



Government of the Republic of Nauru

Nauru Port Pre-Feasibility Study

Final Report

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Nauru Port Pre-Feasibility Study

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This report was prepared by Doug Oldfield, Robert Brown, Christine Chan and John Carter as individual consultants under the guidance and support of the Pacific Region Infrastructure Facility (PRIF) in Sydney, Australia.

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Executive Summary

E1 Introduction

This Report presents the detailed assessment prepared by the Study Team for the Nauru Port Pre-Feasibility Study.

Although potential options to upgrade the port facilities at Nauru have been previously investigated by various development partners, no improvements at the port have been progressed in recent years and the state and operation of the existing port facility continues to present occupational health and safety issues, capacity limitations, and challenges to the import and export of goods and cargo.

The Government of Nauru requested technical assistance from the Pacific Region Infrastructure Facility (PRIF) to investigate feasible options for improvement of the port facilities in the short to medium, in order to progress a solution to address these challenges in the coming years.

E2 Study Objectives

The objectives of the Study are to:

- Determine a preferred port development option for implementation;
- Investigate the economic viability of the options to support partner investment;
- Provide guidance on key risks and activities for future project preparatory technical assistance (PPTA) preparation.

E3 Study Scope

The Terms of Reference of the Study are included in Appendix A. The scope has involved the detailed assessment of the technical, operational, economic, environmental and social aspects of three (3) options for the upgrade the existing port facility at Aiwo, on the west coast of Nauru. Other options have been discussed only at a strategic level for the purpose of comparison of their feasibility.

The Study has involved preliminary investigations of the wave climate, and environmental and social aspects. A key element of the Study has also been to identify key risks to the future investment project and to outline activities required during future PPTA to minimise the risks and prepare the project for investment.

E4 Project Background

The current port facility is extremely run down and has occupational health and safety issues, capacity limitations, and is vulnerable to extreme and seasonal weather events. These poor port facilities induce high cost of consumables in the domestic market due to high cost in port handling and adversely affect bulk transportation of current and potential exports (phosphate, limestone aggregate and fish) and imports. The consequences of the failure of the port facility would be dire for the local economy, workplace and public safety, regional connectivity and the habitability of Nauru, as the port receives all cargo and bulk fuel vessels into Nauru and provides a critical link in a broader Pacific maritime network.

It is clear that there is no viable “do nothing” option given the criticality of the Nauru port. The Government of Nauru needs assistance to improve the situation and preliminary investigations have suggested that the estimated capital cost of required works is a significant investment in a country as small as Nauru. It has been difficult to identify feasible options with favourable investment parameters to encourage investment by any single donor. The case for co-ordination and partnering is therefore very strong, so that all donors can play a role in providing this lifeline to the people of Nauru at least cost.

E5 Situation Analysis

The existing port facilities present a number of challenges for safe, reliable and efficient operation. These challenges are discussed in detail in the report, particularly in Section 3, and are summarized here.

- *Unique hostile geography without a protected harbor* - Nauru does not have the benefit of a protected port facility, due to the unique geography of the island. The extremely deep water (3,000 m within 7 km of the coastline) and the existing port's exposed mooring location, very close to the fringing reef, make shipping and port operations difficult;
- *Condition and vulnerability of the existing mooring system, and associated delays and costs* - Overzealous mooring practices when anchoring general cargo vessels to the outer buoys have occasionally caused damage to components of the mooring system, which then requires costly repair work to be requisitioned from specialist overseas-based contractors. These incidents result in unscheduled closure of the mooring system, thereby delaying the berthing of phosphate vessels, fuel ships and general cargo ships, which causes unnecessary delays to the delivery of essential supplies such as fuels and general cargo goods, as well as delaying the export of phosphate with its attendant financial consequences.
- *Congested land area and backlog of empty containers* - The port land utilised for container storage is congested because a substantial area is occupied by derelict buildings serving no useful purpose. The remaining available space is predominantly occupied by empty containers which can't be exported because of poor ship loading/unloading efficiencies. A significant backlog of empty containers clogs both the port and vacant land across the island; and
- *Existing poor condition* – Existing poor condition of infrastructure and equipment such as vessels, work boats and rafts, and lifting equipment, creates operational inefficiencies and occupational health and safety issues.

E6 Summary of Previous Studies

A number of previous studies have been undertaken over the past six years (ADB/Oldfield, 2009; Bench & Kelly, 2012; JICA, 2014) and are summarized in Section 2 of the Report. While the scope and focus of these studies varied, a number of key themes and conclusions can be drawn from the previous work:

- The existing port buildings and sheds are derelict, unsafe and unserviceable, and should be demolished and replaced where necessary;
- When a new building is constructed, additional equipment such as new barges, crane and equipment should be considered;
- The most effective options to consider further are modest and involve a quay wall along the reef edge to the north or south of the existing harbour, or a semi-enclosed harbour basin;
- Some investment at Anibare Harbour could improve cargo and container handling and provide improved access and contingency during the monsoon months;
- Support for institutional reform, operational improvement, capacity building and asset management will also be vitally important.

E7 Port Development Options Investigated

Based on the preliminary and initial assessments previously undertaken, three options were proposed to be further investigated under this Pre-Feasibility Study:

- (i) **OPTION 1: A new quay wall constructed on the edge of the reef north of the existing harbour**, and accessible by causeway. While this scenario does not provide any opportunity for replacing the existing phosphate loading arrangements, and hence the high maintenance costs for the mooring buoy system will continue, this solution provides the initial stage for a future enclosed harbour development;
- (ii) **OPTION 2: A new enclosed harbour basin excavated from the reef and coastal land north of the existing boat harbour**. This basin is suitably sized to accommodate container and general cargo vessels, but not phosphate ships. The existing phosphate loading facilities therefore must be retained and maintained as at present; and

- (iii) **OPTION 3:** A new quay wall constructed on the edge of the reef beneath the phosphate cantilevers, to accommodate all vessels visiting Nauru, plus berthing dolphins to improve the berthing of phosphate ships.

The details of these options are discussed in detail in Section 5 and Section 7. Concept designs for these three options are presented in Appendix D, and repeated as Figures E1, E2 and E3 at the end of the Executive Summary for completeness.

These options are considered the most beneficial of those previously considered. Other potential options which have been discussed by stakeholders were also considered at high level in the Study. A no-project scenario has been considered for the purposes of the proposed economic evaluation. This is not a do-nothing scenario but one which allows the existing port facilities to continue with the existing plant and operational format. This operating scenario will inevitably include high cost demand for maintenance and continue with highly inefficient cargo handling operations.

A scenario where the mooring system could be removed and replaced with alternative means for holding phosphate ships in position beneath the cantilevers was also considered. The only alternative would be to provide two seagoing tugboats with adequate capacity to hold bulk ships in position. However, the capital, operating and maintenance costs of two large tugs, estimated to be A\$3.0 million in capital investment plus an annual operations and maintenance cost of A\$1.8 million, is not economically feasible. Nauru does not have the technical capacity to operate and maintain a fleet of tug boats. The mooring system serves Nauru better than any alternative arrangement at this time.

E8 Key Technical Aspects of Options Assessed

Option 1 is illustrated in Figure E1. The main features of this option include:

- a) A concrete block quay wall located on the outer edge of the reef, north of the Boat Harbour; to accommodate the design general cargo and fuel vessels.
- b) A rock causeway joining the port land adjacent to the Boat Harbour with the southern end of the quay wall, for access to move containers and general cargo directly from ship to shore, and to support new fuel pipelines to the tank farm;
- c) Retention of the anchored mooring buoys;
- d) Supply of three tractor-trailer units for transferring containers to/from the container yard;
- e) Demolition of old and derelict sheds and buildings, including disposal of asbestos cement cladding;
- f) Heavy duty pavement across the entire container yard area;
- g) New Harbourmaster's office and administration, ablution block and plant workshop;
- h) Site power reticulation, including reefer points and security lighting;
- i) Fire ring main and hydrants.

This Option also provides the potential for future expansion as the first phase of Option 2. Hence, this Option can be constructed now, and can be further expanded in the future with a second phase to construct the remaining works needed to complete Option 2.

Option 1 will permit all vessels visiting Nauru except dry bulk phosphate vessels to be relocated to the dedicated berth north of the Boat Harbour. This new berth will provide a facility which is suitable for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. These tractor-trailers will then transfer containers to the container yard where the large forklift truck places each container into the yard stack awaiting pick-up by the customer. Phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring/buoy system. Hence, the Port Authority must continue to maintain the moorings and buoys to maintain this phosphate loading capability.

Option 2 is illustrated in Figure E2. The main features of this option include:

- a) A concrete block quay wall located on the outer edge of the reef, north of the Boat Harbour, to accommodate general cargo and fuel vessels (identical in arrangement to Option 1);
- b) A rockfill causeway joining the port land adjacent to the Boat Harbour with the southern end of the quay wall, for access to move containers and general cargo directly from ship to shore, and to support new fuel pipelines to the tank farm (identical in arrangement to Option 1);
- c) A rockfill seawall along the outer edge of the reef, extending north from the end of the quay wall, and a rockfill seawall at the northern end, from the shoreline to the edge of the outer reef, to enclose a new harbour basin;
- d) Dredging of the reef to form a harbour basin measuring 400m long by 250m wide to a depth of 10 metres, with a swing basin to accommodate 100m LOA general cargo and fuel vessels;
- e) Supply of two tug boats, for manoeuvring the ships into and inside the basin;
- f) Container yard and building improvements as noted for Option 1.

Option 2 will permit all vessels visiting Nauru except dry bulk phosphate vessels to be berthed at the dedicated berth inside the harbour basin north of the Boat Harbour. This new berth will provide a facility adequate for loading/unloading containers and general cargo using ship's gear directly to the quay or loaded directly onto tractor-trailers. Ships will enter the harbour basin and swing in the turning basin before berthing at the berth located in the south-east corner of the basin. Two tug boats will need to be provided to assist vessels to enter the harbour basin, swing in the turning basin and berth at the harbour wharf. Phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring/buoy system. Hence, the NPA must continue to maintain the moorings and buoys to retain this phosphate loading capability. While the NPA will have the benefit of the use of the two tug boats, it would be prudent to maintain the mooring system in place as support and back-up for the phosphate vessels.

Option 3 is illustrated in Figure E3. The main features of this option include:

- a) A concrete block quay wall located on the outer edge of the reef, south of and between the Boat Harbour and the north cantilever, to accommodate dry bulk (phosphate), general cargo and fuel vessels. The average depth of the reef where this quay wall will be constructed is expected to be about 20 metres;
- b) A rock causeway joining the port land adjacent to the Boat Harbour with the northern end of the quay wall, for access to move containers and general cargo directly from ship to shore;
- c) Two concrete block mooring dolphins beneath and between the foundations of the two cantilevers, for safer berthing of dry bulk vessels for phosphate loading;
- d) Retention of the anchored mooring buoys, including relocation of A1 (combination) and A2 (span) buoys;
- e) Container yard and building improvements as noted for Options 1 and 2.

Option 3 will permit all vessels visiting Nauru, including dry bulk phosphate vessels, to share the dedicated berth and adjoining berthing dolphins south of the Boat Harbour. This new berth will provide a facility which is suitable for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. Bulk fuel ships will also use this berth, including the existing fuel transfer pipelines located on the cantilever.

Phosphate ships will also utilise the berth, and in calm conditions it is expected that little or no use of the mooring system will be required. Instead, phosphate ships will berth safely against the southern end of the new quay wall and the two berthing dolphins located between and beyond the cantilever foundations. In windy conditions it will be necessary to utilise the mooring system to assist with keeping the phosphate ship positioned during loading and for heaving off to reposition the ship when the cantilever spouts change hatches. Hence, it is essential that the mooring system be maintained in full operational condition at all times by the NPA as part of the facility for berthing and mooring all vessels. It cannot be assumed that this

quay wall and berthing dolphins configuration can operate safely in all permissible conditions without the availability of the mooring system.

E9 Environmental and Social Aspects

A high level assessment of existing environmental and social conditions, and the projected impacts of the three (3) proposed options was undertaken and is summarised in Section 9, with a detailed assessment report included in Appendix F.

The environmental assessment identifies the area south of the Boat Harbour (where the cantilevers are operating) as having the poorest environmental conditions at present, due mostly to degraded coral reefs (from cantilever operations and mooring buoy anchor chains), reduced air quality (at times, from phosphate dust), less beach stability (relative to the other locations), and exposure of existing infrastructure to extreme sea states. The most favourable environmental baseline at the moment is evident in the area north of the Boat Harbour which (most of the time) is not exposed to the effects of port operations. Option 1 is expected to produce the greatest extent of environmental degradation (relative to the baseline), since this will impose the impacts of port construction and operations on an area that is relatively immune to environmental degradation at present. Option 3 would make the already degraded environmental conditions in the area south of the Boat Harbour somewhat worse.

It is concluded that from an environmental impact perspective alone, the optimal port development option is Option 3 (south of the Boat Harbour), as it can accept some further environmental degradation without compromising adjacent areas. However, Option 1 has a modest footprint and will impart more impact than Option 3, but is still acceptable. Using the Rapid Environmental Assessment methodology, Option 1 and 3 are considered a Category B, while Option 2 is considered Category A.

The social assessment highlights that there are no impositions on local populations or social conditions for Options 1 or 3. On the other hand, Option 2, which would involve incursion into the derelict housing area (forcing involuntary resettlement) would have negative impacts on a wide range of social criteria (many of which are already negative). Options 1 and 3 can be categorized as C for involuntary resettlement, and option 2 would be category A (i.e. 200 people or more would require physical displacement).

E10 Cost Estimates

Detailed cost estimates have been prepared for each of the three proposed development options, as well as for the additional option of replacing the mooring system with tug boats capable of attending to dry bulk vessels berthed at the cantilevers. All costs are expressed in Australian dollars (AUD), being the applicable currency for Nauru.

Determining unit rates for construction tasks in a remote location such as Nauru is a difficult task, since there is likely to be little or no previous similar construction work of this scale to use as a guide for setting unit rates. Furthermore, the construction tasks typical of a maritime project of this nature are highly specialised, requiring specific plant, materials and labour skills.

Previous maritime projects successfully completed across the Pacific, including in Papua New Guinea, Vanuatu, the Solomon Islands and the Cook Islands, have been used to estimate typical rates for heavy construction tasks, keeping cognisant of the relative similarities of maritime and port projects in different locations, with varying scope for each project and availability of suitable plant, materials and skilled labour. These locations have seen major port development in recent years and provide a bench mark for selecting suitable unit rates for various construction activities.

The ADB's *Financial Management and Analysis of Projects Handbook* has been used to set the amount of physical contingency in these cost estimates. As this is a maritime project Pre-Feasibility Study, physical contingency has been set at 15% of the total estimated cost for each Option. A further 10% has been allowed for engineering studies, detailed design and supervision.

E11 Economic Analysis of Options

An economic analysis of each of the three (3) options has been undertaken in accordance with ADB's *Financial Management and Analysis of Projects Handbook*.

The Economic Analysis is discussed in detail in Section 8, with supporting information included in Appendix C.

Economic costs are in constant prices (Australian dollars) as at January 2015, and are initially estimated in financial terms i.e. actual costs. These have then been converted to economic costs by adjusting certain elements (e.g. shadow pricing labour, deducting taxes etc.). The analysis also includes operations and maintenance costs and reflects reduced maintenance costs resulting from the options which minimise the impact on the existing mooring system. The analysis also includes avoided capital costs when compared with investments required under the 'do nothing' option.

