an appendix to the ESIA report; therefore, the ESIA report should be referred to for further information on the operations of the project, assessment methodology, applicable legislation and assessment findings. This report is a live document and shall be reviewed at predetermined intervals, and/or updated when the scope of works alters, or when further data / information can be added. All personal working on the project will be legally required to comply with the standards set out in this Operations ESMPs.

1.4. MANAGEMENT OF THIS OPERATIONS ESMP

Walvis Bay Waterfront Properties (Pty) Ltd (the proponent) will hold the Environmental Clearance Certificate for the development and will be responsible for the implementation and management of this Operations-ESMP.

Prior to the completion and sign-off of the construction works for either Phase 1 or Phase 2 and thus the project transitioning into the operational phase, this Operations-ESMP shall be reviewed, amended as required and approved ready for implementation.

The implementation and management of this Operations-ESMP and thus the monitoring of compliance shall be undertaken through daily duties and activities, weekly and monthly inspections (see Sections 2, 4 and 5). Regular meetings between designated roles and parties shall occur (see Sections 3.2 and 3.3) to ensure that any environmental issues, lessons learnt or required amendments to this Operations-ESMP is appropriately reported and recorded. The findings of these meetings shall be taken forward and considered during the annual review. This formal annual review shall occur every year from the day of implementation and a summary report shall be produced.

The following shall be considered during the review:

- The review shall include an evaluation of the operations effectiveness of implementing this Operations-ESMP, of environmental procedures, processes, forms, checklists and any other documents;
- The summary report shall include a review of all review findings, including the independent review (Refer to Section 9.2);
- The review shall include an evaluation of environmental incidents and community complaints, and actions taken to rectify or address these events; and
- This Operations-ESMP shall be amended as required based on the outcomes of the review.

This Operations-ESMP shall be circulated to all tenants / owners of the development components, and shall be made available on the proponent's website.

A list of required supporting plans, registers or documents are provided in Annex A.

1.5. LIMITATIONS, UNCERTAINTIES AND ASSUMPTIONS OF THE OPERATIONS ESMP

This Operations-ESMP does not include measures for compliance with statutory occupational health and safety requirements. This will be provided in a site-specific health and safety plan.

Where there is any conflict between the provisions of this Operations-ESMP and any contractor's obligations under their respective contracts, including statutory requirements (such as licences, project approval conditions, permits, standards, guidelines and relevant laws), the contract and statutory requirements are to take precedence.

The information contained in this Operations-ESMP has been based on the project description as provided in the ESIA report. Where the design or operational methods alter, this Operations-ESMP may require updating and potential further assessment undertaken.

1.6. ENVIRONMENTAL CONSULTANCY

Environmental Compliance Consultancy (ECC), a Namibian consultancy registration number 2013/11401, has prepared the ESMPs on behalf of the proponent. ECC operates exclusively in the environmental, social, health and safety fields for clients across Southern Africa in the public and private sector. ECC is independent to the proponent and has no vested or financial interested in the project.

1.7. STRUCTURE OF THIS OPERATIONS ESMP

The following structure has been adopted for this Report:

- Chapter 1 – Introduction
- Chapter 2 – Project Management and Personnel
- Chapter 3 – Training and Communications
- Chapter 4 – Reporting, Compliance and Enforcement
- Chapter 5 – Operational Environmental Management
- Chapter 6 – Register of Environmental Risks and Issues
- Annex A – Document Checklist
- Annex B – Contact Details
- Annex C – Template for Waste Management Plan
- Annex D – Monitoring Plan

2. PROJECT MANAGEMENT AND PERSONNEL

2.1. Walvis Bay Waterfront Properties (Pty) Ltd

The proponent will be the management company, which will hold the Environmental Clearance Certificate and therefore shall be responsible for the implementation and management of this Operations-ESMP across the project.

The project will have various components, such as offices, residential units, hotels, serviced apartments and restaurants. These will either be leased or sold. The proponent is responsible for the following:

- Managing Walvis Bay Waterfront Properties (Pty) Ltd and all personnel, including contractors;
- Managing leased properties and the distribution of profits;
- Managing the development's waste management system, maintaining the central waste and recycling facility, and managing/co-ordinating all waste collection and disposal;
- Care and maintenance of the Outer Marina and Inner Marina, including dredging, flushing of the Inner Marina and regular monitoring;
- Ensuring all occupants (boats) and users of the Marina comply with rules and regulations;
- Managing rental and levy finances for all occupants of the project;
- Undertaking regular communications with updates, news or other information to all occupants and the community;
- Undertaking cleaning, upkeep and maintenance of open areas;
- Undertaking maintenance of utilities and services for all leased or owned buildings;
- Managing and maintaining the interiors of all leased buildings; and
- Managing and maintaining the exterior or all buildings.

The proponent is also responsible for ensuring all tenants / owners, whether being businesses, companies or individuals, demonstrate compliance with this Operations-ESMP. The day-to-day operations of businesses and companies that lease / own components of the project will not be managed by the proponent, for example the operations of a restaurant shall be managed by the business owner or appointed managers. Contractual arrangements with tenants / owners shall stipulate compliance with this Operations-ESMP, therefore they have a duty to comply with this Operations-ESMP and the proponent has a responsibility to monitor their compliance.

2.2. Organisational Structure, Personnel Roles and Responsibilities

The proponent shall be responsible for:

- Ensuring all members of the company and any sub-contractors comply with the procedures set out in this Operations-ESMP
- Ensuring that all persons are provided with sufficient training, supervision and instruction to fulfil this requirement; and
- Ensuring that any persons allocated specific environmental responsibilities are notified of their appointment and confirm that their responsibilities are clearly understood.

Companies and businesses leasing / owning components on the project site shall be responsible for ensuring and demonstrating that each employee is compliant with this Operations-ESMP, as listed above. All companies and businesses shall provide monthly updates to the Environment and Social Manager.

The key personnel and environmental responsibilities of each role during the operations are summarised in **Error! Not a valid bookmark self-reference.**. The contact details of key personnel shall be recorded in Annex B. This register shall be displayed on site and shall be reviewed and updated regularly to ensure all details are correct.

Table 1 – Key Roles and Responsibilities

ROLE	RESPONSIBILITIES
Walvis Bay Waterfront Properties (Pty) Ltd Management Team	– Overall responsibility for the implementation and management of this Operations-ESMP. – Ensure Environmental Policy is communicated throughout the project. – Responsible for providing the required resources to complete the required tasks and to facilitate company corporate support. Resources being financial, technical and includes external resources.
Operational Manager	– Overall responsible for the implementation and management of this Operations-ESMP. – Overall responsibility for ensuring environmental impacts are minimised and environmental obligations set out in this Operations-ESMP are met. – Responsible for delivery of operational activities including routine and non-routine maintenance works. – Responsible for ensuring the commitments, including annual revisions of this Operations-ESMP are met. – Ensure inductions and training for all personnel employed by the proponent, including contractors, and all companies and businesses owning /leasing project components are completed in accordance with this Operations-ESMP. – Main interface with authorities, including reporting any incidents. – Maintains a register of all tenants / owners, with contact details, nature of business, number of employees and any specific environmental issues or risks. – Review Plant and Equipment Registers and Plant and Equipment Registers held by any companies or businesses leasing/owning components on the project site.
Environment and Social Manager	– Reports to the Operations Manager. – The principal point of advice in relation to the environmental performance of the project. – Provides advise to the proponent, and companies and businesses leasing / owning components on compliance obligations against all matters specified in the conditions of the Environmental Compliance Certificate and within this Operations-ESMP. – Responsible for the management, maintenance and revisions of this Operations-ESMP and subsequent environmental plans (e.g. Waste Management Plan). – Oversee the implementation of all environmental management plans and monitoring programs required under the environmental compliance certificate. – Ensure that environmental auditing is undertaken in accordance with all relevant project Environmental Management Systems – Be given the authority and independence to require reasonable steps be taken to avoid or minimise unintended or adverse environmental impacts, and failing the effectiveness of such steps, to direct that relevant actions be

ROLE	RESPONSIBILITIES
	ceased immediately should an adverse impact on the environment be likely to occur. – Reports incidents to Operations Manager. – Conduct and maintain records of training and inductions to employees and contractors on this Operations-ESMP. – Undertakes monthly reviews and collates compliance reports from all tenants / owners. – Responsible for implementing the environmental monitoring programme developed by the independent consultant below. – Maintain the community issues and concern register keep records of complaints and delegated and report to management as required. – Maintains environmental site records.
Operational Site Supervisor(s)	– Reports to the Operations Manager. – Implement this Operations-ESMP and ensures all activities, including maintenance activities (set out in Section 5) are undertaken in accordance with this Operations-ESMP. – Reporting of environmental incidents to the Operations Manager. – Ensure management measures relating to performance are maintained. – Responsible for ensuring any subcontractors engaged in relation to the development are inducted and activities comply with this Operations-ESMP. – Identifies all environmental and safety risks associated with maintenance works and produces any required Method Statements. – Oversees specific maintenance activities to ensure environmental risks are minimised. – Maintains environmental site records.
Walvis Bay Waterfront Properties (Pty) Ltd Operations Team (Personnel)	– All personnel to comply with this Operations-ESMP and to minimise impacts to the environment. – Ensuring they have undertaken a site induction and are conversant with the requirements of this Operations-ESMP. – Ensuring appropriate briefings for certain activities have been provided and fully understood. – Reporting of any operations and conditions that deviate from this Operations-ESMP or any non-compliant issues or accidents to the Operations Site Supervisor or Operations Manager.
Independent Environmental Consultants / Nominated expert	– Provide specialist input and advice on environmental matters. – Conduct independent monthly audits during operations as and when required. – Conduct annual audit of compliance for submission to authorities. – Design and assist in implementing monitoring programs. – Undertake surveys and inspections. – Preparation of environmental reports as and when required. – Ensure environmental impacts are minimised and environmental obligations are met. – Report any activity that has resulted, or has the potential to result in an environmental incident.

ROLE	RESPONSIBILITIES
Companies and Businesses (Tenants / Owners)	– Comply with this Operations-ESMP. – Reporting of environmental incidents to the Environment and Social Manager – Ensure environmental impacts are minimised and environmental obligations are met. – Provide monthly compliance reports to the Environmental and Social Manager. – Ensure all personnel have undertaken a site induction provided by the proponent. – Ensure all personnel are suitable qualified and/or experienced to undertake their role. – All personnel to comply with this Operations-ESMP and to minimise impacts to the environment. – Nominated individuals to attend monthly meetings with the proponent.

2.3. CONTRACTORS

Any contractors hired to perform duties for the proponent shall to be compliant with this Operations ESMP, and would be responsible for the following:

- Undertaking activities in accordance with this Operations ESMP as well as relevant policies, procedures, management plans, statutory requirements, and contract requirements;
- Implementing appropriate environmental management measures;
- Reporting of environmental issues, including actual or potential environmental incidents and hazards, to the Operational Manager or Environmental and Social Manager; and
- Ensuring appropriate corrective or remedial action is taken to address all environmental hazards and incidents reported by employees and subcontractors.

2.4. EMPLOYMENT

The proponent and all companies and businesses leasing / owning components shall comply with the requirements of the Republic of Namibia Regulations for Labour, Health and Safety, and any amendments to these regulations. During operations, the following shall be complied with:

- In liaison with local government and community authorities the Contractor shall ensure that local people have access to information about job opportunities and are considered first for contract employment positions;
- The number of job opportunities shall be made known together with the associated skills and qualifications.
- The maximum length of time the job is likely to last for shall be clearly indicated;
- Foreign workers with no proof of permanent legal residence shall not be hired; and
- Every effort shall be made to recruit from the pool of unemployed workers living in Walvis Bay.

Additional employment principals shall be developed and included to this Operations-ESMP to ensure a robust employment policy is implemented across the project.

3. TRAINING AND COMMUNICATIONS

3.1. Training and Awareness

To ensure the operations of the project minimise potential environment and social impacts, and implement best practice and effective environment and social management, all personnel and subcontractors employed by the proponent as well as by all companies and businesses leasing / owning components within the project shall receive suitable training. All personnel across the project shall be required to attend a site induction upon commencement of employment and shall include the following:

- This Operations-ESMP and its intended purpose, including its relationship to and method of use;
- A general induction that outlines:
  - What is meant by "environment" and "social";
  - Why the environment and community needs to be protected;
  - How operational activities can impact on the environment and community;
  - What can be done to mitigate against such impacts;
- Site environment and social objectives and targets;
- Understanding individual roles and responsibilities;
- The environmental impacts and social responsibilities associated with the inductee's working activities;
- Site environment and social rules;
- Understanding their legal obligations and the potential consequences of non-compliance with this Operations-ESMP and relevant statutory requirements;
- Details of how to deal with, and who to contact for environment or community events or issues should they occur; and
- Emergency procedures and responses, including an outline of the environment and social Incident Management Procedure.

All site staff will be appropriately qualified and trained for the specific role they are to undertake. Training records shall be kept and maintained, and held by each company and business, including the proponent. New recruits and training undertaken shall be reported to the proponent monthly. The proponent shall maintain a record of reports and shall highlight any issues regarding personnel training through the monthly compliance reviews.

Personnel performing tasks that may cause environmental impacts shall have appropriate education, training and/or experience. Method Statements and Risk Assessments will be conducted prior to high risk jobs or projects and shall involve sign off and involvement of the Environmental and Social Manager. Ad hoc Tool Box talks shall be undertaken as and when required to provide updates to personnel across the project, for example on any newly identified environmental issues or lessons learnt.

3.2. Communications: Walvis Bay Waterfront Properties (Pty) Ltd

The proponent's Management Team shall undertake regular meetings such as progress meetings or monthly update meetings, which shall include but not be limited to the following items to ensure environmental management during operations is maintained:

- Recent training undertaken;
- Recent inspections, audits and any non-conformance;
- Any lessons learnt and alterations to this Operations-ESMP;

- Complaints received;
- Visits by external bodies and the outcome or feedback from such visits; and
- Objective / target achievement, including reporting on environmental performance.

Minutes from these meetings will be taken, and key environmental information will be cascaded to all personnel in the company though Tool Box talks and through notices.

Where necessary, separate meetings with contractors will be held as and when necessary to ensure the following:

- Appropriate training has been provided to personnel (in line with Section 3.1); and
- Any additional specific training for the job at hand.

3.3. Communications: Tenants/Owners

At times it will be necessary to communicate and cascade environment and social information to the companies and businesses leasing/ owning a component on the project to ensure environmental compliance is maintained, updates are provided, and any lessons are learnt from. As part of the management duties, the proponent's Management Team will cascade environmental information through the following means:

- Monthly meetings to be attended by nominated representatives from all businesses and companies;
- Email;
- Newsletters;
- Meetings; and
- Notices.
- Social media (what's app group for example)

This Operations-ESMP will be published on ECC website and the proponent's website so that it can be accessed at all times.

3.4. Communications: External

3.4.1. Community

The design of the project has taken into consideration community feedback and where possible has designed out potential impacts, for example setting of the buildings and layout of development. Risk of impacts occurring still remains, as the existing environment will alter as a result of the project, thereby affecting the local community, for example, increase in traffic levels and thus noise levels, and change in landscape character. The Management Team shall ensure that regular communication with the local communities and stakeholders are undertaken to minimise impacts on the environment and community, and potential complaints are minimised. This shall be undertaken by way of forums (to be held quarterly), local newsletters, leaflets, newspaper advertisements, and community notice boards to include information such as:

- Upcoming events;
- Accidents or emergencies;
- Major changes to the development;
- Any major works that may impact the community; and
- Community what's app group
- Environmental forums on a quarterly basis

The environmental forum shall involve a range of stakeholders, including government, local authority, neighbours, and provide them with a platform where issues and concerns can be raised. It will also provide an opportunity for the proponent to present monitoring results; learn and understand community interests and concerns; openly discuss issues, feedback and comments; and encourage interactive working between the proponent and community.

The proponent shall also prepare and circulate an annual community newsletter providing an overview of the past year and performance against environment and social objectives.

The Environmental and Social Manager shall co-ordinate community engagement as well as manage any complaints (see Section 3.5).

3.4.2. Tourists and Visitors

The project shall provide land based and marine facilities for both the community and tourists. Providing environmental information to the public is part of the developments philosophy, in particular, regular monitoring of the marine environment will be undertaken and presented in the form of education notice boards which shall be updated on a regular basis.

3.4.3. Other Stakeholders

During operations, continual engagement with external stakeholders shall be undertaken to ensure the impacts on the environment are minimised. Communication may take the form of scheduled meetings, telephonic calls and written correspondence. The key stakeholders who will be communicated with include, but are not limited to:

- Walvis Bay Municipality;
- The Namibian Dolphin Project;
- Ministry of Environment and Tourism;
- Ministry of Fisheries, Marine and Resources; and
- NAMPORT.

Any agreed monitoring will be shared through reports, with any recommendations to be actioned agreed with the Management Team.

3.5. Complaints Handling and Recording

Complaints shall be directed to a dedicated email address and nominated phone number, the details of which shall be circulated to the local community and displayed on notice boards. Any complaints received verbally by any personnel on the project site shall be recorded by the receiver, including the name and contact details of the complainant, date and time of the complaint, and the nature of complaint. The information shall be given to the Environmental and Social Manager who is overall responsible for the management of complaints, and will provide a written response to the complainant. Any complaints regarding customer satisfaction for services provided by companies and businesses shall be handled directly with the relevant company and business.

The Environment and Social Manager shall maintain a complaint's register that will detail the name and contact details of the complainant, date and time of the complaint, nature of complaint, action taken to resolve issues, and date of complaint handover. Records of all complaints shall be kept for at least four years after the complaint was made.

The Environmental and Social Manager together with the Operations Manager shall be responsible for the nominating the correct personnel to resolve the issue and co-ordinate resolution. All complainants shall be informed in writing of the results of the investigation and action to be taken to rectify or address the matter(s). Where no action is taken, the reasons why are to be recorded in the register.

The Operational Manager shall inform the Municipality of this complaints register; its location and the person responsible to ensure that local community or the general public are aware and know about the complaints register.

Personnel shall be informed about the complaints register, its location and the person responsible, in order to forward to him/her any resident or the general public who wishes to lodge a complaint.

4. REPORTING, COMPLIANCE AND ENFORCEMENT

4.1. ENVIRONMENTAL MANAGEMENT SYSTEM

An Environmental Management System (EMS) shall be implemented across the project and all components shall operate in accordance with the EMS. Once the EMS has been set up, and relevant details, specifications or requirements shall be added to this Operations-ESMP.

4.2. ENVIRONMENTAL PERFORMANCE MANAGEMENT

4.2.1. SUMMARY OF ENVIRONMENTAL RISKS AND MITIGATION MEASURES

Chapter 6 provides a Register of Environmental Risks and Issues, which identifies mitigation and monitoring measures, as well as roles responsible. This register will be subject to regular review by the Environmental and Social Manager together with the Operations Manager, and updated when necessary.

This register will be used to undertake monthly inspections by the Environmental and Social Manager (see next section) to ensure the project is compliant with this Operations-ESMP.

4.2.2. ENVIRONMENTAL INSPECTIONS & COMPLIANCE MONITORING

4.2.2.1. DAILY COMPLIANCE MONITORING

A copy of this Operations-ESMP will be available to all personnel through the proponent's web site, as well as hard copy held by each company and business operating on the project site.

All personnel shall comply with this Operations-ESMP through their daily roles and any activities undertaken. Any environmental problems or risks identified shall be notified and reported to a nominated role in all companies and businesses operating on the project site, or if working for the proponent, directly to the Operations Site Supervisor. Any environmental problems or risks shall be cascaded to the proponent's Operations Manager, and shall be actioned as soon as is reasonably practicable.

4.2.2.2. MONTHLY COMPLIANCE MONITORING

Monthly compliance inspections shall be undertaken by the Environmental and Social Manager, who shall check that the standards and procedures set out in this Operations-ESMP are being complied with and pollution control measures are in place and working correctly across the project (including all tenants / owners).

Monthly Compliance Reports shall be produced by the Environmental and Social Manager, which shall include a summary of compliance provided by each component on the project. The report shall contain a brief description of any areas of non-conformance with the contract specification, the reason for the non-conformance; the responsible party, the result (consequence), the corrective action taken and any necessary follow up measures required. Monthly Compliance Reports shall feed into the annual review, to ensure this Operations-ESMP is appropriate for use.

A register of documents shall be produced and maintained by the proponent, for example the required permits or approvals, and registers, documents and plans (Annex A provides an initial list of requirements prior to operations commence). This checklist shall be used to ensure compliance with this Operations-ESMP, and shall be updated particularly with any required Method Statements. It shall also be used as a log to record when documents are reviewed and updated.

4.2.2.3. INSPECTION OF PLANT AND EQUIPMENT

All plant and equipment performing an environmental function shall be well maintained and serviced in line with their specification. A register of all plant and equipment under the responsibility of the proponent or companies and businesses shall be maintained by the Operations Manager or designated roles, respectively. This register shall be reviewed monthly to ensure all checks and services for plant and equipment have been undertaken. The register shall include, but not limited to the following:

- Piece of plant and equipment;
- Make and Model;
- Frequency of required service and scheduled dates;
- Dates of last inspection, maintenance and/or test;
- Notes of any issues or concerns; and
- Responsible person.

4.2.2.4. Annual Compliance Monitoring

An independent annual audit shall be undertaken to review operations and compliance over the last 12 months. All monthly reports (from all companies, businesses and the proponent) shall be reviewed, identifying any trends or significant areas of concern, as well as measures implemented to manage / resolve the environment or social issue. All complaints or comments and actions taken shall be reviewed. Compliance and legislative changes shall be reviewed, and lessons learnt shall be captured. This Operations-ESMP shall be amended as required, and follow up training, awareness or updates shall be provided across the project.

4.3. Reporting

Whilst the proponent will not manage all operations on the site, there will be a requirement to ensure that any incident is reported to the proponent's Management Team. In the event of any environmental issue, failure of plant and equipment that perform an environmental function or accident, the reporting structure presented in Figure 3.

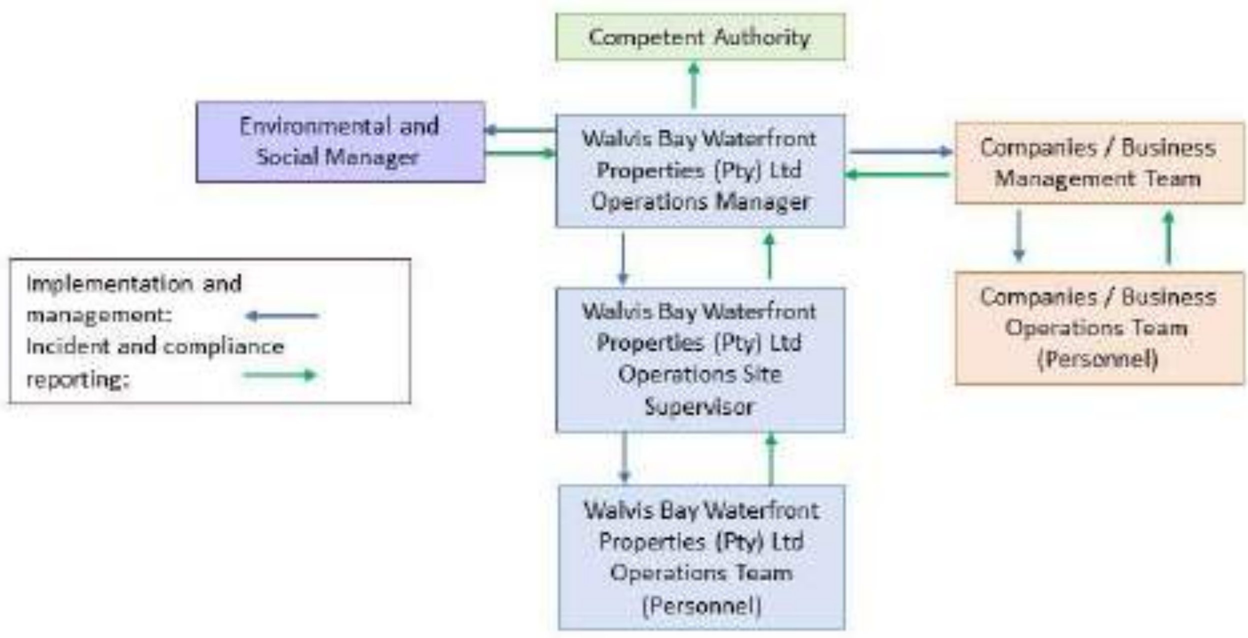

Figure 3 – Reporting Structure overview

4.4. Non-compliance

4.4.1. Non-Compliance Event

The proponent and all companies and businesses operating on the project site shall ensure that this Operations-ESMP is fully complied with by its personnel and contractors. Where it has been identified that works are not compliant with this Operations-ESMP, the corrective actions shall be employed immediately so that the works return to being compliant as soon as possible.

Non-compliance is considered as for example:

- Evidence of contravention of this Operations-ESMP and associated indicators;
- Personnel as having failed to comply with corrective or other instructions issued by the Operational Manager or qualified authority; or
- Complaints from the public having not being responded to.

4.4.2. Disciplinary Action

This Operations-ESMP is a legally binding document and non-compliance with it shall result in disciplinary action being taken against the perpetrator/s. Such action may take the form of (but is not limited to):

- Fines / penalties;
- Legal action;
- Monetary penalties imposed by the proponent on the contractor;
- Withdrawal of license/s; and
- Suspension of work.

The disciplinary action shall be determined according to the nature and extend of the transgression / non-compliance, and penalties are to be weighed against the severity of the incident.

5. OPERATIONAL ENVIRONMENTAL MANAGEMENT

5.1. Objectives and Targets

Environmental objectives for the operations of the project are as follows:

- Zero pollution incidents;
- Minimise waste sent to landfill or being burnt;
- Minimise disruption to residents (and therefore complaints); and
- Protect marine biodiversity.

Procedures for monitoring operational processes against the project environmental objectives will be by the Environmental and Social Manager. Monitoring measures are summarised in Section 5.9

5.2. Method Statements and Risk Assessments

Method Statements and Risk Assessments shall be produced by the Operations Manager (or nominated individual) for specific high-risk activities during the operations and maintenance of the project, and shall include environmental protection and mitigation measures, as well as emergency preparedness appropriate to the activity covered.

Method Statements shall be produced for a range of activities, including, but not limited to:

- Dredging of the Access Channel and Marina (see Section 5.5.1);
- Maintenance and cleaning of the Inner Marina (see Section 5.5.2); and
- Dredged waste material handling and off-site removal.

The list of Method Statements, and in particular ones required for routine and non-route (but scheduled activities) should be listed in the document register (Annex A) and shall be reviewed annually.

5.3. Marina Operations

Approximately 70 boats are expected to be moored in the Marina. These boats will be of various sizes and will be restricted in size to those the Marina has been designed to cater for; this will include leisure yachts and small recreational boats.

Boat operators using the marina will fall under the management of the proponent and therefore the proponent shall enforce strict rules and regulations for boat operators and users of the marina.

Education and notice boards shall be positioned around the Marina, displaying information regarding the code of conduct, rules and regulations of the Marina and other guidance to ensure impacts on the environment are minimised. This shall include but not limited to:

- No littering;
- No feeding of wild animals;
- Speed limits;
- No-go areas including the Lagoon;
- Compliance to Namport's nautical safety requirements;
- Compliance to National Water Safety rules and regulations;
- Safety requirements;
- No mooring outside of the Marina;
- Shut down of fish finding and boat sonar equipment; and
- Rules regarding the use and limited use of lights on masks in the Marina.

Boats will only be permitted to use the Access Channel for entry and exit; this will be demarcated by buoys and access will be speed limit restricted.

Outside of the Marina and Access Channel, the proponent will have limited control over the boats users and their activities, however the proponent will reiterate that all users shall adhere to the following:

- Remain within areas approved for boat use and avoid restricted areas, including the Lagoon;
- Boats within the Bay area will fall under the regulations of Namport and all nautical safety requirements must be complied with, including national laws pertaining to boat use.
- A "Code of Conduct" will be drawn up and in place prior to operations setting out the rules and regulations of the Marina use.

5.4. ROUTINE MAINTENANCE

Routine maintenance shall occur monthly during the life of the project and will be managed by the Operations Manager or Operations Site Supervisor. Routine maintenance could include activities such as:

- Utilities and services;
- Open areas and landscaping;
- Cleaning and repairs or outdoor areas and marina area;
- Drainage, stormwater controls and erosion management;
- Residential properties and serviced apartments;
- Internal roads and parking areas;

As part of routine maintenance, a Routine Maintenance Environmental Checklist shall be used as a guide when undertaking checks, as it shall set out all plant and equipment that perform and environmental function, what the function is and how they should perform, and mitigation measures that shall be applied to minimise impacts prior to undertaking maintenance activities. This checklist shall be consistent with the Plant and Equipment Register as discussed in Section 4.2.2.3, which shall be updated once checks are completed.

All plant and equipment, including infrastructure such as drains performing and environmental function should be well maintained and serviced as and when required.

This checklist shall be reviewed regularly and revised accordingly to ensure all plant and equipment, and any activities are recorded along with any environmental issues identified. It shall be filed in the EMS and immediate corrective actions shall be undertaken where practical. The completed checklist shall be reviewed by the Operations Manager or nominated role (for companies and businesses) that will provide advice and direction any other actions as appropriate. Every month, the Operations Manager shall review Plant and Equipment Registers and Plant and Equipment Registers held by any companies or businesses leasing/owning components on the project site.

In all instances the principals included in this Operations-ESMP shall be followed where applicable to manage anticipated environmental impacts from such activities.

5.5. NON-ROUTINE MAINTENANCE WORKS

Non-routine maintenance will be required during the operations of the project. The key ones that may impact the environment are dredging the Access Channel and Marina, and the draining and cleaning of the Inner Marina.

Prior to any non-routine maintenance works, all contractors and personnel shall have appropriate environmental training and awareness and a Method Statement shall be produced and issued, with the approval of the Environmental and Social Manager and Operations Manager. Prior notice shall be provided to local residents through notice boards or other means described in Section 3.4. Any equipment brought onto site will be fit for purpose, well maintained and regularly serviced.

5.5.1. Dredging Activities

The Access Channel and Marina will require Operational Maintenance Dredging every two and five years respectively. A specialised contractor shall be commissioned to undertake the work and Mr Alan Louw (or his nominated representative) shall be present to oversee the works. The contractor shall produce a Method Statement, which will be approved by the Environmental and Social Manager and Operational Manager. The Method Statement shall include measures to avoid and minimise impacts, and set out any monitoring requirements, which shall include, but not limited to the following:

- Provide early notice to users of the marina, local residents and businesses in line with the communications strategy (see Section 3.4);
- Dredging works to be undertaken on the outgoing tide and to avoid strong trade winds;
- Limit activities to the specified area, schedule and for the planned durations;
- Engage the Namibian Dolphin Project to conduct Hydrophone monitoring prior to and during dredging activities to determine presence of animals;
- Provide early notice to the Namibian Mariculture Association and to all the commercial shellfish farmers in Walvis Bay;
- Do not undertake activities until marine mammals have left the area;
- Ensure a Marine Mammal Observer is available to observe and identify presence of animals prior to works and to cease works if dolphins are within the predetermined safe zones;
- Ensure Mr Alan Louw or his appointed representative is present to oversee all dredging activities;
- Use soft-start and ramp-up operations; and
- Maintain and clean all plant and equipment used in the marine environment.

The management of surface water run-off and activities next to the sea shall be defined within the Method Statement.

5.5.2. Inner Marina Maintenance

The Inner Marina will require draining and cleaning as and when required, which is expected to be between every two to five years. A contractor will be commissioned to undertake the work, who will produce a Method Statement which will be approved by the Environmental and Social Manager and Operational Manager. The Method Statement shall include but not limited to the following:

- Provide prior notice to users of the marina, local residents and businesses in line with the communications strategy;
- Ensure any solid waste is collected prior to the Inner Marina being drained;
- Inform and liaise with local authorities regarding the upcoming works, incorporate any imposed conditions into activity;
- Sample and analyse the water to ensure it is of a quality to drain to the marine environment; and
- Conduct monitoring and inspections throughout the process

5.5.3. Other

Other non-routine maintenance may include:

- Civil works to correct failures/deficiencies in the road network, drainage or other infrastructure
- Electrical works, including trenching, re-cabling and testing
- Structural works
- Maintenance such as replacing infrastructure, washing, painting, welding etc.

In all instances the principals included in the Operation-ESMP shall be followed where applicable to manage anticipated environmental impacts from such activities. Additional environmental management measures for non-routine maintenance works may be required, and a Method Statement may be required for high-risk activities. The Environmental and Social Manager and Operational Manager shall determine when Method Statements are required.

5.6. Solid Waste Management

The EMA (2007), Section 3, paragraph (i) states that waste must be reduced, re-used and recycled where possible, therefore in accordance with the Act, waste generated on site shall be managed and dealt with in accordance with a Waste Management Plan. This Plan will be produced prior to the operations phase commencing and shall include the following information:

- Describe each waste type expected to be produced;
- Estimate the quantity of each waste type;
- Identify the waste management action proposed for each waste stream, including re-using, recycling, recovery and disposal;
- Designated areas to collect and separate waste; and
- Identify waste carrier and waste Disposal Company.

A draft Waste Management Plan template is provided in Annex C. The aim of the Waste Management Plan is to achieve sustainable waste management. Their main purpose is to outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. In addition, it will also outline any potential economical and investment requirements for the treatment and / or disposal of waste.

The Waste Management Plan shall be updated by the Environmental and Social Manager annually (at the same time as the annual review as discussed in Section 4.2.2.4) to ensure all waste and disposal route is identified and waste hierarchy applied where possible. Input from all companies and businesses leasing or owning components on the project site shall be required, which shall be provided through the annual review (see Section 4.2.2.4).

The following waste management measures shall be followed:

- Waste will be collected, separated and stored in a designated area which will be appropriately fenced and signposted to keep out unauthorised people and animals;
- Waste collection containers will be of an appropriate design to ensure that no waste can escape, and will be labelled with waste type (e.g. wood, metals, building rubble, garden waste, domestic waste);
- Waste storage areas shall be kept clean and tidy at all times;
- Bins shall be emptied regularly to avoid pests and bad odours; and
- No burning will be allowed on site.

Any hazardous material and wastes (including medical waste, if necessary) shall be managed in a safe and responsible manner so as to prevent contamination of soils, pollution of water and/or harm to people or animals as a result of the use of these materials. Hazardous and non-hazardous waste shall be stored separately at all times.

5.7. Material Management: Dredged Material

Maintenance dredging activities shall occur approximately every five and two years for the Access Channel and Marine, respectively. As stated in the ESIA report, at the time of writing the preferred site to move this material to has not been identified, and four options remain. The preferred option shall be identified prior to the project entering the operational phase, and this Operations ESMP shall be amended to set out the preferred option.

A Method Statement shall be produced for this activity, which shall set out measures that minimise potential impacts on the marine environment.

5.8. Risks to the Marine Environment

In addition to the maintenance dredging and draining activities, there is potential for the marine environment to be affected through the operations of the project, for example, through:

- Increased boats activities in the mouth of the Lagoon and Bay area, increasing in noise and vibration levels, and human interactions with marine animals;
- Maintenance activities within or adjacent to the marine environment;
- Site drainage and spread of contamination or silty waters;
- Increased noise levels from users of the marina and project site;
- Increased risk of pollution events and litter entering the marine environment; and
- Increased light.

Prior to operations, the Operations Manager shall produce a Rules and Regulations Manual for users of the Marina, setting out rules and codes of conduct for all boat users, operators and owners, other users of the marina and marine environment, and tourists and the general public enjoying the Marina area. This document shall be circulated to all Marina users prior to activities being undertaken, and key rules and codes of conduct shall be publicised on notice boards throughout the development, for example, no littering; speed restrictions and demarcation of restricted areas for boats; no feeding wild animals; and no maintenance work in certain areas.

5.9. Environmental Monitoring

Monitoring during operations shall be undertaken to ensure the impacts on society and the environment are minimised and to evaluate how effective the environmental management has been, over an extended period of time. A detailed environment and social monitoring plan is attached as Annex D.

5.10. Pollution Control and Contingency Plan

5.10.1. Storage of Fuels, Oils and Chemicals

Where fuels, oils or chemicals are stored on the project site, the following should be applied:

- Fuel storage tanks should be sited in a location specified and approved by the Operations Manager and should be enclosed with a security fence with a lockable gate;
- Any fuel tank or container should be on a flat area, at least 100m from residential properties and the sea;
- The container shall be stored on an impervious base, be bunded and capable of containing at least 110% of the total capacity of the storage container;

- The bund should be made of impermeable material;
- Signs indicating 'no smoking' 'no naked flames' and 'danger' will be provided in appropriate languages, and will conform to a recognised standard and national laws;
- The capacity of the tank and the product within the tank shall be displayed using an Emergency System compliance to recognised standard and national laws or similar international code;

5.10.2. Handling of Fuel, Oil and Chemicals

All personnel shall take reasonable precautions to prevent fuel, oil and chemical spills. To this end, the Operations Manager and the Management Team of all companies and businesses shall ensure that:

- All fuel, oil and chemical deliveries will be supervised by a responsible person, who will be trained to deal with any spills;
- All mobile plant shall be refuelled in a designated area on an impermeable surface and away from drains. A spill kit will be at each refuelling point. Where it is impractical to refuel within a bunded area, a drip tray will be available to catch any spills caused by over fuelling;
- Storage tank levels will be checked before delivery to prevent overfilling or delivering the wrong product;
- Daily inspections are performed to verify that no leaking or defective equipment is brought onto site;
- Any oils or lubricants discharged during routine vehicle servicing on site are captured using drip trays, containers or other appropriate containment measures; and
- Equipment is maintained regularly to ensure that no fuel, oil or hydraulic leaks occur.

All vehicles or equipment that are used in close proximity to the sea are cleaned of oil, grease and other contaminants damaging to marine life. Any fuelling or repairs shall be carried out in designated areas more than 100m away from the coastline and shall be supervised by personnel familiar with spill containment and clean up procedures.

The Operations Manager shall ensure that there is sufficient absorbent material and spill kits available on site to manage accidental spills. Spill kits should contain as a minimum, sealed plastic buckets or re-closable plastic bags, pads, socks, safety goggles, gloves, disposal bags and should be clearly marked "Spill Kit". The most appropriate spill kits shall be determined and identified by the Operations Manager, taking into consideration the volume being stored and nature of material.

The location of and instructions on how to use this equipment shall be included in the Site Induction, and nominated personnel shall be appropriately trained to use spill kits. An Environmental Emergency Plan shall be produced prior to operations and shall have detailed instructions on how to respond to spills (see Section 5.12.

Any accidental spillages of fuels and oils, or other hazardous substances, shall be cleaned up immediately and be reported Operations Manager (as per Figure 3). The following responses shall be undertaken:

- Minor spill: Only diesel and oil, with no human injury, contamination to water bodies or other environmental receptors. Contain and clean up the spill using available spill kit. Report to the Operations Manager, supplying the following information:
  - Date, time, and location;
  - Substance spilled and quantity; and
  - Actions taken, and any future remediation required.
- Major Spill: Resulting in human injury or/and environmental contamination and water body contamination. Contain the spill if possible and report the spill to the Operations Manager who shall then alert the

appropriate emergency services (see Table 2). In addition to the above information, the Operations Manager shall also be informed of any immediate dangers, e.g. fire, explosion, release of chemical fumes.

5.11. Fire Prevention

All personnel across the project shall take all necessary precautions to prevent the ignition and spread of fires caused either deliberately or accidentally as a result of the work being performed.

The Operations Manager with support from the Management Teams of companies and businesses across the project site shall prepare a Fire Prevention Plan for fire prevention and emergency management, which shall be communicated to all companies and businesses across the project. The Fire Prevention Plan shall include, but shall not be limited to, the following:

- Potential sources of fire risk;
- Procedures to be followed to control an accidental fire;
- Identification and location of fire-fighting equipment that will be maintained on site and deployed in the event of an emergency.

The Site Induction will include a briefing of the risks and potential consequences of starting fires. Personnel shall also be warned of the risks of careless disposal of burning cigarette butts.

Appropriate fire-fighting equipment shall be provided at specified localities across the project site to meet any emergency resulting from a fire. The locations of which shall be provided in the Site Induction.

5.12. Environmental Emergency Plan

An Environmental Emergency Plan shall be prepared by the Operations Manager, with support from the Environmental and Social Manager, prior to the operational phase and communicated to all companies and businesses, as wells as sub-contractors and Emergency Services.

The plan shall incorporate fire and emergency management measures, and pollution incident response management plan requirements. The plan shall identify and concentrate on potential incidents and emergencies that could occur on the project site, and describes the general policy and approach that should be followed when dealing with an emergency or incident, such as fire, explosion, spills and traffic accidents.

The plan shall outline:

- The development, site plans and maps;
- Incident identification and notification process;
- Emergency contact details;
- Emergency response procedures; and
- Training requirements.

A reportable environmental incident is a pollution incident where there is a risk of causing or threatening material harm to the environment. A pollution incident includes a leak, spill or escape of a substance or circumstances where this is likely to occur.

Responsible staff shall be trained in emergency procedures to form an Emergency Team, so that these procedures can be implemented swiftly and effectively. Periodic testing of emergency procedures will be undertaken by the Operations Manager. Any corrective actions are taken forward for review and approval.

Should an emergency incident occur, the Operations Manager shall be notified immediately, who will call the emergency services and inform the Environmental and Social Manager. The emergency response Shall be coordinated by the Operations Manager. A record of the emergency incident shall be kept illustrating the nature of the event and corrective action undertaken. These reports shall be reviewed annual as part of the annual review (see Section 4.2.2.4).

5.13. Environmental Emergency and Response Contacts

The Operations Manager will be the primary contact person in the event of an environmental emergency. The Operations Manager has the authority and independence to request reasonable steps be taken to avoid or minimise unintended or adverse environmental impacts, and failing the effectiveness of such steps, to direct that relevant actions be ceased immediately should an adverse environmental impact be anticipated.

In the event of an incident that requires the emergency services, the services that should be contacted are listed in Table 2.

Table 2 - Emergency Services contact telephone numbers

AMBULANCE	POLICE	FIRE BRIGADE	SEA RESCUE	NAMPORT FIRE AND PORT CONTROL
+264 81 129 3875	+264 64 - 219 000, +264 64 – 219036 064 219 048 219 048	+264 81 122 0833 or 081 122 0888	208 2221 or 081 129 6295	208 2221 or 208 2265

For large-scale spills and other significant environmental incidents, the fire services should be contacted as required and the MET office informed of the incident (telephone +264 61 284 2111). All correspondence with MET should be undertaken by the PM as guided by the Environmental Officer.

For the clean-up of smaller spills, the relevant Material Safety Data Sheet (MSDS) should be obtained online and consulted to determine the appropriate clean-up procedure. Basic spill response training will be provided as part of the site environmental induction, spill response equipment, including relevant MSDS copies, will be provided in areas where potentially environmentally hazardous chemicals may be used.

All environmental incidents, regardless of their size or significance, should be recorded and reported to the Operations Manager.

6. REGISTER OF ENVIRONMENTAL RISKS AND ISSUES

6.1. Introduction

An environmental review of the project has been completed to identify all the commitments and agreements made within the ESIA report. From this, a schedule of environmental commitments has been produced, which details deliverables including measures identified for the prevention of pollution or damage to the environment during the operations phase.

Table 3 – Environmental Issues, Mitigation and Monitoring Measures

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
1	Inefficient or poor maintenance activities	– Dirty areas and build-up of rubbish – visual impact and pests or scavengers attracted to the area (scare off lagoon birds). – Damage to buildings. – Puts off visitors – loss of income. – Inefficient or failure of plant and equipment performing an environmental function – loss of containment, pollution event, inefficient energy use.	– Daily duties of trained responsible personnel. – Suitable qualified personnel and appropriate tools and equipment. – Weekly and monthly inspections. – Application of methods identified in the Routine Maintenance Environmental Checklist.	– Weekly and monthly inspections. – Complete the Routine Maintenance Environmental Checklist – Update the Plant and Equipment Register as required.	– During maintenance activities and once complete to sign off work. – Monthly inspections.	– Site Operations Supervisor – Operations Manager – Nominated personnel for each company and business.
2.1	Routine Maintenance: Landscaping and open spaces	– Overgrowth of vegetation – visual unpleasing. – Poor maintenance leading to visual impacts, introduction of invasive species and loss of visitors to the development	– Ensure all trees and vegetation has established/reinstated – Keep areas clean at all times, bins shall be emptied daily – Daily sweeping of areas – Control weeds and pests – No invasive species or non-native species to be introduced onto the development. – Application of methods identified in the Routine Maintenance Environmental	– Visual inspections by the Site Operations Supervisor. – Work undertaken in line with the Routine Maintenance Environmental Checklist and update the Plant and Equipment Register as required.	– During maintenance activities and once complete to sign off work.	– Site Operations Supervisor – Operations Manager

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			Checklist.			
2.2	Routine Maintenance: General Activities	– Loss of containment through spills of chemicals, oils or fuels being used – contaminated ground, Inner Marina or Outer Marina.	– Suitable qualified personnel and appropriate tools and equipment. – Application of methods identified in the Routine Maintenance Environmental Checklist.	– Inspections of the work. – Work undertaken in line with the Routine Maintenance Environmental Checklist and update the Plant and Equipment Register as required.	– During maintenance activities and once complete	– Site Operations Supervisor – Operations Manager – Nominated personnel for each company and business.
3	Failure of plant and equipment performing an environmental function	– Various, for example loss of containment (storage containers); insufficient filtering/treatment of liquid effluent entering marine environment; poor drainage leading to siltation.	– Undertake prescribed care and maintenance and servicing of plant and equipment in line with the Plant and Equipment Register and Routine Maintenance Environmental Checklist. – Suitable qualified personnel undertaking the work and implementation of and adherence to reporting structure.	– Regular inspections of plant and equipment in line with the Plant and Equipment Register and Routine Maintenance Environmental Checklist	– Weekly – Monthly – Annually	– Site Operations Supervisor – Operations Manager – Environmental and Social Manager
4.1	Non-routine maintenance works: Operational Maintenance	– Increase suspended solids: reduce water quality, affect aquatic life (fish move away from area, causing dolphins and other mammals to move away)	– Undertake activities on outgoing tide only – Limit works during certain conditions, e.g. when trade winds are strong	– Mr Louw and Site Operations Supervisor to over-see all works – Liaise with the	– Daily checks – Regular Water quality monitoring – Throughout	– Site Operations Supervisor – Site Manager – Environmental and Social

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
	Dredging	and reduce sunlight in water column – Indirect impacts to bird life	– Mr Alan Louw to oversee dredging activities – Suitably qualified and experienced personnel – Use soft-starts and ramp up operations – Avoid dredging between June and September – Follow works in line with the Method Statement	Dolphin Project prior to and during works who will undertake hydrophone monitoring – Conduct sampling and routine turbidity and water quality monitoring – Avian monitoring	dredging works (every 2 years)	Manager
4.2	Non-routine maintenance works: Operational Maintenance Dredging General operations of the site	– Increase noise and vibration: marine mammals will avoid areas – Nuisance to local residents, tourists and visitors.	– Use soft-starts and ramp up operations. – Suitably qualified and experienced personnel. – Marine Mammal Observer to observe and identify presence of animals prior to works and to cease works if dolphins are within the predetermined safe zones. – Avoid dredging between June and September – Limit activities to prescribed durations – Provide early notice to users of the marina, local residents and businesses – Follow works in line with the	– Mr Louw and Site Operations Supervisor to over-see all works. – Liaise with the Dolphin Project prior to and during works who will undertake hydrophone monitoring. – Noise monitoring	– Daily checks – Throughout dredging works (every 2 years) – Every dredging occurrence – Annual	– Site Operations Supervisor – Site Manager – Environmental and Social Manager

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			Method Statement			
4.3	Non-routine maintenance works: Operational Maintenance Dredging and draining/cleaning of the Inner Marina	– Disruption to users of the Marina	– Provide early notice to users of the marina, local residents and businesses. – Follow works in line with the Method Statement.	– When activity occurs	– Throughout dredging works (every 2 years)	– Operations Manager
4.4	Non-routine maintenance works: Operational Maintenance Dredging	– Generation of contaminated dredge material – Disposal of dredged material – land take, potential land contamination.	– Sample dredged material to ensure waste disposal route is appropriate. – Limit dredging to specific areas and during outgoing tides. – Suitably qualified and experienced personnel. – Identify the preferred disposal option and undertake works in line with Method Statement.	– Sampling of material prior to disposal. – Disposal dependent on sample results	– Every dredging occurrence	– Operations Manager
4.5	Non-routine maintenance works: Operational Maintenance Dredging	– Disruption of sea floor causing sulphur eruptions leading to reduced water quality and bad odours – Change in depth.	– Limit dredging to specific areas and during outgoing tides. – Suitably qualified and experienced personnel.	– Visual monitoring – Turbidity monitoring – Routine sediment sampling – Bathymetric survey	– Throughout dredging works (every 2 years)	– Operations Manager

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
4.6	Non-routine maintenance works: Drainage of and cleaning of the Inner Marina.	– Contamination of the marine environment from fuels, oil, litter	– Ensure any solid waste is collected prior to the Inner Marina being drained. – Sample the water to ensure it is of a quality to drain to the marine environment.	– Regular visual checks prior to and during works – Water quality monitoring as per schedule	– Throughout operations	– Operations Manager
4.7	Non-routine maintenance works: Operational Maintenance Dredging	– Direct and indirect impacts to marine mammals and other wildlife (disturbance, injury or mortality)	– Observation of the presence of marine environment for mammals and other wildlife in the area. Hold off on any dredging works until wildlife has moved from the area. No human-wildlife interactions. – Dredging activities shall be undertaken in winter months, from May to August to minimise impacts on sensitive feeding seasons – Marine works will avoid sensitive marine mammal breeding times and should be minimised between June to September. – Implement Method Statement	– Observation of the presence of marine environment for mammals and other wildlife in the area (by the MMO). – Continual liaising with The Dolphin Project. – Hydrophone monitoring	– Throughout dredging works (every 2 years)	– Operations Manager – Environmental and Social Manager
5	Marine Works: Maintenance activities next to or within the	– Loss of fuel or oil (loss of containment or leaks), contaminating marine environment	– Maintenance of vehicles. – Spill kits suitable for marine environment to be located near activities, and staff	– Regular visual checks during marine works. – Daily inspections	– Daily - Throughout maintenance works	– Site Operations Supervisor – Operations Manager

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
	marine environment.		trained to handle spills. – Maintain and clean all plant and equipment used in the marine environment.			
6	Increased marine traffic (leisure boats)	– Direct and indirect impacts to marine mammals and other wildlife (collisions, noise disturbance, injury or mortality) – Increase risk of pollution events	– Implementation and enforcement of the Marina Rules and Code of Conduct. – Demarcated and no-go areas clearly defined and communicated. – Spill kits around Marina.	– Liaising with users – Continual liaising with The Dolphin Project. – Monthly inspections – Ni-annual mock emergency response drills	– Continuous – Bi-Annual	– Operations Manager – Environmental and Social Manager
7.1	Generation of waste	– Loss and inefficient use of resources. – Land use (through landfill), air pollution (through burning). – Increase use of resources through transport.	– Application of the waste hierarchy and compliance with the Waste Management Plan. – Avoid and reduce packaging and other materials purchased, applying pressure on suppliers. – Training and awareness across teams. – Implementation and enforcement of the Marina Rules and Code of Conduct.	– Through daily roles of personnel – Monthly compliance checks.	– Daily – Monthly	– Operations Manager – Environmental and Social Manager – All personnel
7.2	Management of central waste area	– Visual impact. – Risk of odours, pests and scavenger birds.	– Waste to be collected, separated and stored in an appropriately fenced and signposted designated area.	– Routine daily checks. – Monthly Inspections. – Avian Monitoring	– Daily – Monthly	– Site Operations Supervisor – Environmental Officer/Operation

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			– Waste collection containers will be of an appropriate design and labelled with waste type (e.g. wood, metals, building rubble, garden waste, domestic waste). – Waste storage areas kept clean and tidy at all times. – Waste to be separated at source where possible			Manager – All personnel
7.3	Project site littering	– Litter entering the marine environment: entangling animals, suffocating animals, animals consuming litter. – Visual impact. – Risk of odours, pests and scavenger birds (disturbs natural lagoon birds).	– Good site housekeeping. – Bins on and surrounding the site, which are regularly emptied. – Nominated person to undertake litter picking regularly. – Avoid food waste being thrown into the environment. – Clear No Littering signs around the project site. – Implementation and enforcement of the Marina Rules and Code of Conduct.	– Routine daily checks. – Monthly Inspections. – Avian monitoring	– Daily – Monthly	– Site Operations Supervisor – Environmental Officer/Operation Manager – All personnel
8	Increase lights	– Impacts to birds (alter feeding grounds and food availability, and distraction and collision risks leading to injury or	– Reduce lights as much as possible, and ensure lights are turned off when not in use.	– Routine daily checks. – Monthly Inspections.	– Daily – Monthly	– Site Operations Supervisor / nominated personnel within

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
		mortality). – Local resident's amenity impacted.	– Regular maintenance to check lights perform to design standards (e.g. pointed down, energy efficiency light bulbs). – Continual stakeholder engagement.			all companies and businesses. – Environmental Officer/Operation Manager – All personnel
9.1	Storage of fuel and oils	– Loss of containment, causing ground contamination and potentially entering the marine environment	– Licence and certificate to store and dispense fuel. – Stored in a lockable area, on a flat impermeable area, with a bund that is capable of storing 110% of stored capacity. – Libelled tanks and containers. – Any hazardous chemicals, liquids or materials to be stored on site to be in suitable storage containers, in lockable store with appropriate bunding, with an inventory. – Appropriate safety signs around storage area, e.g. no smoking. – Appropriate PPE to personnel. – Site Induction and appropriate training of	– Daily and weekly site inspections and production of monthly compliance report. – Tanks and containers to be checked daily. – Monthly Inspections.	– Daily – Monthly	– Site Operations Supervisor / nominated personnel within all companies and businesses. – Environmental Officer/Operation Manager – All personnel

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			nominated persons.			
9.2	Delivery of fuel and oil	– Loss of containment, causing ground contamination and potential risk to the marine environment.	– All deliveries to be supervised. – Refuel in designated area, on impermeable surface away from drains, residential properties and the sea. Spill kits to be located at nominated locations around site. – Drip trays used where required. – Storage tanks to be checked prior to delivery (level and correct tank). – Regular checks and servicing of storage containers and regular maintenance and servicing of plant and equipment. – Good house-keeping – clean vehicles regularly. – Spill kits to be located around site. – Site Induction and appropriate training of nominated persons.	– Daily and weekly site inspections and production of monthly compliance report. – Audits of vehicles to ensure maintained and not defective. – Checks and reports.	– Daily – Monthly	– Site Operations Supervisor / nominated personnel within all companies and businesses. – Environmental Officer/Operations Manager – All personnel

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
9.3	Use and maintenance of plant and equipment: Spills of fuels, oils or chemicals	– Loss of containment, causing localised ground contamination	– Spill kits in designated areas around site. – Contain and clean up spill in accordance with emergency procedures. – Report spill as soon as possible. – All plant and material to be well maintained and have appropriate containment (drip trays). – Maintenance activities of large plant and equipment shall be undertaken off site. – Site Induction and appropriate training of nominated persons. – Implementation of Environmental Emergency Plan. – Suitable PPE and equipment when handling hazardous chemicals, liquids and materials.	– Daily and weekly site inspections and production of monthly compliance report.	– Daily – Monthly	– Site Operations Supervisor / nominated personnel within all companies and businesses. – Environmental Officer/Operations Manager – All personnel
10	General activities: Energy use	– Use of resources	– Turn off plant and equipment when not in use. – Regular maintenance of plant and equipment. – Minimise / optimise	– Scheduled maintenance (Routine Maintenance Environmental	– As and when scheduled.	– Operations Manager

REF NO.	ACTIVITY	POTENTIAL IMPACTS	MANAGEMENT / MITIGATION MEASURES	MONITORING REQUIREMENTS	FREQUENCY	RESPONSIBILITY
			workforce travel. – Source materials locally. – Source sustainable material and products where possible. – Apply waste hierarchy and reuse and recycle.	Checklist)		
11	General activities: Material use	– Use of resources	– Source materials locally to reduce transportation. – Source sustainable material and products where possible. – Apply waste hierarchy and reuse and recycle material where possible	– In daily duties of specific roles	– Ongoing	– Operations Manager / nominated personnel within all companies and businesses.
12	General Operations: Increase in road traffic	– Increase noise levels – Increase dust deposition	– Quarterly forums – Early notice of events – Good house-keeping and sweeping of local roads	– Noise monitoring – Dust monitoring	– Annual – Daily	– Operations Manager

7. IMPLEMENTATION OF THE OPERATIONS-ESMP

This Operational-ESMP:

A. Has been prepared pursuant to a contract with the proponent;

B. Has been prepared on the basis of information provided to ECC up to January 2018;

C. Is for the sole use of the proponent, for the sole purpose of an ESMP;

D. Must not be used (1) by any person other than the proponent or (2) for a purpose other than an ESMP; and

E. Must not be copied without the prior written permission of ECC.

ECC has prepared this ESMP on the basis of information provided by the proponent, specialist reports and the ESIA. These have been independently reviewed and verified by the Southern African Institute of Environmental Assessment (SAIEA).

ENVIRONMENTAL
COMPLIANCE CONSULTANCY

Operation – ESMP Annexes

Walvis Bay Waterfront Pty Ltd

PREPARED FOR

March 2018

DOCUMENT FOR GOVERNMENT APPROVAL

Contents

ANNEX A: DOCUMENT CHECK LIST

DOCUMENT	PURPOSE	OWNER
Tenants / Owners Register	To provide an up to date list of all businesses and companies leasing or owning a component on the development site. To include contact details, nature of business, number of employees, any specific environmental issues or risks related to their operations and any notes on compliance with the Operations ESMP.	Operations Manager
Complaints Register	Name and contact details of the complainant, date and time of the complaint, nature of complaint, action taken to resolve issues, and date of complaint handover.	Environmental and Social Manager
Monthly Compliance Report	The report shall contain a brief description of any areas of non-conformance with the contract specification, the reason for the non-conformance, the responsible party, the result (consequence), the corrective action taken and any necessary follow up measures required.	Environmental and Social Manager
Plant and Equipment Register	Piece of plant and equipment; Make and Model; Frequency of required service and scheduled dates; Dates of last maintenance and test; and Notes of any issues or concerns.	Operations Manager
Routine Maintenance Environmental Checklist	Used as a guide when undertaking check as it shall set out all plant and equipment that perform and environmental function, what the function is and how they should perform, and mitigation measures that shall be applied to minimise impacts prior to undertaking maintenance activities.	Operations Manager
Rules and Regulations Manual	Sets rules that all users of the marina should abide by. -	Operations Manager
Environmental Emergency Plan	The plan shall incorporate fire and emergency management measures, and pollution incident response management plan requirements. The plan shall identify and concentrate on potential incidents and emergencies that could occur on the proposed project site, and describes the general policy and approach that should be followed when dealing with an emergency or incident, such as fire, explosion and traffic accidents.	Operations Manager
Waste Management Plan	Outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. Outline any potential economical and investment requirements for the treatment and / or disposal of waste.	Environment and Social Manager
Fire Prevention Plan	fire and emergency management measures, and pollution incident response management plan requirements. Identify	Operations Manager

DOCUMENT	PURPOSE	OWNER
	and concentrate on potential incidents and emergencies that could occur on the proposed project site, and describes the general policy and approach that should be followed when dealing with an emergency or incident, such as fire, explosion, spills and traffic accidents. – The development, site plans and maps; – Incident identification and notification process; – Emergency contact details; – Emergency response procedures; and – Training requirements.	

ANNEX B: TEMPLATE CONTACT DETAILS

ROLE	NAME	CONTACT DETAILS
Project Manager		
Site Manager		
Environment and Social Manager		
Ministry of Environment and Tourism		
Ministry of Fisheries and Marine Resource		
Namibian Dolphin Project		
Namport		
Walvis Bay Ambulance		
Walvis Bay Police		
Walvis Bay Sea Rescue		
Namport fire and port control		

ANNEX C: TEMPLATE WASTE MANAGEMENT PLAN

INTRODUCTION

The aim of this Waste Management Plan is to achieve sustainable waste management. The main purpose is to outline waste streams and identify the best treatment and disposal option for each one, applying the waste management hierarchy and avoiding as much waste as possible ending up at landfill or being burnt. In addition, it also outlines any potential economical and investment requirements for the treatment and / or disposal of waste.

This Waste Management Plan is a live document and should be updated during the annual review, which is undertaken by the Operational Manager and Environmental and Social Manager.

PRINCIPALS

The following principles should be applied to the management of waste on site:

- The waste hierarchy (avoid, reuse, recycle, recovery, disposal) should be applied for each waste stream, so that the impact on the environment is reduced as much as possible;
- Waste collection area will be identified prior to operational phase being commissioned, and demarcated and secured with appropriate fencing;
- Bins shall be emptied on a regular basis to avoid pests and bad odours;

Table 1 – Waste Management Roles

ROLE	INDIVIDUAL OR PARTY
Proponent	
Contractor	
Responsible person for the Waste Management Plan	

The following waste management measures shall be followed:

- Waste will be collected, separated and stored in a designated area which will be appropriately fenced and signposted to keep out unauthorised people and animals;
- Waste collection containers will be of an appropriate design to ensure that no waste can escape, and will be labelled with waste type (e.g. wood, metals, building rubble, garden waste, domestic waste);
- Waste storage areas shall be kept clean and tidy at all times;
- Bins shall be emptied regularly to avoid pests and bad odours; and
- No burning will be allowed on site.

Any hazardous material and wastes (including medical waste, if necessary) shall be managed in a safe and responsible manner so as to prevent contamination of soils, pollution of water and/or harm to people or animals as a result of the use of these materials. Hazardous and non-hazardous waste shall be stored separately at all times.

WASTE MANAGEMENT ARRANGEMENTS

The project shall have a dedicated waste collection, sorting and pickup area. This area will be fenced off, clearly signposted and access shall be by those authorised.

The following information shall be provided in this section:

- *Location plan of the dedicated area*
- *Arrangements to appropriately secure and designate the area (fencing, locked gate)*
- *Access arrangements*
- *Drainage arrangements*
- *Set up of the site*
- *Authorised personnel*
- *Any rules or codes of conduct*

Waste Generated

Provide all waste streams, type and quantity, allowing a review to be undertaken and the most appropriate waste disposal options are identified.

Table 2 – Waste Type and Management

WASTE TYPE	ESTIMATED QUANTITY	WASTE MANAGEMENT	WASTE CARRIER INFORMATION AND SITE
Vegetation	(example only) 40 palm trees Other bushes and vegetation	Recover, store and replant palm trees Other bushes etc. give away to community or compost	Company Name: Phone No. xxx xxx xxxxx
Packaging and plastic			
Excavated material (onshore)			
Dredged Material			

ANNEX D: MONITORING PLAN

Item	Rationale	Monitoring Area / Site Description / Details	Frequency	Phase (Construction, Operations, Decommissioning, or All)	Parameters	Quality Control Point
Potential impacts from dredging activities.	Dredging has the potential to smother the seafloor habitat by increase sedimentation. Release of heavy metals can have serious cumulative negative impacts on the marine environment. Release of hydrogen sulphide can cause varying degrees of anoxia resulting in mortalities of marine organisms. Bad odours can also arise as a result of the release of hydrogen sulphide	A. Turbidity & general chemistry of water (sampling and analysis) –Immediately next to the Marina, including the access channel B. Sediment samples – project site, access channel and lagoon entrance	A. Quarterly and during dredging activities B. Before dredging activities commencing; Post dredging samples also to be collected; and quarterly.	A. All B. Operations	A. Turbidity & general chemistry of water B. Chemical composition including heavy metals	A. Yes B. Yes

Bathymetric survey	Analysis of the sea floor to determine potential impacts of siltation	Lagoon – survey area used for the ESIA plus area south of the project	Annual	All	Elevations of water level	Yes
Cetacean Monitoring - Hydrophone monitoring	To monitor the movements of dolphin movements in and out of the Lagoon Hydrophones are used to detect dolphin use and changes in use of the Lagoon environment during activiites compared to before and after impact	Located near the Raft restaurant (use existing Namibian Dolphin Project monitoring site)	Continuous	All	Hydrophone digital waveform characterisation to select clicks and logs the time, centre frequency, intensity and bandwidth of each cetacean click	Yes
Cetacean Monitoring – Marine Mammal Observation (MMO) monitoring	To monitor the movements of dolphin in and out of the Lagoon during dredging activities	Lagoon area and Mouth of the Lagoon	The MMO should 1) Conduct a survey of the entire Lagoon from the Salt Works to the mouth of the Lagoon daily, prior to any dredging or pile driving, to determine the presence and location of animals in	All - Before and during dredging activities	Visual MMO (Dolphins are not in the lagoon before dredging or pile driving occurs and b) not within 1000m of either activity when they are	Yes

			the Lagoon and 2) Keep constant watch during these activities to ensure animals are not approaching into the Lagoon near these activities when they are occurring.		occurring)	
Avian Monitoring	Disturbance of feeding and roosting shorebirds particularly flamingos by human activity. Participate in bi annual bird counts to determine bird use of the Lagoon and Ramsar area	Ramsar Site	Bi Annual	All	Participate in bi annual bird counts coordinated by Mr Peter Bridgeford.	No
Potable Water (supplied by municipality)	To determine suitability of water for drinking	TBD – Source on site	Annual	Construction and Operations	Potable drinking water suite	No
Noise	Noise monitoring to determine impact of development on residents and surrounds	Specific locations to be determined by a noise specialist. Expected to be along KR Thomas Street, Atlantic Street and 4th Road.	A. Quarterly B. Annual	A. Prior to construction commencing and during construction B. Operations	dB	No

Potential pollution from boats	Monitor and control all boat users of the marina, prohibit boat users entering the Lagoon. Oils or chemicals resulting from accidental spills during refuelling, collisions, cleaning pose a serious threat to the ecological function of the Lagoon including seabirds.	Ensure spill contingency plan is in place: A. Containment boom and spill kits to be on site B. Mock emergency response drills conducted	A. Inspected Monthly B. Bi annual	All	Visual and inspections	No

Decommissioning - Environmental and Social Management Plan

Walvis Bay Waterfront Pty Ltd

PREPARED FOR

March 2018

ECC DOCUMENT CONTROL: ECC-41-54-REP-30-A

DOCUMENT FOR GOVERNMENT APPROVAL

TITLE AND APPROVAL PAGE

Project Name:	ECC-41-54-REP-30-A Decommissioning - Environmental and Social Management Plan
Client Name:	Walvis Bay Waterfront Pty Ltd
Ministry Reference:	MET Scope of environmental impact assessment for proposed project of Walvis Bay Waterfront Project, Walvis Bay, Erongo Region
Status of Report:	Document for Government Approval
Date of issue:	16th March 2018
Review Period:	

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Contents

DEFINITIONS AND ABBREVIATIONS

EAP	Environmental Assessment Practitioner
ECC	Environmental Compliance Consultancy
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
I&AP	Interested and affected parties

1. INTRODUCTION

1.1. Project Background

This Decommissioning Environment and Social Management Plan (Decommissioning-ESMP) has been written assuming operation is complete and the project moves into a closure phase.

1.2. Environmental Regulatory Requirements

The project is considered as a Listed Activity as set out in the Environmental Management Act, 2007 (Act No. 7 of 2007) and the Environmental Impact Assessment Regulation, 2007 (No. 30 of 2011) gazetted under the Environmental Management Act, (EMA), 2007 (Act No. 7 of 2007) (referred to herein as the EIA Regulations). As a Listed Activity an application for an Environmental Clearance Certificate is required. An Environmental and Social Impact Assessment (ESIA) report and Environmental and Social Management Plan (ESMP) are required as part of the Environmental Clearance Certificate application, as well as to support the decision-making process.

1.3. Purpose of this Report

The series of Environment and Social Management Plans (ESMP) are tools to be used by the proponent to ensure potential environment and social impacts and risk are managed. The ESMP for the project is a series of three documents, one for each phase of the project:

- Site Preparation and Construction (Titled: Construction – ESMP)
- Operations ESMP Operations (Titled: Operations – ESMP)
- Decommissioning and Reinstatement (Titled: Decommissioning –ESMP)

By having individual ESMPs specific to phases, the application of the plan and the management of environmental risks shall be more effective and easier to implement.

This report provides a conceptual Decommissioning-ESMP, setting out an overarching environmental management framework and the key objectives of what the detailed Decommissioning-ESMP shall achieve.

The project is planned to be a long-term permanent fixture of the urban landscape of Walvis Bay, it is not intended to be closed or removed in the long term. Care and maintenance will be required during this time, and the potential life time of the development may be extended. There is therefore uncertainty as to when decommissioning will be undertaken, if ever (unless unforeseen closure occurs) and at this stage a conceptual Decommissioning-ESMP is deemed appropriate. A detailed Decommissioning-ESMP will be developed once details of decommissioning and site reinstatement activities are fully understood.

1.4. Environmental Consultancy

Environmental Compliance Consultancy (ECC), a Namibian consultancy registration number 2013/11401, has prepared the ESMPs on behalf of the proponent. ECC operates exclusively in the environmental, social, health and safety fields for clients across Southern Africa in the public and private sector. ECC is independent to the proponent and has no vested or financial interested in the project.

2. DECOMMISSIONING AND SITE REINSTATEMENT

2.1. Decommissioning and Site Reinstatement Objectives

The project has a life span, which is yet to be finalised. It is assumed that at a certain point, the development will require decommissioning and the site will be reinstated back to its original or similar condition. At this stage in the design development process, the following objectives for the decommissioning and site reinstatement phase have been set. These should be the foundation for which the detailed Decommissioning-ESMP should be developed against.

- Decommissioning schedule, activities and methods, shall be designed to minimise impacts on the environment and society;
- Zero pollution incidents;
- Pollution prevention measures shall be the most appropriate and best available;
- Waste sent to landfill or to be burnt will be avoided and minimised;
- Material will be reclaimed, reused and recycled where practicable;
- The marine environment will be protected;
- Disruption to local residents will be minimised;
- Regular communications with stakeholders and the local community shall be undertaken;
- Appropriate sub-management plans and Method Statements shall be produced to minimise and manage environmental issues;
- The site shall be returned to as close to the original land use and shall blend in with the surrounding environment;
- Legacy issues shall be avoided and minimised; and
- Socio-economic impacts (including loss of employment) shall be minimised through careful planning and preparation for closure, beginning three to five years before closure takes place.

The above objectives will be refined as apart of ongoing detailed decommissioning and reinstatement planning and costing during the life of the development.

2.2. Detailed Decommissioning-ESMP

A detail Decommissioning-ESMP shall be produced prior to the development entering into the decommissioning and site reinstatement phase. The purpose of the detailed Decommissioning-ESMP shall be to provide a management framework for the identification of the management and control of activities with environmental aspects and key risks. The Decommissioning-ESMP shall provide an overview of how potential decommissioning activities will be controlled so that potential environmental and social impacts of the project are prevented and minimised as far as reasonable practicable, and that statutory requirements and other legal obligations are fulfilled. The Decommissioning-ESMP shall also present protocols and procedures, and roles and responsibilities to ensure the management arrangements are appropriately and effectively implemented.

The Decommissioning-ESMP shall be developed in stages (see Annex A), and will be drafted once the activities and scheduling of the decommissioning and site reinstatement phase is more fully understood.

2.2.1. Assessment of Impacts

This Decommissioning-ESMP forms an appendix to the ESIA report, however decommissioning and site restoration has not been assessed due to the uncertainties around when and how this phase will be undertaken.

2.2.2. Proposed Content of the Decommissioning-ESMP

The proposed content of the detailed Decommissioning-ESMP shall include the following:

- Aims and objectives of the Decommissioning-ESMP;
- End state to be achieved;
- Overview of how the project will be decommissioned and site reinstated;
- An overview of the environmental and social baseline, focussing on any changes from the baseline detailed in the ESIA report;
- Roles and responsibilities;
- Contractors to be employed and their responsibilities;
- Communications (internally and external);
- Training and awareness;
- How the Decommissioning-ESMP will be enforced and complied with;
- Key activities and environmental management arrangements; and
- Register of environmental risks and issues, mitigation measures and responsible person.

ANNEX A: DEVELOPMENT OF THE DECOMMISSIONING-ESMP

Level	Type/Stage	Purpose	Elements
1	Preliminary (Implemented for commencement) **[CURRENT STAGE]**	Approval as part of Environmental Compliance Certificate Application Integrate decommissioning and broad closure objectives into planning at design stage.	General decommissioning and reinstatement objectives identified. No closure costing provided.
2	Operational (Implemented in first 3 years of operation)	Integrate closure objectives into site planning and operational expansions. Describe outstanding decommissioning & rehabilitation work at level of general activities. Allow for financial provisioning.	As above, plus: Closure criteria development. Closure costing based on closure activities and areas (30% confidence) to meet closure criteria.
3	Detailed (Implemented 3 years from estimated site closure)	Describe current outstanding decommissioning & rehabilitation work at level of detailed tasks. Provide for tender benchmarking. Revised periodically (annually).	As above, plus: Assessment of closure criteria Risk analysis against closure criteria. Task register for each closure activity prepared. Decommissioning work schedule drafted. Preliminary stakeholder consultation implemented. Costing based on task register (10% confidence).
4	Final (1 year from known site closure)	Describe outstanding work remaining at closure at level of detailed tasks. Preparation of tender document for closure contractors.	As above, plus: Detailed decommissioning work schedule completed including specific timeframes. Detailed risk assessment against closure criteria. Comprehensive stakeholder consultation program implemented. Refine closure criteria to align with monitoring results and stakeholder requirements. Tender documents prepared.

Transport Impact Assessment

Walvis Bay Waterfront Development

Walvis Bay, Namibia

March 2018- Final

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SUMMARY SHEET

Report Type	Transport Impact Assessment
Title	Walvis Bay Waterfront Development
Location	Walvis Bay, Namibia
Client	Walvis Bay Waterfront Properties (Pty) Ltd
Reference Number	ITS 3791
Project Team	Hugo Engelbrecht Theodore Neels
Contact Details	Tel: 021 914 6211 or mail@itsglobal.co.za
Date	March 2018
Report Status	Final
File Name	G:\3791 TIA Walvisbaai Waterfront Development\12 Report\Issued\3791_Walvisbay Waterfront TIA_HE_2018 02 01.docx

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1 Background and Purpose

This report summarises an investigation of the expected transport impacts from the Walvis Bay Waterfront development planned on Erf 4941 and Remainder of Erf 4939. The purpose of the study is to identify constraints within the surrounding road network and to recommend appropriate mitigation measures.

2 Study Area Description

This proposed development will be fronting onto the Meersig Lagoon within Walvis Bay, with Esplanade Street to the west, Atlantic Street to the north, KR Thomas Street to the south and 4th Road to the east. This development is planned in three phases and it will include retail, office, hotel and residential land uses.

As part of this development, a new water canal is planned from the Meersig Lagoon into the site, which will be used by boats. This will necessitate the closure of a section of Esplanade Street, between KR Thomas Street and the Protea Hotel. However, a new road will be constructed (referred to a Waterfront Drive) between KR Thomas Street and Atlantic Street. See **Figure 1** for a Locality Plan.

3 Existing / Proposed Land Uses

The site is currently utilised as a recreational and sports area with facilities for cricket, swimming and tennis. The proposed development will be a mixed-use development including the following total land uses. See **Figure 2** for the Site Development Plan.

TOTAL	**Land Use**	**Extend**
	Retail	10 000m^2
	Offices	7 400m^2
	Conference Facility	1 000 seats
	Restaurants	3 750m^2
	Residential Apartments	402 units
	Hotel	260 units

The development will be constructed in three phases, with the full retail, offices, conference facility and restaurant component as listed above, included into Phases 1A. Phase 1B and 2 will include only residential and hotel related land uses as summarised below:

Phase 1B	Residential Apartments	120 units
	Hotel	140 units
Phase 2	Residential Apartments	282 units
	Hotel	120 units

Additional retail and office extent scenarios were investigated in this transport study, as summarised below:

Land Use	**Phase 1A** Extent	Scenario 8 **Total** Extent	Scenario 9 **Total** Extent
Retail	10 000m^2	*25 000m^2*	*35 000m^2*
Offices	7 400m^2	*15 000m^2*	*20 000m^2*

These retail and offices extents were evaluated to determine the sensitivity of the surrounding road network to accommodate additional development bulk.

4 Existing Access

There are two existing accesses to this site. The one is from Esplanade Drive, which gives access to a swimming pool area. The other is from Atlantic Street, which gives access to the tennis courts and cricket field. Neither of these existing accesses will form part of the proposed future Walvis Bay Waterfront development. Refer to **Section 15** of this report, for a discussion on future development accesses.

5 Surrounding Roads

See **Figure 1** for the location of these roads, relative to the development. The major roads in the site vicinity include the following:

Atlantic Street: A Class 5 industrial road with one lane per direction.

Esplanade Drive**:** A Class 5 residential street with one lane per direction.

KR Thomas Street: A Class 5 residential street with one lane per direction.

5th Road: A Class 4 Road, which is wide enough for two lanes per direction. There are on-street parking along one side of the road and sidewalks along both sides of the road.

Sam Nujoma Avenue: A Class 4 road with one lane per direction and sidewalks along both sides of the road.

Nangolo Mbumba: A Class 3 road with two-lanes per direction and sidewalks along both sides of the road.

6 Analysis Hours

The Walvis Bay Waterfront development will include retail, offices, conference facilities, restaurants, hotels and apartments. Residential related land uses typically generate more trips during weekday AM and weekday PM peak periods, whereas retail related land uses mostly generate vehicle trips during Friday PM and Saturday midday peak periods. For this reason, the following peak periods were surveyed and included in this evaluation:

- Weekday AM peak hour (Surveyed peak hour 06:30 – 07:30)
- Weekday PM peak hour (Surveyed peak hour 17:00 – 18:00)
- Saturday midday peak hour (Surveyed peak hour 11:00 – 12:00)

7 Scenarios Analysed

The following scenarios were included in the analyses of this development evaluation:

- **Scenario 1:** 2017 Existing Traffic - Based on existing counted traffic volumes
- **Scenario 2**: 2022 Background Traffic Conditions - Existing counted traffic volumes adjusted with a growth rate of 4.7% over five years
- **Scenario 3**: 2022 Total Traffic Conditions – Phase 1A Commercial Component (2022 Background Traffic plus the Phase 1A development trips
- **Scenario 4**: 2022 Total Traffic Conditions – Phase 1B plus 2 Residential Component (2022 Background Traffic plus the Phase 1B plus Phase 2 development trips)
- **Scenario 5**: 2022 Total Traffic Conditions – Full Phase 1A+B and 2 development (2022 Background Traffic plus Phase 1A+B and 2 of the Walvis Bay Waterfront trips)
- **Scenario 6**: 2022 Total Traffic Conditions – Phase 1A+B and 2 (Scenario 5) Traffic with the Esplanade Link between Atlantic Street and KR Thomas Street removed
- **Scenario 7**: 2022 Total Traffic Conditions – Phase 1A+B and 2 (Scenario 6) Traffic with the additional Namport Extension development trips
- **Scenario 8**: 2022 Total Traffic Conditions – Full Development (Scenario 5) Traffic with total 25 000m^2 of retail and 15 000m^2 of offices
- **Scenario 9**: 2022 Total Traffic Conditions – Full Development (Scenario 5) Traffic with total 35 000m^2 of retail and 20 000m^2 of offices
- **Scenario 10**: 2022 Total Traffic Conditions – Full Development (Scenario 9) Traffic with the Namport Extension development trips

8 Study Intersections

The following intersections were included in the analyses of this development evaluation:

- **Int. 1**: Esplanade Drive / Atlantic Street……………………………………Priority Stop Control
- **Int. 2**: Esplanade Drive / Protea Hotel………………………………………Priority Stop Control
- **Int. 3**: Esplanade Drive / KR Thomas Street………………………………Priority Stop Control
- **Int. 4**: Atlantic Street / Future Waterfront Drive…………………………Future Intersection
- **Int. 5**: Future Waterfront Drive / KR Thomas Street……………………Future Intersection
- **Int. 6**: KR Thomas Street / 5th Street……………………………………Priority Stop Controlled
- **Int. 7**: 5th Street / Sam Nujoma Avenue…………………………………Priority Stop Controlled
- **Int. 8**: Nangolo Mbumba Drive / 5th Street…………………………………………….Traffic Signal
- **Int. 9**: Nangolo Mbumba Drive / Esplanade Drive…………………Priority Stop Controlled

See **Figure 3** for the location, geometry and control of the above listed study intersections.

9 Namport Construction Traffic

The traffic counts for this investigation were done in November 2016, when the construction works of the Namport new container terminal was under way. Based on these surveys, up to 300 trucks were surveyed along 5th Road at the Namport access, between 06:00 and 18:00 during a normal weekday. It should be noted that roughly a similar number of truck trips were surveyed, delivering salt to the Namport harbour for export, per day.

Based on these surveys, between 10 and 25 construction trucks were surveyed per hour. Hence, it is expected that a similar number of truck trips could be subtracted along 5th Road, when the construction of the Namport new container terminal is complete.

10 2017 Existing Traffic Conditions (Scenario 1)

Peak period traffic counts of the study intersections were done on Wednesday, 9 November 2016, Thursday 10 November 2016 and Saturday 12 November 2016. The peak hour traffic volumes are illustrated on **Figure 4**. The total two-way link volumes along these study roads are summarised in **Table 1** below:

***Table 1**: Existing Link Volumes along study roads*

Road Name	AM Peak Hour	PM Peak Hour	Saturday
Nangolo Mbumba	960 vehicles	1 055 vehicles	690 vehicles
Sam Nujoma	285 vehicles	550 vehicles	325 vehicles
5th Road (at KR Thomas)	130 vehicles	220 vehicles	95 vehicles
Atlantic Street	115 vehicles	165 vehicles	95 vehicles
The Esplanade Drive	80 vehicles	100 vehicles	65 vehicles

Based on the summary above, Nangolo Mbumba Drive experiences the highest traffic volumes during the peak hours. Sam Nujoma Drive also experiences relatively high traffic volumes during the weekday PM peak hour, whilst all other study roads experience relatively low traffic volumes during the different peak hours.

The Existing Traffic operations are based on existing intersection geometries, controls and traffic volumes as illustrated in **Figure 3**. These analyses were confirmed with on-site observations. The capacity analyses results are illustrated in **Figure 4A-C**. Based on the Existing Traffic capacity analyses results, the following can be concluded:

All study intersections currently operate at acceptable Levels-Of-Service (LOS) during all the peak periods. The current transport network can accommodate the existing traffic demand. Hence, no upgrades are required for the Existing Traffic conditions, *from an intersection capacity point-of-view.*

11 2022 Background Traffic Conditions (Scenario 2)

The 2022 Background Traffic volumes were calculated by adjusting the existing counted traffic volumes with a 4.7 percent growth rate over a five-year period.

Based on the Walvis Bay Council's Integrated Urban Spatial Development Framework (IUSDF), the expected population growth in Walvis Bay will more than double from 2012 to 2030, with an average annual growth rate of 4.7%. This growth rate was used to adjust the existing traffic volumes to determine the future 2022 Background Traffic Volumes.

The Background Traffic analyses were based on existing intersection lane configurations and control. Based on the Background Traffic capacity analyses results, the following can be concluded:

All study intersections will continue to operate at acceptable Level-of-service (LOS) during all peak periods. The current transport network can accommodate the background traffic demand. Hence, no road upgrades are required for the Background Traffic conditions, *from an intersection capacity point-of-view.* See **Figure 5A-5C** for the 2022 Background Traffic conditions.

12 Trip Generation

The trip generation rates used for this development were obtained from the Committee of Transport Officials (COTO, 2013) trip data manual, as follows:

Phase 1A - Land Use (Code)	**a.m. peak**	**p.m. peak**	**Saturday Peak**
Retail (COTO 820)	1.53/100m^2	8.69/100 m^2	11.5/100m^2
Restaurant (COTO150)	0.75/100m^2	11.8/100m^2	11.0/100m^2
Conference Centre (COTO 780)	0.50/Seat	0.50/Seat	0.25/Seat
Offices (COTO 710)	2.10/100m^2	2.10/100m^2	0.45/100m^2

Phase 1B & 2 - Land Use (Code)	**a.m. peak**	**p.m. peak**	**Saturday Peak**
Hotel (COTO 310)	0.50/Room	0.50/Room	0.70/Room
Residential – Apartments (COTO 220)	0.65/Unit	0.65/Room	0.35/Room

The Walvis Bay Waterfront development will generate mainly private vehicle trips. Trips were adjusted for passer-by, internal and public transport trips. According to the Walvis Bay Transport Masterplan, dated November 2015, currently public transport such as busses and taxis could account for around 16% of vehicle trips in Walvis Bay.

The Transport Masterplan also indicate two upgrades to the public Transport system i.e. introduction of direct busses and better public transport stop/station facilities. These upgrades are expected to increase the public transport modal share.

See **Table 2, 4 & 6** for the expected trip generation rates for the respective phases of the proposed Walvis Bay Waterfront development.

13 Development Trips

Based on the above-mentioned trip generation rates, the Full Phase 1A+B and 2 Walvis Bay Waterfront development is expected to generate the following new peak hour vehicle trips:

Peak Hour	In	Out	Total
Weekday AM	573	263	837
Weekday PM	659	1 000	1 659
Saturday midday	766	710	1 476

See **Table 3, 5 & 7** for the expected development trips of each respective phase of the proposed development.

13.1 Development Trips - Scenario 8

The development is expected to generate the following total peak hour vehicle trips for Scenario 8, with the total 25 000m^2 retail and 15 000m^2 offices land uses, as well as the other land uses associated with Phase 1A+B and 2:

Peak Hour	In	Out	Total
Weekday AM	700	302	1 002
Weekday PM	890	1 292	2 182
Saturday midday	1057	999	2 055

13.2 Development Trips - Scenario 9

The development is expected to generate the following total peak hour vehicle trips for Scenario 9, with the total 35 000m^2 retail and 20 000m^2 offices land uses, as well as the other land uses associated with Phase 1A+B and 2:

Peak Hour	In	Out	Total
Weekday AM	780	326	1 107
Weekday PM	1 029	1 472	2 501
Saturday midday	1 231	1 171	2 402

14 Trip Distribution

The following macro-level trip distribution was used for development:

- 30% of trips to/from the east along Nangolo Mbumba Drive
- 5% of trips to/from the adjacent residential area
- 25% of trips to/from the east along Sam Nujoma Avenue
- 30% of trips to/from the south along 5th Road
- 10% of trips to/from the west along Nangolo Mbumba Drive

Refer to **Figures 6, 7** and **8** for the expected development trips and the distribution thereof.

15 Development Accesses

Several new accesses are planned as part of the Walvis Bay Waterfront development (Refer to **Figure 9**). The accesses to **Phase 1A** (commercial component) are summarised below:

- *Access E* – from Waterfront Drive, located 140 meters north of KR Thomas Street and 65 meters south of Atlantic Street. This will be an access to a parking area.
- *Access I* – from Waterfront Dive, located 155 meters north of KR Thomas Street and 50 meters south of Atlantic Street. This will be an access to a service yard.
- *Access J* – from Waterfront Drive, 180 meters north of KR Thomas Street and 25 meters south of Atlantic Street. This will be an access to a parking area.
- *Access K* – from Atlantic Street, 50 meters west of the future Waterfront Drive and 120 meters east of Esplanade Drive. This will be an access to a parking area.
- *Access L* – along Atlantic Street, 90 meters west of Waterfront Drive and 80 meters east of Esplanade Drive. This will be an access to a retail delivery yard.
- *Access M* – from Esplanade Street, 60 meters south of Atlantic Street. This will be the main delivery yard to the retail component of the development.

Accesses to **Phase 1B** (residential/hotel component) are summarised below:

- *Access A* – from KR Thomas Street, 35 meters northeast of Esplanade Drive and 75 meters south-west of 2nd Road / Waterfront Drive. This will be the access to the hotel.
- *Access B* – from Waterfront Drive, 60 meters north of KR Thomas Street and 145 meters south of Atlantic Street. This will be the access residential units.

