Initial Environmental Examination

Project No.: 53045-003-TON

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Tonga: Nuku'alofa Port Upgrade Project

This October 2020 version of the initial environmental examination supercedes ealrier versions.

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ABBREVIATIONS

Abbreviation	Full meaning
ADB	Asian Development Bank
ADCP	Acoustic Doppler Current Profiler
ANZG	Australia and New Zealand Guidelines
BH	borehole (A, B, 01, 03 etc.)
BTEX	A group of volatile organic compounds (VOCs) comprising benzene, toluene, ethylbenzene and xylene
CCP	communications and consultation plan (of the project)
CD	chart datum
CEMP	construction environmental management plan (developed by the contractor)
CLO	community liaison officer (of the contractor)
cm	centimetres
COVID-19	novel coronavirus 2019
CRVA	climate, risk and vulnerability assessment
CSC	construction supervision consultant (supporting the PMU)
CSS	country safeguard system
DFAT	Australian Department of Foreign Affairs and Trade
DMRB	Design Manual for Roads and Bridges
ECH	empty container handler
EEZ	exclusive economic zone
EHSO	environment, health and safety officer (of the contractor)
EHSG	Environmental Health and Safety Guidelines (of the World Bank Group)
EIA	environmental impact assessment
EMP	environmental management and monitoring plan
ERP	emergency response plan (part of the CEMP)
ESS	environmental safeguards specialist
FISA	Friendly Island Shipping Agency
GDP	gross domestic product
GFP	grievance focal point
GPS	global positioning system
GRC	grievance redress committee

Abbreviation	Full meaning
GRM	grievance redress mechanism
HSP	Health and safety plan (part of the CEMP)
ha	hectares
HAT	highest astronomical tide
HGV	heavy goods vehicle
HIV/AIDS	human immunodeficiency virus / acquired immunodeficiency syndrome
Hs	wave height
IAQM	Institute of Air Quality Management
IEE	initial environmental examination
IIC	construction contract
IPCC	International Panel on Climate Change
ISPS	International Ship and Port Security
km	kilometres
m	metres
LAT	lowest astronomical tide
LOA	length overall
MAFFF	Ministry of Agriculture, Food, Forestry and Fisheries
MARPOL	International Convention for the Prevention of Pollution from Ships
MEIDECC	Ministry of Meteorology, Information, Disaster Management, Environment, Climate Change and Communication
MFNP	Ministry of Finance and National Planning
MLSNR	Ministry of Lands, Strategy and Natural Resources
MOI	Ministry of Infrastructure
MOT	Ministry of Tourism
MPA	marine protected area
MPE	Ministry of Public Enterprises
MT	empty container
NAGD	Commonwealth of Australia National Assessment Guideline for Dredging 2009
NBSAP	National Biodiversity Strategies and Action Plan
NGO	non-governmental organisation
NIIP	National Infrastructure Investment Plan
NO_2	nitrogen dioxide
NRMM	non road mobile machinery

Abbreviation	Full meaning
NTU	turbidity
OHS	occupational health and safety
PAH	polynuclear aromatic hydrocarbons
PAT	Ports Authority of Tonga
PM_{10} and $PM_{2.5}$	fine particulate matter
PMU	project management unit (established by MOI)
PPE	personal protective equipment
PPV	peak particle velocity
PSD	particle size distribution
PACWIMA	Pacific Women in Maritime Association
QSIW	Queen Salote International Wharf
RAN	Royal Australian Navy
RL	reference level
SCS	stakeholder communication strategy (for the project)
SEMP	site-specific environmental management plan
SPC	South Pacific Community
SPREP	South Pacific Regional Environment Programme
SPS	Safeguard Policy Statement 2009 (of the ADB)
TBT	tributyltin
TDF	Tongan Defence Force
TEU	twenty-foot equivalent units
TMP	traffic management plan (part of the CEMP)
TOC	total organic carbon
TOR	terms of reference
TPH	total petroleum hydrocarbons
TSDF	Tonga Strategic Development Framework
TSS	total suspended solids
VDV	vibration dose value
WHO	World Health Organization
WMP	waste management plan (part of the CEMP)

EXECUTIVE SUMMARY

1. **Background**. Queen Salote International Wharf (QSIW) is International Ship and Port Security (ISPS) compliant and the United States Coast Guard undertake a yearly audit of the facility. Following a fatal accident at QSIW that cost the life of a port worker, a safety audit conducted by the South Pacific Community (SPC) for the Ports Authority of Tonga (PAT) in July 2018 found serious health and safety hazards, related to the poor condition of the container yard (unpaved and uneven sections, no road markings) imposing a risk of heavy machinery capsizing, the unsafe handling of containers, poor lighting, and the lack of a fire hydrant, life buoys and available first aid kits.

2. The current operating conditions at QSIW are poor, with practices negatively impacting the environment, such as uncontrolled dumping of rubbish and waste (with overspill onto the foreshore), non-bunded fuel storage areas and the pooling of water and other liquids. In June 2018, as part of a green port initiative across several Pacific countries, SPC also undertook an energy audit aimed at assisting PAT to reduce energy consumption. A range of projects and management practices were identified to cut energy consumption and greenhouse gas emissions, such as improved planning and control of vehicle movements or replacement of lighting. However, PAT has only implemented some of the interventions due to lack of capacity and funding.

3. The Government of Tonga (the government) has requested support from the Asian Development Bank (ADB) to prepare a project that will upgrade the Nuku'alofa Port, rehabilitating, renewing and expanding the existing infrastructure and improving management and operational practices. The project will result in the improved capacity and operation of Nuku'alofa Port. The project will provide safer, more reliable and more affordable transport infrastructure and services in Tonga.

4. **Institutional arrangements**. The Ministry of Finance and National Planning (MFNP) will be the executing agency and the Ministry of Infrastructure (MOI) will be the implementing agency for the project. The MFNP and MOI will be responsible for executing and implementing the project and managing funds. PAT will provide feedback and technical advice as the current port operator but will not administer funds or the consulting and works contracts. PAT is a government owned public enterprise reporting to the government through the Ministry of Public Enterprises (MPE). During the second half of 2019 MOI established a Project Management Unit (PMU) for the project's delivery. The PMU will be supported by a construction supervision consultant (CSC), that will include environmental specialists.

5. The government's Technical Working Group, as the project steering committee, will lead and oversee implementation with representatives of relevant line ministries and public and private agencies. The Technical Working Group will discuss, review, and provide guidance on project preparation and implementation issues.

6. The project is estimated to cost $50.0 million. The government has requested a grant not exceeding $45.0 million from ADB's Special Funds resources (Asian Development Fund) to finance the project. The government will provide in-kind contributions in the amount of $5.0 million.

7. **Project screening, categorization and environmental assessment**. The project's components have been screened according to Safeguard Policy Statement 2009 (SPS) and can be classified as category B for environment, because the potential adverse environmental impacts are site-specific, few if any are irreversible, and mitigation measures can be designed readily. This environmental assessment has been carried out in compliance with 'safeguard requirement 1 – environment' of ADB's SPS so as to ensure that potential adverse environmental impacts are identified, avoided where possible and managed or addressed. The assessment also complies with the country safeguard system (CSS). The SPS requires that both the ADB's and the developing member's – the Kingdom of Tonga's – safeguard requirements are complied with (and, in this case, the preparation of an environmental impact assessment (EIA) in line with Tongan regulations). The assessment has identified the potential negative and beneficial impacts of the project, quantified these and, where necessary, proposed mitigation and/or monitoring measures to offset any negative impacts to a level deemed to be acceptable.

11. **Consultation and information disclosure**. A stakeholder communication strategy (SCS) was developed and guided communications during the project's preparation. Early in implementation this will be developed into a communications and consultation plan to be implemented by the PMU on behalf of MOI. The government and PAT staff have been engaged in all aspects of the project through its investigation and design and will be similarly involved in the implementation stages. Information disclosure, including disclosure of this environmental assessment complies with ADB's Access to Information Policy (2018) in addition to requirements of the country system.

12. Early in implementation the project will also establish a grievance redress mechanism (GRM), based on the steps and procedures set out in this IEE and in the social safeguards due diligence report. The GRM will be monitored and reported in progress reports and semi-annual safeguards monitoring reports.

8. **Pre-construction**. An environmental audit of the QSIW facilities and operation undertaken in February 2019 identified a number of environmental, health and safety, and social issues associated with the existing facility. This led to recommendations for the new port facility and ongoing operations. The current design has accommodated the 'structural' recommendations and the environmental management and monitoring plan (EMP) comprises 'operational' aspects to be implemented during the project's construction and operation stages. These include:

- 'Safe' pedestrian routes in/out and around the terminal.
- An appropriate traffic and stack management scheme; inclusive of improved lighting on the terminal and quay.
- Scrap and waste will be removed from the terminal.

- Cables will be made safe.
- The safety of container handling will improve.

9. Although no major changes in project design are anticipated, this environmental assessment will be updated as part of the detailed engineering design. The updated assessment will be formatted as required under the CSS and submitted in support of the application for development consent for the Project. The updated assessment and development consent (with or without conditions) will be incorporated into the bid and contract documents. The contractor awarded the works will be required to develop their construction EMP (CEMP), based on the project's updated assessment EMP, and reflecting their approach to the works and methodology. The CEMP will include sub-plans (a Health and Safety Plan (HSP), Traffic Management Plan (TMP), Waste Management Plan (WMP), Emergency Response Plan (ERP) etc.) and site-specific plans for particular elements of the work (dredging etc.). The CEMP will be reviewed and cleared by the PMU and CSC prior to the contractor being given no objection to commence works.

10. **Construction**. During the construction phase of the project, no or insignificant impacts are predicted with regard to geology; climate; coastal processes; water, sediment and land quality; vibration; and recreation.

11. With the proposed mitigation set out in the EMP (Table 6.1) in place, impacts relating to contaminants; spills; cetaceans; invasive or alien species; and tourism are also predicted to mitigated to insignificant levels and without residual impacts.

12. Minor residual effects (with the proposed mitigation in place) are predicted on the benthic environment, due to new marine infrastructure and suspended sediment during the works, and on the human environment due to dust and (some) noise effects. The CEMP should be prepared to prevent or minimise the release of dust entering the atmosphere and / or being deposited on nearby receptors.

13. The residual impacts associated with an influx of construction workers and risk of transmission of communicable diseases are expected to be of negligible significance with appropriate mitigation in place (e.g. screening and induction of workers of the requirements of the project, a worker's code of conduct and a communicable diseases awareness and prevention programme). Speed controls through villages, appropriate timing of truck movements, travel routes and signage/information for the community will also be implemented to manage any risk to the community and ensure that any adverse impacts are reduced to minor levels.

14. Benefits will also arise during this phase as a clean-up of the existing facility and adjacent seabed is undertaken and a construction workforce is employed/present.

15. **Operation**. During the operational phase significant beneficial effects will occur for both the physical and human environment. For example, oil and grease traps will be operational, septic tanks will be managed appropriately and fuel drums will be stored in bunded areas. Major health and safety improvements will similarly occur, alongside the implementation of a green port initiative.

16. Furthermore, the economy will benefit from more efficient operation of the port's facilities which, in turn, should reduce the costs of imported goods and facilitate the flow of goods which people rely on. The project will improve the efficiency of the port operations and reduce goods handling costs, lost ship berth days and, ultimately, the cost of cargo. Reduced import costs will help to reduce the cost of living and combat poverty.

17. The potential for the introduction of invasive non-native species exists during this phase, but management measures (through a biosecurity method statement) are proposed to mitigate (control and prevent) this risk. Truck traffic to and from the port will increase from (on average) 56 movements a day to 61 movements a day and have a negligible influence. There will be no increase in marine traffic (rather ships will get larger).

18. **Recommendations**. The following actions will be implemented by the project to ensure compliance with environmental safeguard requirements of the SPS and CSS:

- The environmental assessment and EMP will be updated during detailed design. The updated assessment, along with development consent under the CSS, will form part of the bid and contract documents.
- In the construction phase training will be provided for skilled and semi-skilled people. The project will seek to maximize employment of women through the recruitment of female workers where they have the required technical skills.
- During the latter stage of construction, PAT (with support from the CSC) will give priority to establishing the HSP (based on the elements covered in the EMP) as part of the Port Operations Manual and the development of a green port initiative. This will be undertaken in parallel with establishing appropriate organisational arrangements whereby health and safety officers have clearly defined functions and receive the necessary training to undertake their functions.
- In addition, one staff member will be made responsible for implementing, and reporting on, operational phase elements of the EMP, including operationalisation of the ERP specifying procedures in the event of spills and natural disasters. This will include regular training and drills for staff.

1 INTRODUCTION

1.1 Project Background

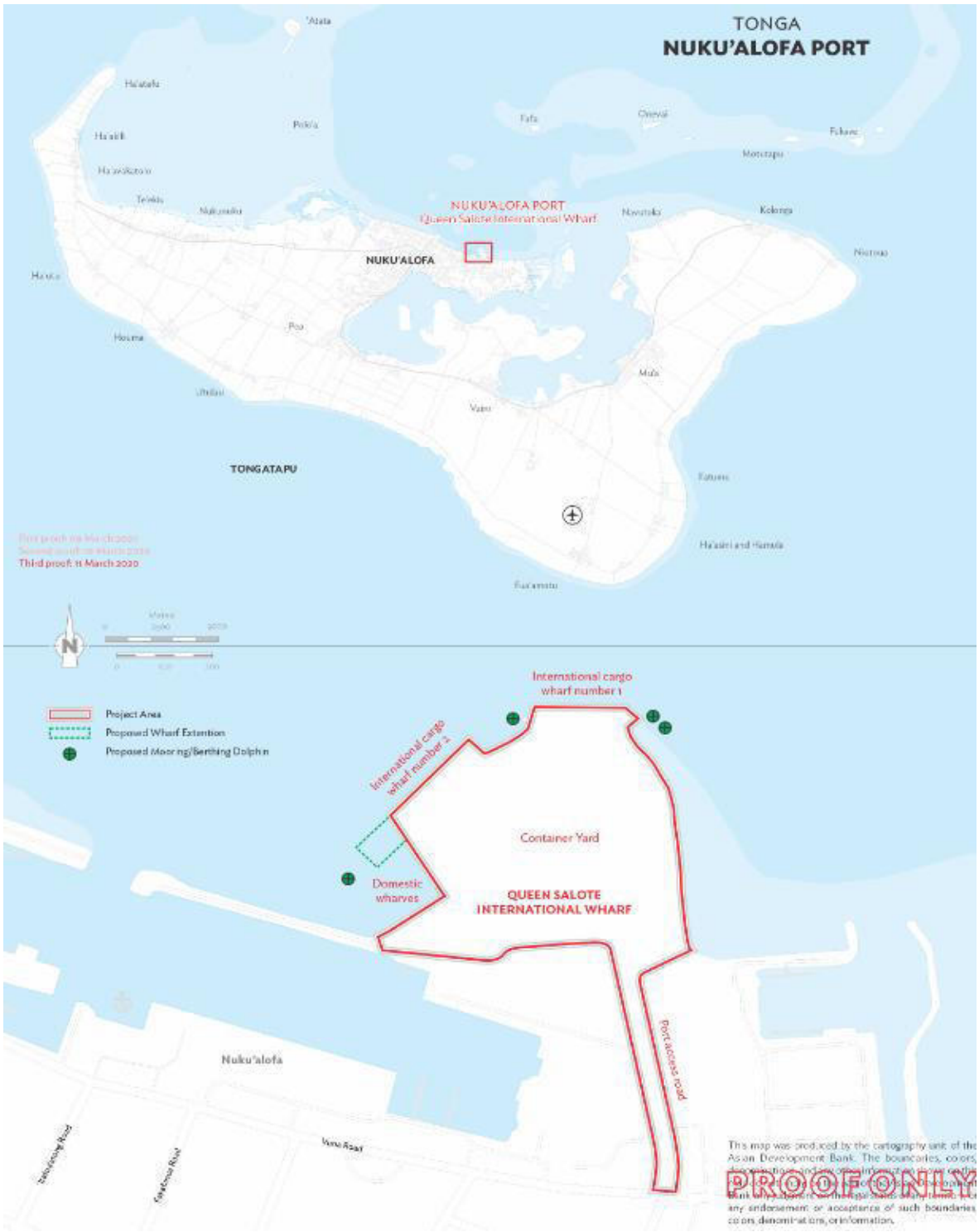
1. **Location**. The Kingdom of Tonga, situated in the southern Pacific Ocean, is an archipelago of 171 islands set across 700,000 km^2 of ocean. Approximately 70% of the population (108,000 people in total) live on the main island of Tongatapu, where the country capital, Nuku'alofa, is located. The rest of the population is distributed across 36 surrounding islands. Being a small island nation most of the goods need to be imported and over 98% of imports use sea transport. The Nuku'alofa Port is the main international port of Tonga and the country's lifeline, given the geographical isolation of the nation from international markets.

2. **Challenges in port safety and operations**. Tonga has been a member state of the International Maritime Organization since 2000 and has adopted the International Convention for the Prevention of Pollution from Ships (MARPOL). Queen Salote International Wharf (QSIW) is International Ship and Port Security (ISPS) compliant and the United States Coast Guard undertake a yearly audit of the facility. Following a fatal accident at QSIW that cost the life of a port worker, a safety audit conducted by the South Pacific Community (SPC) for the Ports Authority of Tonga (PAT) in July 2018 found serious health and safety hazards, relating to the poor condition of the container yard (unpaved and uneven sections, no road markings) imposing a risk of heavy machinery capsizing, the unsafe handling of containers, poor lighting, and the lack of a fire hydrant, life buoys and available first aid kits.

3. The current operating conditions at QSIW are poor, with practices negatively impacting the environment, such as uncontrolled dumping of rubbish and waste (with overspill onto the foreshore), non-bunded fuel storage areas and the pooling of water and other liquids. In June 2018, as part of a green port initiative across several Pacific countries, SPC and the Secretariat of the Pacific Regional Environment Programme undertook an energy audit aimed at assisting PAT to reduce energy consumption. A range of projects and management practices were identified to cut energy consumption and greenhouse gas emissions, such as improved planning and control of vehicle movements or replacement of lighting. However, PAT has only implemented some of the interventions due to lack of capacity and funding.

4. In 2018 a new harbour and domestic terminal – the Island Ferry Terminal – was constructed approximately 1km west of the QSIW. The construction of the Island Ferry Terminal allowed the current configuration and operation of QSIW to be investigated with a view to reorganising port operations to handle the expected growth in container freight through the port over the next 20 years. In response, the Government of Tonga (the government) requested support from the Asian Development Bank (ADB) to prepare a project that will upgrade the Nuku'alofa port, rehabilitating, renewing and expanding the existing infrastructure and improving the management and operations practices. Figure 1.1 shows the project site.

Figure 1.1: Project site: Queen Salote International Wharf, Nuku'alofa, Tongatapu



1.2 Project Outputs

5. The project will deliver the following outputs:

- Output 1: Existing port infrastructure rehabilitated - this output consists of (i) the re-instatement of the top surface (deck) of international cargo wharf 1; (ii) rehabilitation works of all international and domestic wharves; (iii) a new concrete seawall and strengthening the existing rock revetment; (iv) reorganization and reconstruction of the container yard; (v) upgrade of the port access road; and (v) rehabilitation of port auxiliary infrastructure. These interventions will allow the extension of the life of the infrastructure, increase port capacity and improve safety, and lower operation and maintenance costs.
- Output 2: Existing international cargo wharves extended - this output consists of (i) a 50m extension of international cargo wharf 2; (ii) the construction of 4 mooring/berthing dolphins for safer berthing and mooring of vessels during loading and unloading operations; and (iii) the relocation of a channel navigation marker. These interventions will allow the deployment of larger vessels and result in reduced vessel operating costs (charter, bunker and marine costs) and sea freight costs, reducing the cost of importing and exporting goods and contributing to the economic development of the nation. This will encourage regional freight transportation, particularly to neighbouring island states with connecting shipping routes, such as Cook Islands and Samoa, and with Tonga's main trading partners, including Australia, New Zealand and the United States.
- Output 3: Port operations and management improved - this output consists of improving the capacity of PAT to operate and manage the port, covering: (i) preparation of a PAT gender policy, with awareness sessions on workplace anti-harassment, sexually transmitted infections, and opportunities for women in port operations; (ii) training in port terminal operations, introducing environmentally sustainable work practices; (iii) development of an asset maintenance plan and associated training on maintenance, to maintain the infrastructure investments funded by the project; (iv) training on yard equipment operation; (v) training on general workplace health & safety and security; and (vi) a review of the tariff regime and reform options.

6. These outputs will result in improved capacity and operation of Nuku'alofa Port. The project is aligned with the following impact: safer, more reliable and more affordable transport infrastructure and services in Tonga.

7. **Institutional arrangements**. The Ministry of Finance and National Planning (MFNP) will be the executing agency and the Ministry of Infrastructure (MOI) will be the implementing agency for the project. The MFNP and MOI will be responsible for its execution and implementation and managing funds. PAT will provide feedback and technical advice as the current port operator but will not administer funds or the consulting and works contracts. PAT is a government owned public enterprise reporting to the government through the Ministry of Public Enterprises (MPE).

8. During the second half of 2019 MOI established a project management unit (PMU) for delivery of the project. The PMU will be supported by the construction supervision consultant (CSC), which will include environment specialists.

9. The government's Technical Working Group, as the project steering committee, will lead and oversee implementation, with representatives of relevant line ministries and public and private agencies. The Technical Working Group will discuss, review and provide guidance on project preparation and implementation issues.

10. The project is estimated to cost $50.0 million. The government requested a grant not exceeding $45.0 million from ADB's Special Funds resources (Asian Development Fund) to finance the project. The government will provide in-kind contributions in the amount of $5.0 million.

11. **Project preparation**. Royal HaskoningDHV was recruited to undertake a feasibility study and detailed design for the proposed upgrade of QSIW to an international gateway container and general cargo terminal that ensures international port facility standards are attained and vessel berthing, and port operations meet current and future needs. The feasibility study was developed in three stages: (i) phase 1 - assessment of operations and initial development of options; (ii) phase 2 – survey, final development of options and the selection of a preferred option; and (iii) phase 3 – detailed feasibility studies including technical, economic, financial and safeguards due diligence.

12. This report was first produced as an output from phase 3 and provided the environmental assessment required by the government under the country system and by ADB in line with the ADB's Safeguard Policy Statement 2009 (SPS) requirements. It has subsequently (this version) been updated to reflect small project changes associated with the Detailed Design and the results of further investigations.

1.3 Purpose and Objective of the Environmental Assessment

13. **Project screening and categorization**. The project has been screened according to the SPS. Based on the conditions at the existing port site and the activities and works proposed, the impacts are site-specific and limited to the immediate port area, with some adjacent sensitive receptors impacted by certain construction activities. The impacts are manageable and can be mitigated through standard measures and good international industry practice. The project is considered to be category B for environment. The commensurate level of assessment according to the SPS is an initial environmental examination (IEE). This report has also been compiled to meet the requirements for an environmental impact assessment (EIA) under the country safeguard system (CSS)[1].

[1] It should be noted that the EIA under the country system does not constitute an EIA as required for category A projects as per the ADB's SPS.

14. **Purpose and objective**. The purpose of this IEE is to assess the environmental, health, safety and social impacts of the proposed Project. It has been prepared in accordance with the SPS and CSS requirements.

15. The objective of this EIA is to identify potential negative and beneficial impacts, quantify these and, where necessary, develop mitigation measures to avoid or reduce negative impacts to a level deemed to be acceptable.

16. Although no major changes in the project design are anticipated, this IEE will be updated during the detailed engineering design. The updated IEE (EIA under the CSS), along with the environmental clearance/development consent and conditions, will be incorporated into the bid and contract documents.

17. **Approach to the assessment**. In order to confirm to the government and ADB whether or not significant issues are expected to arise due to the project in relation to the potential impacts on the terrestrial and marine environment, community, land (access, use, displacement) or effects on indigenous people, the following tasks were undertaken:

- A literature review and information gathering exercise, which included obtaining formal records of land tenure and written proof of land ownership, as well as data on baseline noise, air quality, traffic and waste management.
- Formal and informal consultation with relevant government agencies, PAT, shipping lines, representatives of the businesses operating in the vicinity of Nuku'alofa Port, research institutes and representatives of woman's groups. Information on stakeholders consulted is presented in Annex 1.
- The preparation of a stakeholder communication strategy (SCS) for the project. Following the preparation of the SCS, stakeholder and community engagement was undertaken by the PMU (the information disclosed, concerns and issues raised, and meeting minutes are included in Annex 1):
    - The first community meeting was held with Tongatapu 4 Council (including Ma'ufanga and part of the Kolofo'ou District) in November 2019.
    - Concerns raised by the community during this meeting, relating to damage to the waterfront which residents rely on for their livelihood (through shallow water fishing), have been addressed in this EIA.
    - Consultation with key stakeholders remains the responsibility of the PMU.
- An environmental audit of the existing port facilities, which included:
    - Interviews with the PAT Harbour Master and Manager of Infrastructure (January 2019) and site visits (February 2019).
    - A survey to identify the presence of any species of importance or problematic species.

  - A review of the port's operation and, in particular, its discharges, chemical storage, waste treatment facilities etc. to determine if they are environmentally sound and/or could be enhanced to improve the quality of Port and its surrounding environment; as well as its occupational health and safety, port marine safety and port security.
  - The development of recommendations for action to be incorporated into the assessment of upgrade options, to bring the facility's environmental management into line with ADB's safeguarding objectives and requirements where necessary.
- A climate, risk and vulnerability assessment (CRVA) has provided baseline information on the current climate and geophysical hazards and their effects on QSIW. This included wave monitoring as well as topographic and bathymetric surveys.
- Plume modelling to determine the potential environment impact of the dredging activity. A computer model was used to predict the suspended sediment plume and associated sedimentation likely to occur.
- An assessment of potential coastal process (waves, currents and sediment transport) effects based on 3D hydrodynamic modelling outputs, review of the outputs from the geotechnical investigation and calculations of wave-induced velocity, thresholds for sediment movement and scour depth.
- A marine ecological baseline assessment was conducted in March 2019 on the marine biomes associated with the intertidal and subtidal reef habitats and benthic substrate within and surrounding the QSIW. The marine assessment was undertaken using a combination of free diving (snorkelling) and SCUBA diving, qualitative and quantitative habitat and resource assessment, and scientific visual survey methods. It included:
  - Marine assessment adjacent to and along the existing four Wharfs and rock revetments associated with the port.
  - Marine assessment of the intertidal and subtidal reef systems directly to the east and west (adjacent to Faua Harbour) of the port.
  - Marine assessment of the southern section of Monu reef to the northwest of the port.
- Consideration of potential effects of the project on cetaceans.
- A soil and marine sediment quality survey and laboratory analysis of the samples obtained for moisture content, metals, mercury, hydrocarbons and organotin.
- Preliminary soil classification of any surplus excavated material for onsite reuse and characterisation of any potential dredged material for reuse or sea disposal.
- Conduct of social safeguards, gender and poverty assessment to identify relevant issues and mitigations.

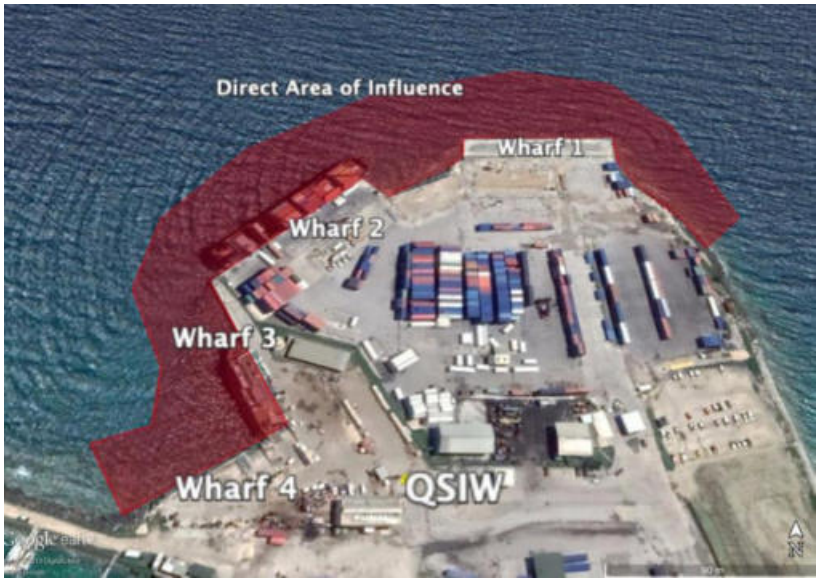
- A review of the existing air quality in proximity to the proposed development and consideration of potential impacts on existing receptors during the construction phase.
- Assessment of the potential noise and vibration issues associated with the project during the construction phase.
- Preparation of an environmental management and monitoring plan (EMP) and grievance redress mechanism (GRM).

18. The government and PAT staff have been, and will continue to be, engaged in all aspects of the project through its investigation, design and implementation stages.

1.4 Area of Influence

19. Figure 1.2 shows the predicted 'direct' marine area of influence of the project adopted for the purposes of this assessment. That is, from the western end of Wharf 4, including Wharf 3, Wharf 2 and Wharf 1, and a short distance along the eastern side of the port (where the focus of the upgrade works will be on the marine-coastal areas around Wharfs 1 and 2 and the area in between these).

Figure 1.2: Predicted direct marine area of influence of the project



20. In addition to the 'direct' area of influence, the 'indirect' marine area of influence of the project has been predicted (i.e. the area within which, for example, increased sediment loads could be experienced due to the works). This is taken to be a small area adjacent to QSIW and the direct marine area of influence of the works (and is shown in Figure 5.4).

21. The predicted 'direct' area of influence for effects such as dust and noise are shown in Figures 5.10 and 5.11. The 'indirect' terrestrial area of influence of the project is taken to be Nuku'alofa, in particular, Tongatapu and Tonga as a whole.

2 POLICY AND LEGAL FRAMEWORK

22. **Introduction**. Environmental assessment of the proposed project has been carried out in compliance with the government's environmental legislation and the requirements of the ADB's SPS. Tonga has a well-established regulatory framework that provides measures to protect and preserve the environment from abuse, pollution and degradation, to manage the environment for sustainable development and to promote environmental awareness. Legislation concerning the protection and preservation of the environment is found in a number of Acts and is the responsibility of a number of different Ministries according to their focus.

2.1 Country Safeguards System

2.1.1 Relevant laws and regulations

23. The Tongan laws relevant to environmental assessment of the Project are summarised below (in chronological order):

- Tonga Climate Change Policy 2016 – which responds to Tonga Strategic Development Framework (TSDF) 2015-2025.
- Environment Management (Litter and Waste Control) Regulations 2016 – this provides environment, health, police and waste officers with powers to issue notifications or on the spot fines for poor waste management practices; such as dumping, burning and littering.
- Seabed Minerals Act 2014 – this provides for the management of Tonga's seabed minerals and the regulation of exploration and mining activities within Tonga's jurisdiction or under Tonga's control outside of national jurisdiction in line with responsibilities under international law.
- National Spatial Planning and Management Act 2012 (Act No. 7 of 2012). This Act establishes the requirement for the Project to obtain a Development Consent – based on a Project Plan (i.e. a Concept Design).
- Environment Management Act 2010 – this established the Ministry of Environment (now MEIDECC) to protect and properly manage the environment and promote sustainable development and EIA Regulations 2010 which implement the EIA Act, delineating major development projects and the processes required for development consent.
- Hazardous Wastes and Chemicals Act 2010 – this regulates and effectively manages hazardous wastes and chemicals in accordance with accepted international practices and the International Conventions applying to the use, trans-boundary movement and disposal of hazardous substances.

- Ozone Layer Protection Act 2010 – this regulates the use of ozone depleting substances and implements the provisions of the Convention for the Protection of the Ozone Layer and the Protocol on substances that deplete the ozone layer.
- Renewable Energy Act 2008 – regulates the development and use of renewable energy in Tonga.
- Waste Management Act 2005 – manages and oversees the function of the Waste Management Board.
- EIA Act 2003 – established and implemented environmental impact assessment procedures for developments in Tonga.
- Marine Pollution Prevention Act 2002 and Fisheries Management Act 2002.
- Birds & Fish Preservation Act 1988 – protects listed bird and fish species, establishes protected areas and describes powers of police and fisheries officers under this Act.
- Parks and Reserves Act 1976 – provided for the establishment of Parks and Reserves Authority and for the establishment, preservation and administration of Parks and Reserves.

24. The Ministry of Lands, Environment and Climate Change and Natural Resources (MEIDECC) is the principal agency responsible for the management of the environment and administering environmental-related legislation in Tonga. It provides environmental assessments, reports and recommendations to the responsible Ministry, as well as being mandated under the EIA Act 2003 and the EIA Regulations 2010 to require environmental impact assessments and impose conditions on development projects within Tonga.

2.1.2 Environmental approvals

25. In broad terms, the environmental approval framework in Tonga involves:

- Land acquisition and lease approval from the Ministry of Lands and Natural Resources. No action needs to be taken in this regard for the Project.
- Building Permit approval from MOI under the Building Control and Standards Act No.39 of 2002. MOI are the Implementing Authority for the Project.
- Development Consent under the National Spatial Planning and Management Act 2012 from the Ministry of Lands, Survey and Natural Resources.
- Environmental approval from MEIDECC.

2.1.3 Environmental assessment process

26. Under the Tongan regulatory framework, all proposals for development activities must be referred to the MEIDECC for approval in line with the EIA Act 2003 and the EIA Regulations 2010.

27. As part of the initial notification process the project proponent (MOI) must complete a Determination of Category of Assessment Form (Form 1 of Schedule 1 of the Regulations), providing an overview of the proposed development and a number of details in relation to the existing environment and potential environmental impacts and mitigation measures. This should be provided to MOI (with reference to the Building Permit) and MEIDECC (the EIA Unit, which will check if Form 1 is attached to the Building Permit application). A registration fee also needs to be paid[2] to the EIA Unit.

28. Based on this information the Secretariat and the Minister determine whether the proposed development is a minor or major project and advises the proponent within 30 days. If the project is a major project, MEIDECC will issue Form 3 (Major Projects) of the Regulations and the proponent will need to submit an EIA for review by the Secretariat. Based on the EIA, the Secretariat makes recommendations to the Environmental Assessment Committee. The Minister receives an assessment report and issues the approval (with or without conditions), a request for further information, or a rejection.

29. If it is a minor project, the Minister will issue a Form 2. Approval will be granted with or without conditions and the project may proceed, usually under the provisions of an EMP which is binding. The EMP will address environmental management and protection measures and will be specific to the development under consideration. EMPs should also accompany a major project application.

30. The Schedule to the EIA Act 2003 lists the projects considered to be major projects. Of particular relevance to the upgrade project, this includes:

(j) marinas (comprising pontoons, jetties, piers, dry storage, moorings) for more than 20 vessels primarily for pleasure or recreation; and the

32(r) construction of roads, wharfs, barrages, embankments or levees which affect the flow of tidal water.

31. The purpose of an EIA is to assess potential significant environmental issues associated with a project and to develop appropriate methods to resolve those issues. The information within has been used to complete the Determination of Category of Assessment Form (Form 1) as part of the Detailed Engineering Design phase of work.

[2] By the PMU on behalf of MOI.

2.1.4 Relevant policies and strategies

32. **Tonga Strategic Development Framework**. The TSDF 2011-2014 (GOT, 2011) emphasizes the need for the Government to ensure safe and reliable transport infrastructure, as well as increase the quality of sea transport services both domestically and between the Kingdom and the rest of the world. TSDF 2011-2014 objectives include appropriate, well planned and maintained infrastructure that improves the everyday lives of the people.

33. TSDF 2015-2025 (GOT, 2015) follows regional and international commitments and seeks to provide a better quality of life for all, through the successful provision and maintenance of infrastructure and technology and provides an overarching framework for the long-term development of Tonga. TSDF2 identifies Tonga as one of the most vulnerable countries (regionally) to natural disasters and recognises that the potential for damage can be lessened by more appropriate infrastructure.

34. The vision of TSDF is for 'More Inclusive and Sustainable Growth and Development'. Pillar 5. National Resources and Environmental Inputs focuses on:

- Improving land use planning, administration and management for private and public spaces.
- Improving the use of natural resources for long term flow of benefits.
- A cleaner environment with improved waste recycling.
- Improving resilience to extreme natural events and impacts of climate change.

35. It establishes seven National Outcomes and the framework identifies key Organisational Outcomes that directly support the National Outcomes. International transport infrastructure is covered in Organisational Outcome 4.2: "*More reliable, safe and affordable transport services on each island, connecting islands and connecting the Kingdom with the rest of the world by sea and air, to improve the movement of people and goods*."

36. It is believed that the Project will contribute to both the organisational and national outcomes of TDSF2 through sustainable growth and development.

37. **National Infrastructure Investment Plan**. The National Infrastructure Investment Plan 2013 – 2023 (NIIP) was developed to identify key drivers for investment in economic infrastructure and outlines the government's priorities and plans for major infrastructure initiatives, including roads and seaports. The Plan addresses the need for improved operation and maintenance of current infrastructure and introduces core themes that justify infrastructure investments; one of which embodies the influence of Tonga's international connections through transport links. That is, Priority 9 outlines the need to upgrade *"berths and related shore facilities to be more resilient to climate change and natural disasters, as well as improving safety and facilities for passengers and cargo"* and improve *"channels and berths to increase safety in all weathers"*.

38. The proposed project is consistent with the core themes and priorities outlined in the NIIP.

2.1.5 International agreements, treaties and standards

39. **Convention on Biological Diversity**. The Convention on Biological Diversity 1988 is a multilateral treaty with three goals: (i) conservation of biodiversity; (ii) sustainable use of its components; and (iii) fair and equitable sharing of benefits arising from genetic resources.

40. The convention was opened for signature at the Earth Summit in Rio de Janeiro in 1994 and was ratified by Tonga in 1998.

41. As part of its obligations to the Convention on Biological Diversity, Tonga has developed a National Biodiversity Strategies and Action Plan (NBSAP) in which Tonga identifies several actions for the protection of marine ecosystems. When considered in relation to this project, actions include:

- Reducing the impact of land-based activities by prohibiting dumping and chemical discharges, prohibiting sand mining, conducting environmental assessments on development and reducing erosion.
- Increasing the number of marine conservation areas.
- Promoting sustainable management of the marine ecosystem.
- Invasive species management through a National Invasive Species Strategy and Action Plan 2013-2020.

42. **Convention for the Protection of the World Cultural and Natural Heritage 2004**. This convention founded the UNESCO World Heritage Site List. To be a site on this List, it must be a place of special cultural or physical significance. The programme catalogues names and conserves sites of outstanding cultural or natural importance to the common heritage of humanity. Tonga became a signatory to this convention in 2004. It does not have any approved sites on the List but does have two tentative items for consideration for the List, neither of which are in the geographic range affected by the Project.

43. **Convention for the Protection of Natural Resources and Environment of the South Pacific (Noumea Convention) 1990**. This convention finds force of law in Tonga through the Marine Pollution Prevention Act 2004. This convention, along with its two protocols, entered into force in 1990. The convention is a comprehensive umbrella agreement for the protection, management and development of the marine and coastal environment of the South Pacific Region. As a signatory of the convention, Tonga has agreed to take all appropriate measures in conforming to international law to prevent, reduce and control pollution in the Convention Area from any source, and to ensure sound environmental management and development of natural resources.

44. **Air quality standards**. The Kingdom of Tonga does not currently have any national ambient air quality standards enforced (Ehsani & Mwaniki, 2017). Therefore, ambient air quality standards from the World Health Organization (WHO), Australia, New Zealand and the European Union (EU) are included for reference (Table 2.1), in the absence of Tongan air quality standards.

Table 2.1: Ambient air quality standards

Pollutant	Average	Concentration			
		WHO	EU	Australia	New Zealand
NO_2	1 hour	200µg.m^{-3}	[a]200µg.m^{-3}	[d]0.12ppm	[i]200µg.m^{-3}
	1 year	40µg.m^{-3}	40µg.m^{-3}	0.03ppm	-
PM_{10}	1 day	50µg.m^{-3}	[b]50µg.m^{-3}	*50µg.m^{-3}	[h]50µg.m^{-3}
	1 year	20µg.m^{-3}	40µg.m^{-3}	*25µg.m^{-3}	-
$PM_{2.5}$	1 day	25µg.m^{-3}	-	[f]*25µg.m^{-3}	-
	1 year	10µg.m^{-3}	25µg.m^{-3}	[g]*8µg.m^{-3}	-
SO_2	10 min	500µg.m^{-3}	-	-	-
	15 min	-	[c]226µg.m^{-3}	-	-
	1 hour	-	[d]350µg.m^{-3}	[d]0.2ppm	[i]350µg.m^{-3}
	1 day	20µg.m^{-3}	[e]125µg.m^{-3}	[h]0.08ppm	-
	1 year	-	-	0.02ppm	-

[a] 1 hour mean not to be exceeded more than 18 times per year (99.79 percentile)
[b] 24 hour mean not to be exceeded more than 35 times per year (90.41 percentile)
[c] 15 minute mean not to be exceeded more than 35 times per year (99.90 percentile)
[d] 1 hour mean not to be exceeded more than 24 times per year (99.73 percentile)
[e] 24 hour mean not to be exceeded more than 3 times per year (99.18 percentile)
[f] 20µg.m^{-3} (2025 goal)
[g] 8µg.m^{-3} (2025 goal)
[h] 24 hour mean not to be exceeded more than 1 time per year
[I] 1 hour mean not to be exceeded more than 9 times per year

*"*Before 2016, there was an allowance of 5 exceedances per year for the PM standards. This was replaced in 2016 by an exceptional event rule. An exceptional event is a fire or dust occurrence that adversely affects air quality at a particular location, causes an exceedance of 1-day average standards in excess of normal historical fluctuations and background levels; and is directly related to bushfire, jurisdiction-authorised hazard reduction burning or continental-scale windblown dust. The handling of exceptional events in the reporting of averages is specified in the Air NEPM [National Environment Protection Measure]."* (Commonwealth of Australia, 2018)

45. **Noise and vibration standards**. In the absence of direct reference criteria for assessing construction noise impacts in Tonga, the following British standards and criteria have been employed for the purposes of this assessment. These align with the requirements of the World Bank Groups' Environmental, Health and Safety General Guidelines (EHSG) pollution prevention standards[3].

46. **British Standard (BS) 5228:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites - Part 1: Noise & Part 2: Vibration.** This guidance has been referenced for good industry practice as it provides recommendations for basic methods of noise (BS 5228-1) and vibration (BS 5228-2) control relating to construction and open sites where work activities/operations can generate increased noise and/or vibration levels.

[3] In line with the requirements of Appendix 1, Section 9, paragraph 33 of the SPS.

47. The legislative background to noise and vibration control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities.

48. This standard also provides guidance on methods of predicting and measuring noise and vibration in addition to assessing impacts on exposed receptors. The guidance is considered the most appropriate guidance for assessing noise and vibration impacts associated with construction of the Project.

49. **BS 6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting.** Structural vibration in buildings can be detected by the occupants and can affect them in many ways; their quality of life can be reduced, as can their working efficiency. BS 6472 provides best available information on the application of methods of measuring and evaluating vibration in order to assess the likelihood of adverse comment.

50. **Design Manual for Roads and Bridges (DMRB) 2019.** The impact methodology Volume 11, Section 3, Part 7, LA 111 provides guidance on the environmental assessment of noise impacts from road schemes. The DMRB contains advice and information relating to transport-related noise and vibration, which has relevance to the construction traffic impacts affecting sensitive receptors adjacent to road networks. The Manual also provides guideline significance criteria for assessing traffic related noise impacts.

51. **Calculation of Road Traffic Noise (CRTN) 1988.** This document provides a method for assessing noise from road traffic. The calculation methods provided include correction factors to take account of variables affecting the creation and propagation of road traffic noise, accounting for the percentage of heavy goods vehicles, different road surfacing, inclination, screening by barriers, and relative height of source and receiver.

2.2 ADB Environmental Safeguard Requirements

52. **Safeguard requirements**. The SPS establishes the three safeguard requirements for projects financed or administered by ADB; environment, involuntary resettlement, and indigenous people. A fundamental requirement of the SPS is avoiding, minimizing or mitigating adverse impacts on people and the environment. The SPS also requires compliance with the World Bank Groups EHSG.

53. Because the Project is proposed to be financed by the ADB, it must also meet the requirements of the SPS. The SPS presents the operational policies that seek to avoid, minimize or mitigate (and/or compensate for) adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalised by a development (ADB, 2009). The goal of the policies is to promote sustainable project outcomes by protecting the environment and people from the potential adverse impacts of projects. Alongside aiming to avoid and minimize adverse effects, they aim to help borrowers to strengthen their safeguarding systems and develop the capacity to manage environmental and social risks.

54. The ADB sets out relevant policy criteria within its SPS and its internal procedural requirements involve the following processes:

i. Screening and scoping of the main issues as soon as potential projects are identified. This continues throughout the project cycle.

ii. Impact assessment, the preparation of safeguard plans summarising mitigation measures, monitoring programmes and proposed institutional arrangements, and arrangements are made to integrate the proposed safeguards into the project design and implementation.

iii. Affected people are consulted during project preparation and implementation and information is disclosed in a form, manner and language accessible to them.

iv. Safeguard plans are disclosed to the general public and the information is updated at various stages in the project cycle.

55. Safeguard instruments prepared to ensure the SPS is implemented will: (i) reflect fully the policy objectives and relevant policy principles and safeguard requirements governing preparation and implementation of projects and/or components; (ii) explain the general anticipated impacts of the project and/or components; (iii) specify the requirements that will be followed for subproject screening and categorization, assessment, and planning, information disclosure, meaningful consultation, and grievance redress mechanism; (iv) describe implementation procedures, including budgets, institutional arrangements, and capacity development requirements; (v) specify monitoring and reporting requirements; and (vi) specify the responsibilities and authorities of the borrower/client, ADB, and relevant government agencies in relation to the preparation, submission, review, and clearance of safeguard documents, and monitoring and supervision.

56. **Screening and categorization**. As per the SPS 2009, the objective of the environmental safeguard requirements is to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process. To help achieve the desired outcomes, the ADB adopts eleven policy principles for guiding the assessment of projects that trigger environmental risks and impacts. The ADB categorizes projects into categories A, B, C, and FI according to the significance of likely impacts.

57. The project's components have been screened according to SPS can be classified as category B for environment because the potential adverse environmental impacts are site-specific, few if any of them are irreversible, and mitigation measures can be designed readily. This environmental assessment is carried out in compliance with 'safeguard requirement 1 – environment' of the ADB's SPS so as to ensure that potential adverse environmental impacts are identified, avoided where possible and managed or addressed. The assessment also complies with the CSS. The SPS requires that both the ADB's and the developing member's – the Kingdom of Tonga's – safeguard requirements are complied with (and, in this case, requires the preparation of an EIA in line with Tongan regulations).[4]

58. The SPS also requires that the borrower establish and maintain a GRM and compliance with the World Bank Group's EHSG for Ports, Harbors and Terminals (2017).

[4] It should be noted that the EIA under the country system does not constitute an EIA required for category A for environment projects as per the SPS

59. The purpose of the GRM is to receive and facilitate the resolution of affected peoples' concerns and grievances about the borrower's social and environmental performance at the project level. The GRM should be scaled to the risks and impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate and readily accessible to all segments of the affected people. This is set out in Section 6.

3 PROJECT DESCRIPTION

3.1 Site Overview

60. QSIW (Figure 3.1), located in the centre of Nuku'alofa (Tonga's capital city), is managed by PAT and functions as the main transport hub of the country, with the majority of international cargo being processed through this facility. The Navy base is located directly east and adjacent to QSIW and a small boat harbour, including a number of fishing wharfs (Faua Harbour), is located directly to the west, with both areas protected by a revetment seawall constructed directly onto the reef edge.

Figure 3.1: Queen Salote International Wharf

3.2 The Existing Port

3.2.1 Current port layout

61. QSIW currently has two international berths, Wharf 1 (the original berth facing North with an east-west alignment) and Wharf 2 (facing Northwest, with a southwest-northeast alignment), which are 93m and 111.2m long respectively and have an average water depth alongside of 12m (Figure 3.2). In addition, two domestic wharfs, Wharf 3 (100m in total length) and Wharf 4 (60m in total length), are located on the Southwest side of the port, with an average water depth alongside of 9m and 4m respectively. QSIW also includes a container yard that is estimated to cover around 3ha.

Figure 3.2: Current layout of QSIW

3.2.2 Audit of existing facilities

62. **Introduction**. An environmental audit of the existing QSIW port facility and operations was undertaken as part of phase 1 of the feasibility study. This involved interviews, site visit and a specific site survey, the output from which was an environmental audit due diligence report, which has been summarized in this section.

63. **Consultations**. Interviews were undertaken with the PAT Harbour Master Mr. Hakaumotu Fakapelea on 17/01/19 and 18/01/19 and the PAT Manager of Infrastructure and Technical Mr. Iketau Kaufusi on 15/01/19. Items highlighted of relevance in this context include:

- Hazardous containers (gas, chemicals etc.) are stored in the south eastern corner of QSIW.
- There are no markings on the ground due to a lack of pavement where full containers are stored.
- Lighting is an issue with several "black spots" present and the face of the wharf cannot be seen. Operations currently rely on ship flood lights.
- Trailers cannot see each other between stacks and can conflict with other trailers. There are no clear gaps between stacks.
- On average there are two accidents/year. In 2018 the death of a worker was due to the absence of a gap between containers, no markings and lighting issues.
- In cyclones, there is no lashing point for containers on the yard. Empties were washed away next to Masefield Base in 2018.
- The wharf level is low for ship crane operations, generating large rolling (1m vertically) motions during crane operations. Only one crane can be used for off-loading at a time, while the other cranes act as counterweight to avoid capsizing of the ship.
- PAT has been selected as one of the two locations for the SPC Green Pacific Port programme and, as part of this, is looking to replace current lighting with LEDs and a 30m pole (currently 15m).

64. **Site survey**. The site survey was undertaken on 14/02/19. It demonstrated that the current environmental conditions at QSIW are poor and include (of relevance here):

- Uncontrolled dumping of rubbish/waste, with overspill onto the foreshore.
- Unbunded fuel storage areas.
- Broken pavements and fencing; uneven surfaces.
- Very limited lighting.
- No road markings for safe vehicle and pedestrian movement.
- Hazardous working conditions.
- Unfinished development.
- The environment has the potential to generate a lot of dust.
- Dangerous cabling and inadequate protection of power supplies.
- Inadequate security.

65. The marine survey also found high levels of rubbish (e.g. plastic and glass bottles) and port related mechanical and infrastructure equipment was located on the substrate throughout the area assessed. Further, although QSIW is a restricted zone, evidence of fishing and resource extraction on both the eastern and western reef systems was recorded.

66. These issues have been addressed through the Project and the proposed remediation and mitigating measures included in the project design as described in this section and reflected in the EMP.

3.3 Analysis of Alternatives

67. A number of options for both the wharf configuration and the yard were considered as part of the feasibility study in order to select a preferred option that best meets the needs of the project. This included consideration of the environmental implications of the options, as well as the engineering and financial implications (e.g. the quantum of dredging and piling likely to be required and the coastal process and seabed implications). The subsections below set out the options considered and the reasons why the preferred options were selected.

3.3.1 Wharf options

68. **Option 1.** This option is shown in Figure 3.3 and consists of: (i) re-instatement of Wharf 1 deck; (ii) dolphins between Wharf 1 and 2; (iii) dolphins east of Wharf 1; and (iv) southern extension of Wharf 2.

69. The main characteristics of option 1 originally included: (i) provision of berth suitable for 220m length overall (LOA) ships by adding 50m of structure; and (ii) potential dredging = 8,000m^3 and backfill = 40,000m^3.