Economic benefits included in the assessment have been considered to include indirect benefits such as new trading opportunities, and direct economic benefits such as:

- Savings in Ship Costs, such as savings for container, fuel, and phosphate vessels
- Savings in Port Costs, such as trans-shipment and labour
- Increased Port Revenue such as increases in port fees and container fees
- Savings from reduced injuries to people and damage to cargo and equipment

The estimated costs, economic internal rate of return (EIRR) and the economic net present value (ENPV) for each of the three port development options assessed for feasibility in this Study are:

Option	Estimated Cost A\$ million	EIRR	ENPV A\$ million
1 Quay wall north of the Boat Harbour	22.97	11.2%	1.47
2 Enclosed harbour basin north of the Boat Harbour	97.70	-0.4%	-55.77
3 Quay wall south of the Boat Harbour	31.15	9.2%	-1.32

E12 Multi-Criteria Analysis

The three port development options were assessed using a Multi-Criteria Analysis, aimed at addressing the trade-offs across a range of criteria:

- Economic parameters;
- Technical and engineering issues;
- Operational efficiencies;
- Environmental impacts;
- Social impacts.

The scores (higher score = greater benefits) for each option were:

Option	Score
1 Quay wall north of the Boat Harbour	126
2 Enclosed harbour basin north of the Boat Harbour	75
3 Quay wall south of the Boat Harbour	106

E13 Summary of Options Assessed

The three options for redeveloping the port have been assessed and compared to determine a preferred option for further detailed consideration within a PPTA process. A summary of this assessment is provided below. The key features, key parameters from the economic evaluation and the ranking from the Multi-Criteria Analysis are included in the table.

Summary of Options Assessment

Summary	Option 1 - North Quay	Option 2 - North Basin	Option 3 - South Quay
Key features	New quay wall constructed on the edge of the reef north of the existing harbour, which provides the initial stage of a future enclosed harbour.	New enclosed harbour basin excavated from the reef and coastal land north of the existing boat harbour, sized to accommodate most vessels except phosphate ships. Includes two tugboats.	New quay wall constructed on the edge of the reef south of the existing harbour, complemented by 2 x dolphins to assist phosphate ships in berthing.
Impact on phosphate operations	Phosphate ships continue to use southern cantilevers and mooring system	Phosphate ships continue to use southern cantilevers and mooring system	Phosphate ships continue to use southern cantilevers and mooring system, and cargo ships use the same system.
Impact on cargo operations	Significantly increased efficiency alongside quay wall	Significantly increased efficiency in most conditions in sheltered harbour.	Significantly increased efficiency alongside quay wall, although some conflicts with phosphate ships
Use of mooring system	Limited to phosphate ships until phosphate operations cease.	Limited to phosphate ships until phosphate operations cease.	Limited to phosphate ships until phosphate operations cease, but may also continue to be used by cargo and fuel ships given close proximity.
Capital Cost	\$23.0 M	\$97.7M	\$31.2M
O&M Costs	\$1.6 M p.a.	\$2.4 M p.a.	\$1.6 M p.a.
30 year ENPV at 10% discount rate	+\$1.5M	-\$55.8M	-\$1.3M
EIRR	11.2%	-0.4%	9.2%
MCA Score	126	75	106
MCA Rank	1	3	2
Economic Criteria	1	3	3
Technical & Operational Criteria	2	1	3
Environmental and Social Criteria	2	3	1

E14 Overview of Other Options not assessed in Detail

Removal and Replacement of the Mooring System

The anchored mooring system is a complex arrangement of anchors embedded on the seabed at great depth, cables, chains, multi-point linkages and mooring buoys. This mooring system is maintained to ensure that ships can be safely and efficiently moored at Nauru to complete their cargo transfer operations. To remove the mooring system completely would not be wise because any alternative arrangement for

anchoring or handling ships will have a higher risk of failure, leaving a ship vulnerable to grounding on the reef edge. Maintaining even a reduced version of the mooring system would be prudent.

The only alternative for the mooring system which could provide a viable method for holding and maneuvering ships at the phosphate cantilevers is for two or more tug boats to be provided around the clock, operated and maintained by the port. The estimated capital cost of this alternative is A\$3.0 million, plus an annual operation and maintenance cost of A\$1.8 million.

Improvements to Existing Harbour in Anibare Bay

Anibare Bay, located on the eastern side of Nauru, offers sheltered waters during the monsoon season, when high waves and strong winds often prevent shipping operations at Aiwo. It would be prudent to invest a small amount in expanding the facility at Anibare Harbour, to provide a larger hardstand area for unloading containers without the current congestion caused by very limited access at this location. While the general cargo ships can operate at this location by drifting, thereby precluding the need for a mooring system on this side of the island, productivity for unloading containers would be significantly enhanced if a larger hardstand area was constructed adjacent to the harbour. An investment of about A\$300,000 would provide an expanded container-handling area of about 2,000 m².

If progressed as priority early in the overall investment project, this modest investment at Anibare Harbour would provide part of a staged solution to improved operations. The upgraded Anibare Harbour facility could act as the temporary site for unloading containers during the construction of the upgraded port facilities at Aiwo.

New Quay Wall at Anibare Bay

A new harbour development at Anibare Bay has been suggested by some. However, there are a number of sound reasons why this is not viable, including:

- The area is exposed to Trade winds and wave climate for about 9 months of the year;
- The sub-sea geology comprises a submarine landslip, thereby presenting a significant risk that further sub-sea instability may severely damage new harbour infrastructure;
- The reef and marine ecosystem around and within Anibare Bay is relatively pristine and any harbour development would place this ecosystem at high risk of irreversible damage;
- Most industrial and commercial activity occurs on the western side of the island, close to the existing port. Moving the port away from this activity would increase transport costs.

Hence, any major port development in Anibare Bay (other than an enlarged hardstand) is not recommended.

E15 Risks, Opportunities and Required Activities for PPTA Phase

Throughout this report, the key assumptions and risks are outlined. There are a number of critical areas requiring further, more detailed, investigation to minimize risks during future Project Preparatory Technical Assistance (PPTA). Key risks identified during the study and associated investigations and tasks required during PPTA are presented in the table below.

Key Risks, Opportunities and Proposed PPTA Activities

Key risk or opportunity	Required PPTA Activities to minimise risk or harness opportunity
<p>Geotechnical conditions of site and quay wall foundation, suitability of construction method, and cost estimates</p>	<p>Extensive geotechnical investigation of the entire development site, both on land and across the reef flat to the edge of the reef. These investigations should be aimed at determining the foundation materials beneath the surface for container park pavement design, hardness of the reef flat to ascertain the excavation parameters for concrete block quay wall construction and to confirm that concrete block quay wall loads can be adequately supported on the reef flat.</p> <p>These investigations should also include deeper investigations to determine the parameters of the underlying reef material, in the unlikely event that piled structures may need to be considered for quay wall/wharf construction. These deeper investigations would also be advisable to inform provide parameters to be used in the hydrodynamic modelling of the reef and proposed quay wall (e.g., drilling and extracting cores to assess the structure of the reef).</p>
<p>Uneven seabed contours for a foundation for mass concrete block quay wall construction</p>	<p>Site survey, both on land and across the reef flat and over the edge of the reef, to determine features and levels across the development site. All features including buildings, vegetation, underground services, mooring system components and the detailed topography of the reef flat and the edge of the reef need to be identified by the survey. This survey should include a high resolution cross-sectional survey of the seaward reef edge in the proposed port locations, to determine feasibility of proposed quay wall and road options.</p> <p>Anecdotal evidence suggests that the edge of the reef may be undercut by natural wave action. This should be investigated as part of this survey by undertaking a vertical survey of the profile.</p>
<p>Uncertainty of land ownership and lease arrangements which could present access and timing challenges for the project</p>	<p>A cadastral survey should be undertaken to accurately define the land ownership parcels within the port limits, and at its periphery. Once the land ownership parcels have been defined, the land proposed to encompass the port land, or the boundary of the port limits, can be defined (as is required under the Port Act).</p> <p>In parallel with the cadastral survey, a review of existing lease arrangements within the footprint of the proposed Option1 and at its periphery should also be undertaken. This will include a review of land ownership, original lease details such as how the land was originally obtained, and whether there are any outstanding issues.</p>
<p>On-going damage to the mooring system from poor ship-handling practices and consequent down-time while the damaged mooring system components are repaired</p>	<p>In order to better understand the current condition and impact of maintaining the mooring system on the economy of the NPA, Ronphos and the GoN, a detailed investigation into the maintenance costs experienced over the past ten years should be undertaken. This investigation will recognise that regular and reactive maintenance is a separate cost imposition compared to the high cost of replacing crucial components of the mooring system (such as anchors and deep-sea chains and cables) which is undertaken every five to ten years. A cost-benefit assessment of the mooring system would assist in demonstrating the ongoing viability of retaining this system as opposed to replacing it with two tug boats.</p> <p>This review of maintenance needs should be accompanied by a detailed independent investigation of the suitability of the existing mooring system and any design and operational improvements to reduce the ongoing cost.</p>

<p>Uncertainty of the cost estimates</p>	<p>Estimating construction costs for large unusual port development projects in remote locations such as Nauru is difficult, since similar comparable projects rarely exist for comparative purposes. To assist with project budgeting, it is recommended that the preferred design for any new port development be assessed either by a Quantity Surveyor or by an international civil engineering contractor with experience in port development in the region.</p>
	<p>The costs estimates are currently based on the mass concrete block construction method, with the blocks assumed to be case on Nauru. A detailed review of the risks associated with this methodology should be undertaken, and should include an assessment of the availability of the skills (e.g., suitably skilled contractor), equipment (e.g., concrete batching) and materials (e.g., aggregate, fresh water) available on Nauru to cast the blocks.</p>
<p>Risk of attracting suitably qualified contractors to undertake the work while providing opportunity to the local private sector.</p>	<p>Consideration of appropriate procurement methods should be built into the PPTA, including potential for Design and Construct (D&C) contract, led by a suitably experienced international maritime contractor to bring innovation to the design solution and transfer design evolution risk to the contractor. Opportunities should also be explored during PPTA for local private sector participants to undertake elements of the work.</p>
<p>Impact of monsoon waves on a west-facing quay wall</p>	<p>A detailed investigation of the suitability of the proposed quay wall to the monsoon season wave climate and extreme events should be undertaken. It is anticipated that this investigation will include hydrodynamic modelling of the proposed arrangement, coupled with the existing bathymetry, and projected wave climate (i.e., extreme wave events), so the design can be verified and refined, as necessary. In particular, the this task will provide information to: determine the expected number of non-operational days which may occur on an annual basis; and inform the detailed design and selection of suitable energy-absorbing fendering for the quay wall to protect ships from impact damage when berthed in marginal sea conditions.</p>
	<p>Early discussions with SPC Geoscience Division reveal that the PACCSAP hindcast data set used for this study is the best available data currently. Further analysis of extremes generated from this data set are available from SPC Geoscience Division and can be used to develop an uncalibrated site specific hydrodynamic model.</p>
	<p>This hydrodynamic modelling should be coupled with the expertise and advise of an experience mariner, to provide guidance on suitable berthing procedures and limitations during specific extreme climate events.</p>
<p>Sensitivity of key assumptions to the economic viability of the project.</p>	<p>More detailed economic analysis to confirm and refine the conclusions reached in this Pre-Feasibility Study. This should include sensitivity tests on some of the critical assumptions such as: continuity of revenue sources; long term maintenance costs of the mooring systems.</p>
<p>Uncertainty of environmental social conditions and understanding of mitigation measures during design, construction and operation</p>	<p>The Prefeasibility Study has determined that the preferred Option 1 or 3 is Category B for Environment. Key PPTA environmental safeguards activities should include: public consultation; visual/photographic transects of the reef; detailed survey of water quality and all contaminant input sources to the marine environment in the port area; detailed survey of active coastal erosion sites in the port area; detailed typology of the reef flat materials and coastal sediments that will require blasting/dredging.</p>

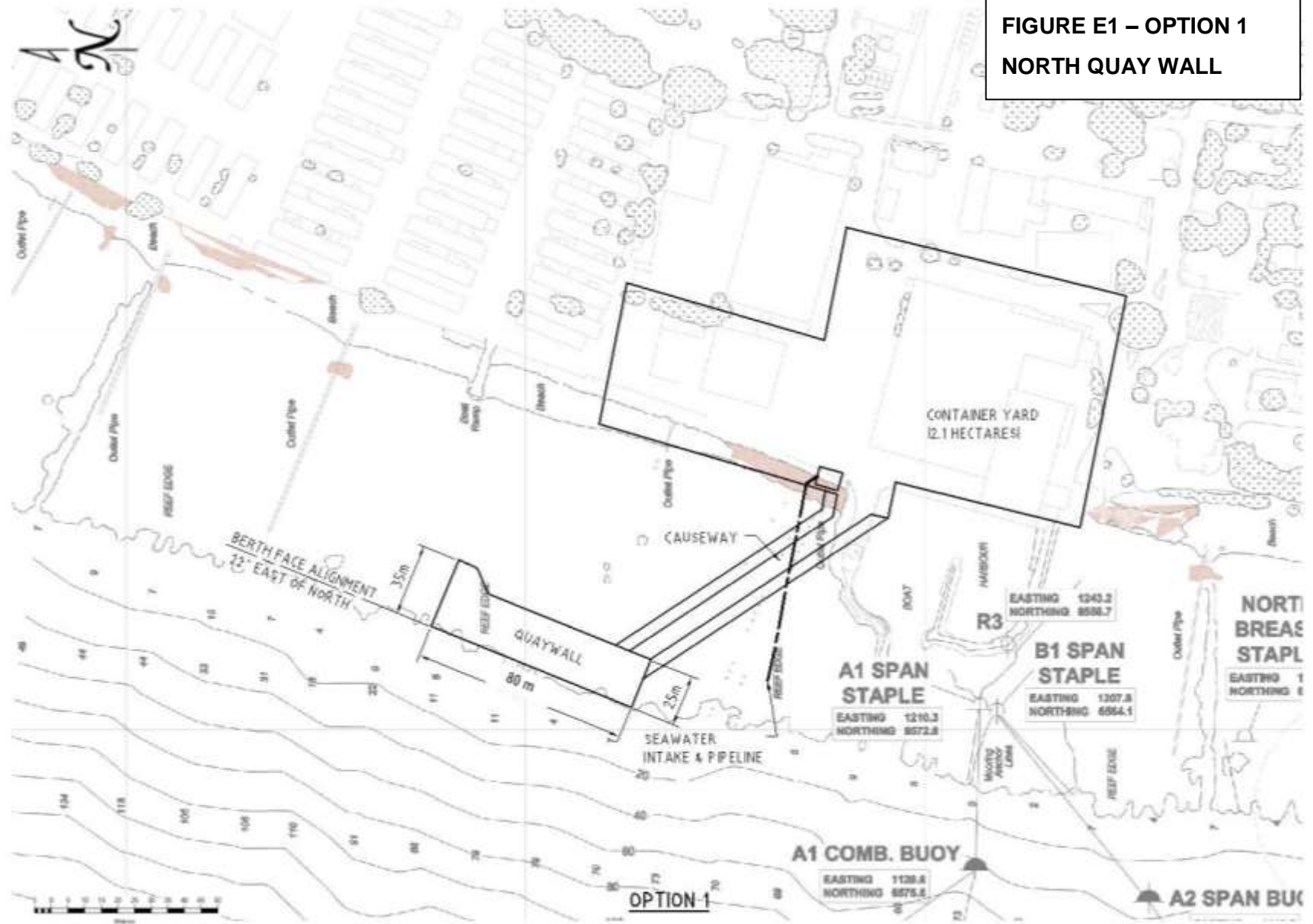
<p>Uncertainty of social conditions and potential mitigation measures during design, construction and operation</p>	<p>The Prefeasibility Study has determined that the preferred Option 1 or 3 is Category C for Involuntary Resettlement. Key PPTA social safeguards activities should include: public consultation; due diligence/social compliance audit (including an action plan to address any outstanding issues); review of land leases and outstanding issues.</p>
<p>Inappropriate demolition, handling and disposal of building materials and hazardous resulting in health, safety and environmental risks.</p>	<p>All the existing buildings within the port boundaries are in very poor or derelict condition and must be demolished as soon as possible. The PPTA should investigate in detail the sequencing and methodology for demolishing the existing buildings to minimize safety risks. This will likely require the skills of a structural engineer with demolition experience.</p> <p>In addition, the environmental specialist for the PPTA should also investigate appropriate methods for handling and disposal of building materials (e.g., asbestos roofing and walls), while opportunities to salvage materials which are in good condition (e.g., steel or aluminium) should also be explored.</p>
<p>Lack of operations and maintenance capabilities within Nauru Port Authority will prematurely undermine the efficiencies gained by new port infrastructure</p>	<p>Institutional reform within the Nauru Port Authority is essential to ensure that the capacity of the organization is commensurate with the value of the proposed investment in port facilities infrastructure. Some key areas for investigation include: financial management (collection of port fees and dues, and the associated accurate accounting); asset management (routine maintenance, management of stores and spares, availability of skilled maintenance personnel); and other critical management tasks, to ensure that the new facility delivers the improved outcomes envisaged in this Study.</p> <p>Institutional strengthening will need to include both (i) the Department of Maritime Transport (planning, financial and strategic management including change management) and (ii) the NPA (management and operational activities including staffing).</p>
<p>Climate change risk and adaptation opportunities</p>	<p>The preliminary climate risk screening for each option reveals a high climate risk. A detailed climate risk and vulnerability assessment should be undertaken, which will include: impact assessment, identification of possible adaptation options; and incorporation of the adaptation measures into the economic analysis. The detailed investigation should include an assessment of the incremental elements of the design attributable to climate change adaptation to inform potential climate change funding opportunities.</p>