Accesses to **Phase 2** (residential/hotel component) are summarised below:

- *Access C* – from KR Thomas Street at the 3rd Road intersection. This is will be an access to the apartments and indoor swimming pool area.
- *Access D* – from Waterfront Drive, 80 meters north of KR Thomas Street and 125 meters south of Atlantic Street. This will be an alternative access to the apartments, visitor parking and indoor swimming pool area.
- *Access F* – from Waterfront Drive, 180 meters north of KR Thomas Street and 25 meters south of Atlantic Street, directly opposite access J. This will be the main access to the hotel.
- *Access G* – from Atlantic Street, 50 meters east of Waterfront Drive and 110 meters west of 4th Road. This will be a service yard access to the hotel.
- *Access H* – from Atlantic Street, 90 meters east of Waterfront Drive and 70 meters west of 4th Road. This will be an entrance to the apartments parking area.

Since all accesses are proposed from lower order roads, it should be acceptable.

16 2022 Total Traffic Conditions (Scenario 3) – with Phase 1A

The 2022 Total Traffic volumes were calculated by adding the expected Phase 1A (commercial component) development trips to the 2022 Background Traffic volumes. The existing intersection geometries were used for this Total Traffic Conditions analyses.

Based on these analyses results, it can be concluded that most study intersections will continue to operate at an acceptable Level-Of-Service (LOS). However, the Sam Nujoma Avenue / 5th Road intersection will experience unacceptable LOS F operations during all peak periods.

The recommended upgrade at the Sam Nujoma Avenue / 5th Road intersection, are discussed in **Section 18** of the report. Refer to **Figure 10A-C** for the expected 2022 Total Traffic Conditions (for Scenario 3).

17 2022 Total Traffic Conditions (Scenario 4) – with Phase 1B and 2

The 2022 Total Traffic (Scenario 4) volumes were calculated by adding the expected hotel and apartment land use development trips (for Phase 1B plus Phase 2) to the 2022 Background traffic (Scenario 2) volumes. The expected development trips generated by the proposed residential / hotel component of the development will be significantly less than the trips that could be generated by the commercial component. The existing intersection geometries and controls were used for the 2022 Total Traffic (Scenario 4) analyses.

Based on these capacity analyses results, all study intersections will continue to operate acceptably during the 2022 Total Traffic (Scenario 4) conditions. Refer to **Figure 11** for the results of the 2022 Total Traffic (Scenario 4) scenario.

18 2022 Total Traffic Conditions (Scenario 5) – with Phase 1A+B and 2

The 2022 Total Traffic (Scenario 5) volumes were calculated by adding the expected full development (Phase 1A, 1B and 2) trips to the 2022 Background Traffic volumes. Based on these analyses, most study intersection will continue to operate acceptably, however the following intersections will experience capacity constraints:

<u>**KR Thomas Street / Waterfront Drive** (Int. 5):</u> The geometry used in the analyses was one lane per direction on all approaches with stop control on the Waterfront Drive and 2nd Road approaches of the intersection. Based on the analysis it is expected that this intersection will operate at unacceptable LOS E, delays greater than 36 seconds and with only 11 percent spare capacity during the p.m. peak hour.

Proposed Mitigation: The following upgrades are recommended at this intersection:

- *The Waterfront Drive approach should consist of a dedicated right-turn lane (15 meters min.) and a shared through and left-turn lane.*

- *The KR Thomas Street (Eastbound approach) should consist of a dedicated left-turn lane (15 meters min.), and a shared through and right-turn lane.*
- *The KR Thomas Street (Westbound approach) should consist of a dedicated right-turn lane (15 meters min.) and a shared through and left-turn lane.*

5th Road / KR Thomas Street (Int. 6): This intersection will operate at unacceptable LOS F during the p.m. peak hour. Long delays and queues will be experienced along the KR Thomas approach of the intersection.

Proposed Mitigation: It is recommended to change the intersection control to a signal, when warranted. This will improve operations at this intersection to acceptable LOS B during the peak periods. It is also recommended that the road markings along 5th Road be upgraded to two-lanes per direction, since sufficient road space is available to accommodate these road markings within the existing road surface space.

Sam Nujoma Avenue / 5th Road (Int. 7): This intersection will operate at unacceptable LOS F with long delays of more than 50 seconds expected on the Sam Nujoma Avenue approaches of this intersection, during all peak hours.

Proposed Mitigation: It is recommended to change the control of the intersection to a two-phased traffic signal, when warranted. This will improve operations at this intersection to acceptable LOS A / B during the peak periods. It is also recommended that the road markings along 5th Road be upgraded to two-lanes per direction, since sufficient road space is available to accommodate these road markings within the existing road surface space.

Refer to **Figure 12** for the 2022 Total Traffic conditions (Scenario 5) as well as **Figure 13** for the operations after the implementation of the upgrades as discussed above. The cross section of 5th Road is shown schematically on **Figure 17**.

19 2022 Total Traffic Conditions (Scenario 6) – with Esplanade Closure

As part of the Waterfront development, a new water canal is planned from the Meersig Lagoon into the site, which will be used by boats. This will necessitate the closure of a section of Esplanade Street, between KR Thomas Street and the Protea Hotel. However, a new road will be constructed (referred to a Waterfront Drive) between KR Thomas Street and Atlantic Street to accommodate the expected redistributed trips.

The 2022 Total Traffic Scenario 6 volumes are based on Scenario 5 traffic volumes; however the traffic volumes were adjusted/redistributed to simulate the expected Esplanade Street closure. Refer to **Figure 2** for the Site Development Plan.

Only the intersections in relative close proximity of this planned road closure were evaluated, since the impact on the intersection further away should remain relatively similar as evaluated in Scenario 5. Based on these analyses, it can be concluded that the intersections surrounding the development will continue to operate at acceptable LOS, with the road upgrades as proposed in Scenario 5. Hence, no additional upgrades are proposed for this Scenario. Refer to **Figure 14A**-**C** for the operations and results as well as **Figure 14D** for the geometries that were used in this evaluation.

20 2022 Total Traffic Conditions (Scenario 7) – with Namport Expansion

A high-level vehicle trip generation was calculated for the planned Namport Waterfront development, based on information provided on **Figure 15**.

The 2022 Total Traffic (Scenario 7) volumes were calculated by adding this expected Namport Waterfront development trips to the 2022 Total Traffic (Scenario 5) trips. The geometries discussed under the 2022 Total Traffic Conditions Scenario 5 upgrades, were used in this scenario. Based on these capacity analyses results the following can be concluded. Refer to **Figures 16A to 16C** for the operation results.

Most study intersections will continue to operate at acceptable LOS, however the following intersections will experience capacity constraints:

Nangolo Mbumba Drive/ 5th Road (Int. 8): will operate at unacceptable LOS E during the p.m. peak hour and at capacity during the p.m. and Saturday peak hours.

Proposed Mitigation: It is recommended that the traffic signal at this intersection be upgraded from a two-phase to a four-phase signal, with protected right-turn movements on all approaches as well as overlapping left-turn movements.

Esplanade Drive / Nangolo Mbumba Drive (Int. 9): This intersection will operate at unacceptable LOS F, due to long delays expected on the southbound approach.

Proposed Mitigation: it is recommended that a median island be constructed along Nangolo Mbumba Drive and that the Esplanade Street approach be remarked to accommodate separate left-and right-turn lanes. The median island should be minimum 6-meters wide to enable the side road traffic to cross Nangolo Mbumba Drive in two stages.

Refer to **Figure 16D** for a schematic layout of the proposed upgrades and the resultant improved operations.

21 2022 Total Traffic (Scenario 8) - 25 000m^2 Retail and 15 000m^2 Offices

The 2022 Total Traffic (Scenario 8) volumes were calculated based on the 2022 Total Traffic (Scenario 5) volumes, with an adjustment for the additional retail (total 25 000m^2 GLA) and office (total 15 000m^2 GLA) land uses. Refer to **Figures 18A** to **18C** for the 2022 Total Traffic (Scenario 8) traffic operations.

Based on these capacity analyses results, the following upgrades are recommended, over and above the road upgrades proposed in Scenarios 5 to 7:

Atlantic Street / Future Waterfront Drive (Int. 4): will operate at unacceptable LOS F, long delays, and at capacity during the p.m. peak hour

Proposed Mitigation: The following upgrades would be required to mitigate the expected p.m. peak hour traffic:

- Install a traffic signal when warranted
- Construct separate left- and right turn lanes on the northbound approach. The left-turn lane should have a minimum storage lane length of 15m.
- Construct a dedicated westbound left-turn lane with a min. storage length of 45m.
- Construct a dedicated eastbound right-turn lane with a min. storage length of 15m.

Nangolo Mbumba Drive / 5th Road (Int. 8): will operate over capacity.

Proposed Mitigation: Construct a southbound dedicated left-turn lane with a minimum storage length of 36m. Based on initial investigations, it might be possible to provide this southbound left-turn lane within the existing road reserve space. However, truck movements will be restricted. The heavy vehicle demand through this intersection is notable and this upgrade should take cognisance of heavy vehicle movements. Hence, additional road reserve space will most likely be required to accommodate this proposed road upgrade, as part of these additional retail and office land uses.

It is recommended that Atlantic Street be dualled between Waterfront Drive and 5th Road and that 5th Road be dualled from Atlantic Street to Sam Nujoma Avenue. Traffic should also be discouraged from using KR Thomas Street, by means of possible traffic calming measures. These measures should encourage the Waterfront Development traffic to rather use 5th Road and Atlantic road instead of KR Thomas Street.

The intersection upgrades proposed for Scenarios 5, 6 and 7 would be sufficient to accommodate the 2022 Total Traffic (Scenario 8) trips at all other study intersections.

Refer to **Figure 18** and **Figure 19** for the 2022 Total Traffic Conditions (Scenario 8) and 2022 Total Traffic Conditions (Scenario 8) with upgrades.

22 2022 Total Traffic (Scenario 9) - 35 000m^2 Retail and 20 000m^2 Offices

The 2022 Total Traffic (Scenario 9) volumes were calculated based on the 2022 Total Traffic (Scenario 5) volumes, with an adjustment for the additional retail (total 35 000m^2 GLA) and office (total 20 000m^2 GLA) land uses.

Based on these capacity analyses results, no additional upgrades would be required over and above the upgrades discussed in Scenarios 5 to 8 of this report. Refer to **Figure 20** for the 2022 Total Traffic Conditions (Scenario 9) operations.

23 2022 Total Traffic (Scenario 10) with Namport Expansion

The 2022 Total Traffic (Scenario 10) volumes were calculated by adding the Namport development trips to the 2022 Total Traffic (Scenario 9) volumes. The geometries and controls used are in this scenario is based on the upgrades recommended in Scenario 5 to 8 of this report.

Based on these capacity analysis results, most study intersections will continue to operate acceptable. However the following intersection will require further improvements:

Sam Nujoma Avenue / 5th Road intersection: will operate over capacity.

Proposed Mitigation: The following upgrades are recommended:

- Construct a southbound dedicated left-turn lane with a min. storage length of 65m.
- Change the westbound approach to a dedicated right-turn lane and a shared through and left-turn lane. The right-turn lane should have a storage lane length of 120m.

The proposed road upgrade on the westbound approach could be accommodated within the existing road reserve space. However, insufficient road reserve space is currently available to accommodate the recommended southbound left-turn lane. Hence, additional road reserve space will be required to accommodate this proposed road upgrade, as part of these additional retail and office land uses.

Refer to **Figure 21** for the analysis results of 2022 Total Traffic Conditions (Scenario 10).

24 Public Transport

Based on the Site Development the following public transport facilities will be provided:

- Bus drop-off zone in Esplanade Street at the Phase 1B Hotel. The bus drop-off zone will accommodate bus-turning movements.
- Bus parking bays would be provided on both sides of Esplanade Street opposite the Protea Hotel and next to the proposed retail development.
- A dedicated taxi parking area (with 17 taxis bays) would be provided in front of the Protea Hotel in Esplanade Street.

Refer to **Figure 22** for the locations of these public transport facilities.

25 Pedestrians

The following pedestrian facilities will be provided as part of this development:

- Sidewalks along all site frontages.
- 3x Pedestrian bridges linking Phase 1A with Phase 1B.

It is proposed that pedestrian movements be highlighted by means of surfacing and road markings were movements would be in conflict with vehicles. This would highlight the conflict zone to both motorists and pedestrians. Walkways should also be highlighted by means of signage. Refer to **Figure 22** for the locations of these pedestrian facilities.

26 Parking

The recommended parking rates and number of parking bays required for each phase of the development are as follows:

Phase 1A - Commercial Component:

Land Use	**Rate**	**Extent**	**Parking Required**
Retail	6 bays / 100m^2	10 000m^2	600 parking bays
Restaurant	4 bays / 100m^2	3 750m^2	150 parking bays
Office	4 bays / 100m^2	7 400m^2	296 parking bays
Conference Centre	10 bays / 100m^2	1700m^2	170 parking bays
Total parking required (Phase 1A)			**1 216 parking bays**

Phase 1B – Hotel and Apartments:

Land Use	**Rate**	**Extent**	**Parking Required**
Hotel	0.72 bays / bedroom	140 rooms	101 parking bays + 20 bays
Residential	2 bays / unit	120 units	240 parking bays
Total parking required (Phase 1B)			**361 parking bays**

Phase 2 – Hotel and Apartments:

Land Use	**Rate**	**Extend**	**Parking Required**
Hotel	0.72 bays / bedroom	120 rooms	87 parking bays + 20 bays
Residential	2 bays / unit	282 units	564 parking bays
Total parking required (Phase 2)			**671 parking bays**

The number of parking bays that will be provided per phase and/or land use, should be checked during the Site Development Plan approval stage., based on the summary above.

27 Visitor Guidance Signs

It is recommended that road signs be provided to guide visitors to/from the Waterfront development, along 5th Road and Atlantic Street. It is also recommended that road upgrades are focussed along these roads. This should assist to mitigate the impact along the other residential streets, near this development.

28 Conclusions and Recommendations

This report summarises an investigation of the expected transport impacts from the Walvis Bay Waterfront development, planned on Erf 4941 and Remainder of Erf 4939. The development is planned in three phases namely Phase 1A, Phase 1B and Phase 2. Two additional development bulk scenarios were investigated (namely Scenario 8 and 9). The land use and extent of each scenario is summarised as follows:

Land Use	Phase 1A+B plus Phase 2	Scenario 8	Scenario 9
Retail	10 000m^2	25 000m^2	35 000m^2
Offices	7 400m^2	15 000m^2	20 000m^2
Conference Facility	1 000 seats	1 000 seats	1 000 seats
Restaurants	3 750m^2	3 750m^2	3 750m^2
Residential Apartments	402 units	402 units	402 units
Hotel	260 units	260 units	260 units

Based on the findings of this investigation, the following can be concluded:

2017 Existing Traffic (Scenario 1): All intersections currently operate acceptably.

2022 Background Traffic (Scenario 2): All study intersections will continue to operate acceptably. Hence, no upgrades are proposed from an intersection capacity point of view.

Development Trips: The Full (Phase 1A+B plus 2) development is expected to generate 837 weekday AM-, 1 659 weekday PM- and 1 476 Saturday peak hour vehicle trips. Scenario 8 will generate 2 180 weekday PM- and 2 055 Saturday peak hour vehicle trips and Scenario 9 will generate 2 500 weekday PM- and 2 400 Saturday peak hour vehicle trips.

Vehicular Access: Refer to **Section 15** and **Figure 9** for the accesses proposed per phase.

2022 Total Traffic (Scenario 3): The following upgrades are recommended:

- Intersection 7: 5th Road / Sam Nujoma Road
    - Provide a two-phase traffic signal, when warranted.

2022 Total Traffic (Scenario 4): All study intersections will continue to operate acceptably. Hence, no upgrades are proposed from an intersection capacity point of view.

2022 Total Traffic (Scenario 5): The following upgrades are recommended:

- Intersection 5: KR Thomas Street / Waterfront Drive
    - Provide a dedicated eastbound left-turn lane (15 meters min.),
    - Provide a dedicated westbound right-turn lane (15 meters min.)
    - Provide a dedicated southbound right-turn (15 meters min.)

- Intersection 6: 5th Road / KR Thomas Street
    - Provide a two-phase traffic signal, when warranted.
    - Upgrade road markings along 5th Road to two-lanes per direction, within the existing road surface.
- Intersection 7: 5th Road / Sam Nujoma Road
    - Provide a two-phased traffic signal (as recommended in Scenario 3)

2022 Total Traffic (Scenario 6): All study intersections will continue to operate acceptably. Hence, no upgrades are proposed from an intersection capacity point of view.

2022 Total Traffic (Scenario 7): The following upgrades are recommended:

- Intersection 8: 5th Road / Nangolo Mbumba Drive
    - Provide protected right-turn (traffic signal) phases on all movements, plus left-turn overlap phases.
- Intersection 9: Esplanade Drive / Nangolo Mbumba Drive
    - Provide separate left- and right-turn lanes on Esplanade approach.
    - Provide a 6-meter wide median island along Nangolo Mbumba Drive.

2022 Total Traffic (Scenario 8): The following upgrades are recommended:

- Atlantic Street / Future Waterfront Drive (Int. 4):
    - Install a traffic signal, when warranted
    - Construct separate left and right turn lanes on the northbound approach. The left-turn lane should have a minimum storage lane length of 15m.
    - Construct a dedicated westbound left-turn lane (min. storage length of 45m)
    - Construct a dedicated eastbound right-turn lane (min. storage length of 15m)
- Nangolo Mbumba Drive / 5th Road (Int. 8)
    - Provide a southbound dedicated left-turn lane with a minimum storage lane length of 36m. *Additional road reserve space* will most likely be required to accommodate this proposed road upgrade. This must be determined by means of a detailed survey and geometric design of this intersection upgrade.
- Atlantic Street should be dualled between Waterfront Drive and 5th Road. In addition, 5th Road should be dualled from Atlantic Street to Sam Nujoma Avenue. Traffic should also be discouraged from using KR Thomas Street, by means of possible traffic calming measures.

2022 Total Traffic (Scenario 9): No additional upgrades are proposed for this scenario, over and above the upgrades discussed in Scenario 5 to Scenario 8.

2022 Total Traffic (Scenario 10): The following upgrades are recommended:

- Sam Nujoma Avenue / 5th Road (Int. 7)
    - Construct a southbound dedicated left-turn lane. Insufficient road reserve space is available to accommodate this recommended road upgrade. Hence, *additional road reserve space* will be required to accommodate this southbound left-turn lane.

- Change the westbound approach to a dedicated right-turn lane and a shared through and left-turn lane. The right-turn lane should have a minimum storage lane length of 120m.

Public Transport: The following public transport facilities should be provided:

- Bus drop-off zone in Esplanade Street at the Phase 1B Hotel. The bus drop-off zone will accommodate bus-turning movements.
- Bus parking bays on both sides of Esplanade Street, opposite the Protea Hotel and next to the proposed retail development.
- A dedicated taxi parking area for 17 taxis, in front of the Protea Hotel.

Pedestrian Walkways: The following pedestrian facilities should be provided:

- Sidewalks along all site frontages.
- Defined pedestrian routes on site.
- 3x Pedestrian bridges linking Phase 1A with Phase 1B.

Parking: to be provided according to the rates as indicated in **Section 23** of this report.

Visitor Guidance Signs: It is recommended that road signs be provided to guide visitors to/from the Waterfront development, along 5th Road and Atlantic Street.

Based on this evaluation, it is evident that this development can be accommodated acceptably, provided that the road upgrades as discussed in this report are in place. Hence, it is recommended that this development be considered for approval, from a transport point of view, with these proposed road upgrades as conditions of approval.

Annexure A - Figures

List of Figures

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	LOCALITY PLAN *WIDER AREA*	1A

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	LOCALITY PLAN *ZOOMED-IN VIEW*	1B

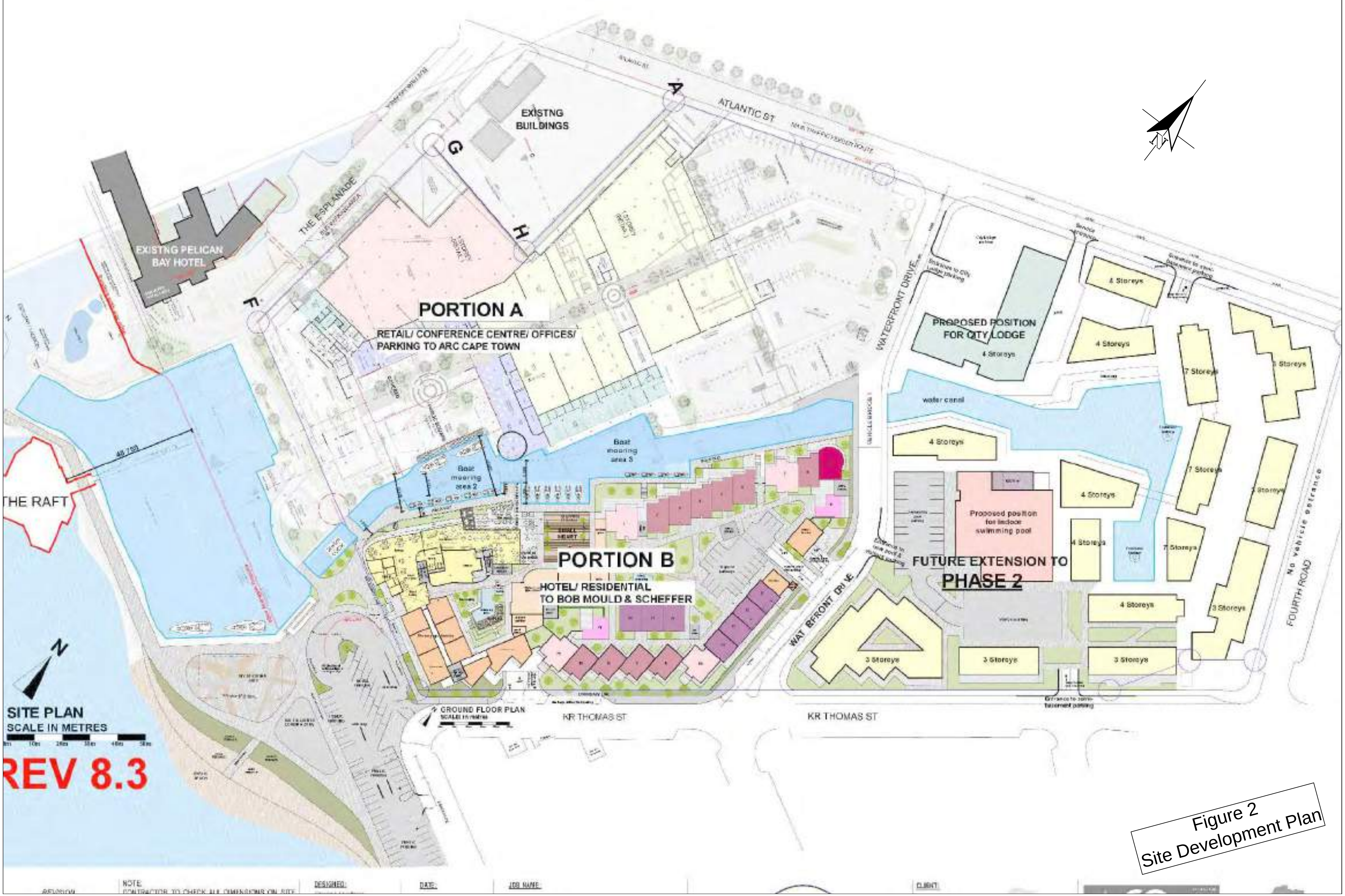
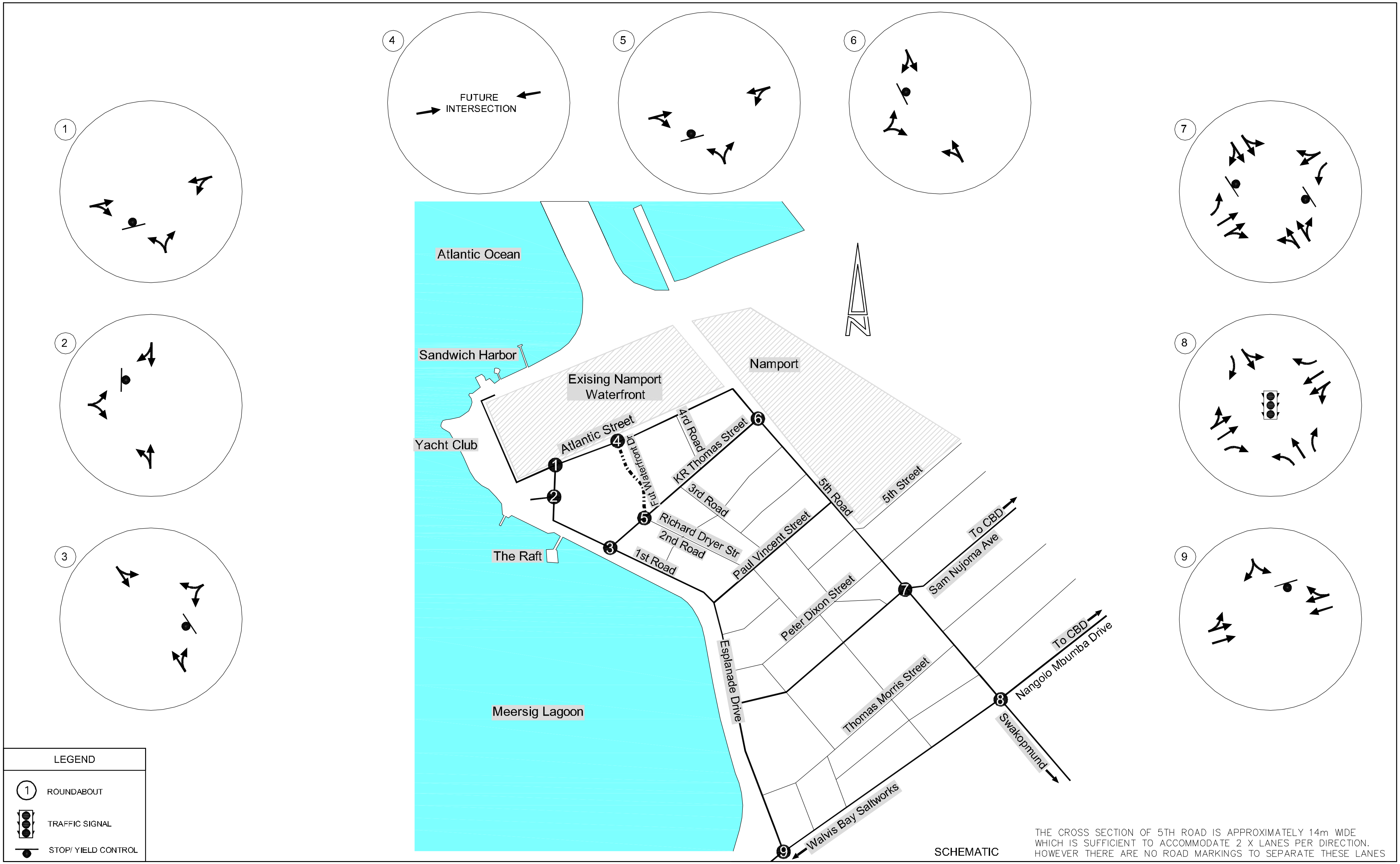
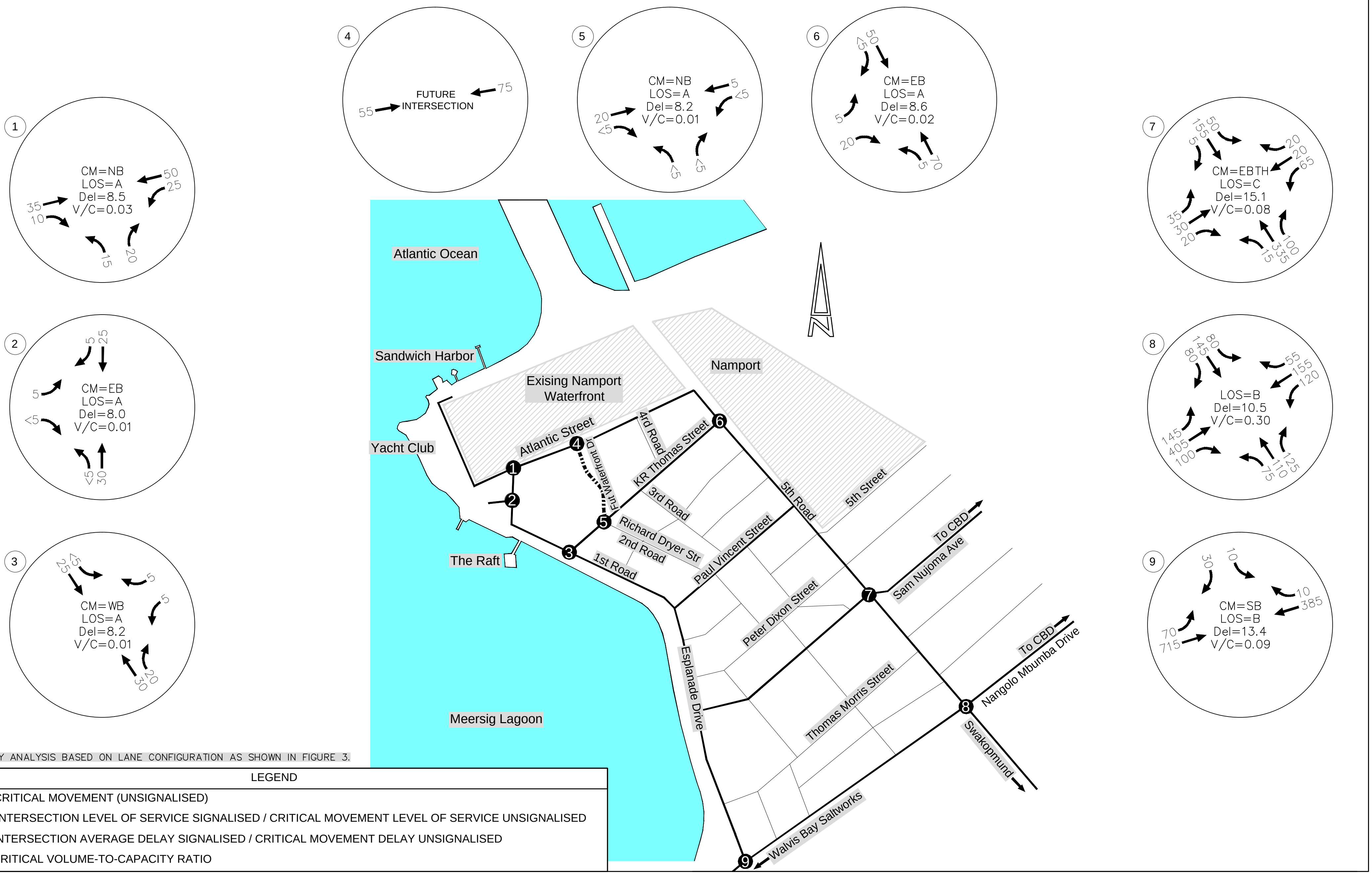


Figure 2
Site Development Plan



PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2017 EXISTING LANE CONFIGURATION	3

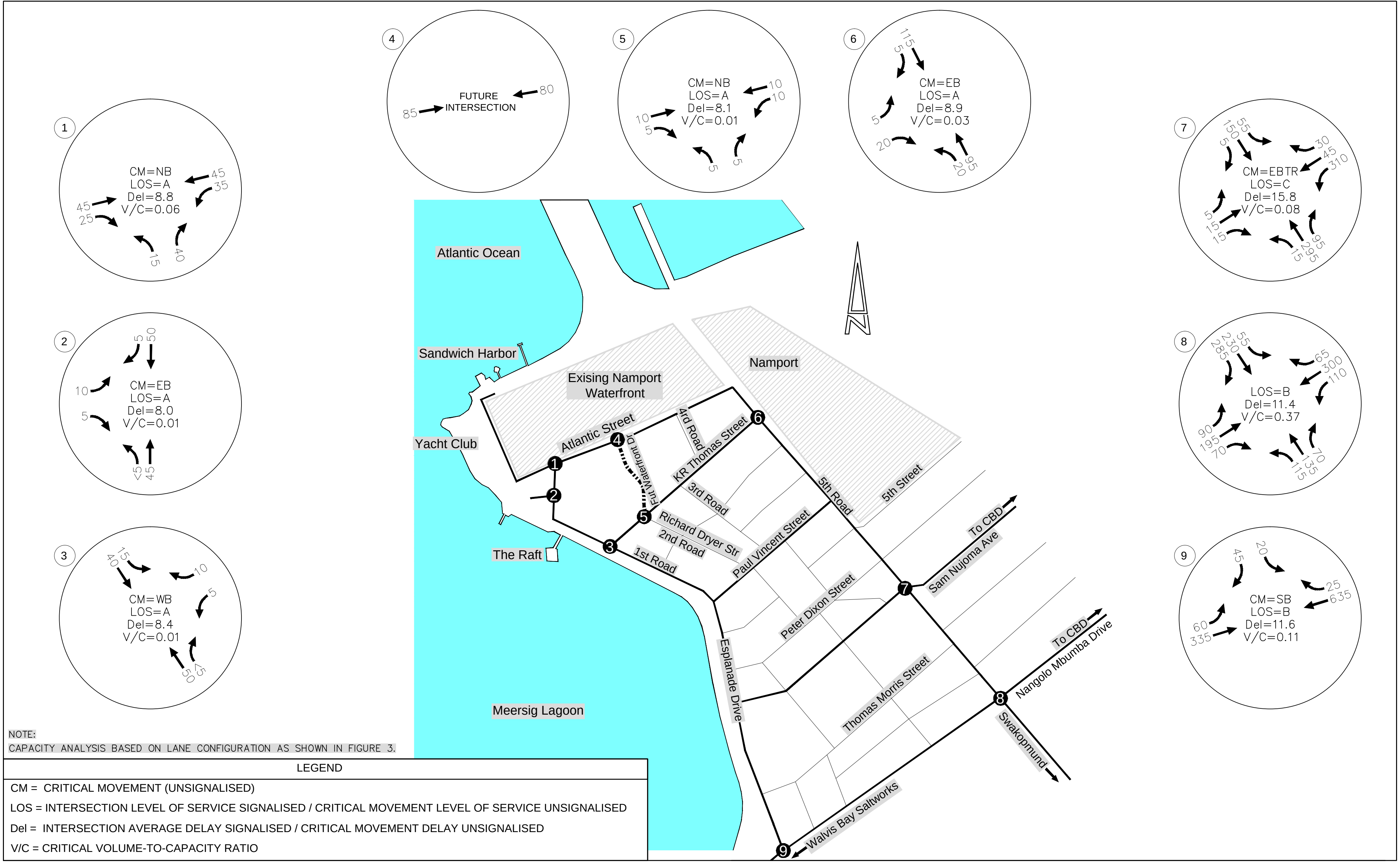


NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2017 EXISTING TRAFFIC CONDITIONS *(SCENARIO 1)* A.M. PEAK HOUR	4A



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND
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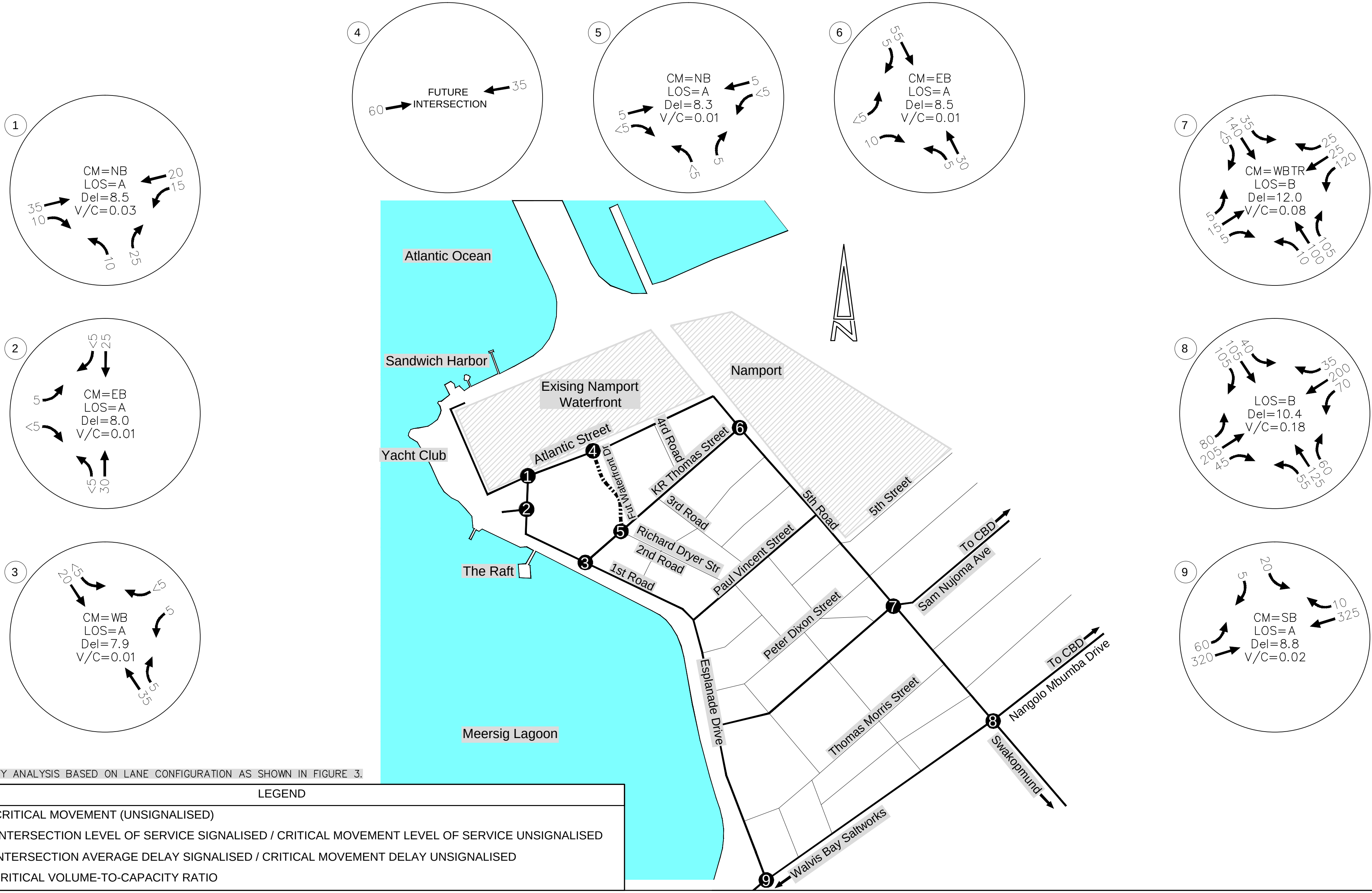
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2017 EXISTING TRAFFIC CONDITIONS (*SCENARIO 1*) P.M. PEAK HOUR	4B



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

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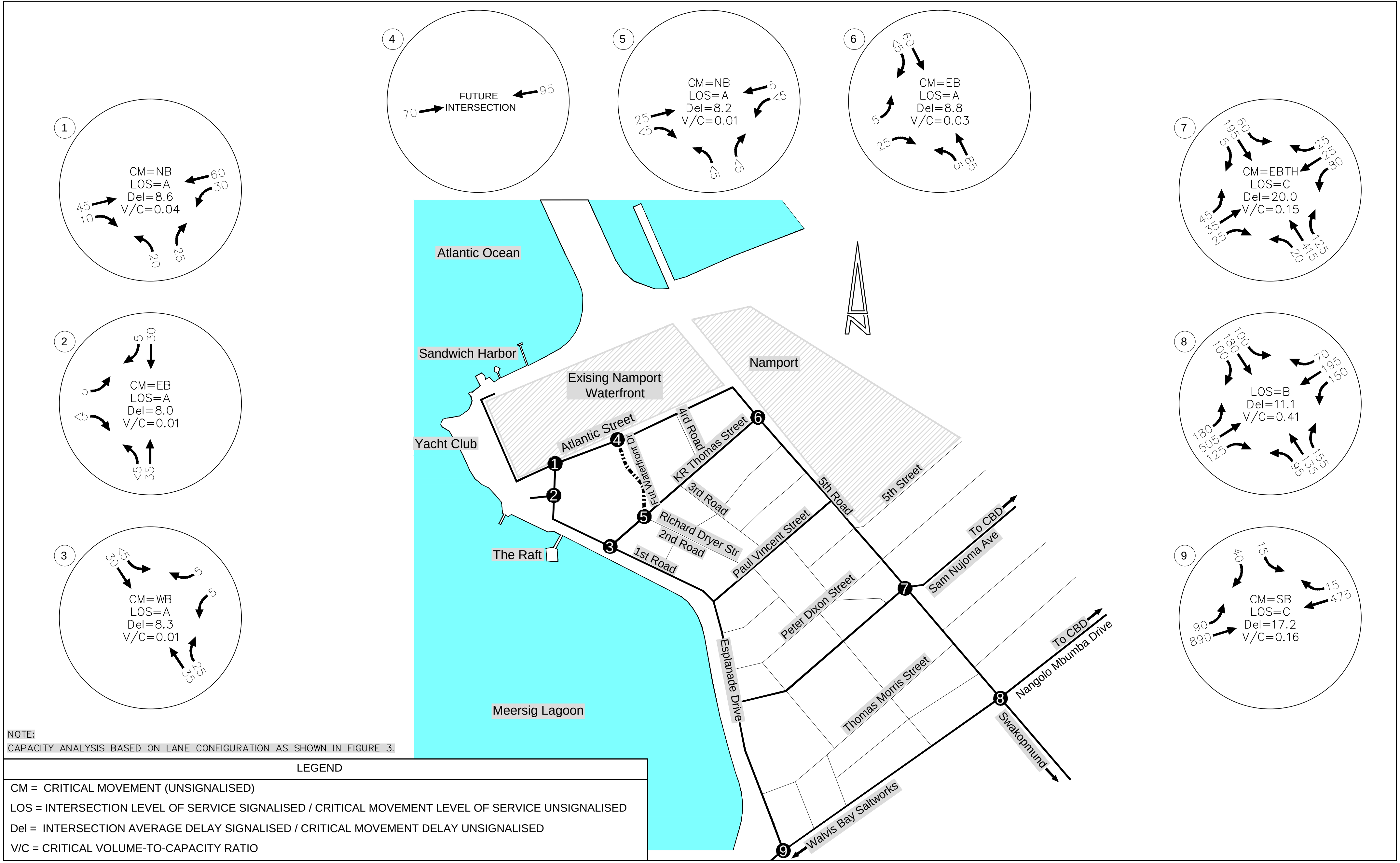
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2017 EXISTING TRAFFIC CONDITIONS (*SCENARIO 1*) SATURDAY PEAK HOUR	4C



NOTE:
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PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 BACKGROUND TRAFFIC CONDITIONS (*SCENARIO 2*) A.M. PEAK HOUR	5A

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND
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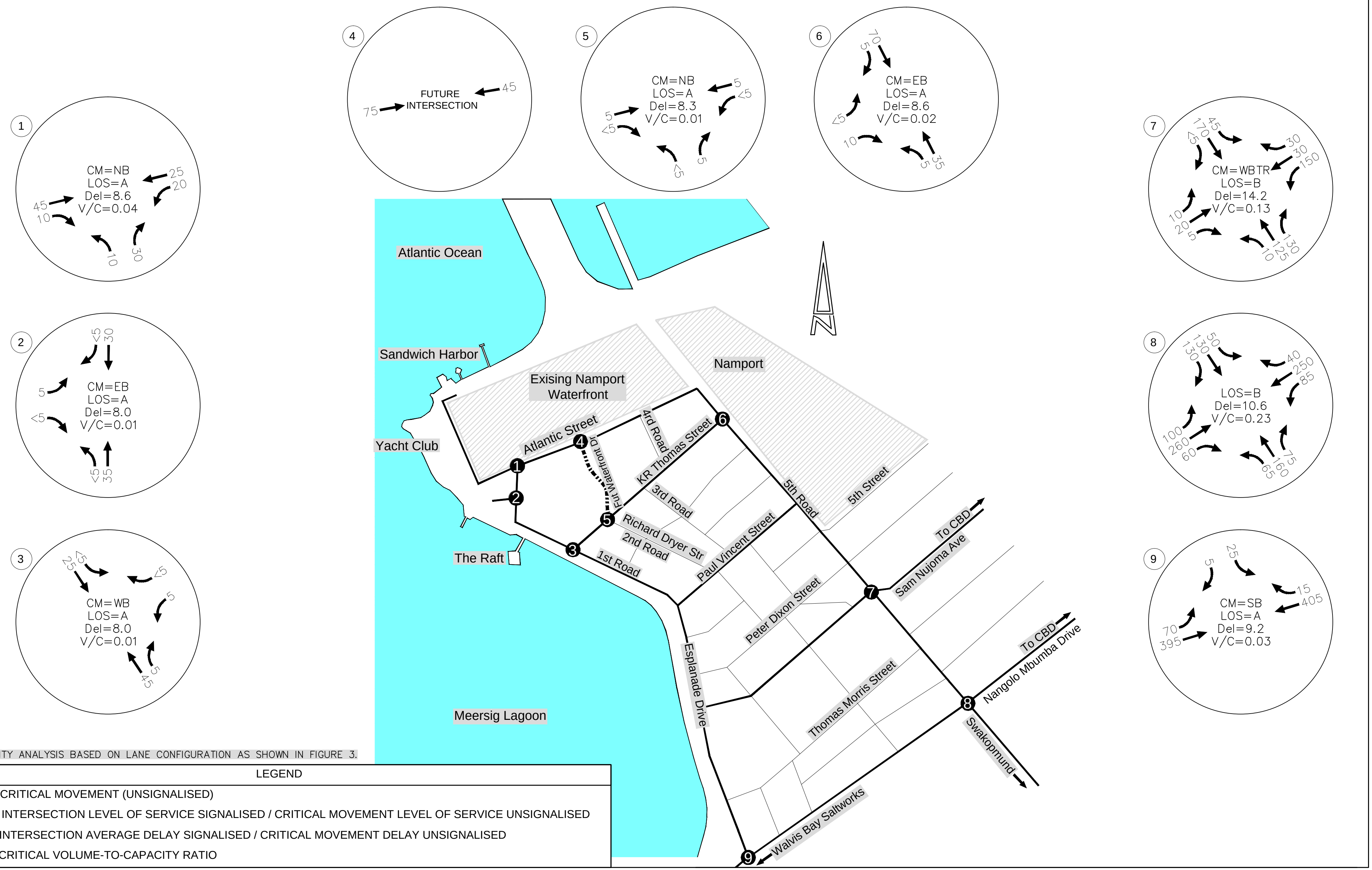
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 BACKGROUND TRAFFIC CONDITIONS (*SCENARIO* 2) P.M. PEAK HOUR	5B



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND

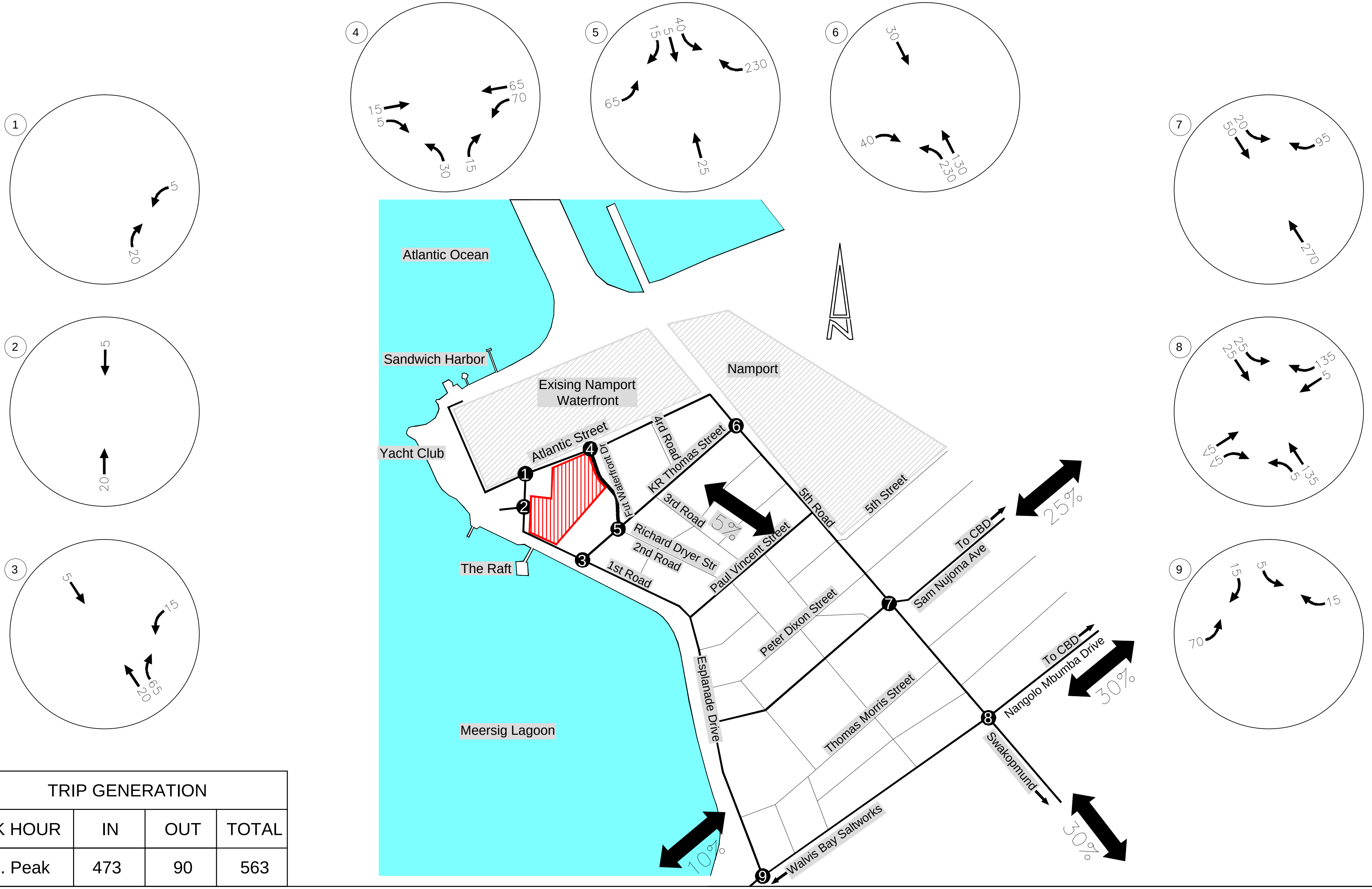
CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 BACKGROUND TRAFFIC CONDITIONS (*SCENARIO 2*) SATURDAY PEAK HOUR	5C



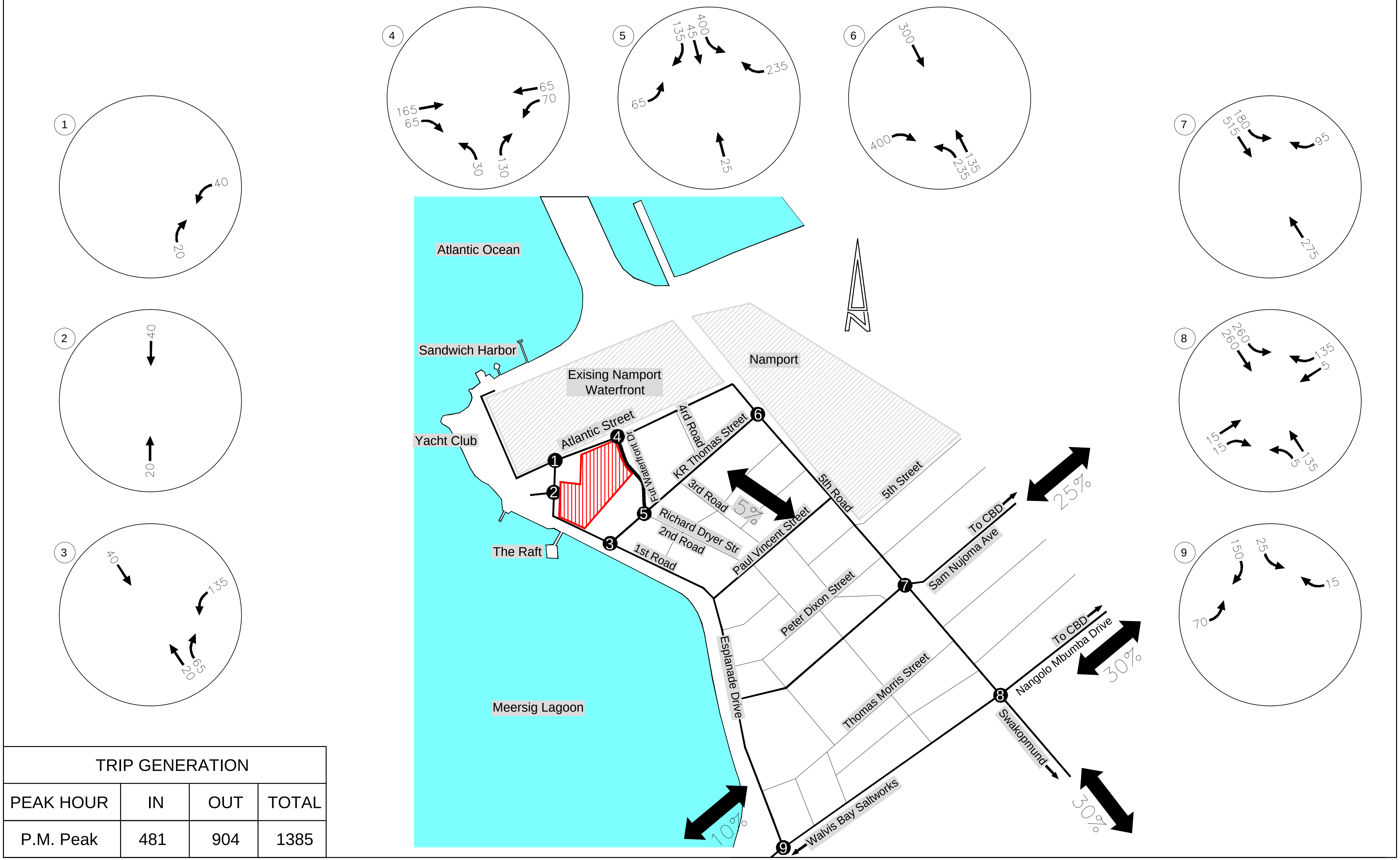
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
A.M. Peak	473	90	563

its

PROJECT:
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:
2022 EXPECTED DEVELOPMENT TRIPS (PHASE 1A)
RETAIL COMPONENT ONLY
A.M. PEAK HOUR

NUMBER:
6A



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
P.M. Peak	481	904	1385

its

PROJECT:

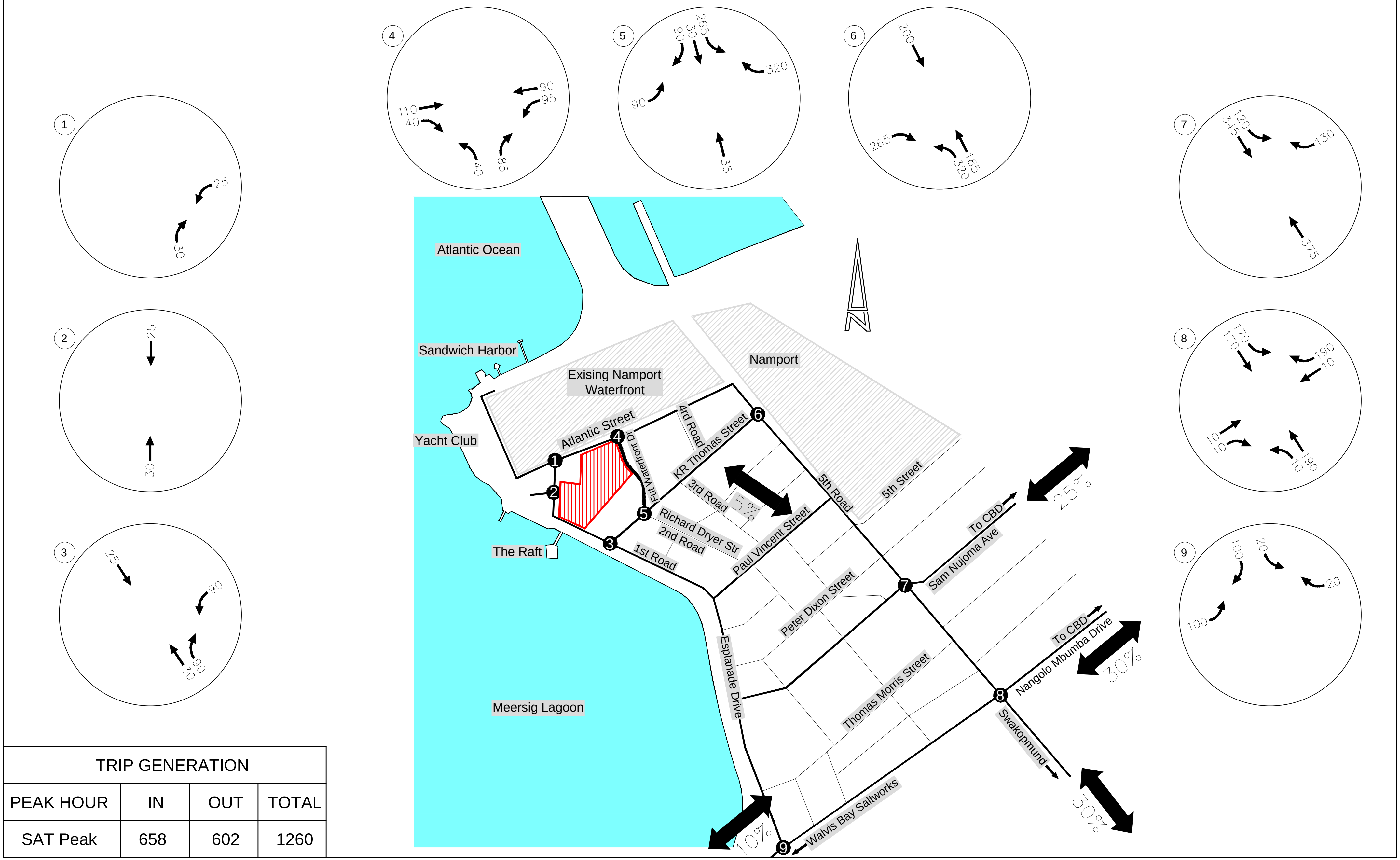
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:

2022 EXPECTED DEVELOPMENT TRIPS (PHASE 1A)
RETAIL COMPONENT ONLY
P.M. PEAK HOUR

NUMBER:

6B



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
SAT Peak	658	602	1260

its

PROJECT:

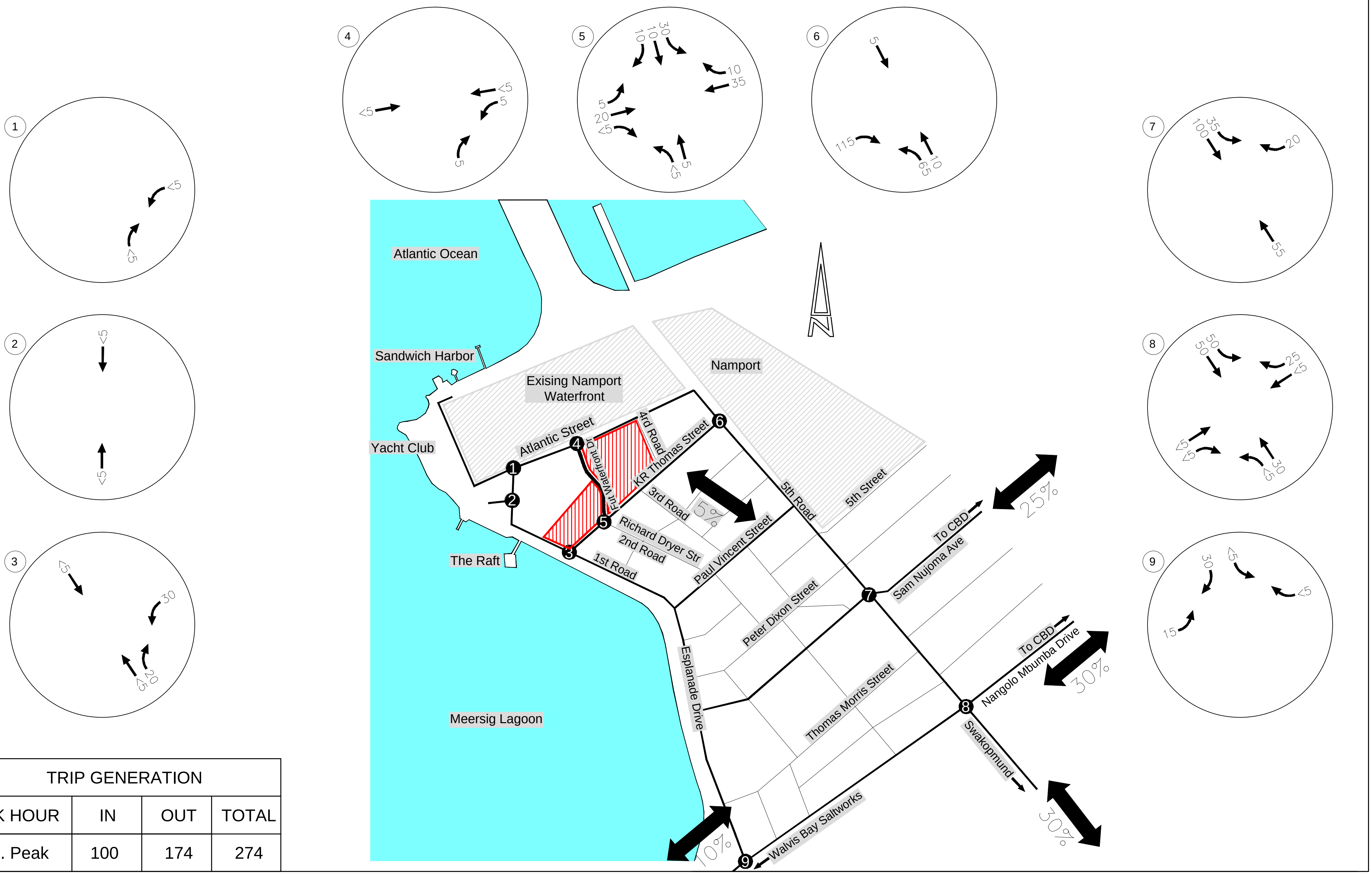
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:

2020 EXPECTED DEVELOPMENT TRIPS (PHASE 1A)
RETAIL COMPONENT ONLY
SATURDAY PEAK HOUR

NUMBER:

6C



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
A.M. Peak	100	174	274

its

PROJECT:

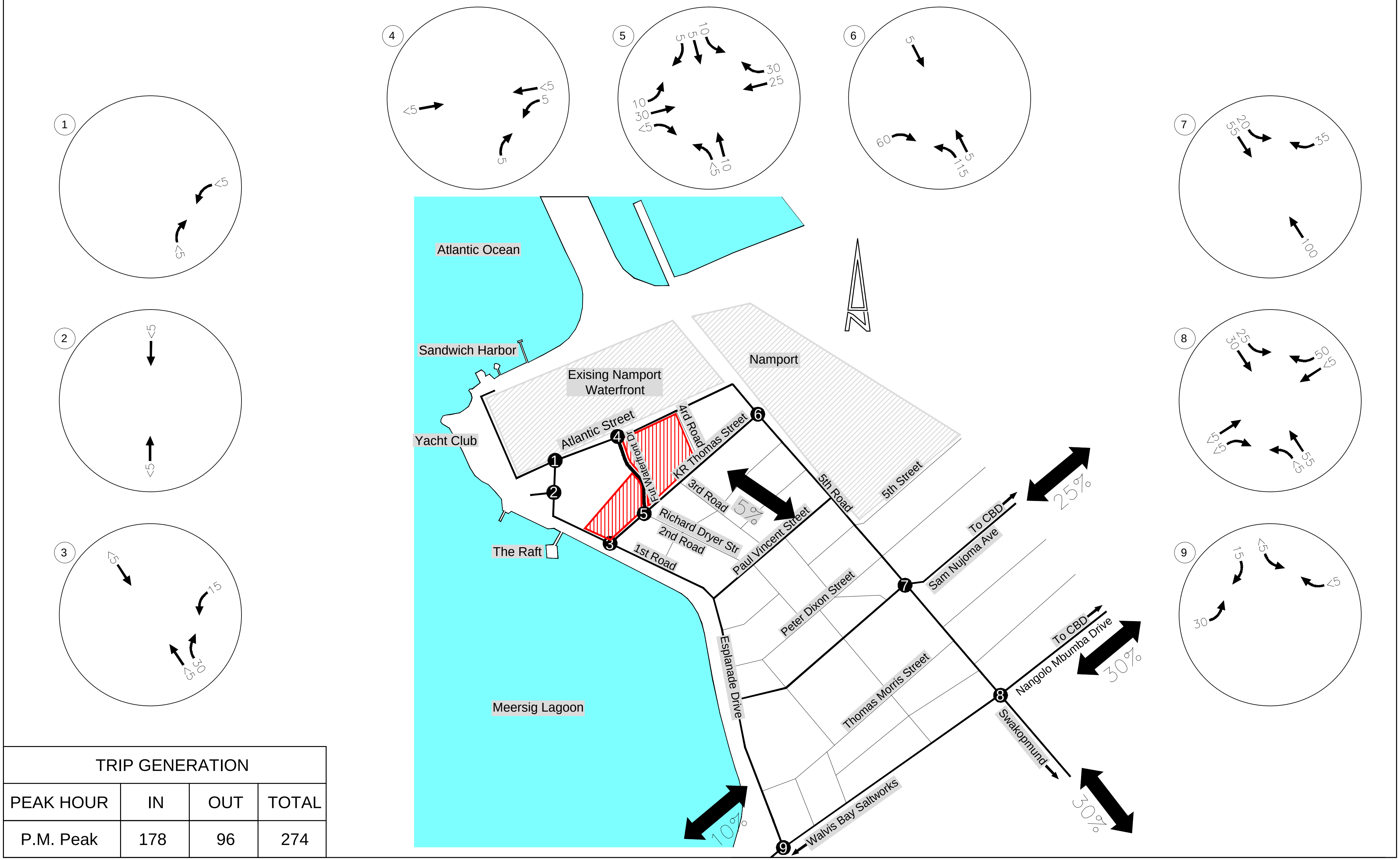
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:

2022 EXPECTED DEVELOPMENT TRIPS (PHASE 1B & PHASE 2)
HOTEL AND RESIDENTIAL COMPONENTS ONLY
A.M. PEAK HOUR

NUMBER:

7A

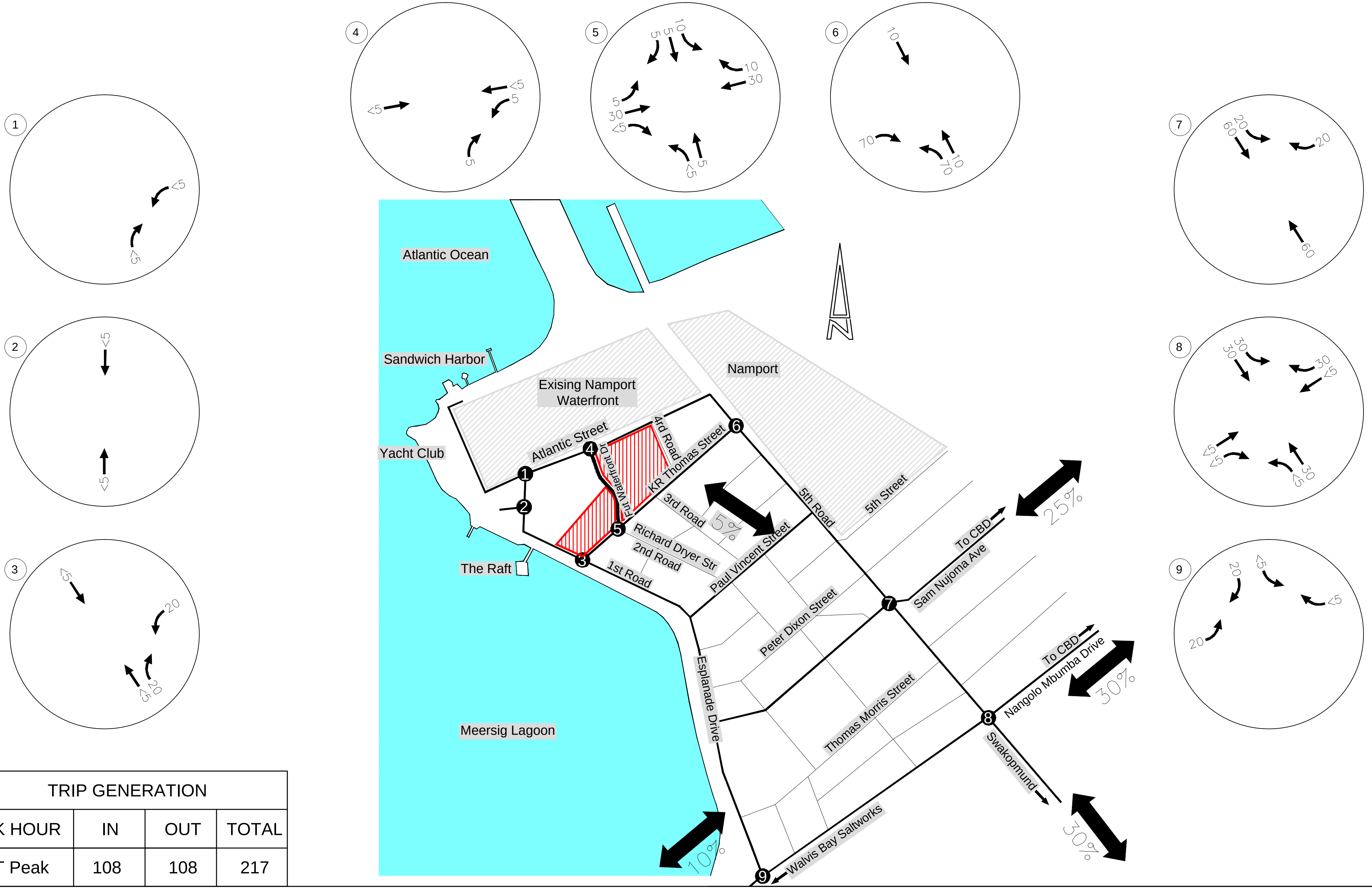


TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
P.M. Peak	178	96	274

PROJECT: WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE: 2022 EXPECTED DEVELOPMENT TRIPS (PHASE 1B & PHASE 2) HOTEL & RESIDENTIAL COMPONENTS ONLY P.M. PEAK HOUR

NUMBER: 7B



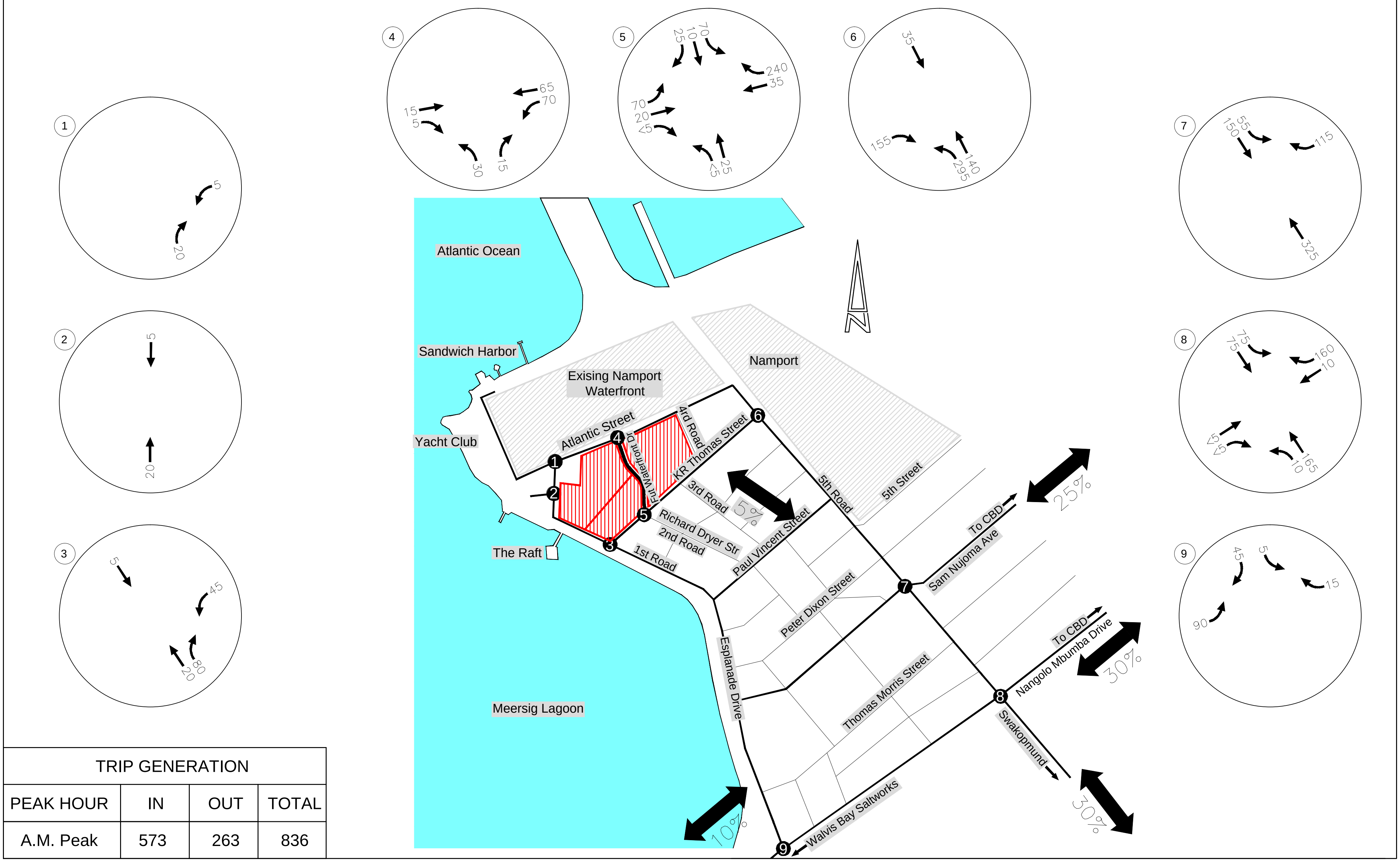
TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
SAT Peak	108	108	217

its

PROJECT:
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:
2022 EXPECTED DEVELOPMENT TRIPS (PHASE 1B & PHASE 2)
HOTEL AND RESIDENTIAL COMPONENT ONLY
SATURDAY PEAK HOUR

NUMBER:
7C



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
A.M. Peak	573	263	836

PROJECT:

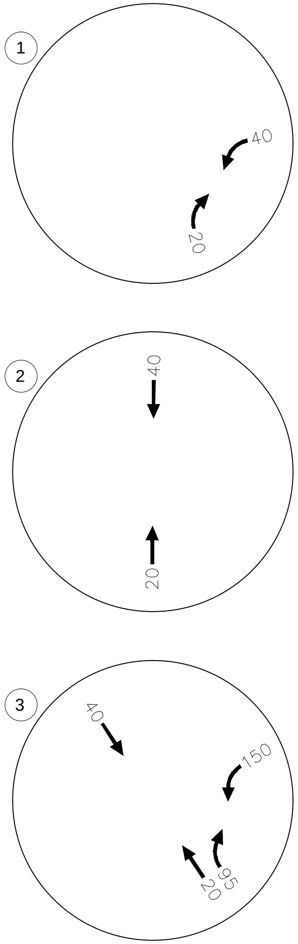
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:

2022 EXPECTED DEVELOPMENT TRIPS
FULL DEVELOPMENT
A.M. PEAK HOUR

NUMBER:

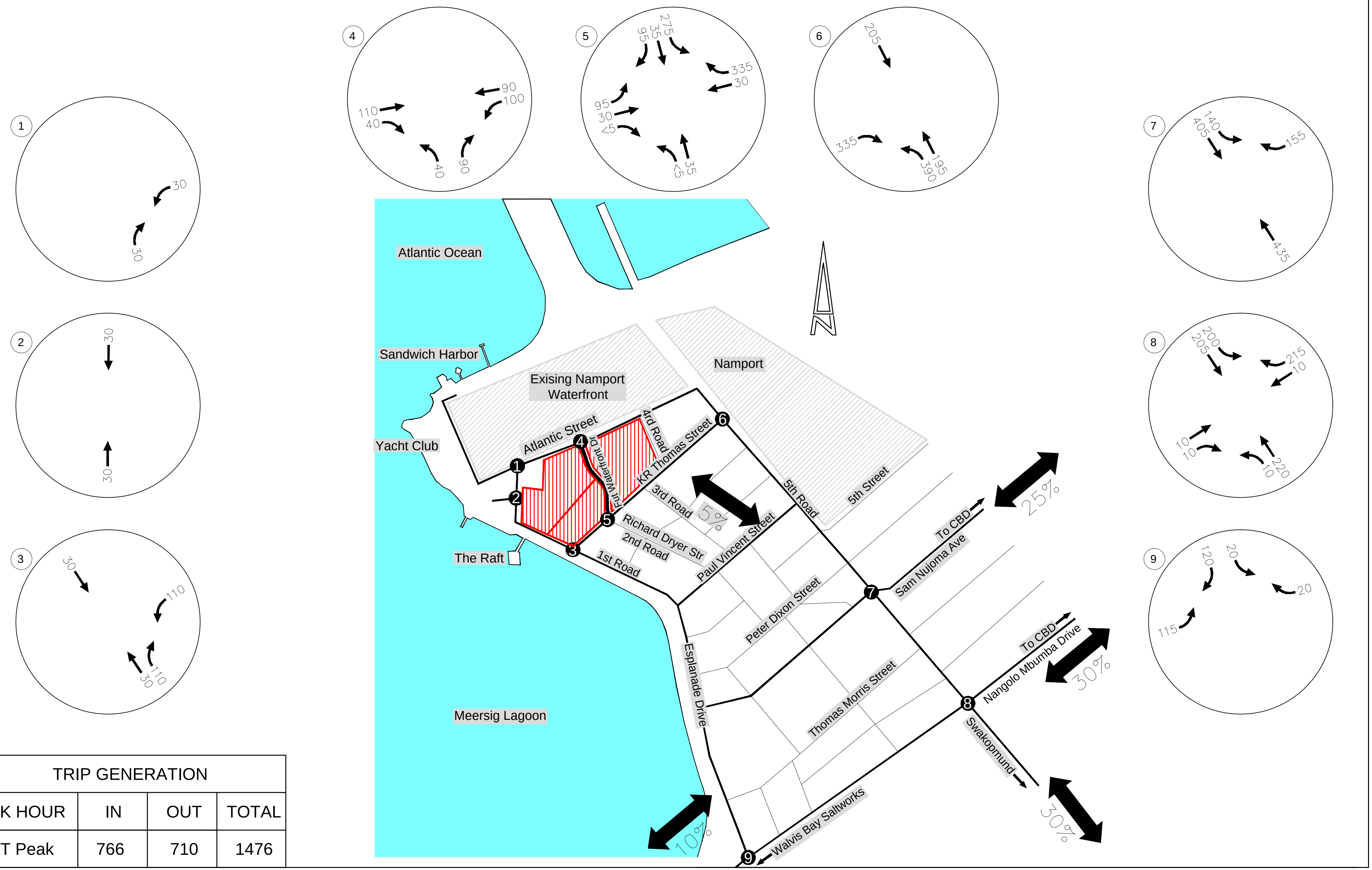
8A



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
P.M. Peak	659	1000	1659

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 EXPECTED DEVELOPMENT TRIPS FULL DEVELOPMENT P.M. PEAK HOUR	8B



TRIP GENERATION			
PEAK HOUR	IN	OUT	TOTAL
SAT Peak	766	710	1476

PROJECT:

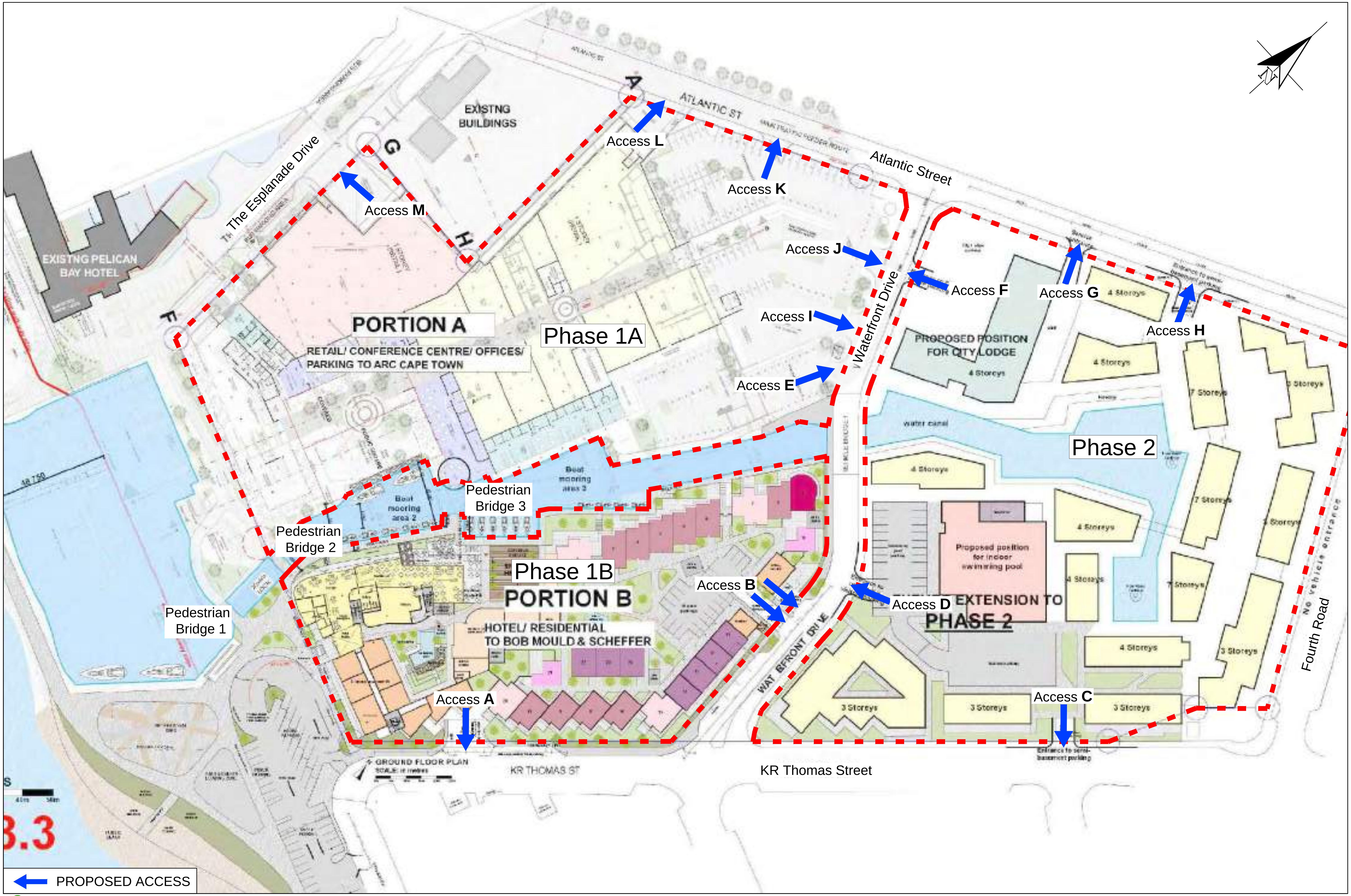
WALVIS BAY WATERFRONT DEVELOPMENT

FIGURE:

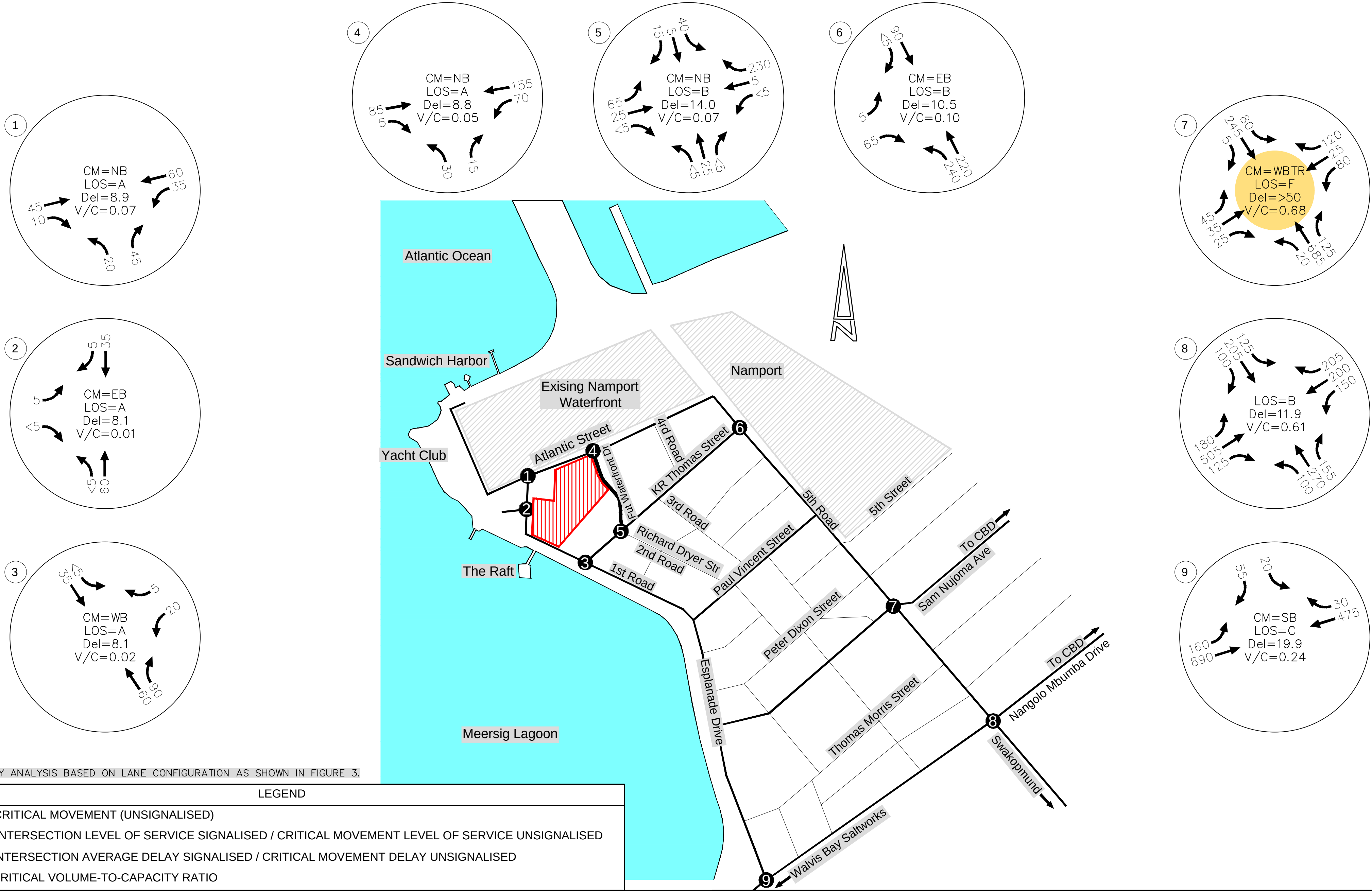
2022 EXPECTED DEVELOPMENT TRIPS
FULL DEVELOPMENT
SATURDAY PEAK HOUR

NUMBER:

8C



PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	PROPOSED DEVELOPMENT ACCESS	9