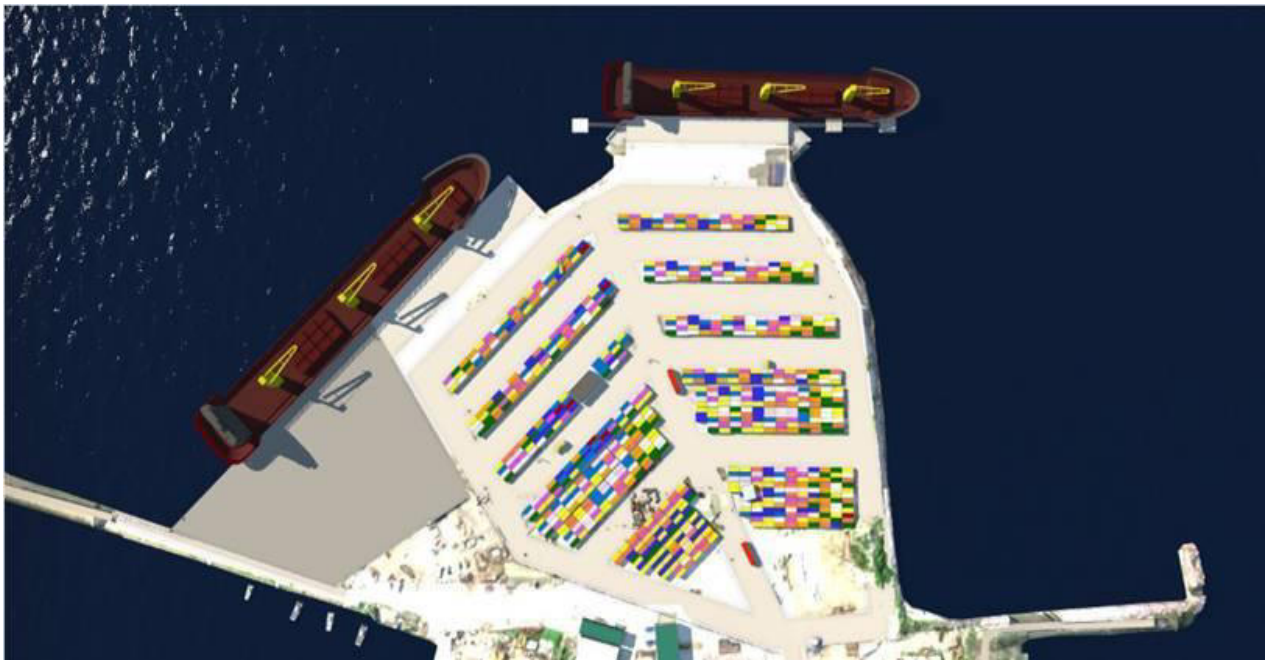
Figure 3.3: Wharf option 1

70. The environmental advantages of this option included relatively limited dredging and backfill requirements, which will reduce the impact on the seabed (see option 2 by comparison). The coastal process implications of all options are predicted to be limited because the wharf decks are proposed to be suspended above the water level for most of the tidal cycle and founded on piles (see Section 5.2.1).

71. **Option 2.** This option is shown in Figure 3.4 and consisted of: (i) re-instatement of the Wharf 1 deck; (ii) dolphins west and east of Wharf 1; (iii) reclamation of Wharf 3 and 4; and (iv) southern extension of Wharf 2.

72. The main characteristics of option 2 were: (i) provision of a berth suitable for 220m LOA ships by adding 160 m of structure; and (ii) potential dredging = 30,000m^3 and backfill = 120,000m^3.

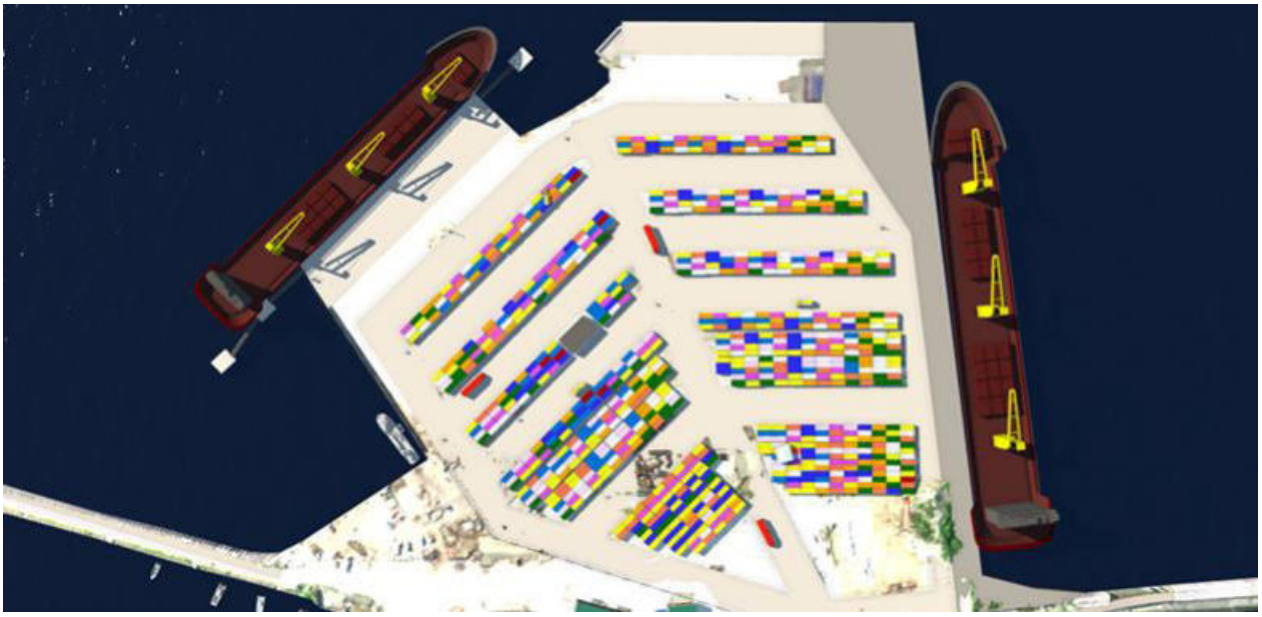
Figure 3.4: Wharf option 2



73. **Option 3.** This option is shown in Figure 3.5 and consisted of: (i) dolphins north and south of Wharf 2; and (ii) a new wharf on the eastern side including reclamation.

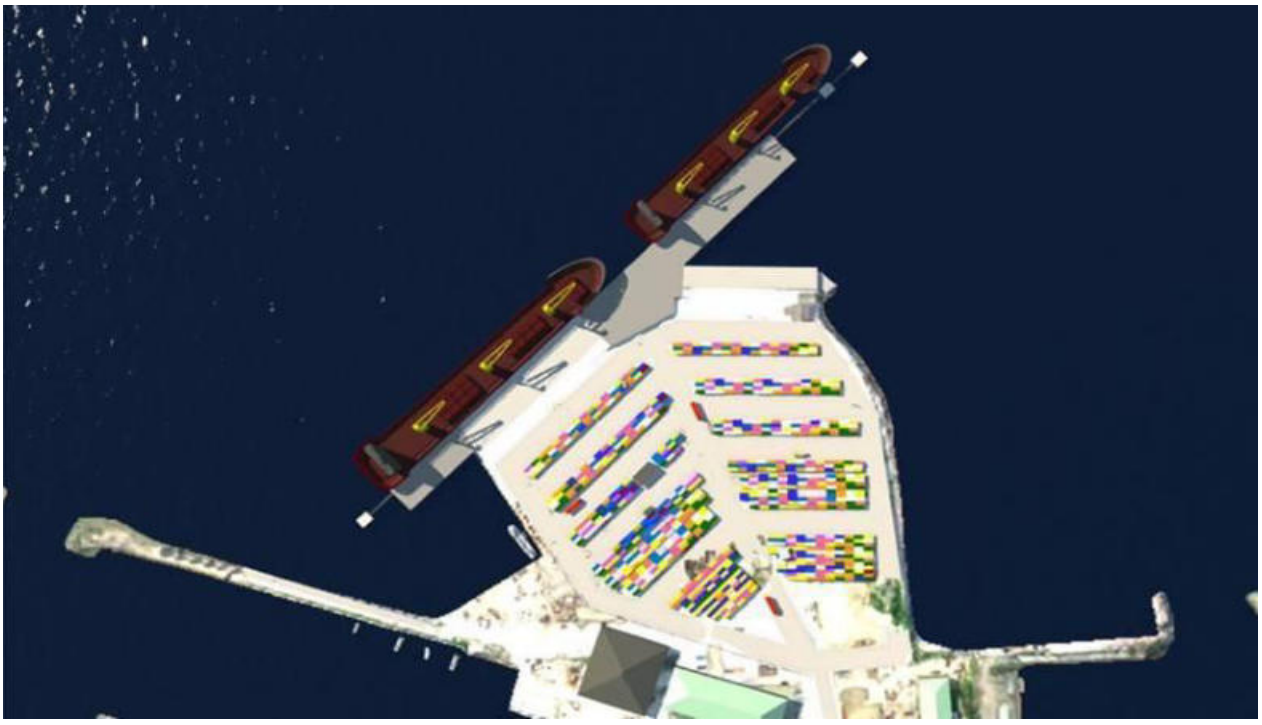
74. The main characteristics of this option were: (i) provision of a berth suitable for 220m LOA ships by adding 280 m of structure; and (ii) potential dredging = 50,000m^3 and backfill = 40,000m^3.

Figure 3.5: Wharf option 3



75. **Option 4.** This option is shown in Figure 3.6 and consisted of: (i) southern extension of Wharf 2; (ii) an infill structure between Wharf 1 and 2; and (iii) northern extension of Wharf 2.

Figure 3.6: Wharf option 4



76. The main characteristics of this option were: (i) provision of a berth suitable for 220m LOA ships by adding 350 m of structure: (ii) potential dredging = 5,000m^3 and backfill = 40,000m^3. As for option 1, the environmental implications of this option (particularly with regard to the effect on the seabed) are limited relative to options 2 and 3.

77. The key advantages and disadvantages of each option are set out in Table 3.1.

78. **Preferred option.** Option 1 was selected as the preferred option because it: (i) achieved all required criteria; (ii) exceeds the operation (efficiency and safety) and constructability criteria; (iii) had the lowest construction cost overall; and (iv) had a smaller environmental footprint.

3.3.2 Yard layout options

79. With the selection of the preferred wharf layout, the yard concept was developed with the yard designed to match the predicted increase in cargo capacity of the wharf.

80. The results of the market demand study showed that container throughput is estimated to be between 44,000 and 61,000 twenty-foot equivalent units (TEU) by the year 2040 and between 51,000 and 75,000 TEU by 2050. This provided a benchmark for the yard design.

81. The difference in the environmental implications of the different yard options are insignificant.

82. **Option 1.** This option is based on container stacks that parallel to Wharves 1 and 2 and a new electricity substation (see Figure 3.7). The total ground slots (TGS) associated with this option is 532 and annual throughput capacity is estimated to be 48,800 TEU (48% full containers, 20% reefers and 32% MTs). The open storage area associated with this option is approximately 5,300m^2.

83. **Option 2.** This option (Figure 3.8) is based on straight continuous container stacks and a new electricity substation. The TGS associated with this option is 488 and annual throughput capacity is estimated to be 46,200 TEU (33% full containers, 18% reefers and 48% MTs). The open storage area associated with this option is approximately 6,700m^2.

84. **Option 3.** This option (Figure 3.9) is based on straight continuous container stacks near perpendicular to wharf number 2 and a new electric substation. The TGS associated with this option is 605 and annual throughput capacity is estimated to be 60,700 TEU (21% full containers, 23% reefers and 56% MTs). The open storage area associated with this option is approximately 7,500m^2.

85. **Preferred option.** Option 3 was selected as the preferred option because of its container throughout capacity (open storage area). However, the yard should be operated with the flexibility to respond to any variability in cargo mix. For example, the area allocated for empty containers could also be temporarily used for dry bulk cargo storage. Likewise, the area allocated for reefers could also be used to store full containers during periods when there is a drop in reefer demand.

Table 3.1: Advantages and disadvantages of wharf options considered for the QSIW upgrade

Criteria	Option 1	Option 2	Option 3	Option 4
Operations	Main wharf under best wave climate. Small boat harbour.	Main wharf under best wave climate.	Exposure and manoeuvrability Lesser throughput. 3 wharves but only one for 220m LOA. Interaction with Navy.	One continuous wharf face of 350m under best waves climate. Navigation issues with North extension.
Maintenance	Maintenance on existing structures. Easy access from land and work boat.	Potential Maintenance dredging. Maintenance on existing structures.	Strain on fender and tug operation. Increase in wharf length Potential maintenance dredging.	Longer length of new marine asset to look after.
Constructability	Yard space for contractor available with water access at old domestic terminal. Local material and contractor can be involved. Shortest timeframe.	Congestion on local road network due to backfill import. Large marine work which will rely heavily on specialized skills and equipment.	Long time frame. Large dredging quantities. Large marine work which will rely heavily on specialized skills and equipment.	Large marine work which will rely heavily on specialized skills and equipment. Long time frame.
Engineering	Flexibility in the design in terms of type of structures selected. Construction cost and risk could be mitigated more easily through design. Impact risk of earthquakes on existing structures.	Impact risk of earthquakes on existing structures. Construction cost and risk could be mitigated more easily through design.	New quay face can be designed as protection for the lower/exposed section of the side. New independent wharf structure can be designed fully to latest earthquake codes.	Seismic structures in 20m of water. New structures to be suspended deck due to water depth – wave attenuation will be limited.
Future proofing	Opportunity to develop the berth into Option 4. No real restriction on developing further the QSIW site (yard or berth).	Limited opportunity.	Limited opportunity.	Limited opportunity.

Figure 3.7: Yard layout option 1

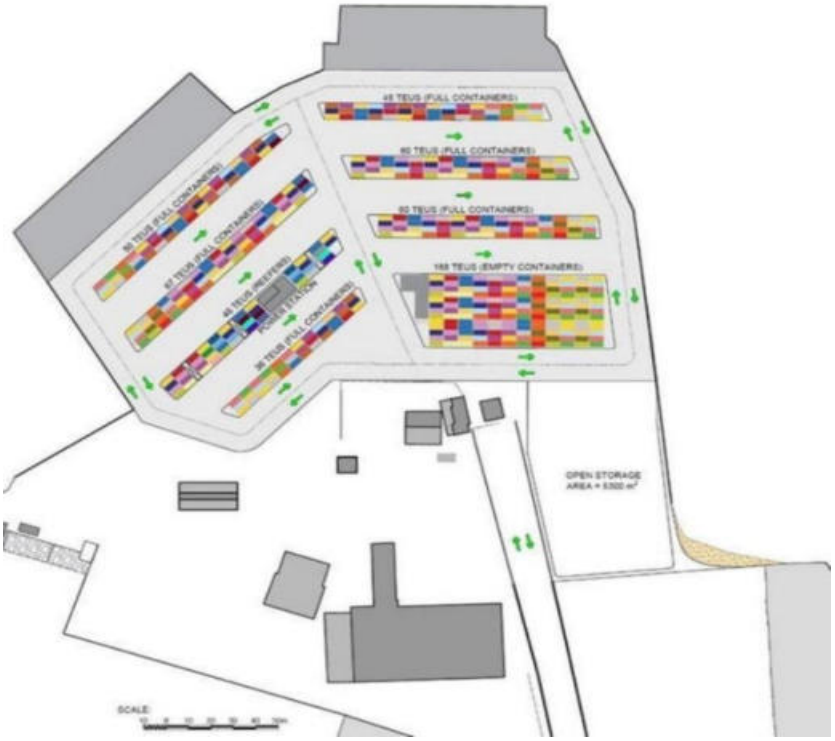


Figure 3.8: Yard layout option 2

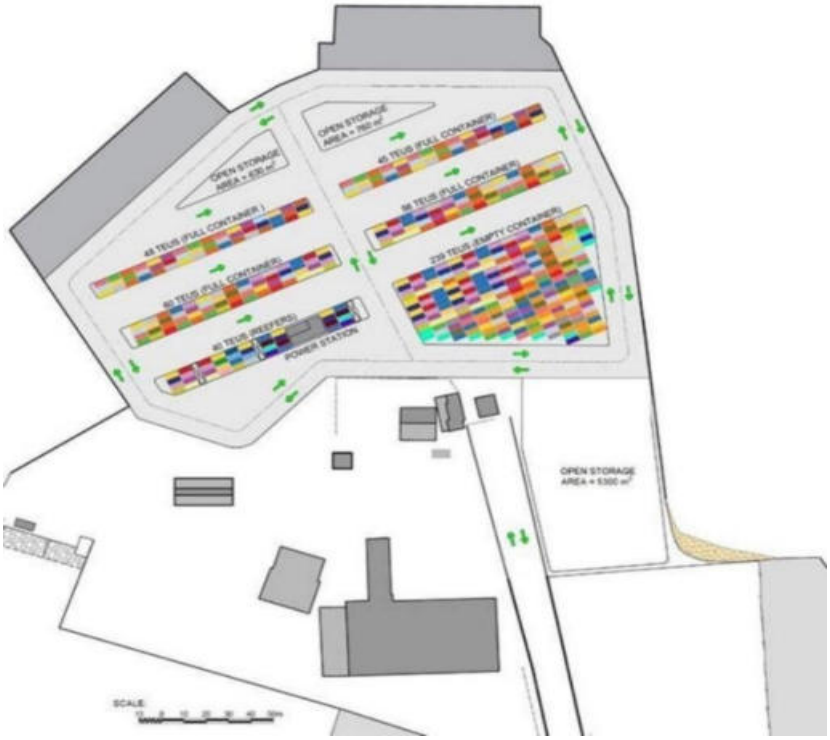
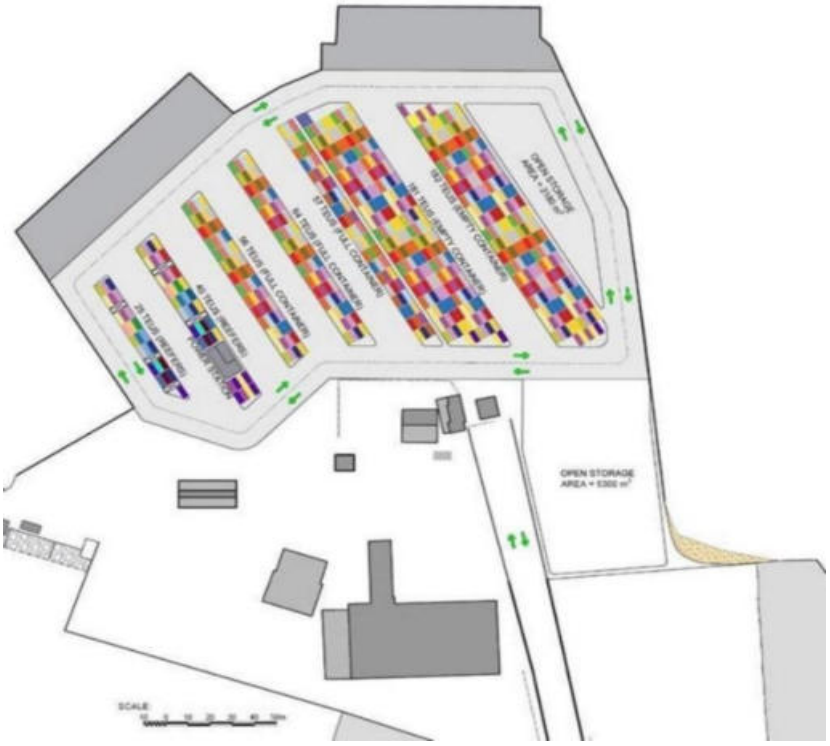


Figure 3.9: Yard layout option 3



3.4 Project Scope

3.4.1 Overview

86. The selected preferred options for the wharf and yard were further discussed and improved at key stakeholder workshops held during the concept phase of the engineering design study. The main aim was to minimise construction and maintenance costs without compromising safety and operational efficiency.

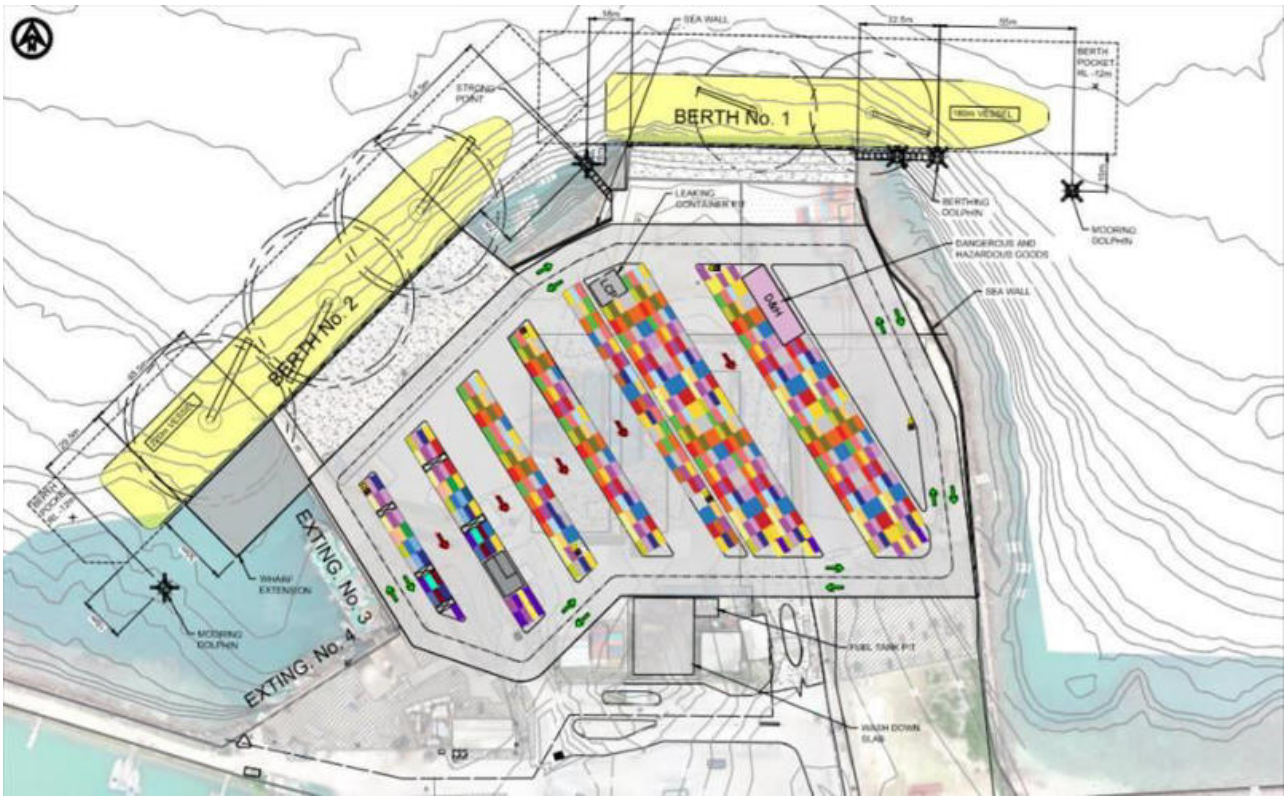
87. The proposed works (wharf option 1 and yard layout option 3) will entail the addition of two dolphins to Wharf 1 to allow for larger ships to dock (amounting to a 40m gain) and the extension of Wharf 2 by 50m, as well as the inclusion of a dolphin at its Southern end. The extension will occur around 60m seaward of the coral reef edge in approximately 11m of water depth (Figure 3.10).

88. The upgrade will allow a container throughput of 60,700 TEUs per year and container ships of the following lengths to be safely accommodated (Figure 3.11): (i) Wharf 1: Lship = 180m, largely a 'stand-by' berth and (ii) Wharf 2: Lship = 180m and 220m.

Figure 3.10: Approximate footprint of the proposed wharf extension

Notes: Drone-captured photograph of the site, looking south east toward the existing wharf; the approximate footprint of the proposed wharf extension is indicated in red.

Figure 3.11: Proposed layout of the QSIW berths 1 and 2



3.4.2 Construction phase activities and works

89. **Offshore works**. To accommodate larger ships the following works are proposed:

- Wharf 2 upgrade including: (i) southwest extension to provide an additional berth for (off)loading and handling containers; (ii) aft and forward piled mooring dolphins for tendering of mooring lines; and (iii) repairs to the wharf cope line and the installation of fenders (existing arch fenders are to be replaced with cone fenders with fender panels).
- Wharf 1 upgrade including: (i) extension of the mooring area via a dolphin to the east but no quay or apron extension; and (ii) a berthing dolphin to the east (next to the existing deck).
- A forward mooring dolphin between Wharfs 2 and 1 for mooring ships at both wharfs simultaneously (this being the same dolphin as the Wharf 2 forward dolphin referred to above).
- A wave barrier between Wharfs 1 and 2 and on the eastern side of the yard.
- Dredging of the seabed at the extended southwest end of Wharf 2 to -12.6m (RL) (see drawings in Annex 2 and Figure 3.12 below). When the quay options were originally considered, the quantity of material (predominantly a gravelly sand, as described in Section 4.2.5) to be removed was predicted to be 8,000m^3. However, following detailed design, this quantity has increased to approximately 17,135m^3 in order to increase the resilience of the new wharf extension to landslides due to earthquakes (through the removal of a top "crust" of seabed sediment). This is expected to increase the length of the dredging campaign by three weeks, which is inside the program contingency of two months.
- Installation of a new marker buoy northwest of QSIW (Figure 3.13). This proposal arose in response to the navigation assessment and discussions between the design team and the Harbour Master regarding access for ships with 11m drafts.
- Replacement of an existing navigation aid located on top of Monu Reef, restrained by small tubes driven into the reef, which cannot withstand cyclones and frequently needs to be reinstalled (see Figure 3.14). The replacement options considered were to drive a pile into the reef (in the existing location) or move it into deeper water (with a sandy seabed; see Figure 3.15) and use a mooring buoy attached to an anchor block on the seabed. The latter was selected as the option to progress.

Figure 3.12: Updated dredging plan

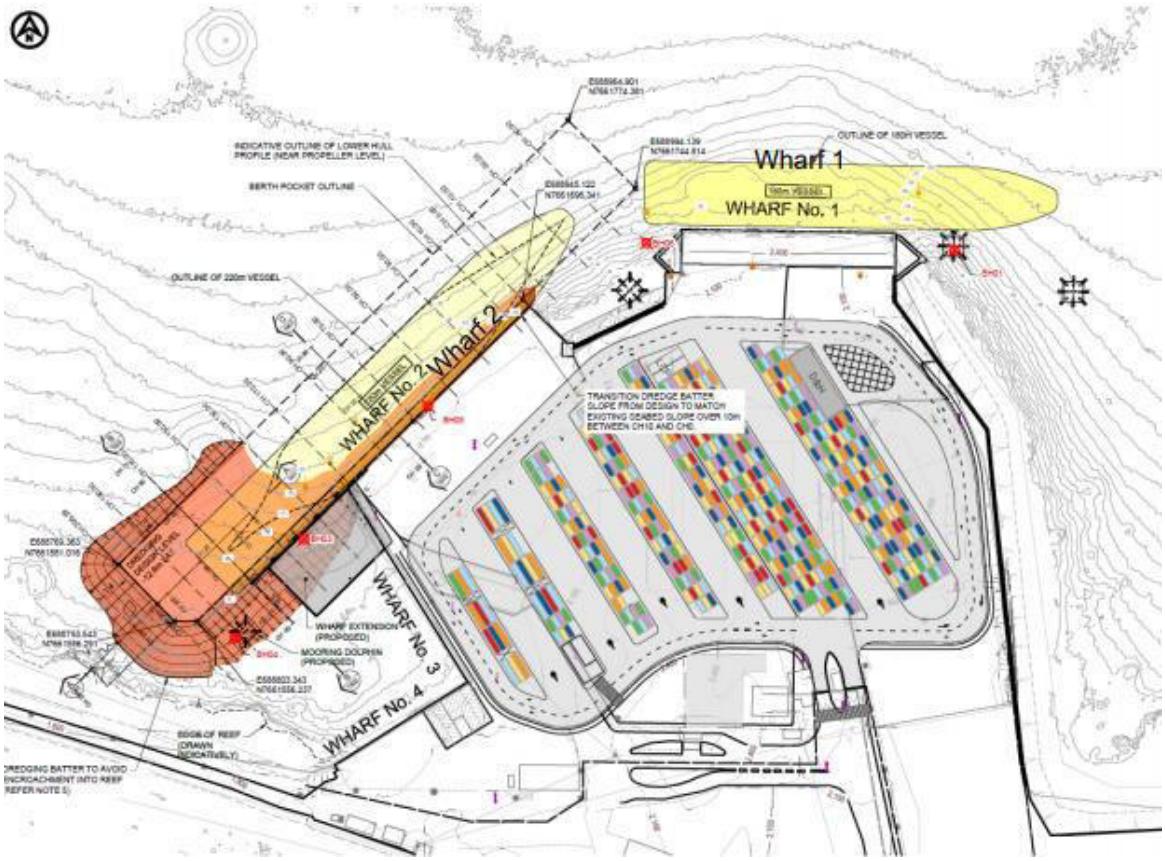


Figure 3.13: Relocation of the marker buoy in front of QSIW

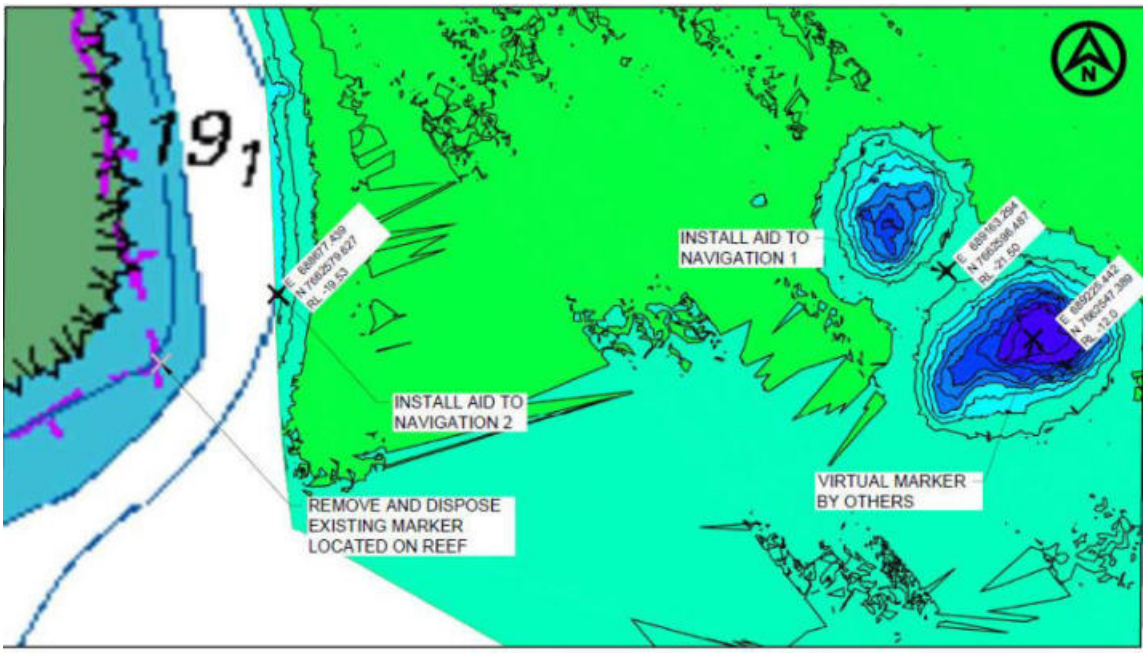
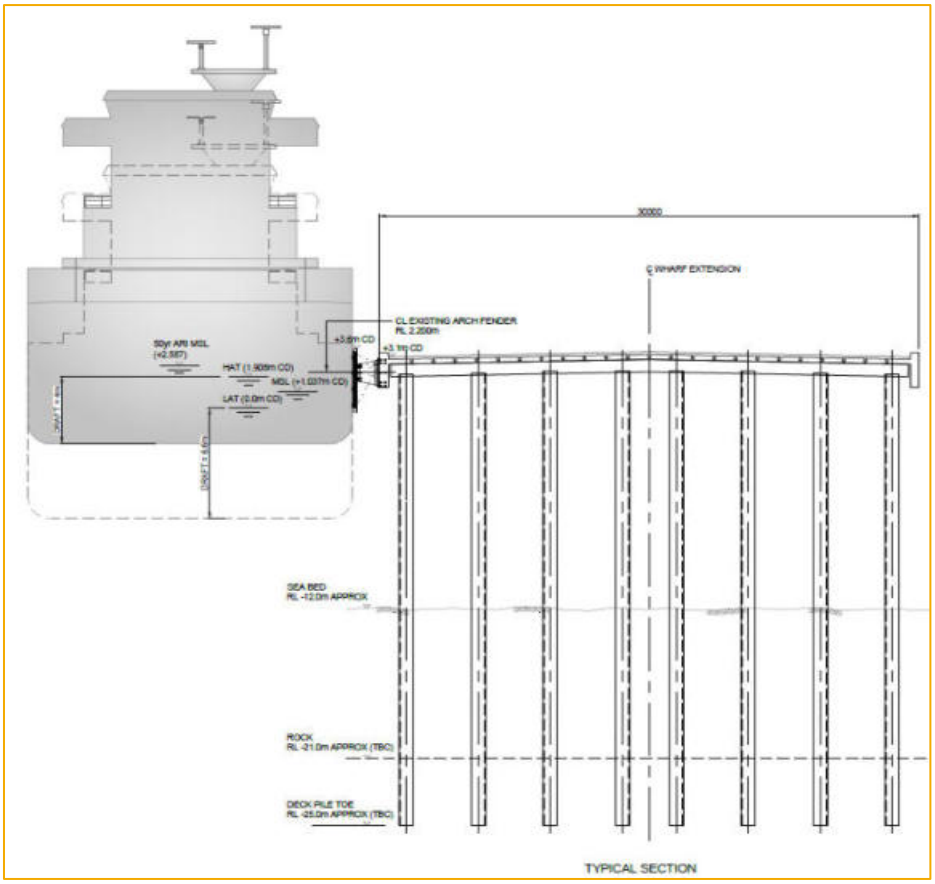


Figure 3.14: Existing (failing) navigation aid on Mona Reef

Figure 3.15: Proposed location for relocated navigation aid

90. During the key stakeholder workshop held in December 2019, the type of structure to be used for the southwest extension of Wharf 2 was selected (refer to Annex 1); that is, a suspended deck on piles. It is anticipated that the structure will be composed of 130 No. steel piles placed in a 4m by 4m grid supporting a concrete superstructure made of precast headstock and slab elements. The piles and superstructure elements (Figure 3.16) will be imported and delivered to site by sea.

Figure 3.16: Wharf 2 extension cross section



91. In general, the marine works will be undertaken by a crane barge for piling and lifting (with a 100-200t crane). A separate (small) barge will be used for the dredge, with a long reach backhoe and silt curtain. It is proposed that the dredged arisings will be dried, stored temporarily and used for another reclamation project (i.e. beneficial use).

92. The drawings contained in Annex 2 summarise the proposed marine scope of works. The proposed duration of the works is covered in Section 3.5.

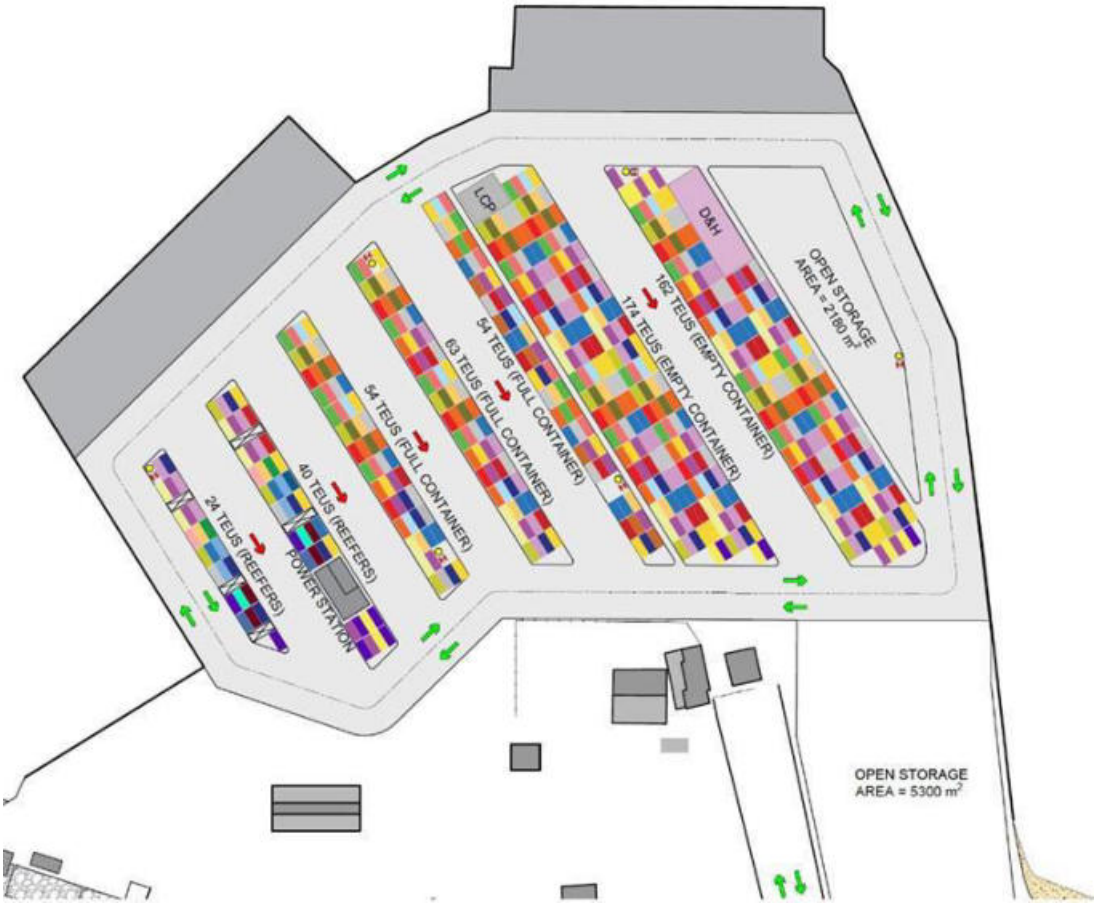
93. **Onshore works**. To provide for safer and more efficient operation, the proposed onshore layout includes:

- 605 TGS.
- 65 TEU for reefers.
- An open storage area of 7,480m^2.
- A 16m wide ring road.
- 17.5m wide internal lanes.
- An additional 20,000m^2 of pavement.

- A new drainage system with oil separators.
- A workshop washdown area and fuel tank concrete bunding.
- A new electrical substation with a generator room.
- 6 No. 30m mast LED lights.
- Firefighting system, including underground tank and hydrants.
- New fences.

94. The upgrade is designed to achieve an annual throughput capacity of 60,000 TEU (21% full containers, 23% reefers and 56% empty containers (MTs) (Figure 3.17).

Figure 3.17: Proposed layout of the QSIW container yard



95. During the workshop held in December 2019, RHDHV were instructed to proceed with the use of flexible pavement (hot mix asphalt) for the circulation/access areas and rigid pavement (reinforced concrete slab) for the container stacking areas.

96. In general, the onshore works will be undertaken from land using local materials and resources. The layout is based around: (i) roads and lanes being clearly demarcated; (ii) container handling being kept separate from main thoroughfares; (iii) one-way traffic being implemented between container stacks; (iv) required reversing manoeuvres being kept to a minimum; and (v) a yard layout that allows for good line of sight, especially at intersections.

97. The area of new pavement will be around 20,000m^2. However, the yard layout has been designed to limit the manoeuvring of terminal equipment so that wear and tear is minimised.

98. The concrete for the pavement (around 3,000m^3) will be produced locally (at an existing plant). The yard works will be undertaken using standard concrete and dump trucks for construction of the sub-base; with around 3 to 5 movements a day on average.

99. The concrete arising from the demolition phase could be crushed and made available for reuse elsewhere. The possible location for this material is not known at this stage. It is not an associated facility. Disposal of any excess material will be at sites selected in alignment with the CSS and SPS. Sites will be approved by the Engineer, prior to any disposal.

100. **Material sources**. Limestone aggregate (for concrete) and rock boulders[5] will be sourced locally; there are three quarry sites (Ahononu, two sites at Pelehake) in the vicinity of Fuaamotu Airport and over 10 quarries on Nuku'alofa that can provide the quantity of material required. New borrow pits will not need to be opened. All other materials will be imported directly to site including: (i) for the marine works - steel piles and the precast concrete elements of wharf extension structure; and (ii) for the yard works - oil traps, electrical equipment, lighting poles, reefer gantries, CCTV equipment and firefighting equipment (pump, tank and hydrants). A dedicated temporary storage area will be established to hold this material.

101. Locally sourced materials will be used for the pavement surface layer (aggregate as part of Asphalt Hot Mix), pavement base material (crushed coral from one of the above mentioned operational quarrys), existing revetment top-up (rock) and concrete (i.e. the slab overlay, wave barrier). The cement will be imported but the concrete produced in an existing batching plant using local aggregate (i.e. a new batching plant does not need to be established). The existing concrete plant (see Figure 3.18) is expected to produce 300 m^3/day and be served by 5 No. 8m^3 trucks.

102. **Contract phasing and workforce**. The proposed works are to be divided into two construction phases over the areas shown on Figure 3.19 and the works involved in these construction phases are described below and shown on Figure 3.20.

[5] Sand has not been able to be extracted in Tonga since 2006 due to overexploitation. Crushed limestone is now used to replace sand.

Figure 3.18: Location of the concrete plant relative to QSIW

Figure 3.19: Proposed construction phases

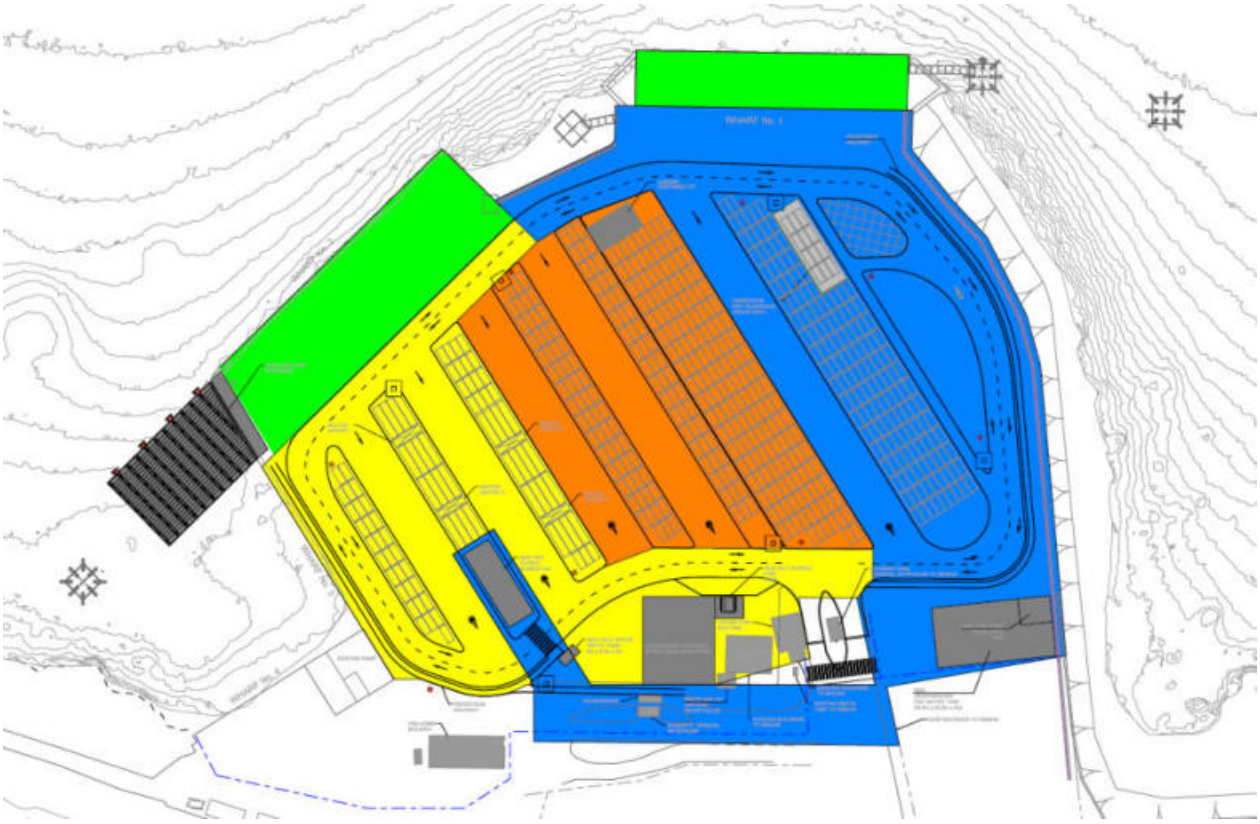
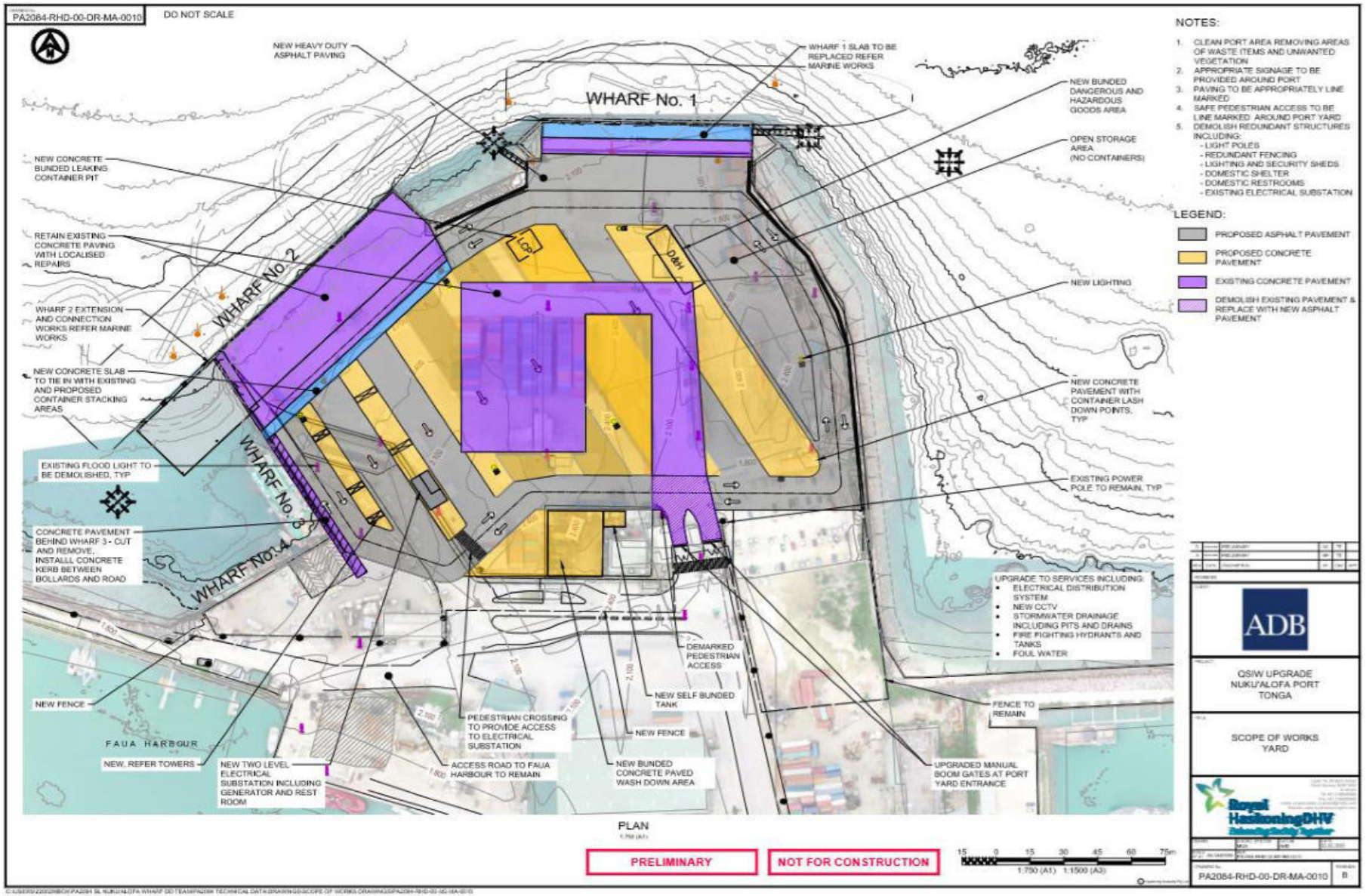


Figure 3.20: Layout of proposed works



103. Phase 1 –

a. September 2021 to February 2022: mobilisation, casting of precast elements offshore and preliminary activities on site. Arrival of barges, equipment and material by ship. Set-up of the Contractor's site office and yard.

b. March to September 2022: refurbishment of Wharf 1 slab and installation of piles. Barges with piling rigs to drive piles and drill rock sockets 4m into the limestone sub-base for approximately 130 piles. Demolition and disposal of 240m^3 of reinforced concrete. Installation of approximately two drain outlets and oil separators. Installation via land crane of 700t of imported precast concrete slab elements. Repair of 400m^2 of existing deteriorated concrete surface.

c. March to June 2022: construction of the wave barrier. Installation of 2,000m^3 of 2t local rock. Pouring 500m^3 of concrete.

d. July to November 2022: construction of pavement and services over Area 1. Installation of 7,500m^2 of pavement. Use of 3,000m^3 of local crushed coral as base material. This would be a shore-based operation using a mobile crane, dump trucks and around three gangs of six labourers.

- Phase 2 –

a. November to March 2023: construction of new substation, underground fire system and pavement over Area 2. Installation of 7,500m^2 of pavement and use of 3,000 m^3 of local crushed coral as base material. Installation of approximately two drain outlets and oil separators. This would be a shore-based operation using dump trucks and around three gangs of six labourers. Construction of the new electricity sub-station will also occur in this phase, to include 100m^2 of electrical switchgear, a generator and toilets

b. November to December 2023: Wharf 2 extension. This activity will occur immediately following the Wharf 1 upgrade to minimise mobilisation requirements. It will include the use of a large mobile crane to lift into position 20t imported precast concrete elements and will use a total of 2,500t of precast material and 225m^3 of locally derived concrete.

c. March to April 2023: switch from existing substation to new substation. Connection of the existing site supply to new reefer gantries and six 30m lighting poles. Demolition of the existing sub-station building.

104. Phase 3 –

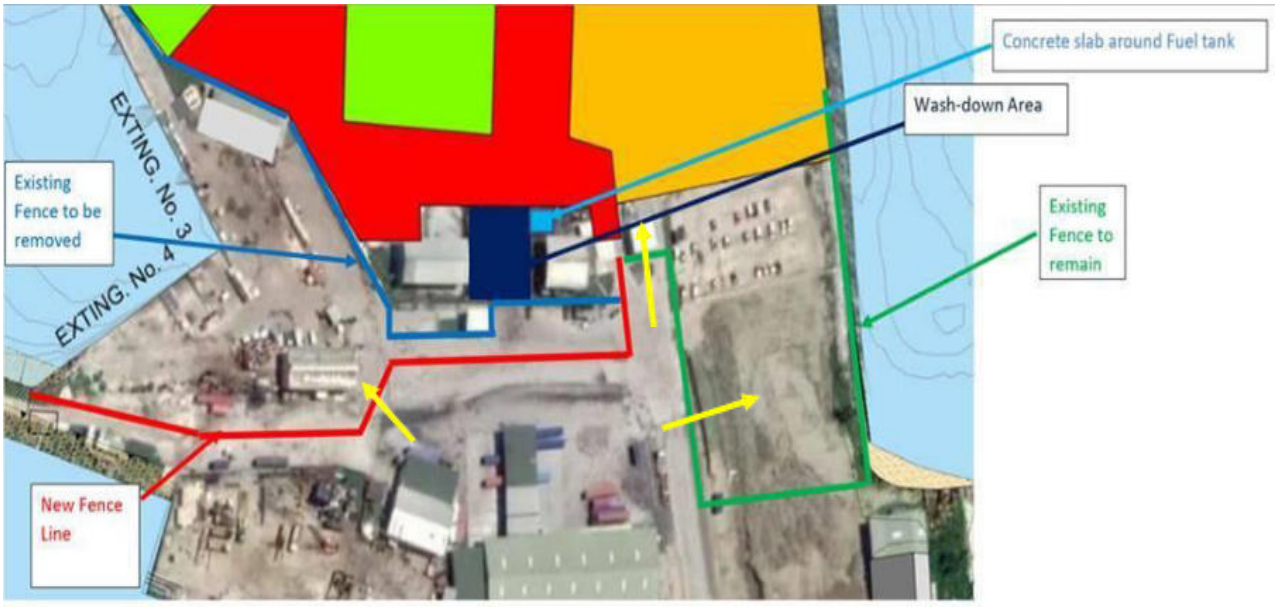
a. January to March 2024: pavement and services over Area 3. Involving the use of 1,500m^3 of local crushed coral as base material. This would be a shore-based operation using dump trucks and around three gangs of six labourers.

b. March to April 2024: refurbishment of the access road and gatehouse.

c. May to June 2024: demobilisation and general finishing around the yard and wharf structures.

105. **Fencing and security**. The fencing and bunding proposals for the construction phase, to minimise interaction between continuing operations and construction, are shown in Figure 3.21. The construction phase will have a duration of around 24 to 36 months, depending on weather conditions. Working hours will be 8:00 to 17:00 Monday to Saturday. The predicted number of workers required is 10 for the marine works and 20 for the yard, at peak.

Figure 3.21: Proposed bunding arrangements for the construction phase (access in yellow)



106. **Vehicles and access**. The number of vehicles to be used during construction will vary depending on the phase but is expected, on average, to be 30-40 a week.

107. Concrete deliveries will be made from a local plant approximately 5.2km west of the site and deliveries of rock boulders and fill material from a quarry located 21.3km southeast of the site (as previously shown on Figure 3.18). It is anticipated that there will be 3-5 HGV movements associated with rock and concrete delivery per day during the peak period of the works. It is assumed that additional construction equipment and materials will be delivered via the local road networks but are unlikely to exceed 3 HGV movements per hour. Deliveries of concrete are likely to be made in the early morning or in the evening using the by-pass road leading directly to QSIW.