E16 Recommendations

The port facilities at Nauru need to be substantially upgraded if they are to provide an operationally and economically efficient port for current and future import and export trade. While growth in trade is expected to be low, the condition and operational efficiency of the existing port infrastructure does not provide adequate levels of service for the import of general cargoes and fuel. To achieve significant improvements in the efficiency of the port, the following recommendations are made:

- **Recommendation 1:** loading facilities for bulk phosphate across the existing cantilevers must be retained for the remaining life of phosphate mining on Nauru;
- **Recommendation 2:** the existing mooring system and anchorage facility must be retained and continued to be maintained for the remaining life of phosphate mining on Nauru so that a safe and reliable anchorage capability remains available for berthing and maneuvering bulk phosphate ships, regardless of the infrastructure solution adopted;
- **Recommendation 3:** a new berth for general cargo, container and bulk fuel ships should be constructed to the north of the existing Boat Harbour (Option 1), together with an access causeway to the port container yard;
- **Recommendation 4:** the existing container storage area should be enlarged by demolishing derelict buildings, paving the entire area with a heavy-duty industrial pavement, and constructing new buildings to accommodate the Harbourmaster's office, a staff amenities building, a gatehouse and a plant workshop, all enclosed in a fully secure perimeter fence;
- **Recommendation 5:** minor investment at Anibare Harbour, to expand the hard-stand area to accommodate container handling operations would be beneficial, and could then be utilized during the construction activities for the upgrade of the existing Aiwo Boat Harbour facilities;
- **Recommendation 6:** progression of Project Preparatory activities by PRIF partner(s) (i.e., PPTA) should consider the risks and PPTA activities outlined in the previous section;
- **Recommendation 7:** consideration should be given by PRIF partners and the Government of Nauru to appropriate institutional reform and capacity building for the Nauru Port Authority to ensure that the capacity of the organisation is commensurate with the value of the investment in port facilities infrastructure.

**FIGURE E1 – OPTION 1
NORTH QUAY WALL**



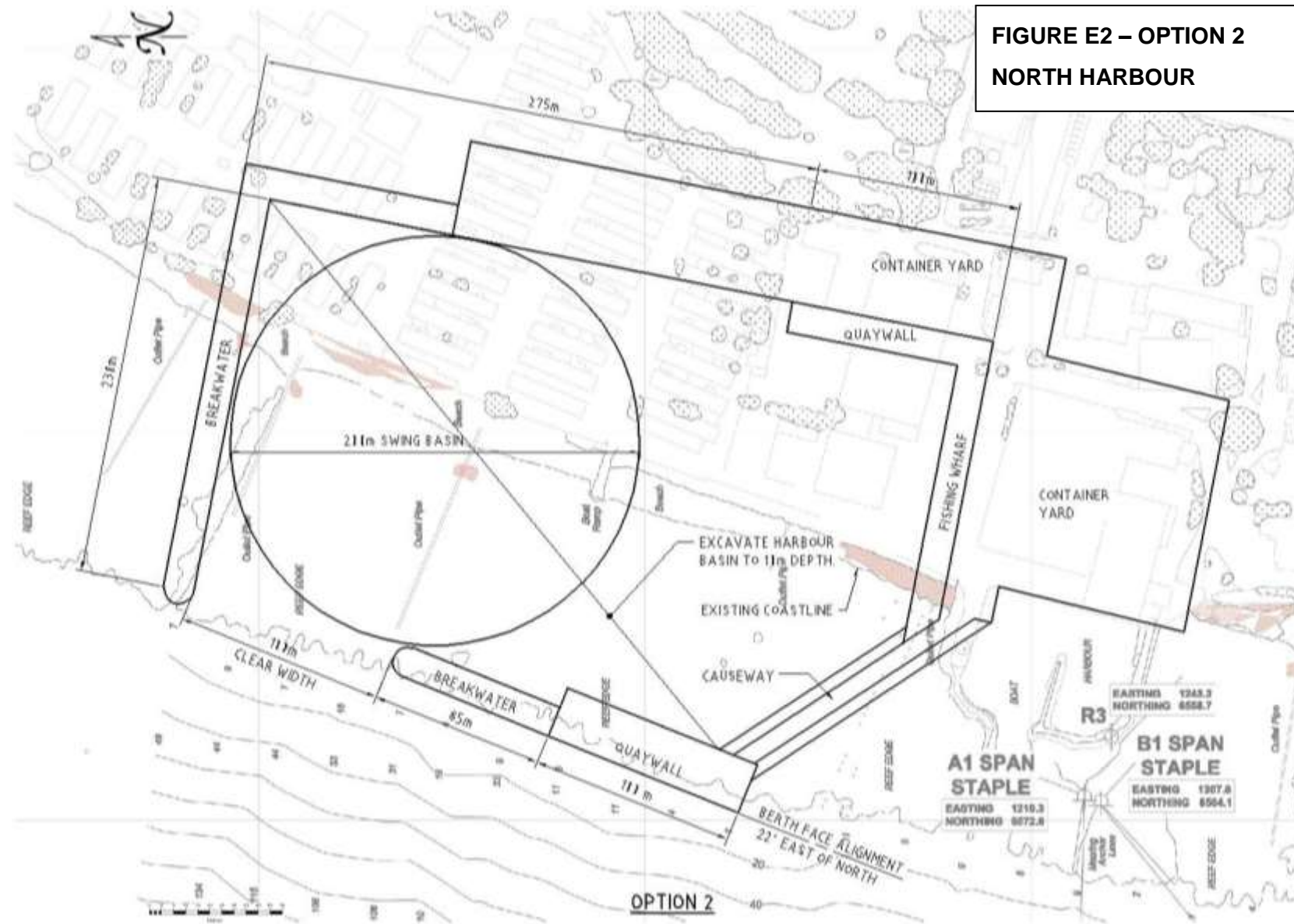
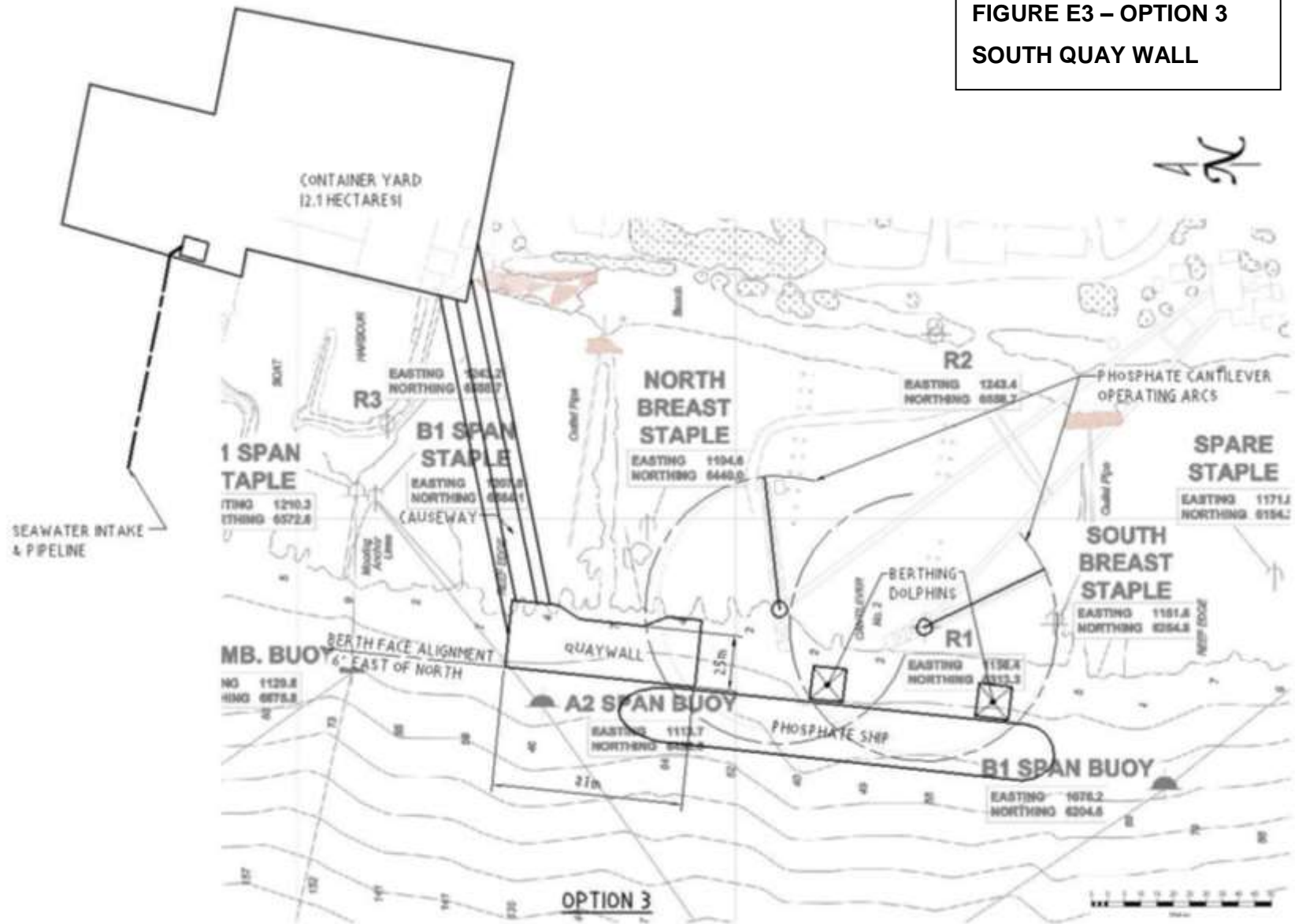


FIGURE E3 – OPTION 3
SOUTH QUAY WALL



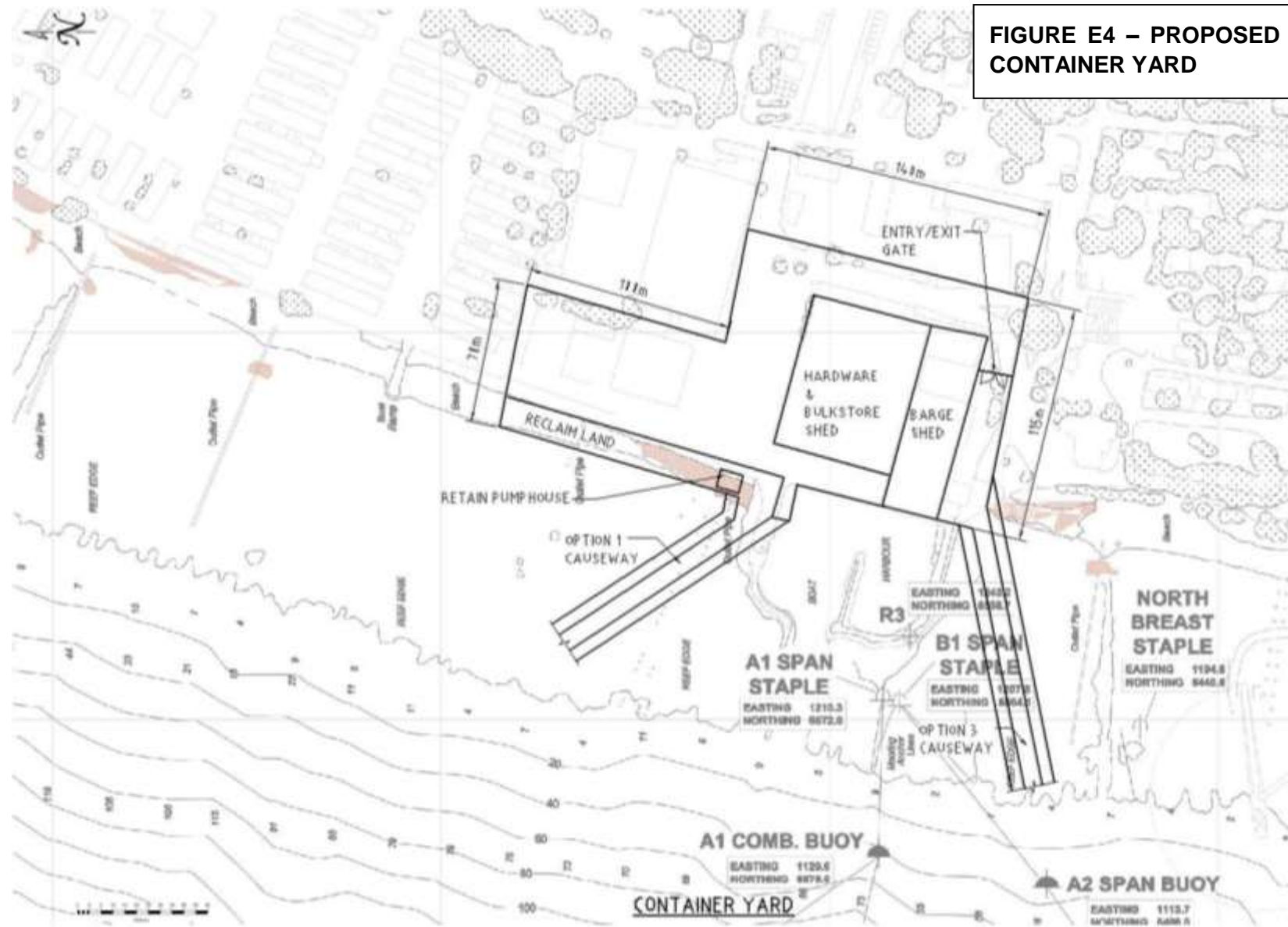


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Appendices

- A. Terms of Reference
- B. Wave climate assessment and analysis
- C. The economic assessment
- D. Port development options drawings
- E. Detailed cost estimates
- F. Environmental and social assessment and Rapid Environmental Assessments;
- G. Multi-Criteria Analysis