NOTE:
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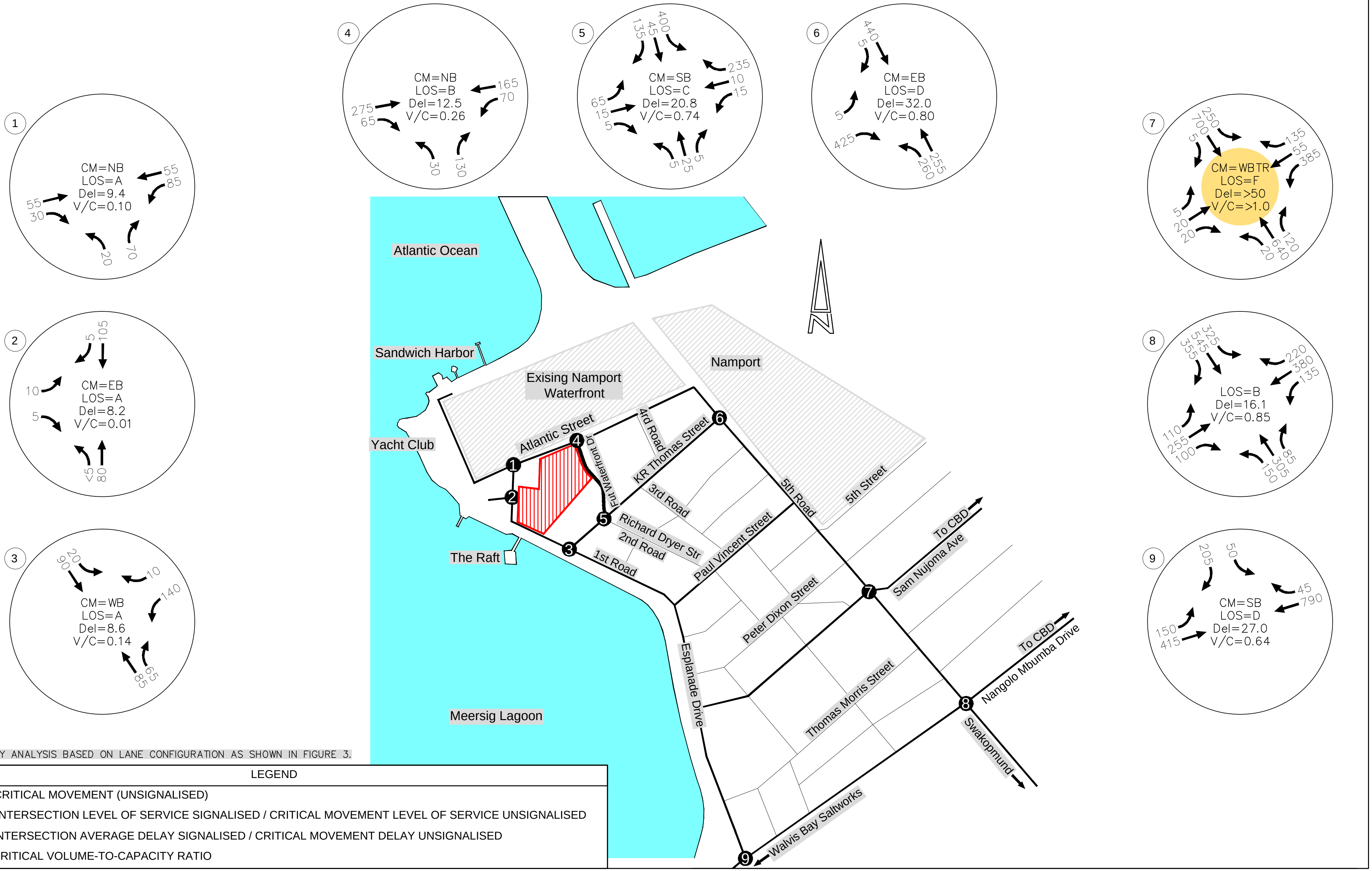
its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 3*) PHASE 1A RETAIL COMPONENT ONLY A.M. PEAK HOUR	10A



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND

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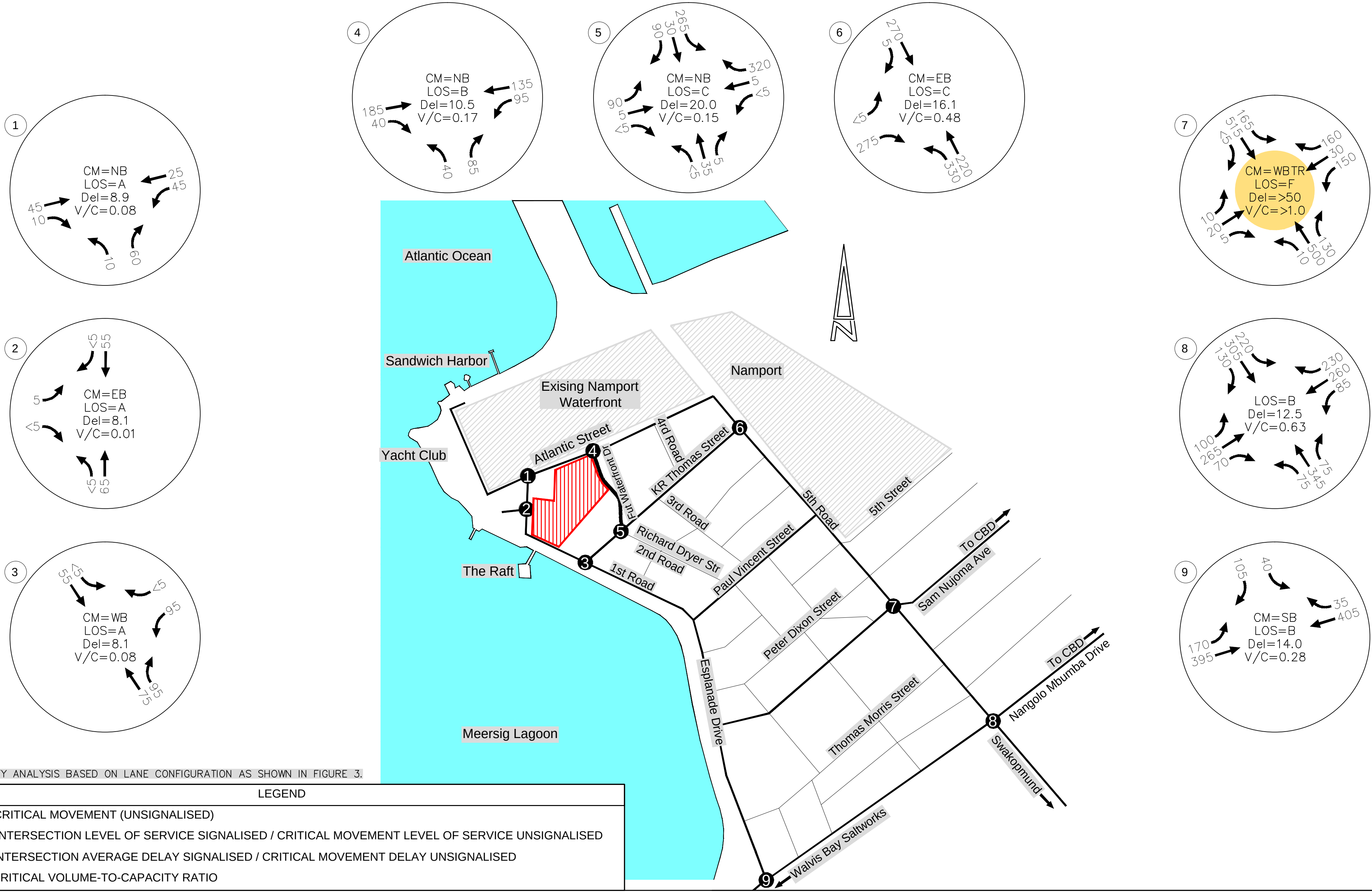
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO* 3) PHASE 1A RETAIL COMPONENT ONLY P.M. PEAK HOUR	10B



NOTE:
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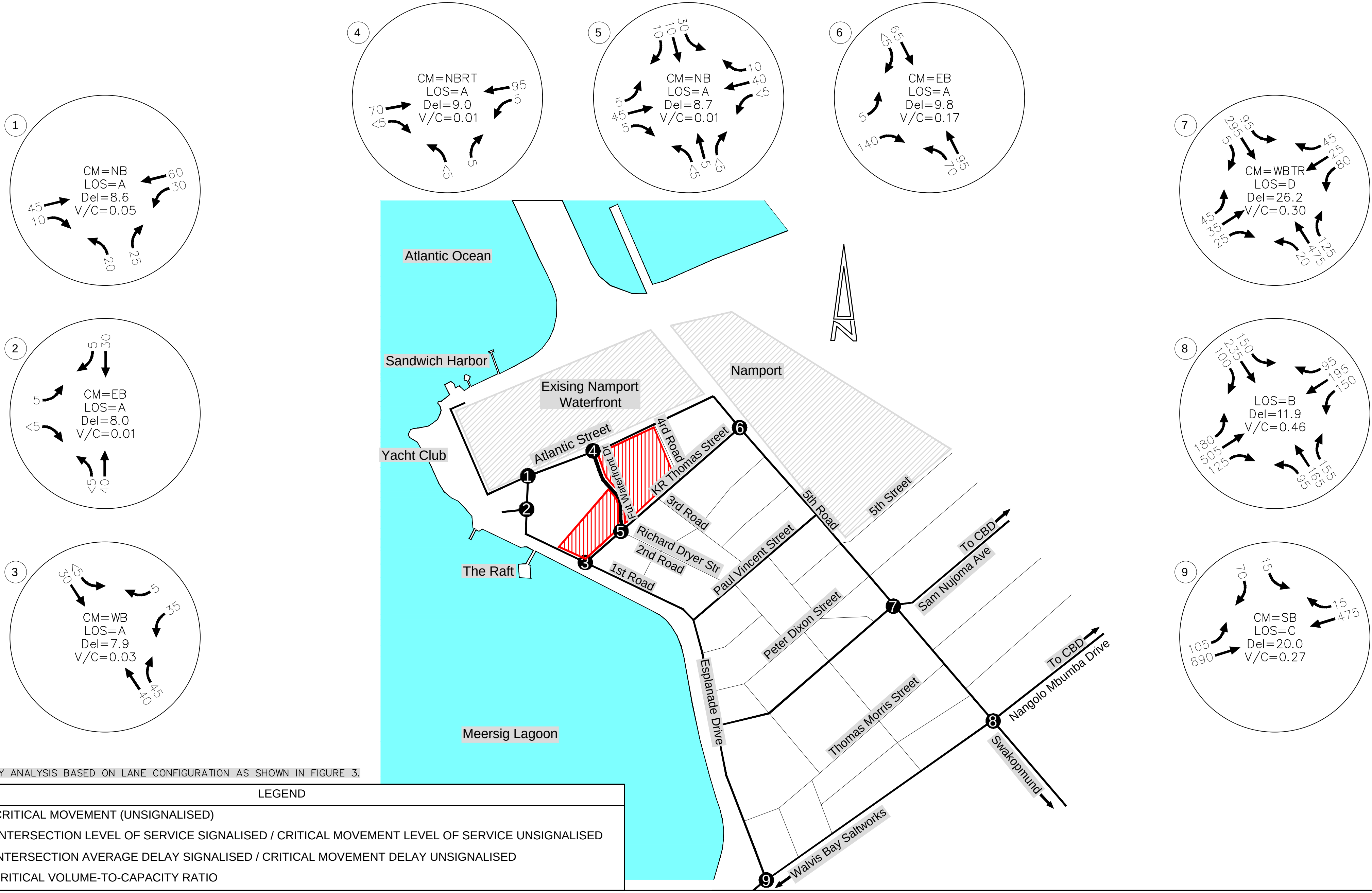
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO* 3) PHASE 1A RETAIL COMPONENT ONLY SATURDAY PEAK HOUR	10C



NOTE:
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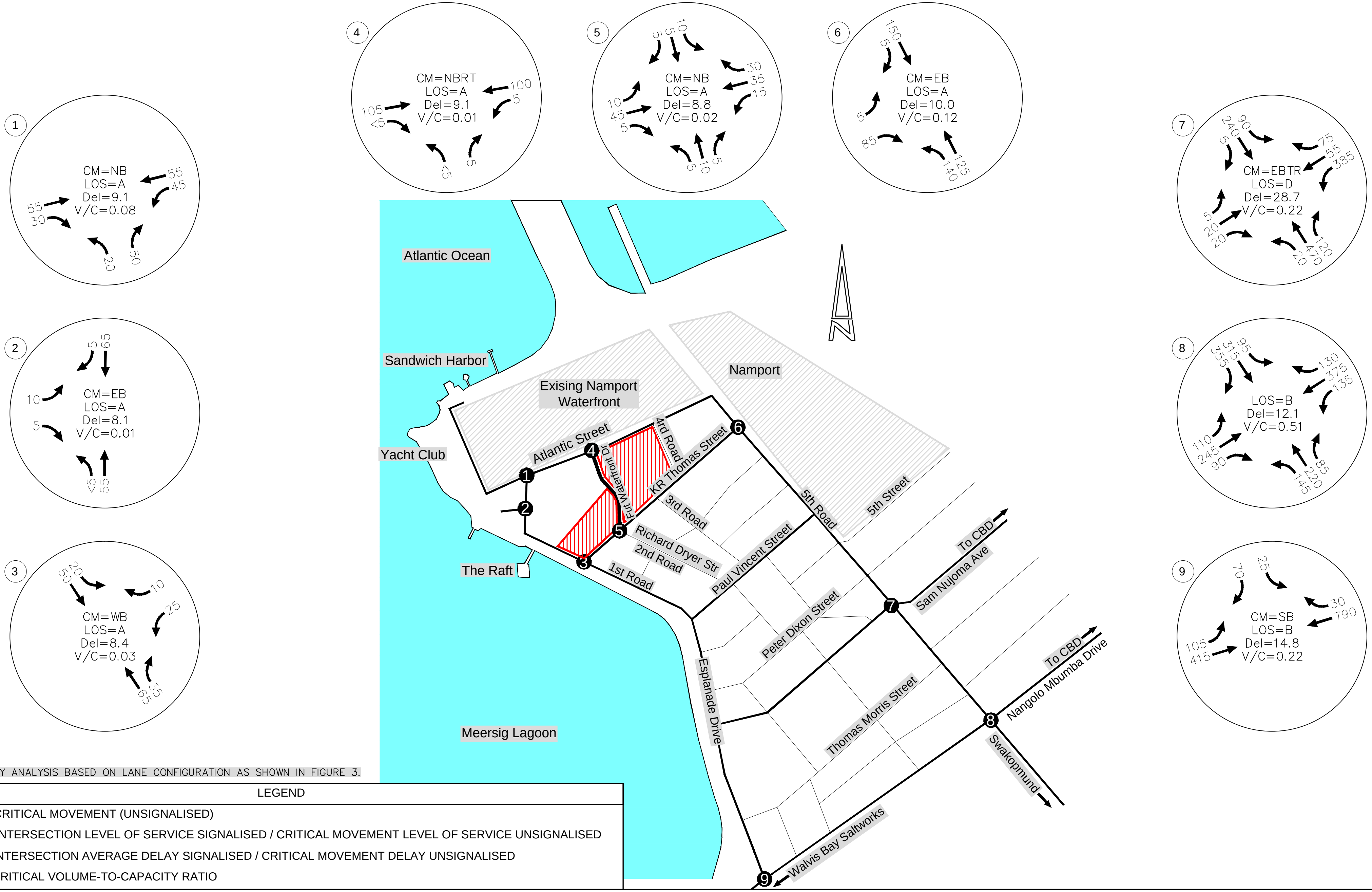
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 4*) PHASE 1B, PHASE 2 HOTEL & RESIDENTIAL COMPONENTS ONLY A.M. PEAK HOUR	11A



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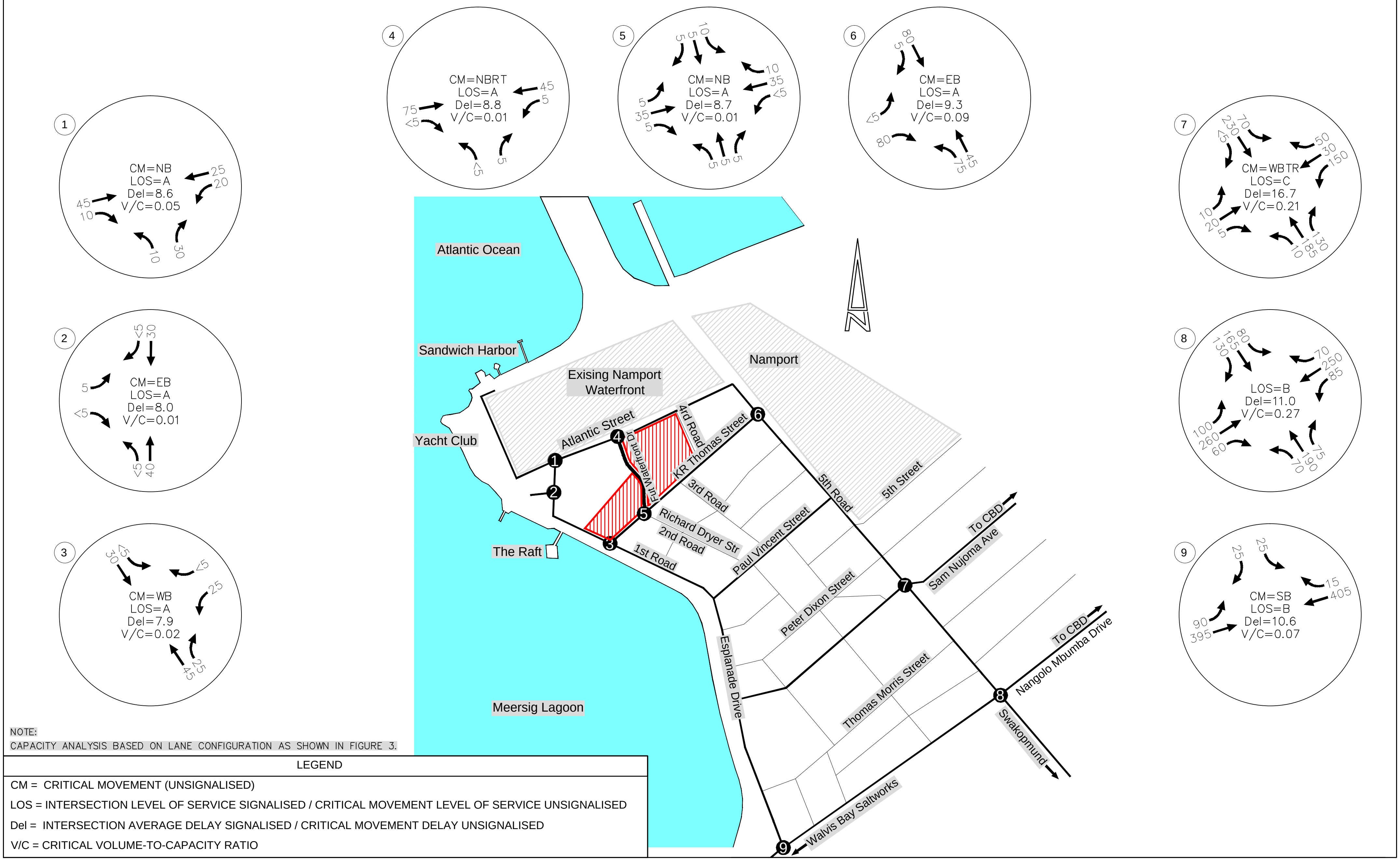
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 4*) PHASE 1B & PHASE 2 HOTEL & RESIDENTIAL COMPONENTS ONLY P.M. PEAK HOUR	11B



NOTE:
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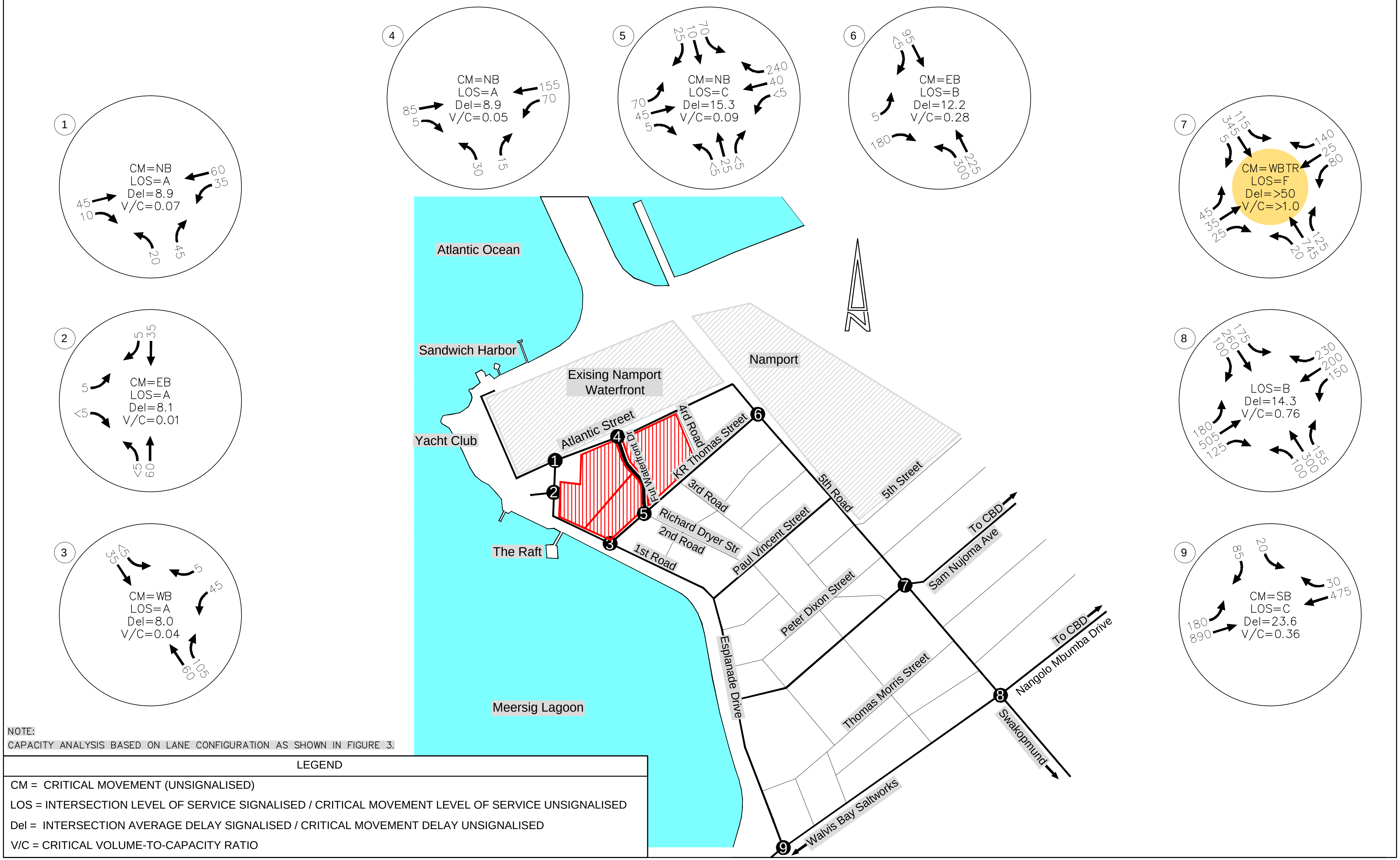
PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 4*) PHASE 1B & PHASE 2 HOTEL & RESIDENTIAL COMPONENTS ONLY SATURDAY PEAK HOUR	11C



NOTE:
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PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 5*) FULL DEVELOPMENT A.M. PEAK HOUR	12A

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND
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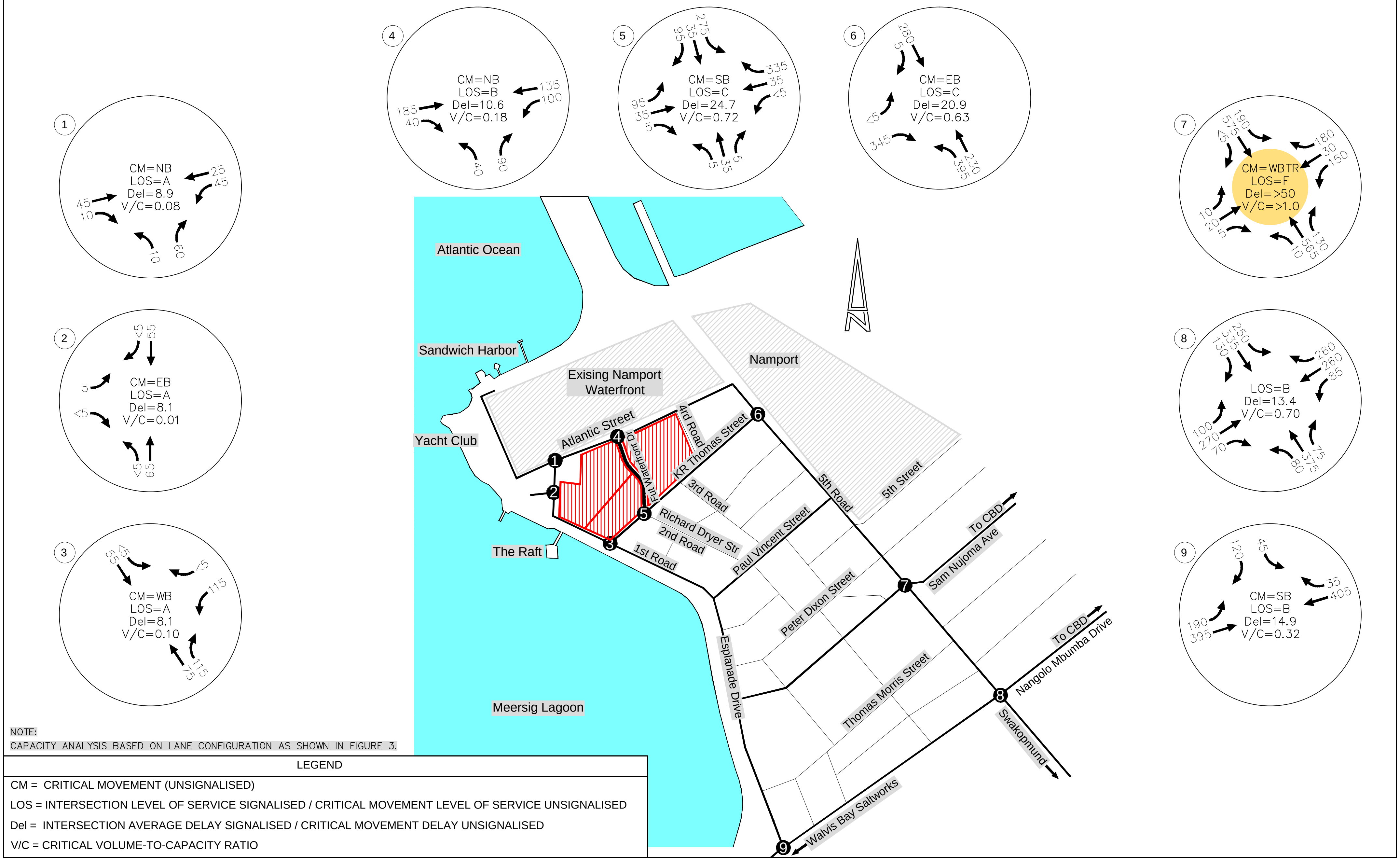
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 5*) FULL DEVELOPMENT P.M. PEAK HOUR	12B



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3.

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

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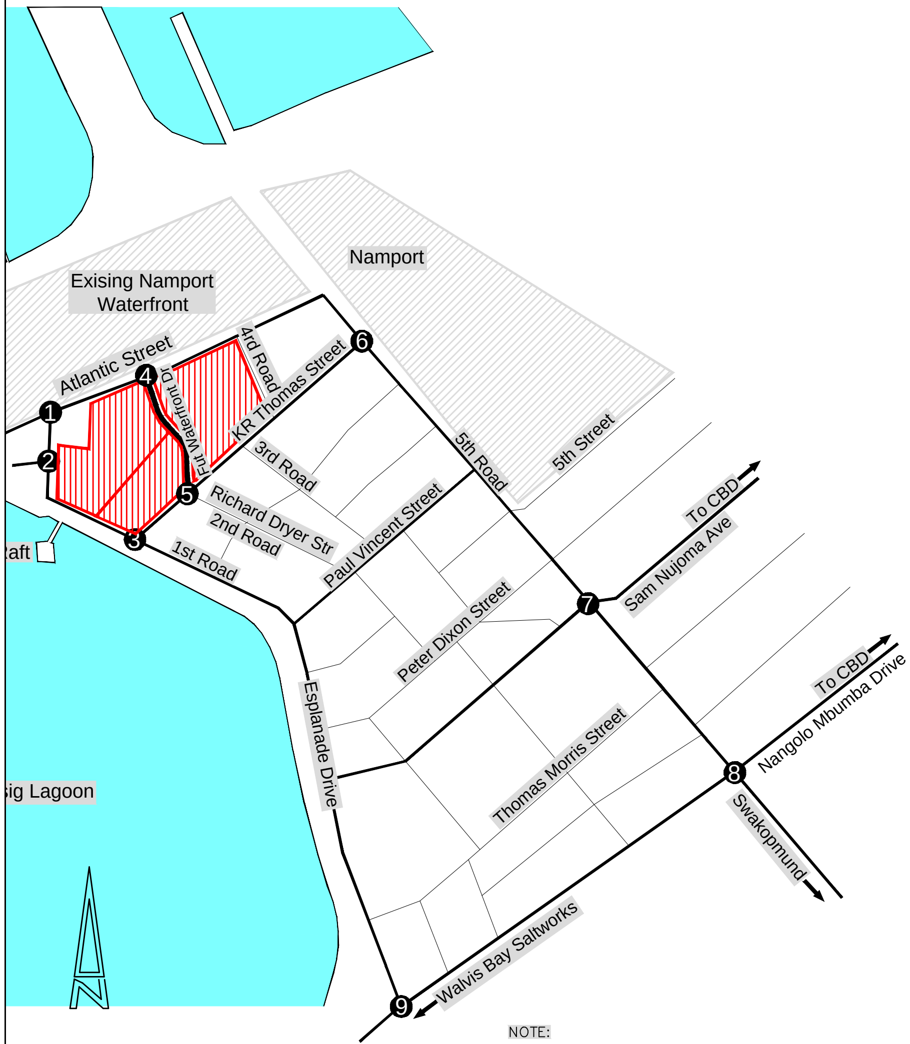
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

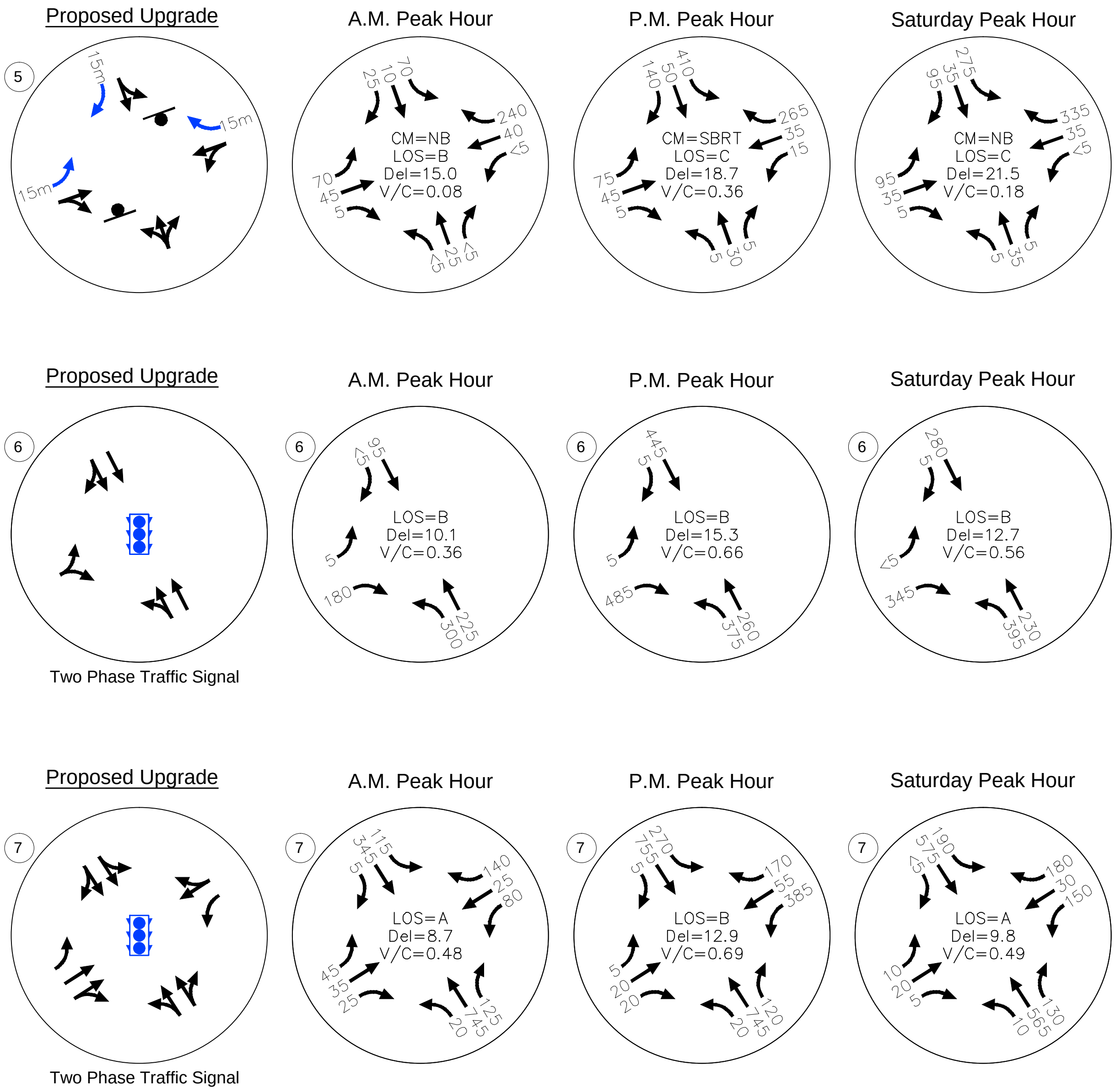
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (SCENARIO 5) FULL DEVELOPMENT SATURDAY PEAK HOUR	12C

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO



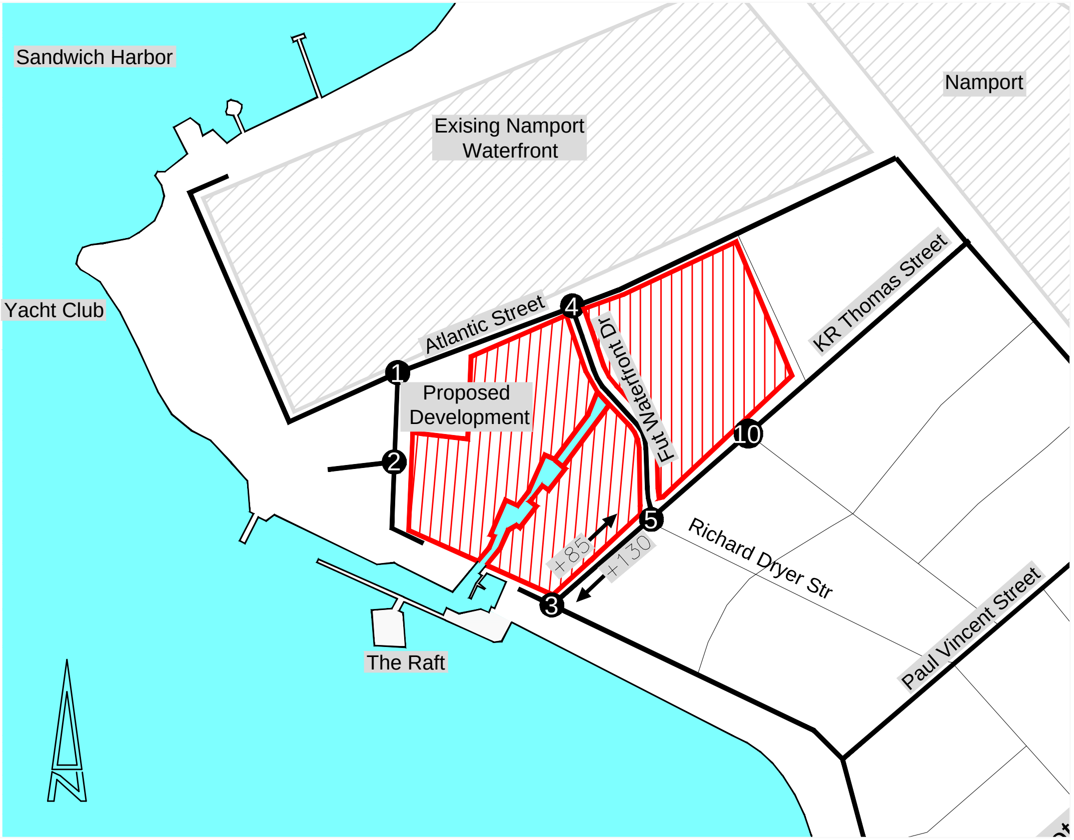


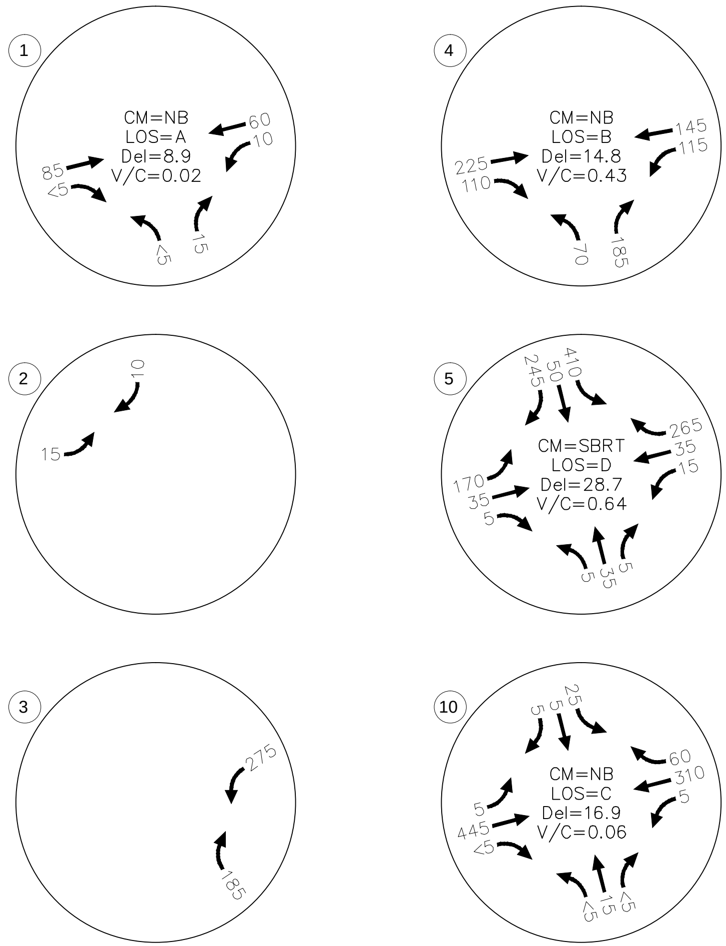
NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN THIS FIGURE

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 5*) WITH UPGRADES	13

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 6*) FULL DEVELOPMENT - WITH MARINA BOAT CANAL A.M. PEAK HOUR	14A

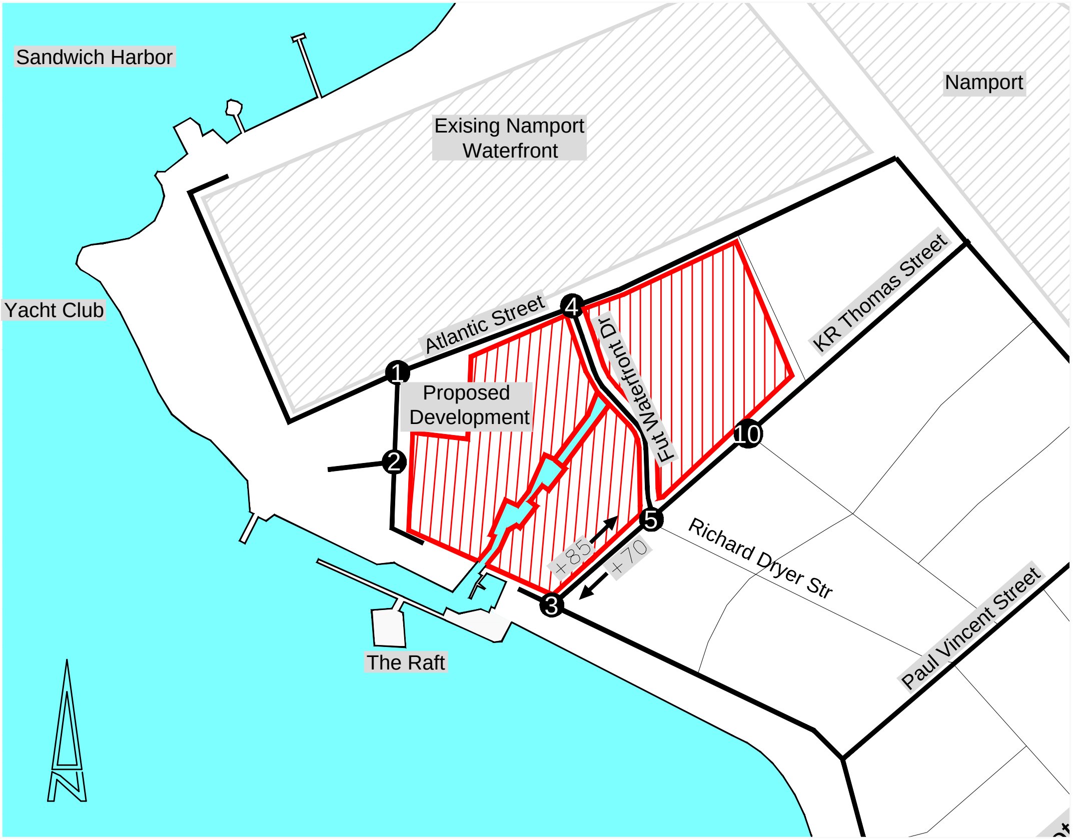


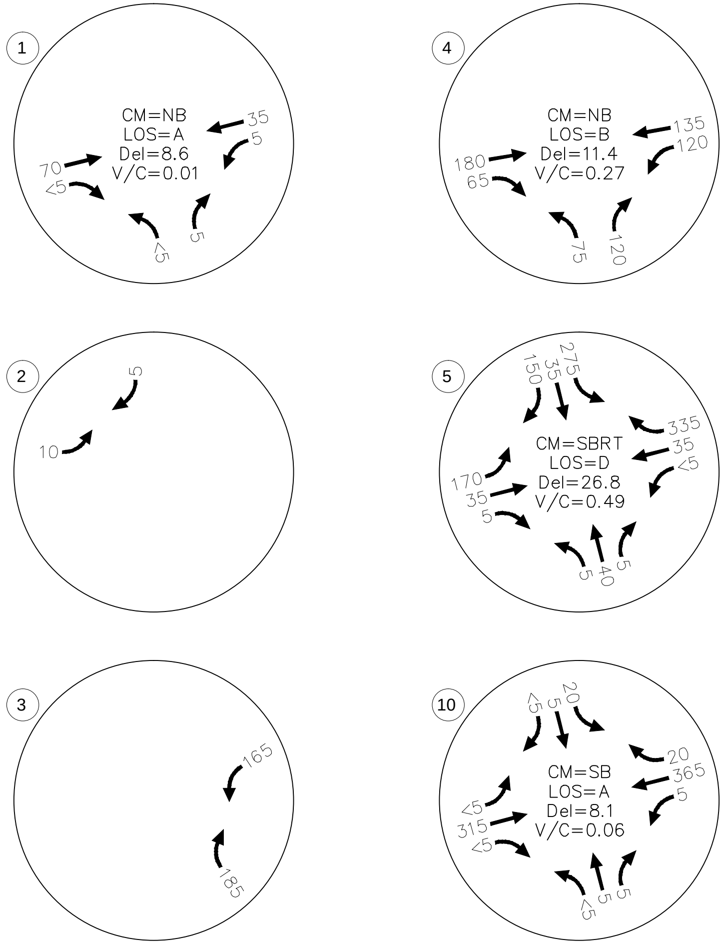


LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 6*) FULL DEVELOPMENT - WITH MARINA BOAT CANAL P.M. PEAK HOUR	14B





LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

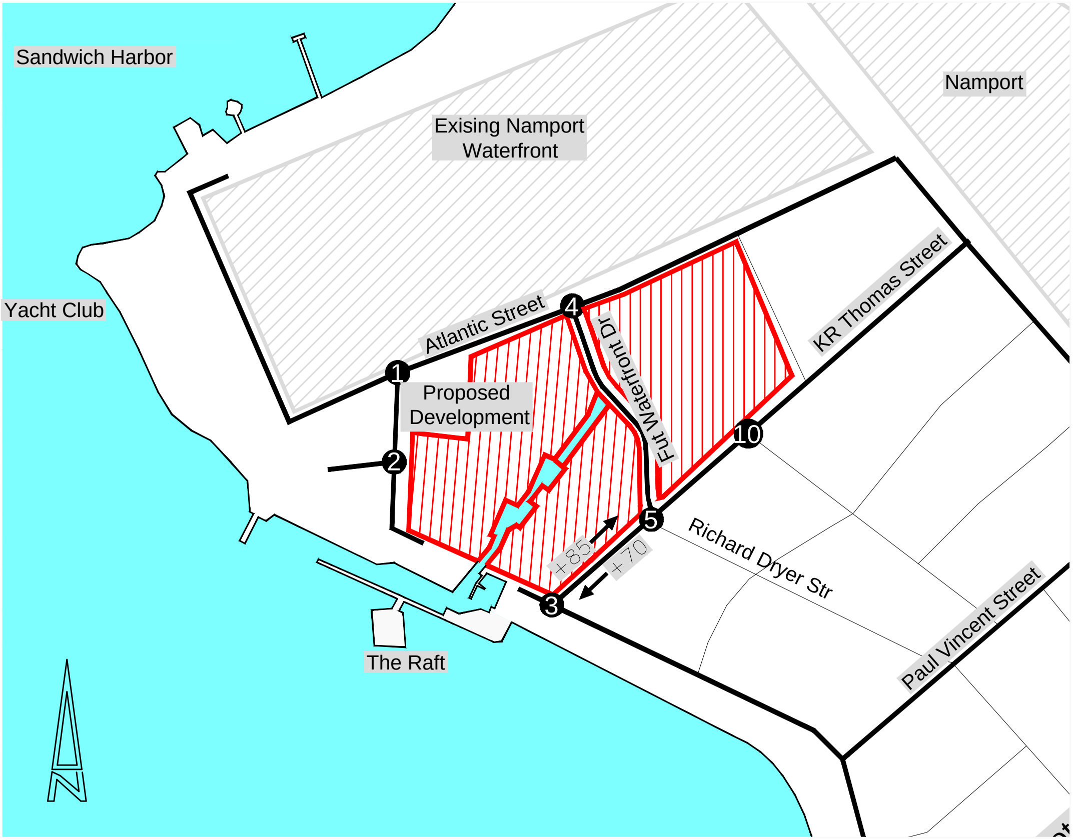
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

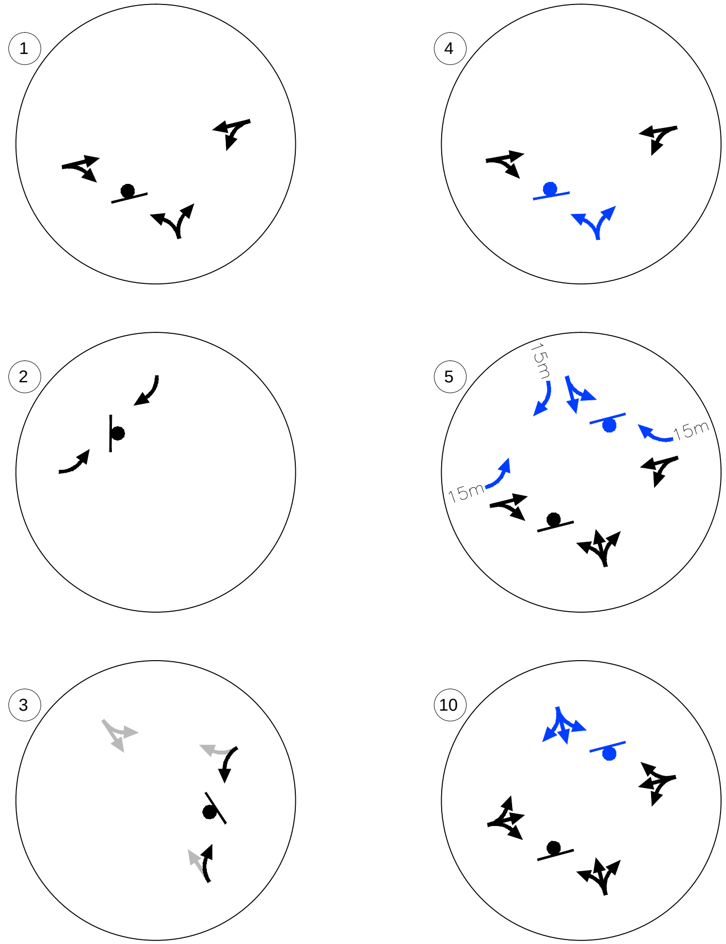
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 6*) FULL DEVELOPMENT - WITH MARINA BOAT CANAL SATURDAY PEAK HOUR	14C

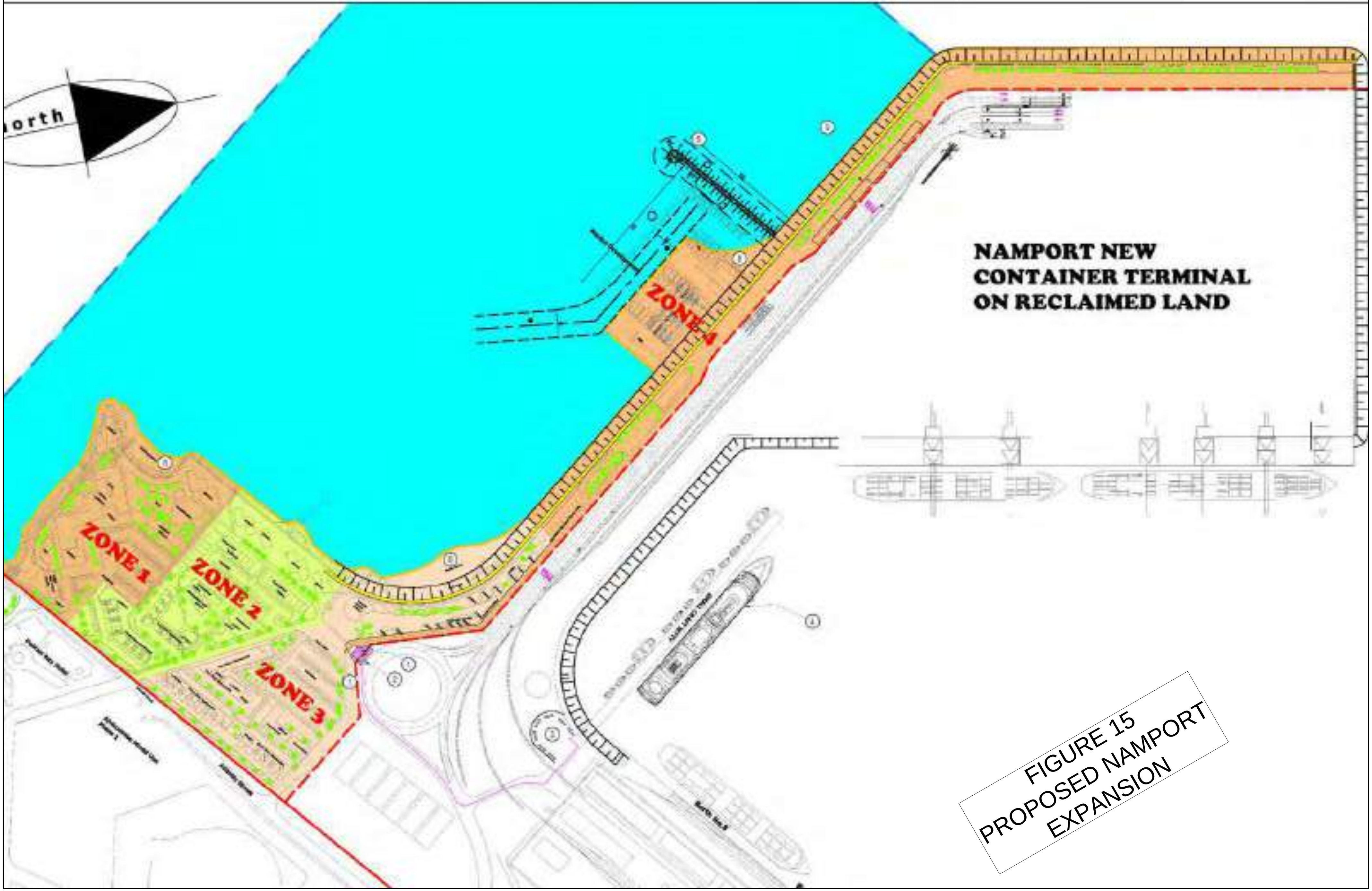


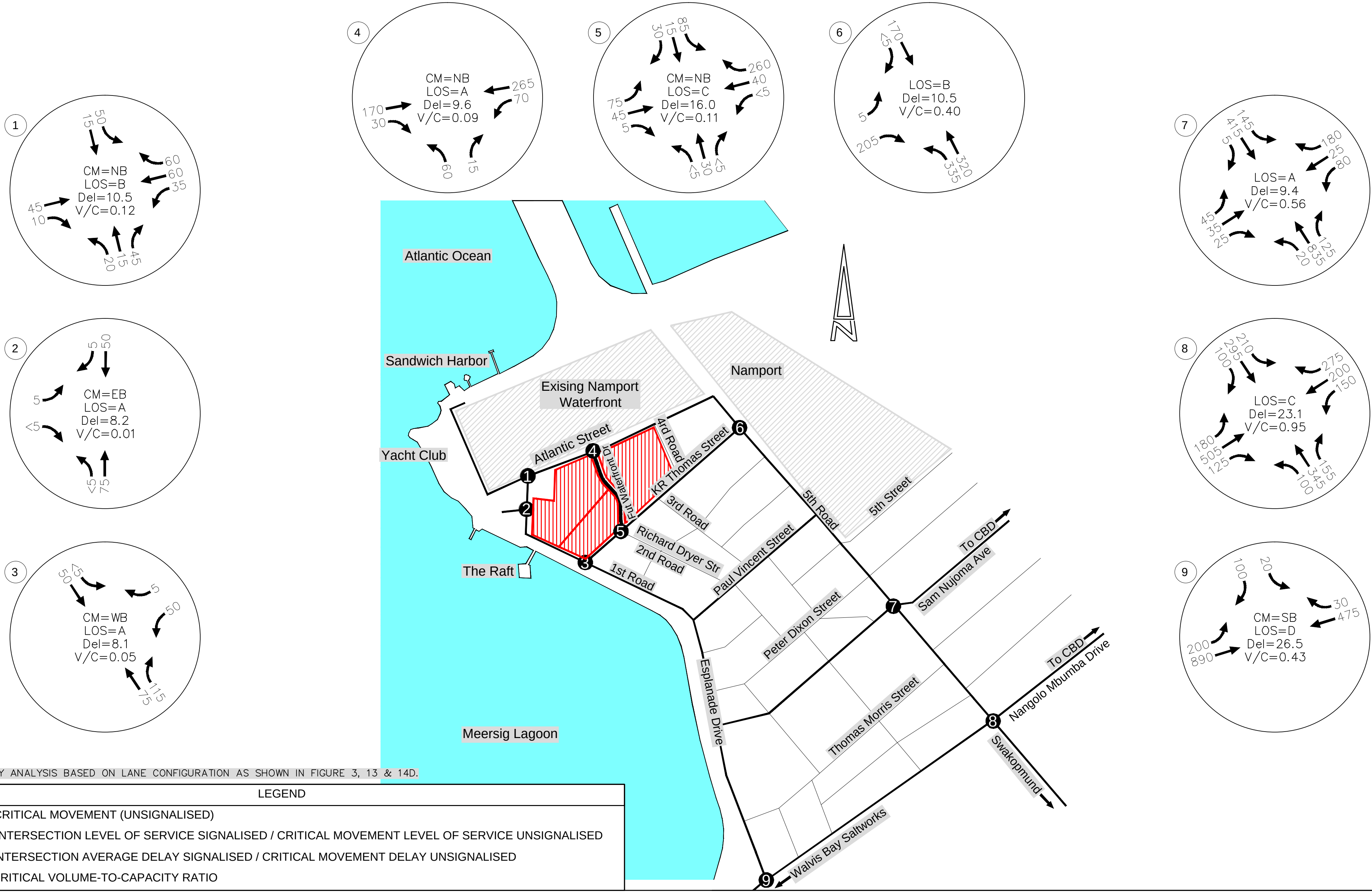


LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL LANE CONFIGURATION (*SCENARIO 6*) FULL DEVELOPMENT - WITH MARINA BOAT CANAL PROPOSED GEOMETRY	14D

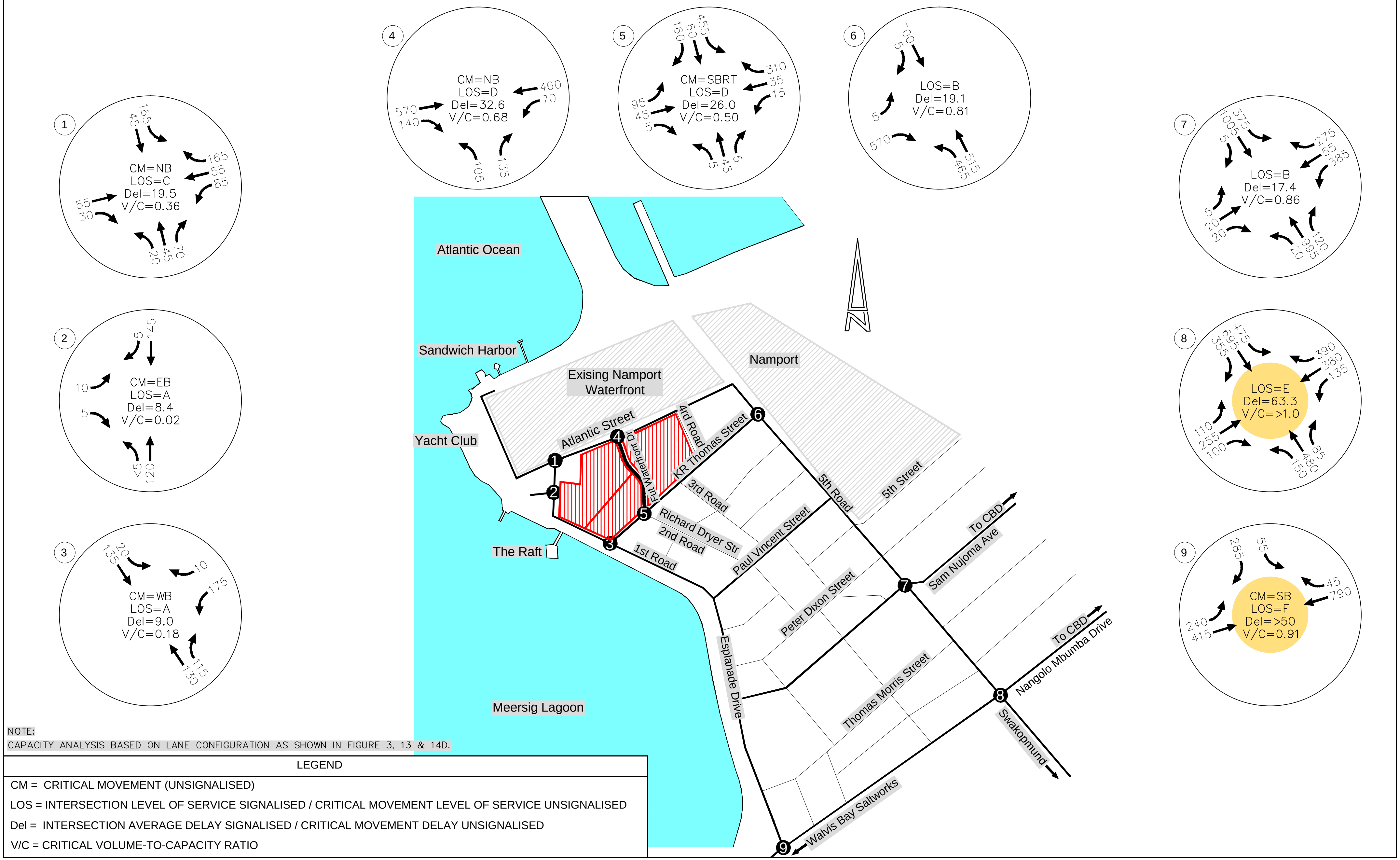

north
NAMPORT NEW
CONTAINER TERMINAL
ON RECLAIMED LAND
ZONE 1
ZONE 2
ZONE 3
ZONE 4
FIGURE 15
PROPOSED NAMPORT
EXPANSION



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3, 13 & 14D.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 7*) WALVIS BAY WATERFRONT WITH NAMPORT DEVELOPMENT A.M. PEAK HOUR	16A



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3, 13 & 14D.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 7*) WALVIS BAY WATERFRONT WITH NAMPORT DEVELOPMENT P.M. PEAK HOUR	16B

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 3, 13 & 14D.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

its

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 7*) WALVIS BAY WATERFRONT WITH NAMPORT DEVELOPMENT SATURDAY PEAK HOUR	16C

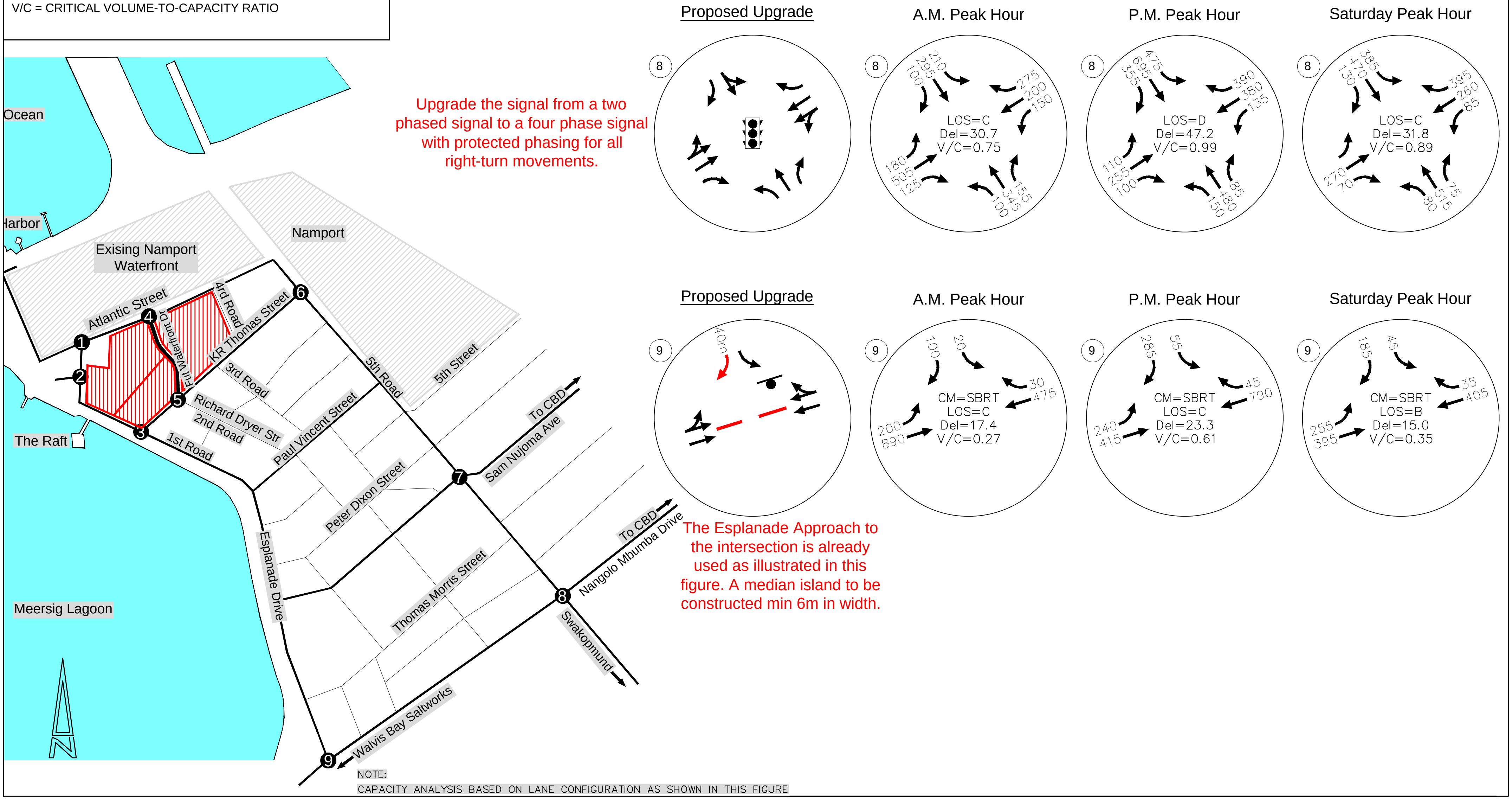
LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

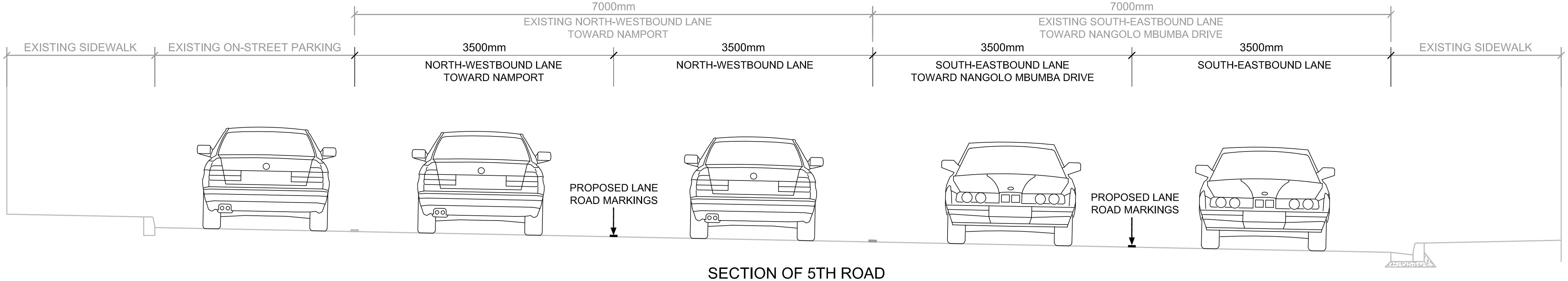
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO



PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC CONDITIONS (*SCENARIO 7*) WALVIS BAY WATERFRONT WITH NAMPORT DEVELOPMENT PROPOSED UPGRADES	16D



SECTION OF 5TH ROAD

SCHEMATIC

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	5TH ROAD - EXISTING AND PROPOSED CROSS SECTION	17

NOTE:

CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS ILLUSTRATED ON FIGURE 13, 14D AND FIGURE 16D

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE A.M. PEAK HOUR	18A

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS ILLUSTRATED ON FIGURE 13, 14D AND FIGURE 16D

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE P.M. PEAK HOUR	18B

NOTE:

CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS ILLUSTRATED ON FIGURE 13, 14D AND FIGURE 16D

LEGEND

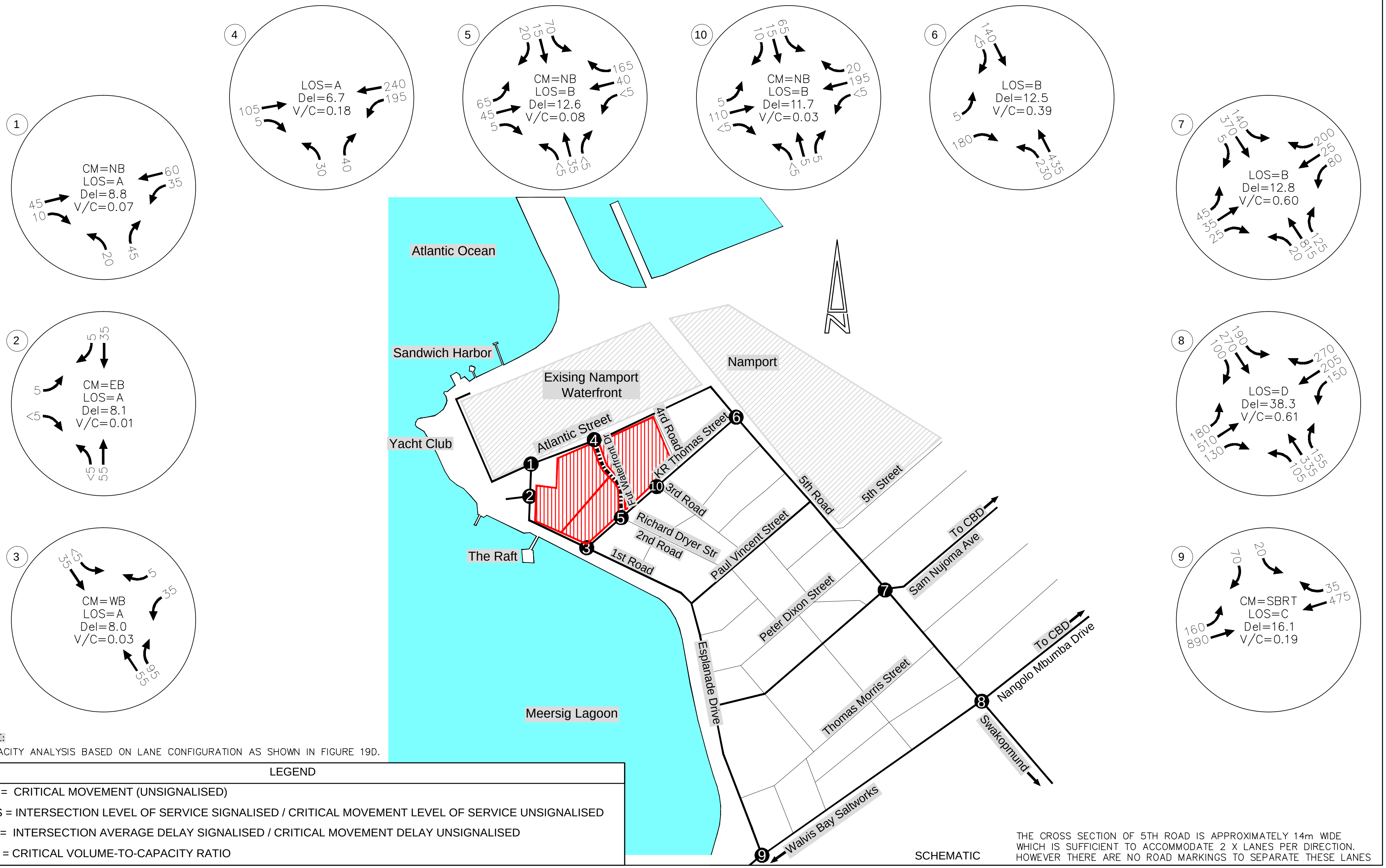
CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE SATURDAY PEAK HOUR	18C



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

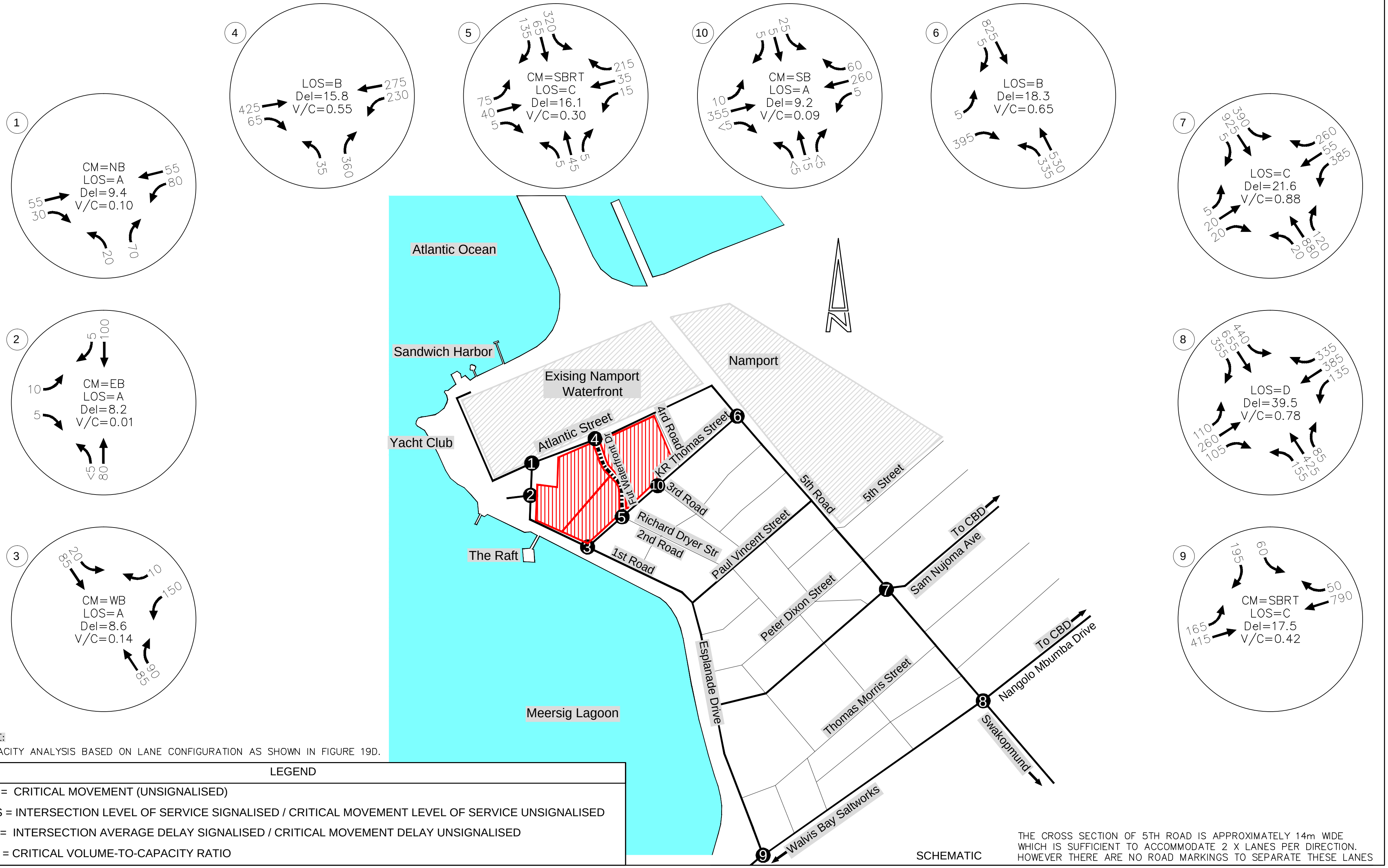
CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) - *WITH UPGRADES* FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE A.M. PEAK HOUR	19A



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

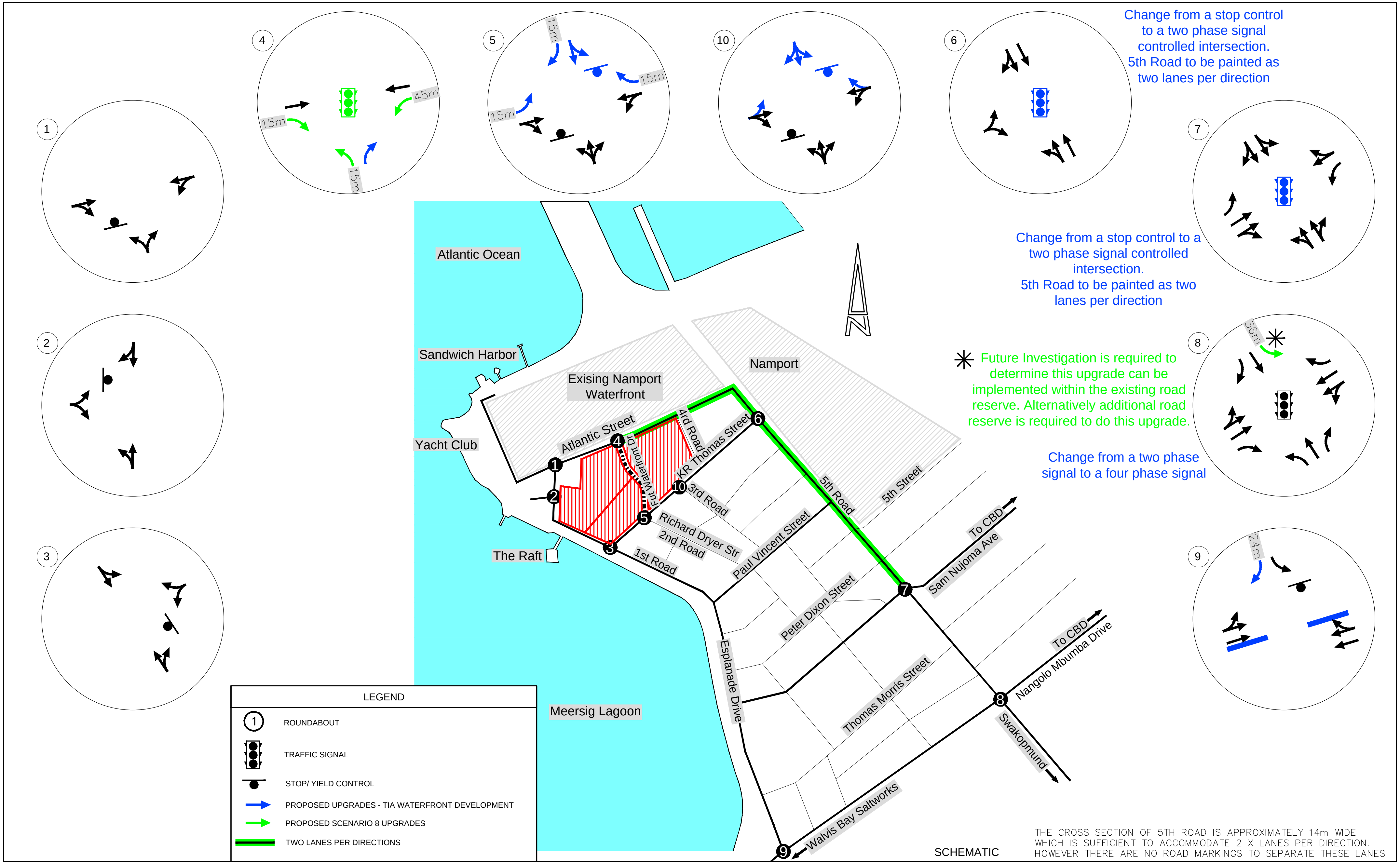
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) - *WITH UPGRADES* FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE P.M. PEAK HOUR	19B

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) - *WITH UPGRADES* FULL WATERFRONT DEVELOPMENT + 15 000m² RETAIL AND 7 600m² OFFICE SPACE SATURDAY PEAK HOUR	19C

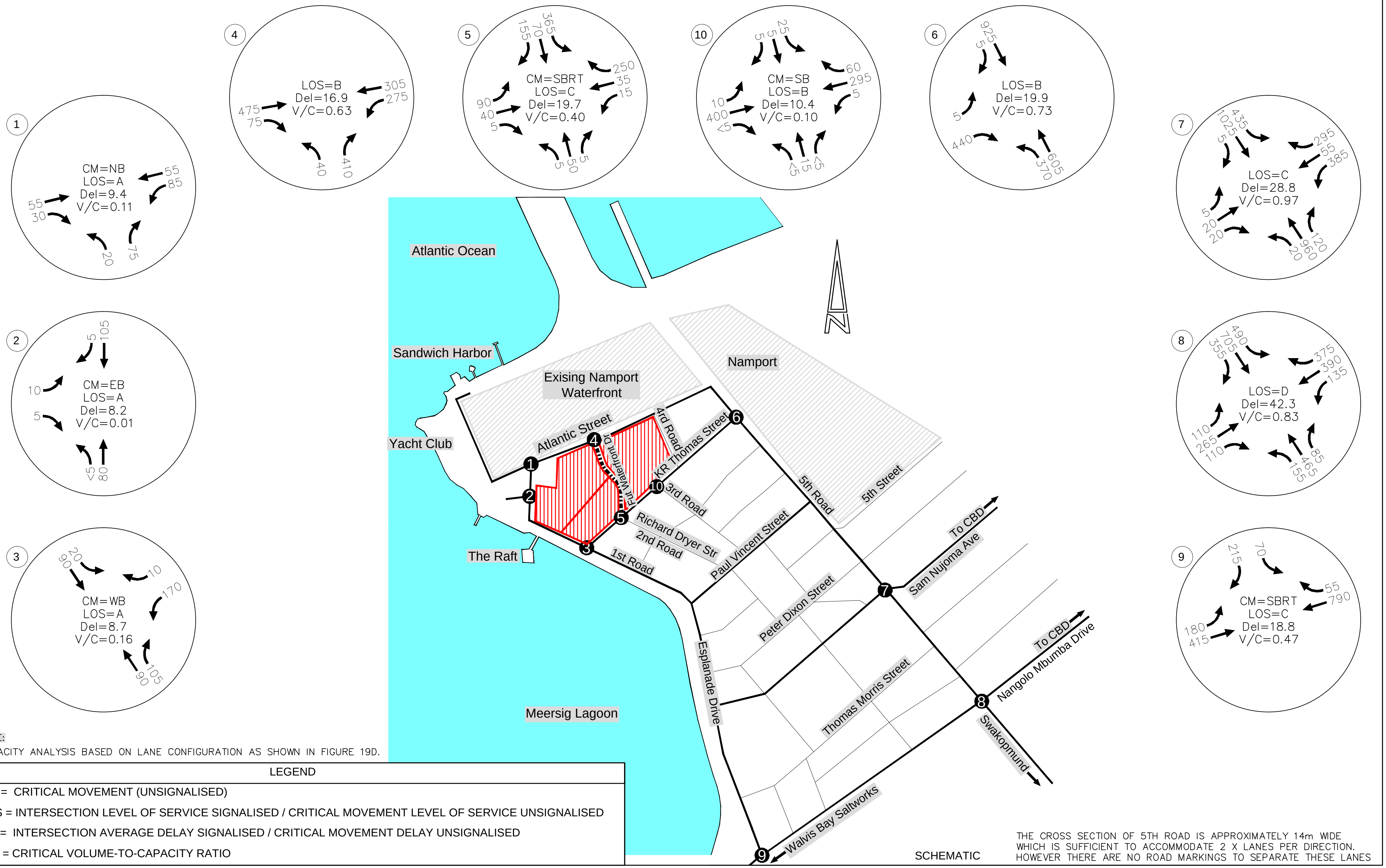


PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 8) PROPOSED GEOMETRY	19D

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND
CM = CRITICAL MOVEMENT (UNSIGNALISED)
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED
Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 9) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE - A.M. PEAK HOUR	20A



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

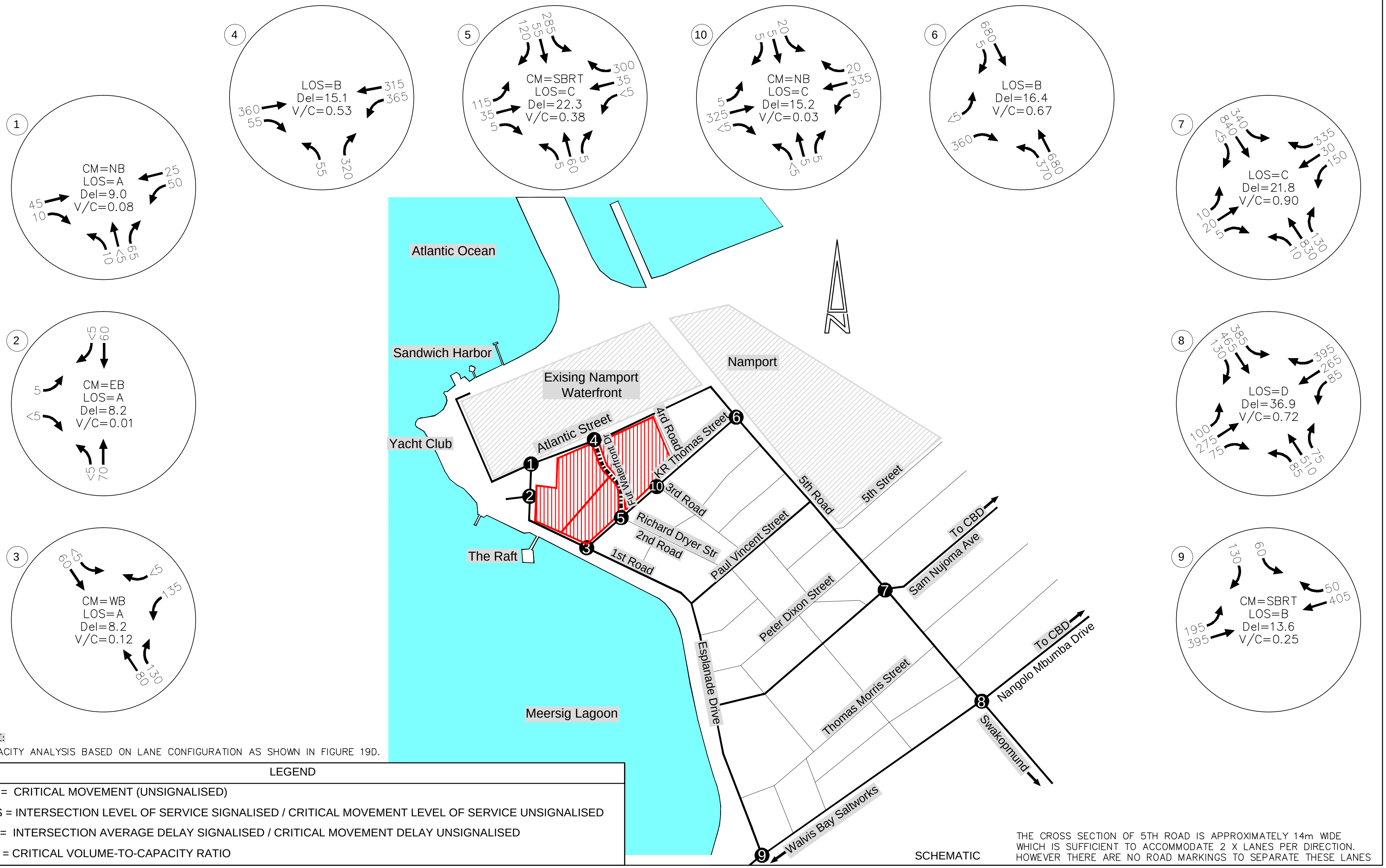
CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 9) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE - P.M. PEAK HOUR	20B



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

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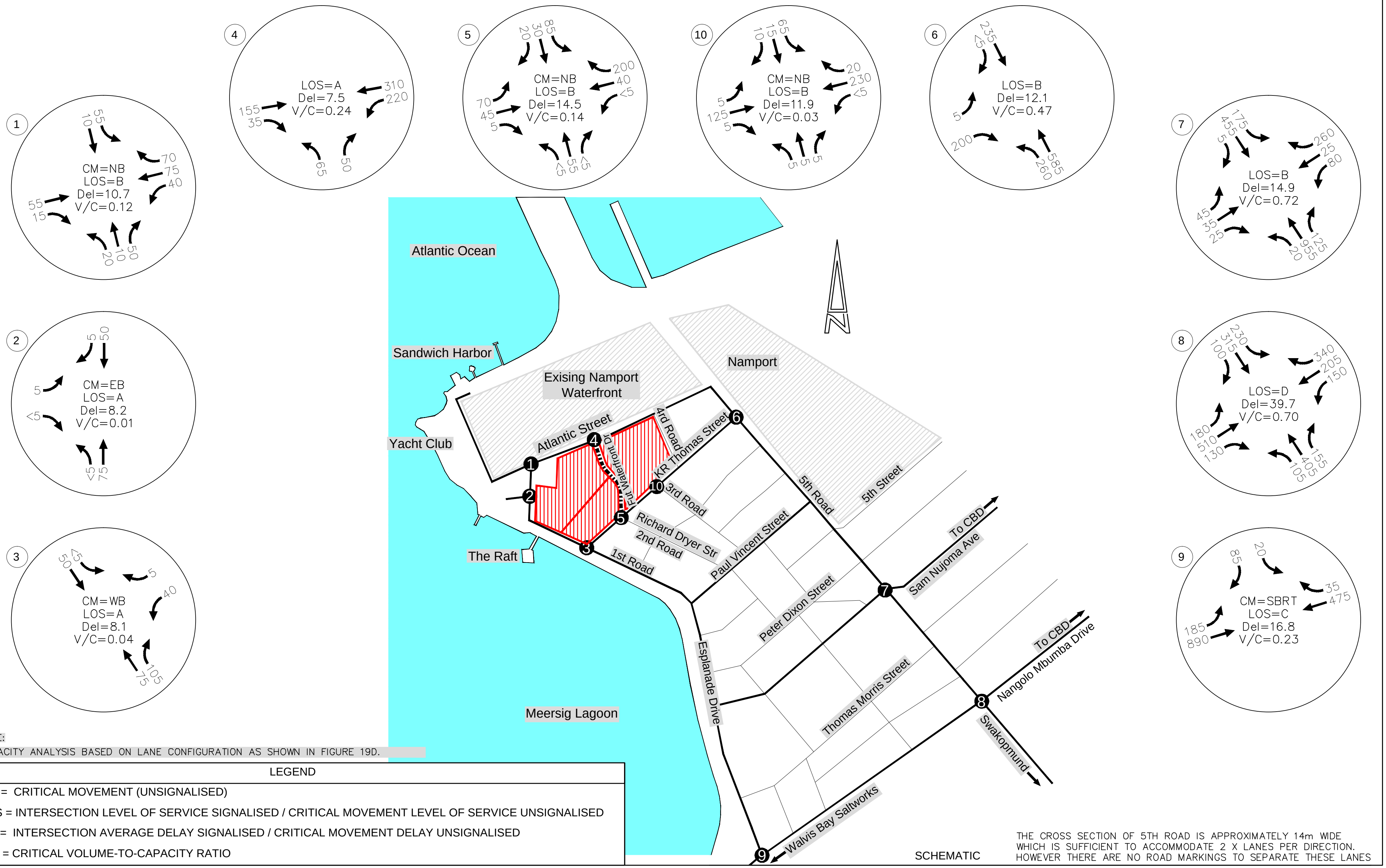
V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 9) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE - SATURDAY PEAK HOUR	20C



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 10) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE WITH NAMPORT DEVELOPMENT TRIPS - A.M. PEAK HOUR	21A

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

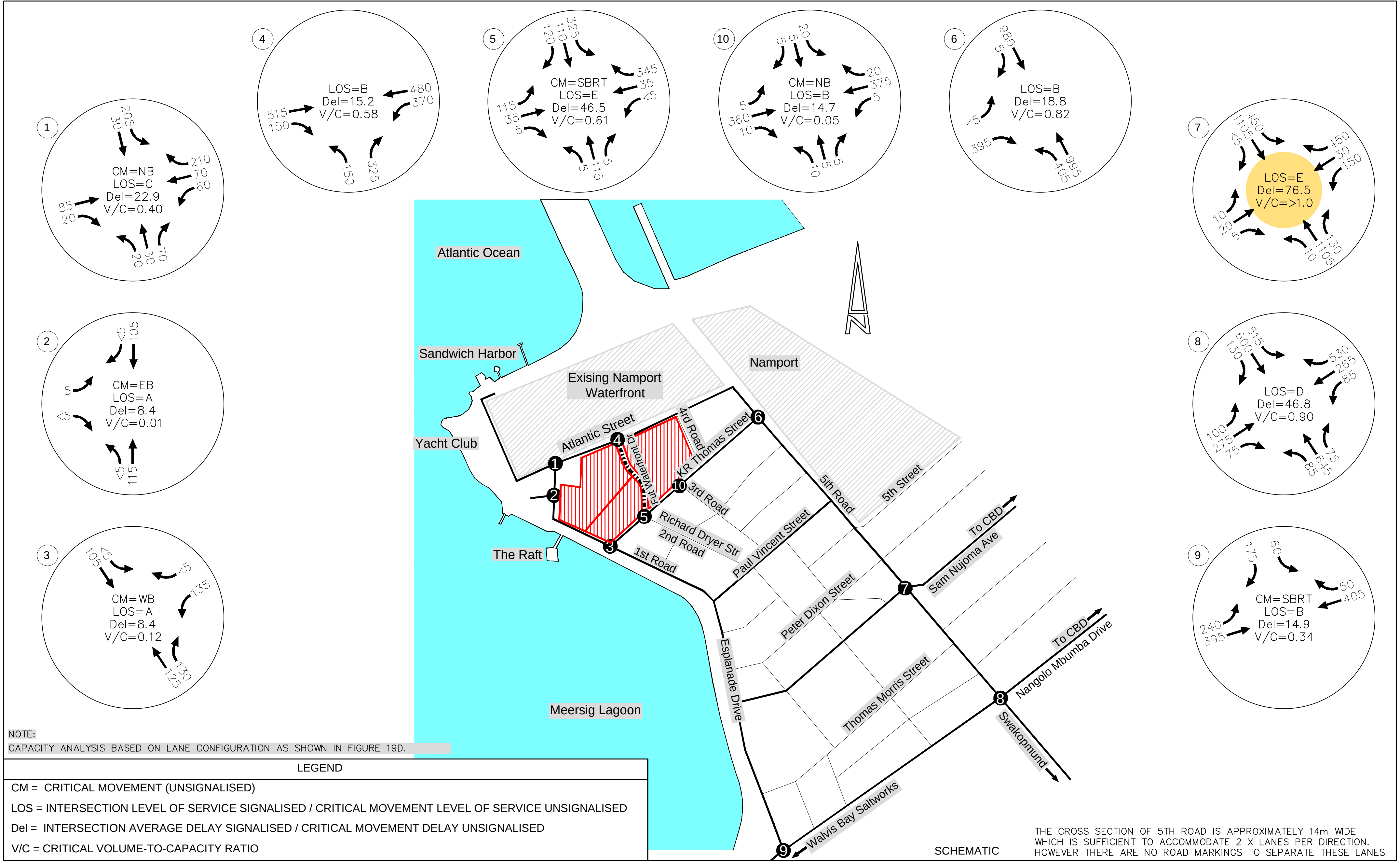
CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 10) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE WITH NAMPORT DEVELOPMENT TRIPS - P.M. PEAK HOUR	21B



NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN IN FIGURE 19D.