3.5 Operational Phase

108. In the operational phase the container yard will be based around a ring road, with one 4m lane in each direction. The access between stacks will be one-way only, with the width between stacks being 17.5m to accommodate reach stacker and empty container handler (ECH) operations.

109. It is recommended that all trucks are required to use the ring road to get around the port and trucks should only be permitted to use the one-way internal roads if they are collecting or dropping off a container in that row. No container or cargo handling should be carried out from the ring road.

110. Access to the wharf apron should be restricted to terminal tractor trailers, with external trucks only collecting/dropping off containers at the container stacks. When undertaking container / cargo handling, reach stackers, forklifts and ECH should operate over short distances only, with the transport between the wharf and storage areas being undertaken using terminal tractor trailers.

111. Each type of container will be stacked and stored as per the parameters defined in Table 3.2.

Table 3.2: Container type, stack and storage parameters

Container type	Max. stack height	Average stack height	Peak factor	Dwell time (days)
Full	3	2.1	1.3	8
Refrigerated (reefer)	3	2.25	1.3	3
Empty (MT)	5	4	1.3	12

112. The number of ship calls to the upgraded facility from the baseline is not expected to increase. Rather, the new facility will be able to accommodate larger ships carrying more containers (i.e. 2,000 TEUs); with units for delivery to Nuku'alofa, Apia, Suva etc.

113. For the purposes of this assessment 2024 has been taken to be the baseline year, with 53 vessel calls expected per annum by up to 1,000 TEU-capacity vessels. Each vessel of this capacity typically delivers 300 TEUs to QSIW. Hence, around 53 x 300 TEUs are delivered annually (15,900 TEUs), amounting to 306 TEUs per week.

114. In the same year, there will also be 25 vessel calls by 1,000-2,000 TEU-capacity vessels, each typically delivering 400 TEUs to QSIW. Hence, they could deliver 10,000 TEUs per year. As this vessel size range calls at the port once every fortnight, the port receives 192 TEUs/week from this size of vessels. In total, therefore, the port currently serves around 498 TEUs per week.

115. By the same logic, with the upgrade, in the Year 2029 the average delivery to QSIW (based on a 2000 TEU vessel) would be 542 TEUs per week.

116. Since most of the dry bulk handled at the port is project cargo (i.e. cargo imported specifically for construction projects) it is not possible to determine an annual throughput capacity for dry bulk. This is due to project cargo typically being imported only a few times a year during short but intense periods. When project cargo is imported, the open storage area will be required for the temporary storage of this cargo. For the rest of the year the open storage area may be used for other purposes, e.g. parking imported vehicles.

4 DESCRIPTION OF THE BASELINE ENVIRONMENT

4.1 Introduction

117. Tonga is a Polynesian country and archipelago comprising 172 islands, of which 36 are inhabited. Its' total surface area is around 747km^2 covering over 720,000km^2 of the central southern Pacific Ocean. Nuku'alofa, located on the north coast of the island of Tongatapu (the largest island in the Kingdom, at roughly 260 km^2) is the capital city of Tonga and serves as the nation's economic, political and education centre. The city accommodates 24,500 people out of Tongatapu's total population of 108,020 according to the latest estimate by the National Statistics Office (2018). Around 71% of the population of Tonga reside on Tongatapu.

118. QSIW is located in Nuku'alofa and is part of the larger Nuku'alofa Port complex. It is Tonga's only international port. The rest of the existing marine facilities are mainly domestic wharves serving inter-island trade.

119. Tonga's international trade is import driven, with around 96% of the total trading volume being imports, and the import cargo volume grew from 128 thousand tonnes to 259 thousand tonnes between 2010 and 2016. The country's import trading partners in 2016 were largely Fiji, the Netherlands and New Zealand.

4.2 Physical Resources

4.2.1 Geology and water resources

120. **Geology**. Tonga's archipelago is situated at the subduction zone of the Indian-Australian and the Pacific tectonic plates and within the 'Ring of Fire' where intense seismic activities occur.

121. Within Tonga there is a western line of islands of volcanic origin, steep topography and generally high elevations, and an eastern line of generally low-lying limestone and mixed geology islands. The eastern group, where the majority of the population lives, includes Tongatapu, 'Eua and most of the islands of the Ha'apai and Vava'u groups.

122. The islands of Tongatapu are composed of emerged and tilted limestones of Pliocene and Quaternary age with a volcanic soil mantle. Their morphologies and surface geology are mainly the result of subaerial and marine erosion. Tongatapu itself is made up of Pliocene and Pleistocene limestone 130-250 m thick overlying lower Pliocene and older volcaniclastics. The limestone is elevated above present sea level and reaches a maximum height of 65-70 m at the southern end of the island. This forms the high point of a narrow and irregular ridge (0.5-1.25 km wide and mostly rising more than 20 m above sea level) that extends to the northeast and northwest along the windward coasts. The ridge encompasses a broad, low area in the central and northern part of the island that rises gently to the south.

123. The seabed on the island's windward coast slopes steeply to depths of 200m but the northern part of the Tongatapu block comprises a shallow lagoon (mostly <50m in water depth) about 600km in area.

124. Tongatapu is surrounded by coral reefs and covered with thick fertile soil (ranging in thickness from about 5m in the west of the island to just 1m in the east) consisting of volcanic ash from emergent volcanoes such as Tofua and Kao and from submarine volcanoes to the west.

125. **Water resources**. Tongatapu has no surface water resources, with water supplied from groundwater stored in a freshwater lens. This lens varies in depth from 1.0 - 2.5m below sea level in the west, and approximately 5-8m below sea level in the central and eastern part of the island. There is a well-field at Mataki'eua that extracts water to supply Nuku'alofa.

126. However, freshwater lenses form on top of seawater in many of the islands due to the difference in density of the two fluids. The interface, or boundary, between the two fluids forms a transition zone. Within the transition zone the water salinity increases from that of freshwater to that of seawater over a number of metres.

127. Rainwater harvesting systems are a complementary freshwater resource, and an essential source of potable water on many of the islands.

4.2.2 Climate, climate change and wind conditions

128. **Climate**. Nuku'alofa has a subtropical climate, with a wet and hot season from November to April, and a dry and cool season from May to October. Rainfall on Nuku'alofa averages around 1,800 mm per year. In the 45-year period between 1970 and 2015, 347 tropical cyclones affected the southwest Pacific. In the same period 73 cyclones passed through Tongan waters, of which 24 were severe (32%).

129. Mean annual temperatures vary from 27^0C at Niuafo'ou and Niuatoputapu to 24^0C on Tongatapu. Diurnal and seasonal variations can be as much as 6^0C throughout the island group. During the hot wet season, the average temperature ranges from 27-29^0C whereas, during the dry cool season, the average temperature ranges from 20-24^0C.

130. Tonga has seen an increasing trend in the occurrence of tropical cyclones and there is evidence that the intensity of cyclones has increased since the 1980s. Cyclone Isaac in March 1982 affected Ha'apai and Tongatapu, Cyclone Renee in 2010 severely affected Tongatapu, Vava'u and the Ha'apai group, a combination of Cyclone Cyril swiftly followed by Cyclone Jasmine heavily affected Tongatapu in February 2012, and Cyclone Gita also heavily affected Tongatapu in February 2018. All of these cyclone events caused severe damage to crops and food supply, infrastructure, tourist resort, the environment and buildings and disrupted essential services and the wellbeing of affected communities for a prolonged period of time.

131. **Climate change**. Climate projections for Tonga are based on three IPCC emissions scenarios: low (B1), medium (A1B) and high (A2), for 2030, 2055 and 2090 (PCCSP, 2011). Climate projections for Tonga suggest that there will be:

- Increasing temperatures - projections for all emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future in Tonga. By 2030, under a high emissions scenario, this increase in temperature is projected to be in the range of 0.3–1.1°C.
- More very hot days - increases in average temperatures will also result in a rise in the number of hot days and warm nights and a decline in cooler weather.
- Changes to rainfall patterns - projections generally suggest a decrease in dry season rainfall and an increase in wet season rainfall over the course of the 21st century. Wet season increases are consistent with the expected intensification of the South Pacific Convergence Zone. Projections show that extreme rainfall days are likely to occur more often.
- Less frequent but more intense tropical cyclones - projections tend to show a decrease in the frequency of tropical cyclones by the late 21st century and an increase in the proportion of the more intense storms.
- Rising sea levels - sea level is expected to continue to rise and, by 2030 under a high emissions scenario, the increase is projected to be in the range of 3-17 cm. The sea-level rise combined with natural year-to-year changes will increase the impact of storm surges and coastal flooding.
- Continued ocean acidification - under all three emissions scenarios the acidity level of sea waters in the Tonga region will continue to increase over the 21st century. The impact of increased acidification on the health of reef ecosystems is likely to be compounded by other stressors, including coral bleaching, storm damage and fishing pressure.

132. Tonga's high vulnerability to the effects of climate change (and, in particular, more intense cyclones and rising sea levels), places Tongans at risk of increased hardship that will predominately affect poor and vulnerable households and individuals. The effects of climate change are also likely to affect port infrastructure and options, disrupting the import of goods, potentially increasing the prices of these goods and, therefore, affecting the poor and vulnerable households, with lower purchasing power.

133. **Wind conditions**. The prevailing winds in Tonga consist mainly of the south-easterly trade winds, but the cyclones that pass through the area are generally from the north-east. Under ambient conditions the wind speed is typically between 2.6m/s and 7.5m/s (according to The National Institute of Water and Atmospheric Research (NIWA) New Zealand) and strong winds are not common. In extreme wind conditions, however, the wind has been recorded to reach 26.3m/s from the northeast. Strong northerly winds are observed during the wet season and it is expected that significant waves (up to 3m) could impact the site during a cyclone from the north. In addition, gales from eastward migrating high-pressure systems can occur during winter.

134. Meteorological data from the weather station at Nuku'alofa, located approximately 1.8km north-west of QSIW (Figure 4.1), were analysed to provide baseline weather conditions for the site.

Figure 4.1: Meteorological station location

135. Wind data were analysed to determine the percentage of observations in which the wind was blowing in each direction, over a period from 1 January 2014 to 31 March 2019. The total number of observations across the monitoring period was 45,951. The results of the analysis are broken down into 22.5° sectors and are detailed in Table 4.1.

136. As can be seen from Table 4.1, over the past five years the prevailing winds at the site were easterly, south-easterly and southernly winds (the Southeast Trade Winds). As Nuku'alofa experiences a wet (December to April) and dry (May to November) season, wind directions were separated further based by season (Table 4.2).

137. As can be seen from Table 4.2, the two different seasons had similar percentages of observations from each direction, with winds originating from the east, south-east and south (90 – 180°) on average 63% of the time from 2014-2018 (61% of the time in the wet season and 64% of the time in the dry season).

138. Wind speeds from the Nuku'alofa Meteorological Station were also analysed by season from 2014-2019 (Table 4.3). Average wind speeds during both seasons were similar over the time period, however, maximum recorded wind speeds were higher during the wet season.

Table 4.1: Wind direction analysis 2014-2019

Wind direction (degrees)	Proportion (%) of observations from direction					
	2014	2015	2016	2017	2018	2019*
0 – 22.5	3%	3%	2%	3%	4%	5%
22.5 – 45	3%	4%	3%	4%	5%	5%
45 – 67.5	6%	6%	6%	7%	10%	9%
67.5 – 90	6%	6%	8%	7%	8%	7%
90 – 112.5	**17%**	**16%**	**23%**	**17%**	**15%**	**21%**
112.5 – 135	**23%**	**24%**	**22%**	**20%**	**18%**	**22%**
135 – 157.5	**13%**	**15%**	**10%**	**13%**	**11%**	**12%**
157.5 – 180	**11%**	**13%**	**9%**	**13%**	**10%**	**10%**
180 – 202.5	5%	5%	4%	6%	5%	2%
202.5 – 225	3%	2%	2%	2%	3%	1%
225 – 247.5	2%	2%	2%	1%	2%	1%
247.5 – 270	1%	1%	1%	1%	2%	1%
270 – 292.5	2%	0%	1%	1%	1%	0%
292.5 – 315	1%	1%	1%	1%	1%	1%
315 – 337.5	1%	1%	2%	2%	2%	2%
337.5 – 360	2%	2%	2%	2%	2%	2%
*from 01/01/2019 to 31/03/2019						

Source: Nuku'alofa Meteorological Station

Table 4.2: Wind direction analysis 2014-2018 by season

Wind direction (degrees)	Proportion (%) of observations from direction by season										
	2014		2015		2016		2017		2018		2019*
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
0 – 22.5	5%	2%	4%	3%	2%	2%	3%	3%	5%	3%	5%
22.5 – 45	5%	2%	5%	3%	4%	3%	4%	4%	5%	6%	5%
45 – 67.5	8%	5%	8%	4%	5%	7%	6%	7%	12%	8%	9%
67.5 – 90	7%	6%	7%	5%	7%	9%	6%	8%	11%	7%	7%
90 – 112.5	**18%**	**17%**	**14%**	**17%**	**29%**	**18%**	**15%**	**18%**	**17%**	**14%**	**21%**
112.5 – 135	**24%**	**22%**	**24%**	**25%**	**27%**	**18%**	**18%**	**22%**	**19%**	**18%**	**22%**
135 – 157.5	**13%**	**13%**	**12%**	**17%**	**7%**	**13%**	**12%**	**13%**	**9%**	**13%**	**12%**
157.5 – 180	**10%**	**12%**	**11%**	**14%**	**7%**	**11%**	**14%**	**13%**	**7%**	**12%**	**10%**
180 – 202.5	3%	6%	4%	6%	2%	6%	7%	5%	3%	6%	2%
202.5 – 225	2%	4%	3%	2%	1%	3%	3%	2%	1%	4%	1%
225 – 247.5	1%	2%	2%	1%	1%	2%	2%	1%	1%	3%	1%

Wind direction (degrees)	Proportion (%) of observations from direction by season										
	2014		2015		2016		2017		2018		2019*
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
247.5 – 270	1%	2%	1%	0%	1%	2%	2%	1%	1%	3%	1%
270 – 292.5	1%	2%	1%	0%	1%	1%	2%	0%	1%	1%	0%
292.5 – 315	1%	2%	1%	0%	1%	1%	1%	0%	2%	1%	1%
315 – 337.5	1%	1%	2%	1%	3%	1%	3%	1%	2%	1%	2%
337.5 – 360	2%	2%	4%	1%	2%	2%	2%	2%	4%	1%	2%
*01/01/2019 – 31/03/2019											

Source: Nuku'alofa Meteorological Station

Table 4.3: Wind speed analysis 2014-2019 by season

Wind speed	Wind speed ($m.s^{-1}$)										
	2014		2015		2016		2017		2018		2019*
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Median	4.1	3.8	3.8	4.0	4.8	3.3	3.4	3.8	4.0	3.6	4.2
Maximum (date)	18.8 (1 Mar)	12.3 (17 May)	14.5 (21 Mar)	11.5 (20 Nov)	17.6 (05 Apr)	14.1 (10 Jun)	15.1 (15 Feb)	13.4 (23 May)	36.6 (12 Feb)	11.3 (02 May)	17.7 (27 Feb)
*01/01/2019 – 31/03/2019											

Source: Nuku'alofa Meteorological Station

4.2.3 Air quality

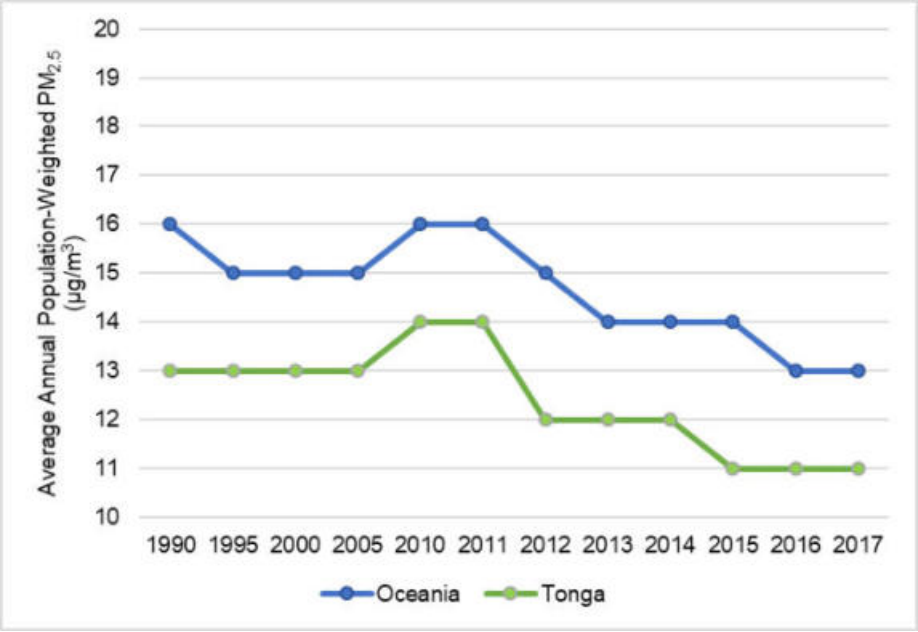
139. While there are no air quality data available for the project area and no air quality standards enforced in Tonga, air quality is expected to be relatively good due to limited air pollution sources. Based on research from 2015 (Ehsani & Mwaniki, 2017), the main sources of air pollution in Tonga are generated by industry (power generation (92% diesel and 8% renewables), transport and some open burning of agricultural / municipal waste).

140. Air emission sources in and around the proposed development site are likely to include vehicular road traffic exhaust releases, shipping vessel emissions and any other port-related fuel combustion processes. The quantity and composition of vehicle emissions is dependent on the type of fuel used, engine type, size and efficiency, vehicle speeds and the type of exhaust emissions abatement equipment employed. Vessel and tug emissions will occur within the approach channel during manoeuvring, and from auxiliary engine use at the quay.

141. The main pollutants of health concern in the exhaust of such marine and road vehicle fuels are nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$), as these pollutants are most likely to approach their respective health-based air quality standards in proximity to ports and busy roads.

142. A review of information available on global air quality found that the average annual population-weighted $PM_{2.5}$ concentration for Tonga was reported as being 11µg.m^{-3} in 2017 (Health Effects Institute, 2019) and the World Health Organization (WHO) reported the annual mean concentration of $PM_{2.5}$ in urban areas of Tonga as being 10µg.m^{-3} in 2016 (WHO, 2018). Figure 4.2 shows the average annual population weighted $PM_{2.5}$ concentration in Tonga from 1990 to 2017, as reported by the Health Effect Institute (2019) and compares it to the Oceania region concentration.

Figure 4.2: Average annual population weighted $PM_{2.5}$ (µg.m-3) for Tonga and Oceania Region



Source: Health Effects Institute (2019)

143. Because some areas of the port are unpaved, dust dispersion can be an issue inside the port, especially during windy conditions. Ship passengers have complained about dust when interviewed.

4.2.4 Marine environment conditions

144. QSIW is located on a reclaimed intertidal reef flat on the northern coastal side of Tongatapu. Its boundary follows the natural coastline and is bordered to the north by Wharfs 1 and 2 and to the west by Wharfs 3 and 4. No reef systems are present seaward of these wharfs, however, between Wharfs 1 and 2 a revetment wall (approximately 60 m in length) is present.

145. The QSIW eastern boundary is defined by a breakwater that is bordered by a subtidal fringing reef (1 – 10m water depth and 15m in width) along its full length that extends through to the western side of the Navy's compound channel. This reef system continues eastwards, following the natural coastline that includes an extensive intertidal reef flat and distinctive reef crest, edge and upper and lower reef slopes.

146. Nuku'alofa Port's initial reclamation activities were undertaken in the 1960s and the port has operated since this time. As such, significant terrestrial, coastal and marine ecosystem alteration has occurred within the port lease and adjacent coastal areas, resulting in a highly modified marine reef and coastal ecosystem.

147. The development of Faua Harbour and the domestic shipping terminal to the west and the Navy boat harbour to the east have contributed significantly to the alteration of the coastal and intertidal reef ecosystems. The reclamation of the original shallow water intertidal lagoonal reef and exposed beach areas has had negative effects on the area's benthic resources, especially the sessile species associated with the area's intertidal reef flat systems.

148. The coastline associated with QSIW port's boundary is protected by a rock revetment seawall (calcareous limestone rock) designed to provide year-round protection from storm surge and waves (Plates 4.1 a and b and 4.2 a and b). The revetment is located directly on the benthic intertidal reef substrate (1 - 8m) and extends several metres above the high-water mark.

Plates 4.1 a and b: Rock revetment east of QSIW

Plates 4.2 a and b: Rock revetment west of QSIW

149. This wall extends westward (outside of the port's boundary) on the intertidal reef flats' outer reef edge/crest to provide protection to Vaua Harbour and further west to the new domestic shipping terminal; as well as eastwards, providing coastal protection for Nuku'alofa.

150. QSIW's four wharfs are bordered on the seaward side by sheet piles and all wharfs, except Wharf 1 (the oldest), are backfilled (Plates 4.3 and b) to the sheet piles. The average depth of water directly adjacent to the port's wharfs ranges from 18m (Wharfs 1, 2 and 3) through to 10m for Wharf 4.

151. The subtidal benthic substrate extends seaward of the wharfs in a gentle decreasing slope to a depth of 23m some 400m offshore and is composed primarily of reef derived sand with a thin layer of finer sediment on the surface of the seabed.

Plates 4.3 a and b: Sheet piles (a) seaward and (b) shoreward of Wharf 1

4.2.5 Soils and marine sediments

152. During the feasibility study investigations, six deep land boreholes and five over the water boreholes (Figure 4.3) were drilled in October and November 2019. Samples for geochemical testing were recovered from the top 2m of BHA, BHB, BHD, BH01, BH03, BH05, BH06 and BHC3. That is, for all locations, soil/sediment samples from depth increments of 0-0.5 m, 0.5-1.0 m and 1.0-2.0 m were obtained.

153. **Subsurface conditions**. The geotechnical investigation revealed the subsurface conditions at the site to be undifferentiated deposits to depths of between -3m RL to -6.15m RL. Stratigraphically this is gravelly sand/silt over sand which overlies a thin layer of silt/clay. This layer is then underlain by the distinctly weathered Pliocene and Pleistocene Biosparite Limestone.

154. The seabed surface sediments comprise silty sand with shell fragments and angular to sub-rounded trace gravel. The surface sediment characteristics at the two boreholes locations in the vicinity of the proposed wharf extension were: (i) BH03: sand, trace silt and gravel, medium dense, pale grey, uniformly graded, angular to sub-angular; wet; and (ii) BH04: Silt, with sand and trace gravel, dark grey, very soft, low plasticity; sand (20%), fine to medium, angular to sub-angular; wet.

155. Tthe surficial seabed sediments are composed of reef-derived (calcareous) sand and coral rubble, primarily occurring via a process of marine dissolution (notching and cliffing) rather than abrasion by waves (which is improbable in view of the protected nature of the inner lagoon) (Roy, 1990).

Figure 4.3: Borehole locations

156. **Sediment quality**. All samples were tested for heavy metals and 50% of samples were also tested for polynuclear aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), BTEX, tributyltin (TBT) and particle size distribution (PSD). A summary of the results obtained is provided in Table 4.4.

157. There are no sediment quality guidelines for Tonga, hence, the contaminant concentrations in the soil and sediments were compared to ANZG (2018). Organic parameters have been normalised to 1% TOC (Total Organic Carbon) over a TOC range of 0.2 – 10%.

158. The results show low concentrations of metals for both the soil and sediment samples. The results for organic material, including BTEX, PAHs and TPHs, were either below guidelines or below laboratory detection.

159. TBT compounds have been used in antifouling paints since the early 1960s to prevent the settlement and growth of marine fouling organisms on ships hulls and other submerged structures. TBT enters the environment via hull cleaning practices and leaching from hulls. The use of TBT was banned worldwide in 2008. TBT concentrations at BH01 exceeded the ANZG (2018) guideline of 9 µgSn/kg, which is also the guideline level for the Commonwealth of Australia National Assessment Guideline for Dredging 2009.

Table 4.4: Summary of soil and sediment sampling laboratory results

	Aluminium	Iron	Antimony	Arsenic	Cadmium	Chromium	Copper	Cobalt	Lead	Manganese	Nickel	Selenium	Silver	Vanadium	Zinc	Mercury	TOC	TPH	Sum of BTEX	Tributyltin	Sum of PAHs
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	mg/kg	mg/kg	ÂµgSn/kg	Âµg/kg
PQL	50	50	0.5	1	0.1	1	1	0.5	1	10	1	0.1	0.1	2	1	0.01	0.02	3	0.2	0.5	4
ANZG ISQG High	--	--	--	70	10	370	270	--	220	--	52	--	3.7	--	410	1	--		--	--	45
ANZG ISQG Low	--	--	--	20	1.5	80	65	--	50	--	21	--	1	--	200	0.15	--	550	--	9	10
NEPM - HIL C (Recreation)	--	--	--	300	100	240	20000	--	600	--	800	--	--	--	30000	400	--	--	--	--	400
Sample ID																					
BHA 1 0-0.5m	470	970	<0.50	<1.00	<0.1	4.7	3.4	<0.5	<1.0	36	<1.0	0.1	0.2	<2.0	1	<0.01	<0.02	165	<0.2	<0.5	<4
BHA 2 0.5-1.0m	1620	1710	<0.50	3.32	<0.1	5.2	3.6	<0.5	<1.0	42	1.6	0.2	0.8	5.8	13.2	0.01	0.06	300	<0.2	<0.5	<4
BHA 3 1.0-2.0m	1160	1970	<0.50	5.22	<0.1	4.8	3.3	<0.5	<1.0	102	1.5	0.2	0.2	7.6	2.6	<0.01	0.02	70	<0.2	<0.5	<4
BHB 1 0-0.5m	780	1250	<0.50	2.08	<0.1	3.5	5.2	<0.5	4.5	73	1.2	0.2	0.3	3	4.2	<0.01	----	----	----	----	----
BHB 2 0.5-1.0m	780	1440	<0.50	2.57	<0.1	4.6	13.4	<0.5	4.4	85	1.5	0.2	0.4	3.6	3.8	<0.01	----	----	----	----	----
BHB 3 1.0-2.0m	1060	4980	<0.50	2.98	<0.1	28	8.4	0.7	8.9	106	6.5	0.2	0.2	4.4	28.9	<0.01	----	----	----	----	----
BHD 1 0-0.5m	800	990	<0.50	1.32	<0.1	6	4	<0.5	<1.0	80	1	0.2	0.2	3.1	1.3	<0.01	<0.02	275	<0.2	<0.5	<4
BHD 2 0.5-1.0m	430	580	<0.50	<1.00	<0.1	5.5	2.7	<0.5	<1.0	50	<1.0	0.3	0.1	<2.0	<1.0	<0.01	<0.02	60	<0.2	<0.5	<4
BHD 3 1.0-2.0m	870	1810	<0.50	4.87	<0.1	4.9	3.7	0.5	1.1	357	2	0.2	<0.1	5	3	<0.01	<0.02	65	<0.2	<0.5	<4
BH01 1 0-0.5m	1340	2440	<0.50	4.11	<0.1	5.5	3.7	<0.5	5	37	1.2	0.3	<0.1	5.8	31.4	<0.01	0.25	308	<0.2	11.6	1.29
BH01 2 0.5-1.0m	750	2800	<0.50	3.7	<0.1	6	2.6	<0.5	<1.0	41	1.7	0.3	<0.1	5	4.1	<0.01	0.08	645	<0.2	24	<4
BH01 3 1.0-2.0m	710	1810	<0.50	2.92	<0.1	5.3	1.6	<0.5	<1.0	29	1.7	0.4	<0.1	3.5	1.8	<0.01	0.06	405	<0.2	<0.5	0.24
BH03 1. 0-0.5m	1090	1550	<0.50	3.34	<0.1	5	8	0.6	2.8	76	1.6	<0.1	0.5	4.4	6.1	<0.01	<0.02	320	<0.2	<0.5	0.74
BH03 2. 0.5-1.0m	950	1410	<0.50	3.39	<0.1	5.1	5.6	0.5	2.6	74	1.6	0.2	0.9	4.3	4.2	<0.01	<0.02	245	<0.2	<0.5	0.59
BH03 3. 1.0-2.0m	1030	1730	<0.50	3.34	<0.1	5.1	9.1	0.6	2.6	62	1.8	0.1	0.3	4.4	5.4	<0.01	<0.02	225	<0.2	<0.5	0.54
BH04 1. 0-0.5m	2600	3140	<0.50	7.3	<0.1	11.7	7.2	0.7	6.2	102	2.5	0.4	0.1	11.6	22.6	0.01	0.35	394	<0.2	<0.5	0.06
BH04 2. 0.5-1.0m	800	1400	<0.50	6	<0.1	4.6	1.4	<0.5	1.3	34	1.5	0.4	<0.1	5.9	4.9	<0.01	0.04	185	<0.2	<0.5	<4
BH04 3. 1.0-2.0m	1960	2260	<0.50	6.14	<0.1	6.2	2.1	0.5	<1.0	44	1.8	0.4	<0.1	10.8	2.8	<0.01	0.14	70	<0.2	<0.5	<4
BH05 1. 0-0.5m	880	1340	<0.50	4.46	<0.1	5.2	1.5	<0.5	<1.0	29	1.3	0.3	<0.1	7	3	<0.01	----	----	----	----	----
BH05 2. 0.5-1.0m	1100	1420	<0.50	4.43	<0.1	4.9	2.1	<0.5	<1.0	28	1.3	0.3	<0.1	7.5	1.6	<0.01	----	----	----	----	----
BH05 3. 1.0-2.0m	790	3760	<0.50	4.6	<0.1	6.3	12.4	<0.5	2.8	40	2.1	0.3	0.3	6	19.2	<0.01	----	----	----	----	----
BH06 1. 0-0.5m	3230	2760	<0.50	4.28	<0.1	5.6	3.8	0.9	<1.0	51	1.8	0.2	<0.1	10.8	5	<0.01	----	----	----	----	----
BH06 2. 0.5-1.0m	900	2100	<0.50	4.81	<0.1	6.3	5	<0.5	6.3	62	1.7	0.2	0.1	5.1	19.8	<0.01	----	----	----	----	----
BH06 3. 1.0-2.0m	710	2460	1.53	3.75	<0.1	6.2	3.3	<0.5	25	61	2.1	0.2	0.4	4.6	15.4	<0.01	----	----	----	----	----
BHC3 1. 0-0.5m	600	6490	<0.50	4.22	<0.1	10.1	8.5	0.5	35.7	65	3	0.2	<0.1	4.9	67	<0.01	----	----	----	----	----
BHC3 2. 0.5-1.0m	600	1810	<0.50	2.8	<0.1	6	4.2	<0.5	5.3	30	1.5	0.4	<0.1	4	13.9	<0.01	----	----	----	----	----
BHC3 3. 1.0-2.0m	1390	1850	<0.50	5.62	<0.1	5.2	1.3	<0.5	<1.0	32	1.2	0.3	<0.1	7.4	2.3	<0.01	----	----	----	----	----

160. A summary of the PSD testing results is provided in Table 4.5. The results show that the soil (on land) (boreholes BHA and BHD) is predominantly a sandy gravel, while the marine sediment (BH01, BH03 and BH04) is predominantly a gravelly sand.

Table 4.5: Summary of PSD results

Sample ID	Clay (<2 µm)	Silt (2-60 µm)	Sand (0.06-2.00 mm)	Gravel (>2mm)
BHA 1 0-0.5m	4	1	10	85
BHA 2 0.5-1.0m	8	3	23	66
BHA 3 1.0-2.0m	13	19	38	30
BHD 1 0-0.5m	1	<1	3	96
BHD 2 0.5-1.0m	1	<1	1	98
BHD 3 1.0-2.0m	3	5	8	84
BH01 1 0-0.5m	8	4	52	36
BH01 2 0.5-1.0m	11	8	59	22
BH01 3 1.0-2.0m	9	7	58	26
BH03 1. 0-0.5m	11	6	82	1
BH03 2. 0.5-1.0m	13	6	78	3
BH03 3. 1.0-2.0m	11	9	79	1
BH04 1. 0-0.5m	22	23	27	28
BH04 2. 0.5-1.0m	17	10	52	21
BH04 3. 1.0-2.0m	15	10	51	24

161. **Suspended sediments**. A water quality survey was conducted on the 4 September 2014 to understand the water quality status around Nukualofa port as part of the environmental assessment undertaken for the domestic wharf project. The suspended sediment data obtained for 11 locations (Figure 4.4) is presented in Table 4.6. The data provide a useful indication of background suspended sediment levels (for a single point in time) and the relationship between turbidity (NTU) and total suspended solids (TSS).

4.2.6 Coastal processes

162. **Sea level**. Hourly wind and tidal (water level) data was obtained from the Australian Bureau of Meteorology Pacific Sea Level and Geodetic Monitoring Project Hourly Sea Level and Meteorological Data Project (BOM, 2020). The site is located in a microtidal setting. Tides are diurnal and their spring range is around 1.2 m. Key tidal planes are: HAT 0.980m (1.908m CD); LAT 0.840m (0.137 CD); and CD -0.928m.

163. The water depth at the site increases rapidly seaward of the reef flat. The existing and proposed wharfs are located at approximately 11 m CD, +/- 1 m dependant on exact location.

164. **Wave climate**. The QSIW is located within Nuku'alofa Harbour and, therefore, afforded significant protection from most ocean waves. For most of the year, the Southeast trade winds create very small wind-waves at the site (with mean heights of around 20cm) along the small fetch created within Nuku'alofa Harbour.

165. Most swell waves at the site occur during November to April, when northerly wave energy from North Pacific storms and cyclones can penetrate Nuku'alofa Harbour. However, wave energy diminishes greatly as it is transformed through the Nuku'alofa Harbour from the open ocean. Shorter period wind waves are also generated along this fetch during this period.

Figure 4.4: Water quality monitoring locations

Table 4.6: Summary of water quality test results

	Layer	Depth (m)	Temp. (°C)	Salinity (‰)	Turbidity (NTU)	SS (mg/l)
W1	S	-	23.1	36	0.11	3
	B	20	23.0	36	0.24	9
W2	S	-	23.3	36	0.11	< 3
	B	15	22.9	36	9.0	10
W3	S	-	23.1	36	0.17	6
	B	25	23.3	36	0.22	8
W4	S	-	23.0	36	0.12	5
	B	12	22.9	36	0.29	11
W5	S	-	23.2	36	0.16	4
	B	7	22.9	36	0.27	9
W6	S	-	23.2	36	0.19	6
	B	7	22.9	36	0.42	9
W7	S	-	23.1	36	0.18	5
	B	15	23.1	36	0.17	< 3
W8	S	< 1	23.1	36	0.64	10
W9	S	< 1	23.3	36	0.71	13
W10	S	-	23.2	36	0.41	10
	B	5	23.0	36	14.3	47
W11	S	-	23.3	36	0.22	7
	B	10	23.4	36	0.16	7

Source: Tonga MOI (2015)

166. Consequently, the wave climate at the site is dominated by a mean northerly wave direction, with waves produced by a mix of swell and local seas (55% and 45%, respectively). The 50th percentile significant wave height (Hs) at Wharf 2 is 0.16m, with the 90th percentile (Hs) and maximum wave heights (Hs) estimated to be 0.3m and 1.27m, respectively.

167. The orbital wave-induced velocity at the seabed of the site has been calculated using Soulsby (1997) for the average, 90th percentile and maximum waves as 0.01m/s, 0.07m/s and 0.46m/s respectively. The threshold orbital velocity for motion of sediment has been calculated to be 0.17m/s, which indicates that the 50th and 90th percentile wave heights (Hs) are not capable of inducing significant sediment transport for the majority of sediment present at the site, and only the maximum Hs at the site would be capable of sediment transport.

168. **Currents**. A field data collection exercise undertaken by RHDHV included the collection of ADCP current data at two locations (at 20m depth) for the period 8/10/2019 to 11/11/2019 (Figure 4.5).

Figure 4.5: Location of ADCP current data deployments

169. The recorded current speeds and directions are shown in Figures 4.6 and 4.7 and shows that current speeds in these locations are typically less than 5 cm/s. The study area is characterized primarily by very slow tidal currents, though stronger currents up to 10 to 20cm/s are generated during periods of strong winds.

170. Wind and tide-induced currents have also been estimated based on a hydrodynamic model. Data was extracted from the model results at three locations (Figure 4.8 T1, T2, and T3) and depth averaged current velocities are also estimated to be typically less than 0.02 m/s.

Figure 4.6: Observed currents – east dock

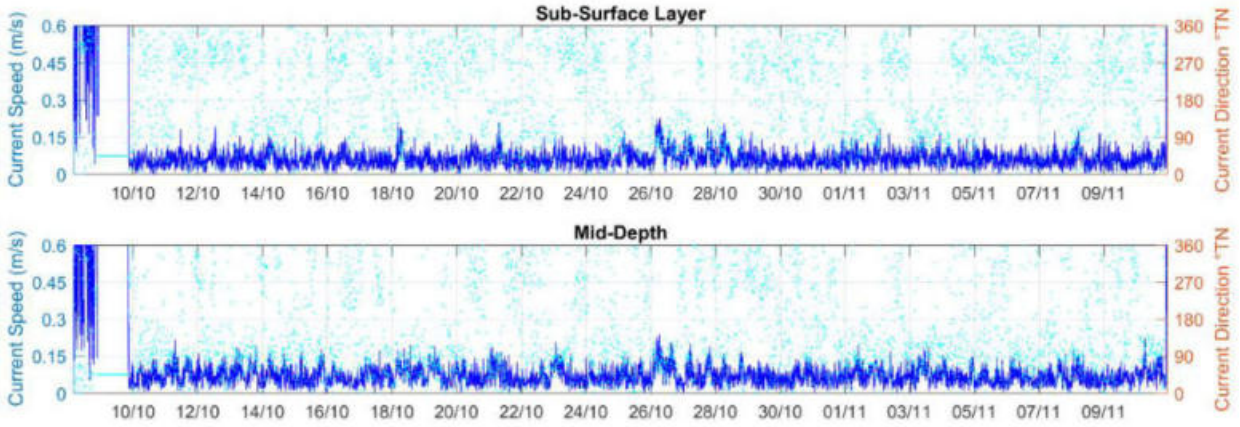
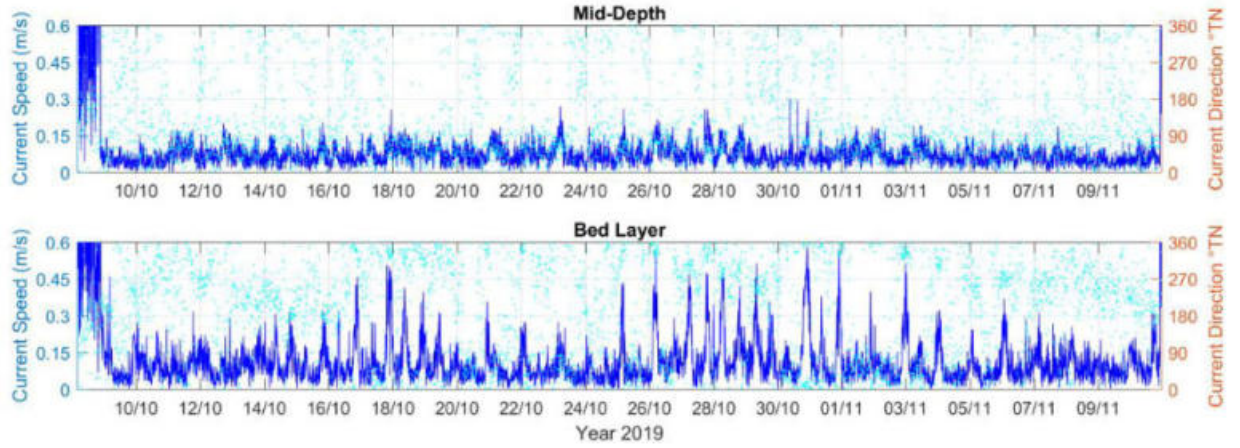


Figure 4.7: Observed currents – west dock

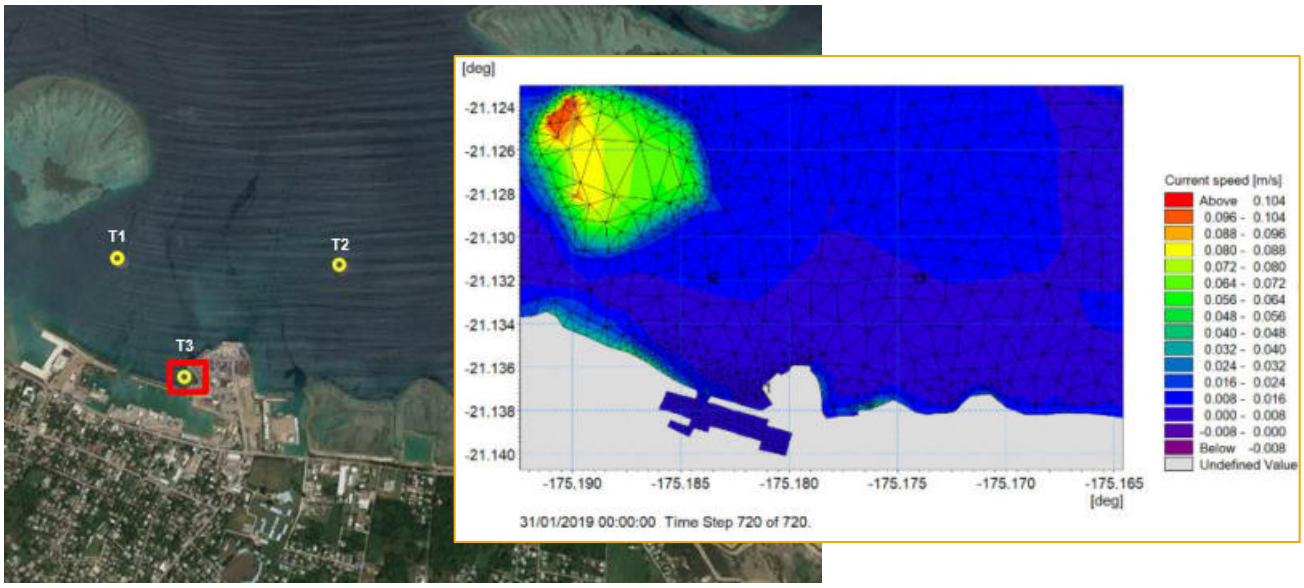


171. Hydrodynamic modelling undertaken by Damlamian (2008) in the vicinity of QSIW indicated that tidal currents in the immediate vicinity of the port generally flow from east to west through both ebb and flood tides, following the direction of the trade winds, and are influenced by water entering Nuku'alofa Harbour via the Piha Passage and Fanga'uta Lagoon. This has been validated by hydrodynamic modelling undertaken by RHDHV in 2020 in the vicinity of the wharf and out into the lagoon.[6]

172. The simulated currents at the site were compared to the estimated threshold current speeds for the motion of sediment (calculated for the site -specific conditions using the formulas of Van Rijn (1984) and Soulsby (1997)); that is, 0.2 m/s. Hence, typical current velocities (as modelled) are not of sufficient magnitude to induce significant sediment transport. Winds are similarly not relevant in this context.

[6] The model was run for a calibration period of one month, being January 2019.

Figure 4.8: Model inspection points and outputs for current data



173. Review of the draft PAT Operations Manual (PAT, 2019) and stakeholder engagement also indicates that berthing, mooring and unloading/loading are not affected by excess current speeds.

174. **Sediment transport**. Although littoral sediment transport is evident to the east and west of the site, as well as on the foreshore of islands within the lagoon, sediment transport is relatively benign. This is due to the relatively low energy produced by current and waves, but primarily due to the significant depth of water at the site.

175. From the above calculations, it is considered that the site seabed is close to the depth of closure. This is a theoretical depth where sediment transport is very small or non-existent, and dependent on wave height and period and sediment grain size.

4.3 Biological Resources

4.3.1 Overview

176. Tonga's flora and fauna are limited in diversity but of value through its endemic plants and bird species, which have the highest diversity. Indigenous vegetation includes a variety of root crops, fruit trees such as mangoes, tava, and a variety of citrus, and native vegetables and grasses. In the settled areas, much of the native vegetation has been cleared for coconut plantations, home gardens, villages and commercial crops. A significant percentage of the country is now under coconut and Panicum grassland. Invertebrates present are mostly agricultural pests widely found throughout the Pacific and tropical environments and include beetles, moths, flies and worms.

177. The major marine ecosystems in Tonga are algal and seagrass beds; fringing and lagoon reefs; rocky coasts; beaches; open lagoons; marine lakes; marine caves and a submarine trench. The reefs and lagoons are the prime fishery for subsistence.

4.3.2 Endangered species and protected habitats

178. Tonga has four national parks, two Parks, one nature reserve, one fauna reserve, one sanctuary, one multiple use conservation area, and four other protected areas. With the loss of habitat that has occurred over a long historical period, there are no specific terrestrial species in Tonga that are known to be rare or endangered. Tonga has several national marine reserves as set out in Table 4.7. None of these reserves (parks or protected areas) are located within the Project's area of influence.

Table 4.7: Marine reserves in Tonga

Name of Reserve	Location and Size	Biodiversity
Hakaumama'o Reef Reserve, Tongatapu	126ha area north of Tongatapu	Parrotfish on the coral reef
Pangaimotu Reef Reserve, Tongatapu	48ha area on the eastern edge of Nuku'alofa harbour	Mangrove forest and eelgrass, along with a wide range of shellfish and invertebrates, including sea cucumbers, marine snails and sea urchins, and with reef fish
Malinoa Reef & Island Reserve, Tongatapu	73ha island located seven kilometres north of Nuku'alofa	Range of fish species including octopus, grouper, clownfish and damselfish
Ha'atafu Beach Reserve, Tongatapu	Western tip of Tongatapu, 2km west of Nuku'alofa	Tropical fish and a variety of soft and hard corals
Monuafe Island and Reef Reserve, Tongatapu	32ha island, some 6.4km north-east of Nuku'alofa	Beach vegetation, butterfly fish and marine snails
Fanga'uta and Fangakakau Lagoons Marine Reserve, Tongatapu	2835ha reserve on Tongatapu's northern coast	Large stands of mangrove forest and saltmarsh, along with shellfish, invertebrates and wading birds such as the Pacific reef heron, the Pacific black duck, the great crested tern and Pacific golden plover

179. Further information on the marine environment in the study area is provided in Section 4.3.4. However, there are no mangrove trees/forests, sea grass beds, marine reptiles (turtles) or birds nesting within or in close proximity to QSIW. Further, it does not support any national or international endangered or protected species. Marine mammals (cetaceans) are covered separately below.

180. There were no threatened, endangered nor endemic hard coral species located during the assessment of reef systems within the Project's area of influence (as shown in Figure 1.2).

181. Finfish population numbers and species diversity is low. Species that were identified during the marine survey were juveniles and included reef dwelling plankitvores (small fish) and herbivores (e.g. *Acanthuridae, Scaridae*), and there was a noticeable lack of predator reef fish.

182. Very low numbers of reef associated invertebrates (apart from corals) were recorded. Those that were recorded have no subsistence or commercial value (e.g. feather stars, non-commercial sea cucumbers).

183. There are no marine or coastal designated marine protected areas or areas of significant biodiversity within or in close proximity to QSIW. The Monuafe Reef marine protected area is located to the northwest of QSIW and is well outside the zone of influence of the project (see Figures 1.2 and 4.4).

4.3.3 Cetaceans

184. **Introduction**. The exclusive economic zone (EEZ) of Tonga is characterized by both resident and transient (migratory) populations of cetaceans (marine mammals; including whales and dolphins). All marine mammals have been protected in Tongan waters since 1978 by Royal Decree and the Fisheries Management (Conservation) Act 2008; which fully protects marine mammals from any disturbance or fishing.

185. Cetaceans are commonly seen in Tongan waters and, as a result of the bathymetry associated with the islands, are found very close to shore. This has stimulated a commercial whale watching tourist industry based primarily on the seasonal migration of the humpback whales.

186. Miller (2009) states that there has been considerable effort dedicated to surveys in Tongan waters to study and identify the nations marine mammal diversity but identifies a paucity of scientific information regionally.[7] Nevertheless, additional assessments are required to provide data on the presence and population status of all resident cetaceans and the seasonal migrations of all species. On behalf of the Whale and Dolphin Conservation Society, Miller (2009) reported that there are 15 species in total with a confirmed presence in Tongan waters, with another 10 species likely to occur. Table 4.8 lists the cetacean species found in Tongan waters.

187. While there are 15 confirmed marine mammal species in Tongan waters, the most notable and abundant of these is, by far, the humpback whale (*Megaptera novaeangliae*) that migrates to Tonga annually. The global population of humpback whales is generally considered to be in the IUCN Red List (version 2010.2) category of 'least concern', however, the literature has indicated that the Oceania subpopulation of humpback whales is considered by the IUCN to be 'endangered' and facing a very high risk of extinction in the wild in the near future.[8]

[7] With information on humpback migration coming from a US team based in the Cook Islands.

[8] It is notable, however, that the Pacific population is starting to recover, with whaling having stopped.

188. One whale, the Sperm whale (*Physeter macrocephalus*) is considered to be globally threatened and vulnerable by the IUCN Red List (version 2010.2). For the remaining cetaceans recorded in Tongan waters there is either not enough information to make scientific assessments (marked as data deficient) or they have been assessed as being of least concern.[9]

Table 4.8: List of cetaceans known to inhabit the waters of Tonga

Species	Common Name	Status	IUCN Category
Balaenoptera bonaerensis.	Dwarf Minke-whale	Confirmed	DD
Megaptera novaeangliae	Humpback whale	Confirmed	EN
Physeter macrocephalus	Sperm whale	Confirmed	VU
Balaenoptera borealis	Sei Whale	Confirmed	LC
Balaenoptera acutorostrata	Antarctic Minke whale	Likely	
Globicephala macrorhynchus	Short-finned pilot whale	Confirmed	DD
Orcinus orca	Orca	Confirmed	DD
Pseudorca crassidens	False killer whale	Confirmed	DD
Stenella longirostris	Spinner dolphin	Confirmed	DD
Stenella attenuata	Pantropical spotted dolphin	Likely	DD
Tursiops truncatus	Bottlenose dolphin	Confirmed	LC
Delphinus delphis	Common dolphin	Confirmed	LC
Feresa attenuata	Pygmy killer whale	Confirmed	LC
Grampus griseus	Risso's dolphin	Confirmed	LC
Peponcephala electra	Melon-headed whale	Confirmed	DD
Mesoplodon densirostris	Blainville's beaked whale	Likely	DD
Balaenoptera musculus	Blue Whale	Likely	VU
Balaenoptera edeni	Bryde's whale	Likely	LC
Balaenoptera physalus	Fin whale	Likely	EN
Steno bredanensis	Rough-toothed dolphin	Likely	LC
Kogia sima	Dwarf sperm whale	Likely	LC
Kogia breviceps	Pygmy sperm whale	Likely	LC
Ziphius cavirostris	Cuvier's beaked whale	Confirmed	LC
Lagenodlphis hosei	Fraser's dolphin	Likely	LC
Stenella coeruleoalba	Striped dolphin	Likely	DD

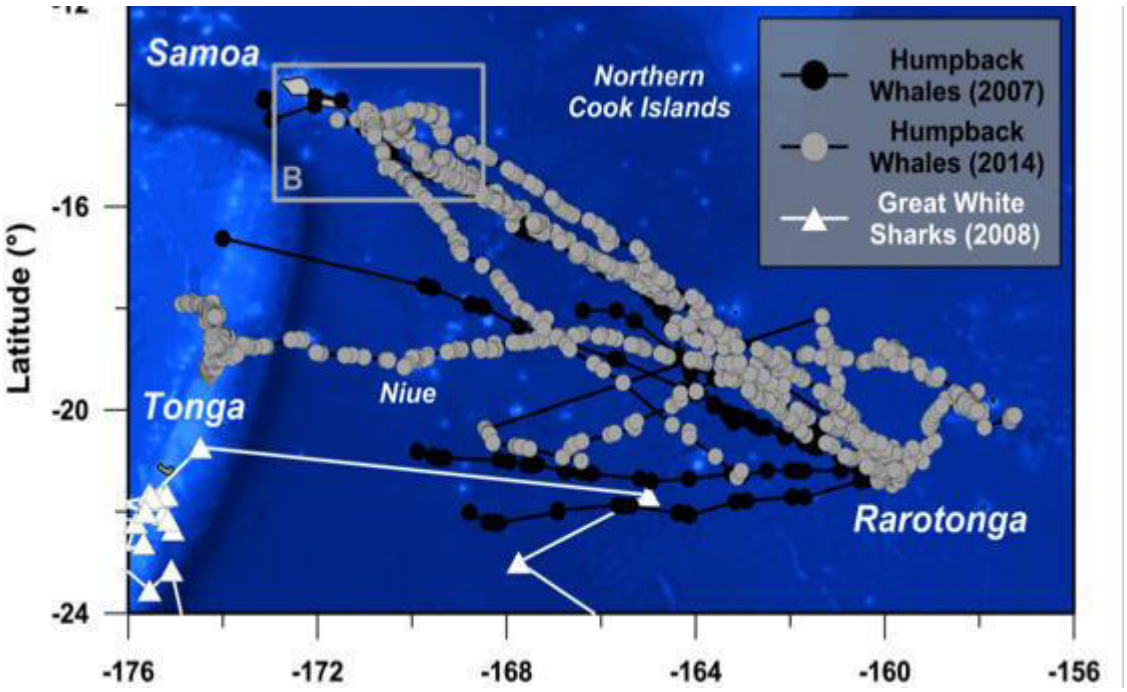
Notes: Confirmed = blue rows; likely = white rows
En = Endangered Dd = Data Deficient Vu = Vulnerable, LC = Limited Concern

Source: Miller (2009)

[9] The Global status of cetaceans under the Convention on Migratory Species lists threatened species in Appendix I of the Convention, and species of Least Concern or where Data is Deficient are listed in Appendix II.