CURRENCY EQUIVALENTS

(As of 30 June 2015)

Currency Unit – Australian Dollar (AUD)
A\$1.00= US\$ 0.769

Abbreviations

ADB	Asian Development Bank
BOM	Bureau of Meteorology, Australia
CIE	Ministry of Commerce, Industry and Environment
DFAT	Australian Department of Foreign Affairs and Trade
DoT	Department of Transport
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
GoN	Government of Nauru
ICT	Information & Communication Technology
IMO	International Maritime Organization
ISPS	International Ship and Port Facility Security Code
ITCZ	Inter-tropical Convergence Zone
MCA	Multi Criteria Analysis
MFEP	Ministry of Finance and Economic Planning
MTC	Ministry of Transport & Communications
NDC	National Development Committee
NEISIP	Nauru Economic Infrastructure Strategy and Investment Plan
NICC	National Infrastructure Coordinating Committee
NPA	Nauru Port Authority
NRC	Nauru Rehabilitation Corporation
NSDS	National Sustainable Development Strategy
NUA	Nauru Utilities Authority
PACCSAP	Pacific-Australia Climate Change Science and Adaptation Planning
PACTAM	Pacific Technical Assistance Mechanism (AusAID)
PAD	Planning and Aid Division, Department of Transport
PIAC	Pacific Infrastructure Advisory Centre
PIPI	Pacific Infrastructure Performance Indicators
PPTA	Project Preparatory Technical Assistance
PRIF	Pacific Region Infrastructure Facility
RoN	Republic of Nauru
RONPHOS	Republic of Nauru Phosphate Company
SOE	State Owned Enterprise
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
TA	Technical Assistance
ToR	Terms of Reference

1. Introduction

1.1. General Situation

Nauru is an independent Republic located just south of the equator. It has an area of 21 sq km and a population of 10,084 residents in 2011, most of whom live in the main town and in villages along the coastal ring-road. As a small Pacific Island nation, Nauru is entirely reliant on sea and air transportation for its trade in goods and services. The effective and safe operation of the Nauru Port facilities and equipment are therefore central to maintaining trade and commerce with the outside world.

The current port facility is extremely run down and has occupational health and safety issues, capacity limitations, and is vulnerable to extreme and seasonal weather events. These poor port facilities induce high cost of consumables in the domestic market due to high cost in port handling and adversely affect bulk transportation of current and potential exports (phosphate, dolomite aggregate and fish) and imports. The consequences of the failure of the port facilities would be dire for the local economy, workplace and public safety, regional connectivity and the habitability of Nauru, as it receives all cargo and bulk fuel vessels into Nauru and is a critical link in a broader Pacific maritime network.

It is clear that there is no viable 'do nothing' option given the criticality of the Nauru port. The Government of Nauru needs assistance to improve the situation and preliminary investigations suggest that the estimated capital cost of required works is a significant investment in a country as small as Nauru. It will be difficult to identify feasible options with favourable investment parameters to encourage investment by any single donor. The case for co-ordination and partnering is therefore very strong, so that all donors can play a role in providing this lifeline to the people of Nauru at least cost.

1.2. Structure of the Report

This report is structured to provide the following (Table 1-1):

Table 1-1: Report Structure

Section	Title	Description
2	Background and Previous Relevant Studies	A number of previous studies have been undertaken. These are reviewed and previous recommendations considered in the context of this Study's Terms of Reference
3	Existing Infrastructure and Operations	Description and assessment of the existing port and port-related infrastructure, marine craft and other facilities. This includes the wharf structures and the Port land under NPA control and its usage under lease arrangements. A physical and desktop assessment of safety and accessibility of the harbour. A review and assessment of supporting infrastructure and facilities including bulk liquids delivery pipeline, pilot boat, and barges and their managed deployment, and fencing and security / safety services.
4	Trade Activity	Analysis of past and current vessel and cargo trade volumes to establish trends and forecasts of trade against known changes in activity. Research and evaluation of potential growth in trade and likely future trading patterns for the future.

5	Engineering	Evaluation of prescribed options to satisfactorily meet future demand by improving current port and cargo operations, and by upgrading existing port and supporting infrastructure.
6	Cost Estimates	Delivery of capital cost estimates for each option.
7	Options to Improve the Port Facility	Analysis of the benefits and disadvantages of the options for providing improved port facilities
8	Economic Analysis	Review and assessment of current revenue and tariff structures. Review and assessment of current and project capital and operating costs. Analysis of key economic ratios and scenario testing of activity against economic variables. Identification of constraints and recommended areas for improvement.
9	Environmental and Social Issues	Assessment of climate change impacts relative to the current and future operations and access of Honiara seaport. Assessment of social and community direct and indirect impacts likely to occur on the basis of seaport infrastructure expansion. Discussion of other relevant issues including potential community relocations.
10	Multi-Criteria Analysis	Description of the methodology and outcomes of the Multi-Criteria Analysis for the three development options
11	Conclusions and Recommendations	Presentation of likely preliminary preferred stages and options. Summary of institutional and financial performance findings and options for improvements. This will be produced in detail under the second report as part of this study 'Port Improvement Strategy'. This Section includes a description of tasks identified by the Study for further attention at the PPTA stage
12	References	

1.3. Scope of the Pre-Feasibility Study

This Pre-Feasibility Study will investigate a range of issues in more detail than considered in previous studies and provide a preferred option suitable for implementation.

The Terms of Reference are included in Appendix A and key activities include:

- (a) Review of existing studies done by ADB, JICA and others and identify any additional urgent data needed to support the multi-criteria assessment proposed as part of the Pre-Feasibility Study.
- (b) Investigation of the wave climate along the western coastline of Nauru, based on currently available data to determine seasonal variation, the frequency and characteristics of extreme events and potential implications of future climate change.
- (c) Investigation of environmental and social risks, and preliminary identification of the categorization of each of the three concepts (environment, involuntary resettlement and Indigenous People).
- (d) Investigation of available construction methods and construction materials, in particular considering the availability of local materials.

- (e) Review of the three previously proposed concept designs and development of a concept level bill of quantities.
- (f) Consideration of the relative risks associated with each option. This should include: sequencing during design, construction and commissioning for each option, including (but not limited to): climate risks, information risks (e.g., geotechnical and hydrographic), operational risks during construction (i.e., maintaining existing port services), environmental and social risks, and staging risks and opportunities.
- (g) Estimation of costs and benefits. This will include: construction, operations and maintenance costs of each option; identification of critical contingency items; and, high level estimation of economic benefits of each option.
- (h) Development of criteria for a multi-criteria analysis addressing the technical, social, environmental and economic aspects of the proposed upgrade.
- (i) A multi criteria analysis to determine the preferred option based on the assessment of the quantifiable and un-quantifiable benefits of each option.
- (j) Summarizing the details of the preferred option and identification the key investigations and studies required during a future PPTA to reduce the risks associated with the project.
- (k) Preparation of a detailed report describing the findings and the recommendation of the assessment.

1.4. Port Development Options Investigated

Following some preliminary and initial assessments by others (ADB/Oldfield, 2009; Bench & Kelly, 2012; JICA, 2014) over the past six years, three options were proposed to be further investigated under this Pre-Feasibility Study:

- (iv) **OPTION 1:** A new quay wall constructed on the edge of the reef north of the existing harbour, and accessible by causeway. While this scenario does not provide any opportunity for replacing the existing phosphate loading arrangements, and hence the high maintenance costs for the mooring buoy system will continue, this solution provides the initial stage for a future enclosed harbour development;
- (v) **OPTION 2: A new enclosed harbour basin excavated from the reef and coastal land** north of the existing boat harbour. This basin is suitably sized to accommodate container and general cargo vessels, but not phosphate ships. The existing phosphate loading facilities therefore must be retained and maintained as at present; and
- (vi) **OPTION 3:** A new quay wall constructed on the edge of the reef adjacent to the phosphate cantilevers, to accommodate all vessels visiting Nauru, plus berthing dolphins to improve the berthing of phosphate ships.

These three options are shown in Figures D2 in Appendix D.

These three options are considered the most beneficial of those previously considered and therefore warrant more detailed investigation. Other potential options which have been discussed by stakeholders will also be summarised at high level in the Study. A no-project scenario has also been considered for the purposes of the proposed economic evaluation. This is not a do-nothing scenario but one which will allow the existing port facilities to continue with the existing plant and operational format. This operating scenario will inevitably include high cost demand for maintenance and continue with highly inefficient cargo handling operations.

1.5. Objectives of the Study

The strategic objective of the pre-feasibility study is to identify a preferred solution for implementation by ADB and potential financing by multiple PRIF partners or other development partners, which will enable effective and safe operation of the port facilities in the future and support trade, commerce and improved efficiency. The three (3) key objectives to support this strategic objective are to:

- Identify the preferred infrastructure solution for improvement of the port operations in the short to medium term, while recognising longer term needs and opportunities
- Evaluate the economic viability of the project based on ADB's investment requirements, with a focus on applying greater rigour than previous economic assessments
- Inform the scope of future preparatory work to be undertaken by PRIF partners (e.g. ADB) by identifying the environmental and social categories of the options, considering optimal procurement issues (e.g., Design Build vs traditional) and additional studies and investigations required (e.g., survey, geotechnical, hydrodynamic modelling).

Key considerations in the Study are expected to include:

- (i) maximizing utilization of existing infrastructure;
- (ii) minimizing life cycle costs, considering the balance between capital and maintenance costs, construction risks and challenges, including seasonal and timing challenges, temporary works and access, geotechnical risks and associated uncertainty in capital cost estimates;
- (iii) operational risks, including maritime safety, equipment requirements and comparative operations and maintenance requirements;
- (iv) environmental, land and social risks and opportunities;
- (v) potential for future expansion and /or climate proofing; and
- (vi) potential to facilitate economic opportunity (e.g., phosphate mining, lime and coral aggregates) to reduce the incremental cost in future to provide such infrastructure.

1.6. Objectives of the Nauru Port

The *Port Authority Act 2006*, amended in 2014, sets down all the requirements for managing and operating the Nauru Port Authority for the benefit of Nauru. The Act states that the functions of the Port Authority are:

The functions of the Authority are to establish, improve, maintain, operate and manage port, services and facilities in connection with the operation of the port, including, but not limited to:

- (a) the management and maintenance of adequate and efficient port, facilities, services and security in the port;*
- (b) the provision of goods and services necessary to give effect to the objectives of the Authority;*
- (c) the regulation of navigation and maintenance of navigation aids within the port;*
- (d) the marketing and promotion of the use, improvement and development of the port; and*
- (e) the co-ordination of all operations within the port.*

The requirements of the Port Authority Act, if correctly and diligently undertaken, should provide for a well-managed port. However, because the existing infrastructure and operational constraints do not enable the NPA to deliver its functions, improvements are urgently needed.

2. Background and Previous Relevant Studies

2.1. Background

The island is surrounded by deep water and has no protective outer reef or natural harbour. It is skirted by a narrow coral reef, which is at low tide and dotted with vertical coral outcrops (pinnacles). The island once had abundant mineral resources and maintains abundant marine resources. Geologically, it consists of a 500 m column of limestone that sits atop the seamount and is interlaced with the remains of a high-grade marine phosphate. Nauru's 200 nautical mile (370 km) Exclusive Economic Zone (EEZ) encloses a maritime zone of some 430,000 sq km, making it one of the largest in the world.

Phosphate mining provided the main source of the nation's income until the late 1980s. However, the industry contracted significantly over the 1980s, with the performance of other industries becoming relatively more important to the economy. Phosphate exports reached a peak in the 1970s at approximately 2,300,000 metric tonnes, falling to 500,000 metric tonnes by the early 1990s and were virtually zero by 2004. With the collapse of phosphate exports, the merchandise deficit had expanded and there was probably also a deficit on the trade services due, for example, of education services, freight services and services provided by non-resident aid workers.

In 2010-2011, it is estimated that exports of phosphate were approximately 440,000 tonnes, up from 319,000 tonnes in 2009-2010. However, poor infrastructure, and exchange rate and market price fluctuations have meant that export earnings from phosphate have failed to meet government forecast, aside from problems with the moorings which have prevented phosphate ships from visiting Nauru.

More recently, fishing licences issued to Japan, China, South Korea, Taiwan and USA are an important source of revenue for Nauru. Pelagic fish abound in Nauruan waters, but Nauru has not been able to establish a commercial fishing industry of its own.

Nauru does not have the benefit of a protected port facility, due to the unique geography of the island. The extremely deep water (3,000 m within 7 km of the coastline) and the existing port's exposed mooring location, very close to the fringing reef, make shipping and port operations difficult. The outer mooring buoys are anchored in this deep water, at a depth of about 540 m, and the ship mooring zones are vulnerable to westerly monsoon winds and waves. The maximum capacity of Nauru's moorings is 42,000 DWT (fully loaded) and this limits the size of the dry bulk vessels handled for the phosphate trade.

There are also occupational health and safety issues associated with the use of old container transport vessels, the work boat and rafts, and the lifting equipment in the port area. An average of two to four vessels per month visit Nauru port, including one to two container/general cargo ships using the Nauru port facilities, a diesel tanker to supply the island's fuel and one to two bulk vessels loading phosphate for export. Thus, even if a container or cargo vessel is discharging, it is normally required to move off the mooring buoys and stand off until the phosphate ship has been loaded.

2.2. 2009 Reeves Construction Services/BMT WBM Study

In April 2009, Reeves Construction Services in association with BMT WBM completed a Study comprising a Review of the Nauru Port Facility, with a focus on craneage, container handling and the port building structure.

Their four recommendations included:

- Curtail operations inside the port building due to its unsafe condition;

- Procure additional operating equipment including a new barge, crane and spares;
- Continue the use of existing cranes for container unloading and demolish sheds in dilapidated condition;
- Construct a new portal lifting frame within an existing functioning shed for lifting containers and vessels, OR construct a new shed including a new portal lifting frame.

The total estimated cost of these four recommendations was \$10.8 million. It is assumed that these are US dollars, as the currency is not specified in the RCS report.

These recommendations are based on the fundamental assumption that the current port operation where general cargo ships are moored offshore and containers are transferred by barge and lighter to the existing Aiwo Harbour remains as the operating scenario for the port.

As noted in Section 1.3 above, this Study essentially presents the “no project” scenario for this Pre-Feasibility Study.

2.3. 2009 ADB Study by Oldfield Consulting Australasia

ADB commissioned Doug Oldfield to complete a Scoping Study for Nauru Port in 2009. This Study focused on the engineering aspects of improving the port facility, and assessed five options (Development Scenarios) for further consideration in a more detailed Study.