LEGEND

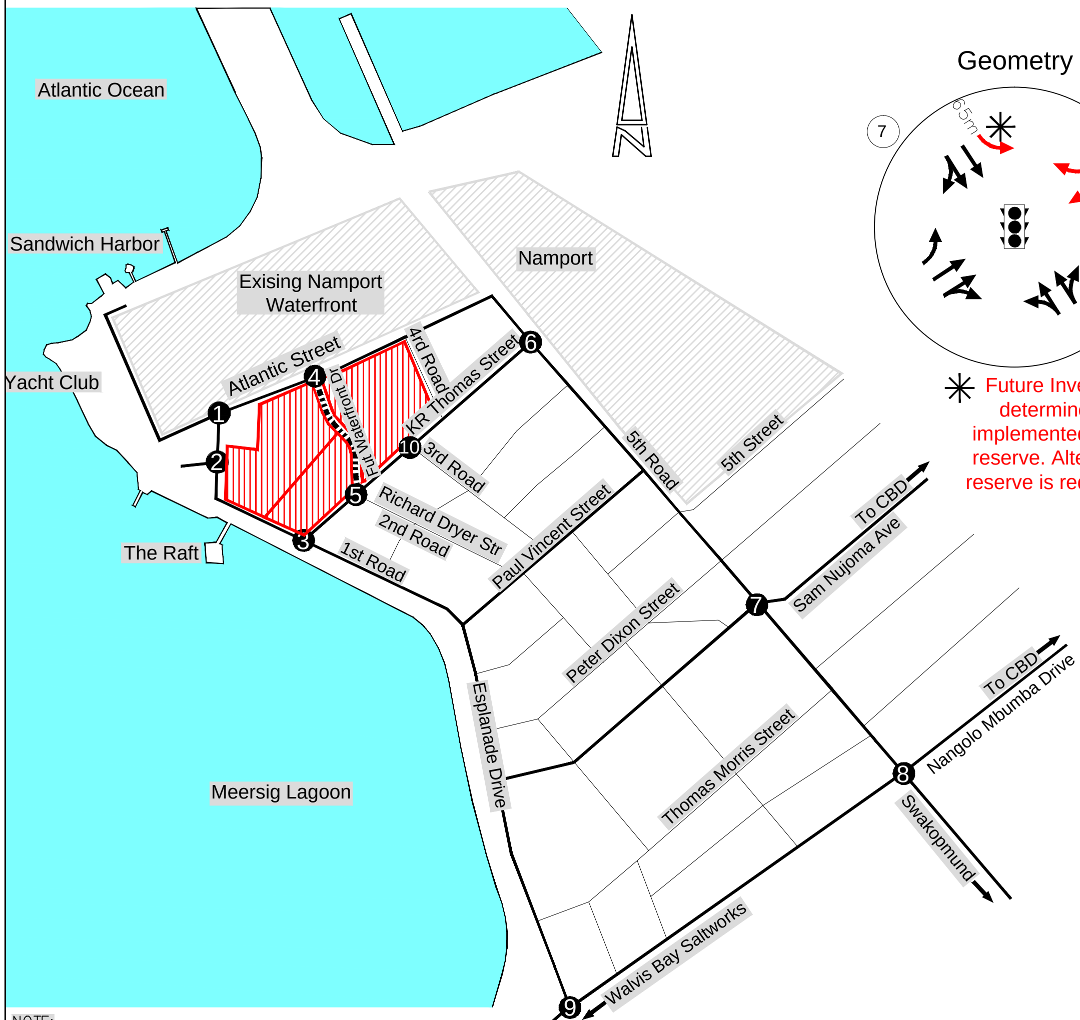
CM = CRITICAL MOVEMENT (UNSIGNALISED)

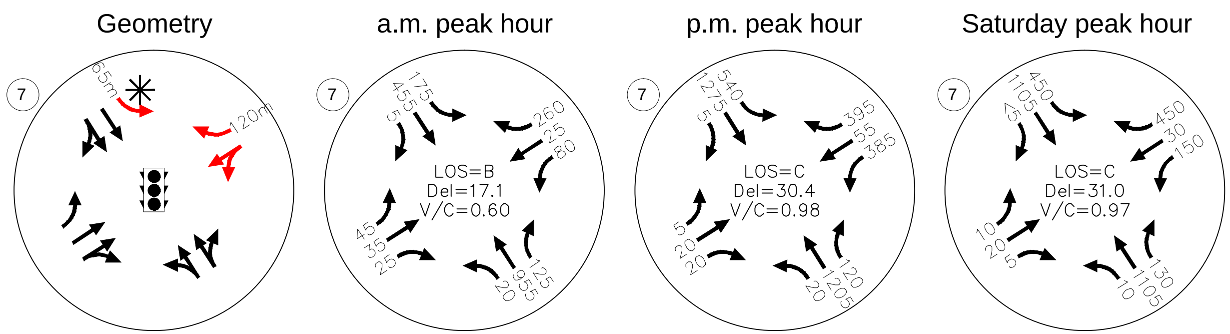
LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 10) FULL WATERFRONT DEVELOPMENT + 25 000m² RETAIL AND 12 600m² OFFICE SPACE WITH NAMPORT DEVELOPMENT TRIPS - SATERDAY PEAK HOUR	21C





Future Investigation is required to determine this upgrade can be implemented within the existing road reserve. Alternatively additional road reserve is required to do this upgrade.

NOTE:
CAPACITY ANALYSIS BASED ON LANE CONFIGURATION AS SHOWN on this figure .

LEGEND

CM = CRITICAL MOVEMENT (UNSIGNALISED)

LOS = INTERSECTION LEVEL OF SERVICE SIGNALISED / CRITICAL MOVEMENT LEVEL OF SERVICE UNSIGNALISED

Del = INTERSECTION AVERAGE DELAY SIGNALISED / CRITICAL MOVEMENT DELAY UNSIGNALISED

V/C = CRITICAL VOLUME-TO-CAPACITY RATIO

PROPOSED SCENARIO 3 UPGRADES

SCHEMATIC

THE CROSS SECTION OF 5TH ROAD IS APPROXIMATELY 14m WIDE WHICH IS SUFFICIENT TO ACCOMMODATE 2 X LANES PER DIRECTION. HOWEVER THERE ARE NO ROAD MARKINGS TO SEPARATE THESE LANES

PROJECT:	FIGURE:	NUMBER:
WALVIS BAY WATERFRONT DEVELOPMENT	2022 TOTAL TRAFFIC (SCENARIO 10) PROPOSED GEOMETRY AND OPERATIONS	21D

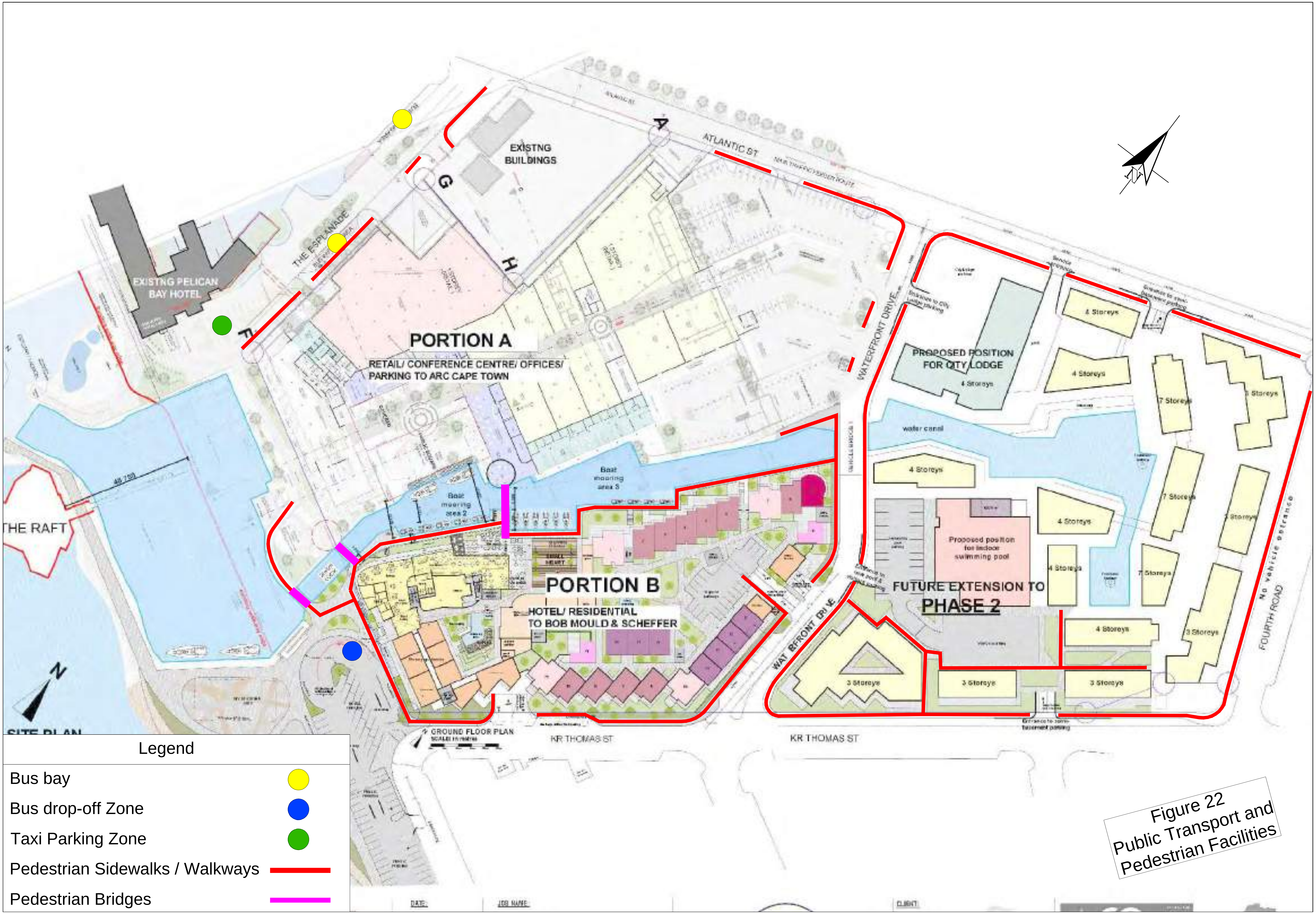


Figure 22
Public Transport and Pedestrian Facilities

Annexure B - Tables

Table 2: Trip Generation Rates – Phase 1A

Land Use	Units	Source	Size	Weekday AM Peak Hour					Public Transport
				Rate	In	Out	Internal	Pass-by	
Retail	m^2	COTO 820	10 000	1,53	65%	35%	15%	0%	20%
Restaurant	m^2	COTO 150	3 750	0,75	70%	30%	10%	0%	20%
Conference Centre	seats	COTO 780	1 000	0,50	90%	10%	10%	0%	20%
Office	m^2	COTO 710	7 400	2,10	85%	15%	20%	0%	20%
Land Use	**Units**	**Source**	**Size**	**Weekday PM Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Retail	m^2	COTO 820	10 000	8,69	50%	50%	10%	10%	20%
Restaurant	m^2	COTO 150	3 750	11,80	40%	60%	10%	0%	20%
Conference Centre	seats	COTO 780	1 000	0,50	10%	90%	5%	0%	20%
Office	m^2	COTO 710	7 405	2,10	20%	80%	15%	0%	20%
Land Use	**Units**	**Source**	**Size**	**Saturday Lunch Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Retail	m^2	COTO 820	10 000	11,50	50%	50%	10%	10%	20%
Restaurant	m^2	COTO 150	3 750	11,00	60%	40%	15%	0%	20%
Conference Centre	seats	COTO 780	1 000	0,25	50%	50%	10%	0%	20%
Office	m^2	COTO 710	7 405	0,45	55%	45%	10%	0%	20%

Table 3: Expected Development Trips – Phase 1A

Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Driveway Trips	100	54	153	434	434	869	575	575	1150
Restaurant		20	8	28	177	266	443	248	165	413
Conference Centre		450	50	500	50	450	500	125	125	250
Office		132	23	155	31	124	156	18	15	33
Total		701	135	837	693	1274	1967	966	880	1846
Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Driveway Trips minus public transport	70	38	107	304	304	608	403	403	805
Restaurant		14	6	20	124	186	310	173	116	289
Conference Centre		315	35	350	35	315	350	88	88	175
Office		92	16	109	22	87	109	13	10	23
Total		491	95	586	485	892	1377	676	616	1292
Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Internal Trips	15	8	23	43	43	87	58	58	115
Restaurant		2	1	3	18	27	44	37	25	62
Conference Centre		45	5	50	3	23	25	13	13	25
Office		26	5	31	5	19	23	2	1	3
Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Pass-by Trips	0	0	0	4	4	9	6	6	12
Restaurant		0	0	0	0	0	0	0	0	0
Conference Centre		0	0	0	0	0	0	0	0	0
Office		0	0	0	0	0	0	0	0	0
Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Public Transport trips	10	5	15	43	43	87	58	58	115
Restaurant		2	1	3	18	27	44	25	17	41
Conference Centre		45	5	50	5	45	50	13	13	25
Office		13	2	16	3	12	16	2	1	3
Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Retail	Net New Trips	65	35	100	300	300	600	397	397	794
Restaurant		14	6	20	124	186	310	161	107	268
Conference Centre		315	35	350	38	338	375	88	88	175
Office		79	14	93	20	81	101	13	10	23
TOTAL TRIPS		473	90	563	481	904	1385	658	602	1260

Table 4: Trip Generation Rates – Phase 1B

Land Use	Units	Source	Size	Weekday AM Peak Hour					Public Transport
				Rate	In	Out	Internal	Pass-by	
Hotel	Rooms	COTO310	140	0,50	60%	40%	10%	0%	15%
Residential (Flats)	Units	COTO220	120	0,65	25%	75%	10%	0%	15%
Land Use	**Units**	**Source**	**Size**	**Weekday PM Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Hotel	Rooms	COTO310	140	0,50	55%	45%	10%	0%	15%
Residential (Flats)	Units	COTO220	120	0,65	70%	30%	10%	0%	15%
Land Use	**Units**	**Source**	**Size**	**Saturday Lunch Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Hotel	Rooms	COTO310	140	0,70	50%	50%	10%	0%	15%
Residential (Flats)	Units	COTO220	120	0,35	50%	50%	10%	0%	15%

Table 5: Expected Development Trips – Phase 1B

Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Hotel	Driveway Trips	42	28	70	39	32	70	49	49	98
Residential (Flats)		20	59	78	55	23	78	21	21	42
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Driveway Trips minus public transport	29	20	49	27	22	49	34	34	69
Residential (Flats)		14	41	55	38	16	55	15	15	29
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Internal Trips	4	3	7	4	3	7	5	5	10
Residential (Flats)		2	6	8	5	2	8	2	2	4
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Public transport trips	4	3	7	4	3	7	5	5	10
Residential (Flats)		2	6	8	5	2	8	2	2	4
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Net New Trips	29	20	49	27	22	49	34	34	69
Residential (Flats)		14	41	55	38	16	55	15	15	29
TOTAL TRIPS		43	61	104	65	38	104	49	49	98

Table 6: Trip Generation Rates – Phase 2

Land Use	Units	Source	Size	Weekday AM Peak Hour					Public Transport
				Rate	In	Out	Internal	Pass-by	
Hotel	Rooms	COTO310	120	0,50	60%	40%	10%	0%	15%
Residential (Flats)	Units	COTO220	282	0,65	25%	75%	10%	0%	15%
Land Use	**Units**	**Source**	**Size**	**Weekday PM Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Hotel	Rooms	COTO310	120	0,50	55%	45%	10%	0%	15%
Residential (Flats)	Units	COTO220	282	0,65	70%	30%	10%	0%	15%
Land Use	**Units**	**Source**	**Size**	**Saturday Lunch Peak Hour**					**Public Transport**
				Rate	**In**	**Out**	**Internal**	**Pass-by**	
Hotel	Rooms	COTO310	120	0,70	50%	50%	15%	0%	15%
Residential (Flats)	Units	COTO220	282	0,35	50%	50%	15%	0%	15%

Table 7: Expected Development Trips – Phase 2

Land Use	Trip type	Weekday AM			Weekday PM			Saturday Lunch		
		In	Out	Total	In	Out	Total	In	Out	Total
Hotel	Driveway Trips	36	24	60	33	27	60	42	42	84
Residential (Flats)		46	137	183	128	55	183	49	49	99
Total		82	161	243	161	82	243	91	91	183
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Driveway Trips minus public transport	25	17	42	23	19	42	29	29	59
Residential (Flats)		32	96	128	90	38	128	35	35	69
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Internal Trips	4	2	6	3	3	6	6	6	13
Residential (Flats)		5	14	18	13	5	18	7	7	15
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Public transport trips	4	2	6	3	3	6	4	4	8
Residential (Flats)		5	14	18	13	5	18	5	5	10
Land Use	**Trip type**	**Weekday AM**			**Weekday PM**			**Saturday Lunch**		
		In	**Out**	**Total**	**In**	**Out**	**Total**	**In**	**Out**	**Total**
Hotel	Net New Trips	25	17	42	23	19	42	27	27	55
Residential (Flats)		32	96	128	90	38	128	32	32	64
TOTAL TRIPS		57	113	170	113	57	170	59	59	119

Annexure C - Photographs

Photo 1: North-Westbound View along 5th Road approaching KR Thomas Str

Photo 2: North-Eastbound View along KR Thomas at 5th Road intersection

Photo 3: South-Eastbound View along 5th Road at KR Thomas Street

Photo 4: North-Westbound View along 5th Road approaching Atlantic Street

Photo 5: North-Eastbound View along Sam Nujoma Ave approaching 5th Rd

Photo 6: South-Eastbound View along 5th Road at Sam Nujoma Ave

Photo 7: South-Westbound View along Sam Nujoma at 5th Road

Photo 8: North-Westbound View along 5th Road approaching Sam Nujoma

Photo 9: North-Eastbound View along Nangolo Mbumba Dr at 5th Rd

Photo 10: South-Eastbound View along 5th Road at Nangolo Mbumba Dr

Photo 11: South-Westbound View along Nangolo Mbumba Dr at 5th Road

Photo 12: North-Westbound View along 5th Road at Nangolo Mbumba

 **Photo 13: North-Eastbound View along Nangolo Mbumba at Esplanade Str**	 **Photo 14: South-Eastbound View along Esplanade Str at Nangolo Mbumba**
 **Photo 15: South-Westbound View along Nangolo Mbumba at Esplanade Str**	

WALVIS BAY – WATERFRONT DEVELOPMENT:

POTENTIAL EFFECTS ON BIRDS OF THE RAMSAR SITE

Prepared for: ENVIRONMENTAL COMPLIANCE CONSULTANCY

Prepared by: BIRDS & BATS UNLIMITED Environmental Consultants www.birds-and-bats-unlimited.com

1 INTRODUCTION

The Walvis Bay waterfront and marina is a new development proposed by Walvis Bay Waterfront (Pty) Ltd in 2017, on the edge of the mouth of the Walvis Bay lagoon. Walvis Bay is a natural embayment on the edge of the Namib Desert that is a wetland, internationally renowned for its diversity and abundance of coastal birds. It holds the single largest accumulation of coastal birds in southern Africa, as well as large numbers of cetaceans (Williams 1983, Wearne and Underhill 2005). As such it was proclaimed a Ramsar Wetland of International Importance in 1995, and is also ranked internationally as an Important Bird (IBA) by Birdlife International (Simmons et al. 1998).

The study of the impacts on the avifauna is triggered under Namibia's Environmental Management Act of 2007 (EMA) and the EIA specifically addresses the effects that the new marina and waterfront development will have on the avifauna of Walvis Bay. The report also provides mitigation measures and alternatives where these are deemed necessary to avoid high impacts.

The development is not large, relative to other on-going construction in the Walvis Bay environs, but it may impact on the mouth leading into the lagoon. The lagoon is already under pressure from wind-blown sediment from the east and increasing organic material accreting in the southern sections.

This report focusses on the effects that the marina itself will have on the prolific birdlife of the area, both within the immediate environs around the marina and waterfront (e.g. noise, light pollution), and "downstream" in the lagoon where sedimentation is a challenge to the long-term future of the lagoon.

Thirty years of twice-yearly bird counts are available from the 1980s to determine long-term avian trends (Wearne and Underhill 2005, Simmons et al. 2015). We also use the fact that the new Walvis Bay container port, under construction since January 2015, may reduce water flow and increase sedimentation in the lagoon. If this affects the birds using the lagoon we should detect a decrease in avian abundance or species diversity in a before-and-after comparison either side of January 2015. This is a report of our findings.

Overall migrant birds have been declining in abundance, while resident and intra-African migrant are stable, or increasing, at Walvis Bay over 30 years.

Depending on the configuration of the protective breakwater for the marina mouth, the flow of the main channel may be intersected, increasing sedimentation down-stream.

1.1 Consultant's Declaration of Independence

Birds & Bats Unlimited are independent consultants to Environmental Compliance Consultancy (Pty) Ltd. They have no business - financial, personal or other interest in the activity, application or appeal other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of the specialists performing such work.

1.2 Qualifications of Specialist Consultant

Birds & Bats Unlimited Environmental Consultants (http://www.birds-and-bats-unlimited.com/), were approached to undertake the specialist avifaunal assessment for the proposed Walvis Bay waterfront and marina and its potential effects on the Ramsar site. Dr Rob Simmons is an ornithologist, with 35 years' experience in avian research and impact assessment work. He was Namibia's state ornithologist for 14 years heading up the research and conservation on wetland and endemic birds, culminating in the first Namibian Red Data book on birds in 2015. He has published over 100 peer-reviewed papers and 2 books, (see http://www.fitzpatrick.uct.ac.za/fitz/staff/research/simmons for details). More than 64 projects and assessments over 23 habitats have been undertaken throughout Namibia, South Africa and Lesotho. He also undertakes long-term research on threatened species (raptors, flamingos and terns) and predators (cats) at the FitzPatrick Institute, UCT.

Marlei Martins, co-director of Birds & Bats Unlimited, has over 6 years' consultancy experience in avian wind farm impacts as well as 20 years in environmental issues and rehabilitation. She has been employed by several consultancy companies throughout South Africa because of her expertise in this field. She has published papers on her observations including a new species of raptor to South Africa (http://www.birds-and-bats-unlimited.com/).

2 TERMS OF REFERENCE

The desk-top study and research includes the following components (as sent by Jessica Mooney of Environmental Compliance Consultancy, 16 March 2017)

- An overview of birds likely to be encountered in the Walvis Bay area including Palaearctic migrant birds;
- A discussion of the potential environmental impact of the construction of the proposed waterfront on said birds, along with suggested mitigation measures;

- The potential environmental impact of prospective daily operational activities associated with the completed waterfront development on said birds, along with suggested mitigation measures;
- MET requests that the study addresses the impacts of lights on the birds in the lagoon and provide alternatives;
- Impacts to the food sources for bird life (e.g. plant life, algae, fish etc.);
- The potential environmental impacts of the waterfront on the RAMSAR site, and
- Any other impacts that may be identified that should be included.

2.1 Need for Proposed Avian Assessment

Birds are known to be impacted directly and indirectly by developments, particularly those around wetlands that are often centers of biological diversity in Namibia (Breen 1991, Barnard 1998). Walvis Bay, the focus of this report, is internationally recognized for its birdlife, and is a proclaimed Ramsar site, and an important bird area (IBA). As such, the development of a waterfront marina triggers an Environmental Impact Assessment under the EMA of 2007, to determine the impacts of the development on the avifauna of the Ramsar site. The Environmental Management Act (2007) promulgated in December 2007 falls under the jurisdiction of the Directorate of Environmental Affairs (DEA), in the Ministry of the Environment and Tourism. Its objectives are to (i) ensure that the significant effects of activities on the environment are considered carefully and timeously; (ii) ensure that there are opportunities for timeous participation by interested and affected parties throughout the assessment process; and (iii) ensure that findings are taken into account before any decision is made in respect of activities.

3 BACKGROUND TO WALVIS BAY AS A BIRD-RICH WETLAND

Walvis Bay is a natural embayment of approximately 70 km^2 in extent on the arid Namib desert coast that holds hundreds of thousands of wetland birds in summer and winter. It vies with Sandwich Harbour (55 km south) as the single-most important wetland in southern Africa in terms of avian biomass and diversity (Williams 1987, Simmons et al. 1998, Wearne and Underhill 2005). The reasons for this can be traced to one of the world's strongest upwelling cells (Sakko 1998) that bring nutrient-rich waters into the protected bay twice a day. The entire central coast benefits from these upwellings (at their most powerful in Lüderitz) because of on-shore winds at certain times of year, and the long-shore Benguela currents that bring the nutrient-rich water from the south (Simmons 1997, Molloy and

Reinikainen 2003). This increases primary productivity in these areas and supports a rich and abundant avian birdlife dominated by wading birds.

Consequently, Walvis Bay is a Ramsar site - a Wetland of International Importance – as well as one of 21 Important Bird Area (IBAs) (Simmons et al. 1998). Namibia acceded to the Ramsar Convention in 1995 and has registered 4 sites of International Importance: Walvis Bay; Sandwich Harbour; Etosha Pan and the Cuvelai Drainage; and the Orange River mouth (jointly with South Africa). The mission of the Ramsar Convention is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world" (http://www.ramsar.org/about/the-ramsar-convention-and-its-mission)

The importance of Walvis Bay as a destination for large numbers of migrant waders and resident species has been recognised since formal counts were undertaken in 1977 (Underhill & Whitelaw 1977). The bay holds substantial proportions of southern Africa's waders (i.e. Charadriidae waders, flamingos, and oystercatchers [Williams 1987, Simmons et al. 1998, Wearne and Underhill 2005]). Peak counts up to 150 000 birds (below) comprise 50% intra-African migrants, 45% Palearctic migrants and 5% residents (Noli-Peard and Williams 1991).

Migrant birds join the resident waders in August, to reach a peak in abundance from September to February in the austral summer, and start to move north in March to April (Hockey et al. 2005). Thus, Walvis Bay acts as a reservoir and destination for both Palearctic migrant waders (e.g. Curlew Sandpipers *Calidris ferruginea*, Red Knot *Calidris canutus,* Little Stint *Calidris minuta)* as well as intra-African migrants (e.g. Greater *Phoenicopterus ruber* and Lesser Flamingo *Phoenicopterus minor* and Chestnut-banded Plover *Charadrius pallidus*).

Counts have been undertaken for over 30 years at the wetland (Bridgeford 2013), and several papers and popular articles have highlighted the trends and compared them with adjacent wetlands. We sourced these and present the results here.

3.1 How does Walvis Bay rank in terms of waders relative to other southern African wetlands?

Walvis Bay and Sandwich Harbour occur as the top two wetlands in southern Africa in terms overall abundance of wading birds. The figures in Table 1 give the maximum numbers of birds at any one time for southern Africa's top 10 wetlands (in terms of avian abundance). They indicate that Walvis Bay has almost 10-fold as many birds at the maxima than any other wetland - other than Sandwich Harbour. These figures are swollen by massive numbers of Common and Black Terns at certain times numbering in the hundreds of thousands. A more accurate assessment, therefore, is the average numbers of waders over the entire period (Table 2).

Table 1. Top 10 coastal wetlands in southern Africa according to maximum counts of wading birds.

Wetland site	Maximum numbers (species richness) of waders	Reference
Walvis Bay Lagoon, Namibia	242,920 (51)	Wearne and Underhill (2005)
Sandwich Harbour, Namibia	401,806 (50)	Simmons et al. (2015)
Langebaan Lagoon, South Africa	38,901	Taylor *et al*. 1999
Swartkops River Estuary, South Africa	14,730	Taylor *et al*. 1999
Voëlvlei, Mossel Bay, South Africa	12,021	Taylor *et al*. 1999
Berg River Estuary, South Africa	11,614	Taylor *et al*. 1999
Baia dos Tigres, Angola	11,000 (25)	Simmons et al. 2006
Lake St Lucia, KZN	9,594	Taylor et al. 1999
Rietvlei, Cape Town	6,130	Taylor *et al*. 1999
Cunene River mouth Angola/Namibia	5,197	Anderson et al. 2001

The median number of wading birds found at Walvis Bay over a 30-year period was higher than at Sandwich Harbour (Table 2). This indicates that Walvis Bay - more consistently - holds larger numbers of birds than any other wetland in southern Africa. The numbers are highest in the austral summer when all the migrant waders congregate at the coastal wetlands. The winter numbers reflect, mainly, the resident species with a few over-wintering subadult migrants that do not head back to the northern hemisphere (Williams 1986).

Table 2. Median numbers of wading birds at Walvis Bay and Sandwich Harbour, summer and winter.

Wetland site	Median numbers of waders Summer : Winter	Number of counts and Reference
Walvis Bay Lagoon	155, 862 : 81, 854	N = 31, 31 (Wearne and Underhill 2005; Simmons et al. 2015)
Sandwich Harbour	96,146 : 52,386	N = 23, 24 (Simmons et al. 2015)

Red Data species and global proportions of each wader species

Biological value is not only measured in total numbers of species but also their significance in a global sense. For Ramsar qualification, a wetland must support 1% or more of the global flyway numbers of each species. Walvis Bay qualifies under these criteria for no less than 25 wetland species (Table 3) that reach or exceed 1% of the African flyway population in the terms of numbers on site (Wetlands International 2017).

Table 3. All wetland species in Walvis Bay that exceed the 1% population flyway threshold (Wetlands International 2017) for inclusion in the Ramsar criteria (after Wearne and Underhill 2005). Namibian Red Data species in red (Simmons et al. 2015).

Species	Maximum count (w= winter, s = summer)	1% threshold of flyway population	Palearctic Migrant (PM) Intra-African Migrant (I-AM) Resident (R)
Black-necked Grebe	13,129 (w)	150	I-AM
White Pelican	637 (s)	200	I-AM
White-breasted Cormorant	593 (w)	120	R
Cape Cormorant	10 850 (s)	2200	R
Greater Flamingo	43,679 (w)	750	I-AM
Lesser Flamingo	43,420 (w)	600	I-AM
Cape Teal	1,813 (s)	1,750	R
African Black Oystercatcher	184 (w)	55	R
Black-winged Stilt	768 (w)	230	I-AM
Pied Avocet	4,102 (w)	190	I-AM
Grey Plover	2,598 (s)	2,500	PM
Ringed Plover	4,545 (s)	1,900	PM
White-fronted Plover	3,108 (w)	180	R
Chestnut-banded Plover	8,428 (s)*	110	I-AM
Ruddy Turnstone	1,883 (s)	1,000	PM
Sanderling	15,169 (s)	1,200	PM
Little Stint	11,592 (s)	10,000	PM
Curlew Sandpiper	44,257 (s)	3,300	PM
Kelp Gull	5,053 (w)	700	R
Hartlaub's Gull	2,020 (s)	300	R
Black Tern	61,015 (s)	4,000	PM
Caspian Tern	116 (w)	15	I-AM
Swift Tern	811 (s)	200	I-AM
Sandwich Tern	1807 (s)	1,700	PM
Common Tern	93,617 (s)	6,400	PM
25 Species			**9 Palearctic migrants** **9 Intra-African migrants** **7 Residents**

* 47% of the world population

Red Data species

Of the 25 species that occur at Walvis Bay and exceed the 1% African fly-way population, 36% (9 of 25) species are threatened Red Data species (Table 3). Indeed, for one of these species, the Chestnut-banded Plover, the maximum numbers at Walvis Bay represent almost half (47%) of the world population (17 800) which includes the East African subspecies *C. p. venestus* (Simmons et al. 2007). For the southern African race (*C. p. pallidus*) alone the maximum Walvis Bay count represents 73% of the 11,500 birds estimated (Simmons et al. 2007).

Several other Red Data avian species also occur within the confines of Walvis Bay but in relatively small numbers. These include Damara Terns *Sterna balaenarum,* and Eurasian Curlew *Nemenius arquata.*

Long-term trends

To determine what influence any development has, in the short-term, on wetland bird numbers we need to understand the long-term population trends for all wader species. This has been undertaken for all main wader species over a 31-year period at Walvis Bay (Simmons et al. 2015) and the following trends were found:

- Significant **population declines** have occurred since the early 1990s in four of the 12 **long-distance migrants i**nvestigated (Turnstone, Ringed Plover, Red Knot, Little Stint);
- The most serious declines were for Little Stint and Ringed Plover, both with approximately 60–90% population declines;
- In contrast, **resident or short-distance migrant** wader populations all exhibited **stable or increasing** population levels relative to the early 1990s;
- Population levels increased for White-fronted Plover (*Charadrius marginatus*), Chestnut-banded Plover, Black-winged Stilt (*Himantopus himantopus*), Pied Avocet (*Recurvirostra avosetta*), and Greater Flamingo (*Phoenicopterus ruber*) relative to the early 1990s;
- The most abundant waders in these wetlands, Curlew Sandpiper and Sanderling (*Calidris alba*), had stable populations, although both populations may have had slightly higher levels from 2005 to 2006. Both species showed a marked drop in winter counts, especially in 2009 and 2010.

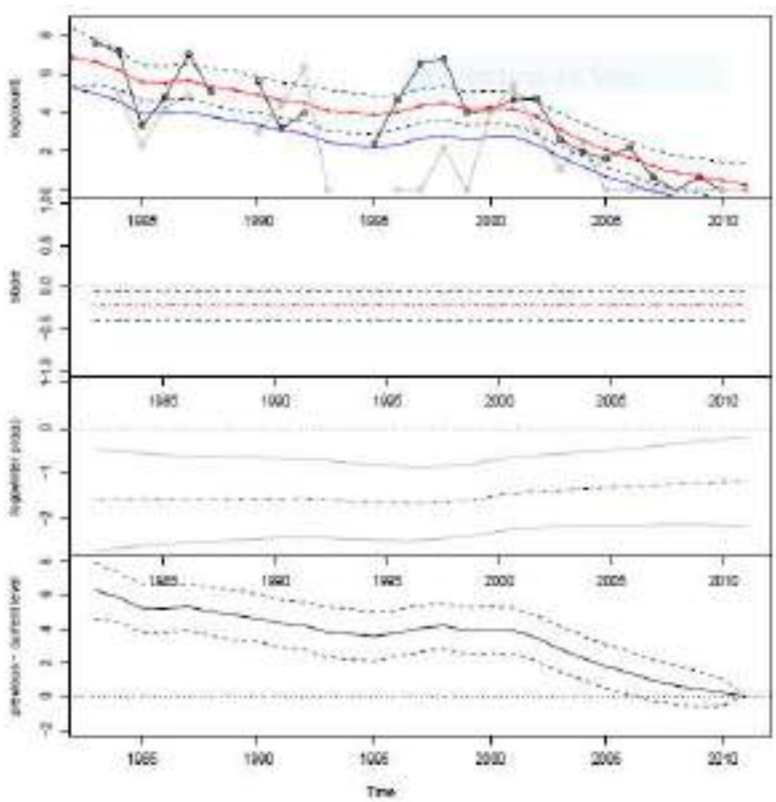


Figure 1: An example of long-term (31 year) population declines in long-distance migrants at Walvis Bay: **Red Knot.**

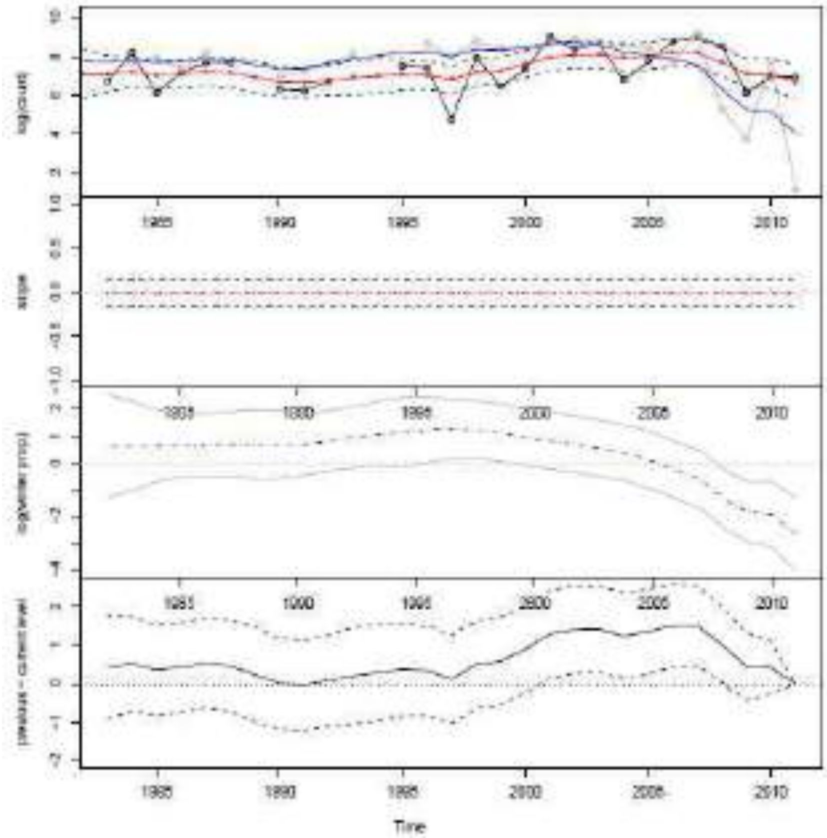


Figure 2: An example of long-term (31 year) population stability for a Red Data, short-distance migrant at Walvis Bay: **Chestnut-banded Plover**

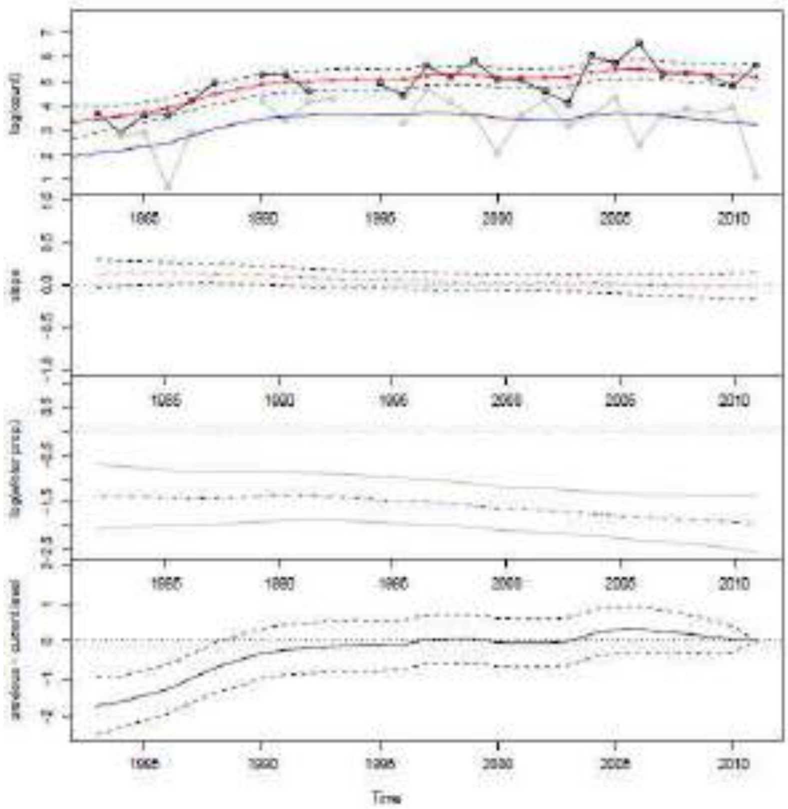


Figure 3: An example of long-term (31 year) population increase for a resident wader at Walvis Bay: **Common Greenshank**

Overall, despite the declines exhibited by some long-distance (Palearctic) migrants, and the stability or increases in resident species, we found no differences between Walvis Bay and Sandwich Harbour (Simmons et al, 2015). This suggests that Walvis Bay showed no adverse effects of the harbour facilities of the time or the potential dangers of pollution from bilge water, or oils. However, this is not true of the lagoon (below).

3.2 How important is the Lagoon: proportions and declines in birds using the lagoon?

Given that the most likely effects of the waterfront and marina will be on the birds of the lagoon, we need to determine what proportions, and which species, the lagoon supports of all Walvis Bay birds.

According to Williams (1997) the lagoon holds about 40% of the total number of waders found in the Walvis Bay wetland (Table 4). The maximum number of waders using the lagoon over this period was about 20 000. Given that the lagoon represents a biologically active area of 9 km^2 in a wetland (including salt works) of ~70km^2, the lagoon is approximately 13% of the total area (Figure 4). That it holds 40% of the waders indicates its high importance to the avian community in Walvis Bay.

For individual species, the proportion using the lagoon varied from 72% for Bar-tailed Godwits to 16% for Lesser Flamingos in the 1990s (Table 4).

Table 4: The maximum numbers (and proportions) of waders, terns and flamingos using the lagoon in the late 1990s (Williams 1997) vs 2013-2017 (this study).

Species (max all of Walvis Bay, 1997)	**Proportion of birds in Lagoon (max counts)**	
	1990s	**2013-2017**
Curlew Sandpiper (24 600)	9 600 (39%)	5 246 (decrease)
Little Stint (6 336)	2 406 (38%)	368 (decrease)
Sanderling (10 500)	4 100 (39%)	1 849 (decrease)
Chestnut-b Plover (6 953)	1 234 (18%)	3 027 (increase)
Grey Plover (3 440)	1 100 (32%)	775 (decrease)
Red Knot (1 850)	1 000 (54%)	3 (decrease)
Bar-tailed Godwit (903)	650 (72%)	888 (increase)
All waders (50 000)	**~20 000 (40%)**	**11 674 (42% decrease)**
Terns+Gulls		
Sandwich Tern (920)	397 (43%)	372 (decrease)
Common Tern (19 880)	5 963 (30%)	1 507 (decrease)
Damara Tern (392)	177 (45%)	79 (decrease)
Caspian Tern (129)	64 (50%)	58 (decrease)
Hartlaub's Gull (1145)	812 (71%)	324 (decrease)
Flamingos:		
Greater Flamingo (25 166)	13 003 (52%)	12 085 (decrease)
Lesser Flamingo (35 126)	5 759 (16%)	13 028 (increase)

We re-assessed the maximum numbers of waders using the lagoon (employing the same counting methods as Williams) from data provided by P Bridgeford, national coordinator for the Walvis Bay wetland count. We also took maximum count for each species and summed the maximums to derive the total number of birds. The data period from the last 4 years (February 2013 – February 2017) covered all winter (July) and summer (January) counts.

We found:

- Over the last 4 years the maximum number of waders using the lagoon was 11 674 (Table 4);
- That represents a decrease of ~42% in waders using the lagoon in the 20-year period from the mid-1990s to 2015 (mid-point of 2013-2017 counts);
- The 11 674-lagoon count represents just 12% of the present day maximum total of 100 835 waders recorded at Walvis Bay (Wearne and Underhill 2005);
- 11 of the 14-species recorded declined in maximum numbers in the lagoon;
- One species, the Red Knot, virtually disappeared from the lagoon (3 birds counted) having supported almost 1 000 birds 20 years before;
- One species of flamingo (Greater) declined and the other (Lesser) increased in their use of the lagoon (Table 4);
- Of the five Red Data species found in significant numbers in the lagoon, two species (Chestnut-banded Plover, Lesser Flamingo) showed increasing numbers, while three species exhibited declines;
- Two species that prefer saline saltpans (Chestnut-banded Plover and Lesser Flamingo : Turpie 2005, Simmons 2005) both increased in number in the lagoon, suggesting that conditions there are becoming more saline.

Thus, for the majority of comparisons, the species in the lagoon showed declining numbers; and overall abundance has dropped 42% in the 20 years since the mid-1990s (Table 4). Given that long-term trends (Simmons et al. 2015) show only four of the 12 long-distance migrants and none of the resident species have declined overall in the Walvis Bay wetland in the last 30 years, these declines in the lagoon cannot be explained by broad-scale declines. We, thus, conclude that it is the lagoon environment itself that is the cause of these avian declines.

Figure 4: The ~70 km^2 extent of the biologically active Walvis Bay wetland (red polygon) in relation to the lagoon (green polygon) of ~9km^2. The lagoon held about 40% of the waders at Walvis Bay in 1997, despite comprising just 13% of the entire wetland.

3.3 What is causing avian declines in the lagoon environment?

To determine what the reasons might be for the declines in the lagoon we asked: Are the declines associated with the port expansion? We suggest that the expansion of the container port might reduce the flow or amplitude of water into the lagoon and, thereby, increase sedimentation in the lagoon. More sediment may decrease feeding opportunities, decreasing the likelihood that wading birds will use the area. A prediction of this scenario is that a decline in bird numbers should be seen after the port expansion began construction in January 2015 (Google Earth images in Figure 5a and b).

Figure 5a: Google Earth images indicating Walvis Bay and lagoon prior to port expansion in August 2014 (left) and after expansion in January 2015 (right).

We found, as expected, a decrease in the average number of wetland birds using the lagoon immediately after port expansion (Figure 6). The average numbers dropped from 21 078 to 17 406 birds, a decline of 17% in 4 years. The long-term decline in wader numbers of ~42% over a 20-year period (1997 – 2017), reported above, gives an average rate of decline of approximately 2.1% per year.

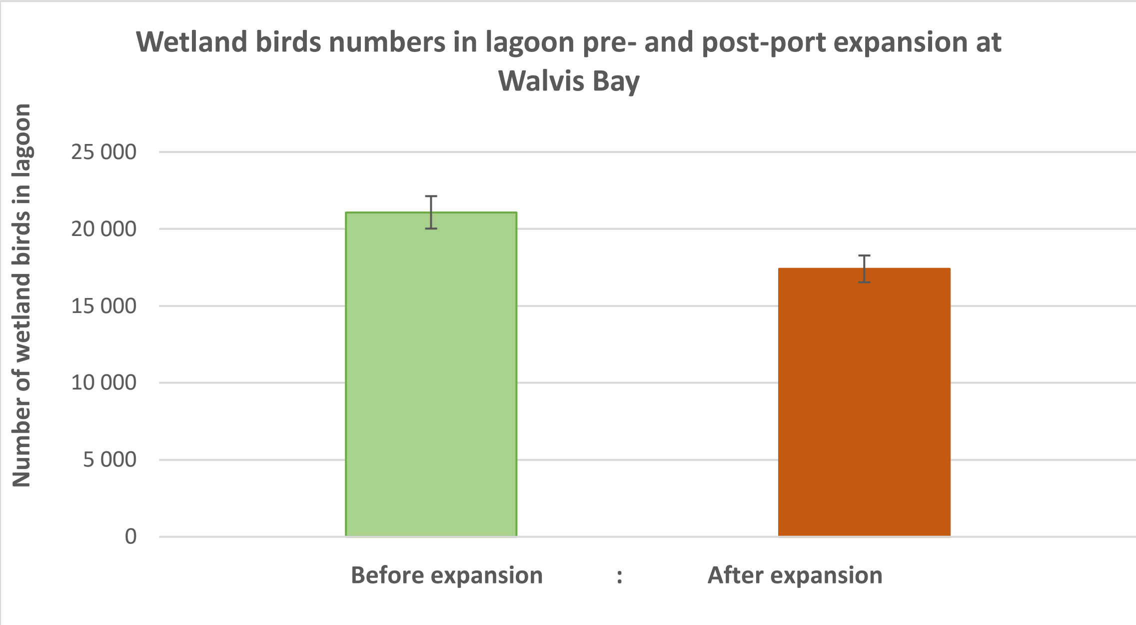


Figure 6: Average numbers of wetland birds recorded in the Walvis Bay lagoon 2 years before and 2 years after the port expansion (January 2015). Winter and summer counts from 2013-2014 (before) were compared to winter and summer counts from 2015-2016 (after).

Therefore, the decline in average numbers of 17% in 4 years before and after the port expansion is double that expected over the same time of (4y x 2.1% =) 8.4%.

This does not prove that the port expansion caused the decline of birds using the lagoon, but the fact that it is associated temporally with it, and doubled the rate of decline over a short period, strongly suggests the two are linked.

This suggests that any additional impacts (such as sedimentation, salinization, pollution or disturbance) caused by the construction of the Walvis Bay waterfront must be strictly minimised to reduce any additional impacts.

4 POTENTIAL IMPACT TO WALVIS BAY BIRDS FROM DEVELOPMENT

Key environmental issues

The main environmental impacts previously associated with developments in Walvis Bay include the following (summarised from Environmental Evaluation Unit [1999] and Namport Walvis Bay EIA study [2009]).

- **Environmental impact of the construction:**
  - Construction may include blasting, dredging,
  - noise of construction.

- **Environmental impact of prospective daily operational activities**
  - The waterfront shops and human activity,
  - Marina itself, noise, lights, pollution, increased water craft traffic.

- **Impacts of lights on the birds in the lagoon and alternatives;**
  - Bright lights are known to attract some night-flying birds and migrants,
  - Collisions with high-rise buildings or tall masts with bright lights.

- **Downstream impacts on avian food sources**
  - Sedimentation from dredging can smother avian foraging habitats,
  - Decreased water flow through lagoon can reduce tidal flushing,
  - Decreased tidal flushing will reduce the invertebrate fauna (Currie 1997),
  - Pollution (e.g. fish or engine oils) introduced to the lagoon (Currie 1997).

We have ranked these in terms of their potential impacts on the abundant birdlife in the lagoon in (Table 5). We have also provided mitigations.

Table 5: Key environmental issues, implications and mitigations arising from the development of the Walvis Bay waterfront and marina on the birds of the Ramsar site.

Potential impact	Reason for impact	Mitigation	Comment/significance
Construction phase: ➢ **Blasting causing disturbance to feeding or breeding birds** ➢ **Dredging operations** ➢ **Spillage of building materials, especially pollutants**	Sudden noise of **blasting** causes feeding birds to fly = reduced energy intake and relocate to less productive areas away from source of noise. **Dredging** operations release sediments and organic material that may smother habitats downstream on incoming tides, adding to the already sediment-rich and over-loaded southern sections of the lagoon. **Spillage** of construction materials including cement, oils and heavy metals	**Main construction** should avoid the main concentration of birds that occur chiefly in the summer months when the long-distance migrants are present. Dredging should avoid incoming tides which will add sediment down-stream into the lagoon, further smothering the feeding areas of the bird life. Strict guidelines to be followed for all waste products from the buildings	The best months for any blasting and dredging are in winter from May to August Out-going neap tides are best to avoid sediment. Research and monitoring of sediments must be ongoing and close down dredging activities if sediment loads are found to increase beyond acceptable levels. This is ranked as low-medium impact with low-medium significance with medium-term effects. With mitigation can be reduces to low/acceptable levels.
Environmental impact of prospective daily operational activities: ➢ **Waterfront and shops** ➢ **Marina traffic**	**Noise, lights and restaurant food** may act as a source of distraction/attraction to different species. **Increase watercraft traffic** in and out of marina may dissuade sensitive species of birds. Increased pollution such as bilge water and plastics are likely from the marina if motorised craft dominate the marina.	**Strictly control the entry and exit** of motorized craft (jet skis and motor boats) in the lagoon area. Only limited numbers of un-motorised craft should be allowed into the lagoon. Control elimination of waste, both human and industrial from the marina. Plastic and oil dumped or spilt in the marina will make it into the lagoon, adding to the environmental stress (high sediment, high salinity, high organic load) in the lagoon.	Likely to be low during daytime hours **Waste-disposal depots** could be created in the marina and marina "sheriffs" could ensure that all waste is disposed of responsibly. This is ranked as medium impact with medium significance with long-term effects. With mitigation can be reduced to acceptable levels.
Impacts of lights on the birds in the lagoon and alternatives ➢ collisions with high-rise buildings or tall masts with bright lights	**Tall masts or buildings with bright lights** attract and kill more birds in North America than any other anthropogenic source bar domestic cats (Loss et al 2014).	**Avoid high masts with constant lights. Avoid high buildings with lights on at night.** If lighting required by law, use flashing lights of colours other than white. Avoid the use of flood lights. Lights should be downward pointing, of lowest	This is ranked as medium impact with medium significance with long-term effects. With mitigation can be reduced to acceptable (low) levels.

➢ nocturnal migrants disorientated by bright lights	**Bright lights attract nocturnal species** and disorientate and kill migrant species that fly into the lights	illumination and be directed away from the lagoon. Flamingos migrate at night and increased use of the lagoon by Lesser Flamingos may mean greater likelihood of disorientated birds. Thus, flood lights and lights on tall buildings should be avoided entirely.	
Downstream impacts on avian food sources: ➢ Sedimentation ➢ Decreased tidal flushing ➢ Decreased invertebrate fauna, ➢ Increased salinity (Currie 1997) ➢ Pollution (e.g. fish or engine oils) introduced to the lagoon (Currie 1997)	**Sedimentation** from dredging can smother avian foraging habitats in the lagoon forcing birds to move elsewhere **Decreased tidal flushing** will decrease invertebrate fauna and may lead to biological "dead zones" un-used by birds or fish. Decreased flushing and increased sedimentation appears to have led to an accelerated decrease in bird numbers: (i) 17% decrease in bird numbers since the port expansion in January 2015 (ii) increased salinity as evidenced by increasing numbers of two saline-loving species (Chestnut-banded Plover and Lesser Flamingo). **Pollution from fish oils, or industrial** contaminants can kill invertebrates and birds directly, and this can threaten the two Red Data species that are increasingly using the more saline conditions of the lagoon	**The marina should not impede the flow** of water in the main channel in any way. **The lagoon-side wall protecting the marina** should be constructed on the north-side of the Raft restaurant, parallel with the coastline. Ideally it should not restrain the flow of water in any way. This is best undertaken with pilings supporting the wall, and no solid construction (i.e. not filled). This could also be achieved by a bridge opening at the south-eastern end allowing the water to flow through and on towards the lagoon. A wall that does not project out into the main lagoon channel at all is the preferred option to decrease the impact of the marina on further sedimentation and reduction of tidal flushing. Long-term the lagoon is likely to silt up and become too saline for most species to feed. Thus, remedial action is required now as the port expansion and the waterfront/marina are developed.	Sedimentation is obvious from the Raft restaurant from Google images and this in combination with the port expansion appears to already be reducing bird numbers. So, this is a high priority to get right. This is ranked as high impact with high significance with long-term effects. With mitigation, this can be reduced to medium levels, that will require research to determine the long term effects. Remedial action may be required to avoid the long-term sedimentation, increased salinization and dying of this biologically and internationally renowned wetland.

		Dredging new channels into the lagoon to increase tidal flushing may be required for the long-term sustainability of the ecosystem. **Pollution control and cleaning** and emptying of bilge water, oils and rubbish needs strict control.	

5 CONCLUSIONS

From previous surveys and research, it is obvious that Walvis Bay is a thriving destination and feeding hub for thousands of long-distance migrant birds from as far as Russia and Eurasia. However, the lagoon, which 20 years ago was, area-for-area, the most productive single element of the Ramsar wetland (supporting 40% of the wader population in 13% of the area) is now ecologically compromised. The lagoon currently only supports 12% of the migrant wader population, and 11 of the 14 species using it have declined in the last 20 years.

That this is probably the result of ongoing anthropogenic activities around the lagoon is evidenced by the accelerated (17%) decrease in birds using the lagoon immediately after the port expansion was started in January 2015.

Surveys of the lagoon and its rate of sedimentation indicate that most of the sediments are wind-borne from the dune fields to the east (Ward 1997, Engelhard and Sell 2013). Aeolian sedimentation from other directions seems to be reduced (captured) by the presence of the salt works to the west and south-west of the lagoon and Walvis Bay town, and the bay to the north. According to Engelhard and Sell 2013) the flooded pans to the east of the lagoon capture sediment blown in from the east (particularly with berg winds). As a result, the pans have reduced in size from 190 ha to 50 ha over a 12 year period (2001 to 2013). Once filled, more sand will penetrate the lagoon. At the same time sedimentation and a layer of 20-50 cm of “oil-like black substance” was found in the southern end of the lagoon (Engelhard and Sell 2013). According to the authors they believe this to be sediments and organic matter brought in from the bay on the high tide, but not taken out by the ebb tide. While it was not stated in their report, this suggests a low-oxygen anaerobic matter and this may correspond to the biologically “dead zones” reported in the surveys UNam report (Unam 2013).

We therefore, concur with the conclusion of Currie (1997, p8) who stated that “*the most critical factor regarding the biota is to maintain tidal flux: the lagoon must provide the physical basis to support its biota”*

Previously the CSIR and Unam (Tjipute and Skuuluka 2006) reported that “*the upper [southern] reaches of the lagoon support insignificant populations of benthic fauna. The surface sediments were anoxic consisting of a silty mud with a high content of organic material. The strong southerly winds reduce the tidal penetration, particularly at neap tides, resulting in elevated temperatures and high salinities which may exceed the tolerance limits of the benthic species occurring in the lagoon*” (Namport 2010).

Currie (1997) reported that the invertebrate animals are distributed into zones according to distance from the mouth. The middle subtidal reaches of the lagoon support the greatest species diversity and density including bivalves and tube worms.

According to Namport (2010) the origin of the organic material transported into the lagoon from the bay seem to partly originate from waste or spill from the fish factories in the harbour. Therefore, waste from the harbour and fish industry should be highly regulated and reduced, to avoid creating more biologically dead zones at the southern end of the lagoon.

Each of these suggest that high organic loads, high salinity and low tidal flushing at the southern end of the lagoon are leading to areas of lower biological activity and "*insignificant populations of benthic fauna*" (Currie 1997).

Further sedimentation or deposition of organic material in these areas will result in reduced proportions of wading birds and will, probably, result in the long-term death of the lagoon that once supported 40% of the migrant waders (Williams 1997).

Further developments therefore, that impede the flow of water into the lagoon, reducing the tidal flushing and increasing salinity and increase pollutants, should be avoided.

The waterfront and marina, thus, present significant challenges to the developers to mitigate any effects of reduced tidal flow or amplitude and to avoid strong lighting, and particularly pollutants such as oil, human waste, plastics and chemicals that may enter the lagoon. All of these may continue to accelerate the present decline seen in wetland bird numbers using the lagoon.

Acknowledgements

Particular thanks are due to Peter Bridgeford for providing up-to-date counts for the Walvis Bay lagoon from 2013-2017, and Jessica Mooney of ECC for supplying background data.

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APPENDIX 1: Raw data for lagoon-side birds 2013-2016. Red Data species in **red** (data as per Peter Bridgeford)

WALVIS BAY BIRDS	**Jul-16**	**Jan-16**	**Jul-15**	**Feb-15**	**Jul-14**	**Feb-14**	**Jul-13**	**Feb-13**
	74 772	***95 280***	***56 448***	***148 475***	***95 386***	***109 044***	***103 106***	***118 850***
		40						
	LAGOON ONLY							
Avocet	407	69	367	2	**589**	9	227	441
Coot Red-knobbed					**1**			
Cormorant Bank								
Cormorant Cape	155	269	57	1	79	331	248	**346**
Cormorant Crowned					1			
Cormorant White-breasted	26	10	23	8	3	10	**37**	10
Curlew		**2**						
Egret Cattle	**10**				8		7	
Egret Little	2	7		2	11	13	9	**18**
Flamingo Greater	10240	4512	9209	5603	5189	4184	**12085**	6847
Flamingo Lesser	**13028**	1946	2017	295	2096	1546	8024	
Flamingo Unidentified					5200			
Godwit Bar-tailed		1133		106	2	**888**	62	215
Godwit Black-tailed								
Goose Egyptian					1			
Grebe Black-necked					3		5	**8**
Grebe Little								
Grebe Great-crested								
Greenshank	8	53	16	2	15	28	15	**80**
Gull Grey-headed						1	**3**	2
Gull Hartlaub's	183	114	122	268	126	**324**	133	226
Gull Kelp	307	172	760	268	98	258	493	**816**
Heron Grey	14	19	46	17	5	19	21	**62**
Knot Red								**3**
Oystercatcher African Black		34	3	21	8	8	7	**36**
Pelican White	267	86	62	277	188	**445**	102	217
Plover Blacksmith	20		11		13		**32**	
Plover Caspian								
Plover Chestnut-banded	48	32	**3027**	944	1411	608	400	1466
Plover Common Ringed		50	2	6		**20**		2
Plover Golden			1					
Plover Grey	4	74	156	**775**	8	507	53	681
Plover Kittlitz's		6						
Plover Mongolian								
Plover Ringed								
Plover Sand								
Plover Three-banded			5		2		**7**	1
Plover White-fronted	54	98	176	38	**1435**	94	132	404
Ruff		1	7	1		20		**21**
Sanderling		1466		**1849**	10	377	6	210
Sandpiper Broadbilled								
Sandpiper Common					2			**4**
Sandpiper Curlew	6	125	99	1228	842	1512	166	**5246**

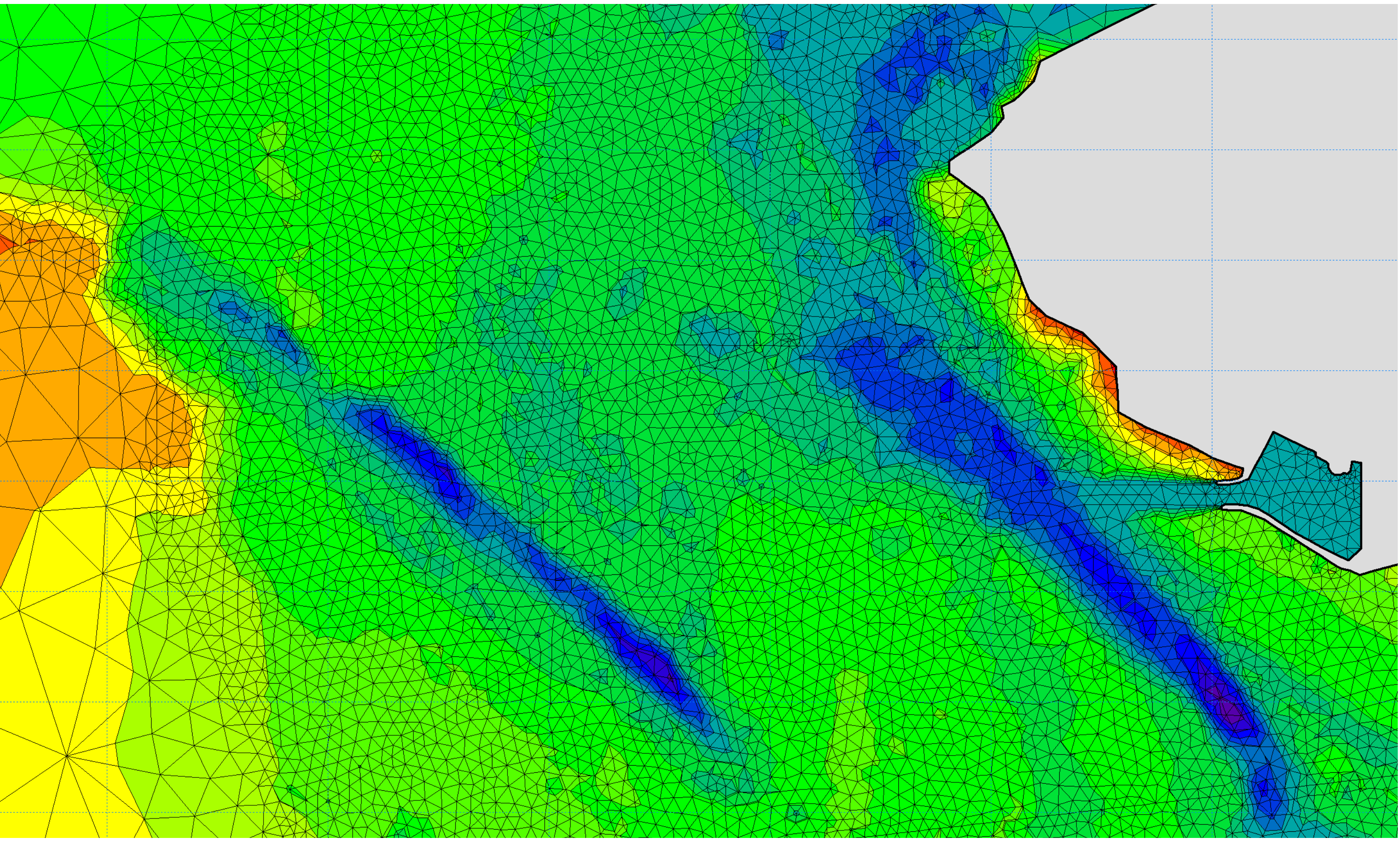
Sandpiper Marsh								
Sandpiper Terek								
Shoveler Cape			**14**					
Stilt Black-winged	5	2	28		3		8	**34**
Stint Little		4	1	9	5	**368**	33	138
Teal Cape	46		100	14	25		27	**212**
Tern Black						**65**		
Tern Caspian	53	36	27	25	11		46	**58**
Tern Common	8	**1507**		117	30	735	5	122
Tern Damara		2		60				**79**
Tern Sandwich		33		1	1			**372**
Tern Swift	41	46	25	8	22	4	25	**295**
Tern Unidentified	200	200		524		230		**2862**
Turnstone	30	142	2	21	27	155	11	**525**
Unidentified large waders			2	10				
Unidentified medium waders		**300**					190	
Unidentified small waders	98	290	951	1652	850	3054	457	**5000**
Whimbrel	3	24	7	22	5	11	11	**16**
Totals	**25 263**	**12 864**	**17 323**	**14 174**	**18 325**	**15 824**	**23 087**	**27 075**
	winter	summer	winter	summer	**winter**	**summer**	**winter**	**summer**
	After naval base				**Before naval base**			

Ave for last 4 years 19 242

Max wader counts **(bold)** over last 4 years **11 674**

EIA Walvis Bay Waterfront

Hydrodynamic study



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Delta Marine Consultants

004330 EIA Walvis Bay Waterfront

Hydrodynamic study

Report number: 004330-rap-u-0001

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Revision	Status	Author		Date	Verified		Date	Released		Date	

Index

Summary

A new yacht marina breakwater is planned in context with the waterfront development at Walvis Bay lagoon. The potential effect of the marina breakwater on the hydrodynamic conditions in the lagoon has been investigated.

The flow conditions at the lagoon entrance and in the lagoon have been numerically modelled for various environmental conditions by the software package Mike 21 FM. The modelling results have been analysed for the present situation (Base Case) and the situation after marina construction.

Based on the numerical modelling the following has been derived with respect to the potential effects of the envisaged marina:

1. Water levels changes in the lagoon are expected to remain in general below 1mm. During spring tides and strong winds the minimum water level may decrease further by 5-10mm compared to the present situation (Base Case).
2. Flow velocities at the lagoon entrance are affected to minor extent by the marina construction (maximum deviation below 3mm/s) when compared to the Base Case. During neap and spring tide conditions the discharge across the indicator line at the lagoon entrance show negligible differences (generally below 0.3%) between Base Case and situation with marina development. Changes in flow direction as derived from the modelling are mostly below 0.5 degrees, with one maximum difference of 2.5 degrees.
3. The relative refreshment after marina implementation is determined 1-2% less compared to the Base Case. At the entrance cross-section, the immediate vicinity to the initial tracer boundary between bay (zero tracer) and lagoon (100% tracer) is unfavourable as it may result in larger uncertainties in calculated refreshment rates.

The envisaged marina breakwater appears to have little or virtually no impact on the flow conditions at the lagoon entrance and the water refreshment rate in the lagoon. The potential environmental implications require assessment by the relevant experts.

1 General

A new waterfront development is planned at Walvis Bay, Namibia. The waterfront shall be situated close to the Lagoon entrance, adjacent to the existing Pelican Bay Hotel and the Raft Restaurant.

In context with the EIA for the waterfront development, DMC has been requested by Environmental Compliance Consultancy (EEC), Windhoek, to carry out a hydrodynamic modelling study to assess potential negative effects caused by the envisaged marina. It was agreed that the study shall be based on a similar approach as applied on the study for the new container terminal at Walvis Bay in 2009. The study shall focus on potential effects of the new marina on the flow conditions and water exchange in the lagoon. No morphological study is included. Potential morphological effects are expected small and of local nature. An indication of potential effects (if any) shall be derived from the changed current pattern in the lagoon.

The starting points of the study are summarized as follows:

1. Methodology and general assumptions as for the EIA in context with the New Container Terminal in 2009
2. Hydrodynamic Modelling to be carried out on Phase 1 Container terminal footprint (construction works close to completion)
3. Bathymetry data in particular of the lagoon entrance will be provided by Client
4. Layout and geometry of marina and marine structures including access channel for the planned waterfront shall be provided by Client
5. The inner channel of the new waterfront development (separated by a lock structure) is excluded from the model
6. The flow conditions and water exchange between Lagoon and Bay will be assessed for the present situation (Base Case) and after construction of the new marina. In addition to the lagoon entrance up to two trajectory lines will be analysed in the lagoon.
7. Wave conditions in the lagoon are benign and will be neglected for the hydrodynamic modelling.
8. Modelling of plume emissions during dredging and disposal or potential emissions from the marina appear to be avoidable by suitable environmental management plans and are not investigated.

The planned development (see artist impression in Figure 1-1) is located inside Walvis Bay Lagoon close to the outlet to the bay (refer to Figure 1-2). The entire lagoon forms part of an important Ramsar site. The footprint and location of the envisaged marina are shown in Figure 1-3.

The design dredging depth in the marina and access channel has been set at -3mCD (email of 24.05.2017). The approach channel has been assumed in continuation of the breakwater arms and runs in east west direction towards the natural tidal channel (channel width 20m, channel length approx. 75m, see Figure 1-3).

Figure 1-1: Artist impression of Walvis Bay waterfront and marina

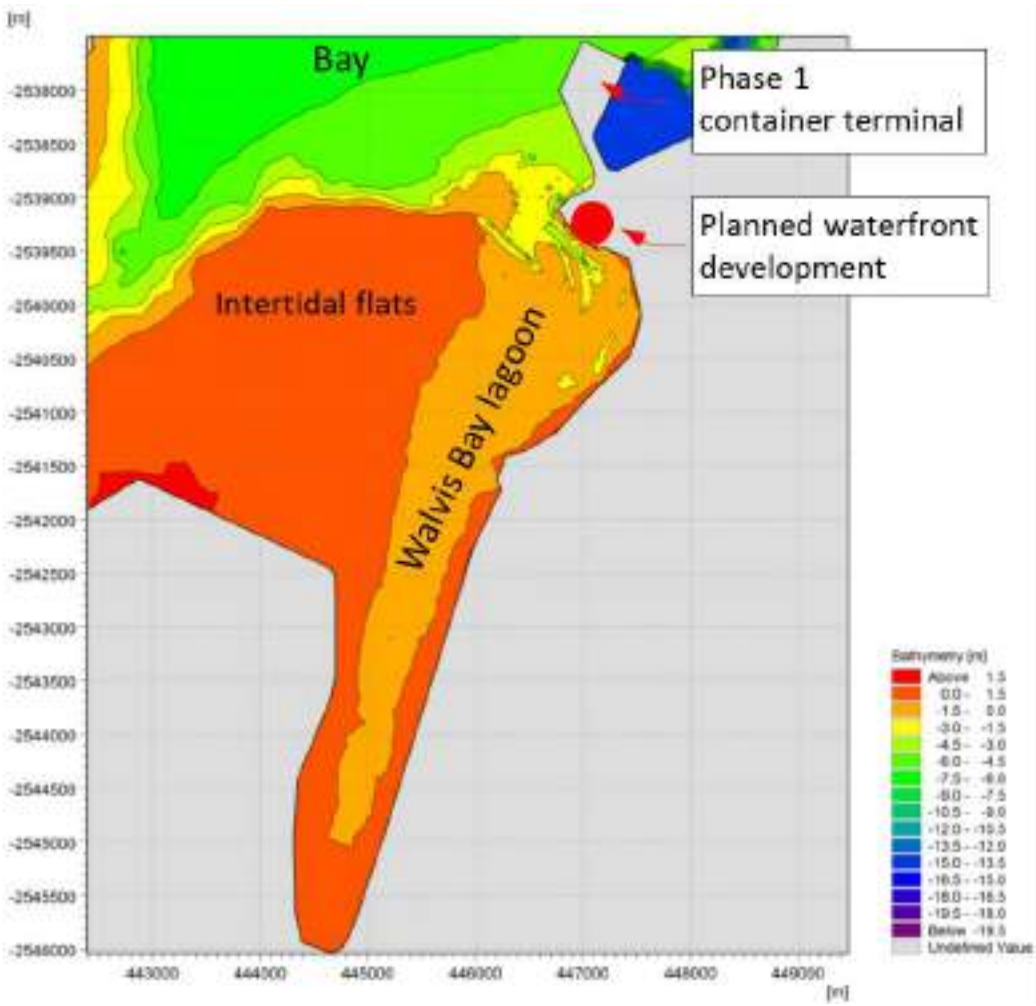


Figure 1-2: Location of the planned waterfront development, Walvis Bay (seabed levels refer to MSL)

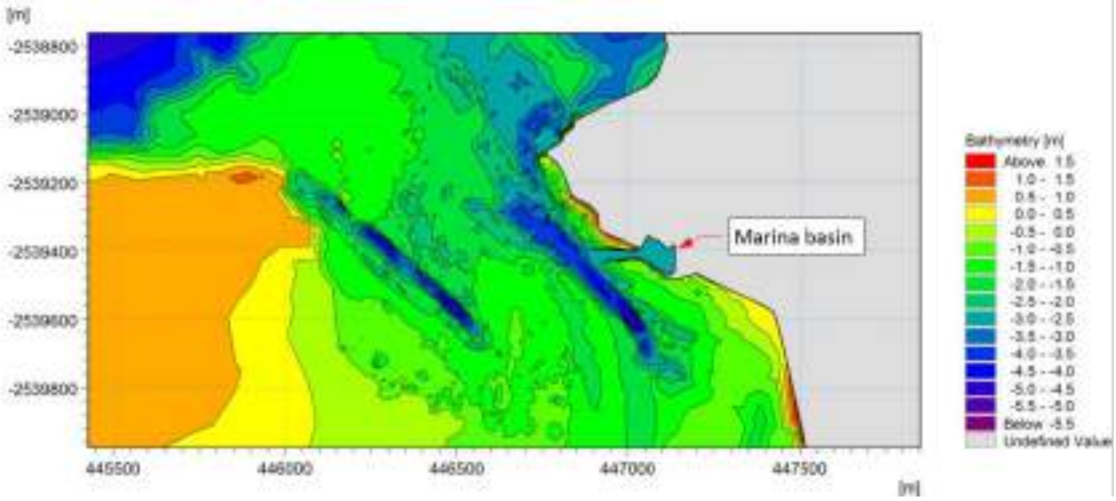


Figure 1-3: Waterfront marina (sea bed levels refer to MSL)

A new bathymetric survey was carried out in June 2017, covering the area of the lagoon entrance and the vicinity of the waterfront (coverage about the area shown in Figure 1-3) to ensure an appropriate basis for the hydrodynamic modelling and for detailed design of the marina infrastructure.

The potential effect of the new marina on currents and water levels at the lagoon entrance and the water exchange between lagoon and bay has been assessed by comparison of the future situation with the situation before implementation. The present situation (Base Case) includes phase 1 of the new container terminal being currently under construction.

2 References

[1] DMC and CSIR: EIA Study for Extension of the Walvis Bay Container Terminal. Volumes I – VI, Final Report, December 2009.

[2] Geoff Toms: Additional Baseline Study Walvis Bay Lagoon Mouth Area (For Namport), December 2013

3 Modelling of flow conditions and water exchange

All modelling has been carried out with the numerical modelling software package Mike 21 FM (flexible mesh) of Danish Hydraulic Institute. For details refer to [1].

3.1 Bathymetry

The bathymetry applied for the modelling have been retrieved from different sources:

- Admiralty charts
- Large scale bathymetric survey of Bay and Lagoon, performed by the Local Agenda 21 Project (DHI/COWI 2002, [1])
- NAMPORT surveys 2009
- Surveys carried out for the project in June 2017

Besides the new data obtained in 2017, survey data including the larger scale bathymetry have been applied as in the in the EIA study for the container terminal (Namport, 2009, [1]).

Admiralty charts are used for the large scale regional bathymetry which has been extracted from MIKE21 C-Map (world-wide electronic chart database from Jeppenson). In addition the comprehensive bathymetric survey performed within the Local Agenda 21 Project (2001-2004) has been used for the Bay and the Lagoon. Port areas, access channel and areas close to the lagoon entrance have been surveyed by Namport in 2009.

The bathymetry in the lagoon entrance is considered most relevant for the flow conditions and water exchange between Lagoon and Bay. The new bathymetry revealed significant changes compared to the situation in 2009, therefore the old data have been discarded and replaced by the new data in that area. In particular the deepening of the eastern tidal channel has been also confirmed in [2]. Morphological changes outside this area are expected less distinct and/or less relevant for the hydrodynamic processes in the lagoon.

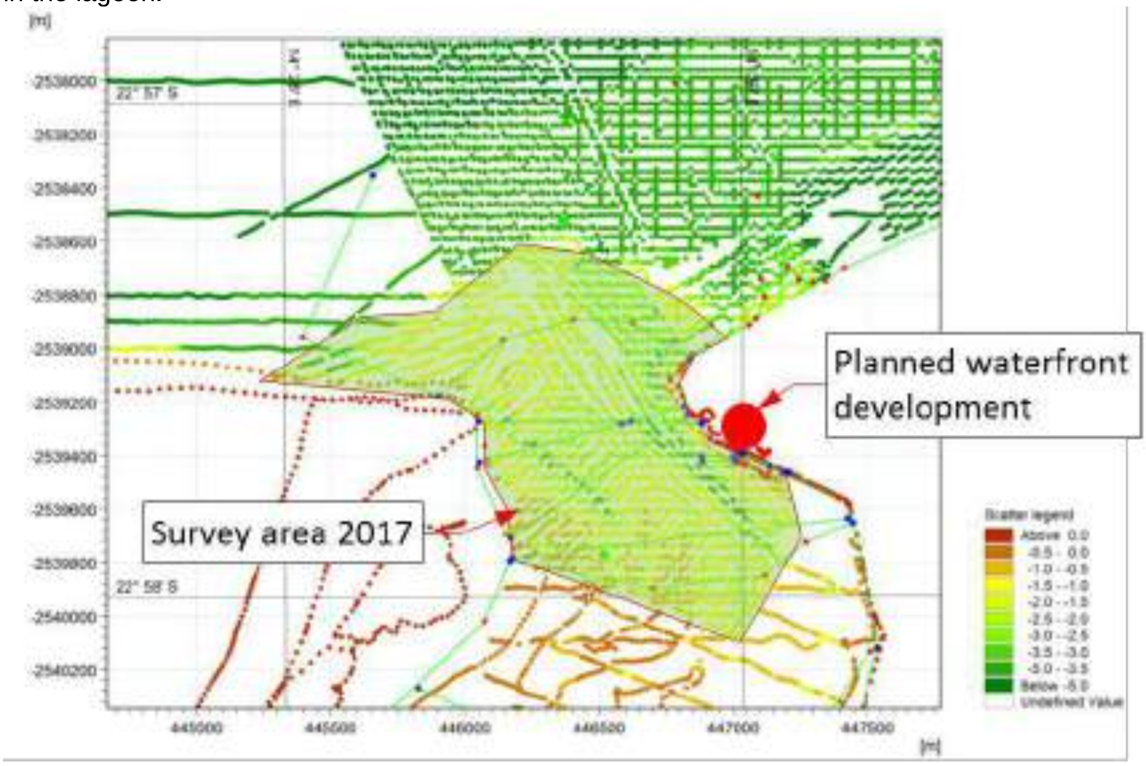


Figure 3-1 Coverage of June 2017 bathymetric survey

When implementing the June 2017 survey data into the numerical model it was found difficult to transform the data set into the correct model projection. The finally decided projection transformation parameters were checked visually as overlay of a referenced google earth image and survey points data in the Mike 21 software (see Annex D). It is recommended to double check the survey data reference and to assess the effect of potential deviations.

3.2 Model grid

The modelling has been carried out based on a flexible mesh which allows to set the grid resolution according to the importance of model areas. The highest grid resolution has been applied in the lagoon entrance and close to the envisaged marina (about 10m node distance, see dark hatched area in Figure 3-2). The tidal flats west of the lagoon as well as the most southern part of the lagoon itself fall dry during low water levels.