189. **Humpback whales**. Recent surveys and tracking programmes based in Tonga and neighbouring nations, in particular the Cook Islands (e.g. the Centre for Cetacean Research and Conservation based in Rarotonga), have identified migration paths of the humpback whale within the Polynesian group of islands (Figure 4.9 - seasonal migration patterns from satellite tagging originating from Rarotonga and movements west to the Tongan islands).

Figure 4.9: Humpback whale seasonal migration patterns



Source: Hauser, personal communication (2015)

190. Humpback whales undertake extensive annual migrations, originating from feeding grounds in cold Antarctic waters to tropical waters for reproduction (mating and calving), requiring generally sheltered water of less than 200 metres. Individuals and/or groups of whales have been documented to return to similar locations seasonally and recent evidence has also indicated that individuals move through neighbouring islands during their migrations (refer to Figure 4.9) (Hauser *et al*., 2010 and in prep).

191. Peak periods of Humpback whale migration entering the EEZ of Tonga occur between the months of July through to November. Data indicates that the majority of individual whales move through the waters surrounding the southern islands of Tonga, including Tongatapu, during their migration route to and from the northern islands of Ha'apai and Vava'u. The less sheltered waters around Tongatapu are less well known for encounters with humpback whales but they can often be found transiting these waters and do pass through the waters to the north of Nuku'alofa, especially towards the beginning and end of the migration season.

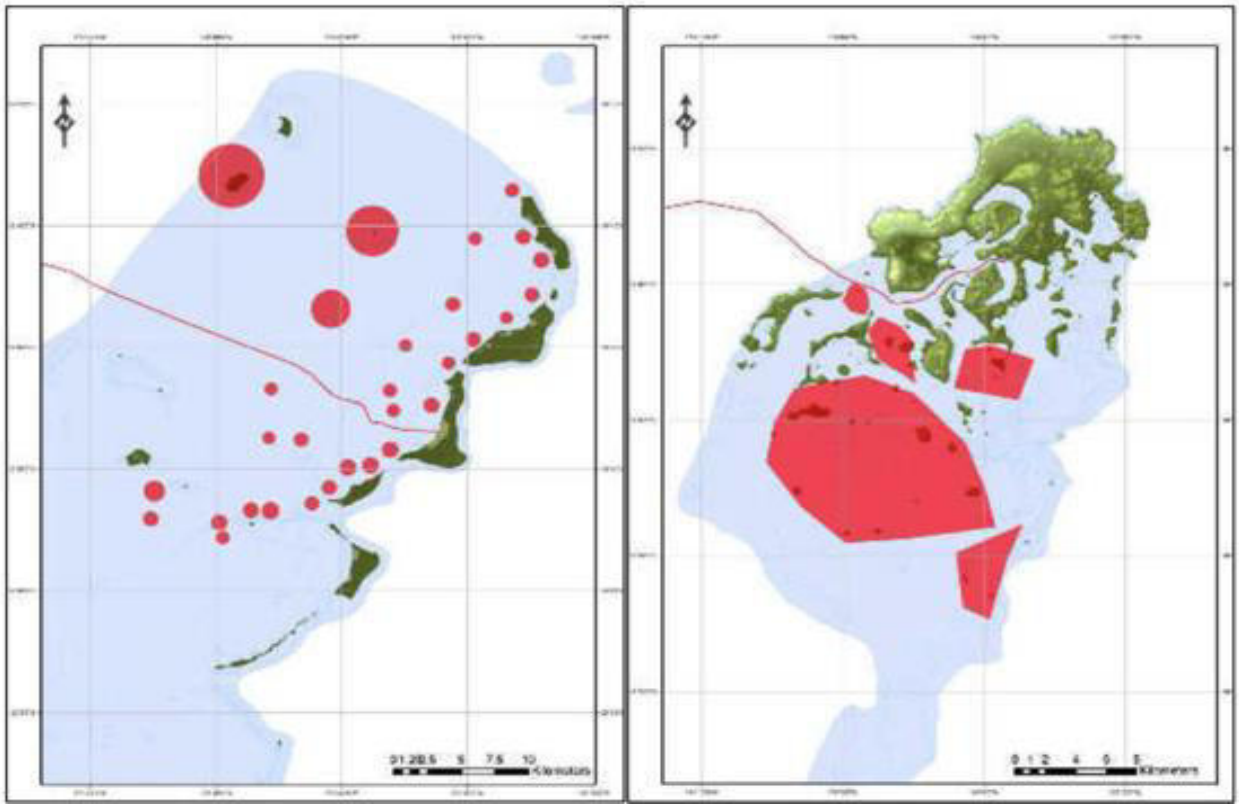
192. Whale watch providers state that encounters off Tongatapu and Eua are frequent in the peak period; August and September. They also encounter pilot whales and bottle nose dolphins. Whales have been reported to very occasionally pass through the waters adjacent to the port.

193. In 2014 the whale watch industry within Tonga developed a humpback whale "hot spot" that recorded areas of frequency of occurrence and sightings within the nation (Figure 4.10). The results clearly identified that the islands within the Vava'u chain (the northern islands) annually have the most densely populated humpback whale populations during their annual migration, whilst the distribution of whales in the waters of the Ha'apai group is also significant.

194. The Vava'u and Ha'apai island groups support a professional ecotourism industry based on whale watching during the migration period and there are three operators who operate from Nuku'alofa in the vicinity of the Port; Deep Lodge, Blue Water and Whale Swim Dive.[10]

195. Information is not available, however, on specific fine scale temporal scales to determine when different species and/or populations of whale species frequent the waters adjacent to Tongatapu.

Figure 4.10: Humpback whale mother and calf pair preferred habitats in Ha'apai and Vava'u



196. **Dolphins**. Based on reports from whale watch operator and fishermen, dolphins periodically use the lagoonal waters associated within the island Tongatapu but are normally seen closer to the reef edges in the deeper water entrances.

[10] The three main whale watch and swim operators working out of Nuku'alofa (and Eua) run trips six days a week carrying around 30 people each, each day. Further, there are approximately another four other smaller operators.

4.3.4 Marine benthos

197. **Seabed**. The QSIW seabed substrate is shallowest in the western (opposite Wharf 4) and eastern (towards the Navy channel) corners of the port (with a water depth between 8 and 10m). The benthic substrate profile gently decreases northwards (offshore) along both sides of QSIW, reaching 18m depth in front of Wharfs 1, 2 and 3. The substrate extends seaward from the port, decreasing through a gentle slope to a consistent depth of 23m some 400m offshore.

198. The seabed substrate next to QSIW's four wharfs is relatively homogenous and is characterized by a bottom layer of coarse sand derived from terrigenous and coral reef origins and a fine top layer of silt (3 to 5 cm thick). Coral rubble and rocks are present in front of each wharf and, predominately, are a result of previous port construction activities.

199. Fluctuations in the depth of the fine sediment layer and resulting water turbidity is directly related to the prevailing weather conditions at any given time.

200. The high level of suspended silt and sand-based substrate associated with the wharfs have a significant detrimental effect on the ability of sessile benthic marine resources to settle (recruit) and survive in these areas.

201. No sessile (non-motile) benthic invertebrate species (e.g. hard and soft corals) were recorded attached to the substrate in front of any of the wharfs or offshore. A small number of hard and soft coral colonies were attached to Wharf 1 and 2 sheet piles, providing evidence that natural coral recruitment can and has occurred since the port construction. The marine benthic environment directly adjacent to all the wharfs contains considerable anthropogenic port-derived material, machinery and rubbish (Plates 4.4 a - d).

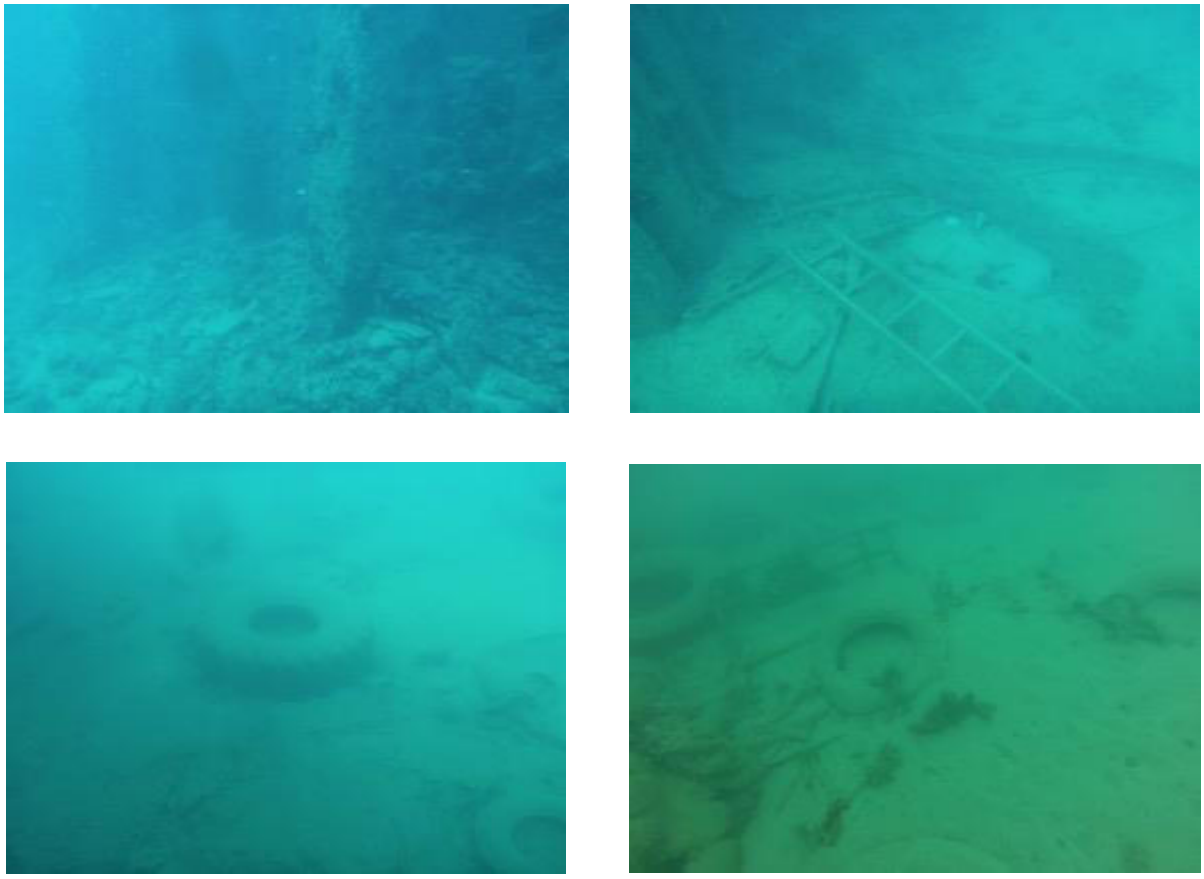
202. The benthic substrate associated with QSIW is highly modified by past anthropogenic (port development) activities and, as such, the benthic habitat within this area can be considered to have a very low coral reef habitat and ecological value.

203. **Reefs**. The reef system within the project's area of influence includes a distinct zonation; a shallow water subtidal reef flat (varying in width from 5 - 8 m), reef edge and crest (5 - 10 m) in part exposed during very low tides, and an upper and lower reef slope which, for the most part, has a vertical drop of more than 60% that terminates onto a sand rubble seabed. There is no intertidal reef flat associated with QSIW, as this area has been reclaimed for the development of the port.

204. Hard and soft live coral percentage coverage, morphological form, diversity and abundance vary between location and zonation on the reefs associated with the project's area of influence. The reef system directly west of Wharf 4 had a higher abundance, percentage live coverage and species diversity than the reef located on the eastern side of QSIW.

205. No hard and soft corals were recorded attached to the substrate directly adjacent to any of the four wharfs, except a very small percentage (less than 2%) of live coverage between Wharfs 1 and 2 (Plates 4.5 a-d).

Plates 4.4 a – d: Representative benthic substrate associated with QSIW Wharfs 1 to 4



206. Both remnant and newly recruited hard and soft coral colonies of varying sizes were located throughout the eastern side of the QSIW and west of Wharf 4, associated with the rock revetment breakwater within the Project's area of influence.

207. Hard and soft live coral percentage coverage for both the eastern and western sides of the port varied between 2 and 40% for the subtidal reef flat, reef edge and crest, except in a small isolated pocket on the eastern side of QSIW where coral coverage reached 80% (two branching *Acropora sp.*).

208. Hard and soft live coral percentage coverage varied between 5 and 50% for the reef slope, with higher coverage at greater depths for both the eastern and western reefs. Hard and soft coral morphology varied throughout the Project's area of influence, reflecting the natural environmental forces affecting the different reef locations.

Plates 4.5 a – d: Hard/soft coral colonies, echinoderm and finfish recorded between Wharfs 1 and 2

209. In each of the reef zones throughout the assessment site, coral species diversity and morphology remained similar. Hard coral digitate (e.g. *Acropora sp., Porites sp*.) branching and plates (e.g. *Acropora sp., Pocillopora sp., Montipora sp*.), sub massive (e.g. *Porities sp., Goniastrea sp., Favia sp., Lobophyllia sp*.) and to a lesser degree encrusting (e.g. *Acropora sp., Echinophyllia sp*.) and solitary (e.g. *Fungia sp*.) morphological forms dominated the subtidal reef flat, reef edge and reef crest (Plates 4.6 a - d). These morphological forms remained dominant throughout the upper and lower reef slopes, however, species diversity associated with the western reef increased to include considerable colonies of the branching fire coral *Millepora sp*., increased diversity of *Acropora sp*. and several small colonies of *Mycedium sp*. and *Pavona varians*.

210. Large massive hard coral colonies (*Porites sp, Goniastrea sp.* and *Favia sp*.) were abundant on the reef slope and sea floor on the western reef, however few were associated with the eastern reef system.

211. Soft coral colonies (e.g. *Lobophytum sp., Sarcophyton sp., Sinularia sp*.) were abundant throughout the subtidal reef flat, edge, crest and upper and lower reef slopes throughout the assessed areas and made up a significant proportion of the coral coverage.

Plates 4.6 a – d: Hard coral colonies located on subtidal reef flats, reef edge, crest and slope outside the direct impact zone (see Section 5.3.1)




212. Species abundance and diversity was slightly higher on the western reef system, particularly towards the western side of the site.

213. A significant number of sea anemones and their associated clown fish were recorded throughout the assessment sites, with higher number of colonies associated with the upper reef slopes.

214. Marine macro algae density, coverage and diversity were low throughout the assessment area; however, a number of algal species were recorded. Brown (*Padina sp. Sargassum sp.*), green (*Caulerpa sp.*), filamentous and blue green algae were present.

4.4 Socioeconomic Conditions

215. **Overview**. Tonga is a predominantly Christian, Polynesian country that has been a constitutional monarchy since 1875. It is a former British protectorate which gained its independence in 1970. King Tupou VI came to power in 2015 and is the Head of State and Commander-in-Chief of the armed forces. A reformed constitution was passed by legislation in April 2010 which decreases the power of the monarchy and delegates more decision making to the Cabinet which answers to the Legislative Assembly; however, the King retains the right to veto legislation.

216. As a small island economy and lower to middle income country, Tonga faces geographic isolation with limited human resources, a high level of imports and low exports (mainly agriculture, fisheries and cultural items) and is vulnerable to external economic change as well as natural disasters. High levels of remittances from family members outside of Tonga are necessary to boost domestic revenue.

217. The ADB Factsheet for Tonga states that its *"medium-term development depends on the continued implementation of structural reforms to improve productivity, remove bottlenecks to growth, and strengthen macroeconomic resilience"* (ADB, 2017). Life in Tonga revolves around strong values of family and the Church and the Kingdom has a well-developed historic and contemporary national identity.

218. **Economy**. Tongan imports vastly exceed exports, with only a small manufacturing export industry. Export income relies on tourism, fish and increasingly agriculture and horticulture. Agriculture, industry and services are the main contributors to Tonga's GDP; with agriculture contributing 65% of Tonga's exports, which comprises 14% of Tonga's GDP. The service sector makes the biggest contribution to GDP. This indicates a change in the economy, with gradual diversification from agriculture to services. It is expected that this sector will continue to strengthen, particularly with opportunities in the tourism market.

4.4.1 Population, livelihoods, health and education

219. **Population and demographics**. The United Nations Department of Economic and Social Affairs Population Division cites the population of Tonga as 106,776 as of 1 January 2017, with 37.2% under 15; 56.7% between 16 and 64 and 6.1% over 65. Male life expectancy is 73.8 years and female life expectancy is 76.6 years. The population of Tonga is stable with a growth rate of 0.2%. The average birth rate is 3.8, with emigration accounting for the difference, as almost as many Tongans live overseas as within the country. There is also a large internal rural-urban push, with high movements from the outer islands to Tongatapu and a negative population growth in the outer islands. Some 98% of the population identify as Tongans (GOT, 2015b). Tongatapu is the country's most populous island, with approximately 73,000 residents constituting 71% of the national population, on an area of 260 km^2.

220. Although an increasing number of Tongans have moved into the only urban and commercial centre, Nuku'alofa, where European and indigenous cultural and living patterns have blended, village life and kinship ties remain influential throughout the country.

221. Despite emigration, Tonga grew in population from about 32,000 in the 1930s to more than 90,000 by 1976 and over 100,000 by the mid-2000s.

222. **Income and livelihoods**. The Household Income and Expenditure Survey from 2009 (Nelson and Fukofuka, 2016) identifies handicrafts as contributing 40% of total household subsistence income and subsistence agriculture comprising 27% (these being the highest two categories). Both income sources are heavily dominated by female labour. However, women's role in agriculture and food production is not recognised fully in official statistics as is predominantly a part of the informal economy (39% of households produce crops and handicrafts to sell through markets and roadside stalls in the informal economy).

223. Many Tongan households rely on remittances from family members. In 2012 remittances were estimated to contribute 20% of GDP (ADB, 2013). Over 30% of households in Tonga receive remittances with Tongans overseas estimated to account for about half the total Tongan population, with over 95% of them living in New Zealand, Australia, or the United States (World Bank, 2015). Australia has a seasonal migrant worker scheme (DFAT, 2014) and is the largest grant-based aid donor to Tonga, contributing the equivalent of 22% to the Tongan national budget (2012/13 financial year).

224. Tonga exceeded its economic forecast for the fiscal year of 2016 due to a recovery in agriculture and stimulus from construction on major infrastructure projects. In addition, remittance receipts were up by 24.8%; private sector by 14.5% and tourism saw international arrivals increase by almost 15% (Nelson and Fukofuka, 2016).

225. **Gender**. Tonga rates 148 out of 188 countries on the Gender Equality Index. The low representation of women in the highest levels of decision making reflects a strong gender bias in Tonga, which sees men as key decision makers in society. In terms of personnel, women represent a total of 14% of all the staff in PAT and the Marine Department of the Ministry of Infrastructure (MOI). The role of women in the sector is minimal and includes only minor involvement in daily port operations (cargo and ship movements, security control). PAT does not have a gender equity policy that encourages the participation of women in these activities or that promotes a gender friendly workplace.

226. **Health**. By some published surveys, Tonga has one of the highest obesity rates in the world. World Health Organization data published in 2014 indicates that Tonga stands 4th overall in terms of countries listed by mean body mass index data. In 2011, 90% of the adult population were considered overweight using national health indicators interpretation of body mass index data, with more than 60% of those obese. Some 70% of Tongan women aged 15–85 are obese. Tonga and nearby Nauru have the world's highest overweight and obese populations.

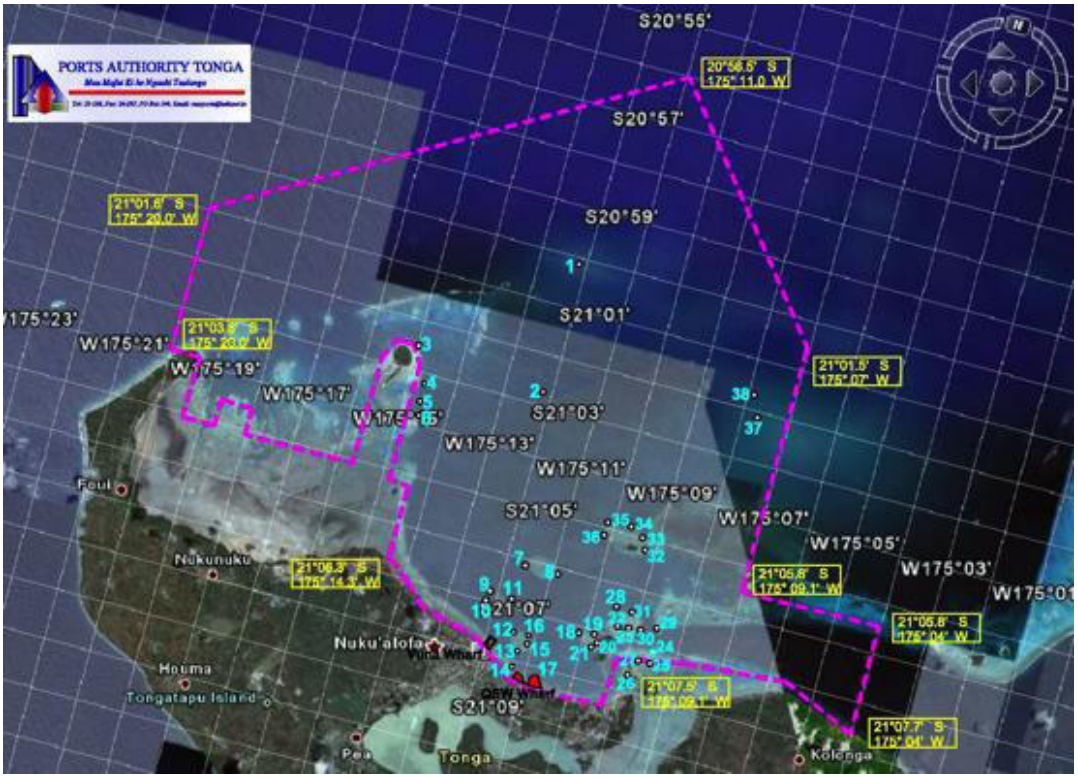
227. **Education**. Primary education between ages 6 and 14 is compulsory and free in state schools. Mission schools provide about 8% of the primary and 90% of the secondary level of education. State schools make up for the rest. Higher education includes teacher training, nursing and medical training, a small private university, a woman's business college, and a number of private agricultural schools. For many Tongans higher education is pursued overseas. Tongans enjoy a relatively high level of education, with a 98.9% literacy rate, and higher education up to and including medical and graduate degrees.

4.4.2 Land ownership and use

228. **Land ownership**. The project is to be located in an existing port facility, operated by PAT, and on an unoccupied, reclaimed industrial site. The Deed of Lease for the land is included as Annex 1 of the land due diligence report.

229. PAT manages a considerable area of water, including intertidal and subtidal fringing and submerged reef systems within the Tongatapu lagoon (Figure 4.11), with its land boundaries defined as the high water mark. This area includes QSIW, Vaua Harbour and the domestic shipping terminal.

Figure 4.11: PAT Boundary within the lagoon and Tongatapu



230. **Land and resource use**. The area immediately surrounding the QSIW primarily consists of port-related industrial activities; however, further south of the site along Vuna Road, residential and commercial properties are present (including the Australian High Commission, shops, a cemetery, hotel/lodges, restaurants, religious buildings and so on). Along the coastal side of Vuna road is a narrow stretch of promenade. Street vendors can sell food along the promenade.

231. The shallow waters to the west of QSIW (and the new domestic terminal) are used by locals to soak materials (e.g. pandanus leaves) for making Taovala (a Tongan traditional mat). According to MOI (2015), there were around 20 people working in the project area for the new domestic terminal. Children bathe inside the jetty built between the port and American wharf and the offshore reef lying northwest of the project site is used as a diving spot by local tour operators.

232. Further to the east is the boat entrance to the Touliki Naval Base and further east still is the fringing reef and reef flat that commonly used by the people of Ma'ufanga for fishing, collecting seafood and the strengthening of pandanus leaves. The collection of invertebrates is carry-out by Kleaners, mainly women, who collect cockles, sea cucumbers, seaweeds and shellfish for home consumption during low tide. Net fishing is common at high tide in this area and the reef-flats and reefs either side of QSIW and Faua Wharfs are allowed to be fished by local communities.

233. The status of the fishery in the study area is considered to be overexploited, based on a socio-economic survey conducted by the Ministry of Fisheries during the promotion of Special Management Area activities (Ministry of Fisheries, 2016). The results indicated that target species like sea cucumbers ('Tu'u lomu and Fakahe te'epupulu') and shellfish (i.e. trochus, cockles, etc.) in particular are overexploited. A moratorium is now in place on the collection of sea cucumbers for commercial harvest until year 2020.

234. The Project's development area itself is within the Ports' jurisdiction and fishing is prohibited within this jurisdiction.

235. The QSIW does not include any sites of cultural, customary or heritage significance.

4.4.3 Noise and traffic

236. **Noise**. Noise levels were measured at QSIW when it was used as the domestic terminal (measurement Stations N1 and N2) and at the roadside in front of the Australian High Commissioner residence (Station N3; adjacent to the new domestic terminal) in 2014 (MOI, 2015). Traffic volume was also counted during the survey and the entrance to QSIW is typically busy, with container trucks moving in and out. Table 4.9 shows the results of the noise survey.

Table 4.9: Noise survey of QSIW 2014

Station	Date/time	L_{Aeq} (dB)	Main noise source
N1	04-11-14 1720-1730	69.1	Ship generator, forklift, car
N2	04-11-14 1740-1750	65.9	Ship generator, forklift, car
N3	04-11-14 1800-1810	63.4	Car (10 mn)
	08-11-14 1020-1030	63.8	Car (15-20 mn)
	08-11-14 1040-1050	66.8	Car (15-25 mn)

Note: L_{Aeq} equivalent sound level; dB decibels

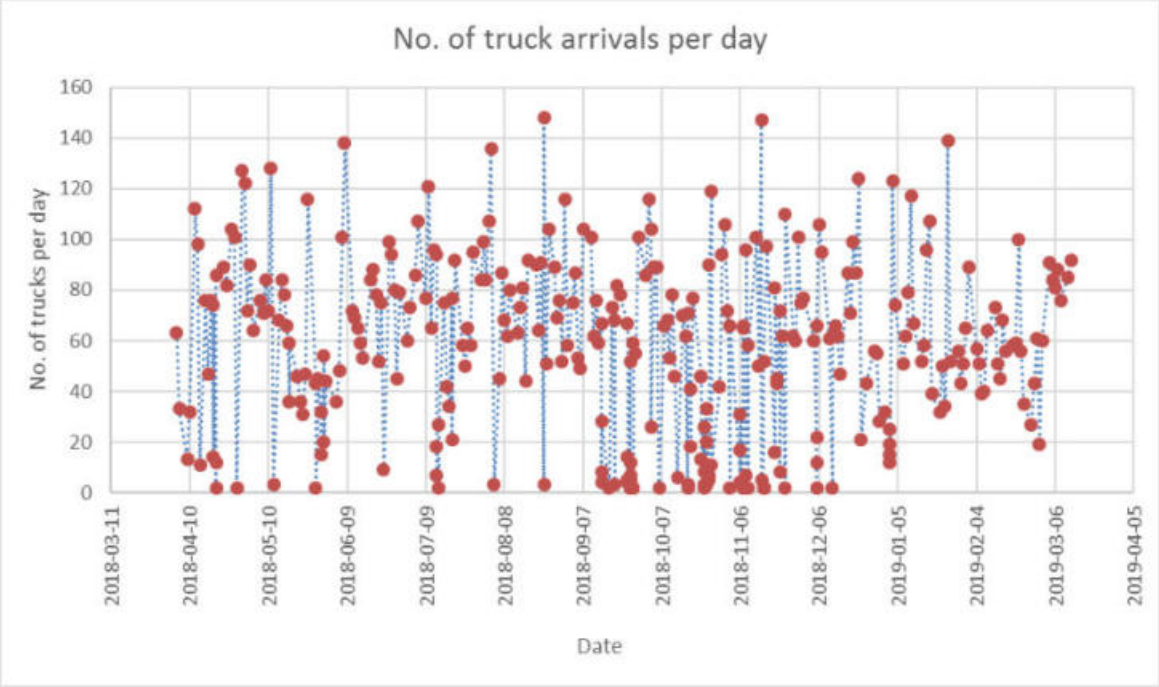
Source: MOI (2015)

237. Noise levels in the domestic terminal area (stations N1 and N2) ranged between 65-69 dB, with the main noise source being ships, forklift and cars. Noise levels in front of the Australian High Commissioner residence (Station N3) ranged between 63-67 dB, with the main noise source being the cars passing through Vuna road.

238. Since Tonga has no noise standards, the noise levels at station N3 were compared by MOI (2015) with the ambient noise standard set by the Ministry of Environment, Japan. The Japanese noise standard is set depending on the characteristics of the receiving environment, and the standard set for roadside residential/commercial area was considered appropriate for comparison, which is 65 dB (daytime). Hence the noise levels at station N3 were compliant with the Japanese standard, although it could be exceeded during periods of high traffic[11].

239. **Traffic**. Currently, on average, around 56 truck visits to QSIW occur each day. A survey of truck visits was undertaken between April 2018 and March 2019. During this 315-day period, the highest number of vehicles that called at the port on one day was 148 (on 23 August 2018) (Figure 4.12). These calls occurred between 09:25 and 20:40 which means that over the period a truck was handled (on average) every four to five minutes.

Figure 4.12: Daily number of truck arrivals at Port April 2018 - March 2019



[11] In the absence of national standards, the ADB defers to the World Bank Groups EHSG standards, which are 55 dB (daytime) for residential properties and 70 dB (daytime) for commercial properties. The predicted effect of the project on properties is considered against these standards in Section 5.4.3.

5 ENVIRONMENTAL IMPACTS AND MITIGATION

241. **Overview**. This section of the EIA considers, in Sections 5.3 to 5.6, the impacts that could arise due to the project in its construction and operational phases. In addition, issues identified in the pre-construction phase as a result of the environmental audit of QSIW and the recommendations arising from this are set out in Section 5.2. Predicted in-combination effects are considered in Section 5.7.

5.1 Pre-construction Impacts

5.1.1 Pre-construction matters to be addressed

242. **Environmental audit of facilities and operations**. The environmental audit of QSIW's facilities and operations undertaken in February 2019 identified a number of environmental and social (health and safety) issues associated with the existing facility (outlined in Section 3.2.2). This led to a number of recommendations for the new port facility being made that were taken into account in the design. These are detailed in the pre-construction section of the EMP (Section 6).

243. **Environmental management requirements**. A number of steps need to be taken prior to the Construction phase being initiated and mobilisation of the contractor. These include:

- Updating the IEE (this document) and EMP, as necessary, during the detailed engineering design phase;
- Obtaining building permit approval from MOI under the Building Control and Standards Act No.39 of 2002.
- Obtaining development consent under the National Spatial Planning and Management Act 2012 from the Ministry of Lands, Survey and Natural Resources.
- Obtaining environmental approval from MEIDECC (see Section 2.2.4).
- Incorporation of the IEE (assessment), updated EMP and any development consent conditions in the bid documents for contractor selection.
- Preparation and submission by the contractor, and clearance by PMU, MEIDECC and ADB, of the construction EMP (CEMP); inclusive of a biosecurity risk assessment (see Section 5.1.2), stakeholder communications plan and workers code of conduct, and the GRM.
- The agreement of a worker code of conduct, to be included in workers contracts, with local leaders.

244. **Land access**. As set out in Section 4.4, the project is to be located in an existing port facility, operated by PAT. Land access is therefore unconstrained (as detailed in the land report)

245. **Construction materials**. No permits or consents are required for construction materials. Limestone aggregate and rock will be sourced locally (see Section 3.4.5) and all other materials will be imported directly to site. Only existing permitted and/or licensed operations will be used for the Project.

5.1.2 Biosecurity and introduction of invasive or alien species

246. **Predicted risk**. The project has the potential to result in the spread of invasive non-native flora and fauna species in the terrestrial and marine environment. This could have detrimental effects on native biodiversity and could be contrary to the Noumea Convention 1990. In particular, the construction works have the potential to both spread invasive and/or alien species that are already established on the site and elsewhere in Tonga and result in the import of invasive and/or alien species from outside Tonga.

247. **Mitigation**. In order to manage this risk, the contractor will prepare a biosecurity risk assessment and method statement to cover all activities. The biosecurity risk assessment should consider in general: (i) measures that would be undertaken to control and eradicate invasive and/or alien species within the area of works; and, (ii) measures or actions that aim to prevent invasive and/or alien species being introduced to the site for the duration of the construction phase.

248. For the management of existing invasive and/or alien species, the biosecurity risk assessment and method statement will detail:

- how areas with the presence of invasive and/or alien species would be demarcated;
- how any contaminated materials would be appropriately managed throughout the works, including where appropriate eradication from the site;
- appropriate disposal; and,
- how any transfer or spread would be prevented.

249. In terms of prevention of new introduction to the site through terrestrial and marine pathways, the biosecurity risk assessment and method statement should detail:

- risk pathways and risk activities for the transfer and spread of non-native species;
- risk assessment for the transfer and spread of individual non-native species of known concern;
- methods to manage risk of transfer including any actions to be undertaken prior to reaching site; and
- contingency planning and corrective actions.

250. The contractor, in conjunction with PAT, will also implement an on-going monitoring programme for non-native species. This will include observational surveys on structures that may provide suitable substrate for non-native species. Surveys will record and report the presence/abundance of non-native species. Where the new presence of invasive and/or alien species is discovered, the biosecurity risk assessment and method statement should be reviewed and amended where necessary.

251. Wherever appropriate, workers will be given an activity specific toolbox talk from the contractor's environment, health and safety officer (EHSO). This should include photographs of any invasive and/or alien species known to be present on a site.

252. For the marine environment, an initial pre-construction survey will be undertaken, and regular surveys should begin once construction is completed. The frequency and extent of monitoring could reduce over time.

253. **Residual impact**. With the proposed mitigation in place, the residual impact associated with invasive species is predicted to be of negligible significance.

5.2 Construction Impacts on the Physical Environment

254. **Geology and climate**. There are **no impacts** predicted to occur in the construction phase of the Project on either geology or climate. Climate change factors have been integrated into design requirements.

5.2.1 Potential effects on coastal processes

255. Given that the proposed new wharf deck will be suspended above the water level for most of the tidal cycle and founded on piles (of 900 mm diameter at 4 m centres), the structure will have little (if any) influence on regional coastal processes. Effectively it will be permeable to processes such as waves, currents and sediment transport.

256. The information provided in and calculations undertaken for Section 4.5 indicate that currents and waves at the site are not expected to produce significant sediment movement under existing conditions. Similarly, it is not anticipated that the open-piled arrangement will affect the hydrodynamic flow regime sufficiently to cause anything other than very minor localised erosion or scouring of the seabed due to localised minor accelerated flow (wave and current induced) adjacent to the piles and, only then, under the most extreme of expected wave conditions. Should this occur, the effect is expected to be relatively minor in extent and only marginally greater in depth and width than the diameter of the piles themselves.

257. Sumer & Fredsoe (2002) predict that the maximum equilibrium scour depth will be 1.3 times the pile diameter, with a standard deviation of 0.6. This implies a maximum scour hole with a depth of 1.1 m. Zaaijer & Tempel (2005) state that a scour hole can reach a depth of up to 1.5 times the pile diameter. However, the conditions at the site (including extreme conditions) are not expected to be able to generate such scour.

258. Calculations based on Breusers, *et al.* (1997) and Johnson (1992) estimate equilibrium scour depths around the piles of 1.23 m and 1.28 m respectively. Such localised changes in sediment transport would occur relatively quickly and be localised.

259. The elevation of the deck is expected to have minor impact on waves approaching the shore, if anything, dampening their effect. That is, there could be a slight dampening of wave activity, with waves interrupted by the wharf deck and, hence, a reduction in wave energy reaching the shore immediately adjacent.

260. **Residual impact**. These effects are not predicted to cause any impacts of significance (i.e. no more than minor significance) to arise.

5.2.2 Potential adverse impacts on water and land quality

261. The works to the yard and the proposed use of marine dredged arisings on land have the potential to affect water and land quality (and ecology) in these locations.

262. However, as set out in Section 4.2.5, the results of the borehole soil sampling and laboratory testing undertaken in the feasibility stage of the project showed low concentrations of metals. The results for organic material, including BTEX, PAHs and TPHs, were also either below the ANZ guidelines or below laboratory detection. Hence the works within the yard to remove the existing pavement and/or soils, and replace them with flexible pavement, are not predicted to have an adverse impact on land or water quality; with one exception.

263. **Risk of soil contamination (fuel spills)**. The potential risk associated with contaminated soils being present below the existing fuel tanks in the yard (Plates 5.1 a and b), and the need to remove these, has been investigated further.

Plates 5.1 a and b: a - Oil tank and contaminated ground; b - location of test pits

264. There is visual evidence of fuel leakage onto the ground in the location shown. Hence samples were taken for testing in March 2020 from two test pits at three depths (10, 30 and 750cm) and were sent to an ALS laboratory in Sydney for testing (see Figure 5.1).

265. Test Pit 1 was located at the site of an existing fuel tank (to be replaced by a new double hull tank) and Test Pit 2 was located on the edge of the proposed wash down area.

Figure 5.1: Test pits

Depth (cm)	Test Pit 1	Test Pit 2
0		
10		
30		
75		

266. The results showed the following:

- Phenolic compounds, PAHS and BTEX levels all below laboratory detection for all samples;
- detectable but relatively low concentrations of heavy metals; and
- elevated concentrations of Total Recoverable Hydrocarbons (TRH) and TPH.

267. Based on the results and their comparison with Schedule B1 of the Australian National Environmental Protection (Assessment of Site Contamination) Measure (NEPM) 1999 investigation levels, the results do not trigger a requirement for a detailed site-specific risk assessment or risk management response.

268. NEPM health investigation levels (HILs) and health screening levels (HSLs) for petroleum hydrocarbons are not exceeded. Further, NEPM ecological investigation levels (EILs) and ecological screening levels (ESLs) for petroleum hydrocarbons were not exceeded for any samples from Test Pit 2. For Test Pit 1, the surface samples (taken at 10 and 30cm) both exceed the commercial and industrial ESL for the TPH fractions (F3 >C16-C34, and F4 >C34-C4); but not the sample at 750cm. However, all samples at both test pits were below the NEPM management limits for TPH fractions F1-F4 in soil. Hence, remediation of the site is not required for its continued use.

269. If any soil at the site needs to be excavated for the proposed works, disposal to landfill would be appropriate. None of the soil would be classified as hazardous waste based on the New South Wales (NSW), Environmental Protection Agency classification (Waste Classification Guidelines Part 1: Classifying Waste). The surface soil from Test Pit 1 would be considered restricted waste but the remainder of the soil from Test Pit 1 and all of the soil from Test Pit 2 would be considered general solid waste. In NSW, both general and restricted solid waste can usually be disposed of to the same landfill. However, because restricted solid waste contains higher (up to four times) levels of contaminants than general solid waste, it should be managed by the landfill with more stringent environmental controls than those for general solid waste.

270. **Mitigation**. It is proposed that the areas of contamination will remain in situ and be capped with concrete pavement in line with the proposed yard construction methodology (see Section 3.5). Capping of this area, with a sump to collect run-off water, is already planned to provide the washdown slab for vehicle cleaning. Furthermore, it is proposed that the existing fuel tanks will be replaced with new, bunded equipment, such as that shown in Plate 5.2, to prevent spills in the future.

Plate 5.2: Example of replacement fuel pump

271. Bunded fuel storage tanks will minimize the risk of spillages and offer better security. A bunded fuel tank houses a primary tank within a fully enclosed secondary tank; where failure or overfilling of the primary tank does not cause spills onto the forecourt. If overfilling does occur, the fuel can be pumped back into the inner tank from the outer bund without causing contamination.

272. **Spills, waste and hazardous materials**. The construction works could affect water quality through leaks and spillages of fuels or oils, heavy metal leaching from soil and cement components in surface water runoff from construction. However, good working practices and the implementation of a waste management plan (WMP) and emergency response plan (ERP) will ensure that any such effects are limited, controlled and managed appropriately.

273. Drainage of the existing site is poor, and run-off will need to be controlled during the construction phase through the use of sandbag to redirect flow towards temporary shallow settlement ponds. Additionally, a temporary oil and waste disposal facility will need to be established by the contractor. For the marine work, a spill boom will be deployed to enclose the water surrounding the working space to prevent any oil, rubbish and debris from the site activity entering the waterbody (as illustrated in Plates 5.3 a and b).

274. **Residual impacts**. With the proposed mitigation in place, the residual impact on land or water quality associated with soil contamination, leaks and spills is predicted to be of negligible significance.

Plates 5.3 a and b: Typical settlement pond and spill boom

275. **Use of dredged arisings**. With regard to the potential risks associated with the drying and use of the dredged arising for other construction projects, there are no soil or sediment quality guidelines for reuse of material in Tonga. The results obtained from the sediment sampling, therefore, have been compared to the Australian recreational health investigation levels (NEPM, 2013). Based on these levels, Table 4.4 indicates the sediment within the proposed dredge area would be suitable for reuse and meets the criteria adopted in Australia for reuse in open spaces, such as parks or playing fields, due to the low level of contaminants observed. Consequently, no adverse impacts will arise due to the reuse of the dredging arisings as construction material.

276. Locations for potential reuse currently are not known, and do not represent associated projects. Disposal of dredged material, similar to any other excess material, will only be at sites selected in alignment with the requirements of the CSS and SPS. The Engineer will approve any sites prior to any disposal.

5.3 Construction Impacts on the Biological Environment

5.3.1 Potential adverse impacts on marine benthos and reefs

277. The proposed scope of works associated with the project includes the upgrading and refurbishment of its existing structure on largely the same footprint both above and below water level. This will include intermittent piling over a period of 3-8 months (expected to be 4-5), backfilling and some dredging. The benthic habitats associated with the project's footprint directly in front of and adjacent to the port's two international wharfs comprise almost exclusively sand/silt substrate (some coral rubble ad rocks) with no sessile benthic organisms. They are highly modified by past anthropogenic activities, principally land and sea (intertidal reef flat) reclamations and port infrastructure development and operations. Thus, the habitat may be classified as disturbed benthic marine habitat of low ecological value.

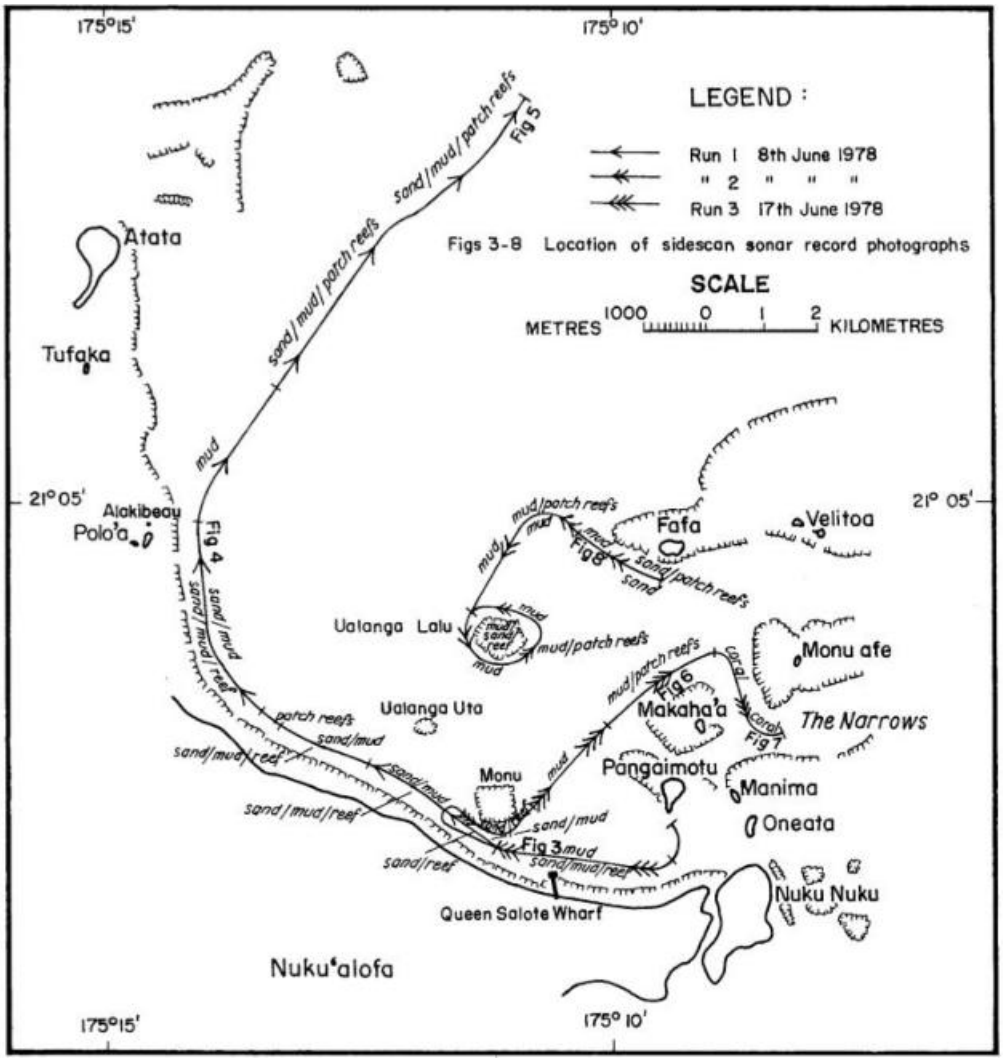
278. The potential impacts of the project on the marine biological environment include: (i) the introduction of new infrastructure; (ii) localised and temporary increased suspended sediment levels adjacent to the port's wharfs, potentially affecting marine habitats and associated resources during construction; and (iii) spillage/leakage of oil and other pollutants into the marine environment from plant and equipment used during the upgrade.

279. **Introduction of new structures**. Based on the proposed scope/scale of works, the introduction of new infrastructure (piles) is predicted to have a minor impact on the marine habitats and resources of the study area. The new structures will be effectively permeable to waves, currents and sediment transport. No changes in these processes will mean that the marine biology of the study area will be largely unaffected. The only effects predicted will occur immediately adjacent to the new piles (i.e. will be localised); with an influence that is only marginally greater in depth and width than the diameter of the piles themselves. Moreover, the habitat value in the immediate vicinity of QSIW is low.

280. With reference to the proposed new marker buoys North of the QSIW site , several studies were undertaken in this location by SOPAC in 1983 and 1991 to assess the viability of sand mining within Tongatapu lagoon. The area of interest (Figure 5.2) was highlighted as being composed of sand, mud and some reef in patches.

281. Because some reef was identified, it is proposed that, in order to avoid any impacts on reef habitat through the relocation of the marker buoy, the area will be surveyed prior to the works occurring and the new location of the buoy micro-sited to avoid any reef. This will ensure that anchors are dropped in areas of sand and mud only.

Figure 5.2: Information from SOPAC studies of seabed in the vicinity of the Ava Lahi channel



282. With reference to the proposed relocation of the navigation aid currently found on Monu Reef, the current navigation aids are located within the shallow water subtidal reef flat and get moved around during cyclonic wave action, which leads to a requirement for repairs. With the proposal to place the aid in the deeper water (subtidal reef slope - seabed) then the impacts on benthic organisms will be negligible (particularly compared to placement in shallow water which has the potential to impact benthic sessile organisms). These areas are devoid of sessile benthic organisms and ecosystems of significance. Minor sand suspension will occur during installation, but this will have no impact on surrounding habitats. The area has limited tidal and wind driven waves and currents at depth (except during cyclones) and, as such, anything suspended will not move far, plus, the coral sand derived from the reef is not easily suspended and the quantity of fine sediment is limited.

283. **Increased levels of suspended sediment due to dredging**. Due to the silt content of the sediment to be dredged (see Table 4.8), disturbance of these sediments will cause turbidity that can adversely affect marine water quality and marine ecology. These effects were therefore assessed.

284. Approach. An existing RHDHV MIKE 21 Flexible Mesh hydrodynamic model of Tonga was updated and refined for this study. It has been calibrated to the project specific water level and currents measurements, updated to include Faua Wharf and upgraded to a 3-dimensional model (i.e. MIKE 3). The model was set up to run for a one-month period from 10/10/2019 to 10/11/2019, which included the period of ADCP data collection. The model validation exercise showed that the model was able to closely reproduce observed water levels at the wharf and that the modelled current speeds matched reasonably well with those observed and had the same characteristics.

285. Numerical modelling was carried out to represent the potential fate of sediments released into the water column through dredging. The modelling simulates the dispersal of suspended sediments due to dredging by ambient currents as well as the subsequent deposition of sediment suspended. To represent the dredging activities in the numerical model it is necessary to define the: quantity, characteristics, location, duration and frequency of the material to be released. RHDHV, in consultation with Hall Contractors (a Pacific based dredge operator), therefore developed a dredging strategy, enabling a realistic representation of the actual dredging works to be developed.

286. The modelled source terms[12] are dependent on several parameters which relate to a number of aspects and processes, including the fines content of the material to be dredged, the breakup of the dredge material under mechanical action and hydraulic transport. Other factors, including dredger efficiency, production rates and cycle times also feed into the magnitude of the source term.

287. Discussions with Hall Contractors indicated that a 50 to 100t long reach excavator / back-hoe dredger on a large spudded barge (such as shown in Plate 5.4) would be the likely plant used for such a dredge operation. The large barge can hold up to 1000m^3 of spoil.

288. A summary of the estimated dredging volumes and other assumptions regarding the dredging operations for the project is provided in Table 5.1.

289. It is intended that surface silt curtains (i.e. shallow draft silt curtains about 4 to 6 m deep) will be used by the BHD to limit the surface sediment plume when the bucket is lifted above the water surface. The assumed location of the silt curtain is presented in Figure 5.3.

[12] The amount of material that would become suspended in the water column during dredging is referred to as the source term.

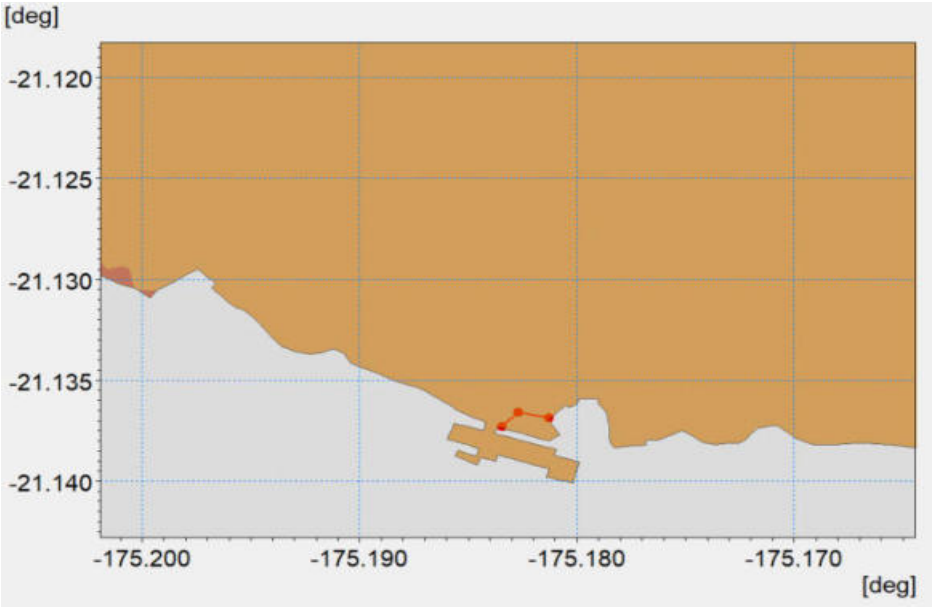
Plate 5.4: Suggested dredge plant – large spudded barge (the Orion) with 80t long reach excavator

Table 5.1: Assumptions for Project dredging

Assumption	Value	Comment
In situ Dredge Volume (m^3)	17,135	
Bucket Size (m^3)	1.2	This is a 50t Cat Long Reach Excavator
Operation Cycle (s)	60	This includes an allowance for barge disposal
Bulking Factor	1.2	Slight increase in volume on disturbance
Operational Hours per Day	8	Assumed – 8am to 4pm dredge operation. Spoil removed at end of day.
Days per week	5	Assumed Monday to Friday operation only.
Bulked density (kg/m^3)	1500	Typical bulked density of sand
Source Term	2	Source term of 1 to 2% usual for BHD.
x (longitude)	-175.182	dredge location
y (latitude)	-21.1375	dredge location
Calculations		
Dredge Rate (m^3/min)	1.0	Considers bucket size, operation cycle and bulking
Dredge Rate (m^3/day)	480	Considers dredge rate and hours/day
Dredge Rate (m^3/week)	2400	Considers operations days/week

Assumption	Value	Comment
Dredge Duration (days)	35.70	Approx. 36 days of dredging (excludes weekends)
Dredge Duration (weeks)	7.14	Less than a 8 week period
Dredge Duration (calendar days)	49.98	Total period, including no dredge days on weekends
Dredge Rate (m^3/s)	0.0167	
Dredge Rate (kg/s)	25	Using assumed density
Spoil released to water column rate (kg/s)	0.5	Using assumed 2% source term
Total volume fines released to environment (m^3)	342.70	Using assumed 2% source term
Total mass fines released to environment (kg)	514,050	Using assumed 2% source term and assumed density
% Fines	30%	PSD shows that at BH04 between 25 and 30% are fines; < 64 microns (um)
% Clay	60%	Approx. 60% of fines are clay. Assume even split (i.e. 10% each) for remaining four silt fractions.