Development Scenarios 2 and 3 were recommended for further investigation. The capital costs estimated for these two scenarios in the ADB Scoping Study are:

Development Scenario	Capital cost, USD (in 2009 \$)	Annual maintenance cost, USD (in 2009 \$)
2	9.6 million	400,000
3	10.1 million	90,000

As this was primarily an engineering investigation, no economic analysis was undertaken for this Study.

The ADB Study has also considered two fully enclosed port basin options, with the smaller basin option shown in the figure in Appendix D.

These three scenarios show the three options as cited in the Terms of Reference (ToR). For the purpose of the Pre-Feasibility Study, the options will be designated as:

- OPTION 1:** A new quay wall constructed on the edge of the reef north of the existing harbour, and accessible by causeway;
- OPTION 2:** A new enclosed harbour basin excavated from the reef and coastal land north of the existing boat harbour; and
- OPTION 3:** A new quay wall constructed on the edge of the reef adjacent to the phosphate cantilevers, to accommodate all vessels visiting Nauru.

2.4. 2011 Nauru Economic Infrastructure Strategy & Investment Plan

This Plan was prepared by the Planning and Aid Division (PAD) of the GoN, assisted by consultants provided by the Pacific Infrastructure Advisory Centre (PIAC). The Plan was completed early in 2011 and comprised an infrastructure stock take, technical and economic analysis, and development of a prioritized list of infrastructure investments. The Plan makes a number of recommendations for the improvement of the maritime component of the transport sector in Nauru. The Plan draws heavily on the previous recommendations made by ADB in the 2009 Port Scoping Study. Their observations were:

“Apart from major infrastructure investments, the key issue with maritime is maintenance of existing equipment and facilities. The main port building is close to collapse and inadequate

for existing operations. Security fencing is completely degraded. There has been the commissioning of two new work boats in 2010, and the funding of a replacement Pilot Boat in 2011, that are central to port operations. However, there are inadequate funds for their correct maintenance. A crane procured in 2008 has still not been erected as it is perceived as inadequate for the job. A larger 65 tonne Omega crane is now proposed to be purchased by Maritime.

As the port is improved, demurrage charges and handling times should decrease as efficiency improves. While this should have carry-on benefits to consumers and exporters, it is essential that some proportion of this saving is retained by Maritime for correct maintenance.

Maritime transport is the critical sector for the economy, being the source of imported goods, and the export of revenue raising phosphate and aggregate. Mining and quarrying sectors provide their own facilities to export products, but rely on the port for imports. Financing the port as a gateway for imports should thus be directed to ensure the full cost of imports including food are passed on through port charges.”

2.5. 2012 World Bank/AusAID Port Infrastructure Priority Needs Assessment

The World Bank, in collaboration with DFAT, undertook a field mission to Nauru in September 2012 with the aim of providing AusAID with guidance for determining short term port craneage solutions. This mission also provided guidance for longer term planning of port infrastructure development needs.

While this mission was primarily focused on the problems of crane availability in the short term, due to crane non-availability at the port, and on the ongoing concerns with the high cost of maintaining the mooring system, the mission participants observed and commented on the poor management of the port's operations. Their recommendation was for NPA to recruit a new Port Operations Manager with international experience to enhance the operation of the port.

2.6. 2014 JICA Study

The Japan International Cooperation Agency (JICA) completed a Preparatory Study in March 2014, which provides a broader assessment of seven options for improving the port facility at Nauru (not including the “do nothing option” which JICA designated ‘as is’. which was dismissed as not feasible). JICA concluded that development of the port is essential to the development of Nauru but, based on savings in maintenance and ship costs, indicated that the project was not economically feasible. The JICA Study outlined the need for a full Pre-feasibility Study to further develop the selection of a preferred option for development of an enhanced port facility.

The JICA Preparatory Study recommended that a new quay wall be constructed directly to the south of the existing Aiwo Harbour, together with retention of the existing phosphate loading facility, comprising the loading cantilevers and buoy system. The proposed arrangement is shown as Plan 1 in Figure D3 in Appendix D.

This option is similar to the ADB Option 3, although the estimated cost is much higher owing to a different method of construction for the quay wall. JICA estimated that the cost-benefit ratio (B/C) for this option is 0.32, based on a capital cost of ¥ 3.8 billion (USD 37.3 million in 2014) and an annual maintenance cost of ¥3,8 million (USD 37,000), and calculating the costs and benefits over a period of 50 years.

The JICA Study also investigated a quay wall north of the Boat Harbour (similar to Option 1 for this Study). However, JICA included in their layout a new set of mooring buoys and associated anchors, bringing the total cost estimate to ¥7.9 billion (USD 77.5 million), plus significant additional maintenance costs.

The JICA Study also considered a number of options comprising quay walls constructed perpendicular to the shore, either north of or south of the Boat Harbour, These were all dismissed as not being feasible because the quay lengths available would be inadequate for the vessels to safely berth.

It should be noted that Option 3 from the ADB Study (2009) described in Section 2.3 above is intended to dispense with the mooring system for phosphate vessels, which in this option would moor against the new quay wall and a number of berthing dolphins for loading phosphate. The JICA version of this option shown in Figure 3-2 does not dispense with the mooring system.

The JICA Study has not included a fully sheltered port basin option.

2.7. Summary of Previous Studies

Key conclusions and common themes from these previous studies are:

- The existing port buildings and sheds are unsafe and should be demolished and replaced where required;
- When a new building is constructed, additional equipment such as new barges, crane and equipment be considered;
- The most effective options to consider further are modest and involve a quay wall along the reef edge to the north or south of the existing harbour, or a semi-enclosed harbour basin;
- Some investment at Anibare Harbour could improve cargo and container handling and provide improved access and contingency during the monsoon months;
- Support for operational improvement, capacity building and asset management will also be important.

3. Existing Infrastructure and Operations

3.1. Introduction

This Section of the Pre-Feasibility Study focuses on a detailed description of the existing infrastructure, facilities and equipment for port operations, in particular, an analysis of the extremely limited capacity of this infrastructure to provide adequate port services as prescribed by *The Port Authority Act 2014*.

Both the Nauru Port Scoping Study (ADB/Oldfield, 2009) and the Preparatory Study for Aiwo Harbour (JICA, 2014) noted significant deficiencies with existing infrastructure and highlighted the constraints on operation of the port facilities at Aiwo.

Other development partners also note the poor condition of infrastructure and associated equipment. The NSDS (2009) stated:

“With the assistance of Taiwan the mooring relay system has been repaired and this has resulted in a significant increase in the number of ships visiting Nauru. However, further action is required at the ports to guarantee regular shipping services to Nauru. This includes an upgrade to the existing port and associated buildings, rafts, barges and cranes.”

Operation of the port has not changed in any significant way since 2009. Recommendations made in the Reeves and BMT-WBM studies (both 2009) have not been implemented. Accordingly the port is operating at a less efficient pace than was observed in 2009.

Anabare Harbour located on the east side of the island comprises a more recently constructed small boat harbour, used primarily as a safe harbour for domestic fishing boats. However, occasionally, particularly during the westerly monsoon season, containers are unloaded at Anibare Bay when wind and wave conditions at the Boat Harbour on the western side of the island are too severe to operate the transfer of containers from container ships.

3.2. Unique Geography of Nauru

The offshore topography of the island of Nauru is unique in the Pacific region and possibly world-wide. From the shoreline of the essentially oval-shaped island, a narrow fringing reef transitions to a seabed which drops away at an abrupt 45 degree slope, down to depths of more than 3,000 metres offshore. There is no lagoon or area of sheltered water inside the fringing reef which could provide sheltered water for a safe anchorage or harbour, as is typical of other Pacific Island Countries. Hence, the island is extremely exposed to Pacific Ocean swells and winds, particularly from the north-west during the monsoon season (October to March), and no natural harbour exists around Nauru’s coastline. Port facilities are limited to two small boat harbours, one on the western coast (Aiwo) and the other on the east coast (Anibare). There has historically been no opportunity to construct a safe harbour capable of berthing ships carrying general cargo, fuels and for the export of phosphate. The mooring system has been the only facility capable of mooring ships visiting Nauru since the middle of the 20th century.

3.3. Port and Shipping Operations

The port authority currently operates the following container handling equipment:

Pilot boat: (2010) (not operating)	1 no.
Sea mule boats: (2009) 250HP	2 no.
Flat barge: (2009) 30 tonne	1 no.
P&H Omega 65 tonne rough terrain crane	1 no.

Kalmar 32 tonne forklift truck	1 no.
Side-lifter truck, 20 tonne	1 no.

The pilot boat is currently not operational reportedly due to damage sustained to its hull. The boat is presently stored on the hardstand at Anibare Harbour. The 30 tonne flat-top barge has recently been repaired and is presently in service.

The loading and unloading of containers is problematic since the entire operation is exposed to the ambient wind and wave climate, and is severely limited by the inadequate container-handling equipment available. Limitations to operations include:

- An inadequate number of transfer vessels to keep pace with ship's gear loading/unloading at the ship;
- Every container is manually handled, with chain slings being individually fitted to each container at both the vessel and at the quay;
- A container yard layout which cannot be operated efficiently because of overcrowding with empty containers, leading to extended travel times for the forklift moving and placing containers in the yard;
- Lack of maintenance for all container-handling equipment and plant leads to unreliability of equipment availability, excessive plant breakdown and poor productivity.

3.4. Maritime Conditions

3.4.1. Tides

A detailed tide plane is not available for Nauru. The tides are reported to be as shown in Table 3-1.

Table 3-1: Tide Levels, Nauru

Tide plane		Level, m
Highest Astronomical Tide	HAT	not available
Mean Higher High Water	MHHW	not available
Mean Lower High Water	MLHW	not available
Mean Sea Level	MSL	1.170
Mean Higher Low Water	MHLW	not available
Mean Lower Low Water	MLLW	not available
Lowest Astronomical Tide	LAT	0.00
Nauru Island Datum		-0.229

3.4.2. Currents

Medium to strong currents are observed during the monsoon season. Typically these currents flow from south to north in the vicinity of the Boat Harbour. These currents predominate during the monsoon season and are reported to be far more benign during the Trades season.

Currents flowing parallel to the reef edge will have some impact on the berthing and mooring of all vessels when considering Options 1 and 3. The semi-enclosed harbour of Option 2 will be less affected by these currents.

3.4.3. Wave climate

Mean wave heights, wave periods, and wave directions are summarized in the table in Appendix B. Mean wave heights are typically 0.3 m higher from December to March compared to June to September, while mean wave periods are 0.7 seconds longer from December to March. Mean wave direction (direction from which waves arrive) are also listed; however the graphs show that the directional time series are bimodal or trimodal, so caution must be used when interpreted mean directions.

Section 5 expands the application of the wave information in guiding the preliminary layout of each port development option.

3.4.4. Marine Chart

No nautical or marine chart has been located for Nauru. However, accurate hydrographic information was obtained by SOPAC in October 2008, which provides a detailed bathymetric survey of the seabed surrounding Nauru for a distance of up to 8 km offshore.

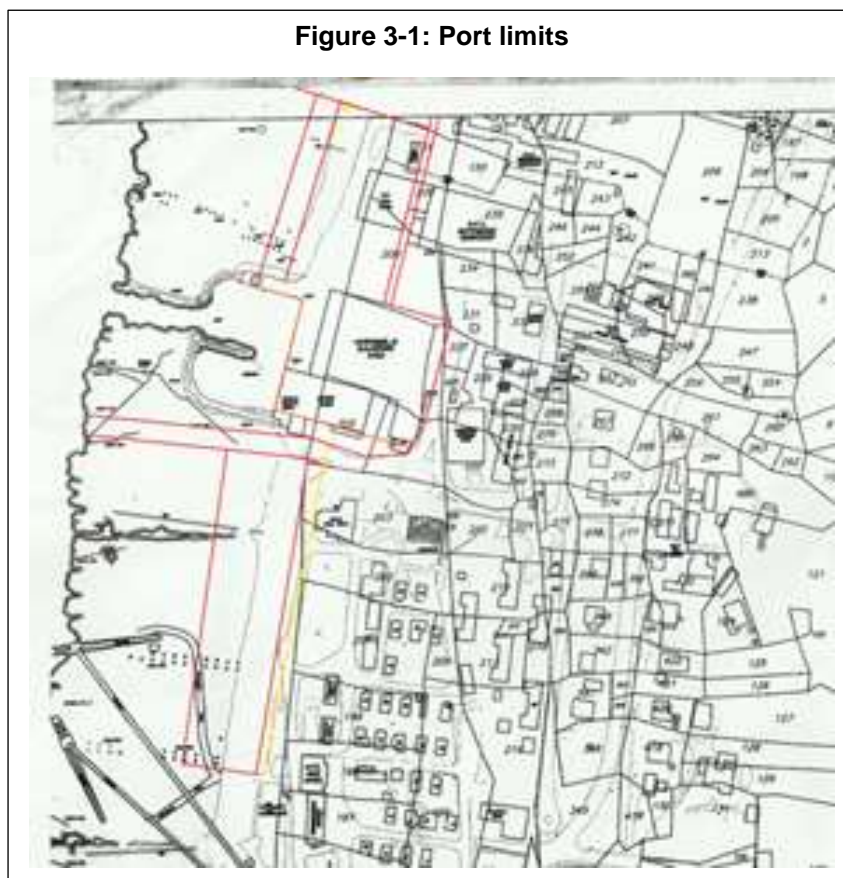
3.5. Port Infrastructure

3.5.1. Port Limits

The Nauru Port Authority has not been able to provide a map which defines the port limits. However, Figure 3-1 shows an indicative arrangement, provided by NPA, of what is considered to be the land occupied by the port. This diagram will be used to define the potential land available for expansion and development of the container yard and associated port infrastructure needed to redevelop the port. The *Port Authority Act 2006* requires that:

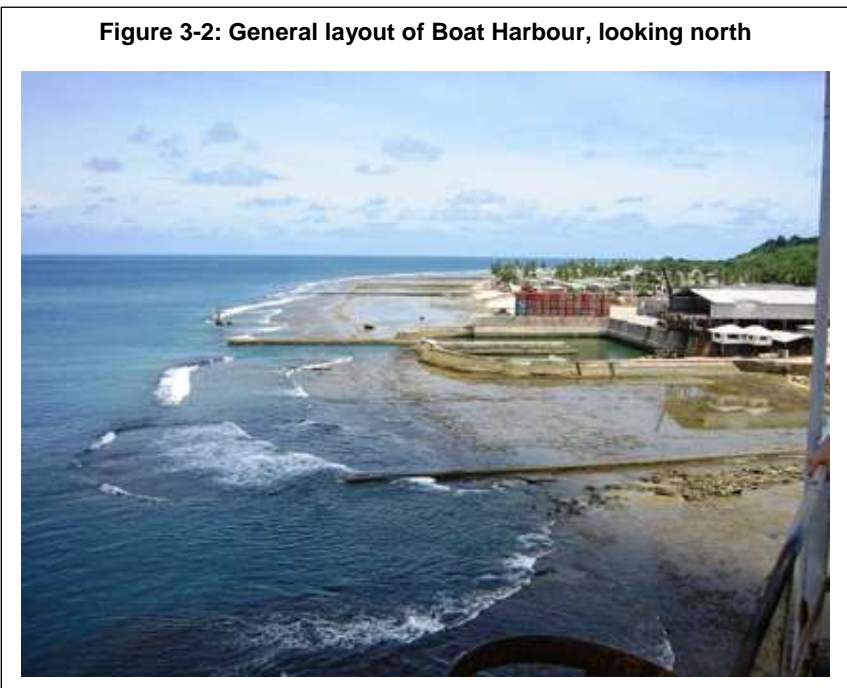
“A port determined or declared shall be defined by means of a chart or plan drawn up by the Ministry and published in the Government Gazette.”