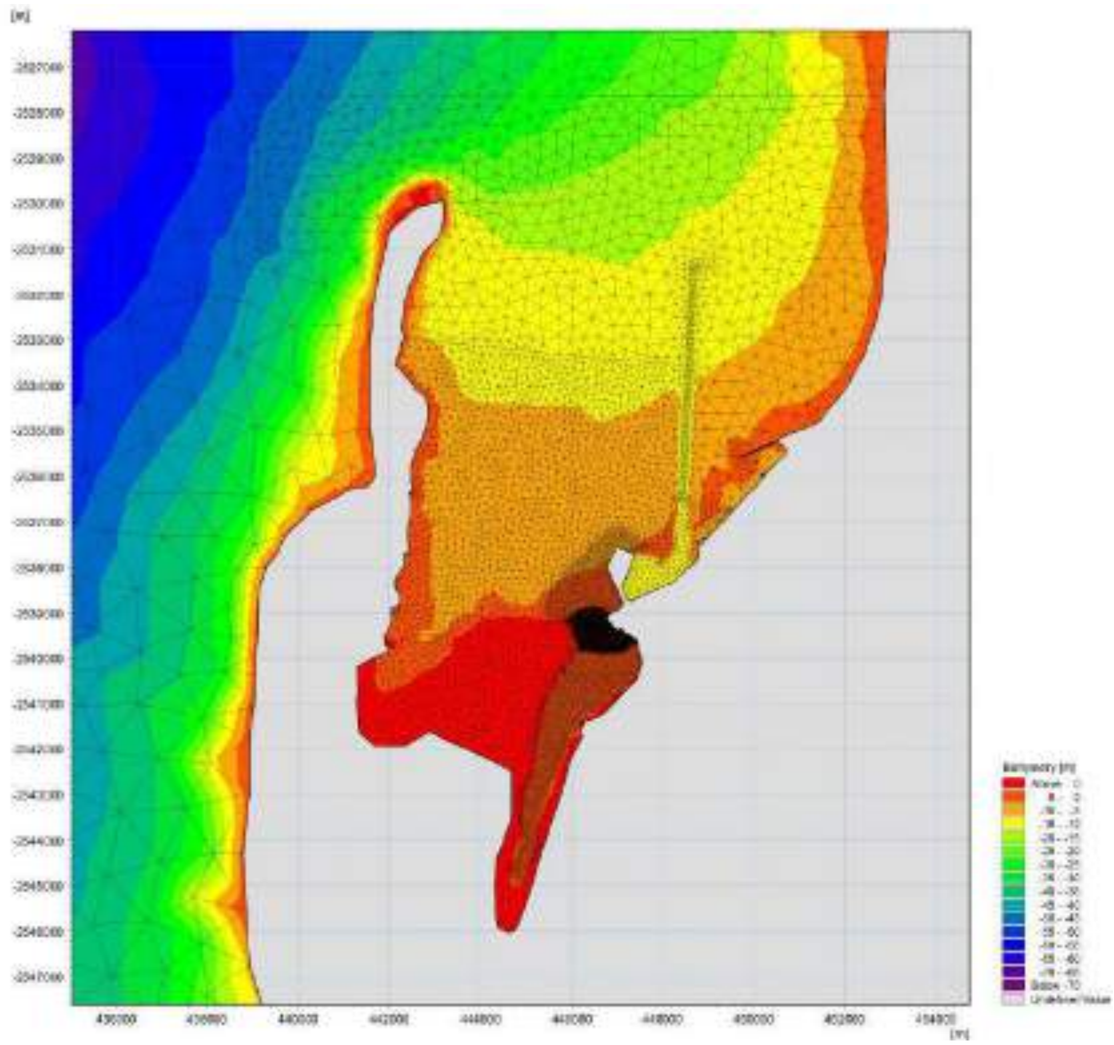


Figure 3-2: Model grid applied for the numerical calculations

3.3 Model output

In addition to spatial output information, e.g. to describe flow pattern and tracer movements, several output points and cross-sections have been defined to characterize the potential effect of the marina on the hydrodynamic conditions.

3.3.1 Output points

Characteristic water levels have been assessed for three different locations

1. Just north of the lagoon entrance (bay side)
2. Just south of the lagoon entrance (lagoon side)
3. Central area of the lagoon

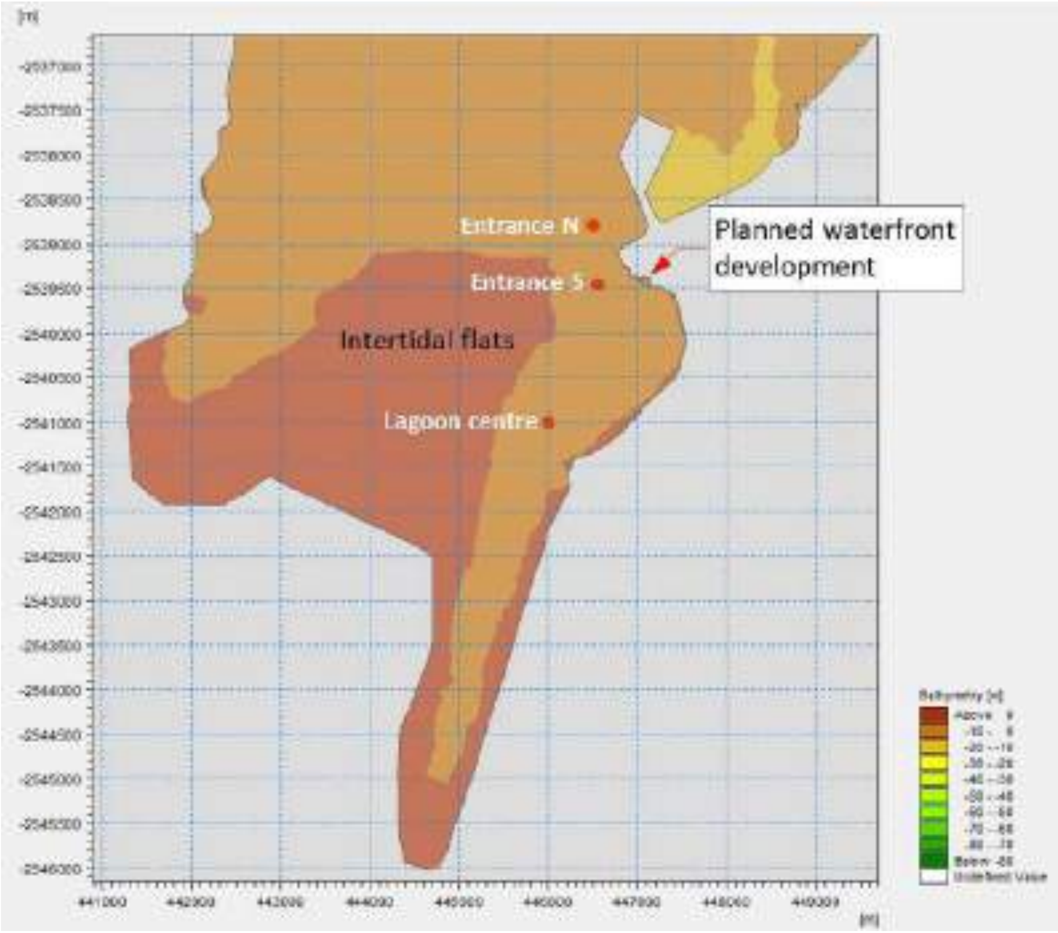


Figure 3-3: Location of output points used

3.3.2 Indicator cross-sections

Three indicator cross-sections have been specified to numerically monitor hydraulic characteristics and asses the water refreshment rates (refer to Figure 3-4):

1. Lagoon entrance (alignment adopted from Line Y in the baseline report - refer to **Error! Reference source not found.**)
2. Line 2 (approx. as in [1])
3. Line 3 (approx. as in [1])

At the lagoon entrance flow velocities, discharges and flow directions have been determined for flood and ebb situations for the scenarios summarized in Table 3-1.

Water refreshment in the lagoon has been analysed based on all three indicator lines.

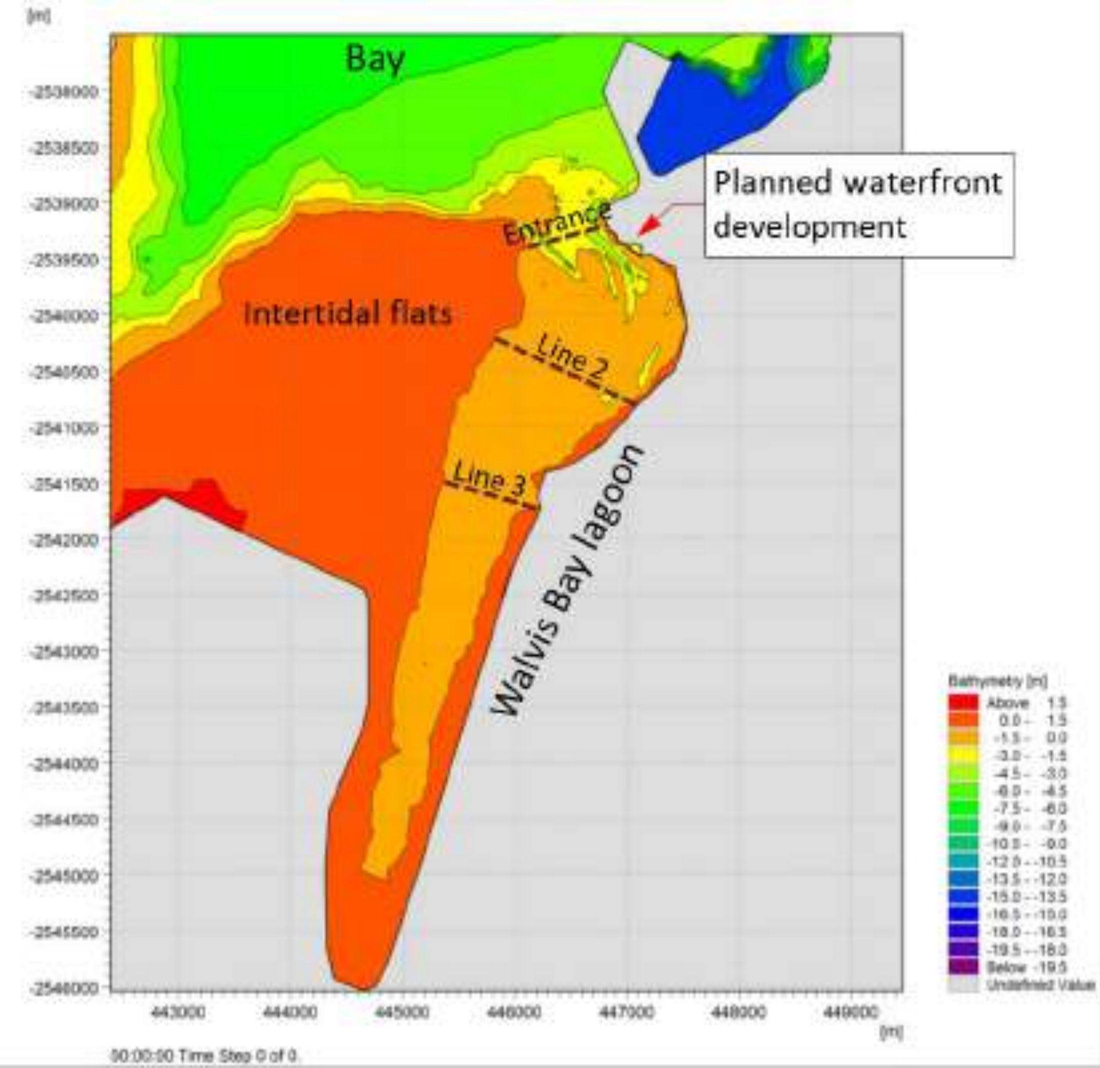


Figure 3-4: Chosen indicator cross sections

3.4 Model scenarios

3.4.1 Flow conditions at the lagoon entrance

The main task of the modelling is to assess whether the new marina will have impact on the hydrodynamic conditions in the lagoon. Interference between flow pattern and structures is expected to be more evident when investigating rather harsh boundary conditions. The modelling of the current pattern at the lagoon entrance has therefore been done with rather distinct wind conditions, as applied during the 2009 EIA modelling ([1]). The tested conditions are based on historical storm events, as selected from offshore NOAA time series (for details refer to [1]). Besides conditions with relatively strong winds also a scenario with neap tide without wind is modelled to assess the effects under smallest flow velocities. An overview of the scenarios is given in Table 3-1.

Table 3-1: Extreme environmental conditions to assess effects on flow conditions

	Water levels	Wind speed	Wind direction
Scenario 1	Neap tide	14 m/s	S (180 ºN)
Scenario 2	Neap tide	10 m/s	NNW (347.5 ºN)
Scenario 3	Neap tide	10 m/s	NE (67.5 ºN)
Scenario 4	Neap tide	0 m/s	No Wind
Scenario 5	Spring tide	14 m/s	S (180 ºN)
Scenario 6	Spring tide	10 m/s	NNW (347.5 ºN)
Scenario 7	Spring tide	10 m/s	NE (67.5 ºN)

3.4.2 Water refreshment in the lagoon

Water refreshment rates have been determined for the Lagoon which indicates the fraction of water volume inside the lagoon (or a certain part of the lagoon) which is replaced by water from outside the lagoon over a defined period of time. For that the water volume in the Lagoon has been marked with a numerical tracer. The refreshment is determined by the mixing of the “marked” water from inside the Lagoon with ambient water from outside the lagoon.

Prevailing (operational) wind and wave conditions, combined with neap and spring tides are used to determine the refreshment rates in the lagoon as well as potential impacts of the new marina. Operational conditions, as specified in Table 3-2, cover about 99% of the range of typical environmental conditions at Walvis Bay.

The modelling has been performed with wind and tidal forcing. Waves have been rated of insignificant influence on current pattern in the lagoon [1] and have been ignored.

The water exchange has been modelled over 4 tidal cycles (of 12.5 hours). The first tidal cycle has been applied as “warm-up” period to provide realistic starting conditions of (spatially variable) water levels and current velocities throughout the modelling area. The water volume in the Lagoon has been marked after the first tidal cycle. The time varying concentration of tracer along the indicator cross sections has been determined after the second and after the third tidal cycle. The refreshment rate, R in this study is defined as $R = (C_2 – C_3) / C_2$ (with averaged tracer concentration after 2 tidal cycles, C_2 and after 3 tidal cycles, C_3).

Table 3-2: Operational conditions for modelling of water refreshment

	Exceedance probability	Tide	Wind speed	Wind direction
Run 1	1%	Neap	13	195
Run 2	10%	Neap	11	195
Run 3	50%	Neap	9	195
Run 4	50%	Neap	9	225
Run 5	50%	Neap	9	315
Run 6	50%	Neap	0	-
Run 7	1%	Spring	13	195
Run 8	10%	Spring	11	195
Run 9	50%	Spring	9	195
Run 10	50%	Spring	9	225
Run 11	50%	Spring	9	315
Run 12	50%	Spring	0	-

4 Modelling results

4.1 Water levels

The water levels evaluated for the chosen output locations (Figure 3-3) over one tidal cycle (12.5 hours) are summarized in Table 4-2 (Base case) and Table 4-2 (marina case). The effect of the wind on water levels is evident. With strong southern winds the water is pushed out of the lagoon average water levels are getting negative and minimum water levels are further decreased.

The effect of the new marina on water levels at the lagoon is concluded insignificant (white cells in Table 4-2 show less than 0.5mm deviation between Base Case and situation with marina). Maximum deviation rarely exceeds 1mm, with exception of average and minimum water levels at the lagoon centre during spring tides and strong winds (scenario 5-7, last row in Table 4-2) which have been found to deviate by up to 8mm.

Table 4-1: Water levels determined for output locations (base case)

Base Case	**Average water level**			**Maximum water level**			**Minimum water level**		
	Entrance north	Entrance south	Centre Lagoon	Entrance north	Entrance south	Centre Lagoon	Entrance north	Entrance south	Centre Lagoon
Scen. 1	-0.069	-0.093	-0.209	0.176	0.162	0.095	-0.361	-0.389	-0.520
Scen. 2	0.007	0.009	0.018	0.244	0.246	0.260	-0.289	-0.288	-0.285
Scen. 3	-0.002	-0.002	0.003	0.230	0.232	0.250	-0.295	-0.295	-0.293
Scen. 4	0.000	-0.001	0.000	0.238	0.239	0.243	-0.293	-0.293	-0.297
Scen. 5	-0.061	-0.088	-0.077	0.818	0.802	0.755	-0.974	-1.003	-0.736
Scen. 6	0.014	0.018	0.118	0.880	0.887	0.909	-0.901	-0.893	-0.543
Scen. 7	0.005	0.006	0.105	0.873	0.878	0.897	-0.911	-0.905	-0.558

Table 4-2: Water levels determined for output locations (marina case)

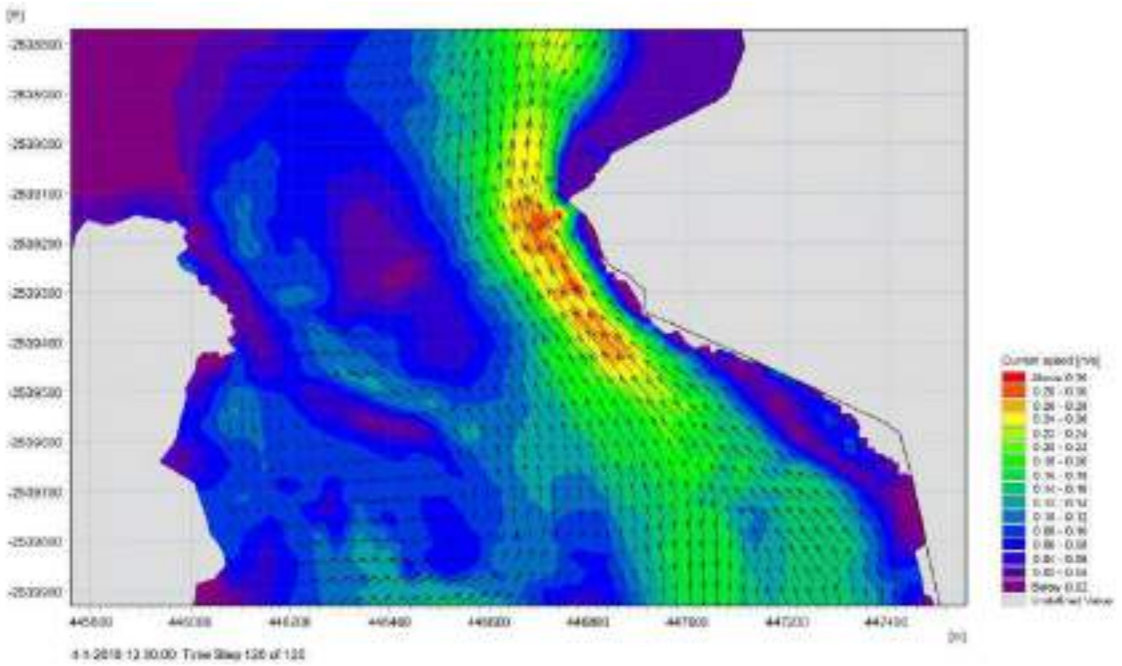
Marina Case	**Average water level**			**Maximum water level**			**Minimum water level**		
	Entrance north	Entrance south	Centre Lagoon	Entrance north	Entrance south	Centre Lagoon	Entrance north	Entrance south	Centre Lagoon
Scen. 1	-0.069	-0.093	-0.209	0.176	0.162	0.095	-0.361	-0.389	-0.520
Scen. 2	0.007	0.009	0.018	0.244	0.246	0.260	-0.289	-0.288	-0.285
Scen. 3	-0.002	-0.002	0.003	0.230	0.232	0.250	-0.295	-0.295	-0.294
Scen. 4	0.000	-0.001	0.000	0.238	0.239	0.243	-0.293	-0.293	-0.297
Scen. 5	-0.061	-0.088	-0.080	0.818	0.802	0.755	-0.974	-1.004	-0.744
Scen. 6	0.014	0.018	0.115	0.880	0.887	0.909	-0.901	-0.893	-0.548
Scen. 7	0.005	0.006	0.103	0.874	0.879	0.898	-0.911	-0.906	-0.563

up to 1mm *1-3mm* *above 5mm* *(deviations from present situation)*

4.2 Flow conditions at lagoon entrance

The effect of the envisaged marina on flow conditions at the lagoon entrance is shown in Figure 4-1 to Figure 4-4. The flow pattern at the entrance for the Base Case and the situation with marina appear very similar. The flow pattern in the immediate vicinity of the marina breakwater is slightly deflected both during ebb and flood. During ebb flow for the Base Case and the situation with marina an eddy is formed on the shallows just south of the Raft restaurant (i.e. south of the envisaged marina). The main ebb flow is conducted through the eastern tidal channel. The (artificial/dredged) western channel is inactive. In contrast the flood flow is distributed over the entire entrance section.

Figure 4-1:   Typical ebb current pattern scenario 2, Base Case



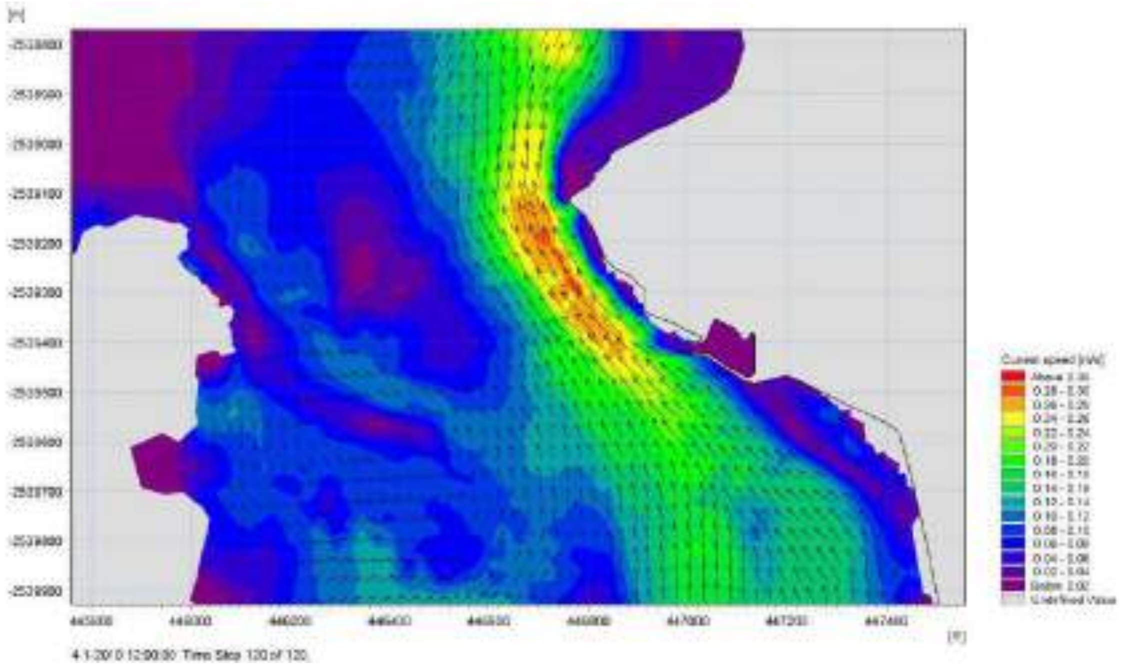


Figure 4-2:   Typical ebb current pattern scenario 2, with Marina

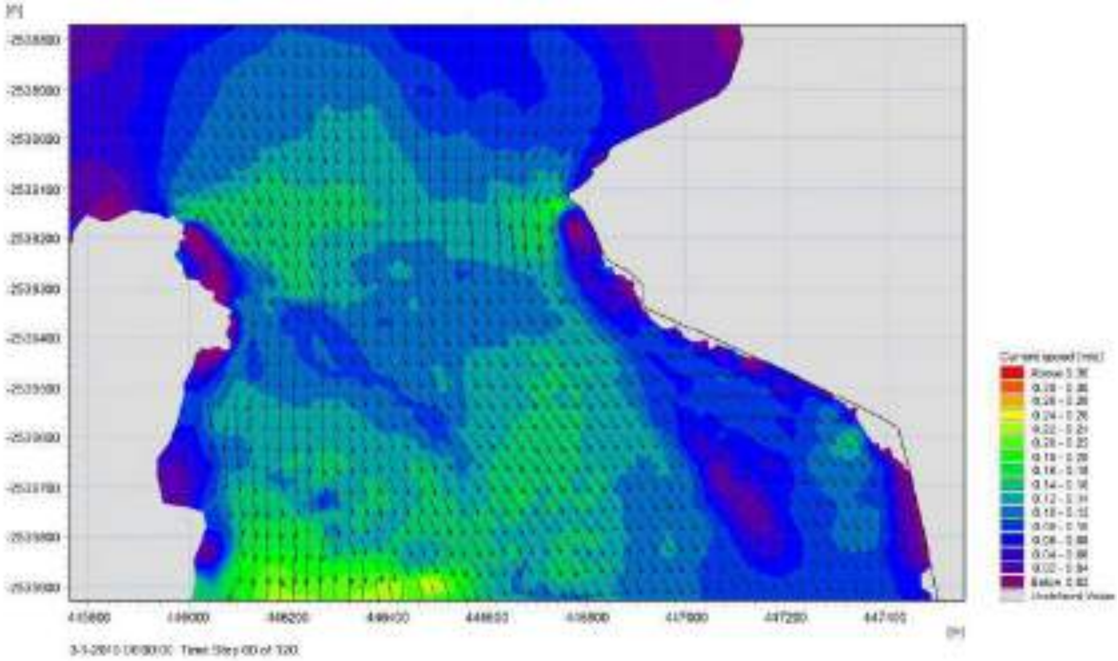


Figure 4-3: Typical flood current pattern scenario 2, Base Case

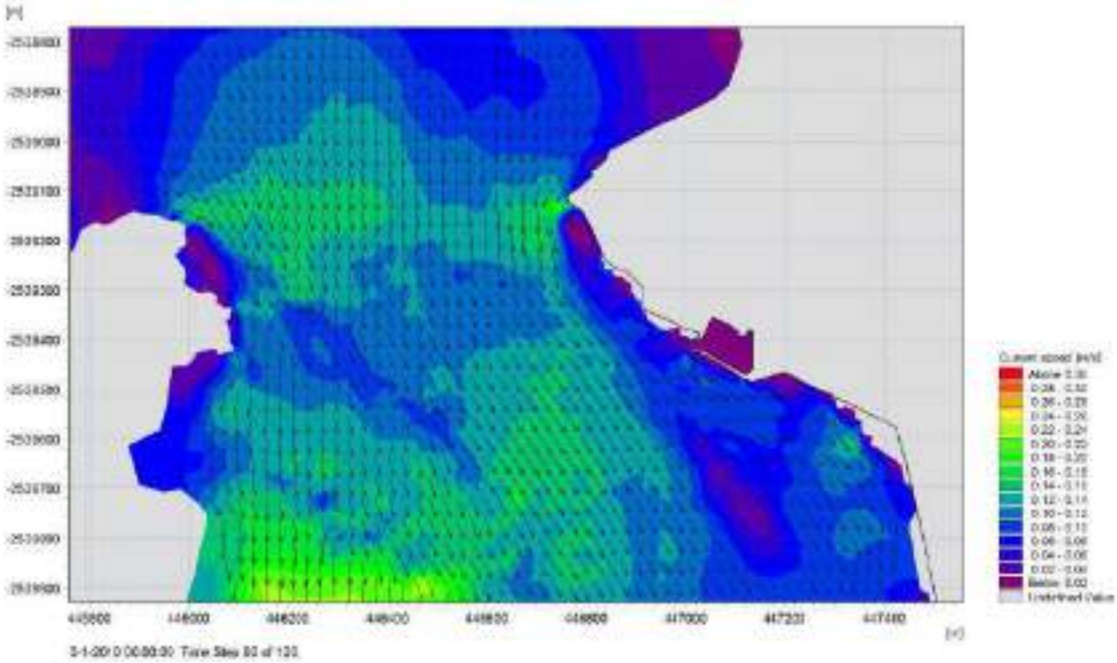


Figure 4-4: Typical flood current pattern scenario 2, with Marina

Flow velocities and discharge rates are given in Table 4-3. The maximum values given in Table 4-3 are maximum values in time of the average over the entire indicator cross section. It is evident that the flow velocities at the lagoon entrance are affected to minor extent by the marina construction (maximum deviation below 3mm/s, see Annex B) when compared to the Base Case.

During neap and spring tide conditions all discharge parameters (average, max flood, max ebb) across the indicator line at the lagoon entrance show negligible differences between Base Case and situation with marina development. The deviations are generally below 0.3% with one outlier (scenario 1 max ebb velocity). Changes in flow direction as derived from the modelling are mostly below 0.5 degrees, with one maximum difference of 2.5 degrees.

Table 4-3: Flow conditions at the Lagoon entrance (refer to scenarios in Table 3-1)

	Average flow velocity [m/s]	Max flow velocity Flood [m/s]	Max flow velocity Ebb [m/s]	Average Q across [m^3/s]	Max Q across Flood [m^3/s]	Max Q across Ebb [m^3/s]	Mean flow direction Flood [degree]	Mean flow direction Ebb [degree]
Scenario 1 Neap tide wind from S								
Base Case	0.18	0.21	0.21	78.83	157.16	129.67	218.88	306.91
Waterfront	**0.18**	**0.22**	**0.21**	**78.74**	**157.03**	**127.98**	**219.56**	**309.36**
Scenario 2 Neap tide wind from NNW								
Base Case	0.07	0.11	0.11	99.22	181.77	157.64	163.85	323.67
Waterfront	**0.07**	**0.11**	**0.11**	**99.40**	**181.58**	**157.67**	**163.93**	**322.84**
Scenario 3 Neap tide wind from NE								
Base Case	0.07	0.10	0.09	95.91	176.99	150.26	167.97	335.85
Waterfront	**0.07**	**0.10**	**0.09**	**95.97**	**176.90**	**150.65**	**167.60**	**335.44**
Scenario 4 Neap tide no wind								
Base Case	0.06	0.10	0.10	96.62	169.00	158.23	166.05	330.82
Waterfront	**0.06**	**0.10**	**0.10**	**96.82**	**169.14**	**158.86**	**166.13**	**331.47**
Scenario 5 Spring tide wind from S								
Base Case	0.25	0.36	0.32	272.97	650.76	547.14	173.98	337.86
Waterfront	**0.25**	**0.35**	**0.32**	**273.42**	**652.24**	**545.61**	**174.92**	**337.33**
Scenario 6 Spring tide wind from NNW								
Base Case	0.21	0.36	0.33	352.02	717.45	682.37	169.02	331.70
Waterfront	**0.21**	**0.37**	**0.33**	**353.11**	**717.65**	**678.10**	**168.56**	**331.96**
Scenario 7 Spring tide from wind NE								
Base Case	0.20	0.37	0.33	345.15	724.30	665.87	169.39	333.02
Waterfront	**0.20**	**0.37**	**0.33**	**346.02**	**723.32**	**661.36**	**169.47**	**333.35**

When comparing the results with earlier analyses done ([1]) it is evident that flow velocities in the present Base Case are in general decreased whereas at the same time characteristic discharges through the lagoon entrance are determined larger, i.e. the flow capacity of the present entrance cross-section is enhanced. This might be associated to some extent to a more refined modelling set-up, however the main influence is expected to be caused by the changed seabed morphology.

This is confirmed when comparing the cross-sections at the lagoon entrance used in both studies. The flow cross-section based on the survey of June 2017 is about 50% larger than determined from the base data applied in the 2009 study. In addition the eastern tidal channel is presently much more distinct and deepened, as has been also found in [2] (see Annex E). The evident changes in flow cross-section have also substantial effects on the water exchange between lagoon and bay.

4.3 Water refreshment in the lagoon

The water refreshment in the lagoon has been determined for the situation with the new marina breakwater and has been compared with the Base Case. The refreshment rates have been analysed for both situations at the three indicator lines in the lagoon (Figure 3-4) . Water refreshment rates are expressed as percentage of the Base Case refreshment rate.

The refreshment rates are summarized in Table 4-4 and Table 4-5. The first block of columns show the percentage of water being refreshed after one tidal cycle (about 12.5 hours). The centre block provides the extrapolated time in hours estimated to completely replace the water at the respective location by water from the Bay. The last block summarizes the refreshment rate compared to the Base Case.

Table 4-4: Refreshment rates during neap tide

	Refreshment percentage per tide			Refreshment time in hours			Relative refreshment to BC		
	Entrance	Location 2	Location 3	Entrance	Location 2	Location 3	Entrance	Location 2	Location 3
	Run 1 - 13m/s S			Run 1 - 13m/s S			Run 1 - 13m/s S		
Base Case	36.1%	37.6%	25.2%	58	55	89	100%	100%	100%
Waterfront	32.4%	37.6%	25.2%	66	55	89	87%	100%	100%
	Run 2 – 11 m/s S			Run 2 – 11 m/s S			Run 2 – 11 m/s S		
Base Case	48.9%	33.4%	21.4%	38	63	107	100%	100%	100%
Waterfront	46.4%	33.2%	21.6%	41	64	106	93%	99%	101%
	Run 3 – 9m/s S			Run 3 – 9m/s S			Run 3 – 9m/s S		
Base Case	55.9%	28.0%	16.4%	32	79	144	100%	100%	100%
Phase 1	55.7%	28.0%	16.3%	32	79	145	99%	100%	99%
	Run 4 – 9m/s SW			Run 4 – 9m/s SW			Run 4 – 9m/s SW		
Base Case	35.3%	20.6%	11.2%	59	112	217	100%	100%	100%
Waterfront	34.3%	20.3%	10.7%	62	114	229	96%	98%	95%
	Run 5 – 9/ms NW			Run 5 – 9/ms NW			Run 5 – 9/ms NW		
Base Case	57.9%	36.6%	16.2%	30	57	146	100%	100%	100%
Waterfront	57.5%	37.4%	16.0%	30	55	148	99%	103%	99%
	Run 6 - No Wind			Run 6 - No Wind			Run 6 - No Wind		
Base Case	13.6%	7.8%	0.2%	176	316	12048	100%	100%	100%
Waterfront	12.4%	7.9%	0.2%	196	314	11714	90%	101%	103%

Table 4-5: Refreshment rates during spring tide

	Refreshment percentage per tide			Refreshment time in hours			Relative refreshment to BC		
	Entrance	Location 2	Location 3	Entrance	Location 2	Location 3	Entrance	Location 2	Location 3
	Run 7 - 13m/s S			Run 7 - 13m/s S			Run 7 - 13m/s S		
Base Case	63.6%	49.9%	34.0%	26	37	62	100%	100%	100%
Waterfront	63.0%	49.6%	32.8%	26	38	65	98%	99%	96%
	Run 8 – 11m/s S			Run 8 – 11m/s S			Run 8 – 11m/s S		
Base Case	60.7%	48.1%	32.6%	28	39	65	100%	100%	100%
Waterfront	59.7%	47.5%	32.4%	28	40	66	98%	98%	99%
	Run 9 – 9m/s S			Run 9 – 9m/s S			Run 9 – 9m/s S		
Base Case	61.4%	48.6%	32.2%	27	39	66	100%	100%	100%
Phase 1	60.3%	47.7%	31.8%	28	40	67	97%	97%	99%
	Run 10 – 9m/s SW			Run 10 – 9m/s SW			Run 10 – 9m/s SW		
Base Case	68.3%	53.5%	36.3%	22	34	57	100%	100%	100%
Waterfront	68.2%	54.4%	36.6%	23	33	57	100%	103%	101%
	Run 11 – 9m/s NW			Run 11 – 9m/s NW			Run 11 – 9m/s NW		
Base Case	81.3%	70.2%	46.3%	15	21	41	100%	100%	100%
Waterfront	81.3%	70.3%	46.8%	15	21	41	100%	100%	102%
	Run 12 - No Wind			Run 12 - No Wind			Run 12 - No Wind		
Base Case	53.1%	45.4%	27.6%	34	43	80	100%	100%	100%
Waterfront	52.4%	44.7%	27.7%	35	44	80	98%	98%	101%

The absolute refreshment between first and second tidal cycle varies for the Base Case between 0% - 58% during neap tide and between 28% - 81% during spring tide. During spring tide the tidal prism is increasing significantly, consequently a larger portion of water is exchanged between lagoon and bay. In addition to the tidal characteristics also the wind conditions appear to play an important role for the refreshment of the lagoon water.

For most scenarios the relative refreshment is determined 1-2% less compared to the Base case. During neap conditions (Table 4-4) it is obvious that largest deviations occur at the entrance cross-section which is situated in immediate vicinity to the initial tracer boundary between bay (zero tracer) and lagoon (100% tracer). It has been concluded that this may influence the calculated refreshment rates at that location.

In situations with generally low water refreshment (small absolute refreshment rates, run 6) deviations in relative refreshment increase and should be weighed together with the absolute rates.

In Annex C the modelled tracer movement (advection and dispersion) is shown for various time steps (each step 0.5 hours) for Run 9 (wind 9m/s from S, spring tide) both for the Base Case and the situation after marina construction.

5 Summary and conclusions

A new yacht marina breakwater is planned in context with the waterfront development at Walvis Bay lagoon. The potential effect of the marina breakwater on the hydrodynamic conditions in the lagoon has been investigated.

The flow conditions at the lagoon entrance and in the lagoon have been numerically modelled for various environmental conditions by the software package Mike 21 FM. The modelling results have been analysed for the present situation and the situation after marina construction.

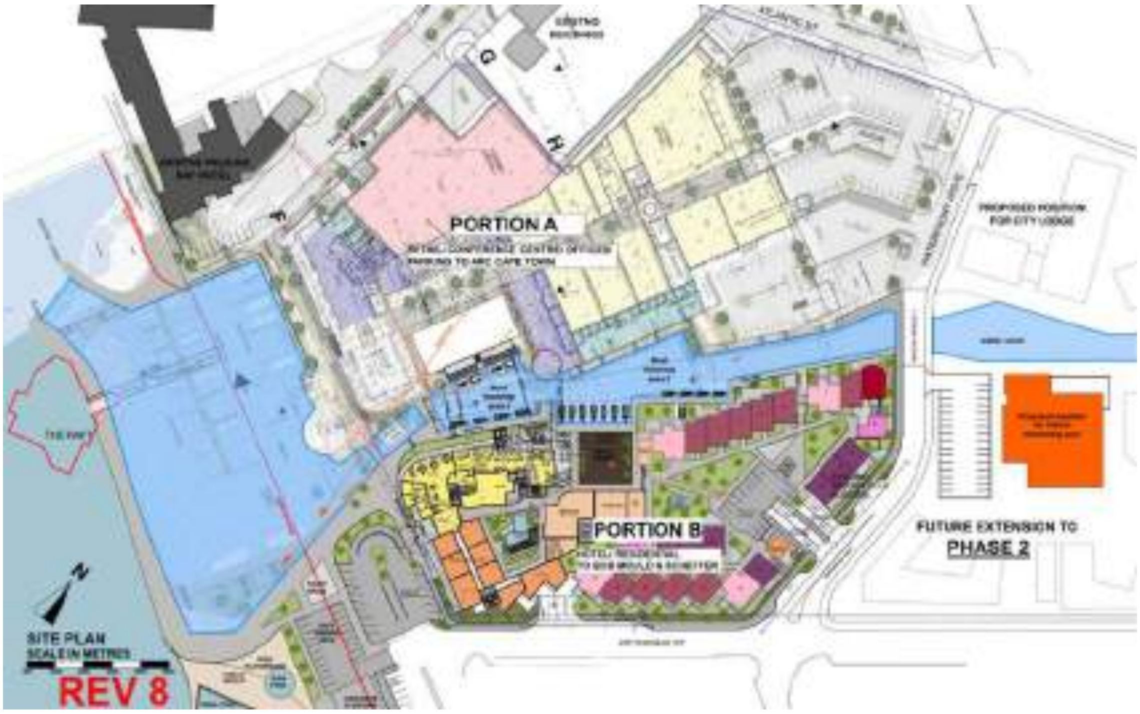
Based on the numerical modelling the following has been derived with respect to the potential effects of the envisaged marina:

1. Water levels changes in the lagoon are expected to remain in general below 1mm. During spring tides and strong winds the minimum water level may decrease further by 5-10mm compared to the present situation (Base Case).
2. Flow velocities at the lagoon entrance are affected to minor extent by the marina construction (maximum deviation below 3mm/s) when compared to the Base Case. During neap and spring tide conditions the discharge across the indicator line at the lagoon entrance show negligible differences (generally below 0.3%) between Base Case and situation with marina development. Changes in flow direction as derived from the modelling are mostly below 0.5 degrees, with one maximum difference of 2.5 degrees.
3. The relative refreshment after marina implementation is determined 1-2% less compared to the present situation (Base case). At the entrance cross-section, the immediate vicinity to the initial tracer boundary between bay (zero tracer) and lagoon (100% tracer) is unfavourable as it may influence the calculated refreshment rates.

It shall be noted that the given results are suitable for comparison of the situations before and after marina construction. For verification of the absolute values determined in the numerical model, further measurement campaigns and monitoring would be required.

The envisaged marina breakwater appears to have little or virtually no impact on the flow conditions at the lagoon entrance and the water refreshment rate in the lagoon. The potential environmental conclusions require assessment by the relevant experts.

ANNEX A – Waterfront Site plan

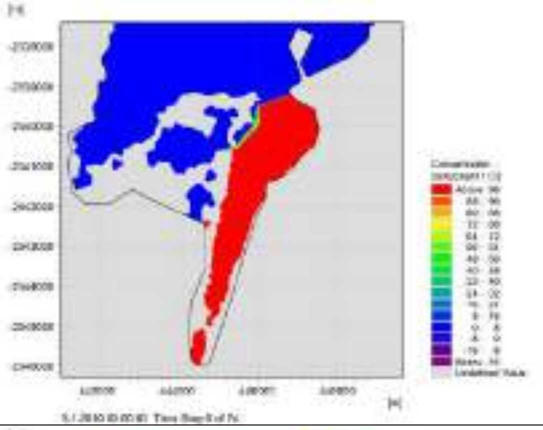
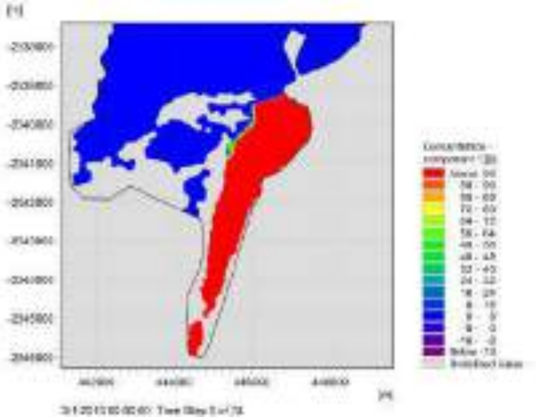
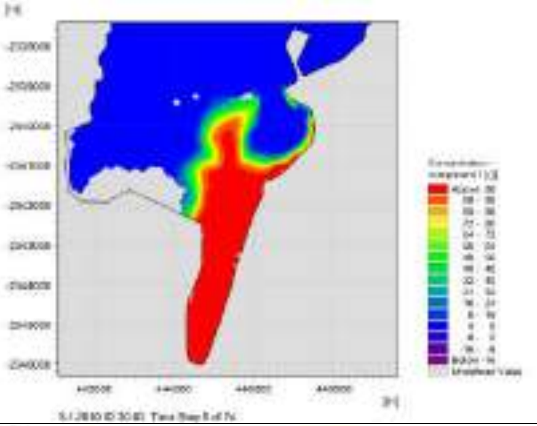
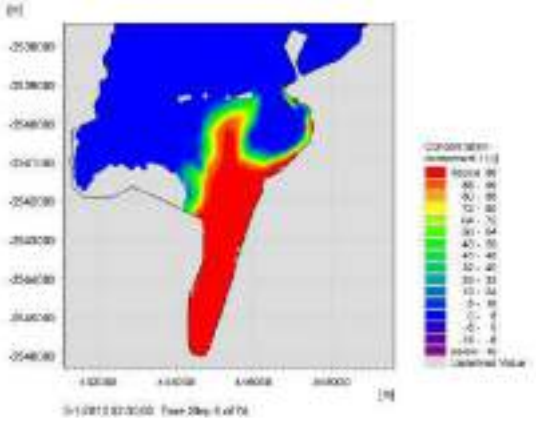
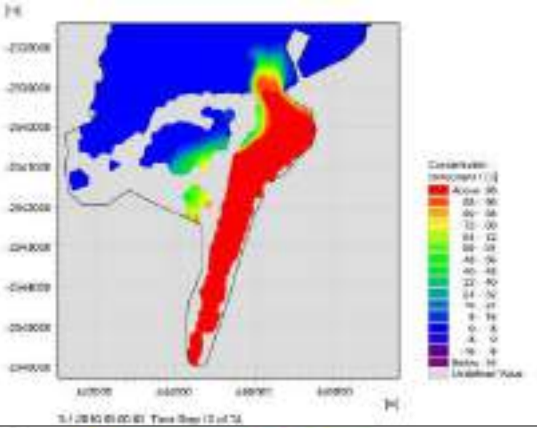
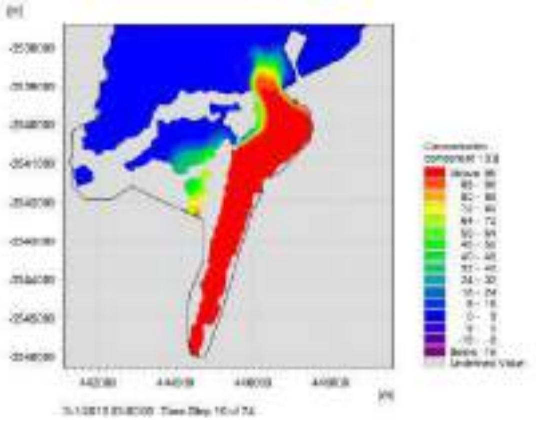
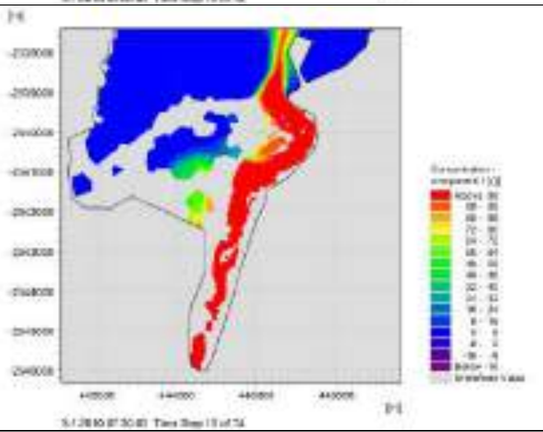
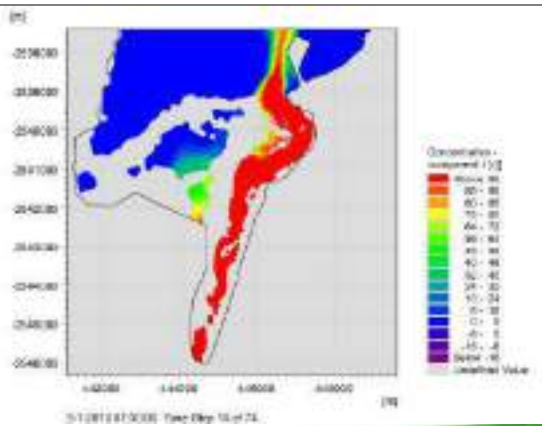


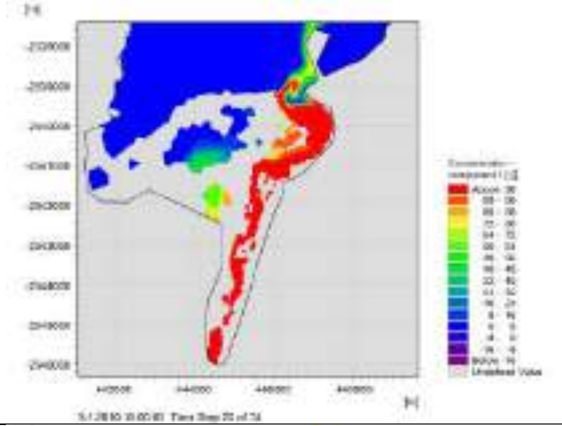
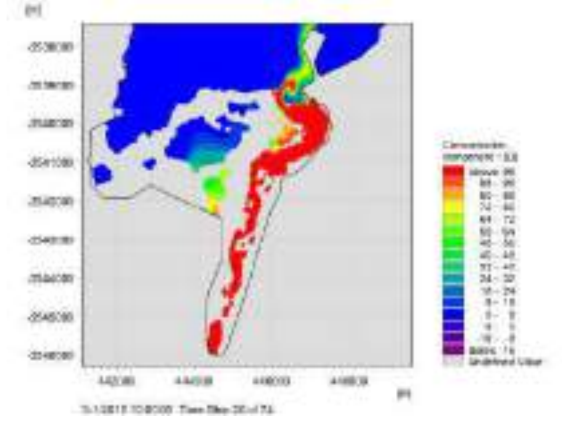
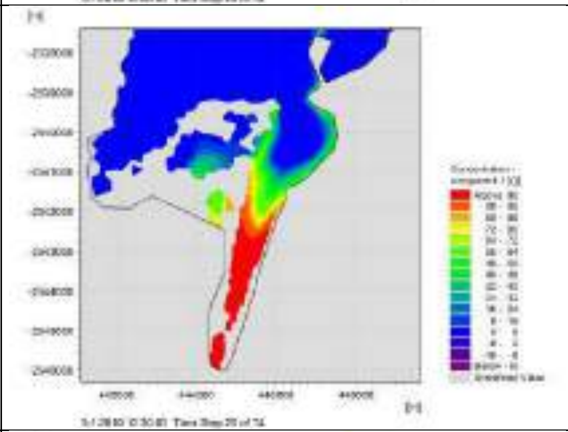
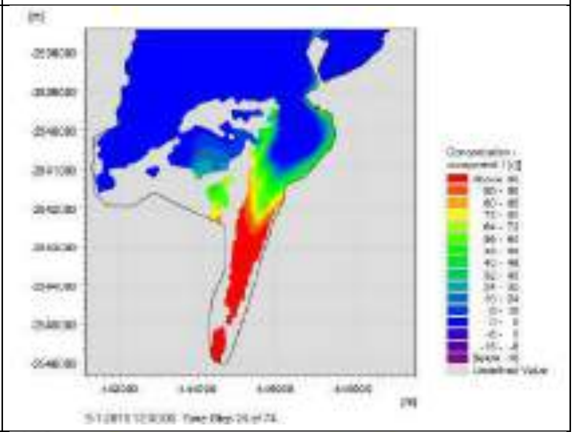
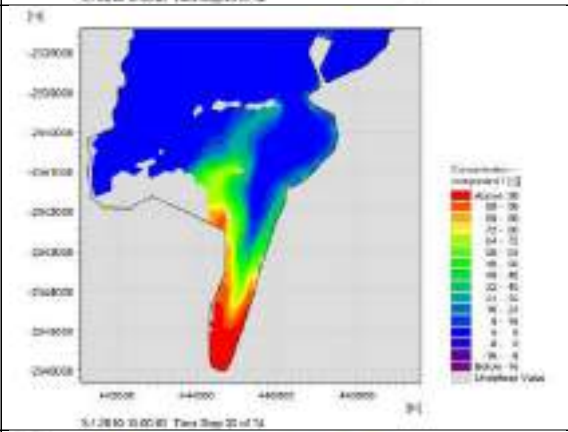
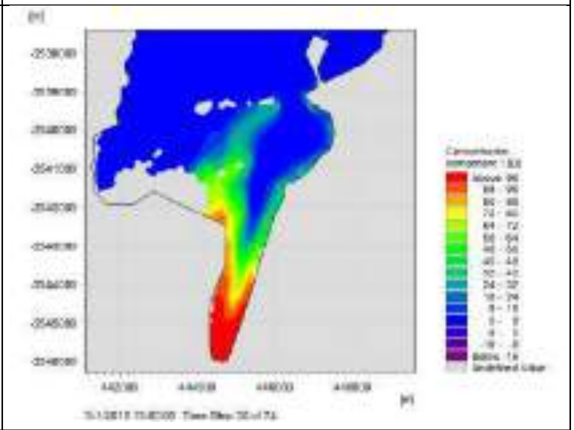
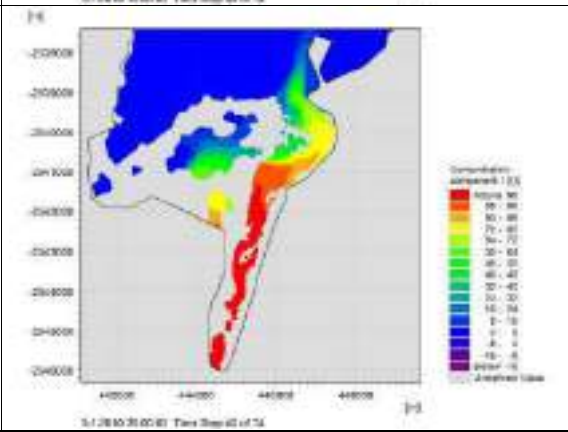
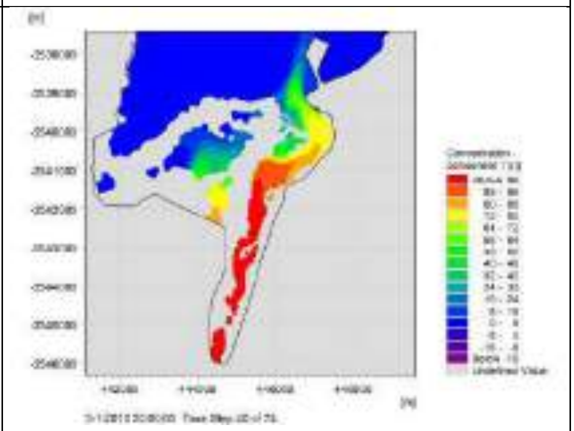
ANNEX B – Flow conditions at lagoon entrance

Table B 1: Changes in flow characteristics at lagoon entrance due to marina construction

	Average flow velocity [m/s]	Max flow velocity Flood [m/s]	Max flow velocity Ebb [m/s]	Average Q across [m^3/s]	Max Q across Flood [m^3/s]	Max Q across Ebb [m^3/s]	Mean flow direction Flood [degree]	Mean flow direction Ebb [degree]
Scenario 1 Neap tide wind from S								
absolute	0.00	0.00	0.00	-0.08	-0.13	-1.69	0.68	2.45
relative	1.2%	0.8%	1.3%	-0.1%	-0.1%	-1.3%	-	-
Scenario 2 Neap tide wind from NNW								
absolute	0.00	0.00	0.00	0.19	-0.19	0.03	0.08	-0.83
relative	0.0%	-0.1%	-1.3%	0.2%	-0.1%	0.0%	-	-
Scenario 3 Neap tide wind from NE								
absolute	0.00	0.00	0.00	0.07	-0.09	0.38	-0.38	-0.41
relative	0.8%	-0.1%	-2.0%	0.1%	0.0%	0.3%	-	-
Scenario 4 Neap tide no wind								
absolute	0.00	0.00	0.00	0.20	0.14	0.63	0.08	0.65
relative	0.4%	0.6%	-1.0%	0.2%	0.1%	0.4%	-	-
Scenario 5 Spring tide wind from S								
absolute	0.00	0.00	0.00	0.45	1.48	-1.53	0.94	-0.53
relative	0.5%	-0.7%	0.0%	0.2%	0.2%	-0.3%	-	-
Scenario 6 Spring tide wind from NNW								
absolute	0.00	0.00	0.00	1.08	0.20	-4.27	-0.46	0.26
relative	0.5%	0.5%	0.4%	0.3%	0.0%	-0.6%	-	-
Scenario 7 Spring tide from wind NE								
absolute	0.00	0.00	0.00	0.87	-0.99	-4.51	0.07	0.33
relative	0.2%	0.6%	0.2%	0.3%	-0.1%	-0.7%	-	-

ANNEX C – Refreshment - tracer movement

Time step	Base Case	After marina construction
0		
5		
10		
15		

20		
25		
30		
40		

ANNEX D – Survey data 2017 fit

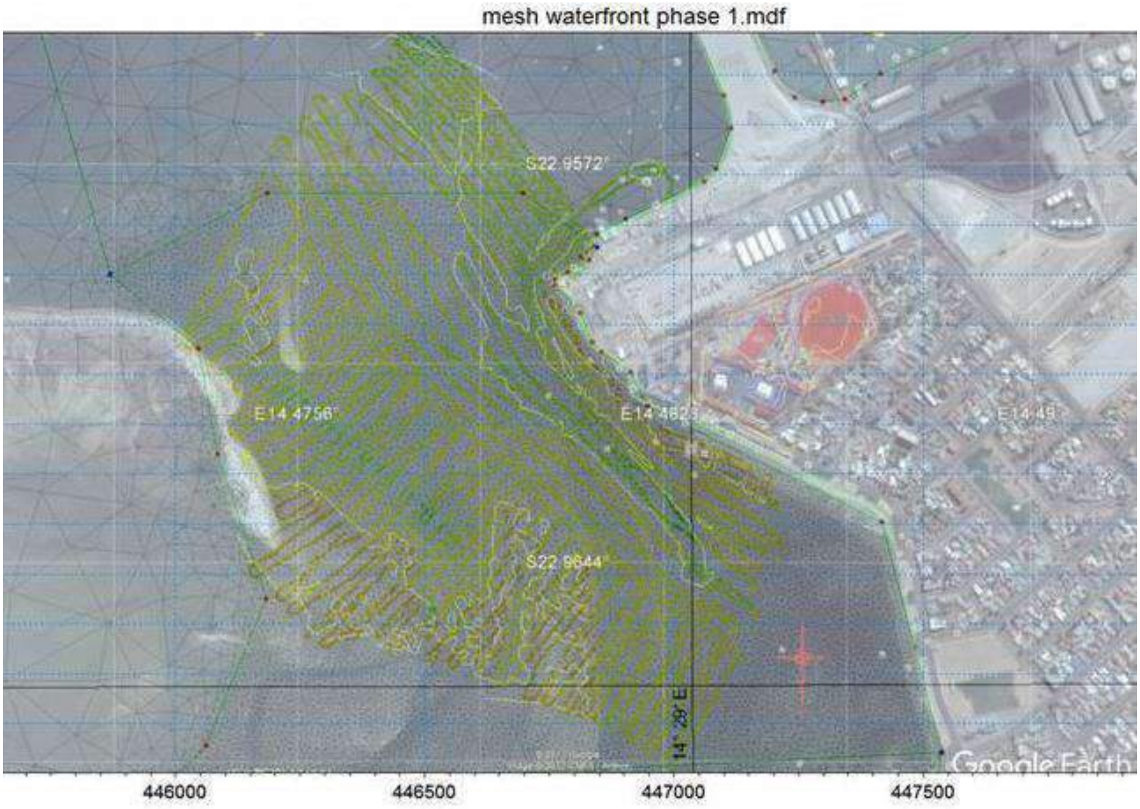


Figure D 1: Fit of June 2017 data into Mike 21 model

ANNEX E – Previous bathymetric surveys at lagoon entrance

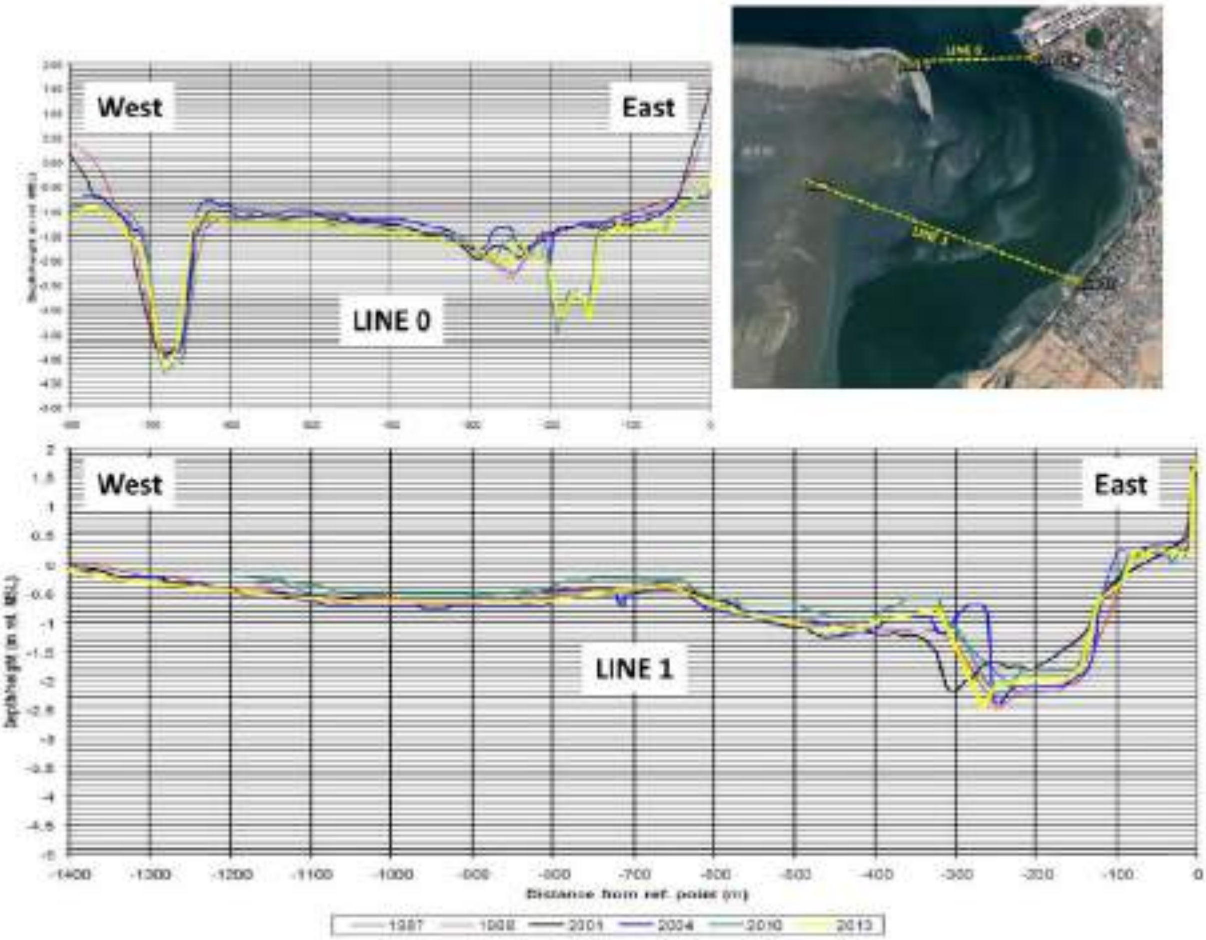


Figure E 1: Deepening of the eastern tidal channel at the lagoon entrance after 2010 (upper left). African Geomatics surveys (2013) adopted from [2]

OVERVIEW OF POTENTIAL IMPACTS ON MARINE MAMMALS IN THE WALVIS BAY AREA WITH RESPECT TO THE PROPOSED WATERFRONT DEVELOPMENT

Dr A.J. Rau PhD (UCT)

March 2017

Statement of Qualification of the Author

Dr Amanda J. Rau was awarded the degree of Doctor of Philosophy (PhD) in Palaeoceanography from the University of Cape Town in 2002. From 2003-2004 she held the position of Post-doctoral Fellow in the Oceanography Department, University of Cape Town.

She completed an MSc in Applied Marine Geoscience at the University of Natal, Durban (1995), with a research focus on the driving forces behind fluctuations in Namibian pilchard and anchovy populations.

Dr Rau has inter-disciplinary qualifications, with most of her research relating to environmental change, both natural and anthropogenically-driven. Dr Rau has worked as a marine geo-science contractor for over 10 years, working on numerous projects in the fields of marine diamond mining, naval research (IMT) and pipeline surveys (SIEP; Kudu gas field). Dr Rau has been involved in environmental issues relating to the Benguela Current Large Marine Ecosystem since 1993 (SFRI), including scientific and environmental collaboration between the mining and living resources industries, and also between neighbouring countries (BCLME, BENEFIT). She has been on working groups at the Sea Fisheries Research Institute, Cape Town (Climate Change Working Group 1993-1994), the Benguela Ecology Programme (BEP, 1993-1994), Quaternary Research Group, UCT (1998-2004), the Lüderitz Cell and Orange River Cone (LUCORC, 2000-2001), BENEFIT (2005) and conservation planning (BCLME 2006). Dr Rau has also lectured, trained and supervised students and employees at various levels in industry and at tertiary education facilities (UCT, NUST). Dr Rau has authored numerous reports related to the potential environmental impact of marine exploration and development.

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GLOSSARY

ABF	Angola-Benguela Front
Audiogram	A graph that shows audible threshold (softest sounds detected) at different frequencies (or pitches)
BCLME	Benguela Current Large Marine Ecosystem
CD	chart datum
CH_4	Methane
dB	decibel - a unit used to measure the intensity or the "loudness of a sound. Used to measure the amplitude of the sound pressure wave of a sound
ENSO	El Niño Southern Oscillation
Frequency	The number of pressure waves that pass a reference point in one second. Measured in Hertz (Hz) or cycles per second. Higher frequency is perceived as a higher pitched sound
HAB	harmful algal bloom
H_2S	Hydrogen Sulphide
Hearing threshold	The sound pressure level that is just audible to a subject under quiet conditions
Hz	Hertz – pressure wave cycles per second
LOW	low oxygen water
Masking	Temporary reduction in ability to detect biologically relevant sounds
Mysticetes	Baleen whales
NBR	Northern Benguela Region
Odontocetes	Toothed whales and dolphins
Otariids	Fur Seals and Sea Lions (eared, clawless seals)
Pinnipeds	Odobenidae (Walrus), Otariidae (sea lions and fur seals) and Phocidae (true seals)
Phocid	True seals (earless, clawed seals)
ppt	parts per thousand
PTS	permanent threshold shift (hearing damage)
SAA	South Atlantic Anticyclone
SBR	Southern Benguela Region
SEL	Sound Exposure Level - the overall acoustic energy impinging on a receiver per unit area within 1 second (dB re 1 μPa^2-s.)
SL or SPL *#	Sound Levels or Sound Pressure Levels - measured in decibels (dB) and referenced to a standard pressure at a standard distance. Reference pressure level for underwater acoustics is 1 micropascal at a reference distance of 1 m (1 µPa@1m). Reference level in air is 20µPa @ 1m. *#
SO_2	Sulphur Dioxide
SST	sea-surface temperatures
Threshold shifts	an animal's ability to hear at a particular frequency
TTS	temporary threshold shift
µPa	micropascal - a measure of pressure. In air 1,000,000 µPa = 1 Pa ≡ 94 dB

*# To compare noise levels in water to noise levels in air, one must subtract 26 dB from the noise level referenced in water. For example, a supertanker radiating noise at 190 dB (re 1µPa @ 1m) has an equivalent noise level in air of about 128 dB (re 20µPa @ 1m).

EXECUTIVE SUMMARY

The Walvis Bay Waterfront Development (Pty) Ltd intends to develop an area stretching from the current position of *The Raft* Restaurant northwards towards the present Yacht Club. The construction will encompass a breakwater, a connecting canal and a basin. Construction activities will comprise dumping of breakwater material, dredging (and possibly blasting) and piling. There will be increased marine traffic to and from the development site during construction as well as afterwards, with the construction of a new marina. The new facilities are aimed at increasing tourism and recreation in Walvis Bay. The potential positive economic spin-off of the proposed waterfront development must be weighed against any possible negative environmental impact.

The nutrient-rich waters of the adjacent coastline and the Benguela Current region support a variety of top predators, including marine mammals. Of consequence to this report are those that inhabit the nearshore areas that may be directly affected by construction activities, or by increased marine vessel traffic, specifically dredgers, small motorised craft and eco-tourism cruises. All marine mammals are protected within Namibian waters. The purpose of this report is to identify potential impacts of the development on the resident and temporary inhabitants of the Walvis Bay region, as well as on the migratory species and transient visitors.

The key environmental concerns are the resident and commonly seen mammal populations. There is a non-breeding population of Cape Fur Seals at Pelican Point. The largest resident dolphin populations are Heaviside's Dolphins (~500 animals), Bottlenose Dolphins (~100 individuals) and Dusky Dolphins (Namibian Dolphin Project, 2016). Killer Whales have been seen at increasingly regular intervals within the bay over the last decade. Humpback Whales migrating along the Namibian coast are seen in peak numbers in June-July and also in September. Other cetaceans seen periodically within the vicinity of Walvis Bay are Risso's, Rough-toothed and Southern Right-whale Dolphins. Leatherback Turtles have been sighted by tourists on marine cruises off Swakopmund between October and April, and in Walvis Bay in February and March (Namibian Dolphin Project, 2016). It is hoped that Southern Right Whales will return to historical breeding grounds around Walvis Bay in the near future.

The area being considered for development is neither pristine nor undeveloped. Although the Walvis Bay lagoon and wetlands have been declared a Ramsar site and are of global environmental significance, there are numerous commercial enterprises in and around the wetlands, including saltpans and a salt works, an upmarket hotel at Pelican Point near the entrance to the lagoon, and popular fishing spots on the sandspit protecting the bay near the lagoon mouth. Walvis Bay is Namibia's largest harbour and port with passenger amenities, cargo loading quays, storage and transport services, dry-dock facilities, and commercial fish processing factories. The protected waters of the bay itself provide ample

offshore anchorage. The lagoon is used for commercial mariculture farms and also for tourism and recreational activities such as wind- and kite-surfing and kayaking. Marine tours take visitors into the lagoon and out to Pelican Point to view seals and dolphins close up. Recreational fishing spots are found on the sandspit at the seaward end of the wetlands, within the lagoon and around the northern shores of the bay. There is 4 x 4 access, via the salt works, through the wetlands to Paaltjies Beach and Pelican Point. The wetlands are popular with birdwatchers, as they host vast populations of resident and migratory birds of a variety of species. The esplanade along the eastern shore of the lagoon affords visitors and locals the opportunity to view flamingos, pelicans, waders and other coastal birds from close range. It is a popular route for joggers and dog-walkers. The marine mammals have been exposed to harbour development with the expansion of the container basin, periodic maintenance dredging, regular sea-going traffic and repeated close contact with humans as a consequence of marine tourism cruises. None-the-less, the new development will add an extra dimension of disturbance and potential threat to the mammals sharing the bay waters.

Despite the increase in commercial activity within Namibia's EEZ, visual observations suggest that whale and dolphin populations have been increasing in the last decade. Baleen whales use migratory corridors along the coast or off the continental shelf during their annual migrations between summer Antarctic feeding grounds and breeding grounds in coastal tropical and subtropical waters. There is documented evidence that Southern Right Whales are returning to historical breeding grounds in southern Namibia, and it is hoped that they will venture further north into the Walvis Bay region. Toothed whales have been seen migrating through the cold Benguela system.

The Benguela (Heaviside's) Dolphin is a resident species endemic to the nearshore waters of the Benguela region. This dolphin is commonly seen between Cape Point (34º20'S) and northern Namibia (17º30'S), concentrated in shallower waters, inshore of the 100 m isobath. There is a resident population of some 500 individuals in Walvis Bay. The larger form of the Bottlenose Dolphin (Common Bottlenose *Tursiops truncatus*), resides in waters less than 10 m deep in the extreme inshore region of northern Namibia, while a slightly smaller form is seen throughout deeper (> 500 m) southern African offshore waters. A pod of ~100 Common Bottlenose Dolphins lives in Walvis Bay. The Dusky Dolphin is a year-round resident of BCLME coastal waters. Sightings are reported generally close to shore within the 50 m isobath, although some individuals have been reported as far out as the 500 m isobath. Risso's Dolphins are the third most frequently seen dolphin in the Northern Benguela Region, usually in deep waters off the Namibian coastline. Common Dolphins avoid the cooler inshore waters of the BCLME region, but have been recorded as regular inhabitants of pelagic Namibian waters. The Long-beaked Common Dolphin *(Delphinus capensis)* is a popular attraction on a dolphin cruises around Walvis Bay and Swakopmund because it is very gregarious and highly vocal and can be seen in large schools. Rough-toothed Dolphins have been seen from Walvis Bay northwards to Möwe Bay in deep, warmer waters. They have been observed in the company of Pilot Whales and offshore Bottlenose Dolphins. According to vessels operating within Namibian waters, dolphin numbers have been increasing in the last decade.

The Cape Fur Seal is a common resident of the BCLME with numerous breeding sites on the mainland and on nearshore islands and reefs. A colony of some 5000 seals that haul-out at Pelican Point is visited frequently by tourists.

Any construction of harbour and quay facilities will impact on the natural environment. Hydrological changes are brought about by the construction of quays and breakwaters and the implementation of dredging programs and dumping of dredged material. Runoff from quays and walkways can pollute the water. Increased organic loading can result from additional sewage outflow or dumping of garbage. Explosive devices and pile driving can cause physical trauma, hearing loss and behavioural change in marine fauna. Dredging to deepen approach channels and basins can result in loss of food sources, turbidity and resuspension of sediments that may contain toxic compounds. Imprudent disposal of waste products and rubbish can lead to entanglement, injury and death in mammals and turtles. Increased tourism and numbers of recreational vessels can lead to masking of biologically important sounds. There is an increased risk of vessel-animal and human-animal interactions and these pose a risk to both the animals and to humans.

Effects on marine mammals associated with the proposed development project include underwater noise impacts, reduced prey availability, disturbances from construction and shipping activities, collisions between marine mammals and vessels, contamination of the water column and resultant bioaccumulation of toxins, injury from litter, stress from increased human activity and habituation to human presence. The significance level of each impact can be reduced through the implementation of mitigation measures.

Underwater noise

Marine mammals (cetaceans and pinnipeds) use sound for communication, orientation, predator avoidance and foraging. Underwater noise has the potential to affect or interfere with these critical activities. The effects range from subtle changes in behaviour to temporary or permanent hearing loss. The response of a marine mammal to an anthropogenic sound will depend on the frequency, duration and energy (amplitude) of the sound, as well as the distance of the animal from the sound source and whether the noise is perceived to be approaching or moving away.

In extreme cases and at very high received SPLs received close to the source, very intense sounds (e.g. underwater explosions) can result in internal injuries that might lead to death.

Masking is the term used to describe a temporary reduction in ability to detect biologically relevant sounds as a result of a loud noise or strong SPL. Masking can shorten the range over which sounds can be detected and across which conspecifics are able to communicate (e.g. mother and calf). However, most mammals communicate across a range of frequencies, so it is highly improbable a construction noise will mask the full range of frequencies used by one specific species. *Threshold shifts* refer to an animal's ability to hear at a particular frequency. Temporary threshold shift (TTS) refers to an animal's inability to hear a particular frequency for a transitory period of hours to days. Permanent threshold shift (PTS) represents a permanent loss of hearing at a particular frequency. *Behavioural disturbances* are reflected by noticeable changes in activity and demeanour in direct response to a sound source (e.g. directional swimming, jumping out of the water, avoidance or reduced acoustic response).

The frequency of sounds generated by marine mammals range from the 10 Hz low-frequency calls of Humpback Whales to the > 200 kHz ultrasonic clicks of offshore dolphins and Harbour Porpoises. The hearing systems of animals are not equally sensitive to all frequencies. The marine mammals of concern in this report, that may be found within the Walvis Bay area, are low-frequency mysticetes (Humpback and Southern Right Whales) that have a vocalisation and hearing range of 7 Hz to 22 kHz, mid-frequency cetaceans (Orcas, Bottlenose, Dusky, Common and Risso's Dolphins) with ranges of 100 Hz to 160 kHz and Cape Fur Seals. There are no auditory records for Cape Fur Seals, so data for similar species (Northern and New Zealand Fur Seals and Australian and California Sea Lions) are used. Seals and sea lions produce sounds that range in frequency from approximately 125 Hz to 40 kHz.

The main sources of underwater noise from the proposed development can include blasting, ramming or impact (strike) pile driving during construction, dredging and operating noise from construction vessels and increased small craft after completion of the waterfront.

Blasting is one of the most powerful sources of underwater sound, but the energy impact is very short-lived. Cape Fur Seals appear to have a high tolerance for underwater sounds. Their habituation to "seal bombs" suggests that they are fairly resistant to loud noise pulses. After an initial startle reaction, it has been noted that individuals quickly reverted back to normal behaviour. Blasting is unlikely to significantly impact the behaviour of Cape Fur Seals or impair their hearing at distances greater than 700 m (Brough et al., 2014; Thompson et al., 2000).

Mid-frequency cetaceans are more sensitive and need to be further (~2 km) removed from the sound source to avoid suffering TTS (NOAA, 2015; Finneran et al., 2002). Behavioural responses can be expected at far as 5 – 10 km away.

Low-frequency Humpback Whales are the most sensitive to blasting noise and will be highly impacted if in close range. There is evidence to suggest some level of disorientation or impairment after blasting events at < 2 km (Madsen and Møhl B., 2000; Todd et al., 1996). However, as Humpbacks are only transient migrants past Walvis Bay, and if the timing of the blasting can be scheduled not to coincide with peak observation periods (June, July and September), the impact level of blasting on the baleen whales is considered to be of very low significance.

While blasting can severely injure turtles at close range, research indicates that masking or behavioural disturbance is unlikely at distances greater that 1 km. This is because magnetic signals are turtles' main navigational tools, rather than sound signals (Lohmann et al., 2001; McCauley et al., 2000).

Acoustic harassment devices have been used successfully used against Ringed Seals and Harbour Porpoises. Effective avoidance zones using pingers have been reported at distances of 200 to 500 m (OSPAR, 2009). It might be necessary to deploy several pingers at different distances from the construction site to keep mammals outside of potential TSS zones.

Pile-driving is undertaken in harbour and offshore construction. Impact pile drivers have much lower peak pressures and far longer rise times than explosives. Source levels vary depending on the diameter of the pile and the method of pile driving: impact or vibro-piling. The frequency spectrum for pile driving ranges from less than 20 Hz to more than 20 kHz with most energy around 100 - 200 Hz (Dahl et al., 2015; AFTT, 2012; Bailey et al., 2010; OSPAR, 2009). Consequently, it is expected that pile driving noise would significantly mask Humpback Whale vocalisations. However, as Humpback Whales are transient migrants through the NBR, and do not come into the bay itself, it is expected that any pile driving operations will have minimal impact on this species. Also, they feed only opportunistically during migration, so displacement of prey species such as anchovy and sardine, is of small consequence.

Mid-frequency dolphins (Bottlenose, Dusky, Common, Risso's) and Killer Whales have less sensitive hearing below 1 kHz. PTS and TTS will occur within 5-10 and 10-20 m, respectively, of the pile-driving process. Masking of vocalisations and echolocation in Bottlenose Dolphins as a result of pile driving is deemed unlikely beyond 100 m (Bailey et al., 2010; David, 2006). Bottlenose Dolphins and Harbour Porpoises have shown avoidance of wind farm construction areas during active piling periods for distances of 20 km. They remained distant from the noise source for 4 to78 hours (Bailey et al., 2010; Brandt et al., 2011; Tougaard et al., 2005; 2003). Additionally, porpoises exhibited significant behavioural changes from non-directional movement (presumably associated with feeding) to directional movement on days with active pile driving operations. Nevertheless, all behaviour returned to baseline levels within 4 hours of cessation of ramming, suggesting no long-term effects (Tougaard et al., 2005; 2003a; b).

Cape Fur Seals vocalise at low frequencies (~ 100 Hz), so their detection of biologically important sounds may be impaired by increased low spectrum noise. However, Bailey et al. (2010) found that PTS is likely only within 20 m of piling at peak source levels of 212 dB re 1 µPa. TTS is possible at 40 m. Masking was deemed unlikely beyond a distance of 100 m, based on a SEL of 166dB re1 µPa2-S. Brough et al. (2014) suggested a precautionary exclusion zone of 700 m to preclude physical injury to New Zealand Fur Seals resulting from pile driving noise. Edren et al. (2004) observed a reduction in numbers of Harbour Seals hauling out at sandbanks 4–10 km away from the piling operations. The avoidance behaviour was very short-term as seal haul-out returned to base level numbers, accompanied by normal behaviour, on days when no ramming was undertaken.

Legislation in several European countries is aimed at limiting piling impacts on marine mammals and reducing avoidance distances to less than 8 km (Dahl et al., 2015). A precautionary approach, based on these regulations and other data, would involve:

- no piling during the seasons with the highest abundance of sensitive species (For this project that would be during the peak Humpback migration in June and September)
- using “soft starts” and ramping-up procedures to allow animals to move away (seals and odontocetes are known to move out of range before SEL reach damaging intensities)
- monitoring noise levels. If they exceed 30 kPa at a distance of 1 m to 2 m from the pilings noise reduction methods should be considered such as hydraulic pile driving or vibratory hammers rather than impact pile driving, mantling orinstalling silt or bubble curtains
- establishing specified safe distance zones (500 m for Cape Fur Seals and 2 km for dolphins) and delaying or ceasing piling operations if a mammal is within these zones.

(Todd et al., 2015; Brough et al., 2014; Bailey et al., 2010; OSPAR, 2009; Marine Mammal Commission, 2008; Würsig et al., 2000).

No mitigation measures other than “soft starts” are deemed necessary with respect to the presence of turtles, as scientific evidence suggests that turtles will move away from the noise source (McCauley et al., 2000; Bartol et al., 1999).

Madsen et al. (2006) determined that pile driving would not have significant masking implications across the entire spectrum of frequency ranges used by Harbour Porpoises, Bottlenose Dolphins, North Atlantic Right Whales or Harbour Seals. Cape Fur Seals have shown a strong resilience to noise impacts from other marine sources in Namibian waters. They purposely approach operational marine survey, mining and fishing vessels regardless of the use of deterrents. Thus, piling activities are not expected to present any long-term detrimental impacts to any of the mammals in Walvis Bay, as long as they are sufficiently removed from direct exposure to the sound source.

Short-term impacts of piling on marine mammals may include avoidance behaviour and reduction in prey species that could move away or otherwise suffer negative consequences. However, the varied diet of seals and cetaceans and their ability to forage some distance away from their usual habitats will negate any temporary reduction in prey availability.

The long-term impact of impulsive noise on turtle migration and feeding is considered to be of low significance, since turtles make use of magnetic cues rather than acoustics for navigation (Lohmann et al., 2001).

Dredging emits continuous broadband sound, mostly in the lower frequencies with bandwidths between 20 Hz and 1 kHz. These sounds primarily fall within the lower frequency ranges of baleen whales, at which toothed whales and dolphins are less sensitive (Robinson et al., 2011; Richardson et al., 1995). Damage to the auditory systems of low-frequency marine mammal is unlikely, but masking and behavioural changes are possible, owing to the increased (and continuous) ambient noise in the low-frequency spectra.

Behavioural responses of baleen whales vary according to the type of construction activity and dredge method, but there is generally some avoidance response. The numbers of Bottlenose Dolphins in established foraging areas in Aberdeen Harbour declined as dredging intensity increased (Todd et al., 2015).

Research suggests that the impact of dredging sounds on pinnipeds is limited. New Zealand Fur Seals, Australian Sea Lions and Hawaiian Monk Seals showed no disturbance reactions, despite the relative closeness of the dredging to popular haul-outs (Todd et al., 2015; EPA, 2007). In some cases pinnipeds and dolphins were actually attracted to areas of active dredging (Anderwald et al., 2013 cited by Todd et al., 2015), possibly because of increased prey numbers as a result of seabed disturbance.

It can be concluded that most effects of construction involve short, perhaps medium-term, behavioural reactions and masking of low-frequency calls in baleen whales and seals. Temporary hearing loss is possible if receivers stay for extended periods near the dredger, but auditory injury is unlikely. It is unlikely that construction noise will interfere significantly with the sonar or hearing ability of mid-frequency cetaceans.
While the preferred prey species of resident mammals may be temporarily displaced through stress and avoidance of the construction noise, this would be of limited duration in time and space and should not cause any feeding stress.

The overall impacts of construction noise and disruption on marine mammals within Walvis Bay may be moderate to high initially, but can be moderated in the medium term. No long-term, significant population-level negative effects are expected as a result of noise associated with this development.

Increased marine traffic:

There will likely be more vessels entering the lagoon area (dredge and construction) during the construction phase of this project than at any time previously. This will create more disturbance within a confined space. Heiler et al. (2016) identified an upward shift of up to 1.99 kHz in the vocalisations of Bottlenose Dolphins in the presence of one or more small boats in Walvis Bay. It is likely that construction, transport and dredge vessels will illicit similar responses, though the significance thereof is undetermined.

In terms of direct effects on marine mammals, collisions are possible, but improbable, given that the marine mammals within Walvis Bay are accustomed to the passage of sea-going vessels in and out of the harbour, as well as to the smaller marine tour boats. Operating dredgers are either stationary or moving at slow speeds and the marine mammals in the bay are highly mobile, so collisions are improbable. Non-the-less, the probability of collisions can be lessened if:

- vessels use predetermined shipping lanes and navigation routes to and from the construction site
- vessels maintain a constant course and constant speed where practical, except in an emergency
- crews of vessels involved in construction activities remain vigilant to the presence of marine mammals in the area
- vessels maintain a distance of 100 m from any marine mammal (if marine mammals deliberately approach within 100 m, vessel speed should be reduced and, if possible, cautiously manoeuvred away from the animal, vessel speed may be resumed once a mammal has moved at least 100 m from the vessel)

The fact that there has only been one case of a small-boat propeller injury suggests that, on the whole, tour operations are not a threat to swimming dolphins. However, an increase in the number of vessels may result in more “jostling” for prime positions, with associated increase in risk of mammal-vessel collision. People need to be educated with respect to approaching and feeding marine mammals. The practise of feeding Cape Fur Seals and encouraging them to board boats should be stopped as they will be unable to distinguish between a tour boat and a small fishing or recreational vessel.

The considerable increase in marine traffic approaching the lagoon will have significant impact on all wildlife life for the duration of the construction. Initially, and in the short term, a high level of disruption to cetaceans and seals is probable, but the significance and level of intensity will moderate with time as the mammals become habituated. Cape Fur Seals will probably habituate faster than the cetaceans in the bay. Long-term impacts of small craft in the bay will be dependent on regulations and enforcement thereof.

Turbidity, water contamination, pollution and litter

Dredging operations, during construction and subsequently, for maintenance purposes, will release sediments into the water column, causing turbidity and remobilizing compounds. Sediment plumes are generally localized and marine mammals often navigate through turbid waters, so significant impacts from turbidity are improbable. Heaviside's, Dusky and Bottlenose Dolphins are highly mobile and would readily avoid turbid water. They also have the ability to use sonar, so that they do not have to rely solely on vision. Sight is not essential to pinnipeds' survival or ability to forage and hence the level of turbidity is inconsequential (Dehnhardt et al., 2001; McConnell et al., 1999). Turbidity has the potential to impact fish abundance and distribution within the lagoon. However, additional food sources are available in the rest of the bay. These highly mobile animals can relocate to more favourable feeding areas or increase time spent foraging for the periods when dredge plumes are present. This may impact the local population densities somewhat in the short term, but is likely to be of low significance in the long term.

Entrainment, habitat degradation, noise, contaminant remobilization, suspended sediments, and sedimentation can affect benthic, epibenthic and infaunal communities, which may impact marine mammals indirectly through changes to prey species. Marine mammals can compensate for small-scale changes in prey abundance by switching prey species or moving to alternative foraging grounds. Dredging could have positive impacts, such as increasing prey availability and species diversity due to a temporary augmentation of nutrients and primary productivity (Todd et al., 2015; Bailey et al., 2010).

The level of the impact of remobilising contaminants within dredged material will be determined by the sediment composition and the distance of the dump site from known breeding and feeding grounds and haul-out sites. If the sediments contain a high degree of toxins that can become bioavailable, the impact of dredging and dredge spoil dumping can be very high in the long term. However, a properly designed and managed dredging programme can have a low impact on the mammal population. There are no reports of significant long-term impact related to the regular maintenance dredging in Walvis Bay Harbour and it is assumed that the sediments in the proposed construction area will be of similar composition.

Stormwater runoff, particularly during the construction phase of the development, may cause water pollution and reduce water clarity if adequate stormwater treatment systems are not established. Mitigation measures can include introducing systems to minimise contamination of runoff and stormwater, introducing and enforcing no dumping policies for construction material and rubbish and placing containment net fences around active construction sites to minimise wind-blown dust and debris. Appropriate design and management can reduce the risks of intense impacts (both long- and short-term) to moderate levels of significance.

Contaminants can be introduced into the marine system through inadequate disposal of construction materials, rubbish generation and accidental oil and chemical spills from construction vessels and machinery. Short term impacts of high intensity and significance can result from oils spills, but can be lessened by quick response and following preset clean-up procedures.

Marine mammals are susceptible to bioaccumulation because they feed at high trophic levels and have a large proportion of lipid-rich blubber which readily accumulates toxins. High contaminant levels have been linked to depressed immune systems and endocrine disruption (Todd et al., 2015; Brough et al., 2014; Bailey et al., 2010; Marine Mammal Commission, 2008). The inshore distribution and movement of the resident dolphin species is a factor of concern. Pollution can impact the health of individual marine mammals and have longer-lasting, population-level impacts such as reproductive complications, developmental defects, strandings and other mortality events. Solid surfaces (walkways, jetties) near and around residences and businesses will facilitate the addition of pollutants into the lagoon waters due to suspension in rainwater run-off and cleaning water that is washed into the waterways. Toxins may also accumulate in the bottom sediments and may be resuspended into the water column by storms and maintenance dredging, and subsequently be taken up by marine mammals. Policies to eliminate the addition of pollutants (cleaning chemicals, rubbish, and effluent) into the waters of the lagoon and bay and control waste disposal must be established and enforced.