Figure 5.3: Adopted location of modelled silt curtain (red line)

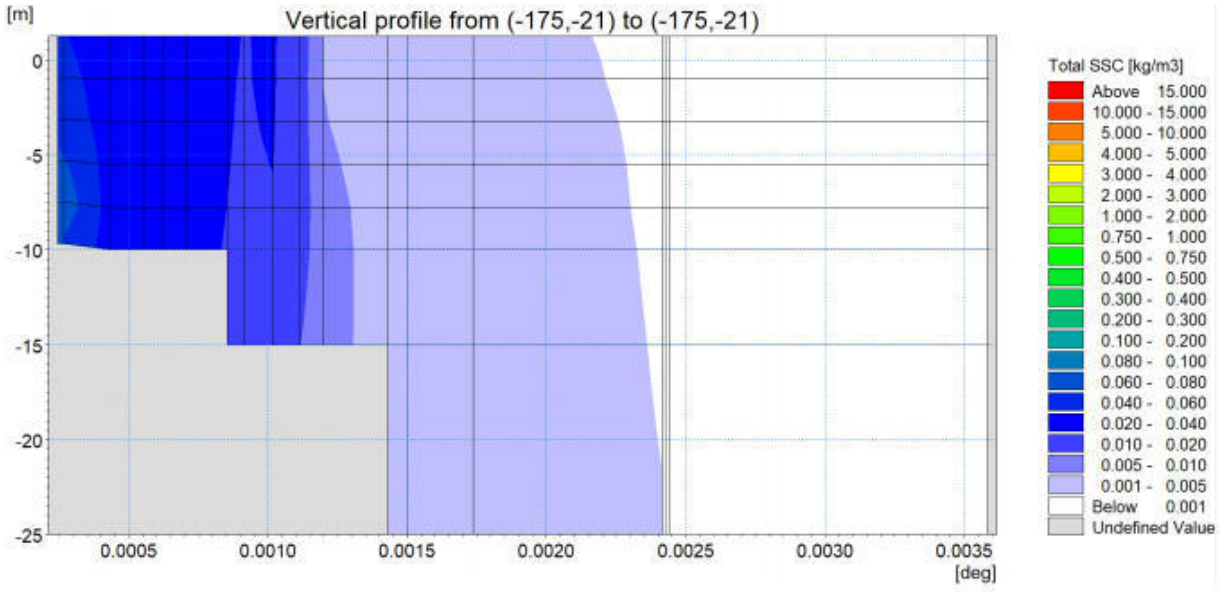


290. The results included in Figure 5.4 show that while concentrations of up to 200 mg/l (1 mg/l = 0.001 kg/m^3) are experienced in the dredge area, concentrations outside of the silt curtain will be below 5 mg/l[13]. As only surface concentrations are presented in Figure 5.4, Figure 5.5 presents a vertical slice through the water column and shows that the TSS is mixed uniformly throughout the water column.

[13] The map presented in Figure 5.4 does not show an actual dredge plume at any point in time, but the maximum concentration that occurred at any point during the one-month simulation.

Figure 5.4: Maximum surface total TSS during two month simulation period

Figure 5.5: Vertical slice (IP1-2) total-TSS during two month simulation period



291. Time series results for TSS through the plume simulation were extracted from the model at the five locations shown in Figure 5.6 and have been graphed in Figure 5.7.

Figure 5.6: Location of five model time series output points

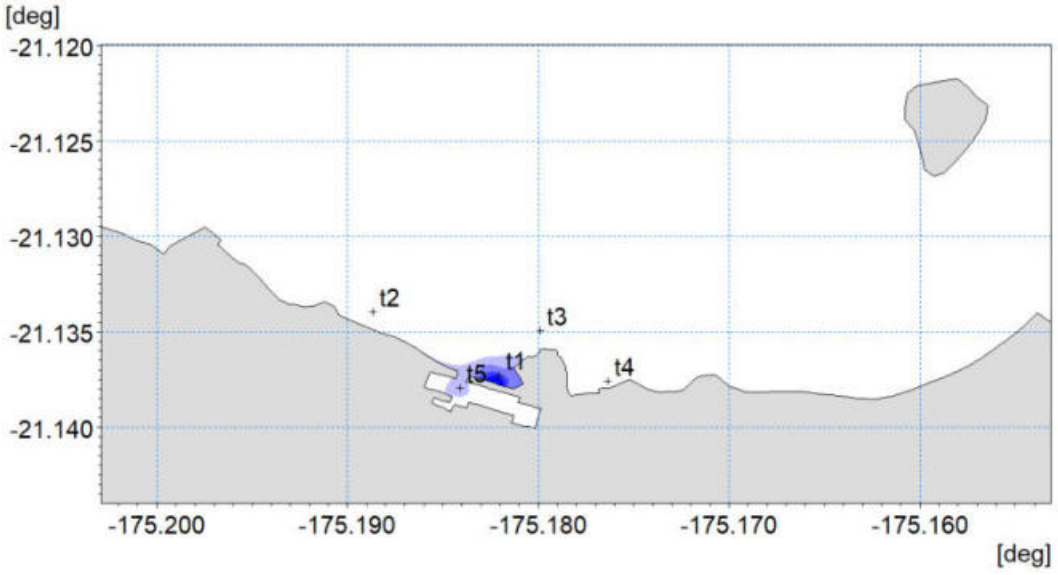
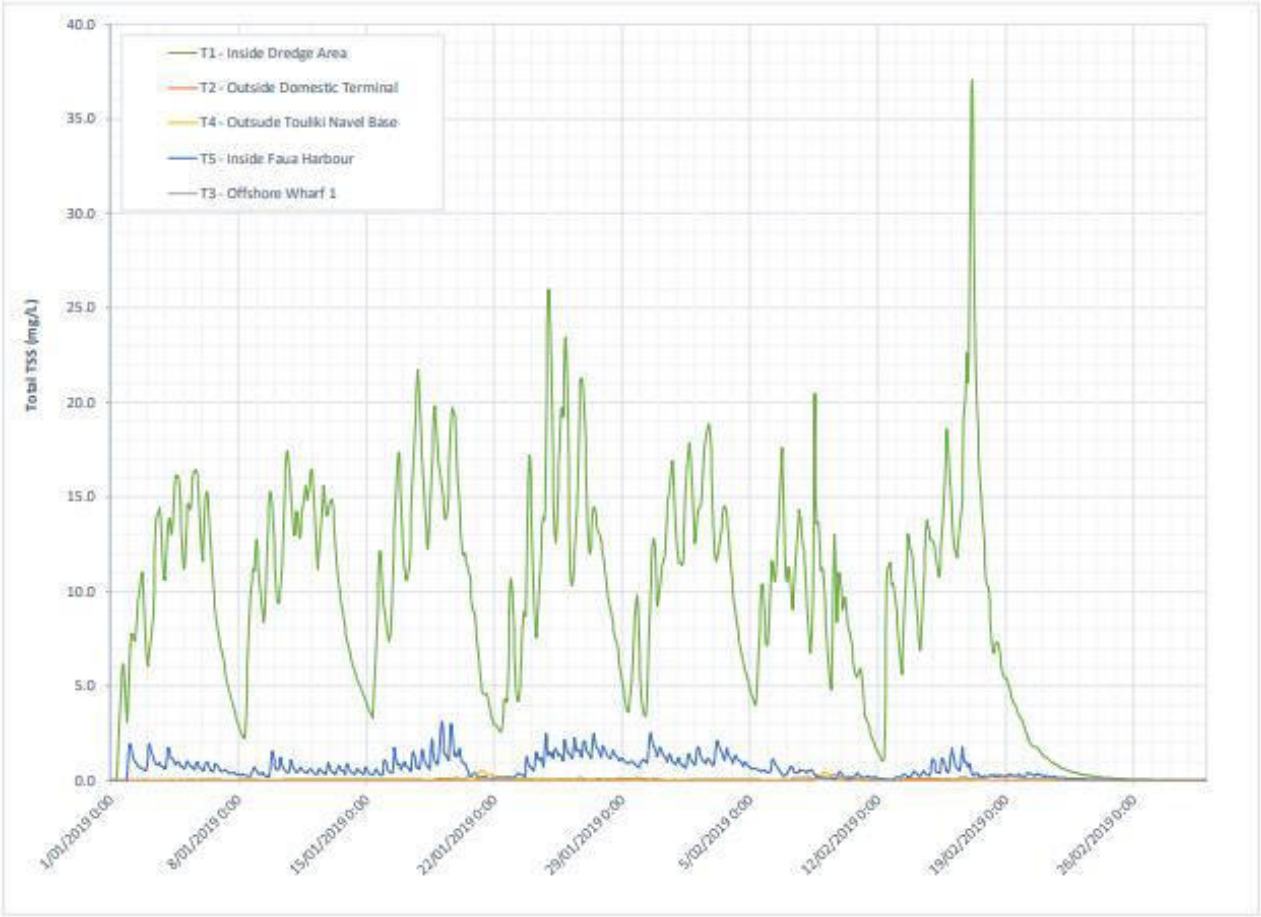


Figure 5.7: Total SSC - time series at five locations

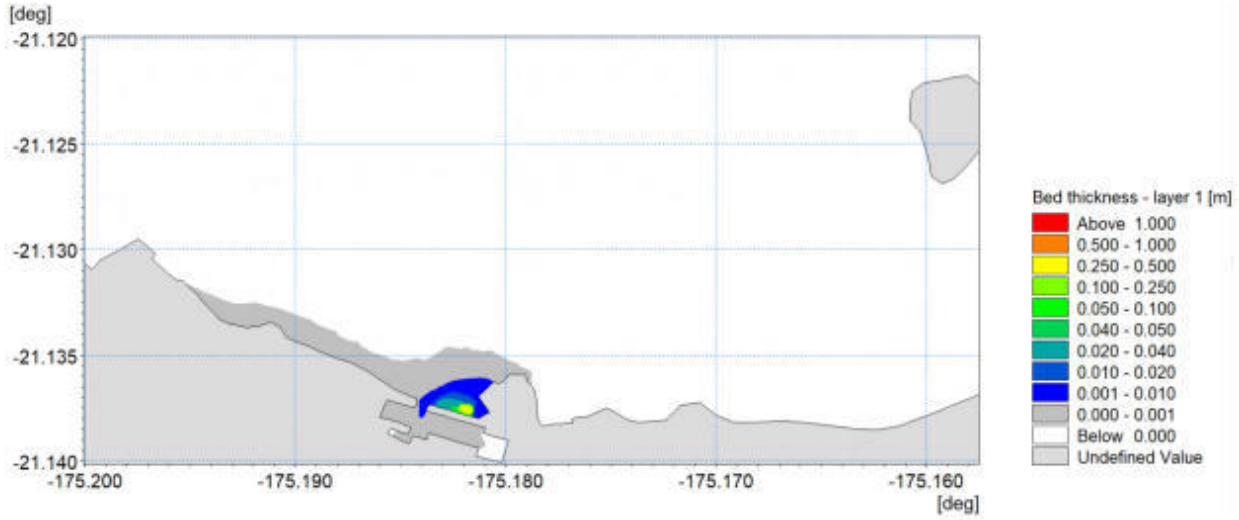


292. The results show that:

- Within the dredge area (i.e. behind the silt-curtain) concentrations of up to 37 mg/l are predicted.
- The concentrations rise sharply during Monday to Friday, 8am to 4pm, but decrease when dredging ceases (i.e. over the weekend). A diurnal (1 peak/day) signal is noted.
- After dredging ceases on the 50th day TSS falls to 0 mg/l within 1 week.
- Within Faua Harbour, TSS is always below 5 mg/l and mostly below 3 mg/l. A semi-diurnal signal is noted due to the tidal influence bringing TSS to and from the harbour.
- At locations T3, T4 and T5 (away from the immediate plume area) TSS concentrations are less than 1 mg/l.

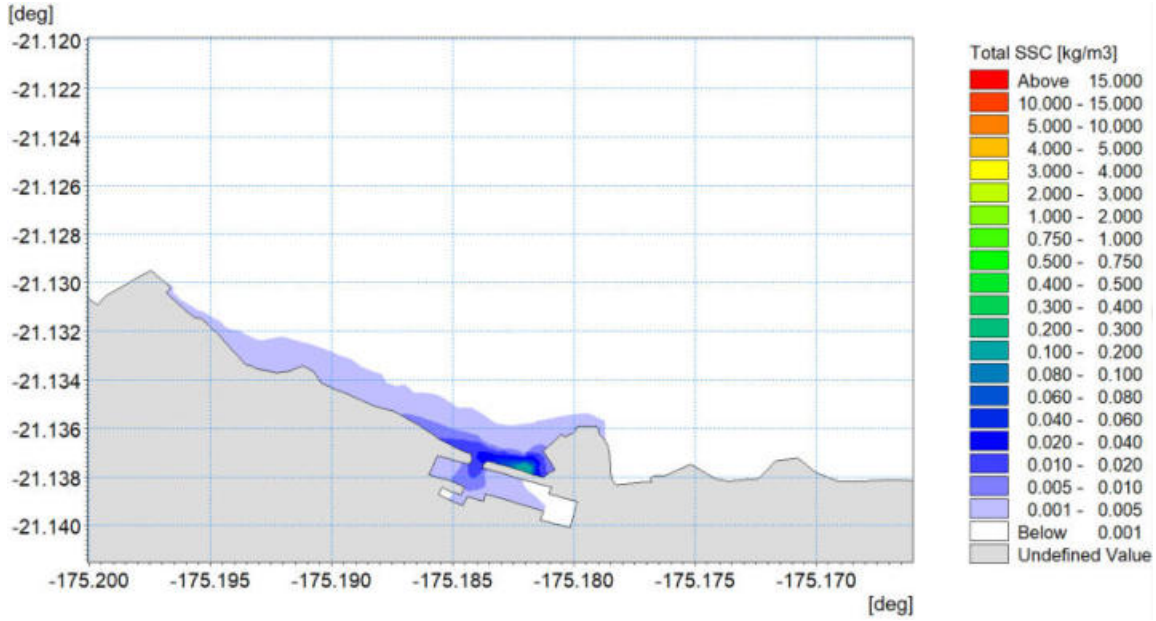
293. A map of the predicted sediment deposition thickness due to the proposed dredging is presented in Figure 5.8. It shows that outside the silt curtain the predicted sediment deposition is less than 1 mm.

Figure 5.8: Map of sediment deposition thickness - end of two-month simulation period



294. For the purposes of comparison only, Figure 5.9 presents a map of maximum surface TSS if no silt curtain was in place. Without a silt curtain, the spread of and plume extent would be larger and higher peaks of TSS within Faua Harbour are predicted; though the duration of high TSS both within the harbour and dredge area would reduce. Outside of the dredge area, a higher level and extent of deposition would occur.

Figure 5.9: Maximum surface total TSS – for a one month simulation period without silt curtain



295. Conclusions regarding the sediment plume. The dredging required as part of the proposed upgrade of QSIW will temporarily degrade the local water quality, as it will suspend/disperse a small quantity of seabed sediment into the surrounding waters. Such dispersion of sediments may affect the surrounding ecosystem through increasing water turbidity.

296. However, due to the relatively small amount of dredging (and other works) required for the Project, the low habitat value and the prevailing high suspended sediment conditions in the area during periods of heavy rain and/or rough sea conditions, the predicted impact is very small/minor and the use of silt curtains will reduce its extent. Given this, it is not considered necessary for the contractor to prepare a dredging management plan (that specifies maximum dredging volumes per day) in this instance.

297. **Presence of contaminants in suspended sediment**. The potential also exists for the introduction of contaminants into the marine environment around the international wharfs due to a temporary increased in suspended sediment levels. That is, any contaminants contained within the marine sediments could be remobilised due to the sampling, dredging and piling works.

298. However, as set out in Section 4, the results of marine sediment sampling and laboratory testing show low concentrates of metals. Furthermore, the results for organic material, including BTEX, PAHs and TPHs, were either below the ANZ guidelines or below laboratory detection.

299. TBT concentrations at sampling site BH01, in the top 0-1m, exceeded the ANZG (2018) and Commonwealth of Australia National Assessment Guideline for Dredging 2009 (NAGD) limit of 9 µgSn/kg. However, it is understood that dredging and sea disposal of sediment is not proposed in the vicinity of BH01 and that these sediments would not be disturbed. Piling for the proposed dolphin in this location would also be limited. TBT was below laboratory detection at all other locations and depths.

300. Assuming that dredging does not occur in the vicinity of BH01, due to the low contaminant concentrations observed, no impacts on water quality or marine ecology due to the resuspension of contaminated sediments is predicted.

301. **Spills**. The construction works could affect water quality, and consequently marine ecology, through leaks and spillages of fuels or oils, heavy metal leaching from soil and cement components in surface water runoff from construction. However, good working practices (WMP and ERP preparation and implementation) should ensure that any such effects are limited, controlled and managed appropriately.

302. **Mitigation and monitoring**. Albeit any effects are predicted to be minor, the potential impacts associated with increased suspended sediment levels, the introduction of contaminants from the works and in relation to the installation of the new marker buoy and navigation aid on Mona Reef can be minimised through the implementation of the following mitigation measures during the construction phase of the project:

- Deployment of silt curtains around the wharfs during all construction and redevelopment activities to directly manage and reduce the dispersion of benthic substrate (silt) disturbed. Figure 5.9 illustrates the extent of the predicted effect without a silt curtain in place.
- Ensuring due diligence when operating machinery during all work activities to prevent and manage the risk of wastewater discharge, petrochemical spillage and contamination of the waters associated with the port.
- No dredging should occur in the vicinity of BH01.
- The area proposed for the relocation of the marker buoy should be surveyed prior to the works occurring and the new location micro-sited to avoid any reef.
- The existing navigation aid located on Mona Reef should be removed from the reef and disposed of appropriately.

303. During the construction phase the contractor will be required to ensure that all equipment is properly maintained and to follow all necessary precautions to prevent spills into the marine environment. That is, pollution prevention measures should be implemented by the contractor and measures to avoid the risk of leaks and spills adhered to. Moreover, should an accident occur, spill kits should be available, appropriate and staff trained in their use. Provided such measures are properly implemented the potential impacts on the marine environment should be insignificant.

304. Nevertheless, while the silt curtains will block the suspended sediment to a large extent, as sediment can leak out through silt curtains, turbidity levels should be monitored in the adjacent waters during the works and an action threshold set. That is, should the turbidity levels exceed a set threshold value, further measures would need to be taken, such as reducing dredging rates. This will ensure that any effects on water quality and the marine environment would be minor and short term.

305. In this case it is proposed that the threshold value should be 50 mg/l above background.[14] That is, a surface (within 0.5m) measurement point should be set up outside but within 10m of the silt curtain and suspended sediment control measurements should be taken twice daily (or whenever considered necessary by the DSC and PMU) during the dredging and reclamation works. A background reference station will also need to be established and sampled at the same time.

306. Should a reading of 50% of 50 mg/l above background be recorded then further investigation should be initiated and hourly readings taken. For example, inspection of the silt curtain, weather conditions and the mode of operation of dredging. Should the readings continue to show an increase in SSC, then dredging rates should be reduced to the point that the SCC level declines.

307. The monitoring results will be reported to the PMU, DSC and MOI once a week, and to MEIDECC when requested. In addition, close supervision of the works should occur to ensure that the above recommended mitigation measures are implemented and effective throughout the marine construction phase. A physical clean-up of the existing debris on the seabed during the works is also recommended.

308. **Residual impacts**. The impacts on the marine environment and coastal waters within and around QSIW predicted to arise from the envisaged scope of works associated with the QSIW project in the construction phase are expected to be minor, temporary (and restricted to the duration of the works), local to the immediate footprint of the works, and easily managed through standard, good practice mitigation measures. No threats to the wider area's marine and coastal biodiversity would be associated with the project.

5.3.2 Potential beneficial impacts on marine benthos and reefs

309. For the facility to comply with the requirements of the ADB's SPS 2009, in line with the recommendations of the environmental audit (see Section 3), the following measures should be brought forward as part of the project for the benefit of the marine environment:

- The marine benthic environment directly adjacent to all the wharfs contains considerable anthropogenic port-derived material, machinery and rubbish. A physical clean-up of this material should occur in conjunction with the works.
- Existing waste deposit sites on the Port should be cleared and the waste dealt with appropriately.

[14] The critical threshold set for marginal reef environments (such as that found in the study area) in Indonesia (Banten Bay) and in Queensland Australia (Paluma Shoals) was 40 mg/l (PIANC, 2010). This threshold should be reviewed by MEIDECC and adjusted, if necessary, during the works if it is deemed to be too high.

- The installation of oil and grease traps in the drainage system at the workshops, maintenance and refuelling areas should occur (and this is proposed; see Section 3) and spill kits should be provided.
- The Port septic tanks should be routinely cleaned, with sludge to be disposed of in accordance with Government regulations.

310. These actions will be overseen by the EHSO.

311. **Residual impact**. These measures will be of moderate beneficial significance to the local marine environment,

5.3.3 Potential adverse impacts on cetaceans

312. **Predicted effects**. The project's scope of works is restricted to the terrestrial footprint of QSIW and the reef edge, adjacent to the existing wharfs (see Figure 1.2)[15]. Of potential relevance to cetaceans, the works in these locations could include the following: (i) surveys (such as MBES hydro survey) during the construction phase to check dredging dimensions etc.; (ii) piling over three to eight months (likely to be for four to five); and (iii) dredging using a backhoe dredger for around two months.

313. Seismic testing in two boreholes locations onshore was undertaken in November 2019. No further testing of this type is proposed. Notably, these works would occur a reasonable linear distance away from oceanic waters and possible encounters with whales. It is conceivable that humpbacks may enter the lagoon in its northern sections to calve or with young, but only during the migration season and, as such, this could be easily managed.

314. Based on the above, the proposed port upgrade is not expected to have a significant direct or indirect impact on any populations of cetaceans occasionally utilising the lagoon (dolphins) and/or oceanic waters (whales) surrounding Tongatapu. However, their behaviour could be affected by the survey, piling and dredging operations. Within the proposed development site, two sources of sound pollution could arise, one specific to the design phase (i.e. due to bathymetric data collection, if using sonar[16]) and one originating during the construction phase (due to piling).

315. During the marine port design phase, the multibeam sonar (for bathymetry) and side-scan sonar (for bottom typing) that could be used are at the lower end of the intensity scale, though they are generally considered high acoustic density sources and medium frequency generators. Their level of sound pressure ranges from about 200 dB re 1µPa to 240 dB re 1µPa. Their frequency ranges from about 50 to 500 kHz. The nature of propagation varies depending on the nature of the survey, although it can be expected to conform to a conical pattern with a greater swath being covered in deeper water.

[15] QSIW is located on reclaimed inshore (intertidal and subtidal) fringing reef and the berths are located on the original reef edge and reef slope, which then enters the lagoon.

[16] Cetaceans have been reported to be impacted by the use of certain types of sonar used in close proximity to an individual, as it directly affects their ability to navigate and communicate by altering acoustics under water.

316. There is a significant difference in the effects of seismic and multibeam/side-scan surveys on cetaceans. Higher frequency emissions utilised in normal multibeam operations tend to be dissipated to safe levels over a relatively short distance, despite having similar sound levels to seismic surveys. By contrast the lower frequency (and higher intensity) emissions of seismic surveys, including air gun arrays, travel over a far greater distance and affect a greater area at greater intensity (Department of Environment, Heritage and Local Government, 2007). Consequently, surveys and piling during the migration season, could displace a proportion of the large whale population and result in modified migration behaviour during this period.

317. **Mitigation**. The proposed mitigation measures include:

- Silt curtains are to be used to control the excursion of any sediment plume.
- Soft start protocols should be applied to any piling works undertaken between July and mid-November.
- A marine mammal observer should be employed between July and mid-November to watch for any dolphins moving into the lagoon or dolphins/whales transiting within 800m of QSIW. Should this be observed, works would need to cease until the cetacean had moved away from the zone of influence of the works.

318. As an alternative to the 2nd and 3rd items above, either percussive piling techniques based on noise mitigation systems (e.g. bubble curtains, hydro-sound dampers or noise mitigation screens) or drill / vibro-piling techniques could be used. Any noise mitigation systems proposed for use by the contractor should first be approved by the CSC/PMU and MEIDECC.

319. Should the project require the use of sonar, to reduce the risk of impacts occurring, vessel and survey operators would be instructed to:

- Undertake all work utilizing sonar outside the annual whale migration periods (July – November);
- Use best practice for operating vessels in proximity to marine mammals;
- Post a watch for whales and suspend activities when whales are within 1 km of a vessel; and
- Use multi-beam and/or side-scan sonar only – no air guns.

320. **Residual impact**. With this mitigation in place, no direct or indirect impacts are predicted on cetaceans due to the construction or operation of QSIW.

5.4 Construction Impacts on the Socioeconomic Environment

5.4.1 Potential impacts on air quality - dust and particulate assessment

321. **Guidance on dust and particulate assessment.** The following guidance was used for the purposes of this assessment the United Kingdom's (UK's) Institute of Air Quality Management (IAQM) *'Guidance on the assessment of dust from demolition and construction'* (IAQM, 2016).

322. The IAQM risk-based approach can be applied elsewhere, provided that consideration is given to the local climate, construction working practices and statutory assessment criteria of the country/region where construction activities are taking place. This guidance is also the recommended guidance for use in assessing risk of dust from demolition and construction in New Zealand (Ministry for the Environment, 2016).

323. **Assessment methodology**. Table 5.2 describes the potential dust emission class criteria for each outlined construction activity.

Table 5.2: Definitions of magnitudes of construction dust and particulate matter emissions

Activity	Criteria used to determine dust emission class		
	Small	**Medium**	**Large**
Earthworks	• Total site area <2,500m^2 • Soil type with large grain size (e.g. sand) • <5 heavy earth moving vehicles active at any one time • Formation of bunds	• Total site area 2,500 – 10,000m^2 • Moderately dusty soil type (e.g. silt) • 5-10 heavy vehicles active at any one time • Formation of bunds 4 - 8 m in height • Total material moved 20,000 – 100,000 tonnes	• Total site area >10,000m^2 • Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) • >10 heavy earth moving vehicles active at any one time • Formation of bunds >8m in height • Total material moved >100,000 tonnes
Construction	• Total building volume <25,000m^3 • Construction material with low potential for dust release (e.g. metal cladding or timber)	• Total building volume 25,000 – 100,000m^3 • Potentially dusty construction material (e.g. concrete) • On site concrete batching	• Total building volume >100, 000m^3 • On site concrete batching, sandblasting
Track out	• <10 HDV (>3.5t) outward movements16 in any one day • Surface material with low potential for dust release • Unpaved road length <50m	• 10-50 HDV (>3.5t) outward movements in any one day • Moderately dusty surface material (e.g. high clay content) • Unpaved road length 50 – 100m	• >50 HDV (>3.5t) outward movements in any one day • Potentially dusty surface material (e.g. high clay content) • Unpaved road length >100m

324. Dust and particulate matter emissions have the potential to affect both human and ecological receptors. Definitions of the different sensitivity levels for human and ecological receptors to dust, according to the IAQM guidance, are detailed in Table 5.3.

325. The overall sensitivity of an area to both dust soiling and human health impacts of PM_{10} is determined using the criteria detailed in Tables 5.4 and 5.5 and distances shown in Figure 5.10 (the area of influence).

Table 5.3: Definitions of sensitivity levels for receptors of construction dust and particulate matter

Sensitivity	Sensitivity of people to dust soiling	Sensitivity of people to the health effects of PM_{10}
High	Residential dwellings, museums and other culturally important collections, medium and long-term car parks and showrooms.	Residential properties, hospitals, schools and residential care homes.
Medium	Parks, places of work.	Office and shop workers not occupationally exposed to PM_{10}.
Low	Playing fields, farmland, footpaths, short-term car parks and roads.	Public footpaths, playing fields, parks and shopping streets.

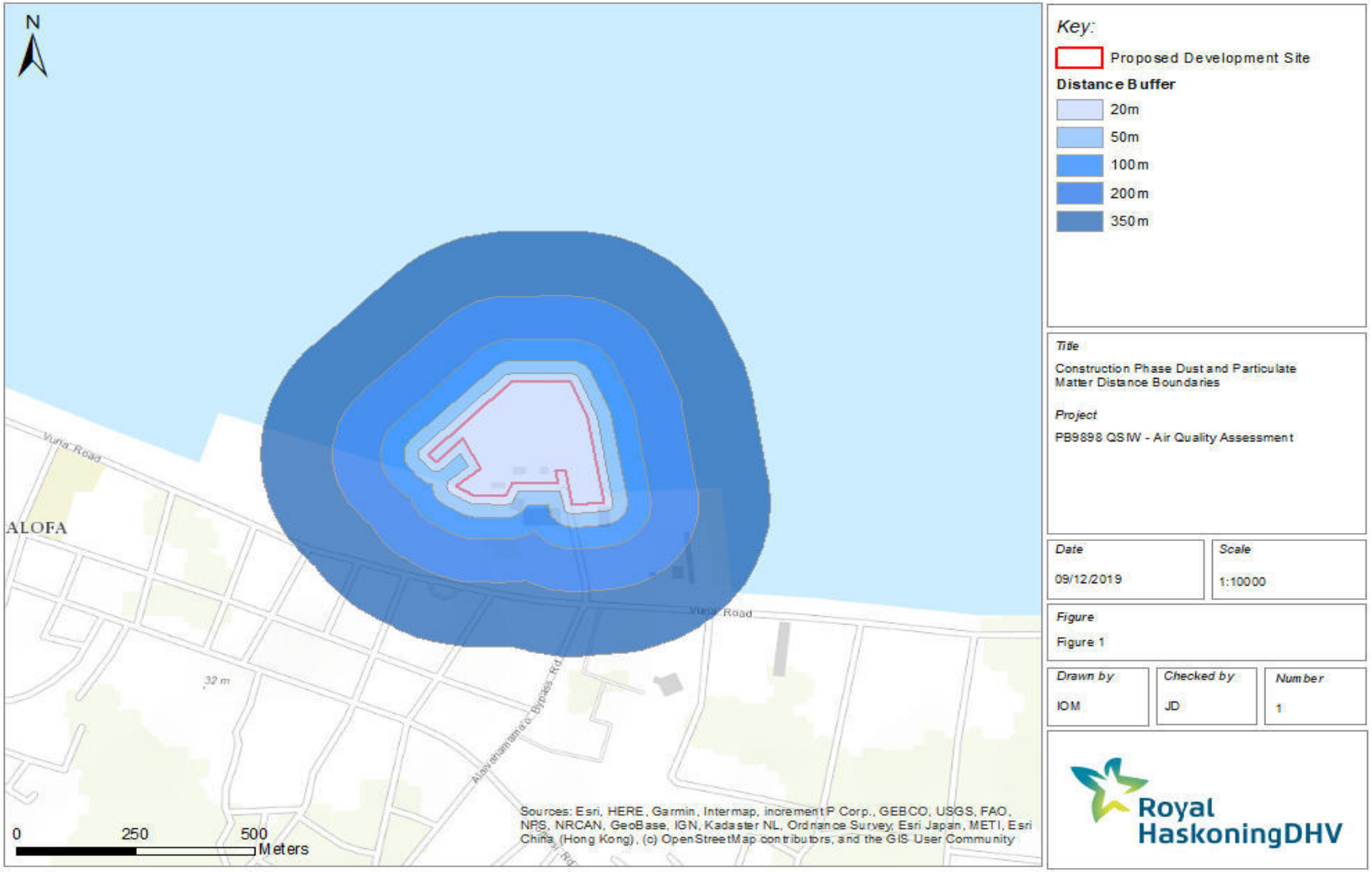
Table 5.4: Sensitivity of the area to human health impacts

Receptor sensitivity	Annual mean PM_{10} concentrations	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32µg.m^3	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	>28-32µg.m^3	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	>24-28µg.m^3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24µg.m^3	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	r>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table 5.5: Sensitivity of the area to dust soiling effects on people and property

Receptor sensitivity	Number of receptors	Distance from source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Figure 5.10: Construction phase dust and particulate matter distance boundaries



326. The dust emission magnitude is combined with the sensitivity of the area to determine the risk of impacts prior to mitigation. This is shown in Tables 5.6 and 5.7.

Table 5.6: Risk of dust impacts – earthworks and construction

Potential Impact	Dust emission magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 5.7: Risk of dust impacts through track out

Potential Impact	Dust emission magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

327. Detailed assessment is required where there are human receptors within 350m of the site boundary and / or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s) (IAQM, 2016); which is the case for this project. Ecological receptors within 50m of the site boundary or within 50m of the route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s), are also relevant; but none are present in this case.

328. The assumptions used in the assessment were as follows:

- Construction programme. Construction is anticipated to begin in March 2021 and completed by December 2023. For the sake of this assessment it was assumed, as a worst case, that all construction activities would be undertaken concurrently, as opposed to in two phases (as proposed). This was to provide a conservative construction phase dust and particulate matter assessment.
- The site. The site is currently unpaved and this results in the generation of airborne dust from the re-disturbance of settled materials. This area will be remediated as part of the project in order to reduce dust generation at the site. In order to produce a conservative dust assessment, it was assumed that some construction works will occur while the site is still unpaved.

- Background air pollutant concentrations. There are no background PM_{10} (particulate matter with a diameter of <10µm) pollutant concentration data available for the study area. Although the available population exposure data indicates low average PM_{10} levels, it was assumed, as a worst case, that annual mean PM_{10} concentrations could be >32µg.m^{-3}, to ensure a conservative assessment.

329. **Predicted effects**. The construction works associated with the proposed development have the potential to effect local air quality conditions in the following ways:

- Dust emissions generated by excavation, construction and earthwork activities associated with construction have the potential to cause nuisance to, and soiling of, sensitive receptors.
- Emissions of exhaust pollutants, especially NO_2 and PM_{10} from construction traffic on the local road network, have the potential to adversely affect local air quality at sensitive receptors situated adjacent to the routes utilised by construction vehicles.
- Emissions of NO_2 and PM_{10} from non-road mobile machinery operating within the development site have the potential to adversely affect local air quality at sensitive receptors in close proximity to the works.

330. The potential for sensitive receptors to be affected will depend on where within the site the dust raising activity takes place, the nature of the activity and controls, and meteorological dispersion conditions. The predicted dust magnitude for earthworks, construction and track out are summarised in Table 5.8. The dust magnitude for construction activities was categorised as 'large' for earthworks and track out and 'medium' for construction.

Table 5.8: Dust emission magnitude for the site

Construction activity	Dust emission magnitude	Reasoning
Earthworks	Large	• Total site area >10,000m^2 • Potentially dusty soil type
Construction	Medium	• Potentially dusty construction material (e.g. concrete)
Track out	Large	• >100m unpaved road length

331. The sensitivity of human receptors to dust soiling and health effects of particulate matter associated with earthworks, construction and track out activities during construction of the proposed scheme was determined and summarised in

332. Table 5.9. The following was also considered in determining the sensitivity of the area: *"Any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant the season during which the works will take place"* (IAQM, 2016).

Table 5.9: Outcome of the sensitivity of the area

Potential Impact	Sensitivity of the surrounding area		
	Earthworks	Construction	Track out
Dust soiling	Low	Low	High
Human health	Low	Low	High

333. As detailed in Section 4.2.4, local meteorological data were analysed and it was determined that the prevailing winds over the site were from the east, south-east and south (2014 to 2019 records). These winds will generally disperse any dust or particulate matter generated from construction of the proposed development away from any human receptors (e.g. residential houses and apartments, hotels, restaurants), as all human receptors in the study area are to the south, south-east and south-west of the proposed development and are >200m from the proposed development. However, there is the potential for wind to blow towards human receptors and, as shown in Table 4.1, winds blew towards receptors approximately 30% of the time during the wet season and 23% of the time during the dry season (overall on average 25% of the time) over the past 5 years (2014 – 2018).

334. Sensitivity of people to dust soiling and to the health effects of PM_{10}. For earthworks and construction there are predicted to be between 10 and 100 high sensitivity receptors within 350m of the site; sensitivity is therefore low. For track out there are potentially between 10 and 100 high sensitivity receptors within 20m of access roads to the site, up to 500m from the site access; sensitivity in this case is therefore high.

335. The risk of impacts. The dust emission magnitude detailed in Table 5.8 has been combined with the sensitivity of the area detailed in

336. Table 5.9 to determine the risk of impacts without mitigation; see Table 5.10.

Table 5.10: Summary dust risk table to define site-specific mitigation

Potential Impact	Sensitivity of the surrounding area		
	Earthworks	Construction	Track out
Dust soiling	Low Risk	Low Risk	High Risk
Human health	Low Risk	Low Risk	High Risk

337. Because the construction phase dust and particulate matter assessment determined that there is a high risk of impacts resulting from certain construction activities, it is recommended that the good practice mitigation measures outlined in the IAQM Guidance are implemented.

338. The recommendations set out below should be detailed in the CEMP to prevent or minimise the release of dust entering the atmosphere and/or being deposited on nearby receptors. Particular attention should be paid to operations which must take place close to the site boundary. The effective implementation of the CEMP will ensure that any potential dust releases associated with the construction phase will be suitably managed and controlled.

339. **Mitigation measures**. The mitigation measures that are 'highly recommended' by the IAQM Guidance for a high-risk site, relevant to QSIW, are set out below. These have been included in the EMP.

- Communications -
    - Develop and implement a communications and consultation plan (CCP) that includes community engagement, before work commences on site.
    - Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the EHSO or the Site Manager.
    - Develop and implement a CEMP to be approved by MEIDECC. The level of detail will depend on the risk and should include, as a minimum, these highly recommended measures. The desirable measures should be included as appropriate for the site.
- Dust management -
    - Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
    - Make the complaints log available to MEIDECC when asked.
    - Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the logbook.
    - Hold regular liaison meetings with other high-risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.
    - Undertake daily on-site and off-site inspection where receptors (including roads) are nearby to monitor dust, record inspection results and make the log available to the local governing body when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and windowsills within 100m of site boundary, with cleaning to be provided if necessary.

- Carry out regular site inspections to monitor compliance with the CEMP, record inspection results and make an inspection log available to PMU and MEIDECC when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
- Erect screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extended period.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover, as described below.
- Cover, seed or fence stockpiles to prevent wind whipping.
- Ensure all vehicles switch off engines when stationary – no idling vehicles.
- Avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable.
- Impose and signpost a maximum-speed-limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas.
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques, such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event, using wet cleaning methods.
- Avoid bonfires and burning of waste materials.

- Measures specific to earthworks and construction -
    - Avoid scabbling (roughening of concrete surfaces) if possible.
    - Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
    - Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
    - For smaller supplies of fine power materials, ensure bags are sealed after use and stored appropriately to prevent dust.
- Measures specific to track out -
    - Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site.
    - Avoid dry sweeping of large areas.
    - Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.
    - Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
    - Record all inspections of haul routes and any subsequent action in a site logbook.
    - Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers, and regularly cleaned.
    - Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
    - Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.
    - Access gates to be located at least 10m from receptors where possible.
- Measures specific to non-road mobile machinery -
    - Non-road mobile machinery and plant should be well maintained.
    - If any emissions of dark smoke occur, then the relevant machinery should be stopped immediately, and any problem rectified.
    - Fuel conservation measures should also be implemented, including: (i) throttle down or switch off idle construction equipment; (ii) switch off the engines of trucks while they are waiting to access the site and while they are being loaded or unloaded; and (iii) ensure equipment is properly maintained to ensure efficient fuel consumption.

- Non-road mobile machinery should be fitted with diesel particulate filters, and the fuel specification should be low sulphur.

340. **Residual impact**. With the implementation of the above mitigation measures, the residual impact associated with the construction phase is not predicted to be significant.

5.4.2 Potential adverse impacts on air quality – road traffic emissions

341. Construction of the yard will require deliveries of concrete for the sub-base, from a local concrete plant on Taufa'ahau Road (approximately 5.2km south-west of the site), using standard dump trucks. However, the delivery numbers are anticipated to be low, with 3-5 per day during peak periods.

342. It is assumed that additional construction equipment and materials will be delivered via the local road networks but are unlikely to exceed two heavy goods movements per hour.

343. Provided that the trucks used during construction of the Project will be regularly inspected and maintained to prevent / minimise air pollutant emissions and they will be routed to avoid sensitive areas in order to minimise air pollution impacts from traffic emissions on local human receptors.

344. **Residual impact**. Consequently, no significant air quality impacts from road traffic emissions are anticipated during the construction phase of the Project.

5.4.3 Potential adverse impacts due to noise and vibration

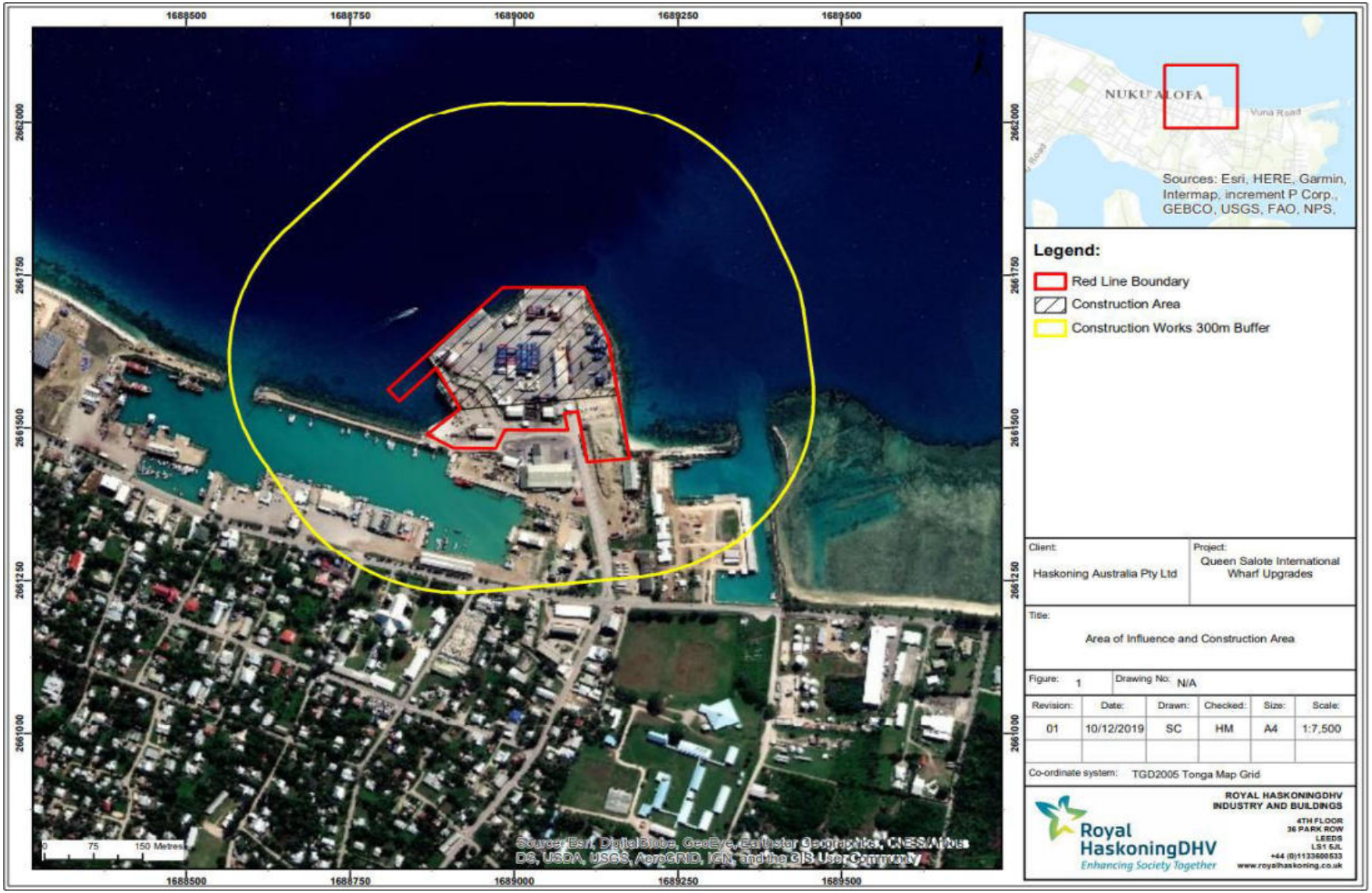
345. **Introduction**. There is a risk that noise and vibration associated with the upgrade construction phase could affect local communities. The Member of Parliament for Tongatapu 4 recalls loud construction hammering at the wharf when he was still in high school. Given this an assessment of potential noise and vibration effects has been undertaken.

346. The project team was asked to consider any disruption to church (including the Roman Catholic Diocese of Ma'ufanga), national funerals and school events (including at 'Apifo'ou College) as a result of construction noise.

347. The area of influence for noise and vibration, shown in Figure 5.11, reflects the Project's potential direct influence (in this context) within and beyond the project boundary and identifies key construction and receptor locations. The on-site construction area is approximately 300m from the nearest receptor locations along Vuna Road. Therefore, the assessment considers a separation distance of 300m between noise sources and receptors; denoted by the yellow line in Figure 5.11.

348. **Construction noise assessment methodology**. Predicted noise levels at receptors have been calculated based on (corrected) distance from a point source. All source levels have been taken using those available in BS 5228-1 Annex C and incorporate on-time corrections as outlined in BS 5228-1.

Figure 5.11: Area of potential noise and vibration influence



349. Potential noise impacts at the human receptor have been assessed in accordance with BS 5228-1 using the ABC method. Table 5.11 (reproduced from BS 5228-1 Table E.1) presents the criteria used for selection of a noise limit for a specific receptor location.

350. In the absence of national standards, the ADB's SPS recommends deferring to the World Bank Groups EHSG standards; i.e. 55 dB (daytime) and 45 dB (night-time for residential properties and 70 dB for commercial properties. Where these limits are exceeded by baseline noise levels, the guidance suggests that project can contribute a further 3 dB in addition. The Category A BS 5288-1 criteria (see Table 5.11) align with the EHSG standards.

Table 5.11: Construction noise threshold levels based on the ABC method

Assessment period	Threshold value, L_{Aeq} (dB)		
	Category A[A)]	Category B[B)]	Category C[C)]
Night-time (23.00 – 07.00)	45	50	55
Evenings and weekends [D)]	55	60	65
Daytime (07.00 – 19.00) and Saturdays (07.00 – 13.00)	65	70	75
A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.			
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.			
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.			
D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.			

351. For this assessment, all residential receptors have been assumed to fall into the lowest noise category, Category A, to assess the worst-case.

352. The proposed operational hours during the construction phase are between 08:00 and 17:00 hours, Monday to Saturday. Table 5.12 outlines the respective noise thresholds during the proposed construction phase operational hours.

Table 5.12: Construction phase noise limits

Assessment period	Category A threshold value, L_{Aeq} (dB)
Weekdays 08:00 – 17:00	65
Saturday 08:00 – 13:00	65
Saturday 13:00 – 17:00	55

353. **Predicted effects**. On-site construction activities have the potential to have noise impacts on nearby receptors. Noise emissions have been identified for construction activities which include: (i) dredging and piling works to enable the refurbishments and extensions of Wharf 1 and 2 and construction of wave barrier; (ii) concrete plant for yard paving improvements; and (iii) general site activities and deliveries (distribution of materials etc.).

354. Noise levels have been predicted based the distance attenuation and separation distance between the receptors and each proposed piece of equipment (i.e. 300m). Source noise levels have been obtained from BS 5228-1 Annex C. All equipment is assumed to be operating simultaneously to provide a worst-case assessment. Screening and ground absorption effects have not been incorporated.

355. Table 5.13 presents the anticipated dominant on-site noise sources/activities during the construction phase.

Table 5.13: Construction noise - assumed plant list

Activity / equipment	Quantity	BS 5228-1 reference	L_{Aeq} at 10m (dB)	Assumed on time
Backhoe dredging	1	C7.1	78	75%
Percussive piling	1	C3.2	87	30%
Crane to assist piling	1	C3.6	68	50%
Concrete pump for yard improvements	1	C4.24	67	75%
Telehandler for distribution of materials	2	C4.55	70	50%
Dump trucks unloading deliveries	1	C2.30	79	30%
Resulting noise level (L_{Aeq}) at 300m from noise sources				54.2 dB

356. **Residual impact.** Table 5.13 shows that predicted noise levels are below the construction phase noise limits outlined in Table 5.12 (65 dB and 55 dB) and adopted by the World Bank Groups EHSG (i.e. 55 dB for residential properties). Therefore, no impact is predicted. In terms of potential effects on churches (including the Roman Catholic Diocese of Ma'ufanga), no works would occur on Sunday or during national funerals. Outdoor school events at 'Apifo'ou College may be able to 'hear' noise, but it is unlikely to cause any disruption to the event.

357. **Mitigation**. Although no adverse impacts associated with construction noise have been identified, best practice measures are recommended below to further minimise potential noise impacts:

- Implementation of relevant and practicable noise nuisance prevention measures as part of an overarching CEMP.
- All site staff to receive appropriate training on good working practice to avoid unnecessary noise emissions. Training should include a site induction programme covering site rules and guidelines for site staff, managers, visitors and contractors.

- Screen construction equipment and activities behind structures (e.g. site cabins, containers, etc.) or screen particularly noisy construction equipment and activities behind mobile screens as far as possible. It is stated in BS 5228-1 that: *"As a working approximation, if there is a barrier or other topographical feature between the source and the receiving position, assume an approximate attenuation of 5dB when the top of the plant is just visible to the receiver over the noise barrier, and of 10dB when the noise screen completely hides the sources from the receiver."*
- Good working practice should include, but not be limited to, the following:
    - avoiding unnecessary revving of engines;
    - shutting down equipment between construction periods;
    - avoiding reversing where possible;
    - driving carefully and within the site speed limit at all times;
    - reporting any defective equipment as soon as possible so that corrective maintenance can be undertaken; and
    - handling material in a manner that minimises noise.
- Wherever possible, use modern, quiet construction equipment and ensure it is properly maintained routinely and in accordance with the manufacturers' guidance. In addition, all construction equipment should be subject to regular inspection to ensure that all equipment is in a good state of repair and fully functional.

358. **Vibration assessment methodology**. Annex E of BS 5228-2 contains empirical formulae derived by Hiller and Crabb (2000) from field measurements relating to resultant peak particle velocity (PPV) with a number of other parameters for vibratory compaction, dynamic compaction, percussive and vibratory piling, the vibration of stone columns and tunnel boring operations. Use of these formulae enables PPV to be predicted and, for some activities (vibratory compaction, vibratory piling and vibrated stone columns), they can provide an indicator of the probability of these levels of PPV being exceeded. The consequences of predicted levels in terms of human perception and disturbance can then be established through direct comparison with the BS 5228-2 guidance vibration levels.

359. Ground-borne vibration assessments can be undertaken directly based on BS 5228-2, the Transport and Road Research Laboratory 246: *Traffic induced vibrations in buildings*, and within the Transport Research Laboratory Report 429 (2000): *Ground-borne vibration caused by mechanical construction works.* However, these calculation methods rely on detailed information, including on the type and number of plant being used, their location and the length of time they are in operation.

360. In this case, given the mobile nature of much of the plant that has the potential to impart sufficient energy into the ground to cause vibration, and the varying ground conditions in the immediate vicinity of the construction works, it was considered that an accurate representation of vibration conditions using these predictive methods was not possible.

361. Consequently, a series of calculations, following the methodologies referred to above, were carried out based on typical construction activities that have the potential to impart sufficient energy into the ground, applying reasonable worst-case assumptions in order to determine set-back distances at which critical vibration levels may occur.

362. Humans are sensitive to vibration, which can result in concern being expressed at energy levels well below the threshold of damage. Guidance on the human response to vibration in buildings is found in BS 6472-1:2008 *Guide to evaluation of human exposure to vibration in buildings, Part 1, Vibration sources other than blasting*. BS 6472 describes how to determine the vibration dose value (VDV) from frequency-weighted vibration measurements. VDV is defined by the following equation:

$$VDV_{b/d,\ day/night} = (\int_0^T a^4(t)dt)^{0.25}$$

363. The VDV is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

364. BS 6472 states that, in homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception. It contains a methodology for assessing the human response to vibration in terms of either the VDV or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as PPV. The VDV is determined over a 16-hour daytime period or 8-hour night-time period. A building's response to ground-borne vibration is affected by foundation type, ground conditions, building construction, and condition. For construction vibration, the vibration level and effects in Table 5.14 were adopted based on BS 5228-2. Limits for transient vibration, above which cosmetic damage could occur, are given numerically in terms of PPV.