In preparation for a PPTA for this project, the Ministry should endeavour to define the port limits. This will need to include an accurate cadastral survey of the proposed boundaries of the port (as shown in concept form in Appendix D) and of the land ownership parcels identified within the port boundaries. This is essential for all three identified port development options. Figure 3-1 shows the complexities involved in identifying land ownership within the port limits.



3.5.2. Boat Harbour

The Boat Harbour is believed to have been constructed around 1907, to provide a safe and sheltered anchorage for unloading imported general cargo and loading phosphate onto lighters for transfer to vessels anchored offshore. Despite its age, and the exposed nature of the outer perimeter of the Boat Harbour walls, it is in reasonable condition. Some remedial work was undertaken about ten years ago to repair the undercutting of the central harbour wall.



ADB (2009) provides a detailed description of the layout and operation of the Boat Harbour, where cargo is landed from the flat barges and sea mules. Containers and general cargo are unloaded from the barge and sea mules using the mobile crane. As noted in Section 3.6.1, this harbour is often not approachable during the monsoon season because of swell waves entering the harbour. The general layout of the Boat Harbour is shown in Figure 3-2.

3.5.3. Anchorage and Moorings

Anchorage for both phosphate dry bulk vessels and container vessels comprises a complex network of deep sea anchors, span and link chains, connecting plates and shackles and ten mooring buoys (Figure 3-3). This mooring system has been in operation in one form or another for more than ninety years and has provided a secure mooring facility for dry bulk ships, fuel ships and general cargo ships in a wide range of weather conditions. The present mooring configuration was originally installed in 1964 or thereabouts.

Ronphos has advised the Study Team that there are few if any alternatives available to replace this mooring system, because dry bulk ships need to be able to haul offshore away from the cantilever spouts during the loading process. This is essential so that the cantilever spouts can be repositioned above each hold in a particular sequence which facilitates even loading of the ship to avoid excessive loads on the ship's hull and to ensure that all holds are evenly loaded. Further discussion of options for replacing the mooring system is included in Section 5.

Figure 3-3 illustrates the layout of this anchorage or mooring system. It should be noted that the four 15 tonne anchors securing each of the outer mooring buoys, A1, A2, B1 and B2, are founded on the seabed at a depth of about 540 m.

Dry bulk vessels to be loaded with phosphate, and the bulk fuel vessels to be unloaded of liquid fuels moor between the A2 and B1 span buoys, while general cargo vessels moor to the A2 and B1 mooring buoys further offshore. Only one vessel at a time can be moored to the mooring system buoys.

Significant effort and attention is placed on keeping this mooring system in operational condition, with regular scheduled maintenance inspections undertaken every year. Failure of mooring system components rarely occurs as a result of normal wear and tear. Most component failures are due to overloading, invariably from general cargo vessels. An inspection of the mooring system in August 2009 made the following recommendations:

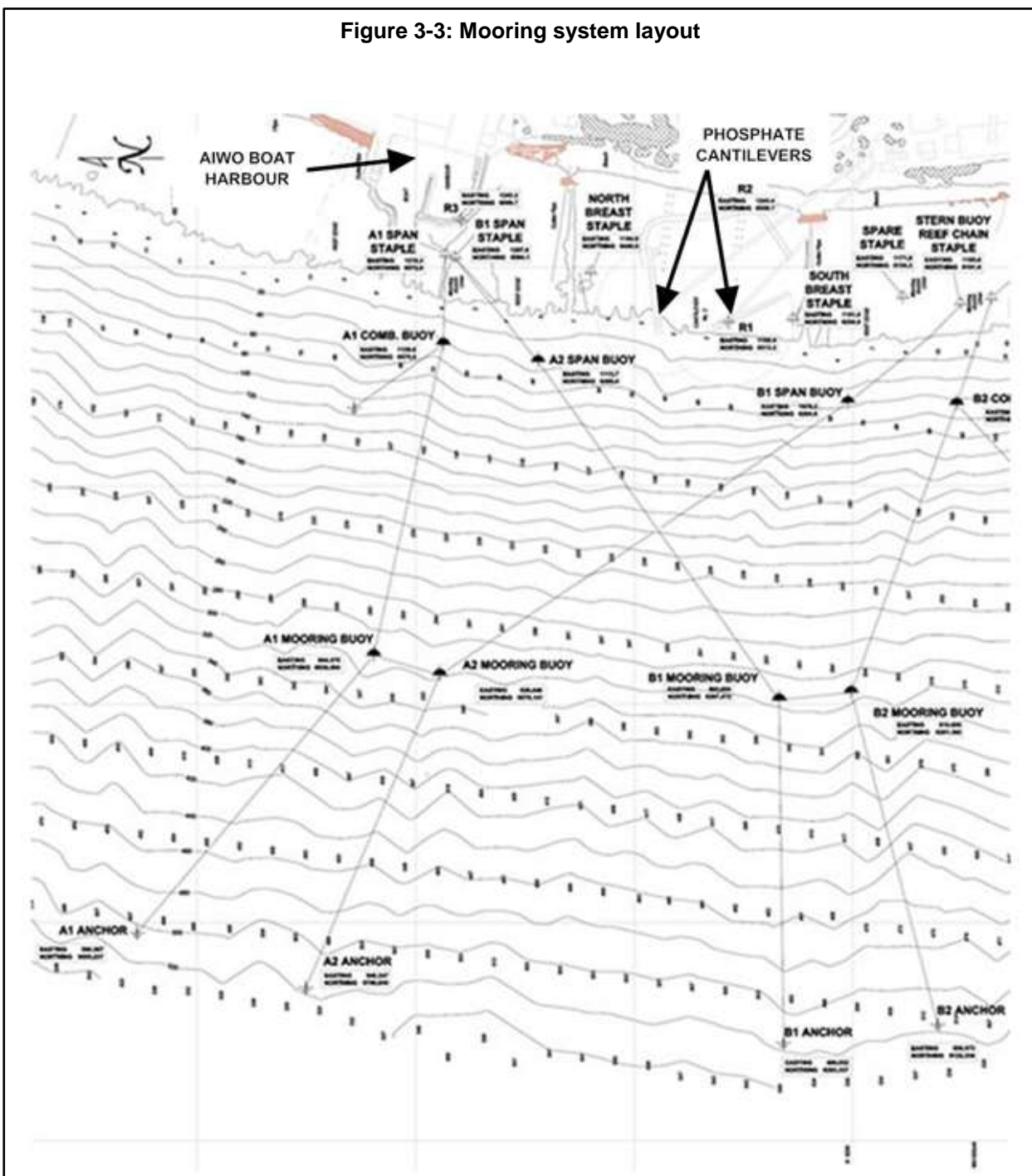
- The [weather operational] limits must always be implemented at the discretion of the Harbour Master, who retains ultimate responsibility for the safe operation of the berth, including the use of the pusher barges during berthing, loading and de-berthing operations.
- Ships in ballast/light condition: Particular care should therefore be taken to avoid berthing a ship in weather conditions which could deteriorate quickly and require it to be heaved out while still at or near ballast draft.
- The Harbour Master must ensure that the berth will be vacated if there is any likelihood that onshore wind gusts could exceed the limit for the vessel size.
- The mooring system must be surveyed annually to confirm acceptable physical condition of the rigging, appropriate stiffness of the sub-systems, no movement of the anchors.

Berthing/mooring operations in recent years using the mooring system to secure general cargo ships has resulted in a number of incidents which have subsequently caused failure of some components of the mooring system. Shipping operations are suspended while repairs are completed to the damaged components, which can result in significant delays to vessels. This problem is confirmed by the findings of the AusAID Nauru Port Infrastructure Priority Needs Assessment mission in September 2012 (AusAID, 2012).

In addition, routine maintenance of the mooring system is carried out on a regular basis, and the entire system is inspected and components replaced about every five years. Financial records suggest that this maintenance work costs in the order of A\$1 million (\$800,000) per year. The most recent partial replacement of the mooring system occurred in 2006. Extensive

maintenance and component replacement was being undertaken during the field visit in March 2015. During this time the moorings were not available for anchoring ships.

A detailed investigation of the mooring system has not been undertaken for this Study, being outside the Study's scope. However, there is considerable information available from a range of mooring experts and repairers going back a number of years. It is recommended that a detailed assessment of the mooring system and in particular the demands required to maintain the system should be made as part of the PPTA.



3.5.4. Buildings

A number of buildings occupy land within the port area, including:

- (i) Harbourmaster's office
- (ii) Barge shed
- (iii) Hardware & Bulkstore shed.

Figure 3-4: Badly corroded structural members in the Barge Shed



All these buildings are in very poor or derelict condition and must be demolished as soon as possible. Since 2009, successive studies have adamantly recommended that these buildings be demolished to provide additional space within the port to improve operations and increase the available land for container storage. The NPA has failed to implement these recommendations.

The barge shed, for example, is in such a dilapidated condition (Figure 3-4) that it is in danger of falling down, with serious safety consequences for NPA personnel. NPA management seems to be negligently oblivious of this situation. The Hardware & Bulkstore shed (Figure 3-5) contains corrugated asbestos cement roof and wall sheeting which may also pose a significant health issue for NPA personnel. The Harbourmaster's office (Figure 3-6) is supported on badly corroded structural members and could fail at any time. This office is entirely inadequate to serve as an efficient office for NPA personnel and is drastically in need of replacement. There is no gatehouse which could serve as a security office for controlling the security of the port. There is no ablution block for NPA personnel.

Figure 3-5: Dilapidated condition of Hardware & Bulkstore shed



3.5.5. Fuel unloading infrastructure

Fuels (aviation gas, petrol and diesel) are regularly delivered to Nauru by dedicated fuel tankers with similar dimensions to the general cargo vessels (refer Section 3.7.5 below). These tanker ships moor beneath the cantilevers and discharge through pipelines attached to the southern cantilever. Fuel tanks are located on the foreshore behind the cantilevers. A total net capacity of 35,000 litres is available. This is approximately equivalent to one month's consumption of fuels on the island. Discharging at a typical rate of 1 500 m³ per hour, a tanker vessel would complete discharging a full load in less than four hours.

3.5.6. Container yard

While the Port Limits shown in Figure 3-1 suggests a reasonably sized area which is available for land-side port operations, this port land is severely constrained from being fully available for container and general cargo storage and handling due to a number of unserviceable and derelict buildings occupying valuable space within the port. In particular, the Barge Shed and the Hardware & Bulkstore Shed (Figure 3-7) have a combined footprint of approximately 8,085 m². The total area available for container storage and landside port operations is approximately 21,800 m², hence these two sheds occupy about 37 percent of the available space. The remaining 13,700 m² is almost fully occupied by empty containers.



Figure 3-6: Harbourmaster's office



Figure 3-7: Hardware & Bulkstore building

3.6. Operational Efficiency Constraints

3.6.1. Monsoon season delays

In the monsoon season (November to March) strong westerly winds accompanied by wave swell from the west typically prevent both bulk phosphate carriers and general cargo vessels from mooring on the anchorage buoys. At these times, vessels are required to drift offshore wait until cargo transfer operations continue at the Harbourmaster's discretion. Draft Guidance to Pilots of Ships in the Port of Nauru, prepared in April 2009 by the Nauru Port Authority, prescribe the limiting offshore cargo handling conditions to be as described in Box 3-1.

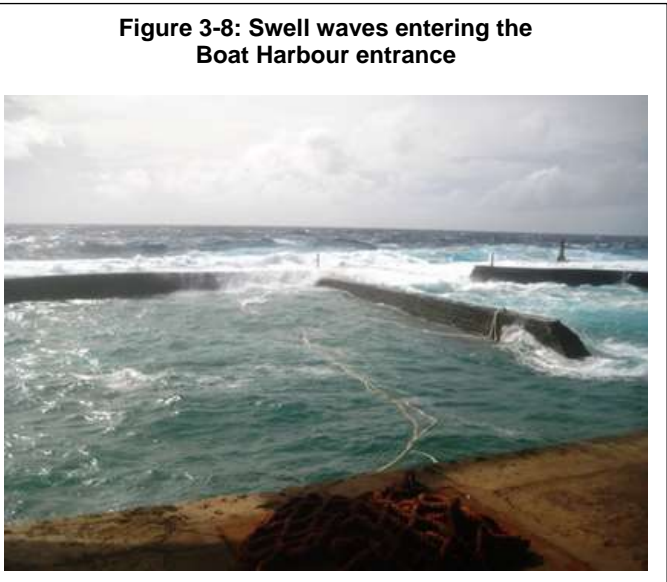


Figure 3-8: Swell waves entering the Boat Harbour entrance

Box 3-1: Mooring System Limits (source NPA, 2009)

The Mooring System is limited by the weather and in particular the wind velocity and direction. Current and wave effects do contribute, however they are not as significant as the wind, because wind loadings are proportional to the square of the wind velocity i.e. V^2

Because of the two distinct seasons that occur the following statement of the limits is provided:

1. The following limits must always be implemented at the discretion of the Harbour Master, who retains ultimate responsibility for the safe operations of the berth, including the use of the pusher barges during berthing, loading and de-berthing operations.

2. Ships in ballast / Light condition

Particular care should therefore be taken to avoid berthing a ship in weather conditions which could deteriorate quickly and require it to be heaved out while still at or near ballast draft.

3. The Harbour Master must ensure that the berth will be vacated if there is any likelihood that onshore wind gusts could exceed the limit for the vessel size.

Because of the current state of the mooring system the following limits apply:

Primary limit

For a typical bulk cargo carrier up to:

i.	Length overall	140 m
ii.	Deadweight (approx)	15,000 tonne
iii.	Maximum Gross Displacement	20,000 tonne

The limiting weather conditions are:

Wind speed - up to **25** knots from the western sector

Current max. - onshore current of 0.5 knot

- significant wave height (average height of one third highest waves. measured crest to trough) not to exceed 0.5 m (which corresponds approx. to max. wave height of approx. 1.0 m)

Calm Weather limit

For a typical bulk cargo carrier up to:

Length overall	170 m
Deadweight (approx)	25,000 tonne
Maximum Gross Displacement	32,000 tonne

The limiting weather conditions are:

Wind speed - up to **15** knots from the western sector

Current max. - onshore current of 0.5 knot

- significant wave height (average height of one third highest waves measured crest to trough) not to exceed 0.5 m (which corresponds approx. to max. wave height of approx. 1.0 m)

Minimum pretension on ships lines.

It is essential a minimum of 3 tonne be applied and maintained to all mooring lines between the vessel and the seaward mooring buoys, to ensure displacement of the vessel towards the reef is minimised.

Mooring Lines provided in aid

The port provides four 8 inch circumference lines, because of the length of line required to moor at the mooring buoys is beyond what is normally carried on board vessels visiting a port.

Furthermore these adverse conditions are hazardous for operation of the container transfer boats and barges due to rough sea conditions in the entrance to the harbour. Figure 3-8 graphically shows these adverse sea conditions in the harbour entrance, observed during the field visit in February 2015.