Marine mammals accumulate high levels of contaminants, irrespective of whether they are exposed to construction and dredging activity, as they are highly mobile creatures and come into contact with contaminants throughout their entire range. Any cumulative effects are only possible to calculate with known baseline levels of toxins in the marine mammals that already inhabit the Walvis Bay area. Dolphins and seals have some of the highest concentrations of organochlorides for any marine animal owing to their fairly regular contact with humans, the close proximity of their habitat, their large coastal distribution and high trophic level. However, the potential impact of toxin accumulation in dolphins as a result of increased exposure to chemical waste is considered high in the long term.

A further point of concern is an increase in non-biodegradable pollution that will result from an increase in tourism and general human activities in and around the waterfront. Non-biodegradable litter and discarded fishing gear pose a serious threat to seabirds and marine animals, such as seals and turtles. Stringent controls and penalties for littering need to be imposed. The impact on seal and turtle injury and mortality due to entanglement or garbage consumption is considered to be highly significant, both in the short and long term.

The level of impact of the completed development is dependent upon what control measures are instigated to combat pollution. High levels of chemical pollution and non-biodegradable waste can potentially cause irreparable harm.

Increased human activity

The Walvis Bay Lagoon is explored by boat and kayak. Wind surfing and kite-boarding are popular on the leeward side of Pelican Point. The shoreline is popular for walking with locals and tourists alike. Recreational fishing occurs at Paaltjies Beach on the sandspit and elsewhere in the bay. There are daily boat tours to Pelican Point and into the bay. Pelican Point can be accessed overland via the wetlands and salt pans. There is a potential for increased activity on a daily basis as a result of the development attracting more visitors as well as local residents, particularly when the accommodation phases are complete. With increased numbers of people comes associated increased disturbance of all nature wildlife in the immediate area, as well as a higher likelihood of human-animal interaction. There is the potential for degradation of the sandspit if numbers are not controlled. Overfishing and removal of bait species can impact top predators in the entire Walvis Bay area.

Dolphins can experience stress from increased human activity, particularly when breeding and nursing. Larger numbers of marine tour boats can influence the vocalization parameters of dolphins and such changes could have a long-term impact if they reduce the communication range of whistles or increase energy expenditure (Heiler et al., 2016). Frequent contact between humans and dolphins, achieved through the regular tourist cruises, can have unknown long-term negative impacts on dolphin health (at population level) owing to the nearness of the interactions. Captive dolphins are susceptible to human illnesses and the dolphin populations in the bay may be similarly exposed through daily contact. Stress and discomfort will make them vulnerable to infection.

Cape Fur Seals are known to become habituated to human presence, particularly if the if humans are providing food. As with all encounters with wild animals, there is potential for injury – both to the animal and to humans. The fact that they will come out of the water represents a greater threat. These are strong animals and encounters will, more often than not, favour the seals. The feeding of seals by the public, tour operators and workers in local business and restaurants will only encourage scavenging and enhance the risk of animal-human conflicts. An apparently easy source of food will persuade more seals to frequent the lagoon area and approach people, both in the water and out of it. Cape Fur Seals are known to predate seabirds in times of prey shortage (Kemper et al., 2007). Becoming accustomed to “easy meals” may encourage predatory behaviour, and this can lead to potential declines in local seabird populations.

The impact of increased human presence can be mitigated by implementing and enforcing regulations and controlling numbers. Discarding of rubbish and fishing gear should be rigorously controlled and penalties should be imposed (e.g. fines or banning from the area). Approach distances to mammals on land and in the water must be applied. Regulations regarding type and amount of fish and bait removal must be enforced.

The safeguarding and preservation of the natural status quo depends on controlling the number of recreational users and tourist visitors to the lagoon and bay areas and relies upon the enforcement of regulations. Poor management and regulatory control can have a significantly high, long-term effect on the natural integrity of the entire bay area. However, the impacts can be moderated through education, regulation and sound management.

Tourism can have substantial positive impacts for Walvis Bay in that it generates employment and foreign exchange. A conscientiously constructed and well managed waterfront can be economically beneficial and if there is a strong environmental component to the management, the long-term negative impacts will be low.

1. INTRODUCTION

DVDM Properties (Pty) Ltd intends to develop a recreational and business waterfront area in Walvis Bay on the northern end of the Walvis Bay lagoon. The development will include a shallow small-craft harbour and tidal marina, restaurants and tourism-related businesses, hotels and residential apartments. The Walvis Bay Waterfront Development (Pty) Ltd intends to develop an area stretching from the current position of *The Raft* Restaurant northwards towards the present Yacht Club. The construction will encompass a breakwater, a connecting canal and a basin that will be at least 3 m below lowest astronomical tide (DVDM Properties, 2016).

Walvis Bay is situated on the west coast of Namibia, midway between its southern and northern borders. It is situated at the mouth of the Kuiseb River at the northern extent of the Namib Desert. The cold, nutrient-rich, upwelled waters of the Benguela Current run northwards along the coastline.

Figure 1: Aerial View of Walvis Bay showing from west (left) Pelican Point peninsula, wetlands, salt pans, lagoon and town. (Source: Uushona and Makuti, 2008.)

An active, northwards-extending sandspit protects a natural, deep-water anchorage against the rough seas of the South Atlantic Ocean. An automatic lighthouse and a luxury hotel are built on the tip of the 18 km-long sandspit at Pelican Point (Figs. 1 & 2). The southern part of the bay comprises a 7 km-long lagoon and some 10 km^2 of coastal wetlands. (Enviro Dynaics, 2012; Namport, 2010; CSIR, 2009; Uushona and Makuti, 2008).

The Walvis Bay wetlands, comprising the eastern half of Pelican Point and its adjacent inter-tidal areas, the salt works south of the town, the naturally flooded areas to the south of the salt works, Walvis Bay lagoon and a second lagoon area near the sewage works, represent one of the most important coastal wetlands in southern Africa. It hosts some 200 000 migrant and 170 000 resident birds throughout the year (Enviro Dynaics, 2012; Uushona and Makuti, 2008). The wetlands surrounding the lagoon have been declared a Ramsar Site. Namibia acceded to the Convention on Wetlands of International Importance (Ramsar Convention, 1971) on 23 December 1995 (Ramsar, 2017). It is an environmentally sensitive area that has been afforded some measure of protection status.

The town of Walvis Bay (Figs. 1 & 2) is built adjacent to one of the best natural harbours along the barren south-west African coast. It has both a deep-water bay and a tidal lagoon. The harbour area is protected from the brunt of the south-westerly winds and currents by the Pelican Point peninsula. The harbour area (Fig. 2) is under the control of Namport and the commercial fishing industries.

The Benguela Current Large Marine Ecosystem (BCLME) is one of the most biologically productive systems in the world's oceans. The nutrient-rich waters support large numbers of pelagic fish such as pilchard, anchovy and juvenile horse mackerel, which in turn sustain an abundance of top predators such as whales, dolphins, sharks, turtles and seabirds, as well as a fishing industry that supports many local Namibians and contributes significantly to the country's GDP.

Within Walvis Bay, eco-tourism, with particular emphasis on marine animal viewing cruises, plays a significant role in the local economy. There is an oyster-farming mariculture industry within the lagoon (Fig. 2).

As the ocean is not our natural habitat, all human activity has an impact on the marine environment to varying degrees. There are always potential environmental impacts associated with any marine and /or coastal project. Coastal ecosystems are extremely fragile and can easily be disturbed by anthropogenic activities. It is important to prioritise the safeguarding of ecosystems and general coastal environments. The purpose of any Scoping Report and EIA is to identify potential negative impacts of the proposed project, determine the significance and consequences of such impacts, and prompt the initiation of mitigation measures to nullify or diminish potentially negative impacts to acceptable risk levels.

This report is a desktop review of marine mammals that occur within the Walvis Bay area. It identifies any potentially negative impacts of the development on these mammals, during both the construction phase and the subsequent operational phase, and suggests mitigation measures.

2. ENVIRONMENTAL AND SOCIO-ECONOMIC SETTING

2.1 LOCATION AND GENERAL DESCRIPTION

Walvis Bay, situated in the middle of Namibia's S-N trending Atlantic coastline, is one of only three west to north-facing embayments that provide significant wave shelter from the South Atlantic swell, the others being Lüderitz and Swakopmund. Thus, it was one of the first settled areas for seafarers. Another draw-card was the presence of fresh water at the mouth of the Kuiseb River. This bay was once a favourite hunting ground for American, British, Dutch and French whaling fleets, owing to the abundance of baleen whales in the surrounding waters.

Being located at the northern extreme of the Namib Desert, Walvis Bay lies within an ever-changing sedimentary environment. The bay itself is bounded to the west by the dynamic Pelican Point peninsula – an 18 km-long, north-westward extending sandspit that is growing at approximately 17 m per annum (Namport, 2010). There is an extensive wetland area to the south and a 7 km-long north-north-eastward oriented lagoon inshore of the spit. The town and harbour are situated on the northward side of the lagoon.

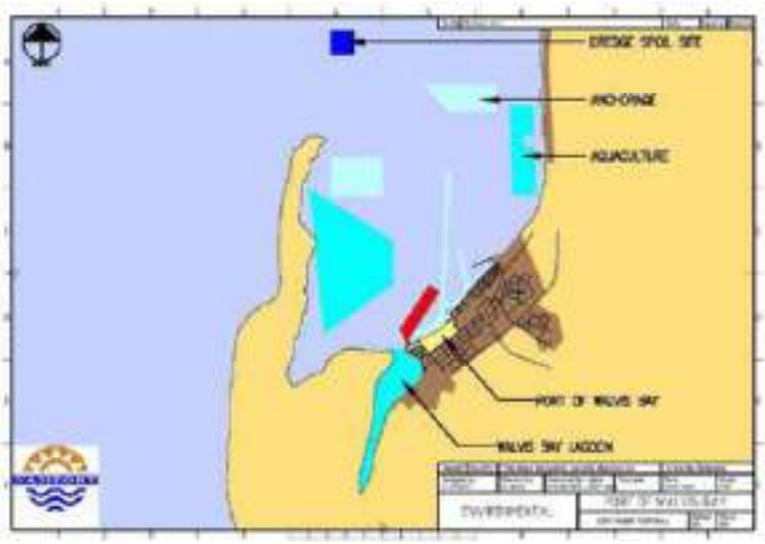

Figure 2: Locality Map. Walvis Bay (Source: OLRAC, 2009).

2.2 CLIMATE

The climate of Walvis Bay is driven by a combination of atmospheric and marine conditions, namely the South Atlantic Anticyclone or high pressure system (SAA), the northward-flowing cold Benguela Current and the divergence of the south-east trade winds along the coast. Walvis Bay falls within a "cool desert" region of Namibia. The general weather changes from cool, foggy, windy and hyper-arid conditions along the coast, to dry and hot in the interior beyond the Great Escarpment. Extremely low rainfall (8 mm / yr), characteristic of the harsh desert environment, is moderated by coastal fog that creeps as far as 70 km inland and contributes 35 - 45 mm of precipitation per year to the coastal area (Enviro Dynaics, 2012; Uushona and Makuti, 2008; Heather-Clarke, 1996). There are on average 150 foggy days per annum in the Walvis Bay-Swakopmund region, mostly between April and August.

The fog attracts and accumulates pollutants. Although the winds are typically strong and hence disperse air pollution, sea breezes present in the lower atmosphere tend to blow pollution back landwards. Stable air conditions result in temperature inversions in the lower atmosphere and pollutant dispersal is limited to the coastal belt. These factors exacerbate the odour pollution problems experienced in Walvis Bay town (Preston-Whyte and Tyson, 1988; Heather-Clarke, 1996).

The curved anticyclonic flow associated with the SAA is steered along the coast by the internal thermal barrier created by the desert conditions of the coastal plain and the orography of the continental escarpment (Nelson and Hutchings, 1983). Coast-parallel, upwelling-favourable winds continue as far as southern Angola, but north of 15°S they weaken and are directed more offshore.

The Benguela coastal region is characterised by hot, dry adiabatic "*berg*" winds blown in off the western escarpment when high pressure cells form over the subcontinent in winter. These winds are locally intensified by topographic features such as river valleys, blowing in excess of 50 km/h and causing severe sandstorms that considerably reduce visibility both at sea and on land. Satellite imagery reveals that they transport significant quantities of terrigenous material far out to sea (Fig. 3). Although *berg* wind conditions occur only intermittently, when they do, they last for up to a week at a time. *Berg* winds strongly affect the local temperatures, which are often above 30°C during "East wind" periods. The warm air associated with *Berg* winds flows over the cold marine boundary layer after passing over the coast. Land-sea breezes blow along coastal areas adjacent to interior coastal plains, resulting in a strong diurnal rotary wind component (Stuut, 2001; Jury *et al*, 1985). This dynamic wind regime influences most biotic and abiotic processes within the Walvis Bay area by changing sedimentation rates, upwelled nutrient flux and primary production within the system.

Figure 3: Dust and Hydrogen Sulphide (green) along the Namibian coast. (Source: NASA, 2010)

Over the Northern Benguela region (NBR), the effects of distinct inter-annual variations associated with the El Niño Southern Oscillation (ENSO) are registered in changes in sea-surface temperatures (SST) and the strength of the longshore, upwelling-inducing winds which weaken during the low phase (El Niño) and strengthen during the high phase (La Niña). This has a modulating effect on the coastal and interior rainfall. (Rau, 2002; Stuut, 2001; Shannon and Nelson, 1996). The almost decadal poleward intrusions of nutrient-poor, oxygen-deficient, warm, saline tropical surface waters along the Angolan-Namibian coastline are often concurrent with heavy rains and temporal proximity to the Pacific El Niño, as well as anomalous sea surface temperatures, salinity levels, winds and mean sea levels (Shannon and Agenbag, 1990; Brundrit *et al*., 1987). These Benguela Niños (Shannon *et al.,* 1986) seem to be responses to broader global or ocean-wide signals and the relative effect and importance of the driving systems may vary locally.

2.3 MARINE ENVIRONMENT

2.3.1 Benguela Current Region

Continental shelf circulation off Namibia is a result of the interaction of three gyral systems: the South Atlantic subtropical gyre, the sub-Antarctic gyre and the sub-equatorial gyre. The Benguela Current is regarded as the eastern boundary current of the South Atlantic Gyre (Shannon and Nelson, 1996). North of Walvis Bay, the current moves offshore away from the coast (Fig. 4). The speed of the Benguela Current varies between 10 and 30 cm/s depending on the location off the coast and wind direction and speed (O'Toole, 2009).

The De Decker Counter-current flows southward nearer the coast at depths greater than 30 metres (De Decker, 1970; Nelson, 1989). The poleward undercurrent flows with varying strength and varying degrees of seasonal dependence. It is identified by its low oxygen content. The Angola-Benguela Front (ABF) marks the northern boundary of the Benguela region. This surface frontal zone is most intense within 250 km of the coast and can be traced westward as far as 0°. The ABF is most marked

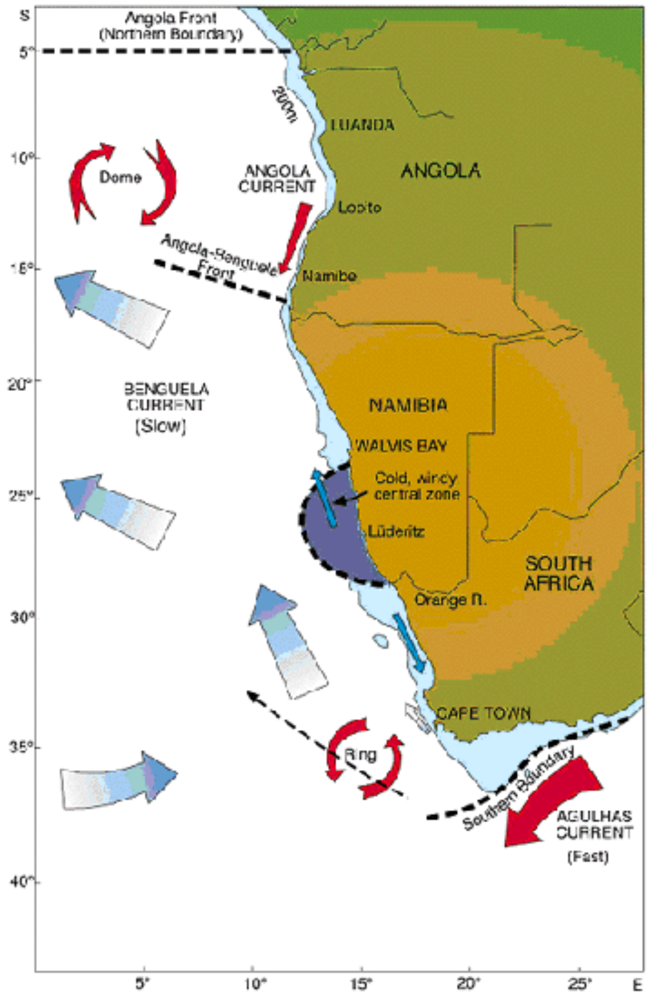

Figure 4: Main oceanographic features and surface currents of the Benguela Current Large Marine Ecosystem. (Source: BCLME programme website)

in the upper 50 m of the water column, but can be identified to at least 200 m. This zone is a permanent feature, migrating seasonally between 14°S and 17°S. The ABF is maintained through a combination of factors including coastal orientation, bathymetry, stratification, wind stress and the opposing flow directions of the Benguela and Angola Currents.

The distinctive bathymetry, hydrography, chemistry and trophodynamics combine to make the Benguela Current one of the most productive ocean areas in the world. This high productivity ensues from the continual fertilisation of surface waters by upwelled nutrient-rich deep water. In contrast to this high productivity, the BCLME carries relatively low biodiversity in all the major marine habitats, as result of the extremely variable nature of the marine environment at a range of temporal and spatial scales. Continuous change is a feature of the physical environment of the BCLME and its marine inhabitants are adapted to cope with this, resulting in generalists dominating over specialists (Maloney and Shannon, 2008; O'Toole, 2007). The biota varies spatially and temporally in assembly, structure and abundance in response to changes in the environment. Discrete biological environments of the BCLME tend to function in unison rather than in isolation.

Marine Mammals represented in Namibian waters include cetaceans and seals. Eight of the eleven species of baleen whales known globally have been seen in Namibian waters. In addition, twenty three species of dolphins and toothed whales have been recorded (NACOMA, 2013). Many cetacean species utilize the waters around southern African as feeding and breeding grounds or simply as part of their migration routes. Baleen whales that were targets of whaling operations in the past, but now find sanctuary in Namibian waters include Southern Right, Bryde's and Humpback whales. Walvis Bay was named by the Portuguese for its abundance of these huge cetaceans. Southern Right whales that were hunted from Walvis Bay and Swakopmund and were extinct in Namibian waters until the 1970s, are re-establishing recurrent birthing and nursing grounds, particularly in southern Namibia. The most common toothed whales in the BCLME include the Common, Dusky and Bottlenose Dolphins and the endemic Heavyside's Dolphin.

The Cape Fur Seal is a common resident of the BCLME, while the Subantarctic Fur Seal is a very rare vagrant in Namibian water and the Southern Elephant Seal a transient migrant. Seal populations vary in response to the abundance of pilchard. The quota for the annual cull, sanctioned by the Namibian government, is based on the status of fish stocks. A large non-breeding colony of Cape Fur Seals hauls out at Pelican Point.

2.3.1.1 Physio-Geo-Chemical Environment

Benguela Niño

The term Benguela Niño was coined by Shannon *et al.* (1986) to describe the almost decadal poleward intrusions of warm, saline tropical surface waters along the Angolan and Namibian coastlines and the associated unusually far southward displacement of the Angola- Benguela Front, moving southwards from 15°S to as far as 25°S. This wedge of warm, nutrient-poor, low-oxygen, salty Angola Current water extends some 150 km offshore and is up to 50 m deep. Concurrent heavy rains, changes SST, salinity and in fish abundance and location have been documented (Veitch *et al*., 2007).

Benguela Niños occur most often in late austral summer and early autumn and were recorded in 1934, 1963, 1984 and 1995. In situ measurements from Walvis Bay spanning 1958 to 2004 show that the frequency of unusually warm water appears to have increased since the early-1990s. Stander and De Decker (1969) observed a significant reduction in one species of zooplankton (*Paracalanus parvus*) during the 1963 warm event. The 1983/84 change from a declining trend to an increasing trend of total copepod abundance in the NBR corresponds to a Benguela Niño. The subsequent decline between 1993 and 1996 has been ascribed to the environmental changes brought on by the extensive hypoxic shelf waters that were present in 1993/94 and the Benguela Niño of 1995 (Veitch, 2007).

Low Oxygen Events

The Namibian continental margin has long been recognized as one of the world's most biologically productive oceanic regions, 30 to 65 times more productive per unit area than the global ocean average. However, massive productivity leads to immense quantities of dead and decomposing organic matter falling through the water column to the sediments below, initiating the development of oxygen-depleted water masses, hypoxic areas in deeper waters with limited oxygen exchange (called oxygen minimum zones) and anoxic sediment-water-interface conditions at the coastal shelf and upper coastal slope (Shannon, 1985). Oxygen-depleted water masses driven shoreward by upwelling in summer, cause mass mortalities of benthic populations (e.g. the well-documented crayfish "walk-outs").

An estimated 36% of phytoplankton and 5% of zooplankton fall to the seafloor annually. The sinking organic matter decomposes in the mid-water column, consuming dissolved oxygen, resulting in oxygen-depleted bottom waters. The combination of high oxygen demand, sluggish circulation and oxygen-poor source waters leads to the development of massive mid-water oxygen minimum zones. The zones are particularly prevalent in summer and autumn. The Benguela oxygen minimum zone starts at about - 200 m and is a few hundred meters thick. Bacteria that use sulphur rather than oxygen reside in the oxygen minimum zone.

Low oxygen water (LOW) variability in the NBR is entirely advection controlled and is strongly linked to the upwelling that peaks in June to August (Veitch, 2007). The periodicity of the wind regimes is an essential component of LOW, as it is the timing of wind-relaxation events that are instrumental in generating hypoxic conditions. The importance of wind variability is highlighted by the fact that a 20% decrease in the winds corresponds to an 80% decrease in productivity.

The LOW advected into the northern and central Benguela originates in the Angola Gyre area of the Southeast Atlantic where the processes of primary production, stratification and retention facilitate the maintenance of LOW in this area. The narrow Angolan shelf is conducive to the seasonal upwelling of water originating from the LOW reservoir and explains the correlation between seasonal oxygen and temperature measurements. As the Angola Current moves southward into the NBR it deepens to form the Benguela Poleward Undercurrent which extends to 27°S and forms the LOW boundary conditions for the northern and central Benguela systems.

A time series of temperature, salinity and oxygen off Walvis Bay shows that LOW variability on the central Benguela shelf does correlate with upwelling intensity or temperature. This is because it is subject to a number of processes and conditions that are not directly linked, such as intensity of and timing of low oxygen warm Angola Current water and the upwelling at both Cape Frio and Lüderitz.

Oxygen minimum zones are exacerbated by the southward intrusion of warm, oxygen-depleted Angola Current water into the NBR, off the self, at 200 – 300 m, most often during Benguela Niño events. The most recent event, in the summer of 1994/95, caused severe anoxic conditions on the shelf in near-bottom and bottom waters over an area stretching between 24°S and 21°S and mass mortality of benthos. While intrusions of Angola water and Benguela Niños are generally decadal events, there are also seasonal LOW intrusions that are less devastating (Veitch, 2007)

Harmful Algal Blooms (HABs)

Low oxygen events are often associated with diatom blooms or Harmful Algal Blooms (HABs / red tides). Although attributed to a number of marine planktonic algae, HABs are most often ascribed to the dinoflagellate species *Ceratium furca* and *Prorocentrum micans.* HABs usually occur in the summer-autumn, but have been documented in winter when warm *berg* winds blow for extended periods. These blooms are able to impact both commercial and recreational interests in the coastal region causing fish kills, contaminating seafood with toxins resulting in serious public health problems (www.nacoma.org.na)

Nearshore low oxygen events have catastrophic effects on the local marine community, as happened in 2008 when a *Ceratium furca* bloom resulted in the largest rock lobster walkout in Namibian recorded history. Mariculture in the Walvis Bay lagoon was badly affected that oyster farmers considered relocating to Lüderitz. Shallow subtidal species, trapped in the oxygen-depleted waters below the surf zone, also succumbed. The bloom was triggered by an unusually calm sea and windless period accompanied by high sea surface temperatures. The anoxic conditions were further exacerbated by concurrent hydrogen sulphide eruptions.

Hydrogen Sulphide Eruptions (H_2S)

Central Namibian waters are renowned for the large-scale, episodic sulphur and methane eruptions that can be traced by satellite photography (Fig. 5). In areas of low-oxygen bottom waters, aerobic decomposition of organic material within the sediments results in the generation of methane (CH_4), sulphur dioxide (SO_2) and hydrogen sulphide (H_2S) gasses that become trapped within the layers of organic-rich, anoxic mud. Over time, pressure exerted by the expansion of these gasses in the sediment, causes the gas to erupt into the water column. These eruption events accentuate the effect of oxygen minimum zones, by causing the upwelling of hypoxic and toxic waters. The sulphur forms visible slicks of discoloured waters on the surface. These events strip the surrounding water column of dissolved oxygen, resulting in mass mortality of the local marine community.

H_2S eruptions are a common phenomenon in Walvis Bay and Swakopmund, and have been recorded since 1901 (Waldron, 1901). Residents have become accustomed to H_2S periods characterised by a pungent odour, lime-green sea surface slicks and the formation of temporary mud islands, seen at low tide in the lagoon area. As these are natural, recurrent events, the local biota has adapted to the toxicity levels and the associated hypoxic water conditions. Some of the H_2S is actually consumed by autotrophic denitrifying bacteria in the intermediate water layers. A catch twenty-two situation arises, as a stronger and healthier upwelling ecosystem, with enhanced productivity, drives an increased *in situ* production of oxygen-depleted waters and therefore, an increased risk of H_2S eruptions (Veitch, 2007).

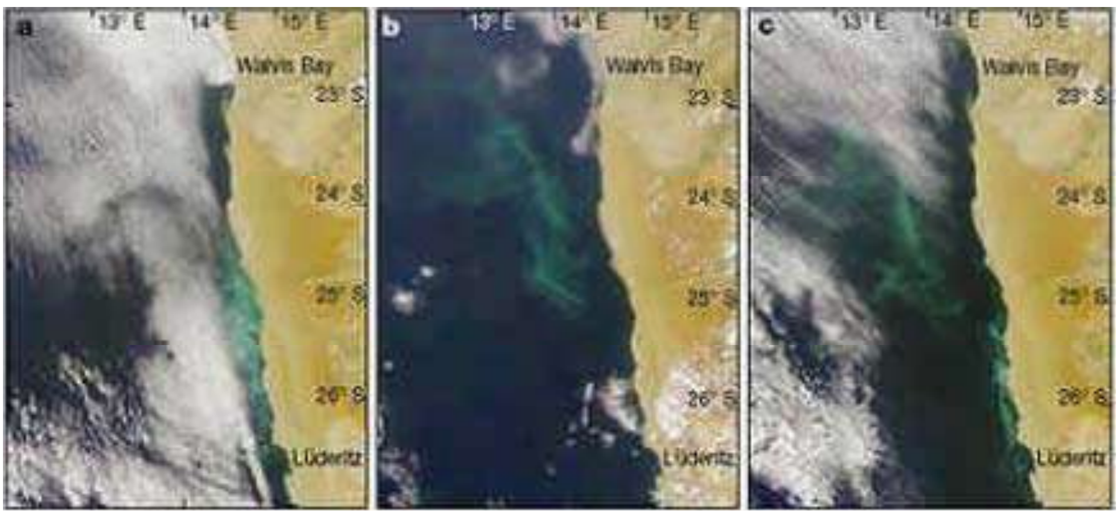

Figure 5: Satellite images showing natural H_2S eruptions (Source: Weeks *et al*, 2004).

2.3.2 The Greater Walvis Bay Area

The central Namibian coastline is influenced by major swells generated in the *Roaring Forties*. Wave shelter is extremely limited and found in isolated northward-facing J-bays, such as Lüderitz and Walvis Bay. Walvis Bay itself is defined as the deeper water enclosed between Pelican Point and Langstrand (CSIR, 1989). The eastern boundary of the bay is regarded as the main road between Swakopmund and Walvis Bay (north of the harbour) and the road running beside the lagoon (south of the harbour). The sandspit bar of Pelican Point peninsula separates the wave-dominated, open-ocean regime of the Benguela Current region (to the west) from the sheltered harbour waters to the east and northeast in Walvis Bay (CSIR, 2009).

The dominant south-westerly winds create a clockwise water flow in the bay, that travels southwards past the harbour. Bottom waters enter the bay area at Pelican Point and surface layers exit at the same point. Current velocities average 0.12 m/s, occasionally increasing to 0.25 m/s. Water circulation takes place mainly in the upper layer and depends on the direction of the wind. The current pattern is clockwise in the morning, towards the south, and reverses later towards the north. At Pelican Point the current is generally northward for the whole day (CSIR, 2009; Uushona and Makuti, 2008). Walvis Bay is flushed twice daily with nutrient-rich water from the open ocean (Namport, 2010).

Tides along the Namibia shelf are semi-diurnal with an average tidal range of between 0.5 and 1.3 m and up to 1.6 m range between mean spring lows and mean spring high tides. The mean spring tidal range for Walvis Bay is 1.42 m (0.27 m – 1.69 m), while the mean neap tide is 0.62 m (0.67 m – 1.29 m). Variations in the absolute water level as a result of strong winds and big waves can, however, occur adjacent to the shoreline, resulting in differences of up to 0.5 m from the tidal predictions. Tidal currents are small (0.1 m/s). (Namport, 2010; CSIR, 2009). Dolphins hunting fish are sometimes trapped in the lagoon when the tide ebbs.

The water depth in Walvis Bay ranges from -20 m chart datum (CD) at Pelican Point to approximately -2.5 m CD at the entrance to the lagoon. Although Pelican Point protects the mouth of the lagoon from the south-westerly swell, waves do occur in the shadow zone, but wave energy decreases progressively in magnitude southwards behind the sandspit. The refraction of waves around the point of the sandspit into Walvis Bay generates a southward longshore current. This transports sediment, including material derived from floods and introduced into the bay via the northern arm of the Kuiseb delta, contributing to the steady shallowing of the low energy environment within the shadow zone.

From the Pelican Point peninsula, the sea floor slopes steeply westward into the Atlantic Ocean. This wind-exposed sandspit is a source of sand for the beach north of Walvis Bay. The peninsula itself is fed by sand blown by the dominant south-easterly winds and brought by currents from Sandwich Harbour. It is estimated to be extending north-eastwards by 17 to 20 m per year (Namport, 2010; Uushona and Makuti, 2008). At the same time the mainland coast is growing southwards towards Pelican Point. Waves approaching the shoreline at an angle generate longshore surf-zone currents. These currents, dominated by wave-driven flows, generally transport unconsolidated sediments northward along the coast at a rate of approximately 800 000m^3/m/year (CSIR, 2009).

The movement of sediment within the central Namibian coastal region involves a dynamic interaction between land and marine components. The complex nature of the sedimentary environment within present-day Walvis Bay is a result of both fluvial and marine deposition over the past 6 000 years, as well as being impacted by the high productivity of the Benguela Current. Water transparency deteriorates from Pelican Point toward the bay, into the harbour and further into the lagoon. The Walvis Bay coastal waters appear are a major sink of organic material. The nutrient-rich, high productivity waters of the Benguela system extend into Walvis Bay lagoon and harbour, providing the basis for the associated organic mud deposits and subsequent H_2S eruptions. A thick, pungent, dark green diatomaceous ooze overlies fine to medium sand that has accumulated in sheltered parts of Walvis Bay at depths below -3 to -4 m. Integrated sedimentary components of silt, diatomaceous muds, aeolian and marine sand trap organic-rich material containing naturally high concentrations of heavy metals. The organic-rich sediments have a high oxygen demand and can become anoxic. Oxygen starvation, toxic red tides and H_2S eruptions occur most frequently during late summer or early autumn when light, predominantly onshore, winds prevail. Additionally, effluent and waste discharges from the fish processing industry require oxygen for neutralisation, which diminishes oxygen levels in the water. Anoxic and toxic conditions can build up in the sheltered waters of the bay, forcing mobile fauna to migrate out of the area and resulting (sometimes large-scale) sessile and benthic organism mortality. An especially large and long-lasting sulphur eruption severely affected aquaculture operations in Walvis Bay in 2008 (Namport, 2010; CSIR, 2009; Seely & Pallett, 2008; Uushona and Makuti, 2008; Heather-Clarke, 1996).

A variety of marine mammals has been recorded in Namibian waters, drawn by the abundance of plankton and fish. Eight of the eleven species of baleen whales known globally, and twenty-three species of dolphins and toothed whales have been recorded in Namibian waters. Baleen whales that were targets of whaling operations in the past, but now find sanctuary in Namibian waters include Southern Right, Bryde's and Humpback whales. Walvis Bay was named "*Ezorongondo*" (Bay with whales) by the indigenous Herero people and subsequently by Portuguese, Dutch and English whalers. Southern Right whales that were hunted from Walvis Bay and Swakopmund and were extinct in Namibian waters until the 1970s, are re-establishing recurrent birthing and nursing grounds, particularly in southern Namibia in protected areas near Lüderitz.

The most common toothed whales in the BCLME are the Atlantic Bottlenose, Common, Dusky, Risso's, Rough-toothed and Southern Right-whale Dolphins. The Heaviside's Dolphin is endemic to Namibian coastal waters. Walvis Bay is home to a small resident population (~77) of Bottlenose Dolphins and a larger (~505) population of Heaviside's Dolphins, that are often seen frolicking in nearshore waters and around pelican Point. There have been sporadic sightings of Killer Whales within the bay area over the past decade (NACOMA, 2017; Namibian Dolphin Project, 2017; Elwen and Leeney, 2010; O'Toole, 2009; Roux, J.P., 2008; Maloney and Shannon, 2008; Uushona and Makuti, 2008).

A non-breeding colony of Cape Fur Seals, numbering some 5 000 (but sometimes expanding to a significantly larger number) hauls out at Pelican Point (Fig. 6).

Figure 6: Cape Fur Seals at Pelican Point. (Source: Uushona and Makuti, 2008)

Recreational fishermen at Paaltjies and overland vehicles and visitors to Pelican Point can alarm the seals and birds. They also contribute to littering. Marine viewing cruises can disturb and harass dolphins. Besides litter from visitors, oil and debris from offshore vessels also pollute the point (NACOMA, 2013; O'Toole, 2009; Uushona and Makuti, 2008; Heather-Clarke, 1996).

2.3.3 Lagoon and Ramsar Site

The Walvis Bay lagoon is approximately 7 km long and up to 2.5 m deep on average, but significantly deeper at spring high tide. There is a maximum tidal range of 1.8 m. A straight line connecting the tip of Pelican Point and the southern boundary of the Walvis Bay harbour area at the Yacht Club has been arbitrarily designated as the north-eastern boundary of the lagoon and the extent of the Ramsar site. The lagoon is characterised by two main habitats: extensive shallow, sandy shores that are alternately covered and exposed by tidal action; and the deeper (up to 5 m) sub-tidal waters of the southern harbour area. The SSW-NNE orientation of the Walvis Bay lagoon closely parallels the dominant wind direction and it is likely that wind processes superimposed on tidal effects have played the dominant role in shaping the original development of the lagoon (Uushona and Makuti, 2008).

Nutrients are imported into the lagoon from the bay through tidal flux. The lagoon is, in general, well-oxygenated since a large portion of its volume is exchanged twice daily during each tidal cycle. Strong winds blowing across the surface facilitate oxygenation in the upper layers. The currents in the lagoon have inflow and outflow velocities of the order of 0.30 m/s at the mouth of the lagoon (Namport 2010; CSIR, 2009; Heather-Clarke, 1996).

Fine sediments and organic matter settle in the wave-sheltered lagoonal environment. These are exploited by a proliferation of invertebrate animals and small fish, which, in turn are a food source to the thousands of birds, larger fish and marine mammals. High primary productivity, warm temperatures and calm water inflow of seawater imports plankton, krill and young stages of fish and invertebrates. In the past, large numbers of coastal fish species were caught inside the lagoon. At present. fish species are limited to large schools of small mullet and springer, as well as skates and rays. Seals and dolphins frequently hunt in the lagoon and occasionally whales have entered, but they can be stranded by the outgoing tide (Namport 2010; CSIR, 2009; OLRAC, 2009; Uushona and Makuti, 2008; Heather-Clarke, 1996.

There is a relatively large degree of mixing of lagoon and bay water, however, due to its shallowness and dynamic nature, the water temperature and salinity within the lagoon vary across special and temporal scales. The limited flushing waters in the southern section result in extreme conditions. Surface heating and evaporation yield temperatures as high as 30°C and salinity values of 46 ppt in the southern-most tip of the lagoon. Bay water is found at the mouth, so salinity levels are much lower. There is a N-S temperature and salinity gradient across the length of the lagoon and a reverse vertical salinity and temperature gradient with water being hot and hypersaline at the surface and cooler and less saline near the bottom. The development of the salt works has profoundly changed the ecology of the lagoon area because of the extensive land reclamation. The access road is a physical barrier to the natural tidal dynamics, cutting off the southern edge of the lagoon and reducing tidal circulation and flushing in this part of the lagoon (Enviro Dynamics, 2012; Namport 2010; CSIR, 2009; OLRAC, 2009; Uushona and Makuti, 2008; Heather-Clarke, 1996).

Mariculture

The commercial farming of oysters is being undertaken in evaporation ponds in the Walvis Bay lagoon. Commercial aquaculture and mariculture ventures started in Namibia in the late 1990's.

Figure 7: Bottlenose dolphin swimming amongst an oyster farm's lines in Walvis Bay © R. Leeney, 2008. (Source: Namibian Dolphin Project, 2015)

Impacts from aquaculture and mariculture can include pollution and the introduction of alien species. These farms also close off spaces previously accessible to wild marine life, possibly impacting habitat and feeding and breeding patterns. They can lie in the direct path of migrating whales. A whale calf became entangled in the lines of an oyster farm in the bay area east of the Walvis Bay peninsula. Bottlenose Dolphins have also been seen swimming between the lines of oyster farms (Fig. 7) and there is a danger of injury or death resulting from entanglement (Namibian Dolphin Project, 2015).

2.3.4 Walvis Bay Harbour

Figure 8: The Port of Walvis Bay.
(From: Informante, 11 February 2016)

The bay is a safe haven for sea vessels because of its natural deepwater harbour, protected by the Pelican Point sandspit. The Yacht Club, port and container terminal are integrated into the town of Walvis Bay. The Walvis Bay harbour is located north and east of the outer lagoon zone. The port comprises a commercial harbour in the southern section, bounded on the west and north by the limits of Namport jurisdiction. It handles containerised and bulk cargo. The fishing harbour in the northern portion is bounded on the east by the shore and factories. This area supports some 15 processing factories and their vessels. In the north-eastern corner is an artificial guano platform for nesting birds. The port is controlled by the Namibia Ports Authority (Namport). Their role is to exercise general infrastructural and regulatory functions (dredging and customs), together with navigational and other commercial facilities. Namport is also responsible for the control of maritime pollution, oil spill containment within the harbour area, the upholding maritime safety and the supplying and/or co-ordinating search-and-rescue services in territorial waters (Namport, 2010; CSIR, 2009, Uushona and Makuti, 2008).

The harbour has a soft substrate measuring up to 15 m thick. The concentrations of metals in the sediment are generally of the same order of magnitude as the BCLME recommended guideline values. This compares favourably with sediment from other harbours around the world. Cadmium levels are elevated; its toxicity is inversely related to salinity, and in an anoxic environment like Walvis Bay, its potential impact is reduced (Namport, 2010; CSIR, 2009).

The tidal range within the harbour areas is as great as 2 m during spring tides. The harbour wall offers rare surfaces for the attachment of indigenous sessile marine animals. However, pollution from fish factory effluent within the harbour is thought to have reduced marine invertebrate biodiversity significantly. The water quality of the harbour changes seasonally as a result of organically polluted sea and freshwater discharges from the fish processing industry (Uushona and Makuti, 2008).

Commercial activities in the harbour occasionally cause minor oil spills and heavy metal pollution of the bay water. Moreover, some ships visiting the Namibian coastline tend to dump their bunker oil out to sea where it poses a threat to marine and bird life. Another source of maritime pollution is the waste and sewage that is dumped from ships anchoring in the harbour and bay area, although Namport does supply a waste collection service for all these ships and they are charged irrespective of whether or not they make use of this service. Unfortunately, substantial amounts of waste are still thrown overboard and washed up along the coastline. Anti-fouling paint and other toxic substances used during ship maintenance at the dry docks are another source of pollution. Such toxins are taken up by invertebrates and pose a threat to predators as bio-accumulation occurs (Uushona and Makuti, 2008, Heather-Clarke, 1996).

2.3.4.1 Dredging

In excess of 200 000 m3 of sediment is dredged from the entrance channel, turning circle and tanker basin by Namport annually. Namport subcontracts to Portnet (South African Ports Authority) to undertake major dredging operations every five to six years. Dredge material is dumped at one of three sites within the bay area, are presently being used.

2.3.4.2 Commercial Fisheries

Whilst individual fishing companies own their berthing facilities, the berths are maintained by Namport using their own internal standards. The fish processing plants in Walvis Bay harbour affect the water quality by both drawing (sometimes organically toxic) water from the bay and then discharging organically loaded effluent into it. Because the receiving waters of the bay area are frequently anoxic, the addition of high BOD waste can have cumulative effects. Fish factory effluent is compounding the already oxygen-stressed condition of the bay, particularly along its eastern shore (Namport, 2010).

2.4 SOCIO-ECONOMIC ENVIRONMENT

2.4.1 Walvis Bay Town

The economy of Walvis Bay is driven by the safe harbour port and associated industry, commercial fishing, tourism and local manufacturing. Other contributors to the economy are the salt works, tourism and mariculture industry. The unemployment rate is estimated at 36% (Enviro Dynamics, 2012; Namport, 2010).

2.4.4.1 The Harbour and Port

Walvis Bay harbour is the largest port in Namibia. It services vessels participating in marine exploration and fishing and serves as the country's main import/export facility. Exported goods are minerals such as uranium, copper, lead, feldspar, salt, beef and canned fish. Imports of general container cargo, motor vehicles and machinery, petroleum and bitumen also pass through the port facilities.

Walvis Bay Harbour is the only deep-water port in Namibia and is the main fishing harbour. The commercial fishing industry supports local worker and contributes significantly to the GDP of Namibia. Almost all processing industries and servicing facilities operate out of Walvis Bay. Fisheries working out of Walvis Bay target small pelagic species, such as pilchard, anchovy, and juvenile horse mackerel, inshore in the NBR. Bottom and mid-water trawlers work further offshore both north and south of Walvis Bay towards Lüderitz, targeting hake, monkfish and horse mackerel. Other commercial fish species include snoek, steenbras, kabeljou, and kingklip. Hangana Seafood are processors and exporters of fish and fish products. The commercial fishery accounts for a major part of Walvis Bay's economy (Nacoma, 2017).

Fishery has an impact on natural marine resources by removing a certain portion of the stock and the physical alteration of habitats. Accidental bycatch of marine mammals and sea birds is a concern.

2.4.4.2 Mariculture

Concessions for aquaculture in the form of oyster rafts have been granted within the broader Walvis Bay area, the lagoon area and the salt works area during the past decade. One oyster farm is located in the primary evaporation pond of the saltworks, while others are in the designated marine farm area in the lee of Pelican Point. Operational activities include diesel-powered pumping systems providing water for the evaporation ponds of the salt works, infrequent harvesting and inspection activities. While the flesh quality and growth rate of the oysters has been high (about 1/3 faster than elsewhere in the world), the risk of losses as a result of sulphur eruption is also high. Major losses were experienced in 2008.

While oyster production in Walvis Bay has been, on the whole, a financial success, possible extensions of this activity pose threats to marine mammals that utilise the bay area. Impacts from aquaculture and mariculture can include pollution and the introduction of alien species. A whale calf became entangled in the lines of an oyster farm in the bay area east of the Walvis Bay. A number of dolphins have been noted swimming amongst the oyster farms and with a potential increase in mariculture activities, the risk of entanglements grows (Namcoma, 2015; Namibian Dolphin Project, 2015; Namport, 2010).

2.4.4.3 Salt Recovery

The windy, arid coastal climate of Namibia is highly favourable for the cheap production of salt, through the evaporation of sea water in ponds that have been established around the Walvis Bay lagoon. The salt works have profoundly changed the functioning and ecology of the lagoon area, particularly in the southern end. Land reclamation and the construction of physical barriers to the tidal dynamics have resulted in decreased circulation and accompanied siltation and lowering of water clarity and quality with increased temperatures and salinity. Some of the natural wetland and lagoon area has been reclaimed for use as evaporation ponds. Access roads have been built which cut off tidal circulation to the southern extremity of the lagoon and also facilitate local and tourist routes through the wetlands to the fishing beach of Paaltjies and to Pelican Point on the sandspit peninsula.

2.4.4.4 Tourism

Pelican Point is a tourism key point because herds of seals and roosting shorebirds attract day visitors who drive there via the salt pans. There is a hotel at Pelican Point that is accessible by 4x4 vehicles.

Paaltjies beach on the sandspit is a popular local spot for shore anglers. Angling, from small craft or from the beach, is a major form of recreation throughout the coastal reaches of the Walvis Bay area.

Imprudent discarding of plastic rubbish as well as fishing gear leads to ingestion and entanglement. Plastic waste blocks up the gut and the creature will slowly starve to death. Even if an animal doesn't drown as a result of entanglement in fishing gear, if not removed, ropes and line wrap ever-tighter, cutting off circulation. The lucky animals have scars where they escaped ropes and lines. In 2012 a Heaviside's Dolphin was photographed in Walvis Bay with a few metres of fishing line clearly embedded in her skin. Her dorsal fin had been cut almost halfway through by the fishing line (Namibian Dolphin Project, 2017).

Artisanal scale beach purse-seine fishing takes place from the beaches immediately north of Walvis Bay town. The catch, mainly mullet, is intended mainly for own consumption, but surplus may be sold. There is always a risk of mammals being caught in the nets.

Tourism (and eco-tourism) is the fastest-growing industry in Walvis Bay. The main limiting factor to tourism is infrastructure. As many as 26 tour boats (5 sailing catamarans and 21 catamaran ski boats, 6 to 9 m long) operate within the bay area, taking tourists to view seals, dolphins and whales, pelicans and the guano platform north of Walvis Bay. There are numerous small-boat enterprises that advertise scenic cruises to view Heaviside and

Bottlenose Dolphins directly north of Pelican Point on a daily basis. Although Walvis Bay is a commercial and fishing harbour, these tour boats represent the vast majority of boat traffic that interacts with dolphins in the bay. There is a "no swim with" policy in place, but Bottlenose and Heaviside's Dolphins are actively pursued by tour boats to encourage bow or wake riding and maximise interaction with the vessel. All vessels operate under power when in the presence of dolphins and this puts them at risk of propeller strikes. A Heaviside's Dolphin with injuries from a small motor was photographed in Walvis Bay on 12 February 2010. Given that tour boats interact with dolphins at Pelican Point on a daily basis and this is the only dolphin to be seen with propeller strikes suggests the risk of direct injury may be relatively low and that in general the animals are able to steer clear of danger (Namibia Dolphin Project, 2017).

Tour operators do, however, feed the mammals and birds to encourage them to approach the boats. Some have seals jump aboard their vessels (Fig. 9). All this interaction puts the mammals at risk of injury. Cetaceans are also susceptible to human diseases. Acclimatisation to humans will make some animals approach humans with less caution – and if something goes wrong, it will be the animal that pays. There are also incidents of rubbish blowing over-board, regardless of how carefully operators instruct tourists. Additionally, the feeding of seals by tour operators can potentially threaten the seabird population, as some lazy individuals will cease to forage out at sea, preferring easy meals within the bay. The practice of gathering food from tourists might reinforce the predatory behaviour of seals on seabirds in Walvis Bay (Namibia-1on1.com, 2017; Wild Africa Travel, 2017, Elwen *et al*., 2012).

Figure 9: Cape Fur Seal on a tour boat.
(Source: Dune Safaris, 2017)

Sailing, wind-surfing and kite-boarding are popular activities on the lagoon. Wind conditions on the outer lagoon make this one of the world's best locations for wind- and kite-surf speed sailing. Walvis Bay hosts world class wind-surfer and kite-surfers. Some of the world's top speed-sailors have reached speeds approaching 50 knots in the unique conditions of the lagoon (Namibia-1on1.com, 2017; Wild Africa Travel, 2017).

The lagoon and surrounding area is also explored by kayak. Motorised craft were accorded limited access to the lagoon for fishing competitions. Owing to the difficulty in controlling motorised craft within the confines of the lagoon, a ban has been placed on all such craft within this zone.

The esplanade along the eastern shore of the lagoon affords visitors and locals the opportunity to view flamingos, pelicans, waders and other coastal birds from close range. It is a popular route for joggers and dog-walkers.

Despite the fact that Walvis Bay lagoon, the saltworks and the southern part of the bay west of the lagoon have been declared a protected Ramsar site (Wetland of International Importance), there is very little official regulation of visitors or activities. Whilst numerous notice boards inform the public of the sensitivity and importance of the area, it is by-and-large a self-regulatory system, with little obvious enforcement.

3. MARINE MAMMALS

3.1 OVERVIEW

The Benguela ecosystem is known for its diversity and abundance of marine birds and mammals that feed on the numerous fish resources. Marine mammals seen in Namibian waters include seals and cetaceans. Thirty-one species of whales and dolphins have been recorded off the Namibian coast. Of the 25 more frequently recorded species, only 5 are seen regularly in inshore of Walvis Bay. Some cetaceans are semi-permanent residents within Namibian waters, others come to breed and still others are long-distance travellers, entering and leaving the Benguela almost without pause, en route to preferred destinations. The most commonly seen mammals within the Walvis Bay area include Cape Fur Seals and Common Bottlenose, Dusky and Heaviside’s Dolphins. The cold coastal waters supply food to migrating Humpback and Southern Right Whales. Killer Whales and Leatherback Turtles are infrequent visitors to the bay area. Risso’s, Rough-toothed and Southern Right-whale Dolphins have been seen along the coast. The Heaviside’s (or Benguela) Dolphin is the only odontocete endemic to the Benguela Current (Namibian Dolphin Project, 2017; NACOMA, 2017).

3.1.1. Cape Fur Seal

The Cape Fur Seal (*Arctocephalus pusillus pusillus*) is the predominant marine mammal in the Namibian portion of the BCLME, with as much as 60% of the global population resident in Namibia. It is misleadingly named, as *Fur seals* belong to the *Otariid* family together with sea lions. True seals (family *Phocidae*) do not have external ear flaps and are less mobile on land than sea lions. *Otariids* can rotate their back flippers to make it possible for them to walk and run on land. Their flippers are hairless and clawless enabling them to grip the surface of rocky terrains, where they rest and breed. Sea lions use their long, strong front flippers for power, steering with their back flippers. This gives them an advantage when escaping orcas and sharks, because if the predator bites their back flippers, they can still swim quickly to get away. A true seal would no longer have the power (back flippers) to keep it moving forward (Wild screen Arkive, 2017). Sea lions can’t store as much oxygen in their lungs as seals can, so their dives are restricted to 450 m, but more commonly dive no deeper than 200 m (Enigma, 2012).

Figure 10: Injured Cape Fur Seal
(© Peter Scoones / naturepl.com)

The Cape Fur Seal is the only member of the order *Pinnipedia* which breeds on the Namibian coast, both on the mainland and on nearshore islands and reefs. The Cape Fur Seal population of South Africa and Namibia is regarded globally as being relatively large and stable. There are 23 breeding colonies of Cape Fur Seals along the west coast of southern African including Atlas Bay, Wolf Bay, Hollamsbird and Long Islands, near Lüderitz. At present, the largest breeding site in Namibia is the Cape Cross Seal Reserve, a 60 km^2 protected area within the Skeleton Coast National Park, some 130 km north of Swakopmund (Nacoma, 2015; Enigma, 2012; Kirkman et al., 2012).

Off Namibia, there has been a significant northwards shift in population distribution. New breeding colonies are thought to exist in northern Namibia and southern Angola. A significant number of Cape Fur Seals haul out at Cape Frio, on the Namibia-Angolan border, where a new breeding colony is possibly established. Seals on Pelican Point generally number around 5 000, but substantially greater numbers are seen at intervals. This mainland-based, non-breeding colony has grown rapidly in recent years. Before 1990, fewer than 10 pups were born annually at Pelican Point, but pup production increased to ~ 1 700 in 2006 and further to > 12 000 in December 2011 (last aerial census December 2011, MFMR unpubl. data) (Nacoma, 2017; Kirkman, 2012).

Figure 11: Cape Fur Seals mating.
(Source: Wild screen Arkive, 2017)

The mating system in sea lions is polygynous. Bulls are not normally resident at the colonies out of breeding season. They generally arrive during late October and fight for territory, which they maintain for about six weeks, holding court over a harem of between 5 and 25 females. The older and more experienced the male: the better location he has and the more females he attracts. Females give birth to one pup during November / December.

Cape Fur Seals feed on at least 11 different species of fish. Their main prey in Namibian waters is juvenile Cape Hake, Horse Mackerel and Pelagic Goby as well as sardine, anchovy squid, lobsters and crabs. Cape Fur Seals generally forage in shallow shelf waters, but can range to distances of over 150 km from the coast. Bulls tend to range further out to sea than females. Individuals have been known to prey on seabirds in times of severe fish shortage. There has also been a substantial increase in predation by Cape Fur Seals on seabirds around southern African islands since the mid 1980s. The main predators of roosting and breeding seabirds are juvenile or adult male seals. Cape Fur Seals have been observed to predate upon African Penguins, Bank Cormorants, Cape Cormorants, Crowned Cormorants and even Cape Gannets. Due to the high predation rate and small population sizes of several of these bird species, particularly in southern Namibia, seal predation of seabirds can have negative impacts on the conservation status of these species. However, the bulk of the seal population in Namibia does not seem to be consuming large numbers of seabirds (Birdlife International, 2016; ICUN, 2016; NACOMA, 2015; Enigma, 2012; Currie et al., 2009; Maloney and Shannon. 2008; Kemper et al., 2007; Kirkman et al., 2007). Elwen et al, 2012 witnessed a Cape Fur Seal predating a Southern Giant Petrel near Pelican Point. The bird, which was attacked in the water from below, was injured and prevented from flying (and hence quick escape) by a rope or line entangled around its right wing. This may have been an opportunistic attack. There are no known breeding colonies of bird species typically preyed upon by Fur Seals on Pelican Point itself, but large numbers of Cape Cormorants from the man-made guano platform in the east of Walvis Bay regularly roost on the beaches around Pelican Point. They also form rafts at sea, potentially providing a nearby food source for seals. The feeding of seals by marine tour operators in Walvis Bay could also encourage some individual seals not to forage out at sea, but rather seek food in the vicinity of the tour boats. An increase in such feeding habits among the seal population could reinforce the predatory behaviour of seals on seabirds in Walvis Bay (Elwen et al., 2012).

3.1.1.1. General Threats to Cape Fur Seals

On land, Brown hyenas and jackals prey on young seals. At sea, seals fall prey to sharks and killer whales (orcas).

The Cape Fur Seal population showed a marked decrease as a result of uncontrolled harvesting from the early 1800s through the 1900s. Sealing was stopped in South Africa in 1990, but continues in Namibia as a population control measure. The Namibian seals are exploited mainly for their pelts (pups aged 7-10 months), blubber and male genitalia (Asian aphrodisiacs market). An annual cull is sanctioned by the Namibian government. There is a regulated quota, with numbers based on the status fish stocks. Seal populations vary in response to the abundance of pilchard (Enigma, 2012, NACOMA, 2013).

Commercial fishermen commonly view seals as a menace, but scientific studies have shown that competition between seals and hake fishing operations is small in the greater scheme of things. (Maloney and Shannon, 2008)

In recent years, rogue bull seals, unable to secure their own harem of females, have been responsible for killing unsustainable numbers of African Penguins, Bank Cormorants, Cape Gannets and Cape Cormorants all of which are endangered bird species. This led to control measures being implemented to deal with individual problem seals (Kemper et al., 2007; Kirkman et al., 2007; Maloney and Shannon, 2008; Currie et al., 2009).

The biggest threats to sustained seal populations are:

- a lack of prey as a result of environmental fluctuations (particularly changes in upwelling intensity) and overfishing, particularly in Namibia, where sardine and anchovy stocks have become inaccessible to breeding seals.
- incidental entanglement in fishing gear
- intentional attacks by fishermen who feel their catch is threatened
- human interference at breeding colonies
- poisoning from toxic algal blooms
- predation of pups by Brown Hyenas and Black-backed Jackals, accentuated by the increased access to remote and offshore areas (sediment redistribution and dumping)
- predation at sea by Great White sharks (*Carcharodon carcharias)*

3.1.2. Heaviside's Dolphin

The Heaviside's or the Benguela Dolphin (*Cephalorhynchus heavisidii*) is endemic to the BCLME and resident in nearshore waters. Heaviside's dolphin is a coastal delphinid with a limited inshore distribution off the west coast of southern Africa. It is one of the smallest dolphins, growing to about 1.8 m in length and weighing up to 75 kg. These dolphins are often mistaken for porpoises due to their small size and the bluntness of their heads.

Figure 12: Heaviside's Dolphin in Walvis Bay (Source: www.travelnewsnamibia.com)

Heaviside's Dolphins are endemic to the BCLME and thus only occur along a total of about 2 500 km of coastline. They are commonly seen between Cape Point (34°20'S) and northern Namibia (17°30'S) inshore of the 100 m isobaths, although the individuals have been noted as far out as the 200 m isobath. Their density is highest close to shore. In Namibia, they occur in abundance around Lüderitz and Walvis Bay where they are often seen close to shore in the mornings, where they can often be seen jumping or playing in the waves, although their presence inshore varies greatly with time of day and brightness of the moon. Heaviside's Dolphins exhibit strong onshore–offshore diurnal movements, generally being closest inshore between 6 am and noon and farthest offshore between 3 pm and 5 am. This pattern is assumed to be related to the movements of their principal prey, juvenile shallow-water hake (*Merluccius capensis*), which migrate into the upper water column at night. Heaviside's also feed on other small fish (usually juvenile hake) and cephalopods. They no doubt come inshore to rest and avoid predators (Elwen et al., 2006; 2009).

Heaviside's Dolphins live in social groups numbering anything between seven and a few hundred. Population size and status from the Namibian coast are unknown. A population of some 500 Heaviside's Dolphins resides within the Walvis Bay area, frequenting the waters north of Pelican Point. Heaviside's are lively animals and can often be seen riding the waves, jumping up to 2 m in the air and somersaulting to land with their flukes slapping the surface of the water. They move along the coast at high speeds, "porpoising" as they travel. They approach boats from a distance and are avid bow-riders. The Pelican Point group is a popular target with the local Walvis Bay eco-tourism industry and can be watched easily from tour vessels inshore as well as from the coast.

The species is categorised as *data deficient* by the *International Union for Conservation of Nature* (ICUN) but is considered vulnerable due to its limited distribution. It is listed by the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as having an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements. Heaviside's Dolphins are covered by the Western African Aquatic Mammals Memorandum of Understanding.

3.1.2.1 General Threats to Heaviside's Dolphins

While Heaviside's Dolphins appear to face fewer threats than other members of its genus, several threats have been identified including:

- entanglement in a variety of inshore gear such as beach seines, purse seines, trawls, and gillnets
- commercial fishery by-catch and incidental mortality
- depletion of prey species in their restricted range
- targeting by illegal direct catch. Dolphin kills with hand-thrown harpoons and/or guns are suspected within the broader Benguela region, despite the full legal protection afforded to all marine mammals in Namibian waters
- interaction with tourists (propeller strikes, pollution, discarded fishing gear)

(Wikipedia, 2017; ICUN, 2015; NACOMA, 2015; Namibian Dolphin Project, 2014; Elwen and Leeney, 2010; Elwen et al., 2006; 2009).

3.1.3. Atlantic or Common Bottlenose Dolphin

Bottlenose dolphins are the most common and well-known species of dolphin. There are three distinct types of Bottlenose Dolphins: Common/Atlantic Bottlenose Dolphins (*Tursiops truncatus*), Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*) and Burrunan Bottlenose Dolphins (*Tursiops australis*). Bottlenose dolphins grow to between 2 and 4 m long and weigh 150 to 200 kg. Differences in size are related to geographical locations. Offshore ecotypes, adapted for cooler waters, tend to be larger than inshore ecotypes. The animals in Walvis Bay have a relatively large body size, growing to over 3.5 meters in length.

Bottlenose dolphins inhabit shallow areas of tropical and temperate oceans throughout the world. Namibian waters host two distinct forms of the Common Bottlenose dolphin (*Tursiops truncatus*). The larger form resides in waters less than 10 m deep in the extreme inshore region of northern Namibia, while a slightly smaller form appears throughout deeper (> 500 m) southern African offshore waters. There is a resident population between Walvis Bay and Cape Cross. This population is unique within the Benguela ecosystem. It is the only inshore population of Common Bottlenose Dolphins south of Angola and numbers less than 100 individuals.

Bottlenose Dolphins are feeding generalists, hunting a variety of fish, squid and shrimp. In Walvis Bay they are regularly observed feeding in association with Cape Fur Seals. When hunting they can reach speeds of over 30 kph. They surface two or three times a minute to breathe in a "porpoising" motion. Bottlenose Dolphins communicate through distinctive whistles and clicks.

Figure 13: Bottlenose Dolphins playing in Walvis Bay (Source: Namibian Dolphin Project)

Bottlenose Dolphins have a strong social structure with long-term, individual-based associations. Schools have been known to come to the aid of an injured dolphin and help it to the surface. Bottlenose Dolphins are generally known to have a calm and playful temperament, particularly around humans. When not travelling or hunting, they seem to enjoy surfing waves, jumping, slapping their tails and tail-walking. Bottlenose Dolphins have been observed to breach up to 5 m, landing with a splash on their back or side.

Because of their large geographical range and large distribution it is difficult to estimate population numbers and trends of Bottlenose Dolphins. The Red Data Book for southern African mammals lists the common species of Bottlenose Dolphin (*Tursiops truncates*) as *Data Deficient*. In Walvis Bay, their numbers are decreasing.

3.1.3.1. General Threats to Bottlenose Dolphins

Coastal populations of Common Bottlenose Dolphins are often resident and small in number, and those in Walvis Bay is no exception. The small population makes them susceptible to natural and man-made threats including interactions with fisheries, coastal degradation and harmful algal blooms. Their very coastal range (usually in waters < 30 m deep) means they come into contact with humans quite frequently. Changes in the behaviour and energy expenditure of Bottlenose Dolphins have been documented in association with tourist, research and recreational vessel proximity.

In 2009 a number of dolphins were stranded up the Walvis Bay lagoon. There seems to be some measure of avoidance behaviour by individuals since this stranding.

Other general threats include:

- predation by sharks and orcas
- by-catch of commercial fisheries
- entanglement in fishing gear and subsequent injury or drowning
- entanglement in mariculture lines and subsequent injury or drowning
- stranding in Walvis Bay lagoon

(Namibian Dolphin Project, 2017; Namibia Travel, 2017; Travel News Namibia, 2017; Heiler et al., 2016; ICUN, 2016, Wikipedia, 2015; Nacoma, 2015; Enigma, 2012; Bianchi et al., 1999)

3.1.4. Dusky Dolphin

Figure 14: Dusky Dolphin in Walvis Bay. (Source: www.namibian.org/travel/)

The Dusky Dolphin (*Lagenorhynchus obscurus*) is the smallest of the world's 33 different species of dolphin, being less than 2 m in length and generally weighing less than 100kg. Dusky Dolphins are widely distributed along the coasts in temperate waters of the southern hemisphere. They are found off South America, New Zealand and the west coast of southern Africa. Like Heaviside's, Dusky Dolphins are distributed throughout and are resident year-round in the BCLME, but they tend to range more widely north-south and further offshore than do Heaviside's Dolphins. Their latitudinal range has been document from Danger Point, South Africa to southern Angola. This is the most abundant cetacean in Namibian waters, often seen in groups, varying in number from as little as 8 up to several hundred individuals. Dusky Dolphins are associated with the colder waters of the Benguela Current. Sightings are reported generally close to shore within the 50 m isobaths, although there have been reports of this species in water some 500 m deep. Dusky Dolphins are the least known of the coastal dolphins of southern Africa.

Dusky Dolphins take a wide variety of prey, including southern anchovy, sardines and mackerel near the surface in shallower waters, as well as mid-water and benthic prey, such as squid, hake and lantern-fish during nocturnal forages. While those in the Walvis Bay region show no predictable special variation with time of day, their numbers inshore are significantly lower when upwelling conditions exist offshore. Dusky Dolphins are able to dive for up to 90 seconds and can reach speeds of 37kph. Several groups of Dusky Dolphins will join together to form a large “hunting” pod. Males and females work together to corner shoals of fish. After feeding they have been seen playing, grooming and leaping together before breaking up into smaller groups again to return closer to the coast to rest.

They are a favourite target of dolphin cruises from Walvis Bay as they frequently bow-ride. Their spectacular aerial displays attract much attention. Dusky dolphins communicate through a series of whistles, but it is not known if they have any sonar abilities when communicating.

Assessment of the global population status is not possible with the current available estimates of abundance. Thus the Dusky Dolphin is classified as *data deficient* by the ICUN.

3.1.4.1. General Threats to Dusky Dolphins

Dusky Dolphins are susceptible to increasing levels of human activity. Direct catches and by-catches have been large and continuous in some regions. Dusky Dolphins are known to be taken directly in the multi-species small cetacean fisheries of Peru and Chile. In 1999 it was calculated that the fishing industry from just one port killed more than 700 Dusky Dolphins annually. Off New Zealand Dusky Dolphins are regularly entangled in gill nets. Incidental mortality at one fishing port was estimated to be 100 to 200 animals per year (Namibian Dolphin Project, 2017; Namibia Travel, 2017; Travel News Namibia, 2017; Wild Africa Travel, 2017; ICUN, 2015; NACOMA, 2015; Elwen et al., 2010; Elwen, 2009; Moloney, C and Shannon, L., 2008)

3.1.5. Risso’s Dolphin

Figure 15: Risso’s Dolphin. (Source:http://www.ocean-institute.org/visitor/risso_dolphin.html)

Risso's Dolphin (*Grampus griseus*) is the only species of dolphin in the genus *Grampus*. Risso's Dolphin has a relatively large anterior body and dorsal fin, while the posterior tapers to a relatively narrow tail. The bulbous head has a vertical crease in front. Juvenile Risso's Dolphins are slate-gray to black in colour. As they age, they lighten in colour and acquire white scars all over their body. These scars are assumed to be from the teeth of other Risso's Dolphins (called rake marks) and from the squid they prey upon, which have sharp hooks on their tentacles. Eventually, a Risso's Dolphin can be almost completely white. At full size these animals measure 3.6 to 4 m and weigh 300 to 400 kg. The oldest known Risso's Dolphin reached an age of 39.6 years. They communicate by a series of whistles and use sonar for echolocation.

Risso's Dolphins are found worldwide in temperate and tropical waters, usually in deep waters, but close to land. They occur in the tropical parts of the Indian, Pacific and Atlantic Oceans, as well as in the Persian Gulf and Mediterranean and Red Seas. Their preferred environment is just off the continental shelf on steep banks, with water depths varying from 400 to 1 000 m and water temperatures of between 15 and 20 °C (min 10 °C). This species is the 3rd most frequently encountered dolphin in the NBR, most often in deep waters of the Namibian coastline. They occur in small groups of around 10 individuals, and are found year-round near the shelf edge throughout the southeast Atlantic Ocean.

Risso's Dolphins travel in pods of 3 to 30 individuals, but these groups can reach 400 members. Smaller, stable subgroups exist within larger groups. They also travel with other cetaceans and are known to harass and surf the bow waves of Gray Whales. Risso's dolphins feed almost exclusively on neritic and oceanic squid, usually nocturnally.

Risso's Dolphin is categorised as *least concern* although they have an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements. They are covered by several international agreements and MoUs including the Western African Aquatic Mammals MoU).

3.1.5.1. General Threats to Risso's Dolphins

Predation does not appear significant in this species and mass strandings are infrequent.

(Namibia-1on1.com, 2017; Namibia Travel, 2017; Namibia Nature Foundation, 2015; ICUN, 2015).

3.1.6. Common Dolphin

The Common Dolphin is a member genus *Delphinus* within the dolphin family *Delphinidae.* Only in the mid-1990s were the different forms within *Delphinus* recognized as species: The Short-beaked Common Dolphin (*D. delphis*) and the Long-beaked Common Dolphin (*Delphinus capensis*). The Indo-Pacific Common Dolphin (*D. tropicalis*) is sometimes considered a separate species, but is more often considered a form of the Long-beaked Common Dolphin. The Long-beaked Common Dolphin is generally larger, with a longer beak and a longer rostrum, than the Short-beaked Common Dolphin.

The Long-beaked Common Dolphin has a dark grey back, a white underside and light grey, gold or mustard-coloured hourglass shapes on the sides. This species also has a rounded melon on tops of their heads used for echolocation. It has a long, thin rostrum with up to 60 small, sharp, interlocking teeth on each side of each jaw, more teeth than any other delphinid. Common Dolphins whistle to communicate with other members of its own species and use sonar for echolocation. This medium-sized dolphin is considerably smaller than the Common Bottlenose Dolphin, averaging around 2.5 m in length and weighing about 150 kg. Males are generally longer and heavier than females.

Despite its name, the Common Dolphin is less well known than the Bottlenose Dolphin, which is sometimes thought of as the "common" dolphin. This is due to its more restricted range and lower tolerance for human interaction. The Long-beaked Common Dolphin has a disjointed range in coastal areas in shallow, warmer temperature and tropical waters. The range includes parts of western and southern Africa, much of western South America, central California to central Mexico, coastal Peru, areas around Japan, Korea and Taiwan, and possibly near Oman. Vagrants have been recorded as far north as Vancouver Island. Common Dolphins avoid the cooler inshore waters of the BCLME region, but have been recorded as regular inhabitants of pelagic Namibian waters, within 50-100 nautical miles (90-185 km) of the coast. They can be found all year round off the coast of Namibia, but are more common in late summer.

Figure 16: Long-beaked Common Dolphins.
(Source: Sea Search Africa, 2017)

The Long-beaked Common Dolphin *(Delphinus capensis)* is a popular attraction on a dolphin cruise around Walvis Bay and Swakopmund because it is very gregarious and highly vocal and can be seen in schools of hundreds. They seem to be compulsive bow-riders of sea-going vessels, regularly Individuals ride the bow-waves, breaching and performing aerial acrobatics. They communicate frequently using clicks, whistles, squeaks and creaks. Long-beaked Common Dolphins sometimes associate with other dolphin species, such as Pilot Whales and Bottlenose Dolphins, and have been seen bow-riding on baleen whales. They are also known to travel with Yellowfin Tuna.

Common Dolphins feed on small fish such as anchovies, sardines, mackerels, pilchards, mullet and squid and they can often be seen following fishing boats or herding prey together. Common Dolphins prey on locally abundant fish species and appears to be well adapted to cope with changes in prey species availability, without impacting on body condition. While feeding they can dive to depths of up to 250 m for as long as 8 minutes.

Since they gather in huge superpods and there is seldom enough food in one place to support all of them and smaller groups break away for a few hours to feed.

Unlike Bottlenose Dolphins, this extremely social species is nearly impossible to tame. If kept in captivity Long-beaked Common Dolphins are extremely stubborn, refuse to be trained and often die.

On the coast of California there are about 25 000 to 43 000 Long-beaked Common Dolphins and on the coast of South Africa there are between 15 000 and to 20 000. *Delphinus capensis* is covered by the Memorandum of Understanding Concerning the Conservation of the Manatee and Small Cetaceans of Western Africa and Micronesia and the Memorandum of Understanding for the Conservation of Cetaceans and Their Habitats in the Pacific Islands Region (Pacific Cetaceans MoU). It is listed by the IUCN as *data deficient*.

3.1.6.1. General Threats to Common Dolphins

Apart from captivity, threats to Long-beaked Common Dolphins include:

- Commercial Fisheries: 120 out of 930 dolphins observed off of Peru between 1985 and 2000 had numerous lacerations on their head, skin, appendages, and teeth. Most of these injuries were from fisheries-related connection.
- Direct targeting: in some regions, such as West Africa, East Asia and the east and west coasts of South America, undetermined numbers of long-beaked dolphins are being directly exploited, or taken as incidental bycatch in other fisheries. In Peru and West Africa in particular, there is increasing concern about the number of Long-beaked Common Dolphins being caught and used for human food and shark-bait
- Pollution: Many of this species have shown signs of organochlorine residue on their blubber.
- Restricted range and lack of quantifiable data

(Namibia Travel, 2017; Wikipedia, 2017; IUCN, 2016; Sea Search Africa, 2017; Ambrose et al., 2013; Wild screen Arkive, 2009).

3.1.7. Rough-toothed Dolphin

The Rough-toothed Dolphin *(Steno bredanensis)* is a primitive-looking dolphin named for the faint ridges on the crowns of the teeth of the upper and lower jaw. It is dark grey to purplish on the back, with yellowish-white or pink blotches and scars on the flanks that mostly come from cookie-cutter shark bites. The lips, snout and ventral surface of Rough-toothed Dolphins are white. It does not have a crease separating its beak from its melon, giving the head a conical shape. The relatively large eyes, narrow head and long, dark, powerful body give Rough-toothed Dolphins a somewhat reptilian appearance. This is a medium-sized dolphin species with males reaching 2.5 m and females 2.25m. On average Rough-toothed Dolphins weigh 145 kg. The Rough-toothed Dolphin is known to live for up to 36 years.

Although widespread, the Rough-toothed Dolphin is not frequently encountered, and thus few studies have been conducted on its ecology and biology. Rough-toothed Dolphins frequent deep, warm tropical waters. In Atlantic coastal areas it has been seen from Walvis Bay northwards to Möwe Bay on the Skeleton Coast. Schools of 50 to several hundred are common. They have been observed in the company of other species such as Pilot Whales, and offshore Bottlenose, Spotted and Spinner Dolphins. They are often associated with flotsam, but the reason is unknown.

Rough-toothed Dolphins are not extremely active animals and seldom bow-ride or perform aerial leaps. They are fast, powerful swimmers, but rather than "porpoising", they "skim" with their heads and chin above the surface of the ocean, facilitating species identification. They often swim in line, with several individuals shoulder-to-shoulder. They tend to travel in small groups of between 10-20 animals.

Figure 17: Rough-toothed Dolphins.
(Source: Ocean Treasures, 2017)

Rough-toothed Dolphins feed on cephalopods, fish, and molluscs. The robust teeth indicate that some particularly large fish may be eaten. Algae have also been found in the stomachs of Rough-toothed Dolphins, although this may have been eaten accidentally. This species is known to dive up to 70 m to remain underwater for 15 minutes when hunting. There is evidence to suggest that this dolphin is actually capable of undertaking much deeper dives.

The global population of Rough-toothed Dolphins is estimated at 150 000. The IUCN Red List classifies this species as of *Least Concern.*

3.1.7.1. General Threats to Rough-toothed Dolphins

Threats to the Rough-toothed Dolphin include:

- small numbers of intentional takes (Japan, West Africa)
- accidental death resulting from bycatch
- entanglement in fishing gear (purse seine nets, gillnets, driftnets)
- possible ingestion of non-biodegradable rubbish (pollutants detected in the blubber).

(Marinebio.org, 2017; Namibia Travel, 2017; Wikipedia, 2017; whales.org, 2017; IUCN, 2016; Ocean Treasures, 2014; Wild screen Arkive, 2009).

3.1.8. Killer Whale / Orca

Killer Whales (*Orcinus orca*) are classified as dolphins, making them the largest species of their kind. They grow up to almost 10 m and weigh as much as 9 000 kg. Females are slightly smaller than males. Killer Whales are easily recognised by their jet black bodies with white patches on their undersides and around the eyes. Their most distinctive feature is the large dorsal fins in the middle of their backs. Orcas live between 30 and 50 years in the wild, but their lifespan is much reduced in captivity. They are susceptible to diseases that can cause reproductive difficulties. They accumulate poisonous chemicals in their body tissue (e.g. PCBs), making them vulnerable to anthropogenic pollution.

The Killer Whales are seen in all oceans, from the polar regions to the tropics, as they tend to travel wherever they can find food. However, there appears to be a preference for higher latitudes and coastal areas over pelagic environments. Killer Whales are reported in southern African waters regardless of season or water depth. Visits to the coastal waters of Namibia by Killer Whales are sporadic. In Namibia, Killer Whales have been recorded on 16 occasions since 2003, usually in late summer and winter. Off Walvis Bay they are usually only seen between August and March, in groups ranging in size from 2 to 20 individuals, but the mostly with fewer than 7 animals.

Figure 18: Orca in Walvis Bay (Source: Namibian Dolphin Project)

Orcas live in complex and cohesive family groups or pods. Their groups are intricately structured and can include up to 4 generations. Mothers calve once every five years usually to a single baby. Mortality is extremely high during the first seven months of life, when 37 - 50% of all calves die. To avoid inbreeding, males mate with females from other pods.

Killer Whale behaviour generally consists of foraging, travelling, resting and socializing. They engage in active and energetic surface behaviour such as breaching, spy-hopping, and tail-slapping. Orcas are notoriously fast swimmers. They are carnivorous hunters and different populations tend to specialize in prey species and use different techniques to catch. Those that feed on mammals may not even recognize fish as prey and vice versa. All pods use effective, cooperative hunting techniques, making use of numerous communications, no matter what the prey. *Resident* pods consume primarily fish and squid; *Transients* hunt small dolphins, seals and seabirds such as cormorants and penguins; while *Offshores* are thought to be responsible for attacks on Humpback and Fin Whales and for the beaching techniques used to grab seals onshore.

There is no current estimate of the number of Killer Whales in the African sub-region. Visits to a specific near-shore region in Walvis Bay seem to be sporadic and unpredictable both within and between years, but records indicate that they may stay in the region for a period of several days.

Due to their enormous range, numbers and density, distributional estimates are difficult to compare and validate. Global population estimates are uncertain, but recent consensus suggests an absolute minimum of 50 000 animals (IUCN, 2016). The IUCN currently assesses the Orca's conservation status as *data deficient* because of the likelihood that two or more killer whale types are separate species. The South African Red Data Book lists the Killer Whale *Orcinus orca* as *Data Deficient*.

3.1.8.1. General Threats to Killer Whales

Some local populations are considered threatened or endangered due to:

- prey depletion
- habitat loss
- anthropogenic pollution (e.g. PCBs)
- capture for marine mammal parks
- conflicts with fisheries.

(Namibian Dolphin Project, 2017; Namibia Travel, 2017; Travel News Namibia, 2017; ICUN, 2015; NACOMA, 2015; Wikipedia, 2015; Elwen and Leeney, 2011; Moloney and Shannon, 2008)

3.1.9. Humpback Whale

The Humpback Whale (*Megaptera novae-angliae*) is one of the larger rorqual species, ranging in length from 12 to 16 m and weighing approximately 36 000 kg, with females being on average slightly larger than males. At birth, calves measure 6 m and weigh approximately 1.8 tons. The Humpback Whale has a distinctive body shape, with unusually long pectoral fins and a knobbly head. Differences in tail fluke patterns are sufficient to identify individual Humpback Whales. The Humpback Whale is known for breaching and slapping the water with its tail and pectorals fins.

Humpback Whales have an incredibly wide distribution, inhabiting all major oceans from the Antarctic ice shelf in the Southern Ocean to 77° N in the Arctic Ocean. They are known for extreme migrations of up to 25 000 km annually, wintering in the tropics after travelling from feeding grounds in the polar regions.

The west coast of South Africa functions largely as a migration corridor, but also serves as a seasonal spring/summer feeding ground for a small number of Humpback Whales. Humpback Whales use migratory corridors along the Namibian coast, travelling from Antarctica to the southern end of Africa and then along the west coast of Southern Africa, through the inshore MPA of Namibia, to the equatorial East Atlantic Ocean offshore of Gabon. They are generally seen over the continental shelf between May and December, with numbers peaking in June/July during the northward migration and again in September, during the southward migration. Given that there are no recordings of Humpback Whales singing in Namibian waters, competitive groups are rarely sighted and very few calves have been observed, it is unlikely that this species breeds in the central Benguela Region. Despite the fact that they are one of the most well-studied whale species in the world, the population structure of Humpback Whales migrating past the west coast of Africa is poorly understood.

Figure 19: Humpback Whale breaching offshore of Walvis Bay. (Source: Mola-Mola Tours.com)

Some non-breeding juvenile Humpback Whales remain off the west coast throughout summer, possibly taking advantage of upwelling productivity to feed within the BCLME. There is evidence to suggest that these animals are, in fact, a sub-population that feeds in the upwelling system throughout the summer months, rather than returning to the Antarctic. Namibian observers have noted a prevalence of Killer Whale bite scars and fresh bites from Cookiecutter Sharks, suggesting that animals seen in Namibia in winter are on their northward migration and have intercepted the coast from farther offshore where Cookiecutter Sharks occur.

Humpback Whales are not exceedingly social animals and enjoy a loose-knit social structure. Typically, individuals live alone or in small, transient groups that come together in summer to forage and feed cooperatively, but disband thereafter. None-the-less, Humpback Whales appear to be a friendly species and are often seen interacting with other cetacean species such as Bottlenose Dolphins. Interaction between Humpback and Right Whales has been recorded in all oceans. Individual Humpback Whales are also known to appear in mixed groups with other species, such as the Blue, Fin, Minke, Gray and Sperm Whales.

Humpback Whales feed on krill, copepods and small shoaling fish. The Humpback is an energetic hunter and has the most diverse feeding repertoire of all baleen whales. Humpbacks hunt by direct attack or by stunning prey by hitting the water with pectoral fins or flukes, but the most inventive technique is known as *bubble net feeding*. Humpbacks feed primarily in summer. In winter they feed only rarely and opportunistically, generally living off fat reserves.

Humpback Whales were heavily exploited in the 19th and 20th centuries and the global population was severely depleted. Humpback Whales were hunted out of Walvis Bay in the early 20th century and Blue Whales were taken as by-catch. Uncontrolled whaling reduced the global Humpback Whale population by an estimated 90%, to 5 000 individuals. A moratorium, introduced in 1966, rescued this species from the brink of extinction, with its population recovering to 80 000 worldwide. Of those 18 000 to 20 000 are found in the North Pacific, 12 000 in the North Atlantic and over 50 000 in the Southern Hemisphere. There are no recent estimates of Humpback populations in the southeast Atlantic Ocean.
In August 2008, the International Union for the Conservation of Nature and Natural Resources (IUCN) changed Humpback Whale's status from *Vulnerable* to *Least Concern*. However, two sub-populations remain endangered. The Red Data Book for southern Africa lists the Humpback Whale as *Near-threatened.*

(National Geographic Society.com, 2017; Wikipedia, 2017; Nacoma, 2017; ICUN, 2015; Elwen at al., 2014; Namibian Dolphin Project, 2014; Enigma, 2012; Elwen and Leeney, 2011; Currie et al., 2009; Maloney and Shannon, 2008; Bianchi et al, 1999).

3.1.9.1. General Threats to Humpback Whales

The main threats to Humpback Whales (other than direct hunting) are:

- possible predation or injury by Orcas
- ship strikes and/or collisions
- entanglement in fishing gear
- entanglement in mariculture lines
- being taken as bycatch
- pollution of the ocean by non-biodegradable materials and accidental ingestion of foreign substances
- internal injuries resulting from noise pollution from marine vessel traffic, marine mining, survey and drilling operations and naval sonar and defence manoeuvres.

3.1.10. Southern Right Whale

The Southern Right Whale (*Eubalaena australis*) is one of three species classified as *Right* Whales belonging to the genus *Eubalaena*. One species is found in the northern Pacific Ocean, one in the North Atlantic and one in the southern hemisphere: *Eubalaena australis*. There are only minor differences in skull shape and size between the 3 species. Individual Southern Right Whales are easily distinguishable by the pattern of callosities on the head and upper jaw. Right Whales are so named because they were the *right* whales to hunt and all three species were decimated to the brink of extinction by early whalers.

Southern Right Whales have a circumpolar distribution between 20°S and 55°S. They migrate northwards in winter for breeding and can be seen along the coasts of Argentina, Australia, Brazil, Chile, Madagascar, Mozambique, Namibia, New Zealand, Peru, South Africa, Tristan de Cunha and Uruguay. Whaling records show that Southern Right Whales were found along the entire southern African coast prior to 1835. Whaling grounds stretched form Walvis Bay, Namibia to Maputo, Mozambique and southwards into the far South Atlantic and Southern Oceans. Whaling activities rendered the Namibian population of Southern Right Whales effectively extinct, before the species was granted protection in 1935. Between 1788 and 1803, more than 3 700 whales were killed out of Walvis Bay alone. The last recorded catch in the region was in 1913 in southern Angola.

Figure 20: Adult female Southern Right Whale with her newborn calf in southern Namibia. © J-P. Roux

Southern Right Whales were extinct in Namibian waters prior to 1971. Between 1971 and 1999 there were 36 incidental sightings of Southern Right Whales in Namibian waters over an area that ranged from 17°16'S to 28°03'S. All sightings were within 3 km of the shore. The coincidence of calves in incidental sightings seems to indicate the occurrence of a small breeding population off Namibia. Most of confirmed Southern Right Whale sightings are restricted to the south of Lüderitz, with only a few animals venturing further north to historical breeding (and hunting) grounds around Walvis Bay.

Southern Right Whales arrive in coastal waters off the southern African west coast in June, building up to a maximum number in September/October and departing again in December. The numbers in Namibia remain low. The population size and status from the Namibian coast are unknown, however, there appears to be an increasing trend from four animals the 1970s more than 150 animals in 80 sightings since 2000.

Global populations are recovering. In October 2008, National Geographic approximated that 10 000 Southern Right Whales are spread throughout the southern part of the Southern Hemisphere. Since whaling stopped, stocks are estimated to have grown by 7% a year. Despite these promising signs, the Southern Right Whale is categorised by the Convention on the Conservation of Migratory Species of Wild Animals (CMS) as being in danger of extinction throughout all, or a significant proportion, of its range.

3.1.10.1. General Threats to Southern Right Whales

The main threats to Southern Right Whales (other than direct hunting) are:

- ship strikes and/or collisions
- entanglement in fishing gear
- entanglement in mariculture lines
- pollution of the ocean by non-biodegradable materials and accidental ingestion of foreign substances

(Namibian Dolphin Project, 2017; Namibia Travel, 2017; Travel News Namibia, 2017; ICUN, 2015; NACOMA, 2015; Wikipedia, 2015; Elwen and Leeney, 2011; Moloney and Shannon, 2008)

3.1.11. Leatherback Turtles

Leatherback Turtles (*Dermochelys coriacea*), the largest living marine reptile, are occasionally sighted off central Namibia. This critically endangered species is known to frequent the cold southern ocean, but cross vast sections of ocean in search of food. Leatherbacks can dive to depths of over 100 m in search of prey, remaining submerged for as long as 35 minutes.

Figure 21: Leatherback Turtle in Walvis Bay area. (Source Namibian Dolphin Project, 2013)

Although they tend to avoid nearshore areas, normally inhabiting deeper waters and travelling the ocean currents in search of jellyfish (their prey of choice), Leatherback Turtles have been sighted by tourists on marine cruises in Walvis Bay and off Swakopmund between October and April. Opportunistic seasonal observations of Leatherback Turtles made during a cetacean research project in the vicinity of Walvis Bay recorded that Leatherback Turtles were only seen in the warmer periods of summer months (February–March) when the surface waters exceeded 15°C. The substantial increase in jelly fish within the BCLME has led to Namibia becoming recognised as a feeding area for Leatherback Turtles. Based on tag returns from animals found dead in Namibia, it has been established that these turtles are known to come from at least 3 breeding populations in the South-West Indian Ocean near Mozambique, Gabon and Brazil.