Table 5.14: Transient vibration guide values for cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50mms-1 at 4Hz and above	
2	Un-reinforced, light framed structures Residential or light commercial buildings	15mms-1 at 4Hz increasing to 20mms-1 at 15Hz	20mms-1 at 15Hz increasing to 50mms-1 at > 40Hz

365. For construction vibration from sources other than blasting, the vibration level and effects presented in Table 5.15 were adopted based on Table B-1 of BS 5228-2. These levels and effects are based on human perception of vibration in residential environments.

Table 5.15: Construction vibration thresholds – human perception

Vibration limit PPV (mm/s)	Interpreted significance to humans
<0.14	Vibration unlikely to be perceptible.
0.14 to 0.3	Vibration might be perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3 to 1.0	Vibration might be perceptible in residential environments.
1.0 to <10.0	Likely that vibration in residential environments will cause complaint but can be tolerated if prior warning and explanation has been given to residents.
>10.0	Vibration likely to be intolerable for any more than a brief exposure to this level in most building environments.

366. Table 5.16 lists the minimum set-back distances at which vibration levels of reportable significance during piling activities may occur. BS 5228-2 calculation methods were used to derive the set-back distances.

Table 5.16: Predicted distances at which vibration levels may occur

Activity	Set-back distance at which vibration level (PPV) occurs			
	0.3 mm/s	1.0 mm/s	10 mm/s	15 mm/s
Vibratory compaction (start-up)	166m	65m	9m	6m
Vibratory compaction (steady state)	102m	44m	8m	6m
Percussive piling	48m	19m	3m	2m

367. **Residual impact**. Based on the above, for percussive piling, negligible vibration effects are predicted at 48m for human receptors and 2m for light-framed structures.

368. Piling works for the project are to be undertaken at distances greater than 300m from sensitive receptors. Therefore, no impact is predicted due to vibration effects associated with the works.

369. **Traffic noise assessment methodology**. The noise associated with construction traffic is generally assessed by analysis of the percentage increase in traffic flow due to construction traffic or by prediction of the noise levels associated with each road link. In this case the construction traffic flow is expected to be well below 50 vehicles per hour and, therefore, prediction of the construction traffic noise level in accordance with CRTN is not possible. Consequently, a qualitive assessment has been undertaken to identify any potential noise impacts associated with construction traffic.

370. **Predicted effects**. Construction traffic will include concrete deliveries from a local plant approximately 5.2km south-west of the site. It is anticipated that there will be 3-5 heavy goods vehicle movements associated with concrete delivery per day during the peak period of the works. It is assumed that additional construction equipment and materials will be delivered via the local road networks but are unlikely to exceed three heavy goods vehicle HGV movements per hour.

371. **Residual impact**. Given the industrial setting of the site and surrounding areas, along with the (low) predicted frequency of heavy goods vehicle movements associated with the construction phase, any additional noise impact is predicted to be of negligible significance.

372. **Mitigation**. Although only a negligible impact associated with construction traffic noise has been identified, best practice measures are recommended below to further minimise potential noise impacts:

- Preparation and implementation of a TMP, as part of the overarching CEMP, to further reduce the likelihood of noise impacts due to construction traffic.
- Careful selection of delivery routes, acknowledging and avoiding more sensitive areas to reduce impact on local communities.
- Adherence to speed limits and awareness of highway safety concerns.
- Ensuring suitable access to the site and appropriate loading/unloading and parking areas.
- Management measures to control timing of deliveries during specified delivery periods, i.e. daytime only.

5.4.4 Potential adverse effects associated with an influx of labour

373. **Risks**. The number of construction workers predicted to be required for the marine works is 10 and for the yard is 20, at peak; so up to 30 in total. The construction phase will have a duration of around 20 months. Given the availability of existing accommodation in Nuku'alofa there will not be the need to construct a dedicated construction camp to house the workers.

374. Given the low number of workers expected, potential social impacts due to the presence of these workers will be negligible. However, the spread of communicable diseases (such as sexually transmitted infections and HIV) can be associated with marine construction sites, along with trafficking of drugs, firearms and people. This is addressed below.

375. **Mitigation**. The following mitigation measures will be implemented:

- The induction of workers on the requirements of the project's SCS[17], GRM[18] and protocols established for any contact between local communities and contractor/workers.

[17] A SCS has been prepared for the project, this will be developed further by the CSC and PMU during the initial stage of project implementation.

[18] See Section 6.3.

- The contractor is to agree a worker code of conduct with local community leaders and MOI, to be included in workers' contracts. The code of conduct will cover the need to respect village and landowner's boundaries, recognise and follow customs and local community/village protocols and rules, including those related to addressing women and elders, and rules governing behavior around children and young people.
- The contractor will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities likely to cause disruption or access restrictions.
- The works yard and facilities will be fenced and sign-posted and unauthorised access or entry by general public will be prohibited.

376. **Residual impact**. With the above mitigation in place, the residual impact associated with an influx of construction workers is expected to be of negligible significance.

5.4.5 Risk of spread of communicable diseases

377. In terms of the risk of transmission of communicable diseases, the project has the potential to enhance the pathways for disease transmission by improving international shipping and facilitating access across international and regional borders. This is an operational impact discussed in Section 5.5.7.

378. In addition, an international contractor could provide a largely foreign workforce. In terms of the transmission of communicable diseases during construction, there is a risk that foreign workers provide a pathway for disease transmission including, but not be limited to, COVID-19 and sexually transmitted infections (STIs), including HIV/AIDS. This risk will be addressed through a communicable diseases awareness and prevention programme to be developed and implemented by an approved service provider engaged by the contractor during construction. The ERP should also cover measures to be taken in the event of COVID-19 outbreak.

379. The following measures will be implemented by the contractor:

- In bringing workers from outside of Tonga into Tonga, all national requirements relating to COVID-19 must be met and 'screening' should be undertaken before any staff travel to Tonga.
- The contractor will engage an approved service provider (possibly a non-governmental organisation (NGO) such as the Tonga Leitis Association which already provides information and support relating to drug use and domestic violence) to prepare a communicable diseases prevention plan and deliver a communicable diseases awareness and prevention campaign. The programme will be delivered to the communities within the project area prior to the mobilisation of workers to the site. The programme will also be delivered to workers upon induction to the site and as new recruits join the workforce.

- The approved service provider will, based on consultation, identify the most appropriate (socially and culturally acceptable) tools and methods for delivering the training.
- The communicable diseases prevention plan will identify measures that are aligned with planning guidance based on traditional infection prevention and industrial hygiene practices, which focus on the need for employers to implement engineering, administrative and work practice controls and personal protective equipment (PPE) to avoid and control the spread of COVID-19; such as that as prepared by the U.S. Department of Labor Occupational Safety and Health Administration *Guidance on Preparing Workplaces for COVID-19* or the World Health Organisation 2020 Considerations for public health and social measures in the workplace in the context of COVID-19.[19]
- The working areas will be established with adequate drainage in order to prevent the formation of breeding sites for mosquitoes.

380. **Residual impact**. With the above measures in place, the residual impact associated with the risk of the spread of communicable diseases is expected to be of negligible significance.

5.4.6 Health and safety – workers

381. Construction activities of any type and scale bring health and safety risks to construction workers. These risks include, amongst others, exposure to dust and hazardous materials that may be present in construction materials and project components, and physical hazards associated with erecting scaffolding and buildings, working at heights or in confined spaces, and the use of heavy equipment.

382. A health & safety plan (HSP) will be submitted by the contractor to establish routine safety measures and reduce the risk of accidents during construction activities. The HSP will cover both occupational health and safety (workers) and community health and safety. The HSP will link with the requirements established in the ERP for any contaminated excavated material to be disposed of in a controlled landfill. The HSP will be appropriate to the nature and scope of the construction activities and, as far as reasonably possible, meet the requirements of good engineering practice and the World Bank Group's EHSG.

383. The HSP will include agreement on consultation requirements (workers and communities) established in the project's SCS, establishment and monitoring of acceptable practices to protect safety, links to the complaints management system for the duration of the works (in accordance with agreed GRM) and systems for reporting of accidents and incidents.

384. Mitigation measures to be implemented by the contractor to ensure the health and safety of workers are as follows:

[19] Available at https://www.osha.gov/Publications/OSHA3990.pdf and https://www.who.int/publications-detail/considerations-for-public-health-and-social-measures-in-the-workplace-in-the-context-of-covid-19

- Preparation of a HSP as part of the CEMP. The HSP will establish or cover: (i) both occupational health and safety (OHS) and community health and safety; (ii) activity/job safety procedures and protocols; (iii) HSP training and "toolbox" sessions for workers; (iv) first aid facilities (on-site and in vehicles), PPE and medical evacuations; (v) routine safety and accident prevention measures; (vi) emergency response and preparedness; (vii) accidental environmental instance (e.g. spill) procedures highlighting the sizes and types of impacts that may occur, and the resources (onsite and/or offsite) that will be required to handle and treat the spill; and (viii) accident, near-miss and emergency registry, monitoring and reporting.
- The contractor will designate one full-time staff as EHSO to implement the HSP.
- The contractor will observe working hours and official holidays as set out in Tongan law and regulations.
- Before construction commences, the contractor will conduct training for all workers on environmental safety and hygiene. The contractor will instruct workers in health and safety matters as required by the HSP, good engineering practice and national regulations.
- Workers will be trained in use of any special equipment or machinery. Workers will be instructed in use of safety equipment (harnesses etc.) for working at heights or on scaffolding.
- The contractor will engage an approved service provider to deliver a communicable diseases awareness and prevention campaign (as detailed above) to workers (and the community).
- The contractor will conduct regular meetings to maintain awareness levels of health and safety issues and requirements.
- A potable water supply and sanitary toilet and ablution facilities will be provided at the site.
- The contractor will ensure that first aid kits and facilities, including access to trained medical personnel, is available on-site, in vehicles and at quarry sites, and that arrangements in place to ensure medical attention (including evacuation as necessary) is obtained by workers who have suffered an accident or sudden illness.
- The contractor will ensure adequate spill response kits are provided, accessible and that designated key staff are trained in their use.
- Excavated trenches must be effectively marked with approved safety signage and/or barrier tape to prevent any accidents.
- Workers, at no cost to themselves, shall be provided (before they start work) with appropriate PPE suitable for the tasks and activities they will undertake. PPE will include safety boots, helmets, gloves, protective clothes, goggles and ear protection. Instructions on their use around the construction site will be delivered as part of the safety introduction procedures and site agents/foremen will follow up to see that the safety equipment is used and not sold.
- Child and/or trafficked labour will be strictly prohibited for any activities associated with the project.

385. All measures related to workers' safety and health protection shall be free of charge to workers. The HSP will be submitted to the PMU and CSC for approval by the contractor before construction commences. The occupational HSP could be extended to cover public safety as below.

386. **Residual risk**. With the above measures in place, the residual risk to workers associated with the construction site will be minor.

5.4.7 Health and safety – community

387. Community safety can be threatened by works in public areas. In this case all construction work will be undertaken within port land, which is a controlled area. General measures and requirements of the HSP which apply equally to workers and the community are discussed above. In addition, the HSP will cover measures to minimise risks to community safety, including:

- The contractor will coordinate directly with the grievance focal point(s) appointed for the project.
- All notice boards and signage to be written in English and Tongan.
- The HSP will include consultation requirements, the establishment and monitoring of acceptable practices to protect community safety, links to the complaints management system for duration of the works (in accordance with the GRM) and a system for reporting of accidents and incidents. The PMU will ensure these actions are enforced.
- As above, before construction commences, the contractor (where appropriate through an approved service provider engaged for the purpose), will conduct training for all workers on environmental safety, environmental hygiene (including communicable diseases awareness and prevention training) and the code of conduct.
- The contractor, following the requirements of the project's SCS, will inform the community of the scope of works (likely impacts and control and mitigation measures), including the timeframe, through notice boards, information brochures and/or community meetings.
- Tongan minimum wage requirements are to be observed for local hires required for any of the works. There should be proper enforcement of all Tongan labour, health and safety laws and regulations in the workplace.
- The office, work's yard and project site will be securely fenced and warning signs erected. Unauthorised people shall not be permitted within the project sites/yards (including quarries).
- The strict imposition of speed limits along access routes through residential areas and locations where other sensitive receptors, such as schools and hospitals, are located.

388. During consultation, concerns were raised about the potential safety issues for the community (particularly pedestrians) associated with increased truck movements to and from the port during construction. Although there are already heavy vehicle movements associated with normal port operations, the trucks associated with construction will temporarily increase heavy vehicle movements through villages and this may result in traffic congestion or safety issues. The TMP to be prepared by the contractor will outline appropriate measures to limit this risk, such as speed control through villages, appropriate timing of truck movements (especially haulage from quarry sites and materials sources), travel routes and signage/information for the community.

389. **Residual impact**. Such measures will manage the risk to community health and safety and ensure that any impacts are reduced to minor levels.

5.4.8 Potential adverse effects on physical cultural resources

390. As noted in Section 4.5, there are no known historic or physical cultural resources or sites within the project area (QSIW and port area). As the works will be confined to within port boundaries or existing quarries, there is not expected to be any impacts on such resources. However, a "chance finds" protocol is included in the EMP to ensure that any discovery of a cultural resource within port boundaries due to the works can be managed in a suitable and appropriate manner.

391. **Residual impact**. Given the above, the risk of an impact on physical cultural resources is expected to be negligible.

5.4.9 Potential adverse effects on tourism and recreation

392. The potential for the QSIW Upgrade to affect tourism relates to the potential effect on whale watching ecotourism. Based on the assessments of the impacts associated with air quality, noise and vibration set out above, no effects on cruise visitors or other tourists visiting Nuku'alofa would arise. Regarding potential effects on whale watching, with the mitigation for potential effects on cetaceans in place (see Section 5.3.3), no direct or indirect impacts are predicted due to the construction (or operation) of QSIW. Hence, no direct or indirect impacts on the economic activities associated with whale watching eco-tourism are predicted. That is, the cetaceans would be unaffected, and the boat operators would still have access to and from the wharfs.

393. At a meeting held on 19 December 2019 with the Nuku'alofa Fishing Club (located behind the Domestic Terminal in Faua Harbour), representatives raised concerns about the potential for the club to need to be relocated due to the works. However, no boundary changes within the operational port are to occur due to the works and the road access to the fishing club and its private mooring on the Faua Breakwater will not be affected. Hence no impact in this regard will arise. Any impact on the club will be limited to some noise during the construction phase and some additional traffic associated with the ex-Friendly Island Shipping Agency office potentially being used as the contractor's site office.

394. **Residual impact**. Negligible impacts on tourism and recreation are predicted due to the works.

5.4.10 Potential beneficial socio-economic impacts

395. **Employment**. Employment generation opportunities will arise both during construction and after completion of the project. The employment opportunities mainly will be taken up by males, i.e. machine operators, assistants, mechanics, welders, etc. However, there will also be wider opportunities to provide services to the construction staff, such as the supply of food, accommodation, transport and services, thus benefiting the local economy.

396. Specifically, it is proposed that the turbidity threshold monitoring to be carried out during the dredging is overseen by MEIDECC and could be undertaken by Tongan's deriving from the local community, including women.

397. A community liaison officer (CLO) will also be included in the contractor's team. The CLO will be appointed from the local community, assuming the necessary criteria included in the job description can be meet.

398. **Improved working conditions**. For the facility to comply with the requirements of the ADB's SPS 2009, in line with the recommendations of the environmental audit, the following measures should be brought forward as part of the project to benefit workers at and users of the port:

- The services and lighting on the terminal will be upgraded as per the approved design.
- An appropriate traffic and stack management scheme should be developed and implemented; with a minimum gap of 600mm between containers in general (as proposed).
- Existing waste deposit sites will be cleared, and the waste dealt with appropriately, an operational waste management plan will be developed and implemented by PAT.
- 'Safe' pedestrian routes in/out and around the terminal should be clearly demarcated (as proposed).
- Environmental safeguards awareness raising should be undertaken for PAT staff; training of staff in hazardous materials handling and usage of spill kits.
- Lifebuoys, fire hydrants, protective equipment and first aid kits should be provided.
- An ERP, to include regular training and drills for port staff, should be developed.
- An operational HSP will be developed for implementation by PAT, along with organisational arrangements whereby health and safety officers (and managers) have clearly defined functions and receive the necessary training to undertake their functions.

399. **Improvements in the port estate**. For the facility to comply with the requirements of the ADB's SPS 2009, in line with the recommendations of the environmental audit, the following measures should be brought forward as part of the project to benefit the landside environment:

- As above, existing waste deposit sites will be cleared, and the waste dealt with appropriately.
- Refurbishment (paving/capping) of all areas of QSIW pavement currently in disrepair should occur (and is proposed).
- All fuel drums should be stored in a covered area surrounded by a spill containment bund.
- Oil and grease traps in the drainage system at the workshops, maintenance and refuelling areas should be installed (and is proposed) and spill kits to be provided.
- The port septic tanks should be routinely cleaned, with sludge to be disposed of in accordance with government regulations.
- A staff member should be designated to be responsible for the overall environmental management of port operations.
- Government regulations in respect to quarantine issues, including prevention of ships disposing of waste at the port, should be enforced.
- An ERP will be developed that specifies procedures in the event of spills and a natural disaster (earthquake, tsunami, cyclone); to include regular training and drills for port staff.

400. Residual impact. The project will have a moderate beneficial impact in the construction phase in terms of employment, improved working conditions and improvements in the port estate.

5.5 Operational Impacts

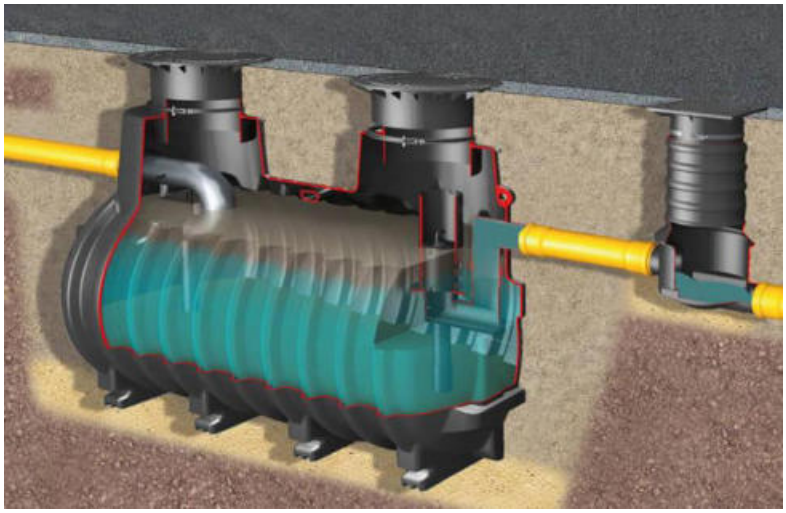
401. Introduction. Impacts potentially associated with the operational phase covered below include those related to spills, invasive species, increased traffic, improved environmental conditions and H&S, benefits for the economy and the risk of spread of communicable diseases. Potential impacts associated with noise and air quality in the operational phase are not assessed because emissions levels will be very similar to those experienced now. Numbers of marine vessels are also not predicted to increase.

5.5.1 Potential adverse impacts due to spills and pollution events

402. There is always a risk of spills occurring in any operational facility, but with the implementation of fuel spill procedures and training in the use of spill equipment, any impacts associated with spills would be limited.

403. Once the port upgrade is operational, permanent oil receptors will be established as part of the drainage system. The most polluted part of the current site is within the equipment pool area, where signs of oil pollution were found. To address this issue, a new self-bunded oil tank will be installed with a fully capped hardstand wash-down area, drainage system with sump and oil separators (Plate 5.5).

Plate 5.5: Example of oil receptor



404. Good practice in the operational phase for the management of wastewater, waste and hazardous materials will also avoid adverse impacts.

405. **Residual impact**. The risk of adverse impacts arising due to pollution in the operational phase minor due to the implementation of good practice.

5.5.2 Biosecurity: invasive or alien species

406. As for the construction phase, the project has the potential to result in the spread of invasive non-native species in the terrestrial and marine environment in its operational phase, that could have detrimental effects on native biodiversity.

407. In order to manage this risk, the contractor is to prepare a biosecurity risk assessment and method statement in the pre-construction phase. This will consider: (i) measures to control and eradicate invasive and/or alien species within QSIW; and (ii) measures to prevent invasive and/or alien species being introduced.

408. For the management of any identified existing invasive and/or alien species, the biosecurity risk assessment will detail:

- how areas with invasive and/or alien species present would be demarcated;
- how any contaminated materials would be appropriately managed to prevent transfer or spread; and,

- appropriate disposal.

409. To prevent new introduction through QSIW, the biosecurity risk assessment will detail:

- risk pathways and activities for the transfer and spread of non-native species of known concern;
- methods to manage risk of transfer, including any actions to be undertaken prior to shipping arriving at QSIW; and
- contingency planning and corrective actions.

410. In the operational phase, it is intended that an on-going monitoring programme for non-native species will be run by PAT. This will include observational surveys on structures that may provide suitable substrate for non-native species. Where the new presence of invasive and/or alien species is discovered, the biosecurity risk assessment will be reviewed and amended where necessary, and corrective action taken.

411. **Residual impact**. The risk of an adverse impact arising due to the spread of invasive non-native species in the operational phase will be minor due to the implementation of good practice.

5.5.3 Increased traffic

412. The number of ship calls to the upgraded facility from the baseline is not expected to increase. Rather, the new facility will be able to accommodate larger ships carrying more containers (i.e. 2,000 TEUs).

413. Currently, on average, around 56 truck visits to QSIW occur each day (except Sundays); that is, one truck every four to five minutes over the operational period (9am to 9pm).

414. To forecast the expected increase in traffic due to the upgrade, the Year 2024 has been taken as the baseline, with 53 vessel calls by up to 1,000 TEU-capacity vessels. Each vessel of this capacity typically delivers 300 TEUs to QSIW. Hence, around 15,900 TEUs are delivered per annum, amounting to 306 TEUs per week.

415. In the same year, there will also be 25 vessel calls by 1,000-2,000 TEU-capacity vessels, each typically delivering 400 TEUs to QSIW. Hence, they could deliver 10,000 TEUs per year. As this vessel size range calls at the port once every fortnight, the port receives 192 TEUs/week from this size of vessels. In total, therefore, the port currently serves around 498 TEUs per week.

416. By the same logic, with the upgrade, in the Year 2029 the average delivery to QSIW (based on a 2000 TEU vessel) would be 542 TEUs per week. Hence, the increase in truck flows from baseline would be 8.8%.

417. A 9% increase to the (on average) 56 truck visits to QSIW a day, amounts to an additional 5 trucks (and 61 trucks in total); which would change the existing frequency of movements from (on average) one truck every four to five minutes (i.e. 4.7 minutes), to one truck every five minutes (i.e. 5.1 minutes).

418. **Residual impact**. This is predicted to have a negligible impact.

5.5.4 Potential beneficial impacts from 'green port' initiative

419. Various 'green port' measures are proposed for the operational phase of the QSIW Project that will provide benefits to the physical, biological and human environments, largely through the avoidance of adverse effects. These include:

- The presence of oil separators.
- The use of solar panels and LED lights on the new yard light posts.
- The inclusion of rain harvesting for the firefighting tank.
- The extension of the bunded slab in the wash-down area to include the existing fuel tanks, with a sump to collect oil.
- A concrete lined pit for leaking containers.
- The monitoring and regulation of fuel usage.
- Proposed improvements in waste management procedures.

420. **Residual impact**. These actions are predicted to have a moderate beneficial impact.

5.5.5 Potential beneficial impacts from improved health and safety

421. Significant improvements in health and safety and strengthen systems will be implemented during the operational phase of the project. These measures will provide a clear benefit to the workers in and users of the port. These include:

- 'Safe' pedestrian routes.
- An organised yard with marked container slots and specific area for container types.
- Traffic circulation regulated around a "ring road" for trucks and lanes for forklift/reach stackers.
- A working firefighting system.
- Adequate lighting for night operations (containers and ship arrival) through new light poles.
- Provision of adequate mooring points to secure ships, including a linemen gangway where auxiliary boat access is difficult. PAT currently use small boats to take mooring lines from ships to bollards. In the future direct pedestrian access will be provided from the land to the dolphins.
- Provision of emergency safety ladders with buoys at 25m spacing.
- Provision of a sound electrical substation building with a toilet facility (where there is currently none).
- Provision of reefer gantries to provide safe access to the connection plugs.

- Provision of lashing points for securing empty container during cyclones.
- Development and implementation of an operations ERP as part of the port operations manual.
- Development and implementation of operations HSP as part of the port operations manual.

422. **Residual impact**. These actions are predicted to have a major beneficial impact.

5.5.6 Potential benefits to the economy, employment and poverty

423. **Economic enhancement**. Tonga is heavily reliant on sea transport for its trade in goods and services. Being a small island nation Tonga imports almost all the goods and over 98% of its imports are through sea transport. The QSIW Project will encourage regional and international freight transportation, particularly to neighbouring Island states such as Fiji, the Cook Islands and Samoa, as well as New Zealand and Australia.

424. Once the Project has been implemented, the primary beneficiaries will be the general public, who will benefit from more efficient operation of the Port's facilities which, in turn, should reduce the costs of imported goods and facilitate the flow of goods which people rely on. The project will improve the efficiency of the port operations and reduce goods handling costs, lost ship berth days and, ultimately, the cost of cargo. Reduced import costs will help to reduce the cost of living.

425. The Member of Parliament for Tongatapu 4 acknowledged the need for the wharf upgrade for long-term development, including the effects on PACER Plus (the Pacific Agreement on Closer Economic Relations https://www.dfat.gov.au/trade/agreements/not-yet-in-force/pacer/Pages/pacific-agreement-on-closer-economic-relations-pacer-plus.aspx), which should increase exports.

426. **Employment**. In its operational phase the project will provide further income opportunities for Tongans and could assist in enhancing living standards through an increase in disposable income; which in turn should improve access to benefits and services. The improvements to port operations, through the optimised configuration of the port precinct, should also attract more business opportunities.

427. **Poverty reduction**. The effective and safe operation of QSIW is essential to Tonga maintaining its trade with the rest of the world. Tonga imports its goods by sea and QSIW is a vital link for the country's current imports and potential exports (squash, fish, agriculture and handicrafts). The existing port facility at Nuku'alofa is suffering from deterioration due to lack of maintenance and capacity limitations, vulnerable to seasonal intrusive swell conditions and inefficiency of the port operations.

428. The Project will contribute to national poverty reduction by ensuring that international port facility standards are attained to allow vessel berthing and operational activities to be undertaken that meet current and future shipping needs, thereby enhancing the import and export (including transhipment) capacity and capability of the Kingdom.

429. This will enable larger vessels recently deployed in the Pacific region to increase their frequency of services to Tonga and it will promote the economic and social inclusion of poor and vulnerable groups by developing an international gateway container and general cargo terminal to enhance trade and employment.

430. The benefits of an optimised container terminal and port precinct will help to reduce the cost of cargo and thus influence a reduction in the cost of consumables within the domestic market. Improved occupational health and safety will also assist in reducing social costs.

431. **Residual impact**. The project will have a moderate to major beneficial impact in its operational phase with regard to economic enhancement, employment and poverty reduction.

5.5.7 Risk of spread of communicable diseases

432. In terms of the risk of transmission of communicable diseases including, but not be limited to, COVID-19 and STIs (including HIV/AIDS), the project has the potential (as QSIW does now) to provide a pathway for disease transmission through the improvement of international shipping and the facilitation of access across international and regional borders.

433. As set out in Section 5.4.5, this risk will be addressed through an operational phase communicable diseases awareness and prevention programme. The programme will be integrated into the port operations manual. PAT will engage an approved service provider to prepare a communicable diseases prevention plan and deliver a communicable diseases awareness and prevention campaign associated with port operations. The programme will be delivered to businesses, workers in the businesses, port workers, communities adjacent to the port and any identified vulnerable people (sex workers, drug users etc.).

434. As for the construction phase HSP, the communicable diseases prevention plan should identify measures that are aligned with planning guidance based on traditional infection prevention and industrial hygiene practices and which focus on the need for employers to implement engineering, administrative and work practice controls, and to provide PPE to avoid and control the spread of COVID-19 (as prepared by the U.S. Department of Labor Occupational Safety and Health Administration).

435. **Residual impact**. With the above measures in place, the residual impact associated with the risk of the spread of communicable diseases is expected to be of negligible significance.

5.6 Cumulative Impacts

5.6.1 Adjacent projects

436. The Navy is proposing future development to the east of the existing port site. Details of the Navy's future plans were not disclosed during the feasibility study. However, it was confirmed by representatives of the Royal Australian Navy and Tonga Defence Services that the proposed upgrade of QSIW would not impact the current or future operation of the Touliki Naval Base. The dolphin to be located east of Wharf 1, will be in line with the current channel access boundary.

437. Given the lack of information available from the Navy on its proposed plans, an in-combination assessment of the potential effects of their proposals in conjunction with the Project cannot be undertaken (at this time).

5.6.2 Combined development effects

438. Although the Project will have a beneficial effect on employment overall and will not have any direct or indirect impacts on fishing (because the works occur with the port boundary where fishing is prohibited), the local community in Tongatapu 4 has expressed concern about the impacts on them due to the combined damage of a series of developments on the waterfront. The residents rely on the waterfront for their livelihood through shallow water fishing. Recent, current and pipeline projects for the waterfront that Tongatapu 4 Council is aware of include (Figure 5.12):

- The domestic wharf.
- QSIW upgrade.
- Proposals for the Touliki Naval Base.
- Fuel pipelines.
- Swimming pool
- Special management areas – a zoning initiative by the Fisheries Department.

439. The community stated that restrictions introduced by these projects leave few options in the area for people who rely on shallow fishing for their livelihood. The Member of Parliament for Tongatapu 4 has submitted a report to Parliament regarding the impacts of waterfront development on the community. The Tongatapu 4 Town Officer emphasized the importance of seeking and providing alternative livelihoods to address social impacts of development projects. This is outside the scope of the Project, but it is recommended that the PMU and MOI give this due consideration and propose an appropriate response.

Figure 5.12: Waterfront development projects

6 ENVIRONMENTAL MANAGEMENT

6.1 Introduction

440. The environmental assessment of the construction and operation of an upgraded QSIW has determined that the project will have an impact on the local environment that can be readily mitigated and/or managed. Environmental mitigation measures have been proposed to avoid or minimise environmental impacts to acceptable levels. The mitigation measures proposed are proven technologies associated with internationally recognised good engineering practice. The EMP included as Table 6.2 complies with government and ADB requirements and provides details of these mitigation measures, as well as monitoring proposals and training recommendations. The responsible agency and proposed timing for the measures are also set out.

441. The following is provided:

- Implementation arrangements for the EMP including:
    - institutional roles and responsibilities for implementation through all stages of the project (procurement, design, construction, operation);
    - capacity building requirements for the implementing agency to ensure environmental management requirements are properly understood and fully implemented;
    - a grievance redress mechanism.
- Environmental mitigation and monitoring matrices including:
    - potential environmental impacts that could occur during each stage of the project (pre-construction/design, construction and operation);
    - proposed mitigation measures to address each impact identified;
    - the agency responsible for implementing each mitigation measure;
    - monitoring tasks to ensure mitigation measures have been implemented effectively during each stage of the project; and
    - a schedule and indication of responsibility for monitoring.
- Predicted costs associated with implementation of all aspects of the EMP.

442. The IEE/EIA and EMP will be updated during the detailed engineering design phase to ensure that the impact assessment and mitigation details reflect the most recent design.

443. Section 6.2 sets out the institutional arrangements for the project's environmental management responsibilities. Section 6.3 outlines the GRM to be established early in the implementation phase and Section 6.4 sets out the monitoring and reporting requirements.

6.2 Implementation Arrangements

444. The main institutions that will be involved in delivering the environmental management activities are the MOF as the executing agency for the project, MOI as implementing agency (along with the PMU), MEIDECC and the contractor.

445. **Ministry of Finance**. The MOF will implement the project commitments on behalf of the government. As the executing agency MOF has overall responsibility for all aspects of the project and will ensure the environmental management and monitoring budgets are available and utilised as necessary, as part of the timely implementation of EMP. The executing agency, with support from the MOI and PMU, will submit six monthly environmental monitoring reports on EMP implementation for ADB's review.

446. **Ministry of Infrastructure**. The MOI is the implementing agency for the project and, as such, will be responsible for overall project implementation, including procurement and construction, and for ensuring that sufficient resources are in place to undertake its environmental safeguards responsibilities. The MOI has established a PMU to oversee procurement, construction and commissioning of the project.

447. The MOI will be responsible for applying for and obtaining development consent from MEIDECC before construction commences. This includes support from the CSC for updating the environmental assessment as the EIA and ensure that it conforms with both CSS and SPS requirements.

448. **Ports Authority of Tonga.** The PAT will be responsible for the operational stage activities of the project. It currently has no in-house staff responsible for environmental issues. The PAT will be responsible for preparation and update of the operational ERP and HSP that will form part of the port operations manual.

449. The PAT will also be responsible for the development and implementation of the green port initiative. The initiative will be implemented as part of the capacity development component of the project and will include aspirational and operational elements such as the following:

- Balancing environmental challenges with economic demands by introducing strategies for minimising, to the extent practicable, environmental impacts directly attributable to port operations in the marine environment.
- Preventing pollution and improving personal, community and environmental health and, when possible, exceeding applicable environmental laws, regulations and other industry standards.
- Ensuring a balance of environmental, social and economic concerns is considered during planning, development and operational decisions.
- Fostering socially and environmentally responsible behaviour through communications with employees, tenants, stakeholders and the community.

- Collaborating with port tenants to develop an integrated, measurable QSIW environmental sustainability plan.
- Liaising with MEIDECC in updating the ERP.

450. **Environmental responsibilities of the CSC**. Specific tasks to be undertaken by the CSC relating to environmental management during detailed design stage are as follows:

- The CSC will support the PMU in updating the IEE/EIA and EMP during the detailed engineering design phase and submitting the 'determination of category of assessment form' (Form 1 of Schedule 1 of the EIA Regulations 2010) under the CSS and the EIA in support of the building permit and development consent (see Section 2.2.4).
- Obtaining development consent for the project prior to commencement of any construction works, including site clearance. Ensure that the updated EMP and any development consent conditions, and all other environmental mitigation measures, are incorporated into the bidding documents and the contract for the civil works. This shall include the framework for all plans/subplans to be covered in the CEMP.
- Supporting tender evaluation with respect to the contractors' environmental management capability and proposed EMP provisions.
- Ensuring that MOI, PAT and the contractor are aware of any development consent conditions and implications those might have for project implementation.
- Supporting MOI to implement the pre-construction and construction elements of the project's SCS and CCP.
- Providing inputs to quarterly progress reports and safeguards monitoring reports to be submitted to the MOF and ADB.

451. During construction, the CSC will include an international environmental specialist[20] to assist the MOI-PMU according to terms of reference that have been separately prepared. Key tasks of the CSC will include ensuring that MOI meets all its obligations with respect to the development consent, updating the EMP and reviewing the approved contractor's CEMP. The CSC will provide training to the MOI and PAT staff in general environmental management of port operations and basic training in internationally recognised good environmental management and health and safety practices. That is:

- Prior to any construction activities commencing, ensuring that all relevant baseline data and benchmark conditions are established.
- Depending on the experience of the contractor in development of the CEMP, provide support and assistance to the contractor.

[20] Or a suitably qualified national consultant with international experience.

- Supporting the PMU in review and approval (including submission to ADB for review and comment) of the contractor's CEMP prior to commencement of any physical work under the civil works contract.
- Subsequently the CSC will be responsible for ensuring that the contractor's approved CEMP – based on the updated EMP and development consent conditions – is implemented during each stage of project implementation (construction and commissioning).
- Inspections and monitoring compliance of the contractor with the approved CEMP and other provisions of the contract.
- Implementation of construction phase requirements of the SCS and CCP.
- Supporting the PMU to implement the project's GRM.
- Undertaking (or facilitating the undertaking of) monitoring against baseline or benchmarked conditions as outlined in the EMP, reporting of exceedances and the identification of remediation or corrective actions as required.
- Review of the contractor's monthly reports on safeguards implementation.
- Providing inputs to quarterly progress reports and semi-annual safeguards monitoring reports to be submitted to the MOF and ADB.
- Capacity building of the MOI and PAT in general environmental management of port operations, especially as it applies to PAT's green port initiative.

452. **Contractor**. The contractor will be responsible for ensuring that all environmental design and construction environmental mitigation requirements specified in the contract are implemented during construction. The contractor's team will include staff specifically responsible for preparation and implementation of the CEMP.

453. Based on the detailed design of the project, the contractor will be required to prepare a CEMP which describes the contactor's construction methodology and measures and plans for implementing the CEMP (including method statements for biosecurity and invasive species control and management, a WMP, a TMP, a HSP and ERP) as specified in the contract. This includes maintaining a site diary and a grievance registry (as per the GRM). As above, the CEMP shall be reviewed and cleared by the CSC prior to the contractor's mobilisation to the site. The contractor will be required to report on the implementation status of the CEMP.

454. The contractor will be required to have at least one staff member with experience in environmental management; and designated as the EHSO. This staff member will be responsible for preparing plans such as the CEMP, and day to day implementation of project's EMP. The EHSO will work closely with the CLO.

455. **Summary**. The roles described above are summarized in Table 6.1 and the proposed organisational set up is shown in Figure 6.1.

Figure 6.1: Project organisation chart for environmental responsibilities

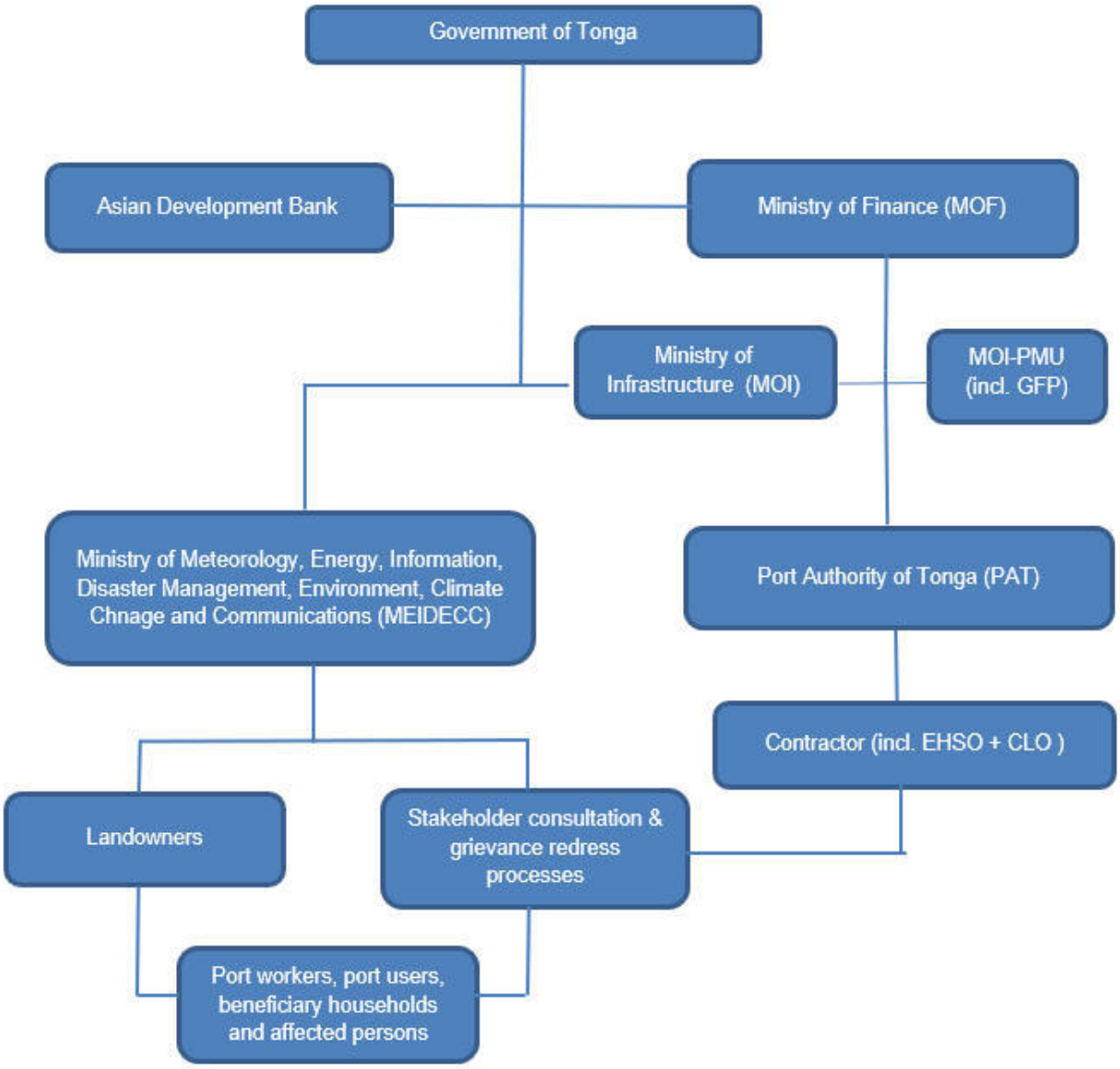


Table 6.1: Roles and responsibilities for environmental management

Project stage	Responsible agency	Responsibilities
Feasibility studies, detailed design & review and project approval	MOF	Undertake to implement project commitments on behalf of the government. Ensure budget is available to implement project as agreed. Support MOI and PAT in implementation and operation.
	MOI-PMU	Review designs prepared as part of ongoing project and complete detailed design. Update feasibility study, including safeguards due diligence, as required. Update IEE/EIA and EMP based on detailed design. Format EIA as per CSS requirements and submit development consent application, include updated EMP.
	ADB	Review all feasibility study documentation (incl. IEE/EIA). Prepare documents package for Board review (incl. terms of reference (TOR), project conditions and covenants in the project agreement). Board approval of project. Assist government to recruit construction supervision consultant (CSC).
Pre-construction	MOI-PMU, CSC	Include environmental specialist as part of CSC team to support and mentor environmental officer in PMU. Update and implement the project's SCS. Ensure updated IEE/EIA and EMP and any conditions of environmental clearance/development consent are included in the bid and contract documents. Include TOR for contractor's ESHO. Prior to works commencing ensure baseline conditions are benchmarked and recorded as required by the EMP - including noise - for subsequent monitoring. Provide inputs to the bid evaluation in respect of the contractor's response to the EMP requirements, including the suitability of the EHSO proposed as part of the contractor's team. Provide induction training to the contractor prior to the preparation and submission of the contractor's CEMP and, as required, work with the contractor's EHSO to identify appropriate construction methodologies and detailed site-specific mitigation. Review and approve the contractor's CEMP and advise CSC of approval to trigger "no objection" to commencement of activities/works. Recruit approved service provider to provide communicable diseases awareness and prevention training for workers and community.
	ADB	Review and clear updated safeguards documents. Provide comments on the CEMP and proposed monitoring checklists.
	Contractor	Recruit suitably qualified EHSO and appoint CLO from the community. Prior to any works commencing, prepare CEMP, including site-specific plans, work method statements and construction methodologies, and establish the GRM. Submit CEMP to PMU and CSC for review and approval (revising as necessary if required). Undertake the biosecurity risk assessment. Identify materials and equipment sources and apply for compliance certificates for imported materials and equipment, as necessary.

Project stage	Responsible agency	Responsibilities
		Provide pre-mobilisation induction training on the CEMP (incl. OHS) to employees.
Construction	Contractor	Inclusion of EHSO as part of core team. Provide ongoing training, awareness and "tool box" talks for workers. Implementation of CEMP. Implementation of CCP and GRM as they pertain to construction. Reporting on CEMP delivery and GRM implementation in monthly reports. Implementation of corrective actions as requested by CSC.
	PMU, CSC	Supervise, monitor and report on contractor's implementation of CEMP and all other contractual obligations. Enforce contractual requirements. Audit construction works through environmental inspections and review of monitoring reports and data. Submission of quarterly progress reports and semi-annual monitoring reports. Work with contractor's EHSO for provision of awareness/training to workers and information transfer to the contractor as required.
	ADB	Undertake regular review missions. Review monitoring reports. Disclose project information as required.
	MEIDECC	Ensure compliance with government requirements. Review complicated issues, if any, arising from the project. Participate in monitoring (as per the EMP).
Operation	PAT	Provide budget to undertake maintenance activities and environmental monitoring as required by environmental audits and the operational phase measures identified in the EMP. Implement the 'green port' initiative. Prepare (with support as required) and implement the port operations manual, including operational phase ERP and HSP. Undertake maintenance as required. Prepare, as required, environmental monitoring reports. Prepare maintenance reports to adaptively manage environmental risks related to operations (as per EMP).

456. **Budget for mitigation and monitoring**. The EMP (Table 6.2) presents the mitigation measures required to be implemented to address the impacts identified in Section 5. The costs associated with pre-construction and construction mitigation implementation and monitoring of its effectiveness are to be included in the construction contract (IIC), unless otherwise stated. Implementation of mitigation and management measures during the operational stage will be included in the operational budget of PAT.

Table 6.2: Environmental management and monitoring plan

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Pre-construction						
Import of materials (incl. any food and beverages) and equipment	Introduction or spread of invasive and/or alien species (flora and fauna)	Preparation of a biosecurity risk assessment and method statement for all activities. This will consider: (i) measures that would be undertaken to control and eradicate invasive and/or alien species within the area of works; and (ii) measures or actions that aim to prevent invasive and/or alien species being introduced to the site for the duration of the construction phase. For the management of existing invasive and/or alien species it will detail: ○ how areas with the presence of invasive and/or alien species would be demarcated; ○ how any contaminated materials would be appropriately managed throughout the works, including where appropriate eradication from the site; ○ appropriate disposal; and, ○ how any transfer or spread would be prevented. In terms of prevention of new introduction to the site, it will detail: ○ risk pathways and risk activities for the transfer and spread of non-native species; ○ risk assessment for the transfer and spread of individual non-native species of known concern;	Contractor, IIC	As per risk assessment and method statement	Before works commence; Inspections and clearance at port of entry; Phyto-sanitary certificates	Review and sign-off by MAFFF; PMU

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ methods to manage risk of transfer including any actions to be undertaken prior to reaching site; and ○ contingency planning and corrective actions. A pre-construction survey will be undertaken.				
Marker buoy relocation in Ava Lahi channel	Effects on reef habitat associated with the channel	In order to avoid any impacts on reef habitat through the relocation of the marker buoy, the area will be surveyed prior to the works occurring and the new location of the buoy micro-sited to avoid any reef.	Contractor, IIC	Presence of reef habitat	Before works commence	Review and sign-off by MEIDECC (EIA Department in consultation with Fisheries)
Construction phase dust and particulate matter assessment	Air quality impacts	The contractor will prepare CEMP, inclusive of a site-specific environmental management (SEMP), to prevent or minimise the release of dust entering the atmosphere and / or being deposited on nearby receptors. Particular attention should be paid to operations which unavoidably must take place close to the site boundary. SEMP will align with requirements set out in the IAQM Guidance, where relevant.	Contractor, IIC	Dust, $PM_{2.5}$, PM_{10} Complaints, grievances	Before works commence; Work method statement and plan incl. in CEMP as per IAQM Guidance	Review and sign-off by MEIDECC (EIA Department); PMU, CSC
Communications and information disclosure	Social disruption and/or nuisances	The SCS will further developed into a communications and consultation plan (CCP) by the PMU with assistance from the CSC. The contractor will implement relevant elements of the CCP and this will be reflected in their CEMP. The CCP will set out details about the project's GRM.	Contractor, IIC	SCS, CCP GRM notice board GRM register Record of public notices	Before works commence and prior to any key activities	PMU, MOI Review and sign-off by ADB

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Workforce mobilisation and presence	Disruption to the local community	Agreement of a Workers Code of Conduct with local leaders, to be included in workers contracts.	Contractor, IIC	Agreed Code of Conduct in place GRM register	Before works commence Code of Conduct integrated in worker contracts	PMU and contractor
Pre-construction, mobilisation and set-up	Construction worker's health and safety	The contractor will prepare a HSP as part of the CEMP. The HSP will comply with the EHSG and Tongan workplace safety legislation. The HSP will cover all measures specified in Section 5 of this IEE.	Contractor, IIC	HSP in approved CEMP PPE provided to workers First aid facilities in works yard and site	Before works commence; updates as required are checked and approved	PMU/CSC
Any related to project	Environmental and social harm	Contractor will address relevant GRM elements in their CEMP. The contractor will appoint a CLO from the local community. The contractor will maintain a GRM register and disclose complaints and grievances to PMU. The PMU will summarize all GRM related issues in the reports submitted to MOF and ADB.	Contractor, IIC	GRM register Monitoring reports CLO appointment	Before works commence and during activities	PMU/CSC
Construction phase						
All activities during the phase	Community engagement	The guidelines and requirements of the SCS and CCP should be followed. Contractor will address relevant SCS, CCP and GRM elements in their CEMP. The PMU will summarize all CCP related matters in the reports submitted to MOF and ADB.	Contractor, IIC	Notices to the public Documents disclosed CLO appointment	Throughout phase	Contractor and PMU, overseen by CSC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Marine works	Opportunity to enhance the condition of the seabed	The following will be undertaken by the contractor (as identified in the SEMP): ○ The port-derived rubbish in the marine environment adjacent to all the wharfs should be cleared. ○ Existing waste deposit sites on the Port should be cleared and the waste dealt with appropriately. ○ Oil and grease traps should be installed in the drainage system at the workshops, maintenance and refuelling areas should occur and spill kits should be provided. ○ Refurbishment (paving/capping) of all areas of QSIW pavement currently in disrepair should occur. ○ Removal of the existing navigation aids from Mona Reef and appropriate disposal.	Contractor, IIC	SEMP (waste management) prepared as part of CEMP Monitoring reports	Early in the construction phase, prior to main marine works	PMU/CSC
	Pollution from spills	For the works near and over water, a spill boom should be deployed to enclose the water surrounding the working space and prevent any oil, rubbish and debris from the site activity entering the waterbody.	Contractor, IIC	ERP as part of CEMP Monitoring reports	Prior to any works over or near water ERP reports	PMU/CSC
Dredging	Increased suspended sediment levels and the introduction of contaminants	The contractor will prepare a SEMP to cover dredging activities. The contractor will implement the following: ○ Deployment of shallow draft silt curtains (about 4 to 6 m deep) around the wharfs. ○ Ensuring due diligence when operating machinery to prevent and manage the risk	Contractor, IIC	SEMP prepared as part of CEMP Plume monitoring during activities Monitoring reports	During the dredging works Monitoring reports	PMU/CSC signed off by MEIDECC (EIA Department) in consultation with MAFFF

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		of wastewater discharge, petrochemical spillage and contamination of water. ○ No dredging should occur in the vicinity of BH01. Piling for the proposed dolphin in this location should also be limited.				
	Increased suspended sediment levels	The contractor will prepare a SEMP to cover dredging activities. The contractor will implement the following: ○ Suspended sediment levels will be monitored in the adjacent waters and at a control site during the works and an action threshold set. Additional measures, such as reduced dredging rates, should be implemented if the SSC exceeds the threshold value. ○ A surface (within 0.5m) measurement point should be set up outside but within 10m of the silt curtain and SSC measurements should be taken twice daily here and at the control station (or whenever considered necessary by DSC). ○ The threshold value should be 50 mg/l above background. ○ Should a reading of 50% of 50 mg/l above background be recorded then further investigation should be initiated and hourly readings taken. For example, inspection of the silt curtain, weather conditions and the mode of operation of dredging. If the readings continue to show an increase in SSC, then dredging rates will be reduced to the point that the SCC level declines.	Contractor, IIC	Turbidity Sediment plume Grievances/ complaints	Twice daily during the dredging works or when CSC deems it necessary Monitoring records and reports Drone footage	Monitoring: MEIDECC (EIA Department) Additional measures: Contractor Supervision: Construction Supervisor and MEIDECC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ Monitoring results will be reported to PMU, DSC and MOI once a week, and to MEIDECC when requested. Close supervision of the works will occur to ensure that the mitigation measures are effective.				
Piling	Impacts on marine mammals	The contractor will prepare a SEMP to cover piling activities. The contractor will implement the following: ○ Soft start protocols should be applied to any piling works undertaken between July and mid-November. ○ Engage a specialist between July and mid-November to watch for any dolphins moving into the lagoon or dolphins/whales transiting within 800m of QSIW. ○ Should this be observed, works will cease until the cetacean has moved away from the zone of influence of the works. ○ In combination with above consider piling techniques based on noise mitigation systems or vibro-piling techniques. ○ Should the project require the use of sonar, vessel and survey operators would be instructed to: (i) undertake all work outside July – November; (ii) use best practice for operating vessels in proximity to marine mammals; (iii) post a watch for whales and suspend activities when whales are within 1 km of a vessel; and (iv) use multi-beam and/or side-scan sonar only – no air guns.	Contractor, IIC	SEMP as part of CEMP If required, specialist to monitor, determine impacts and effectiveness of mitigation	During the piling works if they occur between July and mid-November Monitoring reports	Contractor, to be overseen by CSC and MEIDECC Use of percussive or vibro-piling techniques to be approved by the PMU and MEIDECC prior to use

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Yard construction	Effects on water quality through leaks and spillages of fuels or oils, heavy metal leaching from soil and cement components in surface water runoff	Activities, works and measures to be included in CEMP. Good working practices will be implemented to ensure that any such effects are limited, controlled and managed appropriately, including: ○ All equipment should be properly maintained. ○ Relevant precautions should be taken to prevent leaks and spills should an accident occur, spill kits should be available, appropriate and staff trained in their use following the measures and procedures in the ERP. ○ A waste management plan (WMP) will be prepared and implemented to ensure that any such effects are limited, controlled and managed appropriately. ○ Run-off water will need to be controlled during construction by using sandbags to redirect flow towards temporary shallow settlement ponds. Additionally, a temporary oil and waste disposal facility will need to be established.	Contractor, IIC	WMP and ERP as part of CEMP Pollution and rubbish levels	Throughout the construction phase	PMU/CSC with sign-off by MEIDECC
	Effects on water and land as a result of the presence of contaminated soil	Area of land under the existing fuel tanks to be capped. Any contaminated earth removed, disposed of at approved landfill or disposal site.	Contractor, IIC	Area capped Contaminated earth removed to landfill	Construction phase Monitoring reports	PMU/CSC
Construction in general	Nuisances and grievances	PMU will disclose information about the GRM at the start of construction.	Contractor, IIC	GRM register Noise Dust plumes	During construction	PMU/CSC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		The contractor shall issue notices prior to key activities. Appropriate signage will be erected at the site that provides the public with up to date project information, summarising the GRM process and including contact details. The PMU will summarize all GRM related matters in the reports submitted to MOF and ADB.			Monitoring reports Public notices	
Movement of equipment and materials	Introduction or spread of invasive or alien species	Implementation of the approved biosecurity work method statement. Workers will be given an activity specific toolbox talk from the EHSO. This should include photographs of any invasive and alien species known to be present on site or introduced to Tonga. The contractor will develop an on-going monitoring programme for invasive and alien species. This will include observational surveys on structures that may provide suitable substrate for non-native species.	Contractor, IIC	Biosecurity risk assessment and method statement reviewed and approved by PMU/CSC Implemented by contractor	Throughout the construction phase End of the construction phase	PMU/CSC with sign-off by MEIDECC
Earthworks, operation of machinery, haulage of materials	Emissions of dust and particulate matter	The CEMP will be prepared and implemented and include: ○ Displaying the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. ○ Recording all dust and air quality complaints, identifying cause(s), taking appropriate measures to reduce emissions in a timely manner, and recording the measures taken.	Contractor, IIC	Water spraying schedule Inspections logbook GRM register	Throughout the construction phase Monitoring reports	PMU/CSC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ Recording any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the logbook. ○ Holding regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. ○ Undertaking daily on-site and off-site inspection where receptors (including roads) are nearby to monitor dust and record inspection results. This should include cleaning if necessary. ○ Carrying out regular site inspections to monitor compliance with the CEMP and record inspection results. ○ Increasing the frequency of site inspections when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions. ○ Erecting screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site. ○ Fully enclosing site or specific operations where there is a high potential for dust production and the site is active for an extended period. ○ Keeping site fencing, barriers and scaffolding clean using wet methods.				