Table 3-4 in the JICA (2009) report illustrates the number of non-operational days for cargo vessels recorded from 2001 to 2004, then in 2006, 2007 and 2011. On average over these seven years of data, the reported number of non-operational days due to westerly monsoon wind and swells was 55 days annually.

3.6.2. Delays due to inadequate equipment availability

From time to time, the mule boats and barges used to transport containers between the moored ship and the harbour suffer breakdowns which cause significant reduction in the capacity of the Port Authority to maintain a satisfactory container transfer rate commensurate with normal practice for this method of operation. In 2009, the ADB report noted that typical productivity for transferring full containers from a ship was, in 2009, about 28 containers per day. In recent months, this productivity has reduced to as little as six containers per day because only the two multi-purpose boats have been available for transferring containers, with no support from a flat barge because of damage to the barge. Unloading a container into a multi-purpose boat using ship's gear is very time-consuming, which results in this low productivity.

3.6.3. Delays due to Moorings Non-availability

Occasionally, ships utilising the mooring buoys are over-zealous in their mooring practices and over-winch on their mooring ropes. This can and has in recent times caused some failures in components of the buoy and mooring system, including broken shackles and breakage of other linking components. When this occurs, typically during the westerly monsoon season between November and March, the moorings are not able to be used until repairs are completed and certified. This can take considerable time for the breakage to be identified, spare parts procured, lost chains recovered and shackles or other components replaced, tested and certified. Many of the repair tasks can only be undertaken during Spring low tides, which occur on a two-week cycle. Delays of up to three weeks, when no ships can moor, have been experienced. At these times, the moorings can't be used, phosphate ships cannot be loaded and fuel ships cannot be unloaded. General cargo vessels can sometimes be unloaded as these can drift while unloading operations are conducted. However, unloading of containers and general cargo tends to be even slower than normal.

3.6.4. Limited Export of Empty Containers

Owing to the delays to the transfer of loaded containers from cargo vessels as described above, container ships can be moored in Nauru for a week or more. As a consequence, the cost to the shipping line rises rapidly and to curtail these costs, a vessel is unlikely to wait in port while empty containers are loaded on for export and return to the shipping company. Hence, invariably the container ships leave port without their consignment of empty containers.

As a consequence of this situation, the container yard is presently fully occupied by empty containers, stacked up to 5-high, and there is no remaining space within the port to receive any additional empties. Furthermore space is extremely limited for storing loaded containers and most loaded containers are delivered directly to customers around Nauru.

Improved container handling operations, leading to an increase in productivity, will enable the port to back-load these empties over a period of time, thereby clearing the container yard for more cost-effective storage of full containers. However, as noted by Reeves (2009), adding container transfer vessels to the present fleet, other than one additional flat barge, is unlikely to significantly improve productivity without major investment in alternative container lifting capacity, such as a new fixed gantry crane.

The other significant hindrance to the matter of the empty container backlog is the relatively small and disjointed areas available for storing containers on port land. This unsatisfactory situation would be eased by the demolition of the barge shed and the hardware and bulk store shed located directly north of the barge shed.

3.7. Infrastructure and Equipment Effectiveness

3.7.1. Infrastructure and equipment constraints

Every infrastructure component of the port, including the Boat Harbour, the transfer vessels for moving cargo from moored vessels to the Boat Harbour, craneage to lift containers from the barges, and a congested container yard (and other parts of the island) full of empty containers, all contribute to poor productivity in handling and delivering cargoes to customers, thereby attracting costs which could otherwise be avoided. This is reflected in the supply chain in the cost of goods in Nauru.

While the Boat Harbour has served the needs of cargo transfer from cargo vessels for many decades, the methods used to transfer containers from these cargo ships into the port are outdated, unsafe and a highly inefficient use of available resources and infrastructure. Inadequate budget for maintaining and replacing mule boats results in poor availability of these boats for efficient container transfers from ship to shore. As a consequence ship's gear to unload containers is under-utilised. Inadequate craneage to lift containers onshore within the Boat Harbour adds to the inefficiency of container transfer to the port. A crowded and congested container yard means that the one forklift truck moving containers from the quay-side mobile crane travels greater distances through the container yard than necessary, further adding to the poor productivity of the overall container-handling operation during ship loading/unloading.

3.7.2. Seasonal constraints

Productivity is further eroded during the four months of the monsoon season when the Boat Harbour is often unusable due to excessive intrusion of swell waves. During this season, container unloading is often relocated to the eastern side of the island, where Anibare Harbour is utilised for unloading containers from cargo vessels drifting in Anibare Bay. Anibare Harbour offers reasonable protection from westerly winds and waves during this season for safe loading/unloading of the sea mules using the mobile crane. However, the hardstand area available at this harbour is very small (approximately 500 sq m) which severely constrains the safe and efficient transfer of containers onto side-lift trucks to remove the containers from the harbour. Furthermore, there is no mooring system or other anchorage facility in Anibare Bay, so cargo ships are required to drift under power during loading/unloading operations.

3.7.3. Container yard capacity and empties management

Poor productivity in the port has caused delays to ship sailing schedules, with the consequence that ships are unwilling to wait in port to back-load empty containers, once their full containers have been unloaded. Consequently the container yard has filled to capacity with empty

Figure 3-9: Empty containers stacked in the container yard



containers (Figure 3-9) and empties are scattered across Nauru, occupying valuable land. Any redevelopment of the port's infrastructure needs to include a major investment in improving the efficient operation of the container yard, with the aim of providing additional space for storing and handling containers and general cargoes. In parallel with this expansion of the available space to accommodate a larger number of containers is the need to clear the substantial backlog of empty containers stored in the container yard. This can only be achieved by improving the container-handling procedures to increase the productivity of loading and unloading containers, across the entire container-handling process from ship's hold to departure of a container through the port gate.

3.7.4. Container yard constraints

Over recent years a number of studies have made recommendations for the two sheds (the Barge Shed and the Hardware and Bulkstore building) to be demolished to open up the port area for more efficient landside port operations, in particular to make additional land available for the productive operation of container handling within the port. These recommendations have not yet been implemented.

NPA has been one of the last port authorities world-wide to obtain International Ship and Port Facility Security (ISPS) Code accreditation with the International Maritime Organization (IMO). The ISPS Code requires ports to implement security measures to include:

- Port facility security plans
- Port facility security officers
- Certain security equipment
- Monitoring and controlling access
- Monitoring the activities of people and cargo
- Ensuring security communications are readily available.

Observation of the operations within the port readily demonstrate that most of these security measures are not in place and NPA does not have the resources, infrastructure and procedures which would be needed to comply with the ISPS Code. The most significant omission in this regard is the complete absence of a perimeter security fence around the port site. The port limits are uncertain and personnel and members of the general public enter the port with no restrictions. The activities of the port and Ronphos appear to occur on mutually occupied land, thereby rendering any security within the port limits ineffective.

NPA has reported on a number of occasions over recent months (NPA Monthly Reports, December 2013 and July 2014) that:

“Performance management

The Port area is not a secured area and therefore all staff comes in and out at random in their own times. Until we have a fenced area, then we can control the performance of our staff. They come in at the front gate and goes out at the back gate.”

3.7.5. Fuel unloading

The supply of fuels to Nauru is also constrained by current operating practices. The fuel pipelines used to transfer bulk fuels from vessels is suspended on the northern phosphate cantilever and bulk fuel ships berth at the phosphate berth beneath the cantilevers to unload their liquid fuels. Since dry bulk phosphate ships have universal priority access to the phosphate berth, there can be delays to bulk fuel ships waiting for the berth to be cleared.

3.7.6. Ship access priorities

Exporting phosphate is one of the primary core tasks for the NPA and Ronphos. Accordingly there is a vessel priority arrangement whereby a dry bulk vessel arriving at the port to take on a load of phosphate has priority access to the anchorage beneath the cantilevers over all other vessels. Hence, bulk fuel vessels and general cargo and container ships are not permitted to utilise the anchorage while a phosphate ship is berthed and loading. As noted above, the mooring system has the capacity to handle only one vessel at any time, so fuel and other cargo vessels are required to stand off and drift, waiting for the anchorage to be vacated. Typically a ship can be loaded with its parcel of phosphate in around eight hours, if all conditions are favourable for the operation. Hence, except when unfavourable weather or sea state delays phosphate loading, other vessels are rarely delayed for more than a day by phosphate vessels occupying the anchorage. Separating the berth utilised by the dry bulk phosphate ships and all other vessels would be desirable, bringing benefits to the operation of the port. These benefits will include the capacity to berth two ships concurrently and reducing the wear and tear on the mooring system by eliminating the need for all ships other than phosphate ships to use the mooring system.

4. Trade Activity

4.1. Introduction

This Section of the Pre-Feasibility Study focuses on a detailed description of the trade activity through the port, both the five year historic and five year forecast activity. Forecast of future trade volumes, measured in both the number of ship arrivals and in cargo volumes, provides a basis for determining the future demand for port facilities which are expected to be adequate to satisfy the needs for a port as prescribed by *The Port Authority Act 2006*.

4.2. Nauru Port Current Activity and Forecasts

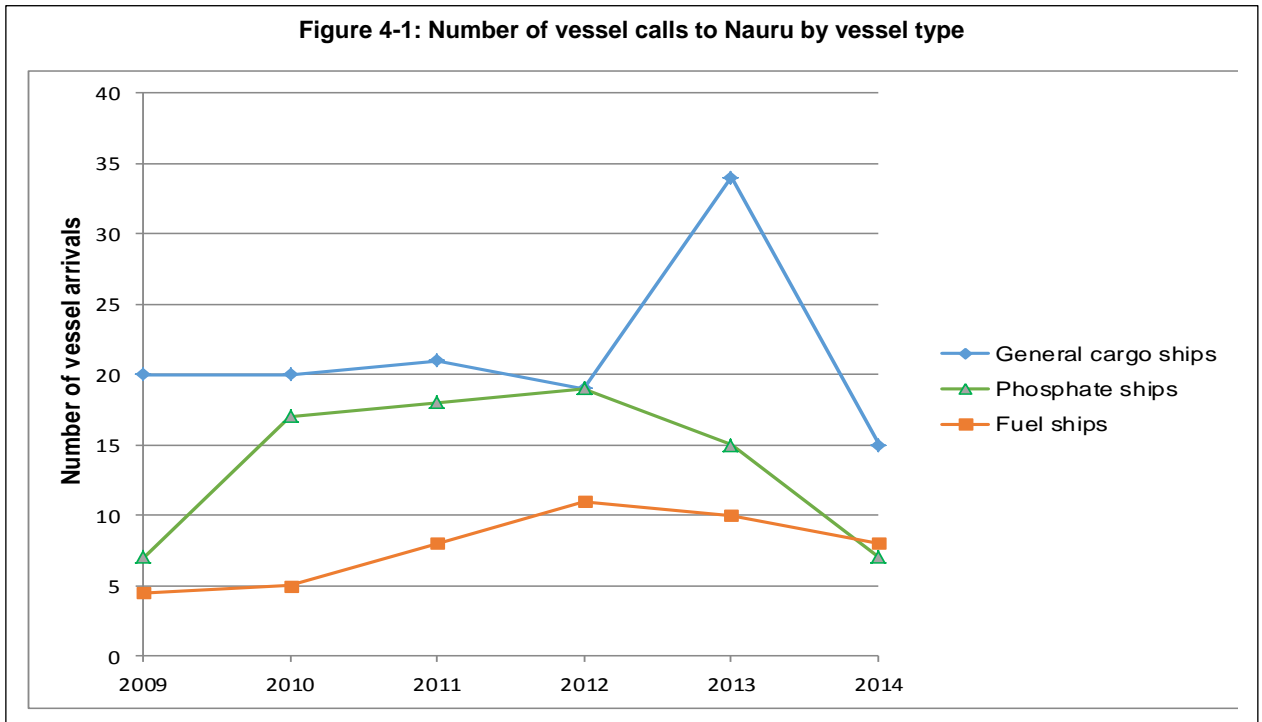
4.2.1. Ship arrivals

Vessels currently arriving at Nauru fall into three categories: dry bulk phosphate export, bulk liquid (fuel) import and general cargo/container vessels. Table 4-1 and Figure 4-1 show vessel numbers by vessel type. The number of general cargo vessels increased significantly in 2012/2013, coinciding with the reopening of the Nauru Regional Processing Centre (RPC) in August 2012. The number of dry bulk phosphate vessels has remained reasonably consistent over the five years of recent trade, indicating a reasonably consistent export trade in phosphate. The reduced number of phosphate vessels in 2014 may be attributable to unseasonal weather conditions combined with a number of incidents with general cargo vessels where the mooring system was damaged, leading to delays in berthing phosphate ships while repairs to the moorings were undertaken.

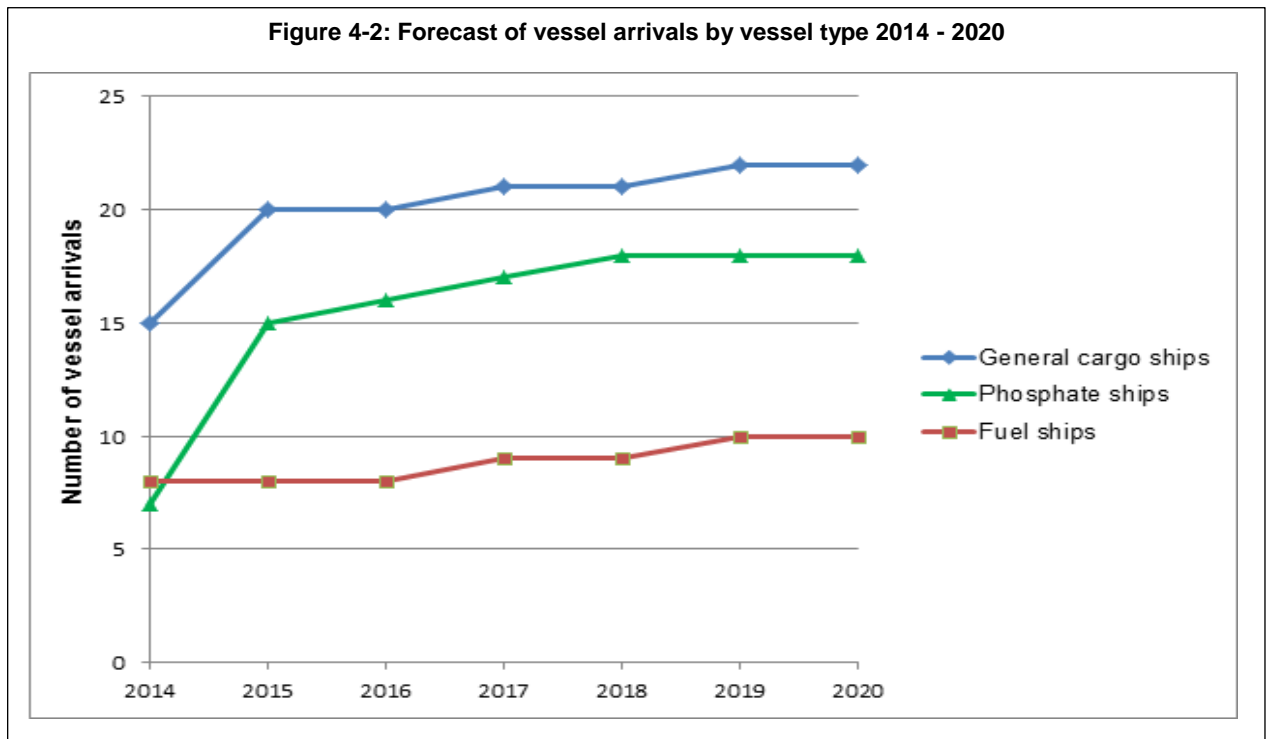
Vessels which operate outside the confines of the port include small boats using Anibare Harbour and aggregate and rock export barges towed by seagoing tugs and operating at a dedicated rock loading landing located to the south of the port have been excluded from this traffic analysis. These vessels and the trade they support are not expected to occupy new a port facility and instead will continue to operate at their separate dedicated facilities. Hence they are ignored for the purpose of determining what new port facilities are needed to serve the future trade through the port.