Leatherbacks are listed in the highest categories in terms of need for conservation in the Convention on International Trade in Endangered Species (CITES) and Convention on Migratory Species.

3.1.11.1. General Threats to Leatherback Turtles

Apart from predation the populations are Leatherback Turtles are threatened by:

- human consumption
- plastic pollution: Turtles mistake plastic waste for jellyfish and subsequently die of starvation as the plastic blocks their gut

As many as 700 sea turtles are caught by the Namibian pelagic longline fishery targeting tuna, swordfish and sharks each year. Catches are likely to be the highest in the northern Benguela, where sea turtle abundance and fishing (longline and artisanal) activity is the highest Additionally sea turtles are caught by artisanal fisheries for consumption in Angola. No mitigation measures are in place throughout the BCLME region.

(Namibian Dolphin Project, 2017; 2013; CITES, 2013; ICUN, 2015; Enigma, 2012; Elwen and Leeney, 2011).

4. POTENTIAL IMPACTS ON MARINE MAMMALS FROM HUMAN ACTIVITIES AND INTERACTION

The marine system is still suffering from the effects of whaling, sealing, the harvesting of guano and commercial fishing operations in the 19th and 20th centuries. It is being increasingly impacted by industrial and commercial activity as technology improves to make the marine environment more accessible. These activities have had serious negative impacts on many species, and while conservation efforts have resulted in some species regaining at least some of their original populations, many others have yet to recover to any significant degree.

The purpose of this section is to identify any possible risks and threats of the proposed Walvis Bay Waterfront Development to the identified marine populations. If any such risks exist, then, where possible, mitigation measures are suggested.

All marine mammals face threats in their natural environment, but many of these are a direct result of human activity. Deliberate targeting, research, exploration, mining, construction, military activities, invasion of territory, negligence and simple ignorance account for numerous injuries and fatalities, many of which can be avoided. The Sea Fisheries Act (29 of 1992) gives Namibia's marine mammals full protection within the 200 nautical mile Exclusive Economic Zone. None-the-less, these animals are strongly impacted by human activities both on- and off-shore. Many species are still vulnerable to human activities and accidental interaction.

4.1. MARINE TRAFFIC

The general increase in marine traffic and utilisation of marine resources results in more frequent accidental encounters between humans and marine animals. Most research has focused on mysticetes as these whales seem more vulnerable to collisions with ships, entanglement in fishing gear and noise pollution. Mammal-vessel collisions are dangerous to both parties. Ship-whale collisions in Tsushima Strait have resulted in injury to whales and passengers and damage to vessels.

Research into marine mammal-vessel collision indicates that the probability of collision depends on a number of factors including vessel type, speed, location, species, and behaviour (Todd eta al., 2015). Studies have shown that the risk of a collision resulting in severe or lethal injury increases when vessels exceed 10–14 knots, regardless of vessel type. Right Whales (*Eubalaena spp.*), Humpback Whales (*Megaptera novaeangliae*), and Fin Whales (*Balaenoptera physalus*) are considered some of the most prone to collisions. Calves and juveniles are struck more often than adults. An 18 m (60 ft) -long Fin Whale was found stuck on the bow of a container ship in New York harbour on Saturday, 12 April 2014, without the crew being aware of anything untoward. However, data on vessel collisions need to be assessed with caution, as most is obtained from historical or anecdotal records that are difficult to verify.

There appears to be a direct correlation between animal seasonality and behaviour with collision rates. Resting or feeding whales were deemed more at risk. Collision rates involving Fin Whales increased during months of intensive feeding, possibly due possibly to the fact that feeding animals are distracted and less aware of vessel movements (Todd et al, 2015).

The discovery of large hydrocarbon reserves off the Namibian coast has lead to an increase in deep-penetration seismic surveys for exploration purposes. While Cuvier's Beaked Whales tend to avoid ships naturally in the open ocean, the increased ship traffic in and out of Lüderitz and Walvis Bay harbours and the general noise in the environment can possibly have a negative effect on other whales and dolphins in the SBR. A species particularly at risk is the slow-moving Southern Right Whale, which makes use of numerous inshore bays for calving and nursing.

Figure 22: Southern Right Whales in Lüderitz Harbour entrance channel. © J-P. Roux 2008

These two Southern Right Whales were photographed swimming in the Lüderitz harbour channel. These slow moving creatures are increasingly at risk of ship strikes as they slowly return to their traditional grounds along the Namibian coast and their breeding habitat is encroached upon by harbour development and increased shipping (Roux, 2008).

Even small motorised tourist cruises pose a threat for mammal-vessel and mammal-human interaction. Porpoising Heaviside's, Bottlenose and Dusky Dolphins are activity pursued by tourist craft. Their energetic and social behaviour makes them a popular target. Movies such as *Flipper* have popularised the idea of human interaction with wild dolphins. Excitement and competition between tour operators can lead to irresponsible craft movement and increase the risk of accidental collision. Luckily, to date, only one case of propeller strike has been recorded in Walvis Bay (Elwen and Leeney, 2010).

Figure 23: Tourist boat pursuing dolphin in Walvis Bay. (Source: Mola-Mola Tours)

Longer dolphin dive times and shorter periods at the surface have been recorded when dolphin-watching boats were present (Marine Mammal Commission, 2007), suggesting that this human activity possibly leads to more energy expenditure on the part of the marine mammals. Changes in dolphin vocalization parameters have been recorded in the presence of tourist boats, most specifically if calves were present. Such changes could have a long-term impact if they reduce the communication range of whistles or increase energy expenditure (Heiler et al, 2016).

Dolphins and seals are sometimes considered to chase off or eat fish targeted by recreational fishermen. Uneducated and irresponsible fishermen sometimes deliberately try to drive away these animals by steering boats directly towards them.

4.2. POLLUTION

Chemical pollution in the world's oceans threatens marine species in general, but some more than others. Blubber samples show an accumulation of polychlorinated biphenyl (PCB) chemicals within the bodies of Blue Whales and Orcas. This is a quiet, less visible threat to population recovery.

Chemicals from ship maintenance end up in harbour waters. These can be toxic to local benthic fauna and fish populations. Anti-fouling paints, originating from the dry docks in the harbour, are among the most toxic anthropogenic compounds that are introduced into Walvis Bay. Together with the run-off from urban areas, such toxins can have severe impacts on the marine organisms as well as posing a health risk to recreational users of the bay water. Mammals feeding on contaminated prey are at risk of poisoning through bioaccumulation (CSIR, 2009; Uushona and Makuti, 2008; Heather-Clark, 1996).

Besides litter from visitors, oil and debris from offshore vessels collect near and pollute the waters around Pelican Point. Oil and petroleum products can have profound effects on marine and land organisms, including reproduction complications, inhibited growth, toxins in fish and shellfish and resultant bioaccumulation up the food chain. Widespread impacts include shifts in dominant species, changes in abundance and diversity and mortality.

Namport is responsible for the harbour/bay oil spill contingency plan and makes provision for oil to be cleaned from the harbour and direct surrounds at all times. However, in the event of a minor oil spill in south of the peninsula, the Namport Contingency Plan recommends that the oil be left to "natural cleaning" unless heavy deposits pollute the recreational facilities and threaten the ecology. This leaves a certain number of mammals and birds at risk of oil contamination (CSIR, 2009; Uushona and Makuti, 2008).

Eutrophication of harbour waters occurs as a result of the addition of high levels of inorganic nutrients, for example from sewage and fish factory effluent. This can lead to excessive algal growth and consequent increased consumption of dissolved oxygen, ultimately leading to anoxic conditions. Not only are algal blooms aesthetically displeasing, they also produce unpleasant odours, particularly when they accentuate H_2S eruptions. Such conditions have detrimental effects on both the fish and shellfish within Walvis Bay. Increasing organic loading of an area by additional sewage outflow or dumping of garbage can dramatically change the structure of the ecology within the bay area.

Plastic pollution and discarded or lost fishing gear are responsible for injury to, restriction of and possible loss of functionality and of appendages of seabirds and marine mammals. Many seals seen in harbours and fishing areas have straps or nooses cutting into their necks. If left unattended, the nooses get tighter and cut deeper into the flesh, causing nasty wounds that become infected and could lead to the death of the animal or become caught on underwater objects when the seal dives, resulting in drowning. These injuries are caused by the seals swimming into items such as fishing line, bait box bands, rope and raffia cord, that find their way into the water as a result of human negligence (Two Oceans Aquarium, 2016).

Figure 24: Cape Fur Seal entangled in a rope (Source: Bruce, 2015)

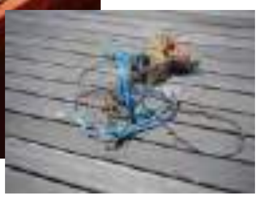

Figure 25: Seal entangled in fishing line and bait box bands (Source: Two Ocean Aquarium, 2017).

Discarded bait box bands and broken fishing line are a major source of strangulation in Cape Fur Seals (Bruce, 2015; South African SPCA Seal Unit, 2016). The hard plastic bands do not need to be cut to remove them from the box; they just slide off and end up in the water where seals swim into the loops. They become embedded around the neck, resulting in slow strangulation. A simple solution would be to cut plastic ties before discarding them, however, many fishermen are disinclined to do so or make an effort to recover bait box bands or other debris from the water. Few will take pity on an injured seal (Bruce, 2015).

Dolphins are also susceptible to entanglement in fishing line in the water. Several dolphins bearing entanglement scars have been recorded in Walvis Bay. Between 2011 and 2012 a Heaviside's Dolphin was recorded to have fishing line caught in her flesh and that had been dangling from her body for over a year after the first spotting (Namibian Dolphin Project, 2017).

Drifting plastic bags are often ingested by mammals, turtles and birds that misidentify them as jellyfish. Ingested plastic causes bowel obstructions and the animal slowly starves to death. Plastic waste has caused fatalities in whales, birds, turtles and sharks (Two Oceans Aquarium, 2017).

Figure 26: Plastic waste (including balloons and string) recovered from a Green Turtle. (Source: Two Oceans Aquarium)

4.3. COMPETITION WITH FISHERIES

Cape Fur Seals are known to regularly interact with the South African offshore demersal, inshore demersal and mid-water trawl fisheries in a number of ways that can be detrimental to either party (fishermen or seal):

- Seals are injured by the propeller
- Seals drown in the nets
- Live seals come aboard and may be severely injured or killed

- Seals take or damage netted fish (at an estimated 0.3% cost of the total fishery)
- Seals damage the nets
- Seals can damage some trawler propellers
- Seals caught onboard below decks can attack and injure fishermen

Seal mortality is mainly through drowning in trawl nets, with between 2 500 and 3 600 deaths recorded annually in South African waters during the 90's. Brightly coloured strips of plastic and canvas are sometimes used to deter the seals, but these have not been very effective. Instead they pose a pollution threat to other sea creatures when they break off in the open waters (Wickens and Sims, 1994).

As many as 570 seals are deliberately killed annually, but this most likely takes place only when they are caught in the nets, are brought onboard and they enter the area below deck, where they are difficult to remove and pose a safety threat to the crew (Wickens and Sims, 1994). The New Zealand trawl fishery uses choker poles, deck and fire hoses and nets to attempt to remove seals from onboard vessels. There are no published data for Namibian trawl statistics with reference to seal injury, mortality or damages and cost to the fishing industry.

In general, the relationship between fishermen and seals is not an amicable one. Local artisanal fishermen describe the seals actions as *theft* from men trying to make a living. Seals are known to simply take snoek off the line. Some fishermen get so angry they shoot the seals, despite seals being protected by South African and Namibian law. In the first half of 2015, 7 seals with bullet holes washed up on the Cape beaches (Bruce, 2015).

4.4. MARICULTURE

Commercial aquaculture and mariculture ventures started in Namibia in the late 1990's. A serious potential impact of mariculture in Walvis Bay lagoon is competition for space. There is a competition in the bay area between the commercial and fishing harbours, marine tourism, recreational users and nature conservation.

Figure 27: Bottlenose Dolphin swimming between the lines of an oyster farm in Walvis Bay © R. Leeney, 2008.

Space required for the rafts will also conflict with the birds and marine mammals that use the bay area as a habitat and feeding grounds. These farms close off spaces previously accessible to wild marine life, possibly impacting feeding and breeding patterns. In Vancouver a dead Humpback Whale was found entangled in empty aquaculture lines on 20 November 2016. That was the second time within 2 months that a whale had been trapped at the same site (Vancouver Sun, 2016). A whale calf became entangled in the lines of one of the oyster farms east of the Walvis Bay peninsula. Dolphins have been reported swimming amongst the lines of oyster farms in Walvis Bay lagoon.

Mussels and oysters are filter feeders that will extract food particles from the water that are required by the other organisms living in the surrounding water. This impact is mitigated to a certain extent by the extremely nutrient-rich water and high productivity rates within the Benguela system and consequently, the bay waters. Introduction of alien species for mariculture is of concern as alien species may be invasive, thus threatening indigenous species and change the composition of the Walvis Bay communities.

Mariculture farms can impact marine populations through pollution from equipment and diesel engines used for pumping.

4.5. LIGHT AIRCRAFFT NOISE

Low-flying aircraft taking scenic tours over the bay and lagoon to Sandwich Harbour can cause startle response and panic if they approach too close to seal colonies and roosting or nesting birds. They can disrupt feeding birds and mammals at sea. At present this does not appear to be a major problem in the Walvis Bay area due to the infrequent nature of these flights.

4.6. MARINE NOISE

(Miller et al., 2011; Finneran and Schlundt, 2010; SOCAL-10; Thomsen et al., 2009; Finneran et al., 2005a; b; Kastelein et al., 2002; Thompson, 2000; Richardson et al., 1995)

The marine environment is filled with noise, but increasingly so through anthropogenic activities. Natural physical phenomena that contribute to underwater ambient noise include wind, waves, swell patterns, bubbles, currents, turbulence, earthquakes, volcanic eruptions, precipitation, lightening strikes and ice (Figure 28). In the absence of anthropogenic and biological sound, ambient noise is wind dependent over an extremely broad frequency band from below 1 Hz to at least 100 kHz. Spilling and plunging breakers can increase noise levels by more than 20 dB (10 Hz to 10 kHz band). Precipitation can raise ambient noise levels by up to 35 dB across a broad band of frequencies (100 Hz to more than 20 kHz). The dominant source of ambient noise in tropical and sub-tropical waters are snapping shrimp, which can increase ambient noise levels by 20 dB in the mid-frequency band (Convention on Biodiversity, 2012).

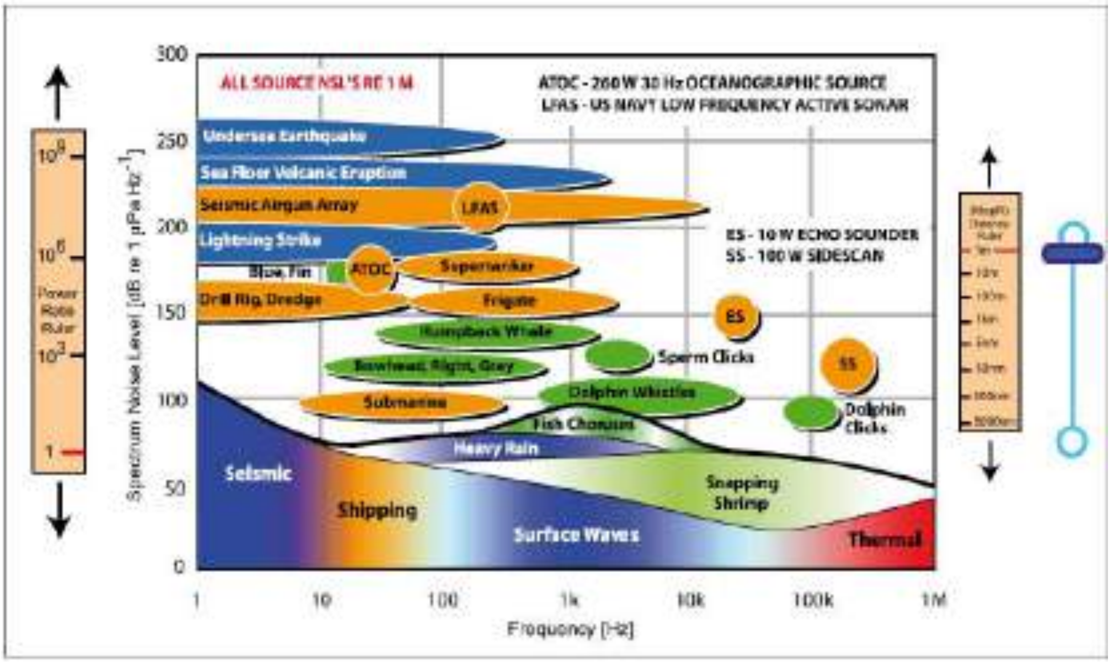

Figure 28: Range of noises in the marine environment showing natural, biological and anthropogenic. (From ESF, 2008)

It is generally considered that intense anthropogenic noise has adverse effects on marine organisms and mammals. While there have been a few cases of strandings of Beaked Whales and Giant Squids coinciding with academic seismic surveys and Humpback Whale mortality has been linked to naval exercises; there is no conclusive evidence of a link between construction noise and marine mammal mortality. As a result of public outcry over the assumed detrimental side-effects and sometimes lethal consequences of man-made activities on some marine mammals, governments (in particular the USA, UK, Australia and Sweden) have commissioned major research projects to identify culprits and differentiate between anecdotal and scientific evidence (NOAA, 2015; AFTT, 2012; Convention on Biodiversity, 2012; OSPAR, 2009; ESF, 2008; Marine Mammal Commission, 2007; NRC, 2005; 2003; DEFRA, 2004; 2003).

The amount of acoustic energy that an animal experiences as a result of an underwater energy source discharge is expressed as the sound exposure level (SEL), which is a measure of the acoustic intensity. This takes into account the overall acoustic energy impinging on a receiver per unit area within 1 second (dB re 1 μPa^2-s.). This measurement allows sounds of differing durations to be characterized in terms of energy (Woodside, 2008). Sound pressure levels (SPL) in water are measured in decibels (dB) relative to a reference pressure of 1 micropascal (1 µPa). The reference distance is 1 m. Thus, the commonly used pressure reference level for underwater acoustics is 1 µPa at 1 m or 1 µPa@1m. The reference level used for air (which matches human hearing sensitivity levels) is 20 µPa@1m.

A variety of marine life has developed special mechanisms both for emitting and detecting underwater sound. In marine mammals (cetaceans and pinnipeds), sound is used for communication, orientation, predator avoidance and foraging. Sounds range from the 10 Hz low-frequency calls of Blue Whales to the ultrasonic clicks of more than 200 kHz in certain offshore dolphins and Harbour Porpoises. Communicative signals tend to be longer in duration, but at lower source levels. Table 1 shows that the hearing of marine mammals spans as wide a range of frequencies as the emitted sounds do (<1 kHz - 180 kHz).

The hearing systems of animals are not equally sensitive to all frequencies (Table 1). The hearing threshold is the average sound pressure level (SPL) that is just audible to a subject under quiet conditions. For example, the Harbour Porpoise's hearing threshold at 500 Hz is about 90 dB re 1 µPa, while its hearing threshold at 50 kHz is in the order of 35 dB re 1 µPa. This would mean that a sound with an SPL of 100 dB re 1 µPa and a frequency of 500 Hz would be barely audible to the porpoise, however, the same SPL at a frequency of 50 kHz would be perceived as relatively loud.

Table 1: Vocalisation and functional hearing frequency ranges for marine mammals (from AFTT, 2012; OSPAR, 2009, Thompson, 2000)

MAMMALS	VOLALISATION RANGE	HEARING RANGE	VOLALISATION SOURCE LEVEL
Low-frequency Cetaceans: Humpback, Southern Right Whales	10 Hz – 20 kHz	7 Hz – 22 kHz	150 - 192 dB re 1 µPa @ 1 m
Mid-frequency Cetaceans: Killer Whales, Bottlenose, Dusky, Long-beaked Common, Risso's, Rough-toothed Dolphins	100 Hz – >100 kHz	150 Hz – 160 kHz	137 - 236 dB re 1 µPa @ 1 m
High-frequency Cetaceans: Harbour Porpoise, Koiga species	100 Hz – 200 kHz	100 Hz – 200 kHz	120 - 205 dB re 1 µPa @ 1 m
Northern Fur Seals And California Sea Lions	125 Hz – 40 kHz	200 Hz – 50 kHz	95 - 160 dB re 1 µPa @ 1 m
Phocid Seals	100 Hz – 120 kHz	75 Hz – 75 kHz	103 - 180 dB re 1 µPa @ 1 m

Species also differ markedly in their audiograms with respect to the frequency range they can hear, and with respect to their absolute sensitivity. Figure 29 shows audiograms for common dolphin species (from Thomsen et al., 2009).

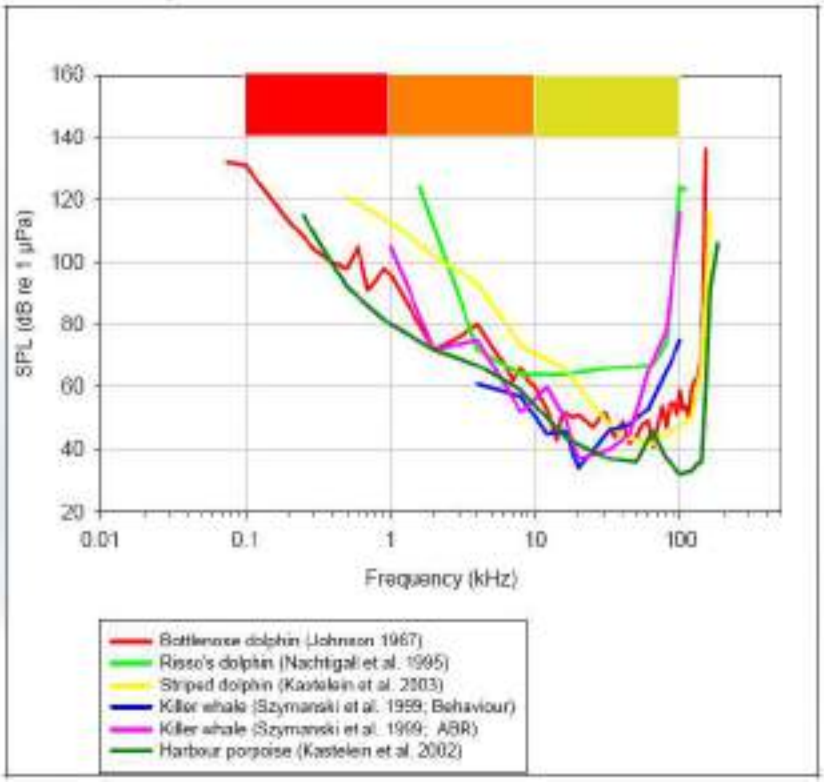

Figure 29: Representative audiograms of some common odontocetes. ABR = auditory brainstem response.

The colours at the top represent the bandwidth and relative energy content of dredging noise:
red = high
orange = low
gold = very low.

(After Thomsen at al., 2009).

The response of and/or injury to a marine mammal to an anthropogenic sound will depend on numerous factors including the frequency, duration, temporal pattern and amplitude of the sound (peak-peak), the distance from the sound source and whether it is perceived as approaching or moving away (SOCAL-10). In a report to the US Congress in 2007 the Marine Mammal Commission identified the various scales of damage that can be affected on marine fauna. A simplistic analysis, as provided by the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Commission) is shown in Table 2.

In extreme cases and at very high received SPLs close to the source, very intense sounds can result in internal injuries and might also lead to the death of the receiver. For example, underwater explosions used during construction or from the detonation of marine ammunition dumps can cause not only hearing damage and injury, but death from the sound shock waves. The only known case where acute exposure to non-explosive sound has led to lethal effects involves atypical mass strandings of beaked whales during navy sonar exercises (AFTT, 2012).

Table 2: Damage affected on marine fauna by anthropogenic sounds. (Source: OSPAR 2009).

IMPACT	TYPE OF EFFECT
Physiological Non-Auditory Auditory - Sound Induced Hearing Loss (SIHL)	- Damage to body tissue: *e.g.* massive internal haemorrhages with secondary lesions, ossicular fractures or dysiocation, leakage of cerebro-spinal fluid into the middle ear, rupture of lung tissue. - Induction of gas embolism (Gas Embolic Syndrome, Decompression Sickness/DCS, 'the bends', Caisson syndrome) - Induction of fat embolism - Gross damage to the auditory system – *e.g.* resulting in: rupture of the oval or round window or rupture of the eardrum - Vestibular trauma – *e.g.* resulting in: vertigo, dysfunction of co-ordination, and equilibrium - Permanent hearing threshold shift (PTS) – *e.g.*, a permanent elevation of the level at which a sound can be detected - Temporary hearing threshold shift (TTS) – *e.g.*, a temporary elevation of the level at which a sound can be detected
Perceptual	- Masking of communication with con-specifics - Masking of other biologically important sounds
Behavioural	- Stranding and beaching - Interruption of normal behaviour such as feeding, breeding, and nursing - Behaviour modified (less effective/efficient) - Adaptive shifting of vocalisation intensity and/or frequency - Displacement from area (short or long term)

Masking is the term used to describe a temporary reduction in ability to detect biologically relevant sounds as a result of a loud noise or strong SPL. The *zone of masking* is defined by the range at which sound levels from the noise source are received above hearing threshold levels. It starts when the received sound level of the masking sound (e.g. a nearby ship engine) equals the ambient noise (e.g. wave or wind) in the frequency of the signal. Masking can shorten the range over which sounds can be detected and across which conspecifics are able to communicate (e.g. mother and calf). In some species (e.g. Killer Whales) communication networks span several thousand kilometres. Masking by continuous noise can considerably reduce the functionality of these distances. However, most mammals communicate across a range of frequencies, so it is highly unlikely that the full range of frequencies used by one species will be completely masked for any significant time period.

Threshold shifts refer to an animal's ability to hear at a particular frequency and occurs at two levels of severity: Temporary threshold shift (TTS) represent changes in the ability of an animal to hear a particular frequency with a for a period of hours to days; permanent threshold shift (PTS) represents a permanent loss of hearing within a particular frequency range. Both TTS and PTS are triggered by the level and duration of the received signal. TTS have been induced in captive dolphin species at received levels higher than 190 dB. Finneran and Schlundt (2010) found that non-impulsive sounds with frequencies above 10 kHz are more hazardous than those at lower frequencies for Bottlenose Dolphins. Although no PTS have been recorded in cetaceans, it is argued that severe damage can occur in high-frequency cetaceans swimming within 265 m of the most powerful active acoustic sources such as hull-mounted sonar (AFTT, 2012). Tables 3 and 4 summarise the threshold levels for TTS and PTS in marine mammals that function in different frequency ranges.

Table 3: Acoustic criteria and thresholds for predicting physiological effects on marine mammals (from AFTT, 2012)

Group	Species	Physiological	
		Onset TTS	**Onset PTS**
Low-Frequency Cetaceans	All mysticetes	178 dB re 1μPa^2-s (low-freq weighting)	198 dB re 1μPa^2-s (low-freq weighting)
Mid-Frequency Cetaceans	Dolphins, beaked whales, and medium and large toothed whales	178 dB re 1μPa^2-s (mid-freq weighting)	198 dB re 1μPa^2-s (mid-freq weighting)
High-Frequency Cetaceans	Harbor porpoise and *Kogia* spp.	152 dB re 1μPa^2-s (high-freq weighting)	172 dB re 1μPa^2-s (high-freq weighting)
Phocid Seals (In-Water)	Harbor, bearded, hooded common, spotted, ringed, harp, ribbon, & gray seals	183 dB re 1μPa^2-s (phocid weighting)	197 dB re 1μPa^2-s (phocid weighting)
Manatees	West Indian manatee		

In only 2 out of 11 studies of impulsive sounds did measurable TTS occur (NOAA, 2015). This may indicate that marine mammals are more tolerant of human activity than previously supposed (Table 5).

Behavioural disturbances are reflected by noticeable changes in activity and demeanour in direct response to a sound source. These effects are difficult to measure and quantify as they depend on a wide variety of factors, for example the characteristics of the signal, the composition of the group (sex, calves present), the behavioural and motivational state (hunting, resting, socialising) prior to the sound disturbance and the individual perceiving the sound (age, sex , social status). Thus, the extent of behavioural disturbance for any given signal can vary both within a population as well as within the same individual.

Kastelein et al. (2013) monitored the response of a captive porpoise in a quiet pool to playback pile-driving sounds. The respiration rate of the porpoise appeared to increase at a threshold SEL of 127 dB re 1 µPa2·s. When exposed to SELs of 145 dB re 1 µPa2·s, the animal tried to avoid the sound by regularly jumping out of the water, whereas it never jumped during the baseline periods. Table 4 summarises the threshold source levels for the onset of behavioural response in marine mammals.

Table 4: Behavioural Response sound source thresholds in marine mammals (after AFTT, 2012)

MAMMALS	BEHAVIOURAL RESPONSE
Low-frequency Cetaceans: Humpback, Southern Right Whales	<= 160 dB re 1 µPa
Mid-frequency Cetaceans: Killer Whales, Bottlenose, Dusky, Long-beaked Common, Risso’s, Rough-toothed Dolphins	167 - >170 dB re 1 µPa
High-frequency Cetaceans: Harbour Porpoise, Koiga species	90 - 140 dB re 1 µPa
California Sea Lions	165-170 dB re 1 µPa
Phocid Seals	<= 190 dB re 1 µPa

Table 5: Summary of TTS studies on marine mammals using impulsive sounds (from NOAA, 2015)

Source	**Species (n)**	**Measured TTS Frequencies ‡**	**Peak Pressure**	**Pulse Duration**	**Ratio* (Pa/s)**	**Reference**
Explosion simulator (500 kg charge)	Beluga (1); Bottlenose dolphin (2)	1.2, 1.8, and 2.4 kHz	69183 Pa (216.8 dB)	0.0095 s	7,282,421	Finneran et al. 2000
Water gun (80 in3)	Beluga (1)	**0.4**, 4, and **30** kHz	158489 Pa (224 dB)	0.0063 s	**25,156,984**	Finneran et al. 2002
Water gun (80 in3)	Bottlenose dolphin (1)	0.4, 4, and 30 kHz	218776 Pa (226.8 dB)	0.01 s	21,877,600	Finneran et al. 2002
Arc-gap transducer	California sea lion (2)	1 and 10 kHz	13963 Pa (202.9 dB)	0.0142	983,310	Finneran et al. 2003
Airgun (20 in3)	Harbor porpoise	**4**, 32, and 100 kHz	5623 Pa (195 dB)	0.05 s+	**112,460**	Lucke et al. 2009
Impact pile driver (4.2 m pile at 800 m)	Harbor porpoise	0.5, 1, 2, 4, 8, 16, 32, 63, and 125 kHz	1000 Pa (180 dB)	0.124 s	1452	Kastelein et al. 2015a
Airgun (40-150 in3)	Bottlenose dolphin (3)	0.25, 0.5, 1, 2, 4, 8, 16, 32, 40, 45, 50, and 64 kHz	31622 Pa (210 dB)	0.3 s	105,407	Finneran et al. 2015

‡ Frequencies in **bold** indicate those where measurable **TTS occurred**.
* Ratios in bold text indicate exposure scenarios where measurable TTS occurred.
+ Lucke et al. 2009 did not provide the exact pulse duration in their experiment and only indicated it was less than 0.05 s. NOAA conservatively chose to use 0.05 s for calculating the ratio (i.e., the use of a shorter duration would only result in a higher ratio).

4.6.1. Impact of Noise on Cape Fur Seals

As there are no data available for the hearing sensitivity of Cape Fur Seals, research relating to other seal species has been investigated. Most research has been undertaken in the Northern Hemisphere, predominantly on phocid species (true seals). Captive phocid seals demonstrate a larger range in hearing and vocalisation frequency compared to otariids (sea lions and fur seals), especially within the higher frequency bands (Brough et al, 2014; Kastelein et al. 2009). Seals and sea lions produce sounds both in air and water that range in frequency from approximately 200 Hz to 40 kHz. It is believed that these sounds are only for social communication (SOCAL-10). The high-frequency limit for California Sea Lions is traditionally considered to be 40 kHz and 80 kHz for Harbour Seals. However, one recent study notes a second detection limit for both species at 180 kHz (two full octaves above the traditional California sea lion high-frequency hearing limit of 36 - 40 kHz). The audiograms for both species showed two distinct slopes relating to frequency-dependant hearing sensitivity (Cunningham and Reichmuth, 2016). A male Wedell Seal exhibits a very high amplitude source level trill of is 193 dB re 1 _Pa recorded at a distance of 1 m from the vocalizing seal. These data possibly indicate extremes of pinnipedia functional ranges.

Evidence suggests that some pinnipeds (seals, sea lions and walruses) can detect underwater sound at frequencies well above the traditional high-frequency hearing limits for their species. Pinniped audiograms are characterized by a rapid decrease in sensitivity with increasing frequency. Steller (Northern) Sea Lions (*Eumetopias jubata*) and California Sea Lions (*Zalophus californianus*) exhibit general avoidance behaviour at exposure levels above 170 dB re 1 µPa (Bain & Williams 2006), while Phocid seals (true seals) showed avoidance reactions at or below 190 dB re 1 µPa (SOCAL-10).

While TTS have been reported in Harbour Seals exposed to continuous industrial noise (sand blasting), there is no documented evidence of marine noise inducing PTS (NOAA, 2015; OSPAR, 2009).

Although otariids have less sensitive hearing thresholds than phocid seals, all seals generally move away from any source of discomfort, thus it is expected that Cape Fur Seals will show similar avoidance behaviour and be beyond the range at which physiological damage can occur. Otariids are known to become habituated to underwater sound, but whether they are capable of voluntarily masking noise as an internal defence is unknown (NRC, 2005; 2003; Edren et al., 2004; Richardson et al., 1995). The presence of Cape Fur Seals near operational mining and survey vessels, returning to construction sites and becoming habituated to “seal bombs” suggests that they are fairly tolerant of loud noise pulses. After an initial startle reaction, it has been noted that individuals quickly reverted back to normal behaviour.

4.6.2. Impact of Noise on Cetaceans

Increased levels of anthropogenic noise can cause cetaceans to avoid areas they would normally inhabit, sometimes permanently. It provokes changes in diving and foraging behaviour, leading to greater energy expenditure and potential loss of feeding opportunities. Anthropogenic noise has the ability to limit communication and the detection of biologically important sound sources. It can cause temporary and permanent deafness and, in some cases, lead to fatalities (Sonic Sea, 2017).

Figure 28 shows that there is a distinct difference in the hearing range of mysticetes (baleen whales) and odontocetes (toothed whales and dolphins): the low-frequency mysticete frequency range is centred below 1 Hz, while the odontocetes operate at higher-frequency ranges between 10 and 100 kHz. Most mysticetes produce low-frequency sounds usually below 10 kHz with the notable exception of Humpback Whales, where some calls exceed 10 kHz. The dolphins and Killer Whales found in the Walvis Bay area are mid-frequency cetaceans with hearing between 150 Hz - 160 kHz (Thomsen et al., 2009). It is possible that some odontocetes are able to detect low-frequency sounds using mechanisms other than conventional hearing, such as perceiving changes in particle velocity or identifying a combination of pressure and velocity in the near-field. At sea observations suggest that Bottlenose Dolphins, Common Dolphins and Harbour Porpoises exhibit behavioural responses to low-frequency pulses of seismic surveys, however most studies agree that the range of best hearing is well above 10 kHz with sensitivity below 1 kHz being relatively poor.

Odontocetes produce a variety of sounds for communication and echolocation, including narrowband, frequency-modulated continuous tonal sounds or "*whistles*" that range from 500 Hz to 80 kHz, and broadband sonar clicks between 250 Hz and 220 kHz including burst pulse sounds. Source levels of most mid-frequency odontocetes range between 137 and 236 dB re 1 µPa @ 1 m, while mysticete cetacean vocalisations range from 140 to 190 dB re 1 µPa (OSPAR, 2009, Marine Mammal Commission, 2008).

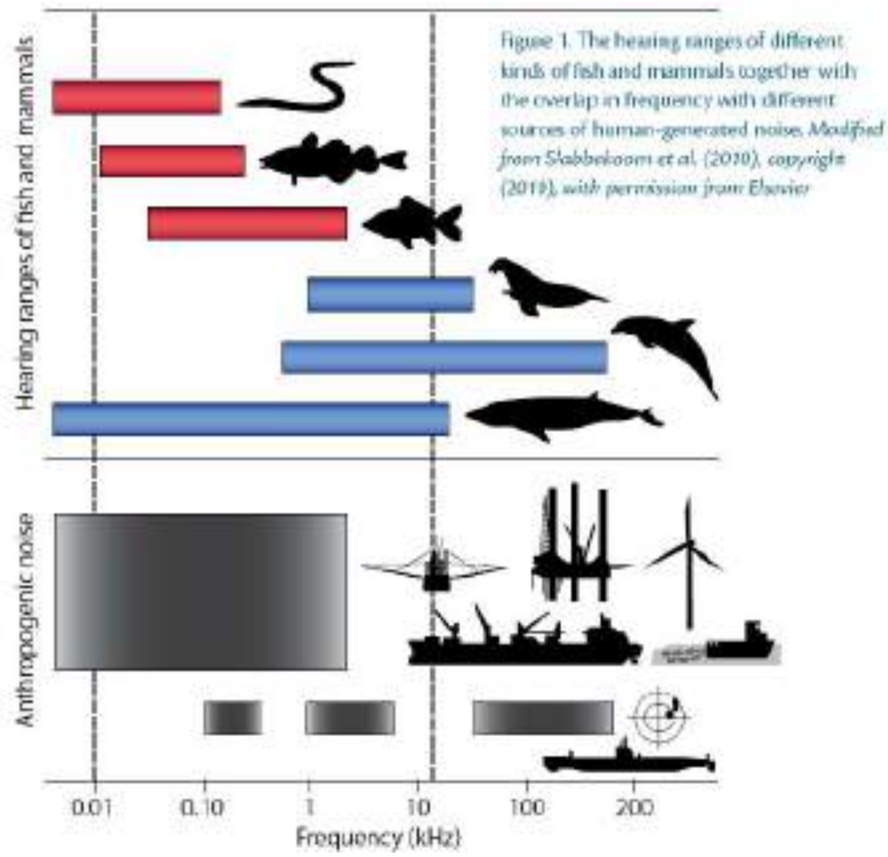

Figure 30: The hearing ranges of marine animals relative to anthropogenic noise. (From Boyd et al., 2011)

Apart from mortal injuries inflicted by naval sonar, there is little evidence of other sources of anthropogenic underwater noise causing direct physical damage to marine mammals. There are a few poorly documented cases of injury (organ damage and rupture of gas-filled cavities such as lungs, sinuses and ears) and deaths of marine mammals being caused by the use of high explosives. The death of two Humpback Whales was attributed to acoustic trauma and severe injury to the temporal bones following a 5000 kg explosion. There is no documented case of injury caused by pile driving for marine mammals at sea, although experimental studies of animals in captivity using simulated source levels indicate the noises are strong enough to cause noise induced hearing loss or TTS in some species of high-frequency hearing-sensitive mammals. These mammals were also exposed at much closer distances to the sound source than would be expected in the wild (Convention on Biodiversity, 2012).

TTS have been induced in captive dolphin species at received levels higher than 190 dB. Finneran and Schlundt (2010) found that non-impulsive sounds with frequencies above 10 kHz are more hazardous to Bottlenose Dolphins than those at lower frequencies.

The Royal Netherlands Navy identified threat of TTS based on species-specific hearing sensitivity for maximum exposure levels of 15 to 20 dB for the following ranges in received sound levels (ESF, 2008):

- Baleen whales and some dolphins 160-185 dB
- Sperm and killer Whales 140-160 dB
- Porpoise 135-155 dB

As with hearing loss, auditory masking can limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and, in the case of odontocetes, echolocate. Humpback whales were observed to increase the length of their “songs” in the presence of low-frequency sonar (AFTT, 2012), indicating there may be some compensatory response to the increased noise level. Whether this is an attempt to transcend the noise or is a competitive or social response is uncertain. It has been found that dolphins can “turn down” the sensitivity of their hearing to avoid damage that could result from loud sounds (Nachtigall and Supin 2013). During these periods of reduced sensitivity they are less likely to detect the vocalisations of conspecifics.

A review of studies conducted since 1995 indicated that most low-frequency cetaceans (mysticetes) avoided sound sources at levels of less than or equal to 160 dB re 1 µPa (SOCAL-10). Subtle behavioural responses (changes in depth and time of dives) have been noted at levels of above 120 dB (Marine Mammal Commission, 2007). Mid-frequency cetaceans (including Killer Whales and Bottlenose Dolphins) showed no clear avoidance patterns, reinforcing the idea that odontocetes are less inclined to avoidance behaviour, or less impacted by impulsive sounds. Studies on captive animals indicated SEL in excess of 170 dB re 1 µPa before the expression of discomfort reactions, such as erratic swimming and attacking the test apparatus. High-frequency cetaceans (observed from studies of Harbour Porpoises) exhibited changes in respiration and avoidance behaviour at levels between 90 and 140 dB re 1 µPa (SOCAL -10).

While the prey of resident odontocetes (Dolphins and Killer Whales) may be temporarily displaced through stress and avoidance of the construction noise, this would be of limited duration in time and space. Odontocetes have a varied diet and a temporary special shift of one species should not cause any feeding stress.

4.6.3. Impact of Noise on Turtles

The effect of noise impacts on turtles is poorly studied in comparison to studies on cetaceans, but those that have been conducted suggest that there are unlikely to be any physical effects or shifts in hearing threshold, if the turtle is not within the immediate vicinity of the sound source. Basking turtles may not move away sufficiently quickly from a sound source and if it is initiated at full power within close range (<15 m), pathological injury can be expected. Bartoli *et al*. (1999) concluded that the hearing sensitivity range for sea turtles is between 250 and 700 Hz.

Research indicates that masking is unlikely to be a significant impact. This mainly because it has been shown that magnetic signals are turtles' main navigational tools rather than sound signals (Lohmann et al., 2001). Trials conducted on caged Loggerhead and Green Turtles (McCauley et al., 2000) revealed behavioural changes at levels in excess of 175 dB re 1 µPa @ 1m. Several experimental results indicate that behavioral responses (rising to the surface, altered swimming patterns) occur at about 2 km from the seismic source at sound exposure levels of 166 dB re 1 µPa @ 1m. The turtles exhibited avoidance behavior (i.e. moving away and not returning to the depths at which they usually rest) at 1 km from the source and sound exposure levels of 175 dB re 1 µPa @ 1m (McCauley et al., 2000; Lendhart, 1994).

5. POTENTIAL THREATS TO MARINE MAMMALS SPECIFICALLY RELATED TO ACTIVITIES ASSOCIATED WITH THIS DEVELOPMENT PROJECT

Any construction of harbour and quay facilities will impact on the natural environment. Hydrological changes are brought about by the construction of quay sides and breakwaters and the implementation of dredging programs and dumping of dredged material. Runoff from quays and walkways can change the water quality and composition. Increased organic loading can result from additional sewage outflow or dumping of garbage. Explosive devices and pile driving can cause physical trauma, hearing loss and behavioural change in marine fauna. Dredging to deepen approach channels and basins can result in habitat destruction and displacement, loss of benthic communities and subsequent forced behavioural changes in higher-order fauna. Marine mammals are particularly sensitive to marine contaminants and at risk of any marine pollution resulting from the development activities. Increased tourism and numbers of recreational vessels can lead to masking of biologically important sounds. Imprudent disposal of waste products and rubbish can lead to entanglement, injury and death in mammals and turtles. There is an increased risk of vessel-animal and human-animal interactions and these pose a risk to both the animals and to humans.

This section looks at potential threats associated with the proposed Walvis Bay Waterfront Development, as they are likely to impact marine mammals. The marine mammals that could possibly be impacted by the development include migrating baleen whales (mysticete cetaceans) such as Humpback and Southern Right Whales, mid-frequency odontecete cetaceans such as Dusky, Common and Bottlenose Dolphins and Orcas and the only resident pinnipeds, Cape Fur Seals.

There is little information relating to the frequency ranges of Heaviside's Dolphins. There are no published audiograms for Cape Fur Seals, so data relating similar type species (e.g. Stellar and New Zealand Fur Seals or Sea Lions) are used. Some mention is also given to sea turtles as Leatherback Turtles are occasionally seen in the NBR.

The level of that impact can be reduced through the implementation of mitigation measures. The extent of mitigation required for a particular project, or a component of the project, depends on the significance level of the perceived impact. Mitigation is not necessary when there is sufficient evidence to show that the animals are not affected by a particular aspect of development. Mmitigation measures that have been applied to harbour and marine construction elsewhere are proposed. The levels of the potential impacts to marine mammals with regard to different aspects of the development are then assessed, based on mitigation being applied.

5.1. CONSTRUCTION PHASE

5.1.1. Construction Noise

Marine construction involves a number of noise-generating processes including pile driving, dredging, dumping of stone, fill and dredge spoil and the use of explosives, if blasting of rock is required.

Stone dumping for breakwaters and harbour walls can generate a substantial amount of underwater noise; however, there are no reports on sound levels emitted by this procedure. Noise pollution could be increased by the physical dumping of large loads of fill into the marine environment. The noise is likely to originate from cavitations as the fill enters the water. The sound levels and frequency spectrum of the dumping of fill are unknown, however for large loads, the levels may be significant and across a broad frequency band. Increased ambient noise can affect marine mammals in a number of ways, so it is important to take into account any addition to ambient noise from dumping of fill.

There are numerous sources of anthropogenic-generated sound in the world's oceans today. Table 6 shows the general acoustic properties of a selection of anthropogenic sources of noise in the marine environment (OSPAR Commission, 2009).

Source levels of most mysticete cetacean sounds range from 137 to 190 dB re 1 μPa and those of most mid-frequency odonticete cetacean (like those found in the Walvis Bay region) vocalisations range from 150 - 236 dB re 1 μPa @ 1 m. Source levels for California Sea Lions and Northern/Stellar Fur Seals are in the order of 95 - 160 dB re 1 μPa @ 1 m.

The vocalisation frequency range of these mammals is 10 Hz – 20 kHz, 100 Hz – >100 kHz and 125 Hz – 34 kHz, respectively. The hearing range is 7 Hz – 22 kHz, 150 Hz – 160 kHz and 200 Hz – 50 kHz respectively (Bailey et al, 2010; AFTT, 2012; Marine Mammal Commission, 2008).

It has been noted that sensitivity to sound of seals and sea lions decreases rapidly with increasing frequency (Cunningham and Reichmuth, 2016). Bartol et al., (1999) concluded that the hearing sensitivity range for sea turtles is between 250 and 700 Hz.

Table 6: Overview of the acoustic properties of anthropogenic sounds (Source: OSPAR, 2009).

SOUND	SOURCE LEVEL (dB re 1µPa-m)	Bandwidth (Hz)	MAJOR AMPLITUDE (Hz)	DURATION (ms)	DIRECTIONALIT
OFFSHORE CONSTRUCTION					
TNT (1-100 lbs)	272 – 287 Peak	2 – 1000	6 – 21	~1 – 10	Omnidirectional
Pile driving (1 = 120lbs)	228 Peak 243 – 257 PtoP	20 - >20 000	100 - 500	50	Omnidirectional
OFFSHORE INDUSTRIAL ACTIVITIES					
Dredging	168 - 186 rms	30 - > 20 000	100 – 500	Continuous	Omnidirectional
Drilling	145 – 190 rms	10 – 10 000	< 100	Continuous	Omnidirectional
Wind Turbine	142 rms	16 - 20 000	30 – 200	Continuous	Omnidirectional
SHIPPING					
Small boats and ships	160 – 180 rms	20 - >10 00	> 1000	Continuous	Omnidirectional
Large Vessels	180 – 190 rms	6 - > 30 000	> 200	Continuous	Omnidirectional
SONAR					
Military Sonar Low frequency	215 Peak	100 – 500	-	600 – 1000	Horizontally Focussed
Military Sonar Mid- frequency	223 – 235 Peak	2800 – 8200	3,500	500 – 2000	Horizontally Focussed
Echo-sounders	235 Peak	Variable	1 500 – 36 000	5 – 10	Vertically Focussed
SEISMIC SURVEYS					
3-DAirgun Array	260 -262 P to P	10 – 100 000	10 - 120	30 – 60	Vertically Focussed
OTHER ACTIVITES					
Acoustic Determent or Harassment Devices	132 – 200 Peak	5000 – 30 000	5000 – 30 000	Variable 15 – 500	Omnidirectional
Tidal and Wave Energy Devices	165 – 175 Rms	10 - 50 000	-	Continuous	Omnidirectional

5.1.1.1. Blasting / Explosions

Underwater explosions are one of the strongest point sources of anthropogenic sound in the marine environment and the sound effects can travel tremendous distances. Explosions are used in construction to deepen areas where bedrock lies close to the seafloor surface and occasionally in the removal of unwanted subsea structures. The transmission of sound and energy from submarine explosions is complex and phased: an initial shock pulse with a high pressures and fast rise time (microseconds) is followed by a succession of oscillating bubble pulses. The pressure decreases with each subsequent bubble; the second bubble has a peak pressure of only 1/5th of the first bubble. As distance from the source increases, the pressure signatures are affected by refraction and multipath propagation, especially the high-frequency sound components (NOAA 2015).

Source levels vary depending on the type and amounts of explosive and the water depth in which the explosion occurs. Source levels can range between 272 and 287 dB re 1 µPa zero to peak at 1 m distance (1 - 100 lb TNT). The peak energy duration is generally extremely short (< 1 - 10 ms). Underwater explosions transmit at low frequencies (2Hz - 1 kHz) with the main energy between 6 and 21 Hz. (Richardson et al. 1995; NRC 2003; OSPAR, 2009).

There are some poorly documented cases of injury and death of marine mammals thought to have been caused by explosions (Richardson et al., 1995). Ketten et al., (1993) report injuries to the ears of two Humpback Whales found stranded after underwater explosions. The use of underwater explosives in structure removals can injure and even kill sea turtles.

There are limited TTS studies for marine mammals exposed to impulsive sounds and out of 11 studies only 2 induced measurable TTS (Finneran et al., 2002; Lucke et al., 2009). Neither was related to construction and both affected mammals species are not found in Walvis Bay (Harbour Porpoise and Beluga Whale). The studies involving Bottlenose Dolphins exposed to an explosion simulator equal to a 500 kg charge showed no TTS for sound exposure levels (SELs) up to 216 dB re 1 µPa peak to peak (Finneran et al., 2000). Table 5 presents these data (from NOAA, 2015). It is also important to note that TTS studies on captive marine mammals are undertaken with the animals extremely close to the source (i.e. much closer than animals are expected to be to the source in real-world conditions) and one of the species where TTS onset occurred is the Harbour Porpoise (a high frequency cetacean), which is known to have a lower TTS onset acoustic threshold level (both impulsive and non-impulsive sources) compared to most other cetaceans measured, such as the mid-frequency dolphins and Killer Whales occurring in Walvis Bay (NOAA, 2015).

There is very little published data on the behavioural reaction of marine mammals to explosions caused by offshore construction or demolition operations. Humpback Whales in the North Atlantic showed no clear short-term behavioural responses or changes in foraging patterns when exposed to explosions associated with marine construction ~~operations~~ in Newfoundland (AFTT, 2012). No immediate behavioural disturbances were noted in Humpback Whales exposed to SPL of 140 - 153 dB re 1 µPa rms at 1.8 km from blasting during the development of an offshore oil platform. However, a higher than usual number of entanglements of these whales in nets was recorded in the area at the time. Although no control data were provided, nor cause-effect relationships established, these entanglements may have resulted from the progressive effects of exposure to damaging sound levels (Todd et al., 1996).

Madsen and Møhl (2000) found no auditory response in five Sperm Whales exposed to the sounds of distant detonators at received SPLs of 180 dB re 1 µPa rms. Additionally, behavioural response at the surface was absent in one individual. This is possibly because the detonator noise resembled Sperm Whale clicks and might have therefore been perceived as signals from conspecifics. Killer Whales have very similar audiograms to Sperm Whales and can thus be expected to be similarly unaffected.

Behavioural responses were noted in trained dolphins when they were exposed to sound pulses replicating explosions of 5 kg TNT at 9.3 km and 5 kg TNT at 1.5 km, with corresponding sound flux densities of 153 and 169 dB re 1 µPa2s, respectively (Todd et al., 1996). Captive Bottlenose Dolphins sometimes vocalized after an exposure to impulsive sound from a seismic watergun (Finneran et al., 2002a).

Seal "bombs" are used to prevent seals feeding around fishing operations and damaging catches. Reports indicate that they initially cause startle and flight responses in some pinnipeds, but the seals become habituated after repeated exposure. "Bombs" have also been used to scare dolphins away from fishing operations with no apparent physical trauma (Richardson et al., 1995).

Trials using impulsive sounds were conducted on caged Loggerhead and Green Turtles (McCauley et al., 2000). Behavioural changes were noted at levels in excess of 175 dB re 1 µPa @ 1m. Several experimental results indicate that behavioral responses (rising to the surface, altered swimming patterns) occur at about 2 km from the seismic source at sound exposure levels of 166 dB re 1 µPa @ 1m. The turtles exhibited avoidance behavior (i.e. moving away and not returning to the depths at which they usually rest) at 1 km from the source and sound exposure levels of 175 dB re 1 µPa @ 1m (McCauley et al., 2000; Lendhart, 1994).

Mitigation

Survey and/or geotechnical investigations will be necessary to determine the depth of bedrock and any need for blasting in the development area.

To date, much of the effort made to mitigate ocean noise has focused on proximity, i.e. trying to spot marine mammals within a few hundred meters of a powerful explosive source and pausing operations until there is no longer any perceived risk of direct injury. Trained marine mammal observers will be required to ensure no mammals are present within the bay or lagoon during blasting. Depending on the size of the blast, exclusion distances of between 2 and 5 km should be considered.

It will be preferable to undertake any blasting outside of known Humpback migration seasons (June, July, September).

Lessening of impacts is also possible through the use of acoustic harassment devices. These have been used effectively against Ringed Seals and Harbour Porpoises. Avoidance zones using pingers have been reported at distances of 200 to 500 m (OSPAR, 2009). It might be necessary to deploy several pingers at different distances from the construction site to keep mammals outside of potential TSS zones.

Assessment with Mitigation

Humpback Whales are the most sensitive to blasting noise and will be highly impacted if in close range. However, as they are only transient migrants, the impact level of blasting on these whales is considered to be of very low significance, particularly if timing of the blasting can be scheduled not to coincide with peak migration periods.

Cape Fur Seals appear to have a high tolerance for underwater sounds. Blasting is unlikely to significantly impact their behaviour of impair their hearing at distances greater than 700 m.

Dolphins and Killer Whales are more sensitive and need to be further removed from the sound source to avoid suffering TTS.

Research indicates that masking in turtles is unlikely to be significant. This is mainly because it has been shown that magnetic signals are turtles' main navigational tools rather than sound signals (Lohmann et al., 2001).

Blasting can be of moderate to high significance depending on the amount of explosives used and the extent of the mammal exclusion zone. The level can be lowered by decreasing the explosive charge and increasing the exclusion area.

5.1.1.2. Pile driving

Pile-driving is undertaken in harbour construction, oil and gas platform installations and in the construction of offshore wind farms. Source levels vary depending on the diameter of the pile and the method of pile driving: impact or vibro-piling. Impact pile drivers have much lower peak pressures and far longer rise times than explosives.

The frequency spectrum for pile driving ranges from less than 20 Hz to more than 20 kHz with most energy around 100 - 200 Hz. Although Humpback Whales can produce sounds up to 8.2 kHz, the dominant frequency band for this species is between 25 Hz and 4 kHz (Table 4; Richardson et al., 1995). Consequently, it would be expected that pile driving noise would significantly mask Humpback Whale vocalisations. However, as Humpback Whales are transient migrants through the NBR, and don't come into the Bay itself, it is expected that any pile driving operations will have minimal impact on this species. Seasonality of operations with respect to migration patterns of Humpback Whales (numbers peak June/July and September) could be considered by the developers.

Mid-frequency dolphins (Bottlenose, Dusky, Common) and Killer Whales have less sensitive hearing below 1 kHz. Thus, increased ambient noise in the low-frequency spectra may not interfere significantly with their sonar. In contrast, Fur Seals produce sounds as low as 100 Hz and so their detection of biologically important sounds may be impacted by increased low spectrum noise.

Madsen et al. (2006) used information about pile driving noise characteristics (sound levels, duration, frequency spectrum and propagation likelihoods) and the acoustic characteristics of four cetacean species to assess the degree of potential masking attributable to pile driving noise. The four species were chosen because they represent a range of functional frequencies:

- Harbour Porpoise – high-frequency cetacean
- Bottlenose Dolphin – mid-frequency cetacean
- North Atlantic Right Whale – low-frequency cetacean
- Harbour Seal – phocid (true seal) higher frequency and hearing sensitivity than otariids (Fur Seals and Sea Lions)

The authors report that significant masking problems were unlikely for all four species assessed, possibly because of the short duration and low duty cycle of pile driving sounds. They determined that pile driving would not significantly interfere with the detection of biologically important sounds in any of the test species.

A protected population of Bottlenose Dolphins (*Tursiops truncatus*) in the Moray Firth Special Area of Conservation (NE Scotland) was monitored during pile driving for the erection of wind turbines in deep water (> 40 m) some 25 km away from Moray Firth. The maximum broadband peak to peak sound level was 205 dB re 1 µPa. Noise was measured at specified distances of 100 m up to 80 km away where it was no longer distinguishable above background noise. It was concluded that for Bottlenose Dolphins, auditory injury through exposure to non-repeated stimuli (224 dB re 1 µPa), PTS and TTS would have occurred only within 5-10 and 10-20 m, respectively, of the pile-driving process, and masking was unlikely beyond 100 m (Bailey et al., 2010).

Although absorption reduced the sound level beyond 10 km from the source, the authors argue that the Bottlenose Dolphins could have experienced behavioural disturbance from the pile driving sounds as far as 50 km away, at a received level of 140 dB re 1 µPa (source 226 dB re 1 µPa), despite their apparently low auditory sensitivity to low-frequency sound.

This deduction contrasted with Southall et al. (2007) who indicated that there was no clear relationship between received noise levels and behavioural response for mid-frequency hearing cetaceans exposed to multiple pulses. They suggested that other factors played a role, such as the duration of the noise and behaviour of the animals at the time of exposure.

Brandt et al. (2011) found a clear relationship between decreasing Harbour Porpoise (*Phocoena phocoena*) acoustic activity and the onset of pile driving for the construction of a wind farm in the North Sea. Acoustic activity can be directly related to mammal abundance in a specific area. It was found that impulsive sounds with peak levels of 235 dB re 1 µPa at 1 m caused the porpoises to move away from the sound source. The effect was concurrent with the onset of pile driving. The duration of this effect decreased with distance from the piling location. At the furthest monitoring station, 21 km away, acoustic activity increased. This suggests that the porpoises moved away from piling action, temporarily increasing the relative abundance of populations at more distant locations. At the acoustic monitoring location closest to the pile driving, porpoise acoustic activity remained lower than baseline levels for 24 to 78 hrs after cessation of pile driving. The median time between pile driving events was 16 hrs, during which time there was no recovery of porpoise activity within 4.8 km from the piling site.

Similarly, earlier records of acoustic activity of Harbour Porpoises during the construction of the offshore wind farms at similar locations in the North Sea (Horns Reef) and Danish Baltic Sea (Nysted) indicated a marked decrease shortly after each ramming event. However, all acoustic activity reverted to baseline conditions within 3 to 4 hours, a much shorter time than in the second phase of construction. The decrease in vocal activity was also recorded at monitoring stations between 11 and 15 km from the construction site, suggesting that the porpoises left the area during ramming periods. Densities of porpoises in the entire Reef area were significantly lower during ramming periods than during baseline observation. Additionally, porpoises exhibited significant behavioural changes from non-directional movement (presumably associated with feeding) to directional movement on days with pile driving operations. All behaviour returned to baseline levels within 4 hours of cessation of ramming, suggesting no long-term effects (Tougaard et al,. 2005; 2003a; b).

Although it has been suggested that pile driving will mask vocalisations in Bottlenose Dolphins (David, 2006) as well as echolocation in Hector's Dolphins (Brough et al., 2014), there is currently no empirical information on the extent to which pile driving may mask biologically significant sounds for these marine mammals. Behavioural changes in high-frequency dolphins (such as Hector's Dolphins) are expected to occur within a 20 km radius from the pile driving site (Brough et al., 2014).

During pile driving procedures for a pier in Hong Kong, the dolphins remained in the vicinity of piling process before and during the operation, but were found to be lower in abundance afterwards. However, the dolphins did exhibit higher travelling speeds during active pile driving periods (Würsig et al. 2000).

Three different received pressure phases are identified for radiated underwater noise generated by pile-driving (Fig. 31) with reference to time duration (Dahl et al., 2015). Behavioural response may be related not only to the sensitivity level of a particular mammal, but also to the "phase" in which the sounds is experienced.

Brough et al. (2014) suggest that pile driving noise can cause physical injury to New Zealand Fur Seals (*Arctocephalus forsteri*) that swim within 700 m of construction opeations. In contrast, Bailey et al. (2010) found that PTS would have occurred in pinnipeds swimming within 20 m of non-repeated stimuli at 212 dB re 1 µPa when considering the peak source levels of the piling action. TTS would have occurred at 40 m. The authors determined that no form of injury or hearing impairment would have been likely beyond a distance of 100 m, based on a SEL of 166dB re1 µPa2-S.

Edren et al. (2004) showed that during the construction and piling stage of building the Nysted offshore wind farm (Danish Baltic Sea) there was a 20 - 60% reduction in the number of Harbour Seals (*Phoca vitulina*) hauling out at sandbanks 4 – 10 km away from the piling operations. It is likely these seals moved to an adjacent area where the noise from pile driving was less intense. The avoidance behaviour was very short-term as seal haul-out returned to base level numbers accompanied by normal behaviour on days when no ramming was undertaken.

In contrast, pile driving had no noticeable effect on Ringed Seals (*Phoca hispida*) off Alaska at received sound pressure levels of 150 dB re 1µPa rms. This was thought to be as a result of this population's habituation to industrial noise in the study area (Blackwell et al., 2004).

Pile driving for wind farm construction is generally louder than for port development and differences between coastal/open ocean and harbour environments may mean received sound pressure levels are different at similar distances from the activity.

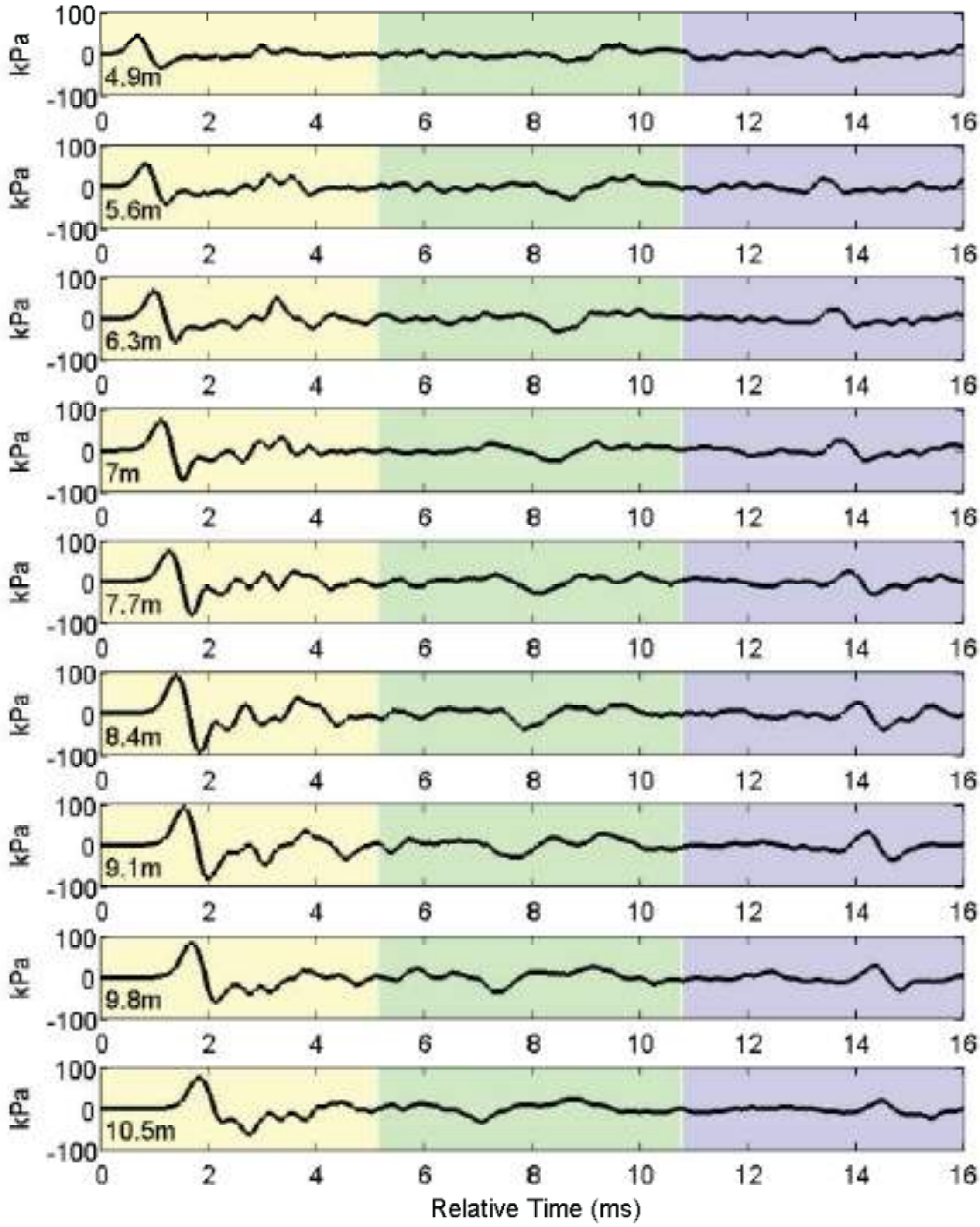

Figure 31: Sound pressure-time series for the radiated underwater noise measured at a 12 m range from a pile undergoing impact driving. Three phases are identified by the different shadings. Hydrophone measurement depth is given at the beginning of each time series. (From Dahl et al., 2015)

Mitigation

There are various approaches within legislation being used in Europe with respect to pile driving in marine construction and its impact on marine mammals. The United Kingdom requires marine mammal observers to visually, and sometimes acoustically, monitor an exclusion zone around the pile driving to ensure the absence of marine mammals. In The Netherlands, no piling may occur during the seasons with the highest abundance of sensitive species. An obligation is also placed on the developer to deter animals from the vicinity through the use of acoustic deterrent devices or by implementing "soft start" procedures (i.e. the pile driving at a lower hammer energy for a specified time period at the start of the piling process). If the level of sound being produced is known and that level is no more than 5 dB above the level where no known effects have been recorded, then there is no need to have 10 to 15 dB attenuation of the source sound signal (Dahl et al., 2015). The German government issued a *Concept for the Protection of Harbour Porpoises from Sound Exposures during the Construction of Offshore Wind Farms in the German North Sea* (BMU, 2014) which states that it is plausible to assume that avoidance and flight behaviour are likely to occur at exposure to a received SELs of 140 dB re 1 $\mu Pa^2 \cdot s$. The German authorities regard a temporary hearing loss or threshold shift (TTS) as an injury and defined noise-induced injury prevention thresholds, declaring that SELs may not exceed 160 dB re 1 $\mu Pa^2 \cdot s$ and a peak-to-peak and SPL may not exceed 190 dB re 1 µPa at a distance of 750 m from the piling activity. The authorities assume (based on research by Lucke et al., 2009) that complying with these criteria will reduce the avoidance distance to 8 km (Todd et al., 2015).

There are several technical options available to mitigate the impacts of pile driving at the source:

- extending the duration of the drive during piling will decrease SL by 10-15 dB at frequencies > 2 kHz);
- enclosing the ramming pile with acoustically-isolated material can decrease SL by 5 – 25 dB;
- installing an air-bubble curtain around the pile reduces the radiated sound levels of piling in shallow waters up to 20 dB, particularly at 400–6400 Hz.

(Brough et al., 2014; OSPAR, 2009; Würsig *et al* .2000)

These methods have both benefits and costs. Ramping-up may cause confusion for mammals trying to pinpoint the sound source. Extending the duration of the strike reduces the source energy level, but the longer noise duration may mask communication signals to a greater extent than shorter noise pulses. This method is also limited technically, since shorter pulses are more effective in driving the pile into the bottom than longer ones. Mantling has shown promising results in relatively short piles. Pile driving using a vibratory hammer is not as loud as impact pile driving. Hydraulic pile driving may provide an alternative method for the installation of foundations. This method results in noise emissions at low levels close to marine background noise level (< 100 dB re 1µPa). Air bubble curtains are expensive, but very effective in relatively shallow water. "Soft-starts" have shown success in alerting mammals and enabling them to swim away before sound levels became harmful (Todd et al., 2015; Brough et al., 2014; Bailey et al., 2010; OSPAR, 2009; Marine Mammal Commission, 2008; Würsig et al*.,* 2000).

As there is some conflicting data and research results and some animals seem to become habituated more easily than others, a precautionary approach is advised. Precautionary mitigation measures should include:

- not carrying out pile driving in confined areas in close proximity to feeding or breeding populations.
- avoiding intense construction activity during known migration periods (June-July and September) and peak breeding seasons should be considered (Autumn and Spring).
- delaying the start of or stopping piling operations if turtles or marine mammals are detected (visually or acoustically) close to the source may also be effective in mitigating TTS or PTS (Todd et al., 2015; OSPAR, 2009).
- the use of MMOs can ensure that there were no marine mammals a specified safe distance (500 m for Cape Fur Seals and 2 km for dolphins).
- minimising multiple activities that generate compound underwater noises where practical
- avoiding pile driving that impacts hard substrates where possible.

It is important to calculate the likely extent of the mammal exclusion zone, in order to minimise the animals' exposure to harmful sound. This would require monitoring of pile driving sound and sound propagation modelling within Walvis Bay, as well as collecting information about the received pressure levels required to induce TTS in specific species, such as Heaviside's Dolphins. As this information is not currently available, a recommended precautionary approach would be to use the ranges given above (as identified by Madsen et al., 2006). Experienced and independent marine mammal observers are the only effective way of searching for and identifying marine mammals in the area before, during and after pile driving.

Underwater noise from pile driving ~~activities~~ should be monitored to verify that it does not exceed 30 kPa at a distance of 1 m to 2 m from the pilings. If it does, measures should be taken to reduce either the intensity of the sound or the way the sound is propagated. These measures can be chosen based on practicality and effectiveness (e.g. installing silt or bubble curtains, vibratory/hydraulic vs impact piling).

No mitigation measures other than "soft starts" are deemed necessary with respect to the presence of turtles, as scientific evidence suggests that turtles will move away from the noise source.

Assessment

As Humpback Whales are transient migrants through the NBR, and don't come into the Bay itself, it is expected that any pile driving operations will have little impact on this species.

Seasonality of operations with respect to migration patterns of Humpback Whales could be considered by the developers. Peak numbers have been recorded in the Benguela Region in June, July and September. The potential impact of pile driving operations inside the bay on Humpback populations is considered low.

'Soft-start' procedures and acoustic harassment devices have been proven to be effective in scaring the animals away from the source at close ranges (OSPAR, 2009). Using a precautionary exclusion zone of up to 2 km for dolphins will assure limited impact, particularly if attention is paid to breeding and nursing seasons. The impact of pile driving with respect to masking and hearing impairment in mid-high frequency cetaceans is considered to be of low significance in the long term. The impact on behavioural changes, avoidance of the construction area and/or relocation following prey species can be significant to population densities in the short-term, but is considered of moderate to low significance in the long term.

Habituation to deterrents is possible, particularly in Cape Fur Seals. None-the-less, the potential for injury or masking in seals is considered to be low as they are such mobile animals. Additionally, their continued presence around marine survey, mining and fishing vessels, in spite of operations and the use of deterrents, shows a strong resilience to noise impacts. The temporary displacement of preferred prey species may be of concern, but seals are known to adjust to available food sources. Thus based on available information, pile driving activity will not significantly impact Cape Fur Seals.

Although Leatherback Turtles are frequenting the BCLME waters more in recent years, they are still only occasional visitors and sightings are rare. Impacts are considered to be of very low probability. None-the-less, should a turtle be in close range, the potential impact is considered to be of high intensity in the short-term. The long-term impact of impulsive noise on turtle migration and feeding is considered to be of low significance, since turtles make use of magnetic cues rather than acoustics for navigation (Lohmann *et al.*, 2001).

5.1.1.3. Dredging

Available data indicate that dredging is not as noisy as sonar, seismic surveys or pile driving, but it is louder than most shipping (Fig. 32). Dredging to maintain shipping lanes emits continuous broadband sound, mostly in the lower frequencies with bandwidths between 20 Hz and 1 kHz (Richardson et al., 1995). These sounds primarily fall within the lower frequency ranges of baleen whales. Most toothed whales are less sensitive to such low-frequency sounds (Robinson et al., 2011). Defra (2003) measured sound spectrum levels emitted by an aggregate dredger at different distances and found most energy to be below 500 Hz. Robinson et al. (2011) found that trailing suction hopper dredgers emit sound levels at frequencies below 500 Hz that are generally in line with those expected for a cargo ship travelling at a modest speed. It was also found that dredger sounds with source levels at frequencies above 1 kHz attenuate rapidly with distance.

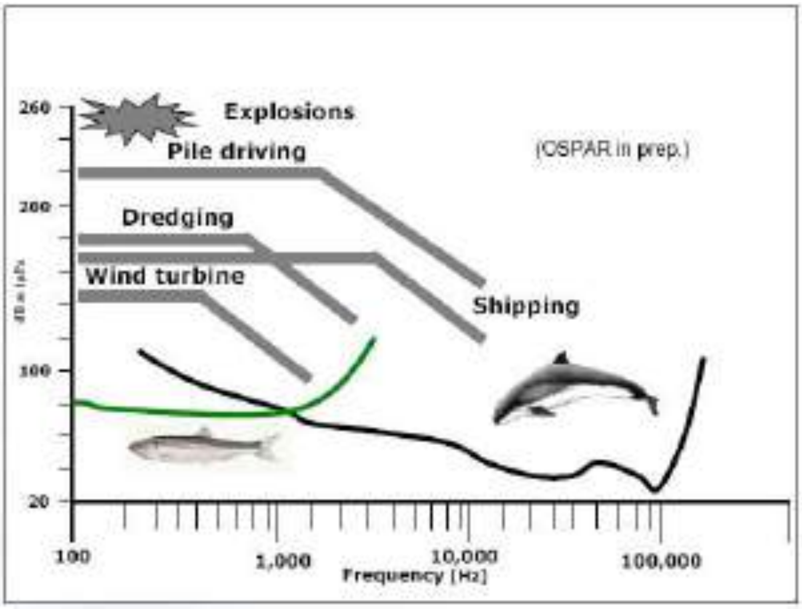

Figure 32: Overview of construction noise sources (SPL and frequencies) with reference to the hearing sensitivity of herring and Harbour Porpoise (from OSPAR, 2009)

Dredging is at the lower end of the scale with regards to emitted sound pressure levels (Fig. 32). Source levels range from 160 to 180 dB re 1 µPa at 1 m to 133 dB re 1 µPa at 0.19 km and 140 dB re 1 µPa at 0.2 km from the dredgers. SPLs and operational frequencies vary depending upon the type of dredger, as indicated in Table 7.

Table 7: Frequencies and Sound Pressure Levels of dredgers (after Todd et al., 2015; Robinson et al., 2011; 1995; Defra, 2003)

DREDGER TYPE	SOURCE SOUND PRESSURE LEVEL	OPERATIONAL FREQUENCY
Cutter Suction Dredger (CSD)	149.3 dB re 1 µPa rms at 89 m	< 500 Hz
Trailing Suction Hopper Dredger (TSHD)	max SPL 189.9 dB re 1 µPa at 1 m	< 500 Hz
Bucket Dredger	163 dB re 1 µPa at 1 m	20 Hz – 100 Hz
Backhoe Dredger	179 dB re 1 µPa at 1 metre	3 Hz – 20 Hz

Behavioural responses of baleen whales vary according to the type of construction activity and dredge method. Off Anchorage, Alaska, Bowhead Whales (*Balaena mysticetus*) showed no apparent response to a suction dredge. However, elsewhere, individuals avoided dredges when exposed to 122 - 131 dB re 1 µPa or 20-30 dB above ambient noise (Richardson et al., 1990). Gray Whales (*Eschrichtius robustus*) avoided a particular breeding lagoon in Mexico after an increase in industrial activities, including shipping and dredging (Bryant et al., 1984).

However, it is not clear whether the avoidance was due to dredging noise or the increased number of ships.

In the Port of Anchorage, Beluga Whales (*Delphinapterus leucas*) were often sighted in proximity to operating dredgers. They could have habituated over time to the general increase in industrial activity.

In contrast, the numbers of Bottlenose Dolphins (*Tursiops truncatus*) in foraging areas in Aberdeen Harbour declined as dredging intensity increased (Todd et al., 2015). The dolphins had previously been exposed to high volumes of shipping, so it was deduced that the avoidance behaviour was directly related to the dredging activities.

Most of the studies undertaken on pinnipeds suggest that the impact of dredging sounds is limited. Observations of dredging operations in Geraldton, Western Australia between 2002 and 2003 concluded that New Zealand Fur Seals (*Arctocephalus forsteri*) and Australian Sea Lions (*Neophoca cinerea*) showed no disturbance reactions, despite the relative closeness of the dredging to popular haul-outs (EPA, 2007). Similarly, Hawaiian Monk Seals (*Monachus schauinslandi*) showed no adverse reactions to bucket dredgers around Tern Island (Todd et al., 2015).

In fact, it has been noted that in some cases pinnipeds and dolphins are actually attracted to areas of active dredging (Anderwald et al., 2013 cited by Todd et al., 2015), possibly because of increased prey numbers as a result of seabed disturbance. Larger than usual numbers of Bottlenose Dolphins were reported around Doonanierin Point, Ireland, during construction involving dredging. While this increase in numbers cannot be conclusively linked to increased prey abundance as a result of seabed disturbance, it was considered a possibility (Anderwald et al., 2013). It was also suspected that Grey Seals (*Halichoerus grypus*) were taking advantage of increased food supply close to operating dredgers (Todd et al., 2015).

Changes in topography could also benefit marine mammals. Allen et al. (2001) found that Bottlenose Dolphins in Anclote Key, Clearwater, Florida, favoured previously dredged channels, over other habitats. They argued that the dolphins used the structural features to aid in prey detection and capture.

Inevitably, dredging results in suspended sediment in the water column. Impacts of increased suspended sediment concentrations are highly species-specific and vary with sediment characteristics. Dredging plumes can release contaminants into the water column that can then become available to marine organisms, and potentially accumulate up the food chain. However, remobilization and bioavailability of contaminants is complex, being site-specific and affected by a multitude of factors (Todd et al., 2015).

Natural events, such as storms, increase turbidity and marine organisms have evolved varying levels of tolerance and survival mechanisms. Cetaceans often create their own sediment plumes through feeding (e.g. Grey Whales) indicating that individual species must have some level of tolerance. However, dredging-related increases in turbidity may exceed natural levels, or vary in terms of timing, which can put strain on some organisms (Todd et al., 2015). Heaviside's, Dusky and Common Bottlenose Dolphins are highly mobile and would readily avoid turbid water. They also have the ability to use sonar, so that they do not have to rely solely on vision.

Pinnipeds are not known to produce sonar for prey detection purposes, so increased turbidity could potentially affect their ability to hunt. However, three apparently blind (identified by opaque and white corneas) Harbour Seals (*Phoca vitulina*) on Gertrude Island, Puget Sound, Washington appeared healthy, suggesting that their ability to forage was unaffected by blindness (Dehnhardt et al., 2001 in Todd et al., 2015). McConnell et al. (1999) tracked foraging areas and trip durations of Grey Seals in the North Sea. The one blind seal that was included in the study showed no significant difference in foraging behaviour. These results indicate that vision is not essential to pinnipeds' survival or ability to forage and hence the level of turbidity is inconsequential as it is likely that pinnipeds use other senses instead of, or in conjunction with, vision.

Turbidity has the potential to impact fish feeding ability, predominantly for piscivorous fish that feed on larger prey that is detected visually over longer distances. Planktivorous fish that detect prey visually over short distances are less affected. Dolphins and seals often enter the lagoon to hunt small schools of fish. Mullet are known to frequent the Walvis Bay lagoon, but may temporarily avoid it during dredging operations. However, mullet are bottom feeders and used to murky, poorly oxygenated conditions, thus the populations are unlikely to be adversely affected by increased turbidity. Additional food sources for dolphins and seals will also be available outside of the lagoon.

A positive aspect of dredging is the release of nutrients into the water column, which can increase productivity, with resultant up-chain benefits due to an increased food supply (Bailey et al., 2010).

Remobilization of contaminants through dredging and dumping can increase uptake by marine organisms, which will disseminate through the foodweb to marine mammals (Marine Mammal Commission, 2008). Linking remobilization of contaminants from dredging to negative biological effects in marine mammals is challenging: Types and levels of toxins in the blubber need to be known before an activity begins and then compared during and after dredging in order to provide conclusive links.

Mitigation

As a continuous source of noise and disturbance, which might last for extended time periods during construction, dredging could be considered to have some impact that will require mitigation, especially in areas of high ecological sensitivity.

Minimum impact is expected from dredging noise on the marine mammals in Walvis Bay, as they are not deemed to be sensitive to such low frequencies. Mitigation of dredging noise is not a necessity.

Mitigation measures to limit the impacts of sediment resuspension by dredging include:

- testing the level of contaminants in the sediment to be dredged to determine the likely concentration that marine mammals (and other marine life) will be exposed to during dredging and dumping of dredge spoil
- Locating dredge spoil dump sites so they have the least possible impact on marine mammals and their prey. If possible, spoil sites used for the maintenance of the Walvis Bay Harbour and approach channel should be used to avoid degradation of new areas
- minimizing the impact and reducing cumulative effects (vessel traffic, noise and sediment plumes) by not scheduling maintenance dredging of the harbour to coincide with construction dredging
- keeping the dumping site away from any known feeding or nursery grounds
- using clean uncontaminated fill where fill is required.

(Todd et al., 2015; Brough et al, 2014; OSPAR, 2009)

Assessment

The overlap of dredging noises with the hearing sensitivity of marine mammals suggests that all marine mammals are likely to be affected to some degree by noise from dredging but that impacts might be more consequential in baleen whales which communicate at very low frequencies (Tervo et al., 2012; Au et al., 2000). Humpback Whales are transient migrant through the Walvis Bay area, and their migration patterns are unlikely to be affected by dredging noise. At present no baleen whales are known to enter Walvis Bay directly or use inshore areas for breeding, so the effect of dredging on baleen whales is regarded as null.

Consensus across numerous studies state that the range of best hearing in toothed whales is shifted to frequencies well above 10 kHz with sensitivity below 1 kHz being relatively poor (Todd et al., 2015) and dredging noise ranges between 0.03 and 0.5 kHz. There are few studies which can conclusively attribute effects on marine mammals entirely to dredging activities in isolation from other sources of potential impact. As the dolphins in Walvis Bay vocalise and hear in the mid-frequency ranges, the effects of dredging noise on the dolphin populations, and any visiting Orcas, is considered negligible.

The impacts from dredging noise, with respect to physiological sensitivity, are potentially greater for seals and fish than for cetaceans, as the overlap between the dredging frequency spectrum and the bandwidth of hearing is larger in seals and fish than for cetaceans (Thomsen et al., 2009). Most research into noise effects on seals has been undertaken on phocids such as Harbour and Grey Seals, which have relatively good hearing at frequencies below 1 kHz. Otariids, such as Fur Seals, have a slightly broader hearing frequency range than phocids, but they tend to vocalise at lower frequencies. However, studies have revealed that otariids are relatively insensitive to marine noise, or become quickly habituated to new sounds. Although investigations indicate that the impact of dredging sounds is limited, caution has been voiced that some degree of masking may occur which could impact on reproduction success if dredging ~~activities~~ were to occur in breeding areas. There are no Cape Fur Seal breeding colonies near the proposed development site, so the impact of dredging noise on Cape Fur Seals is considered insignificant.

In terms of direct effects on marine mammals, collisions are possible, but improbable, given that operating dredgers are either stationary or moving at slow speeds and the marine mammals in the bay are highly mobile and have been exposed to small tour boats as well as larger sea-going vessels.

The effects of turbidity are often localized with minimal direct impact on marine mammals, particularly highly mobile ones such as those that occur within the Bay area. Walvis Bay itself is not an important fishing ground. Limited artisanal beach seine netting for mullet takes place along the shore north of the port and some sport angling in the lagoon. Increased turbidity is unlikely to have a substantial direct impact on the marine mammals that inhabit the bay because they do not rely solely on vision to hunt or forage and hence the level of turbidity is inconsequential (Todd et al., 2015).

Even if some prey species avoid the lagoon during dredging, the varied diet of cetaceans and seals means that significant impacts from turbidity-induced prey reduction are improbable. The dolphin species within Walvis Bay are highly mobile and are able to re-locate to more favourable areas for the duration of any period when dredge plumes are present. This may impact the local population densities somewhat in the short term, but is likely to be of low significance in the long term.

Dredging could even have positive impacts, such as temporarily increasing prey availability. On the other hand, entrainment in nursery or spawning grounds of prey could cause reductions in prey abundance. Still, marine mammals can likely compensate for small-scale changes in prey abundance by switching prey species, moving to alternative foraging grounds or increasing time spent foraging (Todd et al., 2015; Bailey et al., 2010).

Migrating baleen whales (Humpback) do not enter the bay itself. They only feed opportunistically when food sources, such as shoals of sardine, are readily available within their routes, so their feeding patterns are unlikely to be affected by dredging process.

The level of the impact of remobilising contaminants within dredged material will be determined by the distance of the dump site from known breeding and feeding grounds and haul-out sites. If the sediments contain a high degree of toxins that can become bioavailable, the impact of dredging and dredge spoil dumping can be very high in the long term. However, a properly designed and managed dredging programme can have a low impact on the mammal population. There are no reports of significant long-term impact related to the regular maintenance dredging in Walvis Bay Harbour. It is assumed that the ecosystem would have adapted to this type of short-term disturbance to some degree.

The mammals in Walvis Bay are not likely to be significantly impacted by the dredging noise, and if appropriate management procedures are implemented, the effects are most likely to be masking and short-term behavioural alterations. There may be changes to prey availability during dredging periods. Impacts would be similar to those encountered during regular maintenance dredging of Walvis Bay Harbour and the entrance channel, and these have not caused long-term detrimental effects to the ecosystem of the area.

Positive impacts of dredging disturbance have been reported from a number of sources (Todd et al., 2015 cited Claveleau and Desprez, 2009; Newell et al., 2004; van Dalfsen and Essink, 2001; Poiner and Kennedy, 1984; Jones and Candy, 1981). The release of organic nutrients from suspended sediments has reportedly enhanced diversity and abundance of benthic fauna near dredged channels. An increase in species abundance augments food availability at different trophic levels.

5.1.2. Pollution and Water Contamination

General construction activities have the potential to increase contaminants due to inadequate disposal of construction materials, rubbish generation and the risk of accidents. During construction, oil, chemicals and flotsam may enter the water of the bay. These will have the same impact on the environment as oil and chemical spills and litter from ships coming into port.

Additionally, construction activity may increase runoff of terrestrial pollutants from general construction activities. Stormwater runoff, particularly during the construction phase of the development may cause water pollution and reduce water clarity if adequate stormwater treatment systems are not established.