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ Removing materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on site they should be covered. ○ Ensuring all vehicles switch off engines when stationary – no idling vehicles. ○ Avoiding the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment where practicable. ○ Imposing and signposting a maximum-speed-limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas. ○ Ensuring an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate. ○ Ensuring equipment is readily available on site to clean any dry spillages and cleaning up spillages as soon as reasonably practicable after the event, using wet cleaning methods. ○ Avoiding bonfires and burning of waste materials. ○ Ensuring sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.				

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ Ensuring bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery. ○ Ensuring vehicles entering and leaving sites are covered to prevent escape of materials during transport. ○ Inspecting on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. ○ Recording all inspections of haul routes and any subsequent action in a site logbook. ○ Installing hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers, and regularly cleaned. ○ Implementing a wheel washing system (with rumble grids to dislodge accumulated dust and mud). ○ Ensuring there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits. ○ Ensuring plant are well maintained. ○ If any emissions of dark smoke occur, stopping the relevant machinery immediately and rectify any problem.				

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Machinery operation, piling, construction activities	Noise	The CEMP will include a noise mitigation plan and will include: ○ Screening construction equipment and activities behind structures (e.g. site cabins, containers, etc.) or particularly noisy construction equipment and activities behind mobile screens as far as possible. ○ All site staff receiving appropriate training on good working practice to avoid unnecessary noise emissions. Training should include a site induction programme covering site rules and guidelines for site staff, managers, visitors and contractors. ○ Good working practices including, but not limited to: (i) avoiding unnecessary revving of engines; (ii) shutting down equipment between construction periods; (iii) avoiding reversing where possible; (iv) driving carefully and within the site speed limit at all times; (v) reporting any defective equipment as soon as possible so that corrective maintenance can be undertaken; and (vi) handling material in a manner that minimises noise. ○ Wherever possible, using modern, quiet construction equipment and ensuring it is properly maintained routinely and in accordance with the manufacturers' guidance.	Contractor, IIC	Noise baseline updated prior to works Implementation of CEMP (incl. TMP) GRM register	Throughout the construction phase Monitoring reports	PMU/CSC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
		○ Regular inspection of all construction equipment to ensure that it is in a good state of repair and fully functional. ○ Implementation of the TMP. Careful selection of haulage routes, acknowledging and avoiding more sensitive areas to reduce impact on local communities. Adherence to speed limits and awareness of highway safety concerns. Ensuring suitable access to the site and appropriate loading/unloading and parking areas. Management measures to control timing of deliveries during specified delivery periods, i.e. daytime only.				
Machinery operation, piling, construction activities	Disruption of cultural sites	The contractor will prepare and implement a 'chance finds' protocol as part of the CEMP to record and appropriately deal with any chance finds.	Contractor, IIC	Chance find protocol in CEMP Chance find log	During construction Monitoring reports	PMU/CSC
General construction activities	Community and construction worker's health and safety	The contractor will prepare and implement the HSP as part of the CEMP. The HSP will comply with the EHSG and Tongan workplace safety legislation. The HSP will cover all measures specified in Section 5 of this IEE. The contractor will maintain and accidents and incidents logbook. Serious accidents will be reported to PMU within 24 hours of incident.	Contractor, IIC	HSP in approved CEMP PPE provided to workers First aid facilities in works yard and site GRM register Accident logbook	During construction Monitoring reports	PMU/CSC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Presence of workforce (incl. foreigners)	Social consequences due to presence of a workforce	Community protocols to be discussed with workers and training provided. Workers Code of Conduct to be agreed with local leaders and included in employment contracts. Contractor to ensure workers actions outside work site are controlled and community rules and the Code of Conduct are observed. Security to be provided at the work site, such that there is a prohibition on unauthorized people (especially children) entering. Complaints and incidents will be recorded and dealt with in line with the GRM.	Contractor, IIC Approved service provider	Site security measures Workers Code of Conduct GRM registry Training schedules and participant notes and minutes	At the outset and throughout construction Monitoring reports	CSC/PMU MOI
Presence of workforce (incl. foreigners) and interaction with local community	Spread of communicable diseases incl. STIs, HIV and COVID-19	Awareness and prevention (A&P) programme (risk, transmission pathways, prevention measures) to be delivered to workforce and local community. HSP and ERP to cover measures to be taken (i) to prevent and control and (ii) in the event of a COVID-19 outbreak. In bringing workers into Tonga, the contractor shall comply with all national requirements relating to COVID-19 and 'screening' will be undertaken prior to travel.[21]	Contractor, IIC Approved service provider	Labour influx management plan Worker code of conduct Communicable diseases A&P programme GRM registry Training schedules and participant notes and minutes COVID-19 response measures (PPE, controls etc.)	At the outset and throughout construction Monitoring reports	CSC/PMU MOI

[21] https://www.who.int/publications-detail/considerations-for-public-health-and-social-measures-in-the-workplace-in-the-context-of-covid-19

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Operation						
Inbound vessels, bilge disposal, import of goods	Biosecurity and invasive species	An on-going monitoring programme for invasive and alien species will be implemented. This will include observational surveys on structures that may provide suitable substrate for non-native species. Surveys will record and report the presence/abundance of non-native species. Where presence of new invasive or alien species is discovered, the risk assessment and management plan will be reviewed and amended where necessary. Regular surveys to commence once construction is completed. The frequency and extent of monitoring could reduce over time.	PAT, operating costs	PAT (initiated by the CSC)	On-going	PAT, MOI MAFFF, MEIDECC
Waste generation and management	Pollution and contamination hazards and exposure	The port septic tanks will be routinely cleaned, with sludge to be disposed of in accordance with government regulations. Implementation of fuel spill procedures and training in the use of spill equipment. Good practice should be applied in the management of wastewater, waste and hazardous materials. All fuel drums should be stored in a covered area surrounded by a spill containment bund. Fuel usage should be monitored and regulated.	PAT, Operating costs	PAT / environment manager	On-going	PAT, MOF MEIDECC

Project activity	Mitigation requirements			Monitoring requirements		
	Potential effect	Mitigation actions	Responsibility	Parameter	Period and verification	Responsibility
Facilitation of access across borders	Spread of communicable diseases incl. STIs, HIV and COVID-19	PAT to prepare a communicable diseases prevention plan and to provide PPE to avoid and control the spread of disease. Awareness and prevention programme (risk, transmission pathways, prevention measures) to be delivered to the workforce, local businesses, the local community and identified vulnerable people. ERP to cover measures to be taken in the event of a COVID-19 outbreak.	PAT Approved service provider	Communicable diseases prevention plan Training schedules and participant notes and minutes COVID-19 response measures (PPE, controls etc.)	From outset of operation and on-going	PAT. MOI
Port operations	Good H&S performance	A HSP will be prepared and implemented as part of the port operations manual, along with organisational arrangements whereby H&S officers (and managers) have clearly defined functions and receive the necessary training to undertake their functions. Lifebuoys, fire hydrants, protective equipment and first aid kits should be provided.	PAT, operating costs	PAT, initiated by the CSC / H&S officer Port operations manual - HSP	From outset of operation and on-going	PAT, MOF
	Good environmental performance	A staff member should be designated to be responsible for the overall environmental management of Port operations. An operations ERP will be developed that specifies procedures in the event of spills and a natural disaster (earthquake, tsunami, cyclone); to include regular training and drills for port staff.	PAT, operating costs	Port operations manual – ERP Green port initiatives implementation	On-going Monitoring reports	PAT, MOF MEIDECC

6.3 Grievance Redress

6.3.1 Introduction

457. In order to receive and facilitate the resolution of affected peoples' concerns, complaints and grievances about the project's environmental and social performance a GRM is proposed. When and where the need arises, this mechanism will be used for addressing any complaints that may arise during the construction and operation of the project. The GRM will work within existing legal and cultural frameworks.

458. The purpose of the GRM is to record and address any complaints that may arise promptly and transparently, with no impacts (cost, discrimination) to project affected people (APs). The key objectives of the GRM are to:

- Record, categorise and prioritise the grievances.
- Settle grievances via consultation with stakeholders (and inform those stakeholders of the solutions).
- Forward any unresolved cases to the relevant authority.

459. The grievance mechanism presented here has been scaled to the risks and impacts of the project. It is intended to address affected people's concerns and complaints promptly, using an understandable and transparent process that is gender responsive, culturally appropriate, and readily accessible to all affected people at no cost and without retribution. The mechanism does not impede access to the Tonga's judicial or administrative remedies.

460. MOI, through the PMU, will inform potentially affected people about the mechanism before the commencement of any civil works.

6.3.2 The Process

461. Grievance focal points (GFP) will be appointed to receive complaints from potentially affected personal and bring these to the attention of the contractor. These will be designated individuals from within the local community. The contractor will record the complaint in the onsite Complaints Register in the presence of the GFP. The GFP will discuss and agree how to resolve the complaint with the contractor.

462. If the contractor does not resolve the complaint within one week, then the GFP will bring the complaint to the attention of the PMU Safeguards Specialist. The PMU Safeguards Specialist will then be responsible for coordinating with the contractor in solving the issue.

463. If the complaint is not resolved within two weeks the GFP will present the complaint to the Grievance Redress Committee (GRC). The GRC will be comprised of designated officials from the following organizations: MOI, PAT, the PMU Safeguards Specialist and a community representative.

464. The GRC will have to resolve the complaint within a period of two weeks and the resolved complaint will be communicated back to the community. The contractor will then record the complaint as resolved and closed in the register and documented in monitoring reports. In parallel, each GFP will maintain a record of the complaints received and will follow up on their rapid resolution.

465. The complainant reserves the right to take his/her grievance to Court if he/she feels the matter is not satisfactorily addressed. Whatever the outcome of each grievance, it will be recorded in the grievance register and then closed. The details of grievances received and dealt with each month will be reported in the project's quarterly progress reports and semi-annual safeguards monitoring reports.

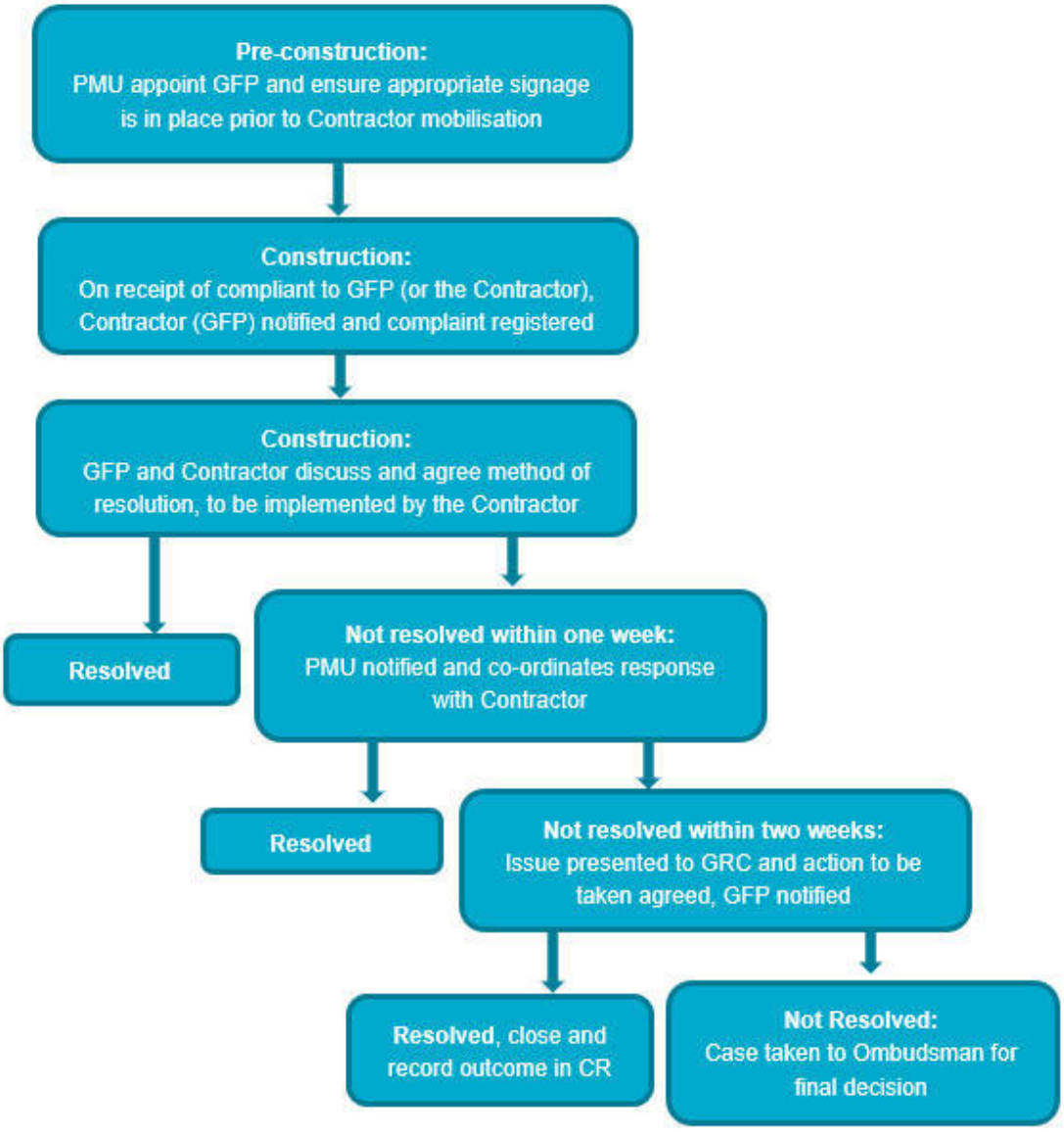
466. The record of a grievance will include the following information:

- Name and contact details of the complainant lodging the grievance.
- The name of the recorder.
- A description of the nature of the grievance.
- Whether it was customary lands related or otherwise.
- For a non-customary related grievance, name of the person(s) who dealt with the grievance.
- Names of the persons (the Site Supervisor, EHSO, PMU Safeguards Specialist, GRC etc.) who considered the grievance.
- Date of deliberation and decision.
- Record of corrective actions.
- Date and format of feedback to the complainant and any subsequent response.
- Date and details of closure of the grievance.

467. Appropriate signage will be erected at the construction site that provides the public with up to date project information, summarising the GRM process and including contact details for the GFP. Anyone is able to lodge a complaint and the method used (in person, by telephone, forms written in Tongan) should not inhibit any compliant being lodged.

468. MOI will also keep track of the status of all complaints through the monthly report submitted by the contractor to the PMU and will ensure that they are resolved in a timely manner. The grievance redress process is outlined in Figure 6.1.

Figure 6.1: Grievance redress process



6.4 Monitoring and Reporting

469. **Monitoring.** The proposed project monitoring programme is commensurate with the project level of risk and focuses on the environment within the project's area of influence. The programme considers the scope and frequency of monitoring. It is largely focused on parameters, as identified in Table 6.1, which can be monitored visually or with the use of basic equipment if required (such as noise meter). Any additional baseline or instrumented testing requirements will be determined by the CSC. In general, the monitoring will focus on compliance with measures in the approved CEMP.

470. The monitoring and reporting requirements are specified in the EMP table (Table 6.2). The monitoring timeframe will require either daily (by contractor and engineer/site supervisor) or monthly (by PMU) inspections during the construction phase, especially during key activities associated with the site clearance and preparation, and earthworks.

471. **Reporting**. The construction contractor will prepare monthly reports that will include a description of CEMP implementation, any non-compliances or corrective actions required, and the ESHO's site diary notes, completed checklists of daily/weekly monitoring, grievances registered and public information disclosure activities undertaken.

472. The CSC, PMU and site supervisor will conduct regular checks of compliance with the approved CEMP as part of site and works quality/performance management and contract supervision. For the PMU this will involve regular (at least monthly) inspections and audits of the contractor's compliance with the approved CEMP. The PMU will prepare project quarterly progress reports (QPR) that will include a section on safeguards aspects, including a summary of the contractor's monthly reports, CEMP compliance monitoring undertaken by the contractor, engineer and PMU, and any training and capacity building activities provided by the CSC to the PMU, other government staff and/or contractor. Based on the QPR, the PMU will prepare and submit to the MOF, MOI and ADB, semi-annual safeguards monitoring reports. The outline contents list for the semi-annual safeguards monitoring reports are included in the project administration manual.

7 CONSULTATION AND DISCLOSURE

473. In line with the ADB's Access to Information Policy (ADB, 2018), consultation and disclosure will continue throughout the pre-construction and construction phases, and into the operational phase.

474. A SCS has been prepared for the project. Consultation and information disclosure during the project preparation stage followed the process established in the project's SCS. Early in the pre-construction phase the SCS will be developed into a CCP which will be implemented for all project-level communications by the PMU on behalf of MOI. The contractor will be required to outline in their CEMP how they will implement relevant elements of the SCS and the CCP relevant to their activities and works.

475. Annex 1 includes details of the consultation undertaken (to date) for the project. Table 7.1 summarises the due diligence consultation undertaken to date and the issues raised; significant consultation has also occurred in relation to the development of the design.

476. Consultation with the community in the pre-construction and construction phases will be managed by the PMU, supported by the CSC, in conjunction with MOI.

477. In the operational phase, consultation and clear, timely and appropriate disclosure with respect to grievances will be managed by PAT.

Table 7.1: Consultation summary

Date	Location	Topic	Attendees	Number (% female)	Issues discussed
March 2019	Various Nuku'alofa	Introduction to the Upgrade Project: initial social, poverty and gender consultation	MOT, MOI, MOF, PAT, MLSNR, MPE, MAFFF, MEIDECC, ITS Consultants, Customs officials, Shipping lines, Handicraft businesses, FISA and representatives of the Climate Resilience Project	22 (32%)	Land ownership Benefits likely to arise; current issues with delay in the flows of goods; and queries around the likely period of disruption
April 2019	MOI, Nuku'alofa	Initial findings of the feasibility study	MOI, PAT, MAFFF, MRC, ADB, RHDHV, RAN, Shipping lines and a Truck operator	16 (25%)	Demand forecast appeared optimistic; dwell times for empty containers; potential to widen the approach channel; container stacking requirements; support for Wharf Option 1 (see Chapter 3 of the IEE)
May 2019	PAT, Nuku'alofa	Presentation of the layout options to stakeholders to gather early feedback for the multi criteria analysis (MCA)	MOI, PAT, Customs officials and RHDHV	15 (20%)	PAT and MOI (MPD) expressed a clear preference for Wharf Option 1; Customs officials shared their future plans for an X-Ray; and discussion regarding the port masterplan and allocation of land for Customs operation
May 2019	MOI (MPD), Nuku'alofa	Presentation of the layout options to stakeholders to gather early feedback for the MCA	MOI, MEIDECC (EIA Unit) and RHDHV	6 (66%)	MEIDECC expressed no preference regarding the preferred Wharf Option
May 2019	Touliki Naval Base	Presentation of the layout options to stakeholders to gather early feedback to incorporate in the MCA.	RHDHV, RAN and TDS	4 (0%)	The Navy advised that future development of the Naval Base will occur to the East of QSIW; Wharf Option 3 was not preferred due to the potential impact on Navy operations
June 2019	MOI, Nuku'alofa	Options workshop and presentation of audit results	MOI, PAT, MAFFF, MEIDECC, TDS, Tongan Gas, Customs officials, ADB, RHDHV, ITS Consultants and Stevedores	16 (44%)	Benefits expected to arise; current issues with delay in the flows of goods; queries regarding potential effects on the Navy

Date	Location	Topic	Attendees	Number (% female)	Issues discussed
June 2019	QSIW, Deep Blue Office	Whale watching	Deep Blue Diving and RHDHV	6 (33%)	Numbers of whale watch operators and presence of whales in the study area (see Annex, meeting report 4)
August 2019	MOI, Nuku'alofa	Yard Layout	MOI, PAT and RHDHV	5 (20%)	Selection of the preferred layout for long and short term; Yard Option 3 (see Chapter 3 of the IEE) was preferred, however some revisions in terms of stack orientation were proposed by PAT and agreed
Oct 2019	ADB Office, Nuku'alofa	Findings of the Phase 2 site investigations and presentation to the Independent Third-Party reviewers (GHD)	ADB, PAT, MOI, PMU, GHD, MEIDECC and RHDHV	13 (23%)	Proposed Basis of Design and progress of investigations to date
Nov 2019	Tongatapu 4 Constituency Office	Implications of the Upgrade Project	Tongatapu 4 constituents	24 (29%)	Noise disturbance; flooding potential; traffic; need for the extension; and concerns about combined effects on the waterfront
Dec 2019	MEIDECC, Nuku'alofa	Design workshops	MOI and PAT	6 (16%)	Pavement type and suspended deck structure; preferred options selected
Dec 2019	Touliki Naval Base	Potential effects	Tongan Defence Service	4 (25%)	No concerns given that the development is to the west; Navy's future plans will not affect QSIW
Dec 2019	NFC office, Nuku'alofa	Potential effects	Nuku'alofa Fishing Club (NFC) members	2 (0%)	Proposed layout; concerns regarding potential need to relocate; the report Annex, meeting 10, sets out how these concerns are not valid, as relocation is not required
Jan 2020	ADB Office, Nuku'alofa	Findings of site investigations and presentation of selected structural options	ADB, PAT, MOI, PMU and RHDHV	13 (30%)	Findings of the structural assessment of the existing wharves (which do not comply with latest international guidelines); discussion on wharf type, pavement and concrete repairs - no change to previous options selected

Date	Location	Topic	Attendees	Number (% female)	Issues discussed
Dec 2019	Touliki Naval Base	Potential effects	Tongan Defence Force	4 (25%)	No concerns given that the development is to the west; Navy's future plans will not affect QSIW (see Chapter 3 and Section 5.7.1)
Dec 2019	NFC office	Potential effects	Nuku'alofa Fishing Club	2 (0%)	Proposed layout; concerns regarding potential need to relocate (not realised) (see Chapter 3)

8 CONCLUSION

478. **Summary**. The construction of a new domestic terminal in 2018 allowed the current configuration and operation of QSIW to be investigated, with a view to reorganising port operations to handle the expected growth in container freight over the next 20 years. The Government of Tonga requested support from ADB to undertake a feasibility study and prepare a project to finance an upgrade of QSIW to an international gateway container and general cargo terminal.

479. As part of the feasibility study, this environmental assessment was prepared. The assessment complies with requirements of the CSS and those of the SPS. It has identified the potential negative and beneficial impacts of the project, quantified these and, where necessary, proposed mitigation and/or monitoring measures to offset any negative impacts to a level deemed to be acceptable.

480. **Pre-construction**. The environmental audit of the QSIW facilities and operation undertaken in February 2019 identified a number of environmental, health and safety, and social issues associated with the existing facility. This led to recommendations for the new port facility and ongoing operations, the current design has accommodated 'structural' recommendations and the EMP comprises 'operational' aspects to be implemented during construction and operation stages. These include:

- 'Safe' pedestrian routes in/out and around the terminal.
- An appropriate traffic and stack management scheme; inclusive of improved lighting on the terminal and quay.
- Scrap and waste will be removed from the terminal.
- Cables will be made safe.
- The safety of container handling will improve.

481. Although no major changes in project design are anticipated, this environmental assessment will be updated as part of the detailed engineering design phase. The updated assessment will be formatted as required under the CSS and submitted to MEIDECC in support of the application for development consent for the project. The updated assessment development consent (with or without conditions) will be incorporated into the bid and contract documents. The contractor awarded the works will be required to develop their CEMP based on the project's updated assessment EMP and to reflect their approach to the works. The CEMP will include sub-plans (HSP, TMP, WMP, ERP etc.) and site-specific plans for particular elements of the work (dredging, piling etc.). The CEMP will be reviewed and cleared by the PMU and CSC prior to the contractor being given no objection to commence works.

482. **Construction**. During the construction phase of the project, no or insignificant impacts have been predicted with regard to geology; climate; coastal processes; water, sediment and land quality; vibration; and recreation.

483. With the proposed mitigation set out in the EMP (Table 6.1) in place, impacts relating to the resuspension of contaminants; spills; cetaceans; invasive or alien species, and tourism have also been predicted to be mitigated to insignificant levels and without residual impacts.

484. Minor residual effects (i.e. with the proposed mitigation in place) are predicted on the benthic environment, due to new marine infrastructure and suspended sediment during the works, and on the human environment due to dust and (some) noise effects. The CEMP and appropriate fencing should prevent or minimise the release of dust entering the atmosphere and/or being deposited on nearby receptors.

485. The residual impacts associated with an influx of construction workers and risk of transmission of communicable diseases are expected to be of negligible significance with mitigation in place (e.g. screening and induction of workers of the requirements of the project, a worker's code of conduct and a communicable diseases awareness and prevention programme). Speed controls through villages, appropriate timing of truck movements, travel routes and signage/information for the community will also be implemented to manage any risk to the community and ensure that any adverse impacts are reduced to minor levels.

486. Benefits will also arise during this phase as a clean-up of the existing facility and adjacent seabed is undertaken and a construction workforce is employed.

487. **Operation**. During the operational phase significant beneficial effects will occur for both the physical and human environment. For example, oil and grease traps will be operational, septic tanks will be managed appropriately and fuel drums will be stored in bunded areas. Major health and safety improvements will similarly occur, alongside the green port initiative.

488. Furthermore, the economy will benefit from more efficient operation of the port's facilities which, in turn, should reduce the costs of imported goods and facilitate the flow of goods which people rely on. The project will improve the efficiency of the port operations and reduce goods handling costs, lost ship berth days and, ultimately, the cost of cargo. Reduced import costs will help to reduce the cost of living and combat poverty.

489. The potential for the introduction of invasive non-native species exists during this phase, but management measures (through a biosecurity method statement) are proposed to mitigate (control and prevent) this risk. Truck traffic to and from the port will increase from (on average) 56 movements a day to 61 movements a day and have a negligible influence. There will be no increase in marine traffic (rather ships will get larger).

490. **Recommendations**. The following measures will be taken by the project to ensure compliance with the environmental safeguard requirements of the SPS and CSS:

- The environmental assessment and EMP will be updated during detailed design. The updated assessment along with development consent under the CSS will form part of the bid and contract documents.

- In the construction phase training will be provided for skilled and semi-skilled people. The project will also seek to maximise the employment of women through the recruitment of female workers where they have the required technical skills.
- During the latter stages of construction, PAT (with support from the CSC) will give priority to establishing a HSP (based on relevant elements in the EMP) as part of the port operations manual and the development of the green port initiative. This will be in parallel to establishing appropriate organisational arrangements whereby health and safety officers have clearly defined functions and receive the necessary training to undertake their functions.
- One staff member will be made responsible for implementing, and reporting on, operations stage elements of the EMP, including the operationalisation of the ERP (specifying procedures in the event of spills and natural disasters). This will include regular training and drills for staff.

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Annex 1: Summary of Stakeholders Consulted and Responses

The signature sheets and meeting minutes included in this annex record attendance at and/or outcomes of:

- Initial social, poverty and gender consultation undertaken in March 2019 by Mosese Latu, ITS.
- Consultation undertaken by Stephen Lindsey in support of the marine ecological survey undertaken in March 2019.
- A workshop held at MOI (Marine and Ports Division) to report the initial findings of the feasibility study in April 2019 with officials representing Customs, MAFFF (Quarantine), MEIDECC, MOF, MORC, PAT, Shipping Lines (CFR, Transpacific, Dateline Transpacific, Polynesian Shipping and PFL), RAN/Australian High Commission, a Trucking Line (Malappo) and TDS.
- A Due Diligence Options Workshop held in June 2019 run by Environment Lead Sian John, RHDHV.
- A meeting between Environment Lead Sian John meet with one of Tongatapu's Whale Watch operators in June 2019.
- A meeting held by MOI on the Transport Project Development Facility (TPDF) G6018 TON: Nuku'alofa Port Project with Tongatapu 4 Council on 5th November 2019.
- Notes from December 2019 Mission: Design Workshop with MOI and PAT (17/12); Navy Consultation (17/12); Quarry (Ahononou) visit (18/12); Concert plant (Royco Ready Mix Plant) visit (19/12); follow-up meeting with PAT (19/12); and consultation with the Nuku'alofa Fishing Club (19/12).

Royal HaskoningDHV **ITS Engineering Consultants**

Upgrading and Development of the Queen Salote International Wharf in Nuku'alofa Port, TONGA, Feasibility Study

Initial Social, Poverty, Gender and Social Safeguards Consultation

Name	Position	Ministry/Dept/Org	Work: phone & email
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TEUTA LAVEMAI	DIRECTOR OF LANDS	MINISTRY OF TRANSPORT INFRASTRUCTURE	7388586
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Penilikata Tafi Uhatafe	A/D CEO	MOFNP	
Malolesi			

Royal HaskoningDHV **ITS Engineering Consultants**

Name	Position	Ministry/Dept/Org	Work: phone & email
MAKER MATELE	~~MD of~~ Managing Direct	Trans Pacific Shipping	7817505
Tupou'ahao Fakakovikaetau	Principal Programme Officer,	MIA, MAD	27-145
MAFUA MAKA	Acting Director for DEMO	MEIDECC	7737481
Viliami TAKAU	CEO	FISA	7778002
S. Langitoto Helu	National Education & Communication Specialist	CRSP/MEIDECC	774-4404
FEAO VAKATA	Former Minister of Pub Evts	MOPEs	7716294
MALAKAI VAKASIUOLA	Deputy Team Leader	Climate Resilient Sector Project	24 668
		MOI/PIU	
		Project Implementation Unit	
Kelela Tonga	Deputy CEO	MOI (Marine Transport)	705 2655 27555

Kelela Tonga.
Ktonga16@gmail.com
7705203.
22555.

Date – Day	Stakeholder
05.03.19 Tuesday	Ms. Kelela Tonga – Director for Marine and Ports – Ministry of Infrastructure. PH: +676 7705203, Email: ktonga16@gmail.com Mr. Tevita Iketau Kaufusi – Manager Infrastructure & Technical - Ports Authority, Tonga. PH: +676 23168. Email: ikaufusi@portsauthoirty.tbu.to
06.03.19 Wednesday	Meeting to discuss marine survey methodology and Tongan safeguard requirements (afternoon). Attendance: Mr. David Perby – Project Team Manager. Ms. Kelela Tonga – Director for Marine and Ports – Ministry of Infrastructure. PH: +676 7705203, Email: ktonga16@gmail.com Mr. Poasi Ngawafe – Ministry of Fisheries (poasi66@hotmail.com) Mr. Kosilio Fakaois – MEIDECC – EIA unit (kosiliofakaosi@gmail.com). Ms. Peta Koloamatangi – MEIDECC – EIA unit (petakoloamatangi@gmail.com). Ms. Meliame Tualau Marine Environment/UPD (meliametk@gmail.com).
07.03.19 Thursday	Mr. James Lolohea and Mr. Vaea Kaho – Port's boat operators who assisted with the marine field assessment.
08.03.19 Friday	Tongan Deep Blue diving services assisted with the marine field assessment included Mr. Litani Taufa and boat assistants Mosese and Uaisake.
12.03.19 Tuesday	Mr. Semisi Fuapam – Ports boat operators assisted with the marine field assessment.
13.03.19 Wednesday	Met with Pacific Sunrise Fishing (Ms. Rosemarie Palu) discussed commercial fishing activities and specific port requirements.
14.03.19 Thursday	Marine assessment presentation. Attendance: Mr. David Perby – Project Team Manager. Ms. Kelela Tonga – Director for Marine and Ports – Ministry of Infrastructure. PH: +676 7705203, Email: ktonga16@gmail.com Mr. Poasi Ngawafe – Ministry of Fisheries (poasi66@hotmail.com) Mr. Hemaltot Tupou - Ministry of Infrastructure (likewater83@gmail.com) Mr. Petersio Manukeu – Ministry of Infrastructure (peteleno403@gmail.com)

Royal HaskoningDHV
Enhancing Society Together

Note / Memo

Haskoning Australia PTY Ltd.
Maritime & Aviation

To:	Juan Francisco Gonzalez Jimenez
From:	David Perbey
Date:	05 May 2019
Copy:	Cha-sang Shim; Michael Sanders
Our reference:	PA1922-RHD-MEM-0014
Classification:	Open

Subject: **Report Findings Presentation - 30/04**

These notes were compiled by David Perbey following the meeting presentation with representatives of key stakeholders.

Attendance:

Royal HaskoningDHV	Michael Sanders	Team Leader
	David Perbey	Deputy Team Leader
MOI	Kelela Tonga	Marine Department Manager
	William Fonua	Civil Department Manager
PAT	Alo Maileseni	Deputy CEO
	Iketau Kafausiva	Infrastructure & Technical Manager
	Etikeni Samani	Risk and Compliance Manager
ADB	Tatafu Moeaki	Sr. Country Coordination Officer
MAFFF	Peioneti Lui	Quarantine Rep
MORC	Kelemete Vahe	Custom CEO
CFR Line	Lavinia Tuitani	Shipping Line Rep
Transpacific	Manu Matele	Shipping Line Rep
Dateline Transpacific	Fuie Tolui	Shipping Line Rep
Polynesian Shipping	Pate Topu	Shipping Line Rep
PFL	Latu Lui	Shipping Line Rep
Malappo	Vatau Pallu	Truck Operator Rep

1 Presentation

Presentation of the powerpoint document "Upgrading and Developing the QSIW in Nuku' alofa Port Tonga_Workshops" attached as Appendix 1 to this is memo was Made by Michael Sanders, Team Leader from RHDHV.

It will be noted that additional stakeholders (MFNP, Freight Forwarders and Truck Operators) were invited by Kelela Tonga from MOI but unfortunately could not attend the meeting. Additional MOI CEO, Ringo Fa'oliu was at the time of the presentation in mission outside of Tongatapu Island. However, a representative range of key users/operators of the QSIW facility were present for this presentation.

2 Comments/Feedback from Stakeholders

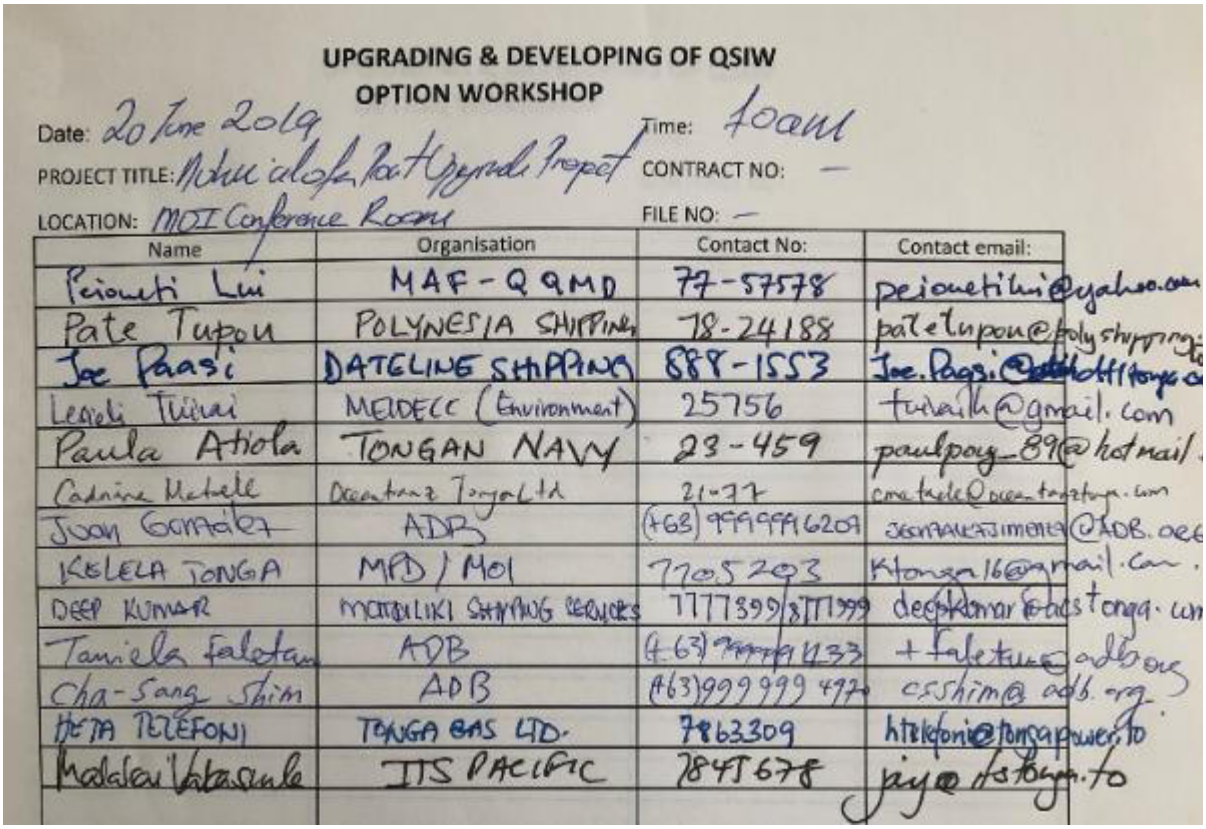
No specific comments were made during the presentation, however further discussions occurred during the open question session which follows. The main comments made by the stakeholders are reported below per key topic:

Reports findings and assumptions

- Some of the shipping lines representatives think that the demand forecast is potentially too optimistic.
- The average dwelling time of 14 days for the empty containers is currently dictated by the scheduling of ship calling QSIW form New Zealand which around this frequency.
- The current free storage is therefore based on this ship rotation and currently there is no congestion in the yard generated by lack of space.
- Explanation was made that the change of dwelling time is not required to increase capacity in short term but potentially for 2040-2050 time frame if yard space is not increased by then.
- Custom representatives mentioned that they are actively looking into acquiring an x-ray scanner equipment funded from Chinese government. They wish to discuss this further with PAT and RHDHV regarding location of the facility, general organisation of the yard layout and import/export process of containers.
- Benchmarking with Suva is relevant, and PAT mentioned that they are as well looking into the possibility of having an inland port (other side of the lagoon) as per Suva port. This will increase considerably the storage space of containers offsite and therefore decrease the dwelling time inside QSIW facility.
- Questions were asked about the navigation channel if it was going to be widen as Stakeholders agreed that it could be a restriction for the port in future. Assumption of 12m draft limit was judged to be correct as the naval chart rate 12.2 to 12.5m declared dredged depth. Some believe that the channel is actually deeper than the chart declared and are more concerned about the width for future vessels such as Medium Range Tankers (MR).
- Wingwalls of wharf 1 are only wave breakers not part of the main wharf structure or retaining walls.
- It is believed that Kramer Ausenco has drawings of the QSIW '86 expansion. MOI will arrange and accompanied RHDHV to their office in Nuku'alofa this week.

Observations/comments on Options

- Option 1 was appealing by most stakeholders.
- Option 2 was found interesting by some Shipping Lines representatives because of additional storage space presented by the reclamation behind wharf 2 extension.
- Option 4 could be a future variation of Option 1. PAT representatives liked the idea and mentioned that they have not thought of it before at the contrary of Option 3 which is inline with their previous CEO intension regarding QSIW expansion.
- Option 3 and 5 will need to be checked with Navy Acting Commander as most of the stakeholder voiced their concern in term of impact/interaction between container ships and patrol boats.
- Inside the yard, shipping lines agent raised the need to have four different/separate areas for container stacks: full, Dangerous goods, and two empties – MPI (for exported to NZ) and normal.
- Export of Reefers is becoming an issue toward the end of the year with pumpkin. They need to be relocated with their substation further away from the empty stacks.
- PAT needs to have sufficient space to moor their new tug and potentially working barge in near future. Currently there is a lack of space for the pilot boat which is moored against the new tug. It will be noted that the tug was brought by sea from Townsville and it took 14 days to PAT crew to make the journey back to Tonga.
- The yard layout on the options presented is not developed enough at this stage. Containers will need to be orientated for the main berth.



UPGRADING & DEVELOPING OF QSIW
OPTION WORKSHOP

Date: 20 June 2019 Time: 10am
PROJECT TITLE: Nuku'alofa Port Upgrade Project CONTRACT NO: —
LOCATION: MOI Conference Room FILE NO: —

Name	Organisation	Contact No:	Contact email:
Peioneti Lui	MAF-QSMD	77-57578	peioneti lui@yahoo.com
Pate Tupou	POLYNESIA SHIPPING	78-24188	pate tupou@polyshipping
Joe Paasi	DATELINE SHIPPING	888-1553	Joe.Paasi@datelinetonga
Leoleli Tuinai	MEIDECC (Environment)	25756	tuinaih@gmail.com
Paula Afiola	TONGAN NAVY	23-459	paulpay_89@hotmail.
Cadnine Metaele	Oceantranz Tonga Ltd	21-77	cmetaele@oceantranztonga.com
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KELELA TONGA	MPD / MOI	7705203	Ktonga16@gmail.com
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Cha-Sang Shim	ADB	(+63)999999 4970	csshim@adb.org
HETA TELEFONI	TONGA GAS LTD.	7863309	htelefoni@tongapower.to
Malakai Vakasuka	ITS PACIFIC	7847678	jay@itstonga.to

Royal HaskoningDHV
Enhancing Society Together

Note / Memo

Haskoning Australia PTY Ltd.
Maritime & Aviation

To:	Juan Francisco Gonzalez Jimenez
From:	Sian John
Date:	26 June 2019
Copy:	Cha-sang Shim; Michael Sanders, David Perbey
Our reference:	PA1922-RHD-MEM-00XX
Classification:	Open

Subject: **Discussion with Whale Watch Operator - 19/06/19 midday**

These notes have been compiled by Sian John following a discussion held with Deep Lodge whale watch and swim operator.

1 Attendance

Royal HaskoningDHV	Michael Sanders	Team Leader
	David Perbey	Deputy Team Leader
	Sian John	Environment Lead
Deep Lodge	Various	Manager and Tour Guides

2 Comments/Feedback

Whale encounters

- Peak periods of Humpback whale migration in Tonga occur between July and November.
- The humpbacks move across the north of Nuku'alofa and north from there.
- The Vava'u and Ha'apai island groups support a professional ecotourism industry and attract a lot of international business.
- However, humpback whales can also often be found transiting Tongatapu: passing through the waters to the north of Nuku'alofa.
- Humpbacks are prevalent in/around Tongatapu and Eua at the beginning and end of the season, but they say that encounters are frequent and that the peak period is August and September.
- They swim with whales and calves off Tongatapu frequently.
- They also encounter pilot whales and bottle nose dolphins.
- Whales have been reported to occasionally pass through the waters adjacent to the port.

Operators

- There are three whale watch and swim operators who operate from Nuku'alofa in the vicinity of the Port;
  - Deep Lodge (Tongan operated – who work out of Nuku'alofa port and Eua),
  - Blue Water (Australian operated), and
  - Whale Swim Dive (NZ operated).
- The three main whale watch and swim operators working out of Nuku'alofa (and Eua) run trips six days a week, carrying around 30 people each, each day.
- There are approximately another four other smaller operators in addition to the main three.

MINISTRY OF INFRASTRUCTURE

TRANSPORT PROJECT DEVELOPMENT FACILITY (TPDF)
G6018 TON: NUKU'ALOFA PORT UPGRADE PROJECT

COMMUNITY CONSULTATION MINUTES

Date : Tuesday 5 November 2019
Community : Tongatapu 4 Council (Ma'ufanga and part of Kolofo'ou District)
Venue: Tongatapu 4 Constituency Office
Government Representative: Ms. Kelela Tonga, Director for Marine and Ports

Meeting commenced with an opening prayer and welcoming remarks by the Chairperson, Mr Tamaseno Penitani, then the time was handed over to the project team for the presentation.

Ms. Kelela Tonga, Director for Marine and Ports presented the project update informing the Council that the presentation was to share project information including project background, provide an update on work progress and share the findings of the investigation surveys thus far. A copy of the presentation is attached as Annex 1.

Discussion Points

Relationship between the wharf project and Tongatapu 4

One participation sought clarifications on the link between the wharf project and Tongatapu 4. It was clarified that the location of QSIW and the traffic load may have some impact on Tongatapu 4 residents, and that meaningful community consultations was a requirement of the safeguards due diligence process. The Council were informed that this was the first meeting with other meetings scheduled for future as the project development and implementation progresses. Busy traffic, piling and hammering works may cause noise in area.

It was proposed that any concerns raised from the public would be addressed by the Ministry and project information be shared.

Will Wharf 1 and Wharf 2 be connected?

It was confirmed that wharf 1 and wharf 2 will be connected as per option A in the presentation.

Options

MINISTRY OF INFRASTRUCTURE

TRANSPORT PROJECT DEVELOPMENT FACILITY (TPDF)
G6018 TON: NUKU'ALOFA PORT UPGRADE PROJECT

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Options

MINISTRY OF INFRASTRUCTURE

Environmental Concerns from Siesia

Concerns raised from Siesia village was sea level rise and possibility of a similar experience to Manima Is. which was cut off by sea water. The village currently experiences some impacts from the construction of the domestic wharf.

In terms of Wharf 1 – While the gap between the wharf 1 and 2 will be connected it will be connected in an angle not connected in a straight line for safety purposes. Two dolphins will also be built to assist with mooring. And Wharf 2 will be extended by 54.5m to receive 220m ships.

It was clarified that the environmental impact will involve minimal dredging and the same depth and that the Taufa'ahau Wharf has a nationwide advantage.

Compensation and Alternative Livelihood

The project team was asked whether there were any funding assistance or compensation to the Council for affected communities/environmental damage to the waterfront which community residents rely on for livelihood through shallow water fishing.

The Town Officer emphasized the importance of seeking and providing alternative livelihood to address social impacts of development projects including the SMA zoning initiative by Fisheries Department. The Chairperson and Council agreed.

Recent, current and pipeline projects for the water front development that the Council is aware of includes;

i. Domestic Wharf
ii. QSIW Upgrade
iii. Navy Base
iv. Fuel Pipelines
v. Swimming Pool
vi. SMA zoned area

The restrictions leave very little options for people who rely on shallow fishing for livelihood.

MINISTRY OF INFRASTRUCTURE

The closing remarks were offered by the Member of Parliament for Tongatapu 4. In his summary, he shared that Tongatapu 4 submitted a report to Parliament regarding the impacts of the water front development and will request further details from PAT on impacts in the water front area of the district.

He recalls the loud construction hammering at the wharf when he was still in high school, however acknowledges the need for wharf extension for long-term development included the impacts on PACER Plus which will increase exports. The project team was asked to consider any disruption to church, national funerals, and school events as a result of construction noise. Additionally, for the project team to consult 'Apifo'ou College and the Roman Catholic Diocese of Ma'ufanga.

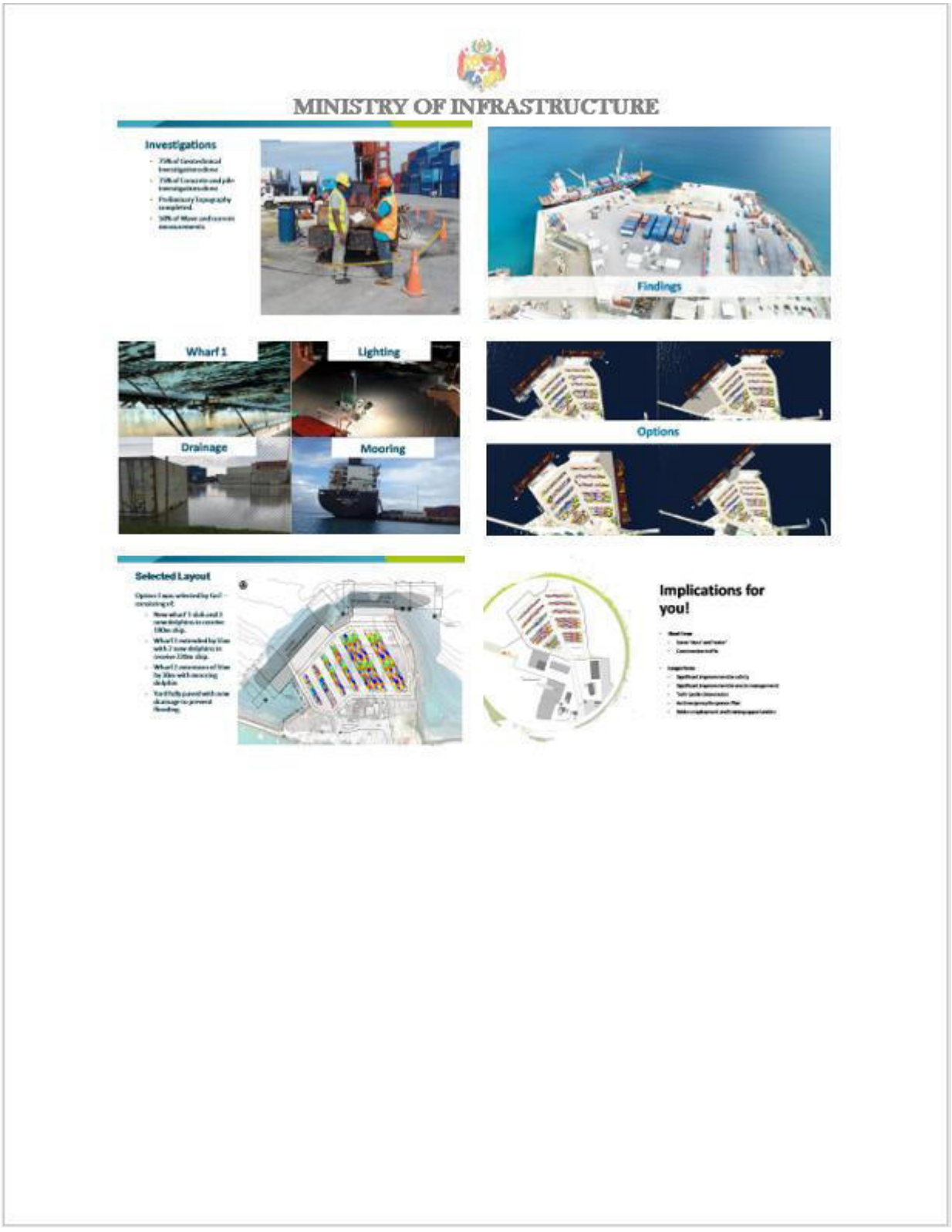
It was confirmed that the Member of Parliament and Town Officer will voice any issues from Tongatapu 4 as their representative. Members of the Council will include a briefing on today's presentation in the next Village Council meeting in their respective villages.