Coastal development can result in localised increases in marine pollution. Contaminants can be introduced from the dumping of fill from dredging or from land reclamation. Depending on its origin, fill may include a range of contaminants that are harmful to marine life, and marine mammals are especially susceptible to the effects of pollutants due to their high trophic level (Brough et al., 2014). The inshore distribution and movement of the resident dolphin species is a factor of concern. Pollution can impact the health of individual marine mammals and have longer-lasting, population-level impacts such as reproductive complications, strandings and other mortality events. Therefore, any increased risk of marine pollution from the development should be given due consideration.

Marine mammals are susceptible to bioaccumulation because they feed at high trophic levels and have a large proportion of lipid-rich blubber which readily accumulates toxins. High contaminant levels have been linked to depressed immune systems, endocrine disruption, reproductive complications and developmental defects (Todd et al., 2015; Brough et al., 2014; Bailey et al., 2010, Marine Mammal Commission, 2008). However, marine mammals accumulate high levels of contaminants, irrespective of whether they are exposed to construction and dredging activity, as they are highly mobile creatures and come into contact with contaminants throughout their entire range.

Mitigation

The construction of quays, jetties, walkways and business and residential buildings next to large bodies of water can pose significant threats of pollution. A properly designed construction environmental management plan to ensure that stormwater and contaminant treatment is upheld to a standard of modern "best practise" will mitigate most negative effects from chemical and material pollution, thus reducing the likelihood of marine mammals being exposed to toxins. Mitigation measures include:

- introducing appropriate systems to eliminate or minimise contamination of runoff and storm water
- introducing and enforcing no dumping policies for construction material and rubbish
- placing shade netting fences around active construction sites to minimise dust blow-off into the bay and mitigate impacts
- analysing any sediments used for fill before deposition, thus reducing the likelihood of marine mammals being exposed to toxins
- adhering to local and international policies that reduce the risk of an oil/fuel/chemical spill
- having appropriate systems in place to deal with such an event

(Todd et al., 2015; Brough et al., 2014)

Assessment

If construction activities introduce large quantities of foreign chemicals into the water of the bay and lagoon, there could be a highly significantly long-term impact. Short term impacts of high intensity and significance can result from oils spills from construction vessels and machinery, but can be lessened by quick response and following preset clean-up procedures. Appropriate design and management can reduce the risks of intense impacts (both long- and short-term) to moderate levels of significance.

5.1.3. Increased Marine Traffic

There is likely to be a substantial increase in marine vessel traffic to and from the development site during the construction phase of this project. As there is already a large range of vessel types and sizes making use of the Port of Walvis Bay, mammals in the bay area are likely to be used to the engine noise. Larger vessels enter the harbour under pilotage, following a designated route and at reduced speed.

There will likely be more vessels entering the lagoon area (dredge and construction) during the construction phase of this project than at any time previously. This will create more disturbance within a confined space. Given that active dredgers are stationary (or travel at very slow speed), collision risk is perhaps greatest when dredgers are in transit, but in areas already characterized by heavy shipping traffic, the addition of dredging vessels is unlikely to increase the collision risk substantially.

A study of Bottlenose Dolphins in Walvis Bay revealed an upward shift of up to 1.99 kHz in several whistle frequency parameters when dolphins were in the presence of one or more tour boats and the research vessel (Heiler et al., 2016). A similar, although less pronounced difference was observed in response to engine noise generated by the research vessel when idling, suggesting that noise alone plays an important role in driving this shift in whistle frequency. The greatest difference in whistle parameters was detected between resting and behavioural states that are associated with higher degrees of emotional arousal. Additionally, the presence of calves affected the variation observed (Heiler et al., 2016). The authors did not comment on the significance of the vocal change. It is likely that construction, transport and dredge vessels will illicit similar responses.

Mitigation

During construction there is expected to be a significant increase in the amount of traffic around the construction area. This will have significant impact on all wildlife life for the duration of the construction.

There are no effective mitigation measures to reduce ship-generated noise other than reducing vessel speed.

Collision risk is perhaps greatest when dredgers are in transit, mostly at times when animals may be distracted (e.g. while foraging) or in areas where calves are abundant. The probability of impacts and intensity levels can be mitigated in the following ways:

- all project vessels should follow predetermined shipping lanes and navigation routes
- all project vessels should maintain a constant course and constant speed where practical
- crews of vessels involved in construction activities should remain vigilant for marine mammals in the area
- under no circumstances, other than an emergency, will vessels purposely approach within 100 m of any marine mammal
- if marine mammals approach within 100 m, vessel speed should be reduced and, if possible, cautiously manoeuvre away from the animal
- vessel speed may be resumed once a mammal has moved at least 100 m from the vessel

(Todd et al., 2015; Brough et al., 2014; Bailey et al., 2010).

Assessment

The expected increase in vessel numbers during construction will have significant impact on all wildlife life for the duration of the construction. Marine mammals are likely to become habituated to the increase in marine traffic and the associated noise levels in the long term. Cape Fur Seals will possibly habituate faster than the cetaceans in the bay. Initially and in the short term, a high level of disruption to cetaceans and seals is probable, but the significance and level of intensity will moderate with time as the mammals become habituated.

There is always a risk of collision, but in areas already characterized by heavy shipping traffic, the addition of dredging vessels is unlikely to increase the collision risk substantially.

The impact of changed noise levels due to increased vessels traffic on cetaceans and seals is low and is unlikely to be lowered significantly by any on-board measures, other than running at reduced speed when approaching Walvis Bay.

5.2. OPERATIONAL PHASE

5.2.1. Dredging Pollution, Sediment Plumes and Sedimentation

The noise impacts of maintenance dredging will be similar to those described for the construction phase, but presumably less intense and of shorter time duration. They will also be similar to the maintenance dredging for Walvis Bay Harbour and approach channel. The potentially positive effect of nutrient enrichment into the water column is likely to be short-lived during these periods. The potential effect of release of toxins and accumulation by mammals is difficult to predict without baseline studies.

In general, regularly disturbed habitats characterized by fine sands and fast-growing opportunistic species are affected less and recover more quickly than stable habitats monopolized by coarse gravels and slow-growing sessile fauna and flora.

The dumping of dredge spoil will cause noise and turbidity disturbance that will be of short duration, but on a regularly recurring basis. The location of the disposal site must be carefully considered so as not to impact habitat that is important for marine mammals and other taxa. The level of the impact will be determined by the distance of the dump site from known feeding grounds and haul-outs. If it is possible to utilise the same dump site as that already used by harbour maintenance dredging, this will limit the damage from this procedure.

The most obvious long-term effect of the construction of additional quays and walkways is the effect on the water circulation in the bay and upon tidal flow in and out of the lagoon. Assuming that structures will reduce wave action, wave-driven longshore sediment transport could also consequently be dramatically reduced. The channel, basin and quays could trap finer sediments generally carried by the clockwise circulation to the mouth of the lagoon. On the plus side, less sediment transported to the lagoon mouth can be seen as beneficial to an area under pressure from siltation and competition for space and natural resources as a result of increased mariculture.

Mitigation

Adverse impacts from periodic dredging can be limited by implementing mitigation measures, such as the use of environmental windows. Cognisance should be taken of breeding seasons for all the marine mammals that are found in and around Walvis Bay.

To minimize impact and reduce cumulative effects (vessel traffic, noise and sediment plumes), maintenance dredging of the harbour should not coincide with construction dredging.

Assessment

Dredging is undertaken to maintain the Walvis Bay Harbour and approach channel. So mammals will previously have been exposed to the noise and turbidity levels. There are no reports of significant long-term impact related to this activity. Similarly, maintenance dredging of the new development should have very low impact levels.

As the Walvis Bay area experiences heavy shipping traffic and periodic dredging for the harbour, addition of dredging vessels for the new development is unlikely to increase the risk of mammal-vessel collisions. Even so, marine mammals will tolerate disturbance, and remain near active dredgers, in a prime foraging location, if rewards are high. In these cases the short-term risk of collision and injury to distracted animals is high. If dredging is well managed and dredgers avoid critical times when animals may be distracted or areas where calves are abundant, and if the skipper and crew remain vigilant, the risk of collision between marine mammals and active dredgers is minimal given their slow operational speeds.

The possible, though unlikely, effects of masking, avoidance and short-term changes to prey availability are of limited significance in the long term, as periodic dredging to maintain entrance channels and basin depth can be scheduled across non-biologically critical periods.

5.2.2. Increased Marine Traffic

The Port of Walvis Bay is Namibia's largest harbour and already accommodates a range of vessels, both within the harbour and moored offshore. Large sea-going vessels entering and exiting the Port of Walvis Bay do so under pilotage and follow the designated channel at low speed. Consequently cetaceans become habituated to this pattern and will likely avoid ships.

Smaller craft do not need to use the dredged approach channel and behave more randomly. They are thus more likely to have encounters with marine mammals. An increase in the number of small craft making use of the new basins can consequently raise the risk of mammal strikes. Dolphins are usually easily able to avoid vessels and generally can co-exist comfortably with both ships and smaller craft. Nevertheless careless and reckless handling of high-speed craft in the presence of dolphins could result in injury through propeller-strikes.

Wounds of dolphins and whales are known to heal rapidly and thoroughly in both natural and controlled situations, though scarring may be forever. Even severe wounds exposing muscle have been reported to heal within 5 to 8 months. A Heaviside's Dolphin with propeller cuts (Fig. 33) was photographed in Walvis Bay in February 2010 and the healing process monitored and documented (Elwen and Leeney, 2011). As this is the only such injury

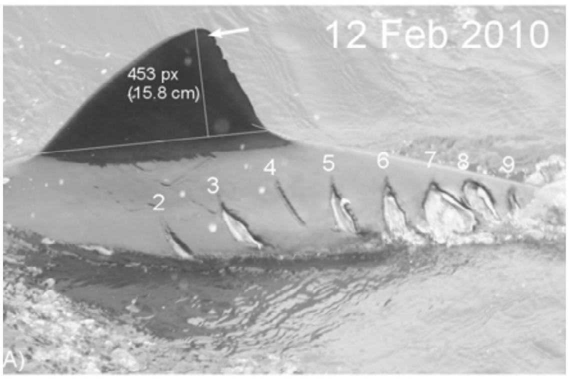

Figure 33: Propeller strike wounds on a dolphin in Walvis Bay. (Source: Elwen and Leeney, 2010)

of which they are aware, the authors feel that, despite daily visits to the resident dolphin population, small craft tourism is, at present, not major cause of distress to the marine mammals in Walvis Bay.

5.2.2.1. Marine Tourism Cruises

Nacoma argues that the pressure on seals, dolphins and the recovering whale populations is increasing with the growing number of tour operators. They feel that it is necessary to be very careful and vigilant, in particular as the Southern Right Whales are slowly recovering from extinction in the Namibian waters. A new waterfront development could add to the number of tour operators and the daily amount of people interacting with marine mammals. Even if they abide by the “Code of Conduct” drawn up by CETN, MFMR and MTAN by remaining outside of the *critical distance* zone, motorboats bringing visitors close to the dolphins, seals and birds on a daily basis present an almost permanent disturbance factor.

Although there is a “no swim with” policy for the Walvis Bay marine cruises, people want to get as close as possible to these generally friendly and tolerant animals. Cetaceans in captivity are known to be susceptible to human diseases. There is little data relating to the illness in wild dolphins from repeated exposure to humans.

Figure 34: Tourist boats closing in on a Heaviside’s Dolphin in Walvis Bay.
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The presence of calves in a group has been noted to affect the vocalisations of the dolphins (Heiler et al., 2016), suggesting that dolphins become more stressed by human presence at such times. Cognisance should be taken of behavioural patterns and rules applied to the tourist cruises accordingly.

Cape Fur Seals are known to predate birds (African Penguins, Bank Cormorants, Cape Cormorants, Crowned Cormorants and even Cape Gannets) on the southern Namibian islands, particularly in times of limited fish abundance (Kemper et al., 2007). A Fur Seal was recorded predating a Southern Giant Petrel off Pelican Point (Elwen et al., 2012). The authors felt that marine tour operators feeding seals in Walvis Bay could reinforce the predatory behaviour of seals on seabirds.

Mitigation

Marine mammals become habituated to vessel movement, especially where there are pre-defined routes into harbours and ports. None-the-less, an increase in tourism and more small craft anchorage facilities, as a result of the development, will provide the potential for an increase in the number of marine tour operators. Collisions and injury from propeller strikes are possible. This, along with the increased noise and disturbance, could have a significant negative impact on the resident mammal populations. A number of measures can be introduced to diminish the potential impact:

- speed limits must be set, adhered to and enforced
- the number of marine tour operators should be limited and controlled
- crews should remain vigilant at all times
- the number boats on site at Pelican Point at one time should be restricted
- marine vessels approaching groups with calves should be stringently regulated
- feeding of wild animals (particularly Cape Fur Seals) should be reduced or stopped
- dispersal of rubbish into the ocean should be rigorously controlled.

Promoting knowledge and understanding is generally the best way to convey any message. This can be achieved by introducing obligatory educational programmes for recreational boat users to increase awareness of marine mammal and vessel related issues. Such programmes could be incorporated into the new marina development.

Although the overall impact of the increased ship traffic on marine mammals, particularly within Walvis Bay, is deemed to be low, all skippers should be mindful of the potential for ship strikes, especially outside of the harbour area where migrating whales may be encountered. This will become especially significant as Southern Right Whales move further up the Namibian coast. Should Southern Right Whales begin frequenting the Walvis Bay area again, policies should be developed to reduce ship strike risk by limiting large vessel speeds and compelling the use of marine mammal observers.

Assessment

If established guidelines for speed, routes and approaching marine mammals are adhered to, then the impact of increased marine traffic can be kept moderate and be of low significance. Despite a daily exposure to tour boats in this area, specialists suggests the risk of direct injury through collision may be relatively low (Elwen and Leeney, 2011). However, impact levels will increase proportionally with increased tourist pressure and commercial competition.

While the impact level of marine eco-tourism at the moment is low, it could become moderately to highly significant with increased pressure, particularly at biologically critical times. Besides, the reality is that regulations will not be followed by all people at all times, resulting in an increased impact level, which will vary according to and be dependent on increased numbers of users of the bay and lagoon waters.

5.2.3. Increase in Visitors to Pelican Point

Overland visitors to Pelican Point disturb and alarm seals and birds and could contribute to accidental injury and trampling of young seals, fledglings and eggs. Although all pedestrian and vehicular traffic must keep a minimum of 50 m away from resting seals and roosting birds, these regulations are not necessarily enforced due to a lack of permanent authoritative presence. Non-motorized vessels such as kayaks and canoes also frequent the shores of Pelican Point, but possibly pose less of a perceived threat.

Over-fishing, due to the increased number of fisherman, is an impact of recreational fishing and it may result in pronounced changes in the fish community structure of the bay. This may lead to competition over food supply and change the structure of other ecological levels in the bay. Apart from over-fishing, over-collection of bait species due to increased number of fisherman is a possibility. Over-collection of bait species may also result in a change in the community structure of benthic and sessile organisms. The Sea Fisheries Act (Act No. 29 of 1992) is an attempt to manage the impacts of recreational fishing through regulating the amount of different species of fish that may be caught daily or transported per vehicle, as well as the quantity and type of species of bait organisms that may be harvested from the sea. However, numbers of Sea Fisheries Inspectors patrolling the coast to enforce these regulations are limited. As tourism increases in the area, further exploitation can be expected that may have an up-chain effect on the top level predatory species in the Walvis Bay area.

On the positive side a new breakwater will provide new niches for small fish, fish spawning, bait and other fauna and flora. This will benefit the ecosystem once construction is complete.

Mitigation

The increase in numbers of recreational users of the lagoon and visitors to Pelican Point will have similar effects to increased marine tour operators. Similar mitigation measures can be applied:

- numbers should be limited and controlled – this applies to fishermen as well as tourists.
- dispersal of rubbish and discarded fishing gear should be rigorously controlled and penalties imposed (e.g. fines or banning from the area).
- approach distances to mammals on land and in the water must be applied.
- observers can be appointed to limit human-mammal interaction and have the authority to intervene in legitimate infringement cases.

- regulations regarding type and amount of fish and bait removal must be enforced (These regulations may have to be revised dependent on the number of fishermen present in a specific area).

Assessment

The impact and level of significance is totally dependent on the number of recreational users and tourist visitors and the enforcement of regulations. No enforcement or control of numbers will have a significantly high, long-term effect on the natural integrity of Pelican Point and the sandspit. However, as long as the interactions and activities are controlled the impact should be fairly low.

5.2.4. Marine Pollution and Litter

With increased marine traffic comes the increased risk of accidental oil and chemical spills into the water. Development may lead to water impurity if adequate stormwater treatment systems are not established. Solid surfaces (walkways, jetties) near and around residences and businesses will facilitate the addition of pollutants into the lagoon waters due to suspension in rainwater run-off and cleaning water that is washed into the waterways. Toxins may also accumulate in the bottom sediments and may be re-suspended into the water column by storms and maintenance dredging, and subsequently be taken up by marine mammals.

Pollutants bioaccumulate in food chains and marine mammals, being high up, are particularly at risk from contaminants (Brough et al., 2014). Oil, petroleum, pesticides and cleaning chemicals can by acutely toxic and/or cause sub-lethal and chronic effects. However, any impending cumulative effects are only possible to calculate with known baseline levels of toxins in the marine mammals that already inhabit the Walvis Bay area. Dolphins and seals have some of the highest concentrations of organochlorides for any marine animal owing to their fairly regular contact with humans, the close proximity of their habitat, their large coastal distribution and high trophic level.

Figure 35: Cape Fur Seal pup caught in netting.
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Apart from detracting from an area's natural beauty, litter has a serious negative effect on the marine environment. Wind-blown plastic and discarded fishing gear pose a serious threat to seabirds and marine animals, such as seals and turtles. Fishing lines, rope, plastic bait box bands, netted carrier bags (e.g. for oranges) and such cause entanglement of seals and seabirds, leading to severe injuries and often death.

Turtles often mistake plastic for food. Items such as plastic bags and rubber balloons cause bowl blockage, resulting in starvation and a slow, painful death.

Mitigation

Measures to reduce the likelihood of marine mammals being exposed to toxins include:

- introducing appropriate systems to eliminate or minimise contamination of runoff and stormwater
- introducing and enforcing no dumping policies for rubbish
- introducing and enforcing policies for type and disposal of chemical cleaning agents (domestic and commercial)
- more stringent control measures need to be implemented on fishing beaches and within the harbour
- enforcement and issuing of penalties for littering

Assessment

The impact of toxin accumulation in dolphins as a result of increased exposure to chemical waste is considered high in the long term.

The impact on seal and turtle injury and mortality due to entanglement or garbage consumption is considered to be highly significant, both in the short- and long-term.

All the above mitigation and assessed impacts and levels of significance as a result of increased tourism and people-presence will only be effective if there is regular and visible enforcement of regulations.

5.2.5. Increase in Activities On and Around the Lagoon

The Walvis Bay Lagoon is explored by boat and kayak. Wind surfing and kite-boarding are popular on the leeward side of Pelican Point. The shoreline is popular for walking with locals and tourists alike. There is a potential for increased activity in the lagoon area on a daily basis as a result of the development attracting more visitors as well as local residents, particularly when the accommodation phases are complete. With increased numbers of people comes associated increased disturbance of all nature wildlife in the immediate area, as well as a higher likelihood of human-animal interaction.

Cape Fur Seals are known to become habituated to human presence, particularly if they associate the presence of humans with an easy and readily available food supply. As with all encounters with wild animals, there is potential for injury – both to the animal and to humans. Uneducated visitors and curious children who approach wild animals pose a particular risk (to themselves and the animals). Cape Fur Seals regularly rest on jetties in harbours and waterfront developments (e.g. Kalk Bay; V & A Waterfront, Cape Town). Sudden disturbance of a resting seal can cause aggressive startle reactions with severe consequences.

Figure 36: Cape Fur Seals on Kalk Bay Harbour wall (from Bruce, 2015)

The feeding of seals by the public, as well as workers in local business and restaurants (e.g. throwing food and garbage into the water), will only encourage predatory and scavenging behaviour and enhance the risk of animal-human conflicts, potentially encouraging aggression from the seals. This practice also puts the seal at risk of injury and mutilation through entanglement and ailment resulting from ingestion of non-biodegradable and toxic substances. An apparently easy source of food will encourage more seals to frequent the lagoon area and this, in turn, will lead to more human-seal interaction, both in the water and out of it.

Figure 37: Cape Fur Seals on jetty in Kalk Bay Harbour (from Bruce, 2015)

Mitigation

The increase in numbers of recreational users of the lagoon will have similar effects to the increased numbers of visitors to Pelican Point. Similar mitigation measures can be applied, such as controlling approach distances to mammals and enforcing littering regulations.

The greater increase in people presence will be along the edges of the lagoon and on newly constructed quays, jetties and walkways. Fixed measures can be incorporated into the construction and design to hinder seals from getting onto these structures (safety rails), but still supplying them with possible resting facilities (tyres and beams fixed at levels below the walkways).

People need to be educated with respect to approaching and feeding marine mammals, especially Cape Fur Seals. Seals become habituated to human presence, but can be aggressive. The fact that they will come out of the water represents a greater threat. These are strong animals and encounters will more often than not favour the seals.

The direct impact of human presence could be mitigated through:

- strict control and enforcement of rubbish disposal
- limiting human-mammal interaction through controlling accessibility
- employment of observers to limit access and prevent feeding and harassment of animals
- providing educators and educational material and/or facilities

Assessment

The impact of increased users of the lagoon waters is very low, but the impact of increased numbers of users of the terrestrial environment can be very high if mitigation measures are not applied and enforced.

The impact of human-seal interaction and potential injury is considered high in the short term and moderate in the medium- to long-term, if education measures and monitors are introduced.

Tourism can have substantial positive impacts for Walvis Bay in that it generates employment and foreign exchange. The tourist interest in the birdlife of the Walvis Bay lagoon generates a few million Namibian dollars per annum. This gives the lagoon and wetlands area an explicit monetary value. A well managed waterfront can be economically beneficial and if there is a strong environmental component to the managed, the long-term negative impacts will be low.

6. CONCLUSION

Human activities in the marine environment cause disturbance to a lesser or greater degree. The purpose of this report is to identify and assess the potential impacts of the proposed Walvis Bay Waterfront Development on marine mammals within the Walvis Bay area. As no scientific research relating to the impact of noise from construction activities on marine mammals has been undertaken specifically within Namibian waters, the assessments of potential impacts are based on international, peer-reviewed studies.

Any construction of harbour and quay facilities will impact on the natural environment from the construction phase (blasting, piling, dredging) through to the final use (pollution, more marine traffic, higher risk of human-animal interactions). Firstly, the impacts of noise trauma, vessel collisions, water pollution and turbidity, prey displacement, and disturbances (inducing behaviour responses) that may be caused by the construction have been considered. Thereafter, the impacts of increased tourism and human activity that will result from the completed waterfront development were discussed.

Marine mammals use sound to hunt, communicate and protect themselves and are thus susceptible to noise disruption in their natural habitats. Marine mammals vocalise and hear over a range of frequencies and sound pressure levels and consequently are not impacted equally by different anthropogenic sound producing activities. Similarly, marine construction procedures produce different sound energy levels at varying frequencies.

Physical injuries can be expected at very close ranges and high sound intensities, but are improbable in most species present in Walvis Bay, as free-swimming animals will initiate avoidance behaviour well before they are within ranges at which physical effects are felt. Noise levels and construction disturbance (e.g. turbidity and entrainment by dredging) may distress or displace some fish species that are generally food sources for the mammals in Walvis Bay. Dolphins and seals can compensate for small-scale changes in prey abundance by switching prey species, moving to alternative foraging grounds or increasing time spent hunting.

Noise emissions associated with the construction operations of this project (blasting, pile driving, dredging) are in the lower frequency ranges with energy or source sound pressure levels generally below 1 kHz. The construction will, thus, have more impact on low frequency mysticetes (5 Hz – 25 kHz vocalisation and hearing range) than on the mid-frequency odontocetes (100 Hz – 220 kHz) more commonly found in the bay. Fur Seals have lower hearing sensitivity as well as lower function ranges (125 Hz– 50 kHz) than the phocids (true seals) which have been used for most auditory research studies.

Blasting

Underwater explosions are one of the strongest point sources of anthropogenic sound in the marine environment. Source levels for blasts from 1 - 100 lbs TNT range between 272 and 287 dB re 1 µPa zero to peak at 1 m (OSPAR, 2009). However, the peak energy duration is extremely short (< 1 - 10 ms). Also, underwater explosions transmit at low frequencies (2Hz - 1 kHz), below the functional range of most mammals.

At close range, the energy generated by explosions can kill turtles and cause fatal trauma to Humpback Whales by destroying auditory canals (Ketten et al., 1993). Killer Whales are unlikely to be affected by isolated blasting noise at greater than 2 km (Madsen and Møhl, 2000). Studies involving Bottlenose Dolphins exposed to noise simulating a 500 kg explosion showed no TTS for sound exposure levels below 216 dB re 1 µPa (Finneran et al., 2000). Some short-term behavioural changes can be expected for dolphins between 5 and 10 km away. Cape Fur Seals appear to have a high tolerance for underwater sounds and have shown habituation to seal "bombs" and seismic equipment. Blasting is unlikely to significantly impact their behaviour or impair their hearing at distances greater than 700 m from the sound source. Turtles exhibited avoidance behavior at 1 km from the source at SELs of 175 dB re 1 µPa @ 1m (McCauley et al., 2000).

Blasting can be of moderate to high significance depending on the amount of explosives used and the proximity to marine mammals. The most realistic mitigation is exclusion distance. Marine mammal observers should ensure that no mammals or turtles are present within the bay or lagoon during blasting at exclusion distances of between 1 and 5 km (700 m for Cape Fur Seals, 1 km for turtles and 2 km minimum for dolphins). Mammals most affected by explosive noise are baleen whales, so it would be preferable to preclude blasting operations during known Humpback Whale migration seasons (June, July, and September).

Pile driving

There is no documented case of injury to cetaceans in the wild as a direct result of pile driving. Source levels for the various types of piling range from 243 to 257 dB re 1 µPa@ 1m, in a frequency bandwidth of 20 Hz to 20 kHz (Dahl et al., 2015). Research indicates that for Bottlenose Dolphins PTS and TTS will only occur within 5 – 10 m and 10 - 20 m, respectively, of the pile-driving activity. Masking for mid-frequency cetaceans and seals is unlikely beyond 100 m (Bailey et al., 2010, Ma Madsen et al., 2006).

Behavioural responses (including avoidance) in dolphins, porpoises and seals have been inferred for distances ranging from 4 to 20 km from the construction site, lasting for a time period of between 4 and 72 hours after cessation of piling (Brandt et al., 2011; Bailey et al., 2010; Edren et al., 2004; Tougaard et l., 2003). The intensity and extent of behavioural response may be related, not only to the sensitivity level of a particular mammal, but also to the “phase” in which the sounds is experienced, the duration of the noise and conduct of the animals at the time of exposure (Dahl et al., 2015; Southall et al., 2007).

Based on available information, pile driving operations are unlikely to have long-term significant impacts on Cape Fur Seals, dolphins or Killer Whales, particularly if the suggested mitigation measures are applied. These include:

- Minimising multiple activities that generate compound underwater noises where possible
- Instigating ramping-up or “soft-starts” procedures
- Avoiding pile driving into hard substrates where feasible
- Using methods with lower level noise emissions, e.g. Vibratory hammer or Hydraulic piling
- Extending the duration of the piling strike to reduce the source energy level, where practical
- Mantling or using air bubble curtains

The highest potential impact from piling will be on Humpback Whales and the lowest on Cape Fur Seals. A precautionary approach would be to of preclude pile driving near feeding or breeding populations and limit high intensity activity during migration periods. Applying visual monitoring and exclusion zones (500 m for Cape Fur Seals, 1 km for dolphins) will reduce the potential impact levels with respect to masking and hearing impairment to low significance. The impact of behavioural changes (avoidance of the construction area and/or relocation to find preferred prey species) can be significant to population densities in the short-term, but is considered of moderate to low significance in the long term.

Dredging

Compared to other activities that generate underwater sound, dredging is within the lower range of emitted sound pressure levels. However, the overlap in the dredging noise frequency spectrum and the hearing bandwidths of marine mammals indicates that the impact of dredging noise is potentially greater for mysticetes and seals than for mid-frequency cetaceans, such as are found in Walvis Bay. Source levels range from 149 to 180 dB re 1 µPa @ 1 m depending on the dredger type, across a frequency band of 20 Hz - 1 kHz (Todd et al., 2015; Robinson et al, 2011; 1995; Defra, 2003).

There are hardly any studies where any negative impacts on marine mammals can be attributed wholly to dredging activities in isolation from anything else. In general, evidence suggests that if management procedures are implemented, effects will probably be partial masking of low-frequency communications of baleen whales and seals, short-term behavioural reactions in all species, and changes in prey availability. Observations of Bottlenose Dolphins around dredging areas show contradictory behavioural responses: In Scotland, Bottlenose dolphins avoided locations where dredgers were working, but off Ireland, they were apparently attracted to areas of active dredging (Todd et al, 2015). Some short-lived hearing loss is possible if mammals stay near the dredger for extended periods of time (Todd et al. 2015; Thomsen et al., 2002), but indications are that if seabed disturbance temporarily increases food supply, both seals and dolphins will approach operating dredgers. Observation from a number of construction sites indicate that, on the whole, marine mammals are not overly bothered by dredging activities (Todd et al., 2015; Thomsen et al., 2009). No disturbance reactions were observed in New Zealand Fur Seals, Australian Sea Lions or Hawaiian Monk Seals, despite the proximity of dredgers to haul-out sites (Todd et al., 2015; EPA, 2007).

Minimum impact is expected from dredging noise on the marine mammals in Walvis Bay, as they are not deemed to be sensitive to such low frequencies. Mitigation of dredging noise is not a necessity. The Walvis Bay environment is already exposed to dredging activity for harbour maintenance and, thus far, no long-term negative impacts have been reported. Cumulative impacts of dredging (vessel traffic, noise and sediment plumes) can be lessened by not letting maintenance dredging of the Walvis Bay harbour coincide with construction dredging. Degradation of new areas can be circumvented by using the existing harbour dump site for construction dredge spoil.

Entrainment could cause reductions in prey abundance, but dolphins and seals have a varied diet. They are highly mobile and will be able to compensate for small-scale changes in prey abundance by switching prey species or seeking alternative foraging grounds. Migrating Humpback Whales (Humpback) feed opportunistically when food sources are readily available within their routes, so their feeding patterns are unlikely to be affected by dredging.

Dredging could even have positive impacts: Bottlenose Dolphins are known to preferentially use dredged channels when hunting (Allen et al., 2001). The release of organic nutrients from suspended sediments has reportedly enhanced diversity and abundance of benthic fauna near dredged channels with concomitant supplementary food availability at upper trophic levels.

Dredging can cause a temporary, but significant increase in turbidity levels. Heaviside's, Dusky and Bottlenose Dolphins are highly mobile and would readily avoid turbid water. They also have the ability to use sonar, so that they do not have to rely solely on vision. Sight is not essential to pinnipeds' survival or ability to forage and hence the level of turbidity is inconsequential (Dehnhardt et al., 2001; McConnell et al*.,* 1999). Turbidity has the potential to impact fish abundance and distribution within the lagoon. However, aadditional food sources for dolphins and seals will be available in the rest of the bay.

The effects of turbidity are often localized with minimal direct impact on marine mammals, particularly highly mobile ones that can relocate to more favourable feeding areas for the periods when dredge plumes are present. This may impact the local population densities somewhat in the short term, but is likely to be of low significance in the long term.

Increased Marine Traffic

There will be an increase in marine traffic both during the construction phase and afterwards owing to the new basins within the waterfront development. Collisions between dredgers and mammals are possible, but improbable, given that operating dredgers are either stationary or moving at slow speeds. Risks of collision are greatest when dredgers are in transit, but Walvis Bay is already characterized by heavy shipping traffic, so the addition of dredging vessels is unlikely to increase the collision risk substantially. The marine mammals in the bay are highly mobile and have been exposed to small tour boats as well as larger sea-going vessels making use of Walvis Bay harbour facilities. Precautionary measures that can be applied include setting predetermined shipping lanes and maintaining a constant course and speed where practical. There is a necessity for visual attentiveness to the presence of marine mammals and evasion distances of 100 m should be enforced where practical. Cape Fur Seals are known to approach active survey, mining and fishing vessels, so there is a strong probability that they will approach construction vessels. Despite their apparent lack of concern, caution must still be exercised by the skippers.

The large increase in the number of vessels in the lagoon and travelling between the construction site and the harbour will have significant impact on all wildlife for the duration of the construction. Changes in the whistle frequency parameters of Bottlenose Dolphins in the presence of tour boats have been recorded in Walvis Bay. Similar reactions can be expected owing to the increased presence of construction vessels. There are no effective mitigation measures to reduce ship-generated noise other than reducing vessel speed. Initially, and in the short term, a high level of disruption to cetaceans and seals is probable, but the significance and level of intensity will moderate with time as the mammals become habituated. Cape Fur Seals will probably habituate faster than the cetaceans in the bay.

Despite concerns voiced by Nacoma, there is no scientific proof that the current amount of marine boat tourism is a threat to the populations of dolphins presently in Walvis Bay. There will certainly be an increase in small motorised craft on completion of the new waterfront. Increased noise and vessel traffic outside of the bay may impact on any Southern Right Whales that may venture further north than their current distribution. The risk to these whales is equally high from harbour activity.

Dolphins are usually easily able to avoid vessels and can generally co-exist comfortably with both ships and smaller craft. To date there has only been 1 recorded incident of a dolphin being injured by a propeller. However, with greater numbers of small, high-speed craft comes a higher potential for collisions and injury to marine mammals. The increased noise and physical disturbance could have a significant negative impact on the resident mammal populations. If guidelines for speed, routes and approaching marine mammals are established and enforced, then the impact of increased marine traffic can be moderated.

Pollution

Being at the high end of the food chain, marine mammals are very susceptible to pollution, particularly through bioaccumulation. There is a substantially higher risk of contaminants entering the water during marine construction than at present. An increase in marine pollution can be brought about by inadequate disposal of construction materials, rubbish generation, oil and chemical spills and general flotsam accumulation. The impact on the environment will be equal to any oil and chemical spills and litter from ships coming into port and appropriate clean-up procedures must be established and implemented.

Storm-water runoff, particularly during the construction phase of the development, may cause water pollution and reduce water clarity if adequate storm-water treatment systems are not established. Addionally, windblown material can accumulate in and around the construction area. A well thought-out and executed construction environmental management plan will mitigate most negative effects from chemical and material pollution. The plan should be cognisant of runoff containing pollutants, storm water and contaminant treatment, construction dust accumulation in the bay, containment of construction material and the dumping of rubbish.

If construction activities introduce large quantities of foreign chemicals into the water of the bay and lagoon, there could be highly significantly long-term impact. Short term impacts of high intensity and significance can result from oils spills from construction vessels and machinery, but these can be lessened by quick response and following preset clean-up procedures. Water pollution can be mitigated by proper implementation of a good management plan.

Dredge plumes can release contaminants into the water column that can potentially accumulate through the food web. Coastal cetaceans are prone to elevated levels of toxins owing to their habitat range and regular interaction with humans and anthropogenic waste and the propensity for chemical accumulation by the lipid-rich blubber. Connecting the release of contaminants from dredge plumes to potentially negative effects in marine mammals requires baseline information regarding current blubber toxicity levels in a statistically valid number of specimens. If significantly large proportions of bioavailable toxic compounds are remobilised, then the impact of dredging and dredge spoil dumping can be very high in the long term. However, a properly designed and managed dredging programme can have a low impact on the health of the mammal population. As yet, there have been no documented negative, long-term impacts linked to the regular maintenance dredging of the Walvis Bay harbour. It is assumed that the ecosystem would have adapted to this type of short-term disturbance and will be able to tolerate similar levels of turbidity and compound suspension from the proposed development.

Harbour and residential developments may lead to water impurity through the addition of pollutants (cleaning chemicals, rubbish, effluent) into the waters of the lagoon and bay. Pesticides and cleaning chemicals can be acutely toxic and have chronic lasting effects. Although dolphins and seals generally have high concentrations of organochlorides, additional absorption of noxious substances can have severe, long-term, population-level consequences. The development plan should devise and encompass appropriate systems to eliminate or minimise contamination of runoff and storm water. The impact of toxin accumulation in dolphins as a result of increased exposure to chemical waste is considered high in the long term. Therefore, policies for waste disposal must be established and enforced.

Non-biodegradable litter and discarded fishing gear pose a serious threat to seabirds and marine animals, such as seals and turtles. Stringent controls and penalties for littering need to be imposed. The impact on seal and turtle injury and mortality due to entanglement or garbage consumption is considered to be highly significant, both in the short- and long-term.

Human Interactions

Seals swim in and around harbours. They become habituated to humans, scavenge rubbish and scraps and see humans as food providers (Bruce, 2015). Humans become accustomed to their presence and forget they are wild animals. An overall increase in tourism at the new Walvis Bay Waterfront may facilitate such negative trends. The impact of human-seal interaction and the potential for injury is considered high in the short-term and moderate in the medium- to long-term, if education measures and monitors are introduced.

Predation of seabirds by seals may be stimulated by the practice of feeding seals from tour boats. It is suggested that this practise be stopped, as it encourages seals not to hunt, but rather to approach humans for food. This can lead to aggressive behaviour if the desired outcome is not forthcoming.

Frequent contact between humans and dolphins, achieved through the regular tourist cruises, can have unknown long-term negative impacts on dolphin health (to population level) owing to the nearness of the interactions. Captive dolphins are susceptible to human illnesses and the dolphin populations in the bay may be similarly exposed through daily contact. Stress and discomfort will make them vulnerable to infection.

Recreational fishing is undertaken at a number of locations around the lagoon and bay. An increase in tourism can result in exploitation of the natural resources. Over-fishing may lead to competition over food supply among the top level predatory species. On the plus side, a new breakwater will provide new niches for small fish, fish spawning, bait and other fauna and flora. This will benefit the ecosystem once construction is complete. The impact of recreational users of the lagoon and coastal environment can be very high if mitigation measures and regulatory controls are not applied and enforced.

Concluding Statements /Assertion

Precautionary regulation is leading to considerable burdens being placed upon future development in some areas. Development that will secure employment and increase domestic income must be considered beneficial to Namibia. All development, industry and activities have some impact on the natural environment. If the impacts are inconsequential or can be mitigated to an acceptable level, then progress should continue.

The impacts and level of significance associated with the proposed Walvis Bay Waterfront Development have been presented. There will be considerable disruption during the construction phase, but the overall, long-term impacts on the marine mammals in the Walvis Bay area will probably be low, if mitigation measures are applied. Certain potential impacts need to be assessed prior to construction, for example the chemical properties and characteristic of the sediments to be dredged.

The level of impact of the completed development is dependent upon what control measures are instigated to combat pollution. High levels of chemical pollution and non-biodegradable waste can potentially cause irreparable harm.

The safeguarding and preservation of the natural status quo depends on controlling the number of recreational users and tourist visitors to the lagoon and bay areas and relies upon the enforcement of regulations. Lack of enforcement or failing to impose penalties can have a significantly high, long-term effect on the natural integrity of the entire bay area. However, if activities and actions are controlled and human-animal interactions limited, the impacts can be moderated.

Tourism can have substantial positive impacts for Walvis Bay in that it generates employment and foreign exchange. A conscientiously constructed and well managed waterfront can be economically beneficial and if there is a strong environmental component to the management, the long-term negative impacts will be low.

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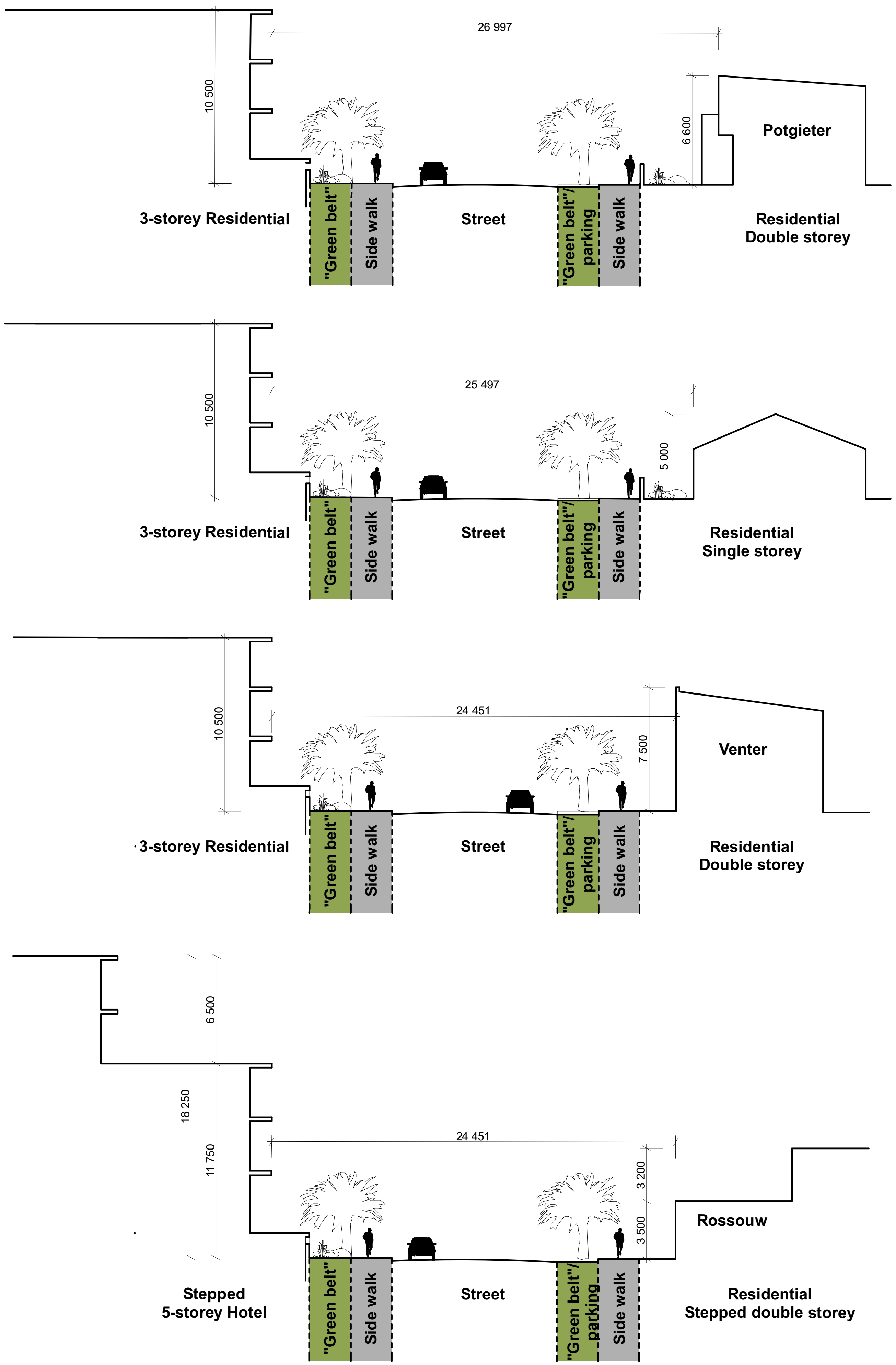
HEIGHT STUDY

Sections not to scale

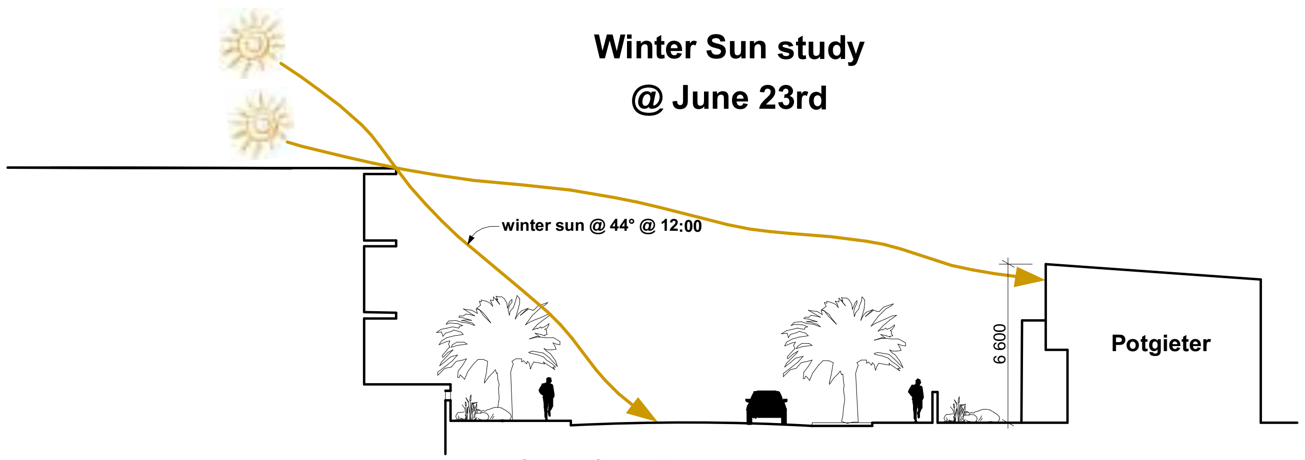


Examples of other Multi-storey Residential buildings in the vacinity

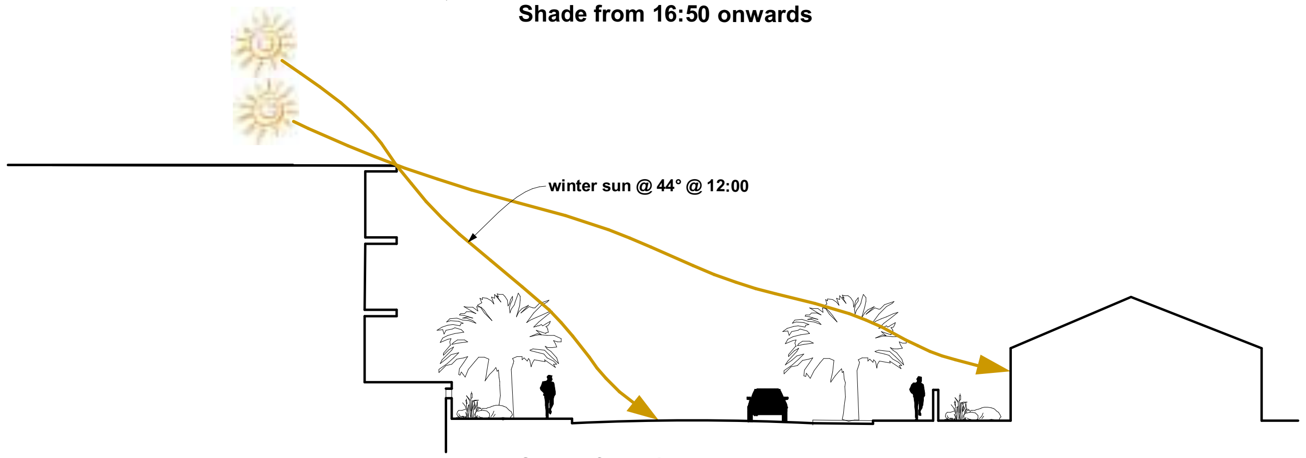
SUN STUDY

Reference: Info retrieved from [www.Suncalc.org]

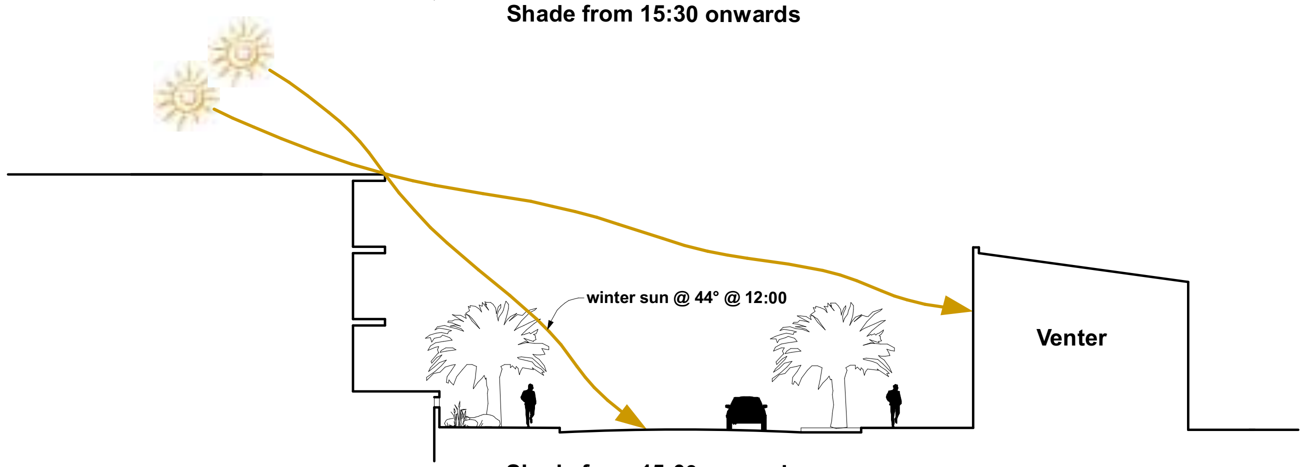
Winter Sun study @ June 23rd



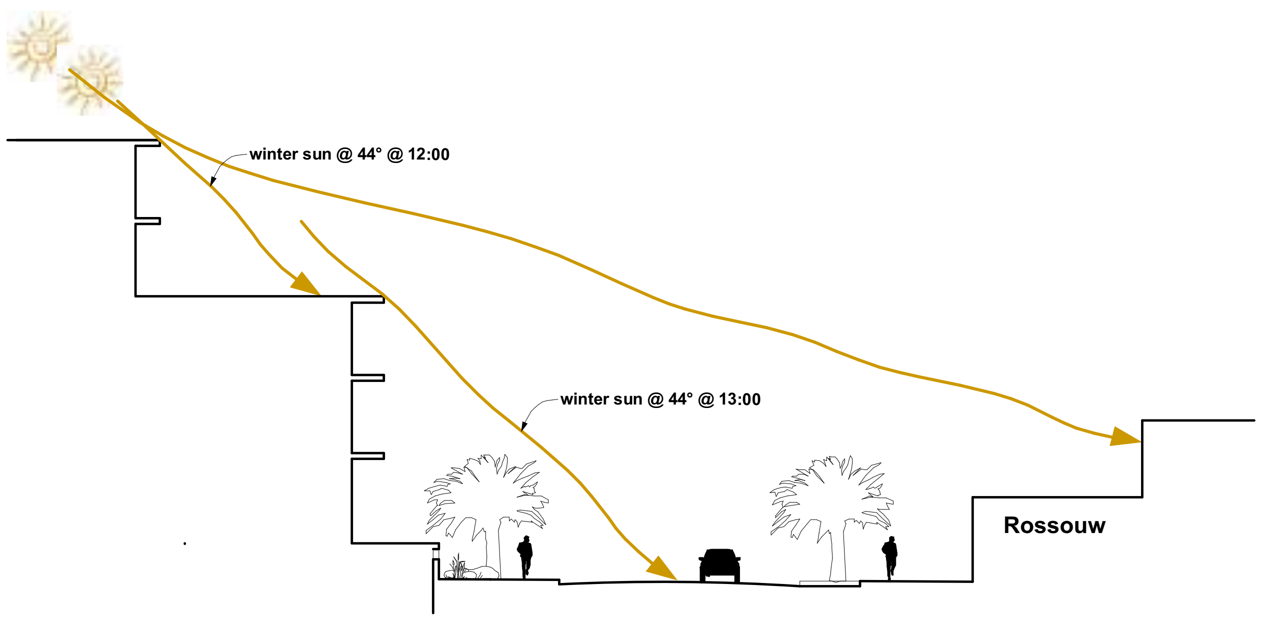
Shade from 16:50 onwards



Shade from 15:30 onwards

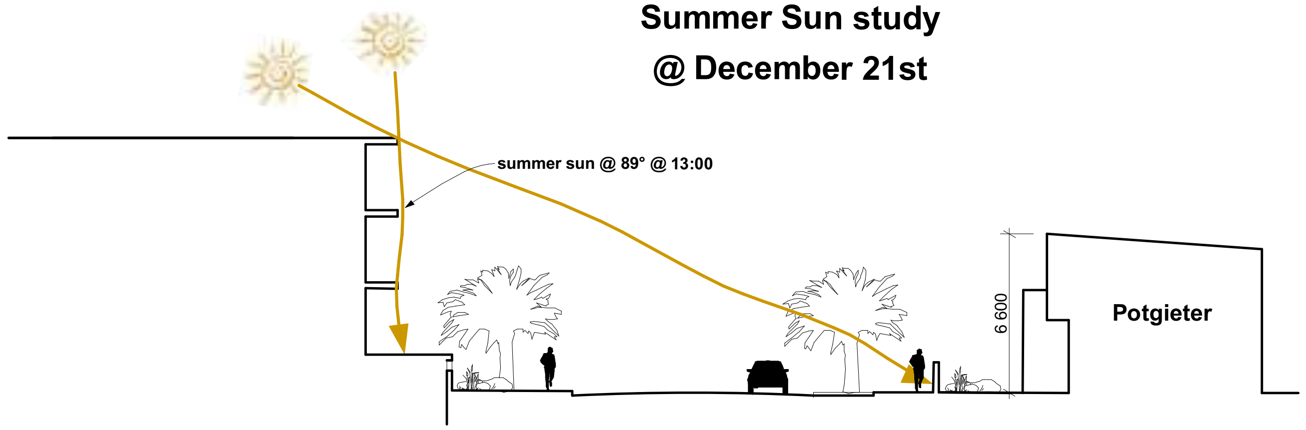


Shade from 15:00 onwards

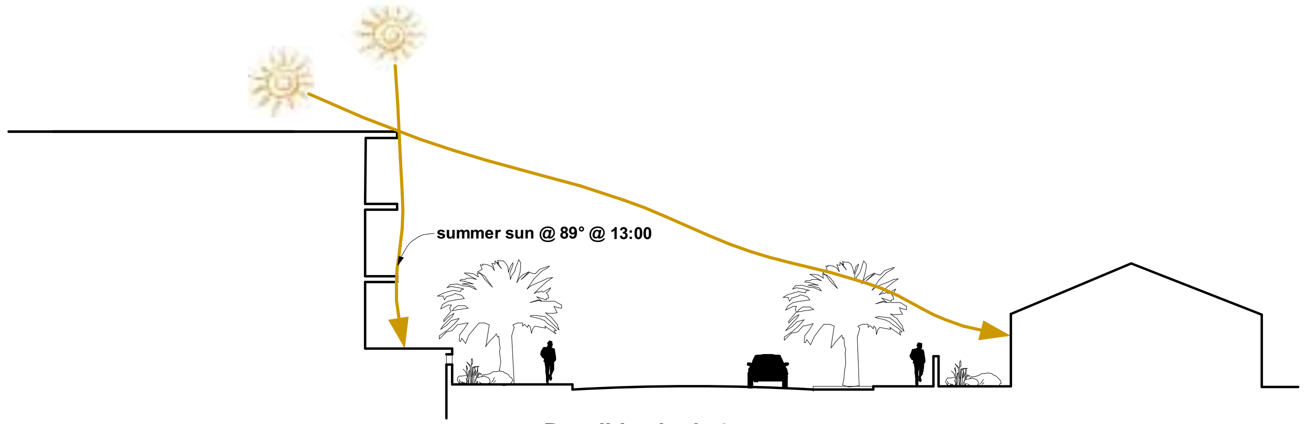


Shade from 15:00 onwards

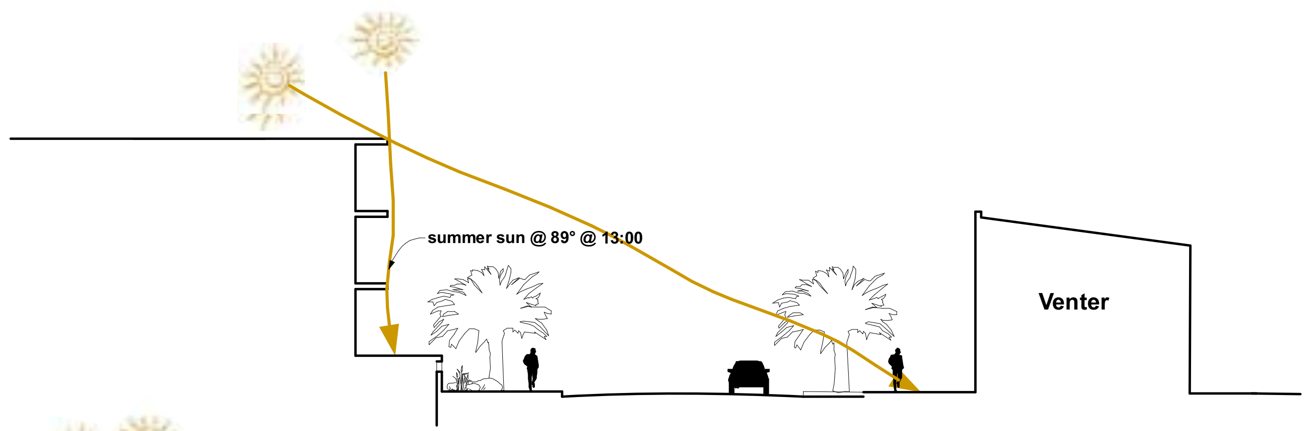
Summer Sun study @ December 21st



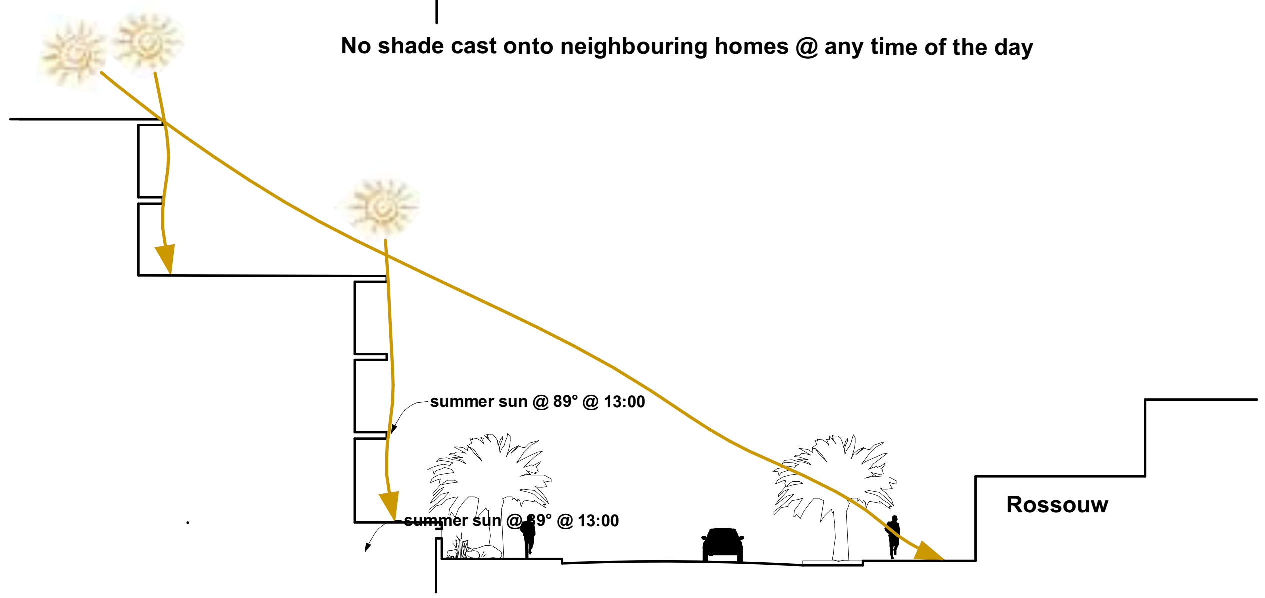
No shade cast in summer



Possible shade from 19:00 onwards



No shade cast onto neighbouring homes @ any time of the day



No shade cast onto neighbouring homes @ any time of the day

Method Statement for relocation of the sewer gravity main through the proposed Walvis Bay Waterfront Development

1. INTRODUCTION

The purpose of this method statement is to provide insight into the construction of the proposed relocation of the gravity sewer through the Walvis Bay Waterfront Development. This method statement will be supplemented and further developed through the Preliminary and Detailed Engineering Design Phase.

2. EXISTING AND FUTURE SEWER RETICULATION

2.1 Existing reticulation through the development

There are three existing sewer gravity mains running through the proposed development site. These sewers will have to be relayed. The existing sewermains convey sewage from the Protea Hotel in Pelican Bay, and the Yacht Club. The existing sewer mains on property 4941 are indicated on "Drawing 2" attached in Annexure A.

The 2 sewer mains from the Yacht Club and Protea Hotel respectively (110 mm diameter mains) connects in the middle of the proposed development site, from which it becomes a 200 mm diameter gravity main flowing towards KR Thomas Street (previously First Street West), from which it flows into the existing reticulation network in an easterly direction.

2.2 Planned upgrades

The intention is to construct a new sewerage pumpstation on site. This pumpstation will then collect sewerage from the proposed development and pump (via a new rising main) along Esplanade Street and Union Street towards the existing pumpstation as indicated in the marked up image below. The pumpstation will pump from a height of around 2 m to approximately 7 m (pumpheight around 5 m). The average annual daily dry weather flow is expected to be approximately 220 kl/day (based on the assumption that sewage will be approximately 80% of the water demand). Based on a peak factor of 2.5, and allowing for an additional 20% for potential stormwater infiltration and other unknowns, the peak flow will be approximately 8 l/s.

The existing sewage from the Protea Hotel and the Yacht club will be diverted through new gravity mains, first south along The Esplanade Street and then west (just north of the planned new Marina), crossing via the planned pedestrian bridge (or underneath the planned channel should the invert levels not make it possible to gravitate if fixed under the bridge) towards the new proposed pumpstation (situated close to the corner of KR Thomas Street and The Esplanade Street). The new pumpstation will be designed to also include for the sewage from these diverted mains to be pumped. The exact flow and pump details will be confirmed and calculated during the detailed design phase.

The drawing below indicates the proposed rising main route. The pipeline will be laid within the existing road reserve and then within the existing golf course as indicated. The final position will depend on the detailed design requirements and the discussion with the relevant owners and local authority. The yellow marked in the drawing below indicates the proposed development, from where the sewage will be pumped, towards the red arrow (the position of the connection and discharge into the existing reticulation system).

The local authority has confirmed verbally that the existing system has sufficient capacity from this point to deal with the additional flow as a result of the proposed development.

3. DRAWINGS

Drawings relating to the proposed site and relocation of the sewer has been included in Annexure A. These include the following:

a) Marked-up "Drawing 2" indicating the existing infrastructure (water, sewer and irrigation network within the development area).
b) Drawing A105 – indicating the Site plan and detailed Phase 1 development area.
c) Drawing A103 – layout indicating the proposed Marina and Canal with pedestrian crossing (Phase 1)
d) Drawing A114 – Isometric View of the design development (Phase 1)

4. CONSTRUCTION METHODOLOGY

4.1 Role-players

During the general construction phase the following role-players will be involved (in addition to the Environmental Agent and Health and Safety Agent).

Surveyor
At start-up of the construction phase the surveyor needs to peg out the construction route. Existing benchmarks will be used where applicable. In addition, all existing manhole invert levels and services will be confirmed. The levels will be confirmed with the design engineer to ensure that all gravity mains and connections are still correct and can drain.

Contractor
After the surveyor is finished pegging out the site, the Contractor will clear and grub the route before excavation starts. Excavation will commence thereafter but will necessitate the allocation of stockpile areas where the excavation material can be placed. Excavated material should as far as possible be used for backfilling. Where it is unsuitable, the material should be spoiled off site. Where there is a shortfall of material, material may be imported as required. Bedding material should match that as specified in SABS 1200 LB.

Engineer
The Engineer shall inspect all construction work as detailed in the Contractor's programme and as stated in the Bill of Quantities of the Contract Document.

Structural Engineer

The Structural Engineer will design and detail all concrete and reinforcing steel required for the pumpstation structure (where applicable) based on the loads imposed on it. The inputs required include the geotechnical conditions, dead loads and live loads on the structure. The Structural Engineer will be responsible to ensure that all required structural checks are done in accordance with hold points as agreed beforehand with the Contractor.

Local Authority

The Local Authority will be invited to the start-up meeting and will be involved from the beginning to ensure that they are satisfied with the works in accordance with the local authorities' expectations and standards.

4.2 Construction Sequencing for Sewer mains

The following items shall be addressed during construction, ideally during the summer months, and will follow in sequence of each other:

a) Set-out planned works (pipelines and pumpstations)

b) Clear and grub site

c) Excavate and place services located in road reserve

d) Backfill above services

e) Place, shape and compact remaining layerworks to required densities

f) Ensure area where pipes will be located is dry at all times. Dewatering may be required

g) Where concrete encasement is required, cast 30 MPa/19mm concrete in dry conditions. Contractor to compact adequately to prevent voids from forming

h) Once the sewer main has been constructed, overpumping of the existing sewerage from the manhole upstream to the manhole downstream to where the connection to the existing sewer network will be done, will occur. The new sewer main will be connected into the existing network (either at a new manhole or at an existing manhole). The existing main downstream of this connection will be plugged.

i) Once the existing sewer network through the development is blocked off, the existing sewer mains will be removed.

j) The new pumpstation needs to be operational prior to the blocking off the existing sewers through the development. Only once the pumpstation has been tested and is in a condition to be taken over by the local authority, can the existing sewer mains be blocked off.

k) The new sewer main will cross over the new planned canal leading into the marina (refer to the attached drawings indicating the Marina). Depending on the levels of the canal and new pumpstation (can only be confirmed during the detailed design stage), can it be confirmed whether the pipeline will cross over the pedestrian bridge, or underneath the canal.

l) Refer to items below for methodologies on "Clearing and Grubbing", "Stripping, Stockpiling and Re-instatement of Topsoil", "Backfill", "Gabions", "Re-instatement", Safety and Health Requirements.

4.3 Clearing and Grubbing

a) Unless otherwise specified, the area designed for clearing and grubbing shall be cleared of all trees, stumps, bushes, roots, rubbish, debris and other objectionable matters.

b) Before removal of any trees or shrubs written consent needs be obtained from Resident Engineer prior of the plant removal. The Engineer's approval of any removal of trees and undergrowth will be obtained before commencement of work. No indigenous riparian vegetation, including dead trees, will be removed from any area located outside the approved work area.

c) For the full width to be cleared, all objectionable materials and any other obstructions shall be grubbed from areas to be excavated, to the satisfaction of the Engineer.

d) Any rubble, litter or other foreign material found within the demarcated work area will also be removed from site and taken to an approved spoil site.

4.4 Stripping, Stockpile and Reinstatement of Topsoil

a) Activities will start-up stream and proceed in the downstream direction.
b) Prior to the commencement of any works, topsoil will be removed from the area of work.
c) The topsoil will be removed to a depth of at least 150 mm and investigated if any unsuitable materials exist. The unsuitable materials, if any, shall be removed to the depth required by the Engineer's Representative and replaced by approved suitable material. All excavated material will be stock piled as per Specification and as per stock pile management procedure, all bulk stock pile areas will be pre-approved by the Engineer.
d) It will then be stockpiled at the designated stockpile areas for later use in the rehabilitation/reinstatement process. This stockpile area to be some 30 m away from the areas mentioned previously.
e) All topsoil will be stockpiled in such a way that it does not exceed 2 metres in height.
f) If the stockpile starts to erode significantly or cause excessive dust, water will be used for dust control.

4.5 Backfilling

a) Where possible the original material that was excavated will be used to backfill. This is to preserve and restore the construction areas back to its original state.
b) Imported material of similar soil type may have to be used, (the source and type of material will however be pre-approved by the Engineer & Environmental Control Officer (if applicable)).
c) With both methods of backfilling, the soil must be compacted. This compaction will be done by means of a wacker and/or pedestrian roller to the required compaction specified.
d) Care will be taken not to over compact soils and ensure embankment profiles are retained/reinstated.

4.6 Gabions

Should gabions be required, the approved area will be cleared, grubbed and reduced to level as required. Gabion mattresses and baskets shall be packed where applicable and its position and sizing will be determined during the detailed design stage of the project. The gabion rock to be used will be pre-approved by the Engineer.

4.7 Reinstatement

a) The contractor will ensure that upon reinstatement, stormwater flow is no way restricted or hindered. Any outstanding shaping of disturbed area will be undertaken to ensure embankment profiles are reinstated.
b) The remaining topsoil and any indigenous foliage will be redistributed along the affected area, and the area reinstated as much as possible to the original condition or pre-construction condition.
c) Alien vegetation (if applicable) will be removed and taken offsite to a registered waste facility.
d) The area will then be inspected by the site Environmental Control Officer and Engineer to assess whether any further action or active rehabilitation is required.

4.8 Safety Requirements

a) The working area should be barricaded and warning signs to be placed to prevent public from entering the work area.
b) Work area to be kept as dry as possible.
c) Employees to wear proper steel-toe water boots and rain suite when working in the muddy area.
d) Training by means of Toolbox Talks on the works should be held prior to activity commences.

4.9 Environmental Requirements

a) Drip trays will be provided for any parked or standing plant and machinery.
b) In the event of an oil spill or other related emergency a full 200l capacity spill kit will be on site and in close proximity of the works. Trained persons will be on hand to apply and to utilize the spill kit.
c) All other environmental requirement as per the Environmental Management Plan will be adhered to.

4.10 Site Demarcation & No-Go Areas

a) 1m high aero-mesh with wooden poles with 2 wire strands will be erected and maintained both sides of the construction areas within the road reserve and golf course, in order to minimise impacts on the system due to construction activity.
b) Proper sign boards with the wording "NO-GO AREA" will be attached to the constructed aero mesh to prevent people from entering the restricted area.
c) Any servicing required and refuelling of plant will be done outside of the no-go area, on an open space area located on the proposed development site.
d) The exact demarcation will be confirmed with the contractor during the tender phase.

5. MECHANICAL EQUIPMENT

For the objectives of the Contractor to adequately complete all construction work, they would likely require the following mechanical equipment (which can only be confirmed once the contractor has tendered and been appointed to construct the works):

a) Grader
b) Digger loader
c) TLB
d) Smooth drum roller
e) Watercart
f) Wacker
g) Concrete mixer
h) $6m^3$ up to $20m^3$ tippers – At the Contractor's discretion
i) Pipe testing equipment as per SABS 1200
j) Laboratory for concrete test results
k) Vibrating poker

6. QUALITY MANAGEMENT

The Engineer must obtain all test results and as-built records from the Contractor in accordance with standards and local authority requirements/quality control specifications.

The design will be done in accordance with the "RED BOOK" and relevant SANS standards. Where applicable, the local authorities' standards will apply.

Daniel Smit

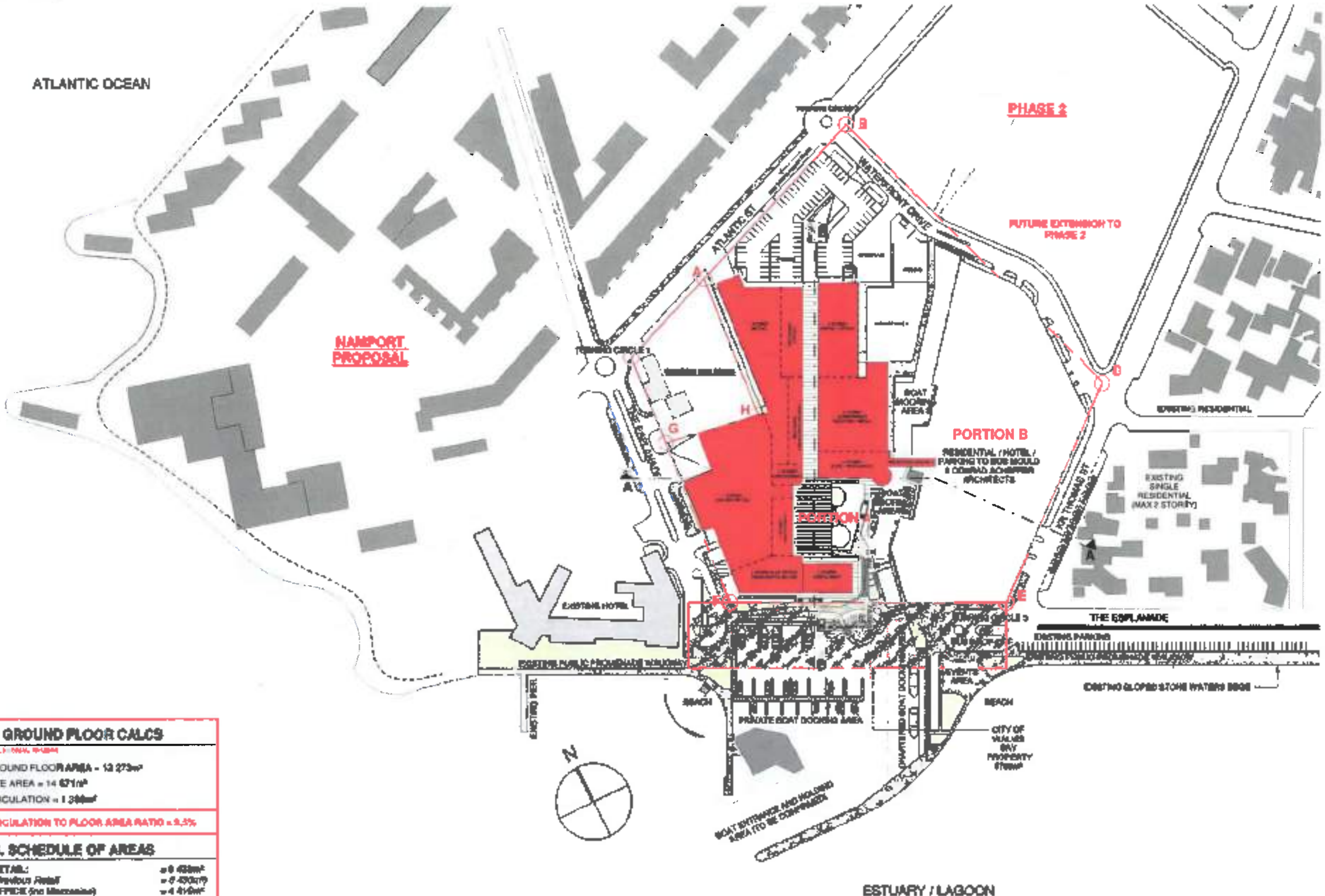
on behalf of

BIGEN AFRICA SERVICES (PTY) LTD

ANNEXURE A: DRAWINGS

Drawing 2


Existing sewermains to be Relayed
PUMPSTATION AT A.
110ø PUMP MAIN.



A. GROUND FLOOR CALCS

GROUND FLOOR AREA = 12 273m²

SITE AREA = 14 671m²

CIRCULATION = 1 3[illegible]m²

CIRCULATION TO FLOOR AREA RATIO = 9.5%

B. SCHEDULE OF AREAS

RETAIL:	= 6 4[illegible]m²
(Previous Retail	= 6 450m²)
OFFICE (inc Mezzanine)	= 4 4[illegible]m²
(Previous Office	= 14 917m²)
Note: This excludes the future phased office block on the Northern side of the site	
RESTAURANTS	= 2 1[illegible]m²
MULTI - USE EXHIBITION SPACE	= 1 7[illegible]m²
BREAK AWAY ROOMS	= 2[illegible]m²
CIRCULATION AREA	= 2 4[illegible]m²
ABLUTIONS	= 1 5[illegible]m²
PUBLIC SQUARE TOTAL	= 2 4[illegible]m²
(Covered)	= 5[illegible]m²
(Open Air)	= 1 810m²
BASEMENT AREA	= 14 2[illegible]m²
TOTAL AREA	= 21 1[illegible]m²

AFRIKUUMBA

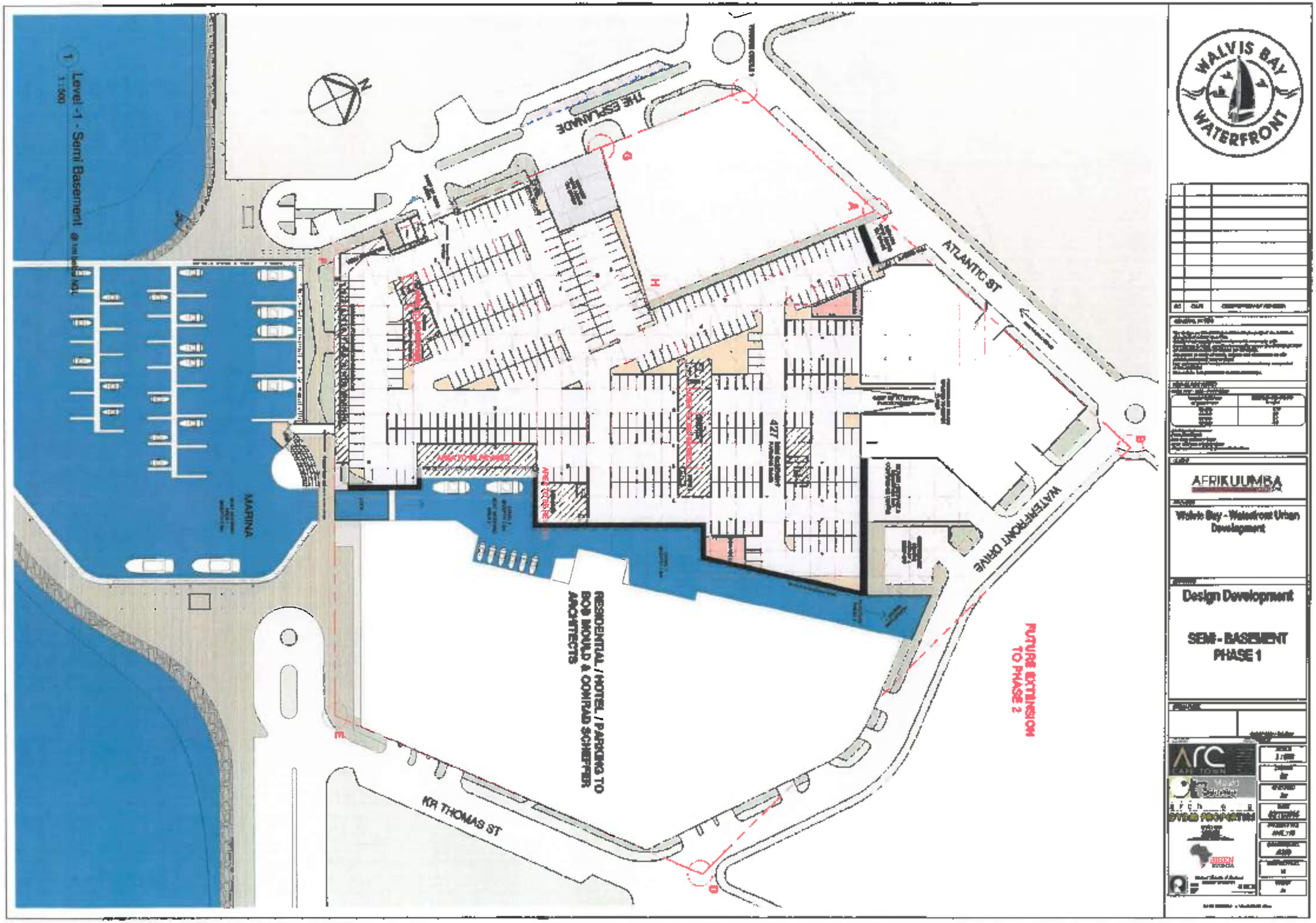
Walvis Bay - Waterfront Urban Development

Design Development

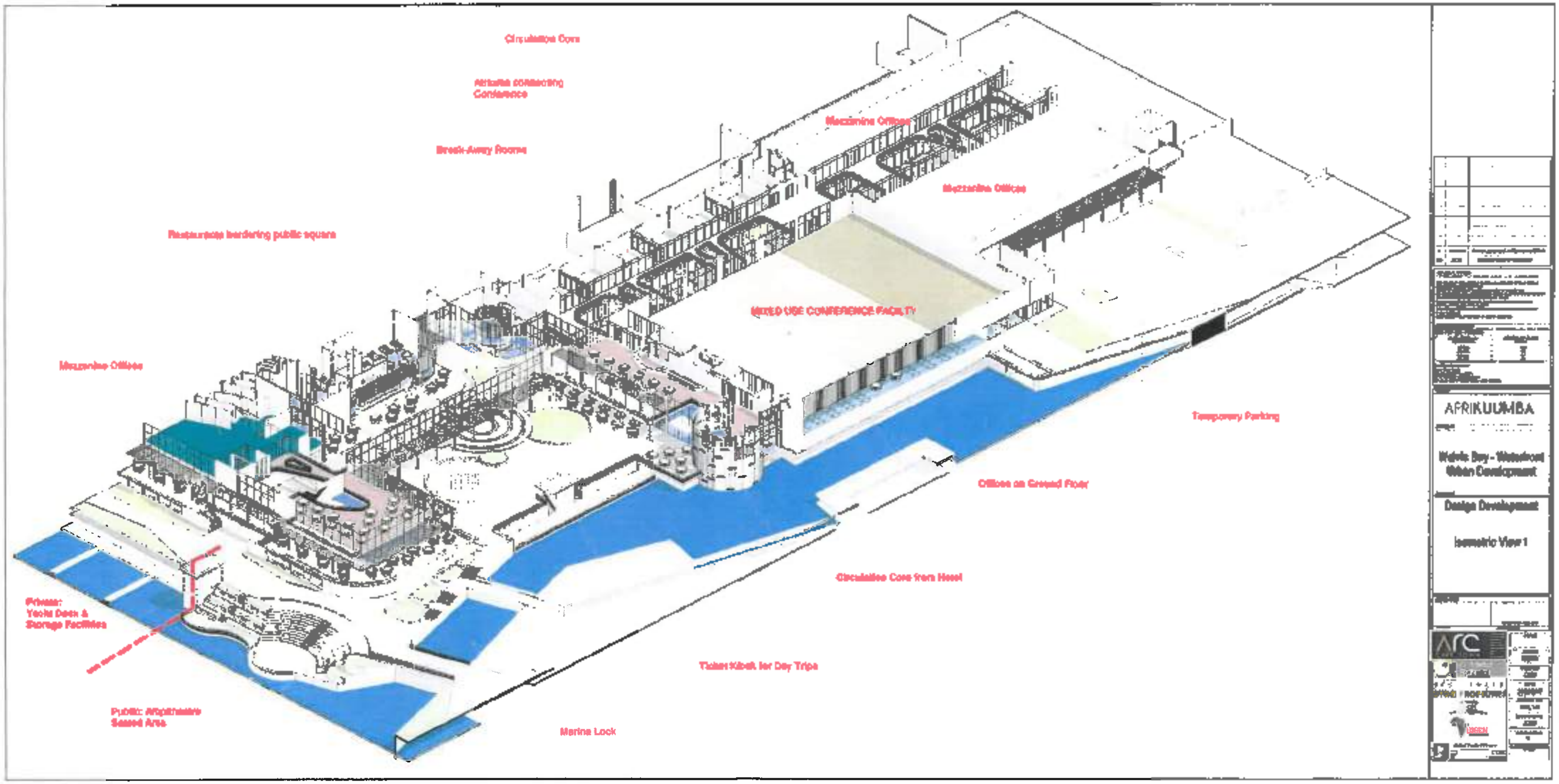
Site Plan - PHASE 1

arc CAPE TOWN

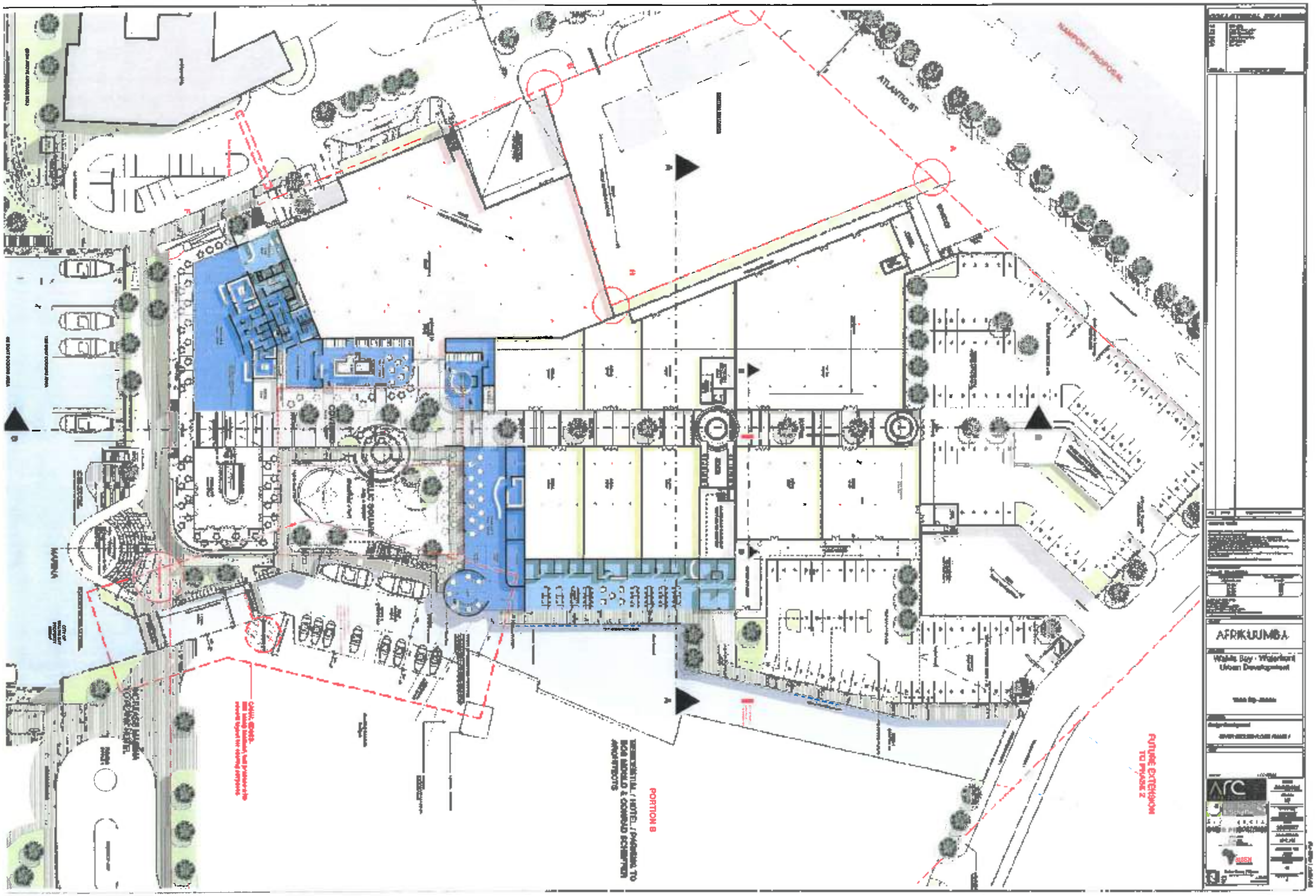
architects



Level -1 - Semi Basement
1:500
THE ESPLANADE
ATLANTIC ST
WATERFRONT DRIVE
KR THOMAS ST
MARINA
AREA TO BE REVISED
427
RESIDENTIAL / HOTEL / PARKING TO
BOB MOULD & CONRAD SCHEFFER
ARCHITECTS
FUTURE EXTENSION
TO PHASE 2
WALVIS BAY
WATERFRONT
AFRIKUUMBA
Walvis Bay - Waterfront Urban Development
Design Development
SEMI - BASEMENT
PHASE 1
ARC
CAPE TOWN



Circulation Core
Break-Away Rooms
Mezzanine Offices
Mezzanine Offices
Restaurants bordering public square
MIXED USE CONFERENCE FACILITY
Mezzanine Offices
Temporary Parking
Offices on Ground Floor
Circulation Core from Hotel
Private:
Yacht Dock &
Storage Facilities
Ticket Kiosk for Day Trips
Public: Amphitheatre
Seated Area
Marina Lock
AFRIKUUMBA
Walvis Bay - Waterfront
Urban Development
Design Development
Isometric View 1



ATLANTIC ST
MARINA
PORTION B
FUTURE EXTENSION TO PHASE 2
AFRIKUUMBA
Walvis Bay · Waterfront Urban Development