The MP and Town Officer will voice in any issues from Tongatapu 4 as their representatives.

Minutes Prepared by:
'Ana Bing Fonua, Project Coordinator

MINISTRY OF INFRASTRUCTURE

Annex 1: Powerpoint Presentation


MINISTRY OF INFRASTRUCTURE
Investigations
Findings
Wharf 1
Lighting
Drainage
Mooring
Options
Selected Layout
Implications for you!

MINISTRY OF INFRASTRUCTURE

Annex 2: Participation List

	Name	Village	Position	Contact Details	
1	Malia Mafi	Houmakelikao	Sekelitali	7746844	
2	Puniani Molitika	Ma'ufanga	Deputy Chair & Treasurer	7753174	
3	Taniela Latu	Fangaloto	Deputy Chair	7775515	
4	Hanisi Misinale	Houmakelikao	Deputy Chair	21539	
5	Paea Filimoehala	Ma'ufanga	Town Officer	7585159	
6	Isapela Tuivai	Kumi Fonua	Deputy Chair	8814923	
7	Sosefo Selui	Kumi Fonua	Secretary	7714217	
8	Ahosivi Lea'amanu	Touliki	Secretary	26484	
9	Tevita Havili	Touliki	Chairperson		
10	Siulangape Fukofuka	Touliki	Treasurer	7715800	
11	'Asupa Latu	Nukunukumotu	Youth Rep	7754832	
12	Hua Latu	Nukunukumotu	Council Rep	7754832	
13	'Ilaisaane Faka'osifolau	'Umusi	Secretary	7707213	
14	Daisy R. Fonua	Va'epopua	Chairperson	7704417	
15	Tevita Fatai	Popua	Town Officer	7753007	
16	Fangupo Latu	Siesia	Town Officer	7754832	
17	Kiu Futuna Tatafu	TBU4 Council	Treasurer	7759063	
18	Manitasi Leger	Houmakelikao	Chairperson	7717571	
19	Mateni Tapueluelu	TBU4 Council	Member of Parliament		
20	Tamaseno Penitani	TBU4 Council	Chairperson		
21	Kelela Tonga	MOI	Director, Marine & Ports Division	23100	
22	'Ana Bing Fonua	PMU	Project Coordinator	7703320	
23	Fisilau Leone	PMU	Deputy Project Coordinator	7817004	
24	Andrew Niukapu	Ports Authority	Architectural Draughtsman		

MINISTRY OF INFRASTRUCTURE

Annex 3: Consultation Pictures




Note / Memo

Haskoning Australia PTY Ltd.
Maritime & Aviation

To:	Juan Francisco Gonzalez Jimenez
From:	David Perbey
Date:	24 December 2019
Copy:	Cha-sang Shim; Ana Bing; Fisilau Leone; Andrea Tora; Michael Sanders, David Perbey
Our reference:	PA1922-RHD-MEM-0029
Classification:	Confidential

Subject: **December Mission – 16/20**

These notes were compiled by David Perbey following the Mission in Nuku'alofa from 16 to 20/12.

The following meetings and workshops were held during the mission:

- Workshop with PAT and MOI (Tuesday at 12.30 am)
- Consultation with Navy (Tuesday at 3.00pm)
- Meeting with Fletcher (Wednesday at 8.30am)
- Visit of Ahononou plant (Wednesday at 11.00 am)
- Visit of Vuna Wharf (Wednesday at 3.00 pm)
- Meeting with PAT (Thursday at 8.30 am)
- Visit of Royco Ready Mix Plant (Thursday at 11.00 am)
- Consultation with Fishing Club (Thursday at 4.00pm)

Notes from the meeting with Fletcher and the visit to Vuna Wharf are not included herein, as they are not relevant to the EIA.

Workshop MOI and PAT – 17/12

- The workshop was organised to discuss the recommendation provided by RHDHV regarding Wharf 2 extension structure and type of pavement to be used in the yard.
- MOI explained that their main criteria for Wharf extension option are:
    - Construction cost
    - Safe Operation
    - Maintenance cost
    - Safety

<u>Wharf 2 Extension</u>

- MOI raised their concerns regarding the suspended deck structure durability based on recent experience with QSIW Wharf 1.
- RHDHV explained the difference with Wharf 1:

  - Wharf 1 is more exposed to wave from North-East compare to Wharf 2 extension which is the most sheltered location of the site.
  - Wharf 1 has a revetment and old vertical wall underneath the slab against which wave are crashing, projecting splashing seawater on the concrete soffit.
  - It is believed that the concrete mix used was inadequate including very porous limestone aggregate with low density concrete.

- RHDHV explained that additional protection measures will be included on the extension design to avoid similar outcome:
  - Silane coating
  - Imported slab element with high quality marine concrete
  - Galvanised reinforcement
  - and/or Plastic sheeting incorporated on the slab soffit.
- PAT mention that maintenance and inspection of the Suspended deck structure could be undertaken from a small boat at low tide, while most of the maintenance for a sheet pile wall was going to be under water (large face of steel pile vs few piles) requiring commercial diver which are not currently available in Tonga.
- MOI and PAT are in line with the wharf structure recommendation, as impact on operation, construction cost and timeframe are the lowest of all the options.

Follow-up action: MOI instructed RHDHV to proceed with the Option 1 – Suspended Deck pile for the Detailed Design.

Yard Pavement

- PAT has still reservation with the Block pavers due to tyre wear and fuel consumption.
- RHDHV explained that based on PAT financial record, the fuel consumption of reachstacker is by far the main operational cost. Eco-driving and use of truck-trailer should be encouraged to cost reduction and the type of pavement has little impact in comparison.
- MOI explained that they tried Block pavers for the outer island ports in the past and that they have since reinstalled Rigid Concrete Pavement due to numerous challenges encountered in term of maintenance.
- RHDHV explained that Rigid Concrete Pavement offer the best durability and require the lesser maintenance, however the area concerns for the QSIW yard makes this option very expensive in term of initial construction cost.
- PAT explained that the Flexible Asphalt pavement installed 2-3 years are not performing well and is already in need of replacement due to puncture with container castings. The type of asphalt currently provided in Tonga in Cold-mix Asphalt which is of much lower quality than the Hot-mix Asphalt used for the TBU airport refurbishment.
- RHDHV explained that the lack of plant to produce Hot-mix Asphalt will be an issue as mobilisation of such equipment will be potentially required every 5 years, which will have a significant impact in term of cost.

- MOI are currently looking into procuring such Hot-mix Asphalt plant which will allow local workforce to undertake refurbishment.

Follow-up action: MOI has instructed RHDHV to proceed with an option composed of Flexible Asphalt Pavement for the circulation/access and Rigid Concrete Pavement under stacking areas

Consultation with Navy – 17/12

- RHDHV presented the selected Layout to Paul Ryan RAN rep who has seen the previous Options in May.
- They have raised no concerns with the option as most of the development is located on the Western side.
- Additionally, the East Mooring Dolphin of Wharf 1 is inline with the existing shoreline (80-100m from Wharf 1 Eastern edge) which is not blocking access to the Channel.
- Without providing futher details, Navy confirmed that their future extension plan has no impact on the QSIW.
- Further explanation was made by RHDHV regarding potential impact during construction which will be the noise during pilling and traffic (min impact).
- Captain Paul Ryan is leaving his position in Tonga end of December and will be replaced in January.

Follow-up action: Proposed development has no impact; however, it is recommended to meet and inform the new Navy representative in 2020.

Visit to Ahononou Plant – 18/12

- This quarry was previously owned by MOI but they closed it due lack of ongoing work and a chance in their policy toward privatisation.
- Since 2016 the quarry is leased by MOI to private operator.
- The aggregate produced by the quarry are currently been used for the TBU runway upgrade.
- Large rocks were produced out of the quarry for the Domestic terminal in 2016 (up to 2.0t rock).
- Large Blocks are detached from the rock face, using dynamite which are carried by truck into a crusher.
- White blocks which are denser and stronger, can be drilled to insert dynamite. Block of lesser quality (light brown colour) too soft to be drilled and remain inside the quarry.
- The capacity of the quarry is limited by the transport of the material to site – relying on 6 trucks.
- Daily capacity varies between 200 to 400 m3.
- Aggregate size delivered are 13mm to 20mm.
- Wet season is challenge for mining and crushing as it softens the rock.
- Rock and aggregate are to be pre-ordered prior the season or/and store under sheltered (none currently). The supply will not be reliable at that period of the year.
- For previous projects in town (Domestic Terminal – 800m away from QSIW), delivery were organised early morning or late night to minimise impact. However, it is not anticipated that traffic is likely to be an issue as there is direct access to QSIW from the By-pass.

- An alternative will consist in stock pilling onsite as done for the Domestic terminal in 2016. It will be noted that a concrete batching plant was as well set-up for this project.
- There is test certificate available for the aggregate regarding mechanical properties – however it is not likely for the chemical composition.
- Minimal quality check is undertaken at site and crusher is relatively small.

Follow-up action: Further information regarding chemical testing of the aggregate should be requested.

Meeting with PAT– 19/12

- PAT mentioned that block pavers were not going to be adequate due to NZ quarantine rules imposing to store empties on concrete pavement only.
- PAT would like to have ideally concrete pavement everywhere on the yard. However they understand that cost vs project budget could be an issue.
- They therefore see the alternative of providing Flexible pavement on the access road as acceptable. Block pavers and/or asphalt on the whole yard area not been adequate for quarantine requirement reasons.
- The key items to be covered by the project are:
    - Wharf 2 extension
    - Pavement
    - Lighting
    - Firefighting
- Government of Tonga should be able to provide small contribution regarding Smart Port items such as CCTV and Fuel consumption monitoring.
- There is local capacity for small quantity of pavers but currently only for light traffic pavement.
- RHDHV explained that the wharf 2 could be raised by 0.75m but this would impact the seismic capacity of the structure.
- PAT instructed RHDHV to not proceed with this Option. Their main concern in term of sea level rise concern the vessel movement during off-loading using their ship gear.
- RHDHV explained that Super Cone Fender using large panel extending above deck level will reduce this issue. The new fenders which are similar to the one used at the Vuna Wharf provide a much larger and overall higher contact area with the ship hull than the existing arch fenders.
- RHDHV has proposed to install a seawall similar to the Domestic Terminal on the east side of the yard to minimise impact of sea-level rise as this section of the yard is the lowest but as well the most exposed to swell and wind waves.
- PAT raised their concern regarding the condition of Vuna Wharf piles which shows already sign of corrosion 7 years after construction.
- RHDHV explained that the steel was used as casing for the reinforced concrete column inside and therefore the steel was not coated or protected with jacket or anode. While this is not aesthetically attractive, it has no issue on the overall capacity of the piles. Wharf 2 extension will have coated pile, anodes and jackets provided.

- PAT and RHDHV discussed the implication of Tsunami to the terminal. It is understood that the existing wharves are not designed to resist Tsunami and arguably the earthquake creating the Tsunami in first place will is mostly irremediably damage the wharves.
- Based on Domestic terminal, inclusion on the design could be made for emergency operation for the aftermath – such as providing a generator above the substation to a higher ground level than the expected inundation to provide electricity at site.

Follow-up action: PAT has instructed RHDHV to not pursue height increase of the wharf 2. Additional information should be requested with MEIDECC regarding Tsunami.

Visit of Royco Ready Mix Plant – 19/12

- This plant was originally set-up in 1976. Upgrade in 93 with introduction of weight scale to comply with AS/NZ standard.
- Capacity of 20m3/h but no enough truck to deliver.
- Based on 5 trucks available, capacity is around 200-300m3/day.
- Concrete was used for the Domestic terminal project (2016), TBU airport Tower (2016) and is currently used for the TBC early warning communication system and MEIDECC building.
- 1,500m3 delivered over the last 6 months for the Early warning system for DAI Nippon Construction. They are using aggregate from YenGin quarry.
- In 2012, they have provided 500m3 in 7 days for new pavement at the QSIW site.
- GP cement with limestone aggregate, crusher dust/powder is used.
- Blended cement was used occasionally for special concrete but quality was too inconsistent and this option was abandoned since. Royco has since provided only general-purpose concrete.
- Beach sand was stopped to be used in 2006 due shortage and is since banned to extract sand from seabed or beach because of environmental issues.
- Additionally, sand needed to be washed which was very labour intensive.
- River aggregate and sand could be imported from Fiji; however, testing will be required to redefined adequate mix composition.
- Aggregate are known to be porous, very several test results available regarding density but none for chemical analysis.
- Delivery can be undertaken early morning or evening to avoid traffic in town and Hycol admixture can be added as retardant.
- Wet season has impact on delivery of aggregate and import of cement.
- The plant is equipped with generator, store spare and has an in-house mechanic.
- Compressive strength is undertaken onsite.
- Lack of quality control (Water added by hose directly in truck) and safety (PPE).

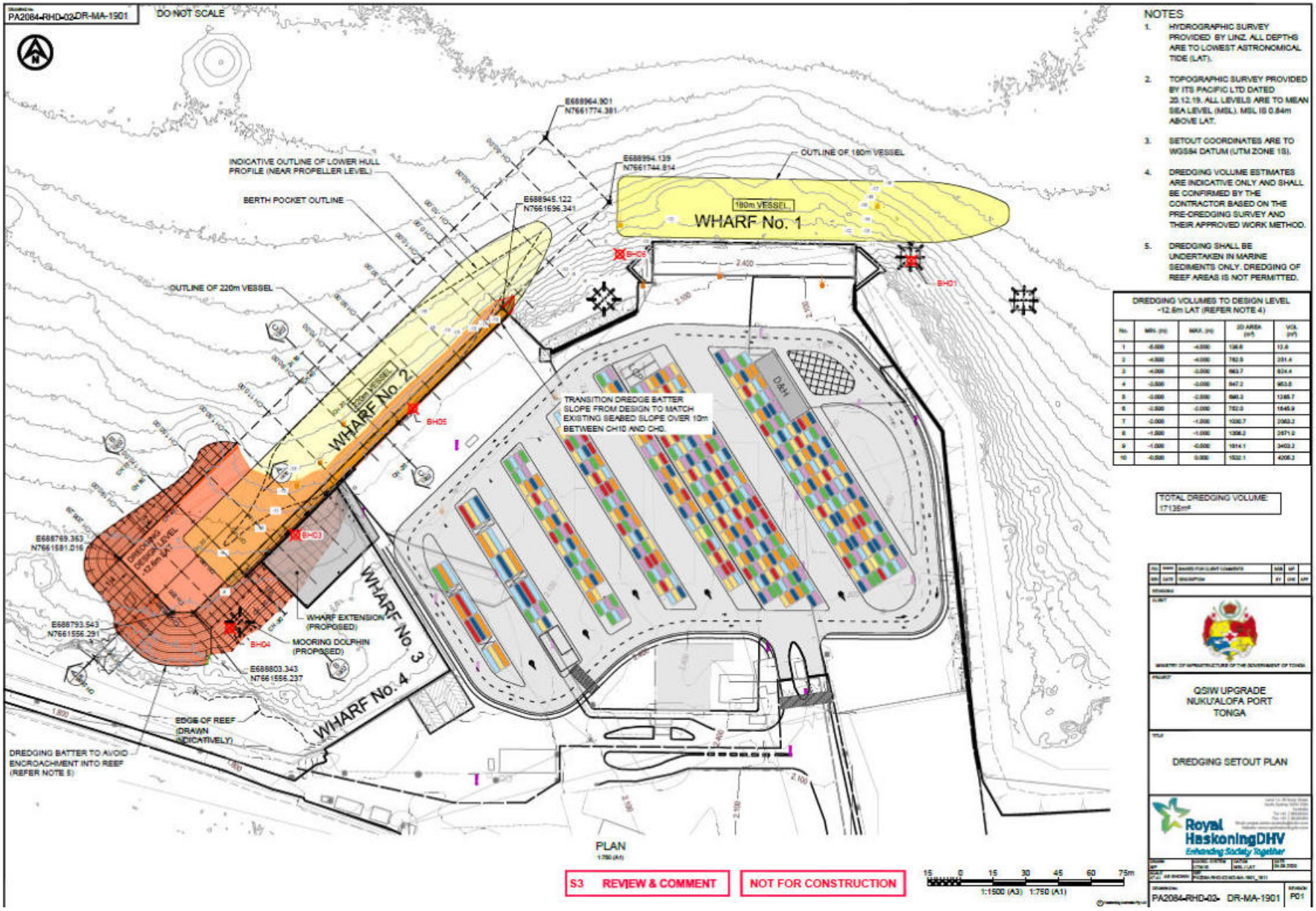
Follow-up action: None

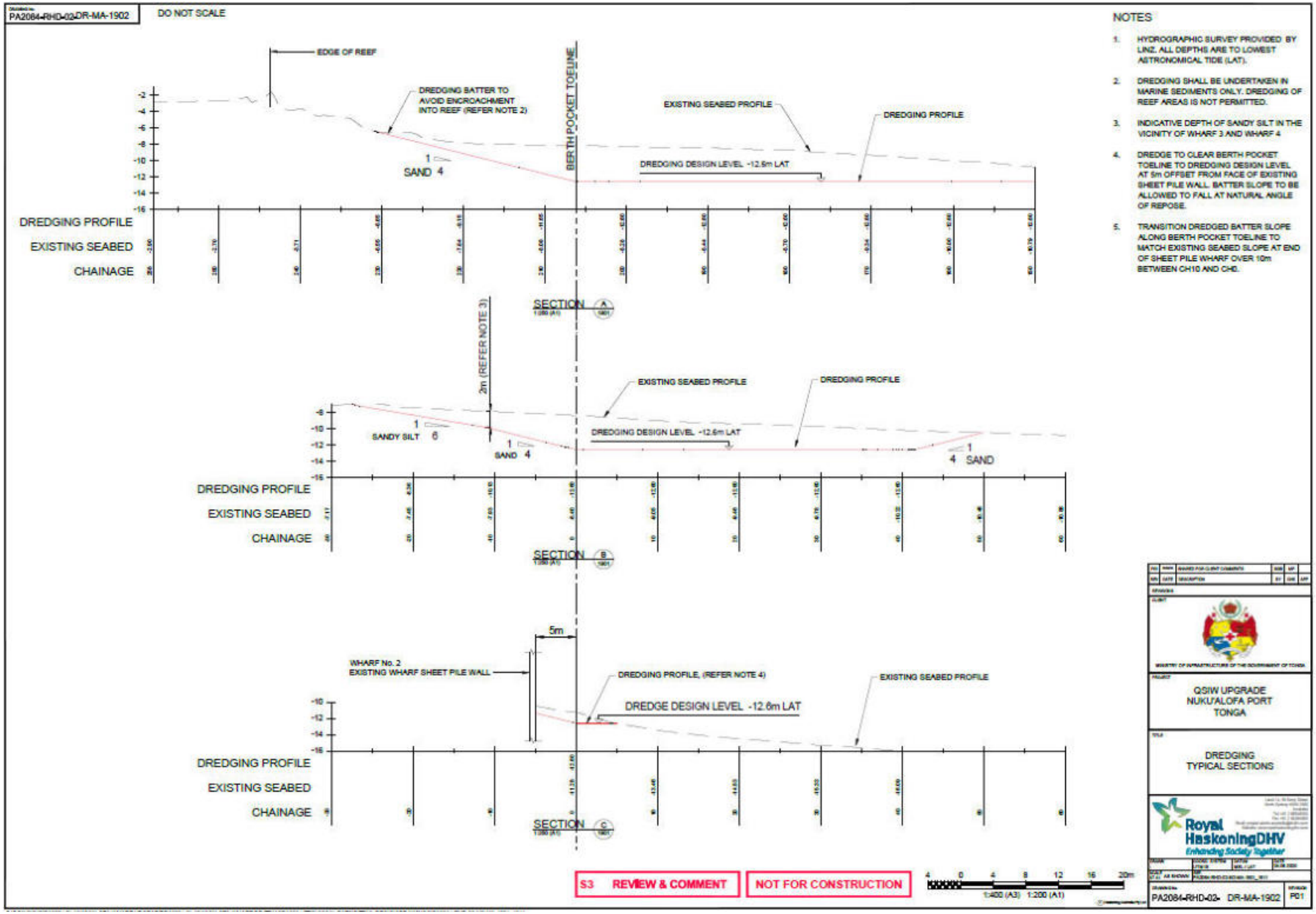
Consultation with Fishing Club – 19/12

- RHDHV presented the selected Layout to Fishing Club representative.
- Proposed layout was received positively.
- Fishing Club representative raised concern regarding relocation of the club.
- RHDHV explained that the new boundaries were in line with the existing Domestic terminal and that the road access to the fishing club and private mooring on the Faua Breakwater will remain.
- Further explanation was made by RHDHV regarding potential impact during construction which will be the noise during pilling and traffic as the ex-FISA office will be most likely used for contractor as site office.

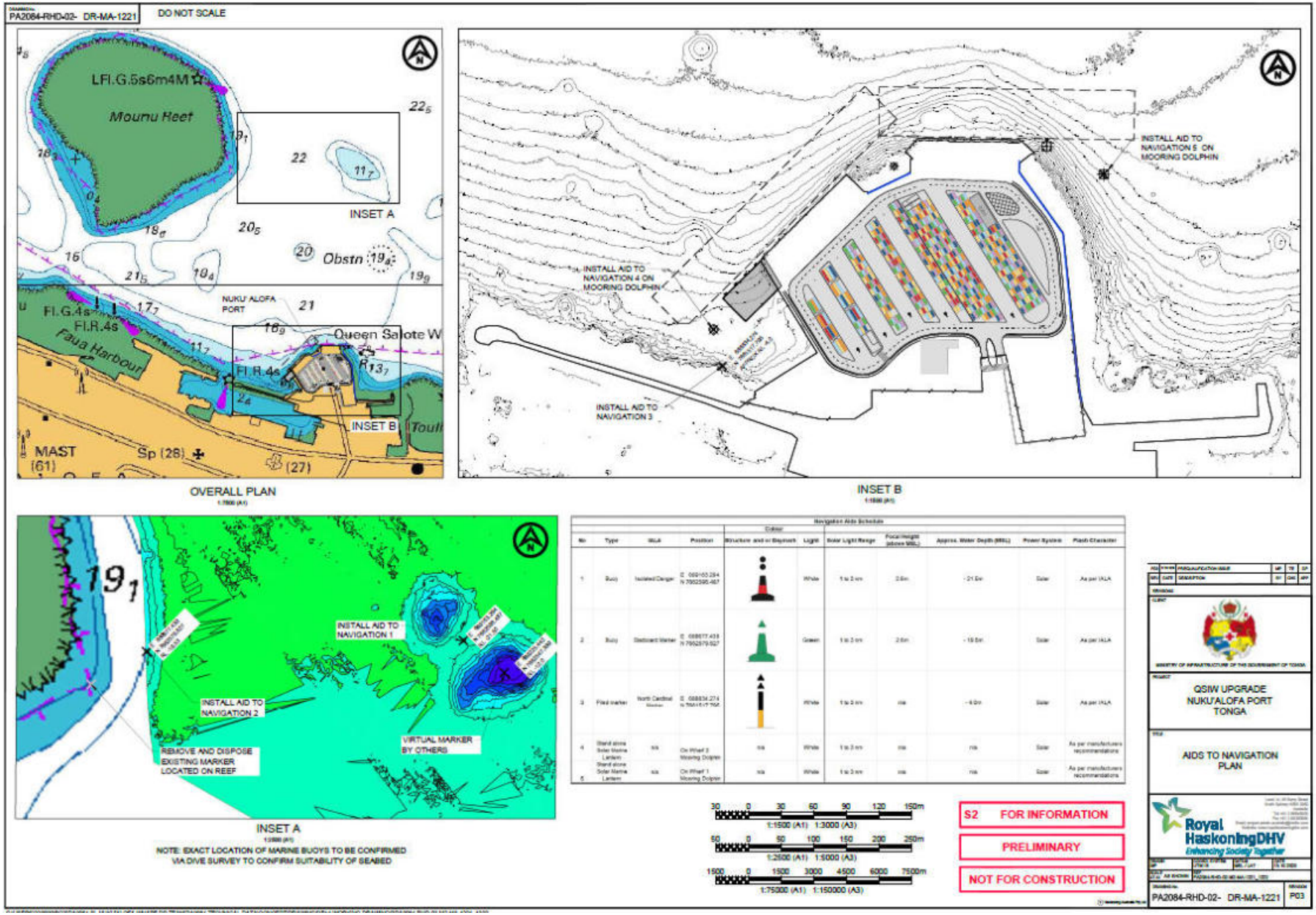
Follow-up action: None

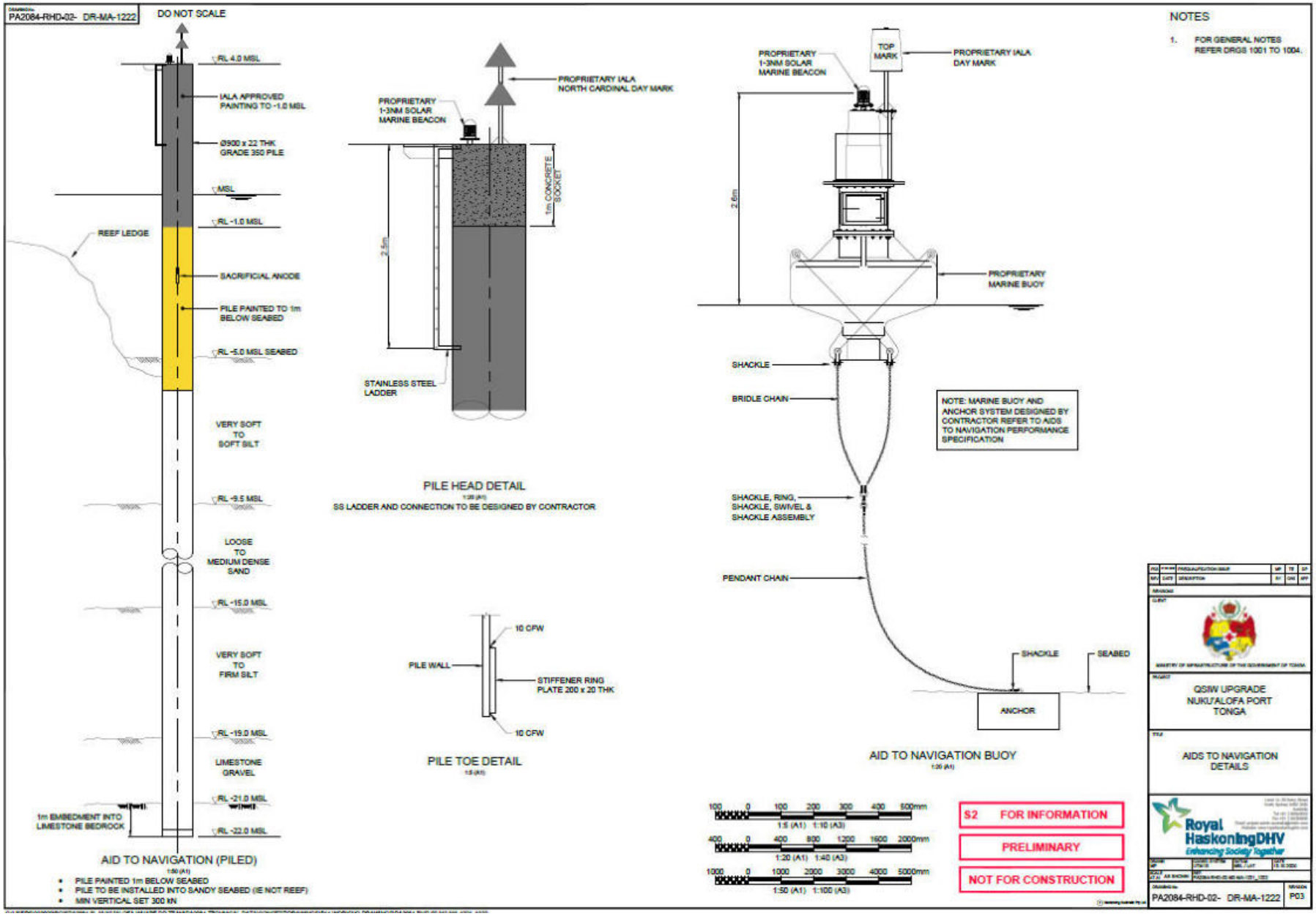
Annex 2: Drawings

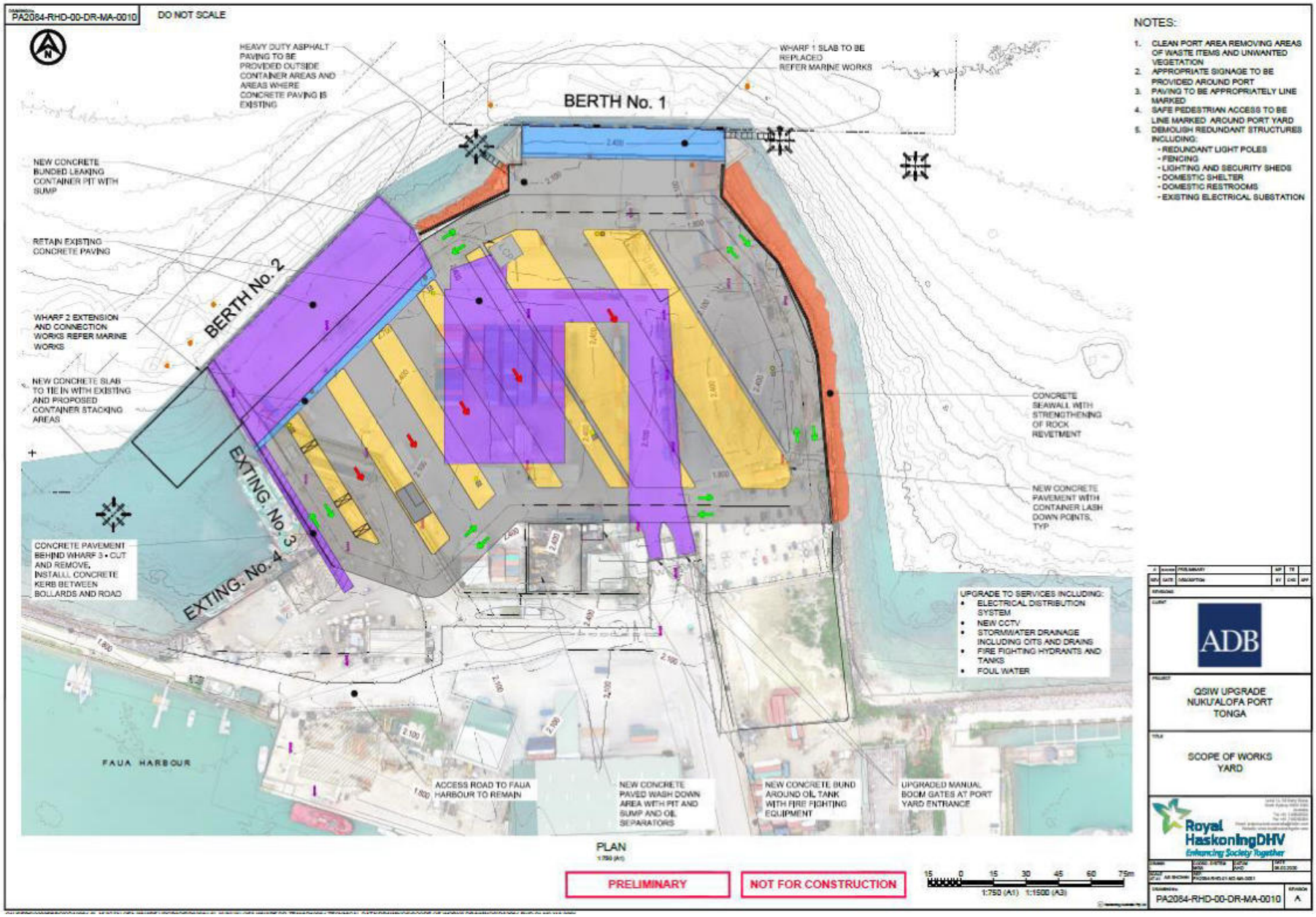

PA2064-RHD-02-DR-MA-1901
DO NOT SCALE
NOTES
1. HYDROGRAPHIC SURVEY PROVIDED BY LINZ. ALL DEPTHS ARE TO LOWEST ASTRONOMICAL TIDE (LAT).
2. TOPOGRAPHIC SURVEY PROVIDED BY ITS PACIFIC LTD DATED 20.12.19. ALL LEVELS ARE TO MEAN SEA LEVEL (MSL). MSL IS 0.84m ABOVE LAT.
3. SETOUT COORDINATES ARE TO WGS84 DATUM (UTM ZONE 1S).
4. DREDGING VOLUME ESTIMATES ARE INDICATIVE ONLY AND SHALL BE CONFIRMED BY THE CONTRACTOR BASED ON THE PRE-DREDGING SURVEY AND THEIR APPROVED WORK METHOD.
5. DREDGING SHALL BE UNDERTAKEN IN MARINE SEDIMENTS ONLY. DREDGING OF REEF AREAS IS NOT PERMITTED.
DREDGING VOLUMES TO DESIGN LEVEL -12.6m LAT (REFER NOTE 4)
TOTAL DREDGING VOLUME: 17135m³
INDICATIVE OUTLINE OF LOWER HULL PROFILE (NEAR PROPELLER LEVEL)
BERTH POCKET OUTLINE
OUTLINE OF 220m VESSEL
OUTLINE OF 180m VESSEL
220m VESSEL
180m VESSEL
WHARF No. 1
WHARF No. 2
WHARF No. 3
WHARF No. 4
WHARF EXTENSION (PROPOSED)
MOORING DOLPHIN (PROPOSED)
TRANSITION DREDGE BATTER SLOPE FROM DESIGN TO MATCH EXISTING SEABED SLOPE OVER 10m BETWEEN CH10 AND CH0.
DREDGING DESIGN LEVEL -12.6m LAT
EDGE OF REEF (DRAWN INDICATIVELY)
DREDGING BATTER TO AVOID ENCROACHMENT INTO REEF (REFER NOTE 5)
E688964.901 N7661774.381
E688964.139 N7661744.814
E688945.122 N7661696.341
E688769.363 N7661581.016
E688793.543 N7661556.291
E688803.343 N7661556.237
BH01
BH02
BH03
BH04
BH05
PLAN
S3 REVIEW & COMMENT
NOT FOR CONSTRUCTION
1:1500 (A3) 1:750 (A1)
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
DREDGING SETOUT PLAN
Royal HaskoningDHV
Enhancing Society Together
PA2064-RHD-02- DR-MA-1901
P01

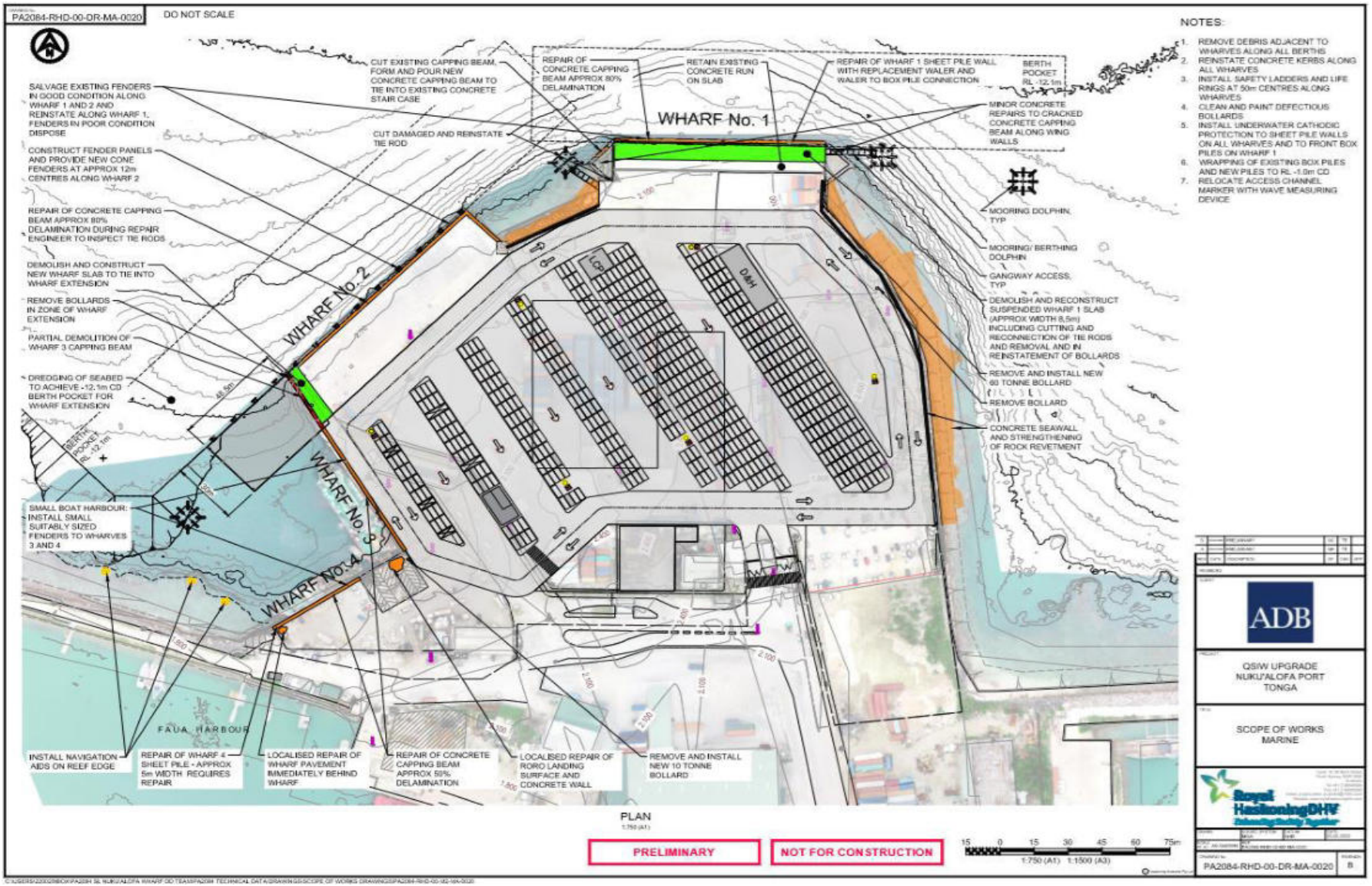

PA2084-RHD-02-DR-MA-1902
DO NOT SCALE
NOTES
1. HYDROGRAPHIC SURVEY PROVIDED BY LINZ. ALL DEPTHS ARE TO LOWEST ASTRONOMICAL TIDE (LAT).
2. DREDGING SHALL BE UNDERTAKEN IN MARINE SEDIMENTS ONLY. DREDGING OF REEF AREAS IS NOT PERMITTED.
3. INDICATIVE DEPTH OF SANDY SILT IN THE VICINITY OF WHARF 3 AND WHARF 4
4. DREDGE TO CLEAR BERTH POCKET TOELINE TO DREDGING DESIGN LEVEL AT 5m OFFSET FROM FACE OF EXISTING SHEET PILE WALL. BATTER SLOPE TO BE ALLOWED TO FALL AT NATURAL ANGLE OF REPOSE.
5. TRANSITION DREDGED BATTER SLOPE ALONG BERTH POCKET TOELINE TO MATCH EXISTING SEABED SLOPE AT END OF SHEET PILE WHARF OVER 10m BETWEEN CH10 AND CH0.
EDGE OF REEF
DREDGING BATTER TO AVOID ENCROACHMENT INTO REEF (REFER NOTE 2)
BERTH POCKET TOELINE
EXISTING SEABED PROFILE
DREDGING PROFILE
DREDGING DESIGN LEVEL -12.6m LAT
SAND 4
DREDGING PROFILE
EXISTING SEABED
CHAINAGE
SECTION A
2m (REFER NOTE 3)
EXISTING SEABED PROFILE
DREDGING PROFILE
DREDGING DESIGN LEVEL -12.6m LAT
SANDY SILT 6
SAND 4
4 SAND
DREDGING PROFILE
EXISTING SEABED
CHAINAGE
SECTION B
5m
WHARF No. 2
EXISTING WHARF SHEET PILE WALL
DREDGING PROFILE, (REFER NOTE 4)
EXISTING SEABED PROFILE
DREDGE DESIGN LEVEL -12.6m LAT
DREDGING PROFILE
EXISTING SEABED
CHAINAGE
SECTION C
S3 REVIEW & COMMENT
NOT FOR CONSTRUCTION
1:400 (A3) 1:200 (A1)
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
DREDGING
TYPICAL SECTIONS
Royal HaskoningDHV
Enhancing Society Together
PA2084-RHD-02- DR-MA-1902
P01


PA2084-RHD-02-DR-MA-1910
DO NOT SCALE
WHARF No.1
WHARF No.2
WHARF No.4
HARBOUR ENTRANCE
QUEEN SALOTE
INTERNATIONAL WHARF
POTENTIAL ONSHORE
TRANSFER WHARF
EQUIPMENT
SHED
OFFICE
BUILDING
AREA
B
ALTERNATIVE
DREDGED MATERIAL
STORAGE AREA
FAUA BOAT HARBOUR
AREA
A
PREFERRED DREDGED
MATERIAL STORAGE
AREA
POTENTIAL ONSHORE
TRANSFER WHARF
VUNA ROAD
S3 REVIEW & COMMENT
NOT FOR CONSTRUCTION
1:2500 (A3) 1:1250 (A1)
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
DREDGED MATERIAL
STORAGE AND ONSHORE
FACILITIES
Royal HaskoningDHV
Enhancing Society Together
PA2084-RHD-02- DR-MA-1910
P01


PA2084-RHD-02- DR-MA-1221
DO NOT SCALE
LFl.G.5s6m4M
Mounu Reef
INSET A
Obstn
NUKU'ALOFA PORT
Fl.G.4s
Fl.R.4s
Faua Harbour
Queen Salote W
INSET B
MAST
Sp (28)
(27)
OVERALL PLAN
INSTALL AID TO NAVIGATION 5 ON MOORING DOLPHIN
INSTALL AID TO NAVIGATION 4 ON MOORING DOLPHIN
INSTALL AID TO NAVIGATION 3
INSET B
INSTALL AID TO NAVIGATION 1
INSTALL AID TO NAVIGATION 2
REMOVE AND DISPOSE EXISTING MARKER LOCATED ON REEF
VIRTUAL MARKER BY OTHERS
INSET A
NOTE: EXACT LOCATION OF MARINE BUOYS TO BE CONFIRMED VIA DIVE SURVEY TO CONFIRM SUITABILITY OF SEABED
Navigation Aids Schedule
1:1500 (A1) 1:3000 (A3)
1:2500 (A1) 1:5000 (A3)
1:75000 (A1) 1:150000 (A3)
S2 FOR INFORMATION
PRELIMINARY
NOT FOR CONSTRUCTION
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
AIDS TO NAVIGATION PLAN
Royal HaskoningDHV
Enhancing Society Together
PA2084-RHD-02- DR-MA-1221
P03


PA2084-RHD-02- DR-MA-1222
DO NOT SCALE
RL 4.0 MSL
IALA APPROVED PAINTING TO -1.0 MSL
Ø900 x 22 THK GRADE 350 PILE
MSL
RL -1.0 MSL
REEF LEDGE
SACRIFICIAL ANODE
PILE PAINTED TO 1m BELOW SEABED
RL -5.0 MSL SEABED
VERY SOFT TO SOFT SILT
RL -9.5 MSL
LOOSE TO MEDIUM DENSE SAND
RL -15.0 MSL
VERY SOFT TO FIRM SILT
RL -19.0 MSL
LIMESTONE GRAVEL
RL -21.0 MSL
1m EMBEDMENT INTO LIMESTONE BEDROCK
RL -22.0 MSL
AID TO NAVIGATION (PILED)
1:50 (A1)
PILE PAINTED 1m BELOW SEABED
PILE TO BE INSTALLED INTO SANDY SEABED (IE NOT REEF)
MIN VERTICAL SET 300 kN
PROPRIETARY IALA NORTH CARDINAL DAY MARK
PROPRIETARY 1-3NM SOLAR MARINE BEACON
1m CONCRETE SOCKET
2.5m
STAINLESS STEEL LADDER
PILE HEAD DETAIL
1:20 (A1)
SS LADDER AND CONNECTION TO BE DESIGNED BY CONTRACTOR
10 CFW
PILE WALL
STIFFENER RING PLATE 200 x 20 THK
10 CFW
PILE TOE DETAIL
1:5 (A1)
TOP MARK
PROPRIETARY IALA DAY MARK
PROPRIETARY 1-3NM SOLAR MARINE BEACON
2.6m
PROPRIETARY MARINE BUOY
SHACKLE
BRIDLE CHAIN
NOTE: MARINE BUOY AND ANCHOR SYSTEM DESIGNED BY CONTRACTOR REFER TO AIDS TO NAVIGATION PERFORMANCE SPECIFICATION
SHACKLE, RING, SHACKLE, SWIVEL & SHACKLE ASSEMBLY
PENDANT CHAIN
SHACKLE
SEABED
ANCHOR
AID TO NAVIGATION BUOY
1:20 (A1)
NOTES
1. FOR GENERAL NOTES REFER DRGS 1001 TO 1004.
100 0 100 200 300 400 500mm
1:5 (A1) 1:10 (A3)
400 0 400 800 1200 1600 2000mm
1:20 (A1) 1:40 (A3)
1000 0 1000 2000 3000 4000 5000mm
1:50 (A1) 1:100 (A3)
S2 FOR INFORMATION
PRELIMINARY
NOT FOR CONSTRUCTION
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
AIDS TO NAVIGATION DETAILS
Royal HaskoningDHV
Enhancing Society Together
PA2084-RHD-02- DR-MA-1222
P03


PA2084-RHD-00-DR-MA-0010
DO NOT SCALE
NOTES:
1. CLEAN PORT AREA REMOVING AREAS OF WASTE ITEMS AND UNWANTED VEGETATION
2. APPROPRIATE SIGNAGE TO BE PROVIDED AROUND PORT
3. PAVING TO BE APPROPRIATELY LINE MARKED
4. SAFE PEDESTRIAN ACCESS TO BE LINE MARKED AROUND PORT YARD
5. DEMOLISH REDUNDANT STRUCTURES INCLUDING:
- REDUNDANT LIGHT POLES
- FENCING
- LIGHTING AND SECURITY SHEDS
- DOMESTIC SHELTER
- DOMESTIC RESTROOMS
- EXISTING ELECTRICAL SUBSTATION
HEAVY DUTY ASPHALT PAVING TO BE PROVIDED OUTSIDE CONTAINER AREAS AND AREAS WHERE CONCRETE PAVING IS EXISTING
WHARF 1 SLAB TO BE REPLACED REFER MARINE WORKS
BERTH No. 1
NEW CONCRETE BUNDED LEAKING CONTAINER PIT WITH SUMP
RETAIN EXISTING CONCRETE PAVING
BERTH No. 2
WHARF 2 EXTENSION AND CONNECTION WORKS REFER MARINE WORKS
NEW CONCRETE SLAB TO TIE IN WITH EXISTING AND PROPOSED CONTAINER STACKING AREAS
EXTING. No. 3
EXTING. No. 4
CONCRETE PAVEMENT BEHIND WHARF 3 - CUT AND REMOVE, INSTALL CONCRETE KERB BETWEEN BOLLARDS AND ROAD
CONCRETE SEAWALL WITH STRENGTHENING OF ROCK REVETMENT
NEW CONCRETE PAVEMENT WITH CONTAINER LASH DOWN POINTS, TYP
UPGRADE TO SERVICES INCLUDING:
• ELECTRICAL DISTRIBUTION SYSTEM
• NEW CCTV
• STORMWATER DRAINAGE INCLUDING OITS AND DRAINS
• FIRE FIGHTING HYDRANTS AND TANKS
• FOUL WATER
FAUA HARBOUR
ACCESS ROAD TO FAUA HARBOUR TO REMAIN
NEW CONCRETE PAVED WASH DOWN AREA WITH PIT AND SUMP AND OIL SEPARATORS
NEW CONCRETE BUND AROUND OIL TANK WITH FIRE FIGHTING EQUIPMENT
UPGRADED MANUAL BOOM GATES AT PORT YARD ENTRANCE
PLAN
1:750 (A1)
PRELIMINARY
NOT FOR CONSTRUCTION
15 0 15 30 45 60 75m
1:750 (A1) 1:1500 (A3)
ADB
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
SCOPE OF WORKS
YARD
Royal HaskoningDHV
Enhancing Society Together
PA2084-RHD-00-DR-MA-0010
A


PA2084-RHD-00-DR-MA-0020
DO NOT SCALE
NOTES:
1. REMOVE DEBRIS ADJACENT TO WHARVES ALONG ALL BERTHS
2. REINSTATE CONCRETE KERBS ALONG ALL WHARVES
3. INSTALL SAFETY LADDERS AND LIFE RINGS AT 50m CENTRES ALONG WHARVES
4. CLEAN AND PAINT DEFECTIOUS BOLLARDS
5. INSTALL UNDERWATER CATHODIC PROTECTION TO SHEET PILE WALLS ON ALL WHARVES AND TO FRONT BOX PILES ON WHARF 1
6. WRAPPING OF EXISTING BOX PILES AND NEW PILES TO RL -1.0m CD
7. RELOCATE ACCESS CHANNEL MARKER WITH WAVE MEASURING DEVICE
SALVAGE EXISTING FENDERS IN GOOD CONDITION ALONG WHARF 1 AND 2 AND REINSTATE ALONG WHARF 1. FENDERS IN POOR CONDITION DISPOSE
CONSTRUCT FENDER PANELS AND PROVIDE NEW CONE FENDERS AT APPROX 12m CENTRES ALONG WHARF 2
REPAIR OF CONCRETE CAPPING BEAM APPROX 80% DELAMINATION DURING REPAIR ENGINEER TO INSPECT TIE RODS
DEMOLISH AND CONSTRUCT NEW WHARF SLAB TO TIE INTO WHARF EXTENSION
REMOVE BOLLARDS IN ZONE OF WHARF EXTENSION
PARTIAL DEMOLITION OF WHARF 3 CAPPING BEAM
DREDGING OF SEABED TO ACHIEVE -12.1m CD BERTH POCKET FOR WHARF EXTENSION
BERTH POCKET RL -12.1m
CUT EXISTING CAPPING BEAM, FORM AND POUR NEW CONCRETE CAPPING BEAM TO TIE INTO EXISTING CONCRETE STAIR CASE
CUT DAMAGED AND REINSTATE TIE ROD
REPAIR OF CONCRETE CAPPING BEAM APPROX 80% DELAMINATION
RETAIN EXISTING CONCRETE RUN ON SLAB
REPAIR OF WHARF 1 SHEET PILE WALL WITH REPLACEMENT WALER AND WALER TO BOX PILE CONNECTION
BERTH POCKET RL -12.1m
WHARF No. 1
WHARF No. 2
WHARF No. 3
WHARF No. 4
MINOR CONCRETE REPAIRS TO CRACKED CONCRETE CAPPING BEAM ALONG WING WALLS
MOORING DOLPHIN, TYP
MOORING/ BERTHING DOLPHIN
GANGWAY ACCESS, TYP
DEMOLISH AND RECONSTRUCT SUSPENDED WHARF 1 SLAB (APPROX WIDTH 8.5m) INCLUDING CUTTING AND RECONNECTION OF TIE RODS AND REMOVAL AND IN REINSTATEMENT OF BOLLARDS
REMOVE AND INSTALL NEW 60 TONNE BOLLARD
REMOVE BOLLARD
CONCRETE SEAWALL AND STRENGTHENING OF ROCK REVETMENT
SMALL BOAT HARBOUR: INSTALL SMALL SUITABLY SIZED FENDERS TO WHARVES 3 AND 4
FAUA HARBOUR
INSTALL NAVIGATION AIDS ON REEF EDGE
REPAIR OF WHARF 4 SHEET PILE - APPROX 5m WIDTH REQUIRES REPAIR
LOCALISED REPAIR OF WHARF PAVEMENT IMMEDIATELY BEHIND WHARF
REPAIR OF CONCRETE CAPPING BEAM APPROX 50% DELAMINATION
LOCALISED REPAIR OF RORO LANDING SURFACE AND CONCRETE WALL
REMOVE AND INSTALL NEW 10 TONNE BOLLARD
PLAN
1:750 (A1)
PRELIMINARY
NOT FOR CONSTRUCTION
15 0 15 30 45 60 75m
1:750 (A1) 1:1500 (A3)
ADB
QSIW UPGRADE
NUKU'ALOFA PORT
TONGA
SCOPE OF WORKS
MARINE
Royal HaskoningDHV
PA2084-RHD-00-DR-MA-0020
B