Table 4-1: Ship arrivals per year, 2009 - 2014

Vessel Type	2009 (6 month) Actual	2010	2011	2012	2013	2014 (actual)
Container Ship Calls per Year	10	20	21	18	32	14
Phosphate Ship Calls per Year		17	18	19	15	7
Fuel Ship Calls per Year	3	5	8	11	10	8
Total Ship Calls per Year	13	42	47	48	57	29



A forecast for the next five years shows a trend of relatively modest growth in numbers of vessel arrivals for all three vessel types corresponding to modest growth in trade expected over this period. This forecast is based on the assumption that the RPC continues to operate over this period, requiring ongoing servicing and maintenance. The forecast vessel arrivals at Nauru are shown in Figure 4-2.



4.3. Existing and Future Port Capacity Requirements

4.3.1. General

As a consequence of both the slight growth in trade predicted for Nauru, together with the very poor condition of the existing port facilities, the port's capacity to provide adequate services for import and export trades has already been attained. NPA has previously been provided with advice and recommendations for improving the port's efficiency in the short term but this has not been acted upon, due to a shortfall in available capital funds within the port's budget. Development options for meeting the future demand with the current port facilities primarily focus on a short-term improvement program for improving the existing facilities to operate the port more efficiently. Implementation of this short-term improvement program requires NPA to modify its operations so that revenue can be grown to provide funding for these improvements.

4.3.2. Existing and future port traffic

Past (2009 to 2014) volumes of various cargoes handled through the port are shown in Table 4-2.

Table 4-2: Cargo throughputs and ship numbers 2009 - 2014

Description	2009	2010	2011	2012	2013	2014
Imported TEUs/year	850	645	721	944	2,485	1,835
Exported TEUs/year	676	604	700	630	1,308	1,021
Total TEUs/year	1,526	1,249	1,421	1,574	3,793	2,856
No. of general cargo ships	20	20	21	18	32	14
No. of phosphate ships	7	17	18	19	15	7
No. of fuel ships	5	5	8	11	10	8
Total no. of ships	32	42	47	48	57	29

The container yard size required to operate efficiently is dictated by the volume of containers handled and the time needed to handle these containers. Other cargo volumes, such as phosphate and fuels, have not been assessed for determining the size of the container yard since these cargoes are handled by dedicated unloading facilities external to the port. From 2015 to 2020, the forecast container volumes are shown in Table 4-3.

Table 4-3: Forecast cargo throughputs and ship numbers 2015 - 2020

Description	2015	2016	2017	2018	2019	2020
Imported TEUs/year	982	1,021	1,062	1,104	1,149	1,194
Exported TEUs/year	1,174	1,350	1,553	1,786	2,054	2,362
Net TEUs/year	192	329	491	772	905	1,168
Cumulative net TEUs	192	521	1,012	1,784	2,689	3,857
Total TEUs/year	2,156	2,371	2,615	2,890	3,202	3,556
No. of general cargo ships	20	20	21	21	22	22

The average time to unload and load a ship is based on a sample of recorded times for vessels taken in 2009, which shows that the current operation where a general cargo vessel is moored offshore on the anchorage can transfer eight containers in a normal hour of operation. These data were recorded when conditions were favourable for efficient transfer of containers. Less favourable conditions would slow the transfer rate.

For a port facility where the vessel could operate at a quay wall, loading/unloading directly to the quay with ship's gear, it is expected that a typical loading/unloading rate will be 20 TEUs per hour, when utilising two ship's cranes for unloading and loading. This rate can only be sustained

if land-side facilities, container-handling equipment and manpower are provided to match this productivity rate.

4.3.3. Container yard size

In assessing the capacity of the existing container yard to handle the existing and future forecast container volumes, a number of operating assumptions have been made. These include:

- (iv) Full imported containers are stacked two-high, to facilitate ready access from the stacks to deliver to customers. While stacking higher than two-high increases the capacity of the container yard, accessibility to individual containers is significantly reduced;
- (v) Empty containers (for export) are stacked three-high;
- (vi) One forklift truck with capacity to lift full containers is available at all times to operate in the container yard;
- (vii) Up to two smaller forklifts are available at all times to move empty containers;
- (viii) The average cycle time for loading and unloading a container vessel is 20 TEUs per hour;
- (ix) Containers are held in the yard for an average time of 6 days.

Using UNCTAD guidelines¹, it is estimated that the sizes of container yard needed for current and future forecast container throughput are shown in Table 4-4.

Table 4-4: Container yard size estimate

Year	Container Throughput, TEUs/year	Container Yard Size, hectares
2015	2,200	1.3
2018	2,900	1.7
2020	3,600	2.0

This estimate of container yard size is further supported by the fact that the existing container yard is 2.2 hectares in area, and appears to be adequately sized if some derelict sheds are demolished. The current available space is approximately 1.4 hectares. However, this space appears to be inadequate primarily because of the substantial backlog of empty containers held in the yard which need to be cleared and returned to their home ports.

4.3.4. Container-handling equipment

The Port currently provides stevedoring services in the container yard with one large fork lift truck (FLT) and one smaller FLT, along with the all-terrain mobile crane. This combined fleet has the capacity to handle up to 8 TEUs per hour in the yard at its present size of two hectares. Based on industry benchmarks for Pacific Island countries, the FLT should be able to deliver up to 12 TEUs per hour when unloading and loading a container ship. This productivity rate is rarely achieved because:

- The distance to travel from the ship to the storage slot in the yard can be long, requiring excessive travel time;

¹ UNCTAD, Port Development, A handbook for planners in developing countries, 1985.

- Some break-downs reduce the availability of FLT's in the yard;
- Productivity can be dictated by the capacity of ship's gear to load and unload the ship.

Productivity between the quay and the container yard can be improved by providing other container-handling equipment. Tractor-trailer combinations can be useful as they can be loaded directly by ship's gear without the aid of a FLT and can travel to the distant container slot in the yard typically more quickly than a FLT.

4.3.5. Number of berths

The present and forecast future container volumes and ship numbers also provides the necessary data to estimate the number of berths required to support the ship arrivals without constant queuing of vessels. Again using the UNCTAD Guidelines, the estimated number of berth days needed to accommodate 22 container ships and 10 fuel ships per year, as forecast for 2020, is 70 berth days. This analysis is validated using the estimated ship stay per voyage of 30 hours, a ship stay period typical of Pacific Island ports (the actual average in 2014 was 10 days for general cargo vessels and 3 days for fuel ships). Hence, to accommodate 70 berth days per year (365 days) only requires one berth for the number of vessels forecast to arrive in 2020.

4.3.6. Other potential trade

Apart from the three dominant trading commodities being exported or imported to Nauru – phosphate, rock and aggregate products, containers/general cargo and fuel, the likelihood of new major import or export trade volumes is highly unlikely. There may be an opportunity for fish transshipment if a suitable port facility is made available.

A number of potential exports have been discussed in previous Studies, including:

- (i) Export of rock and rock products – these commodities are being produced by NPC and exported primarily to Majuro for coastal protection works against sea level rise and storm activity. This trade is growing after starting around 2008, and all products (armour rock and aggregates) are being loaded onto their transshipment barges at a landing separate from the port facility. A new landing is expected to be constructed near Anibare Harbour in Anibare Bay. The port will not be utilised for exporting this trade.
- (ii) Fish from a processing plant – while a processing plant for fish canning has been discussed on Nauru for many years, the major hindrances to this trade becoming established in Nauru include a shortage of water and power, as well as a lack of skilled labour to be employed in the plant. It is highly unlikely that any sort of fish processing will ever be established in Nauru.

Hence, no new trade commodities are expected to require port facilities in the foreseeable future.

5. Engineering

5.1. Introduction

This Section of the Pre-Feasibility Study focuses on the engineering aspects of future development of the port, in particular, the preparation and engineering assessment of the three options for a new port facility.

5.2. Port Infrastructure and Shipping Operations

Section 4 of this Report describes in detail the existing infrastructure available at the port to support the provision of essential port services as prescribed by *The Port Authority Act 2014*.

Significant shortcomings in both the infrastructure and the operation of the port have previously been identified in studies conducted in 2009 (ADB, Reeves), 2012 (AusAID/World Bank) and 2014 (JICA), and the recommendations of those studies have not, as far as can be ascertained, been implemented by NPA. In fact, it is evident that the core infrastructure of the port facilities has further deteriorated to an extent that operation of the port is constrained and limited to a significantly lower level than was reported in 2009 and 2014.

The need for capital investment in a new port facility is clearly evident. It is also clear that a major investment in upgrading the port facilities needs to be accompanied by a radical change in the way the port is administered, maintained and operated. If this is not realised, the new facility proposed by this Study will rapidly deteriorate to a state of limited capability and will again fail to provide the services required by *The Port Authority Act 2014*.

5.3. Concept Design Criteria

The concepts for each development option investigated for this Study have been prepared using a range of design and operating criteria, including:

5.3.1. Design Vessels

The design dry bulk phosphate vessel, general cargo vessel and fuel vessel has the characteristics outlined in Table 5-1.

Table 5-1: Design capacity for dry bulk phosphate vessels, general cargo and bulk fuel vessels, (as limited by the design capacity of the mooring system)

	Dry bulk phosphate vessel ¹		General cargo vessel	Bulk fuel vessel
	Calm weather ²	Limiting weather ³		
Length x Beam, m	192 x 28.3 170 x 25.5	150 x 24.0	100 x 17.3	100 x 15.5
Draft, m	11.0	8.5	6.0	6.4
Deadweight tonnage (tonnes)	37,500 25,000	15,000	4 800	5 200
Displacement (tonnes)	45,000 32,000	20,000	3,650	4,400
Container capacity	not applicable	not applicable	224 TEU	not applicable
Volume capacity (m ³)			not applicable	5 447
Load-out rate, maximum	not applicable	not applicable	not applicable	2 400 m ³ /hr (300 mm dia discharge)

1. As shown in OMC (2009) for the mooring system design of 1993
2. Calm weather conditions are: wind up to 15 knots from the west, plus onshore current of 0.5 knot plus significant wave height up to 0.5m

3. Limiting weather conditions are: wind up to 25 knots from the west, plus onshore current of 0.5 knot, plus significant wave height up to 0,5m.

5.3.2. Design Life

A major port facility of this nature needs to be designed with a Design Life of at least 50 years, as prescribed in Table 6.1, AS 4997-2005, *Guidelines for the Design of Maritime Structures* for normal commercial structures, and BS 6349, *Maritime Structures Code*.

5.3.3. Channel and turning basin design

The principles and guidelines provided in PIANC Report No. 121 – 2014 *Harbour Approach Channels - Design Guidelines* have been adopted for estimating the approach channel and turning basin dimensions for Option 2, and for assessing the navigation requirements for ships approaching the quay wall in Options 1 and 3.

5.3.4. Fendering design

Concept design for the berthing of vessels and the associated fendering for the three Options has been based on PIANC Report WG33, 2002, *Guidelines for the Design of Fenders Systems*.

5.3.5. Container yard size and features

Demolition of derelict and unutilised buildings within the port area will clear the way for redeveloping a new container yard which will be far more efficient in storing and handling containers and general cargoes. This container yard is a common element for all three options for the port's redevelopment. A heavy duty pavement, suitable for carrying the loads imparted by a fully laden forklift truck and other heavy container vehicles, will be needed across the entire container yard.

The desirable size for the container yard is determined by analysing the demand for container storage, based on annual container throughput through the port, and the typical waiting time for a container to be held in the yard before delivery to the customer. This analysis assumes that the container yard is not simply used for storing empty containers as presently occurs. As previously noted, one of the main aims of providing a new port facility is to enable the backlog of empty containers to be cleared back to Brisbane and other home ports.

Based on an annual container throughput of about 3,600 TEUs per annum, and an average waiting time for a container of six days, the total area needed for a container park is estimated to be 2.0 hectares (20,000 m²). This container yard will need to include new buildings (Harbourmaster's office, ablution block, gatehouse and plant workshop). To comply with Pacific Island port infrastructure benchmarks, the area will also need to be provided with area security lighting, a set of reefer electrical plugs and a fire ring main with a number of fire hydrants. The entire paved container yard will have a stormwater drainage system to ensure the area remains flood-free. For Options 1 and 2, the existing fuel pipeline located on the cantilever will be relocated to the new quay wall so that the unloading of bulk fuels can be removed from the cantilever moorings. To comply with the IMO's ISPS Code for port security, the entire port yard will be enclosed with a security fence, accessible via a single security gate for entry and exit. The security gate will be serviced by a manned security gatehouse.

The container yard area of 2 hectares can only be provided by removing derelict buildings from the port area, namely the barge shed (north and south sides), and the hardware and bulk store shed. This will open up an area of about 8,100 m² of land which is currently unavailable for port operations.

5.4. Assumed construction methods

As described in ADB (2009), the construction method adopted in this Study for the quay walls incorporates a mass concrete block structure constructed on a prepared flat base excavated into the reef. Precast concrete blocks are constructed in a precasting yard and positioned into the quay wall using a barge-mounted floating crane. These precast blocks will be shaped so that successive blocks are keyed into the preceding layer of blocks, thereby forming an interlocking mass structure with the capacity to withstand the expected berthing and wave loads. Figure 5-1 shows an image of wall under construction using this method.

One of the benefits of this construction method is the total avoidance of the need to drive or bore piles into the reef rock, which is expected to be too hard to receive driven or bored piles. This is likely to deliver cost and time savings although the method requires floating dredging plant for excavating the reef, substantial barge-mounted craneage for constructing the quay wall and water to mix the concrete on-island. The other advantage is that the concrete blocks do not contain any steel reinforcement which eliminates the problem of reinforcement corrosion leading eventually to rapid deterioration of concrete structures commonly experienced in the marine environment.



Figure 5-1: Concrete block quay wall construction

This method of quay wall construction is particularly suited to Nauru because extensive quantities of rock suitable as concrete aggregate are readily available on Nauru, and NRC already have in place an aggregate crushing capability which is presently used for the export of significant volumes of crushed rock products. Hence, the concrete blocks can be cast using local aggregates and local labour, with the need to only import cement and materials for reusable forms for casting the blocks. This significantly reduces the need to import construction materials such as steel tube piles and steel reinforcement.

BS 6349-2 describes in detail the design approach and methods for this type of mass quay wall. Recent examples of this type of quay wall construction for port development includes Qatar’s Doha Newport project, completed in 2014 and comprising more than 35,000 concrete blocks each weighing 110 tonne to complete a quay wall 8.5km in length. Previous examples of this type of quay wall construction include the Jebel Ali port

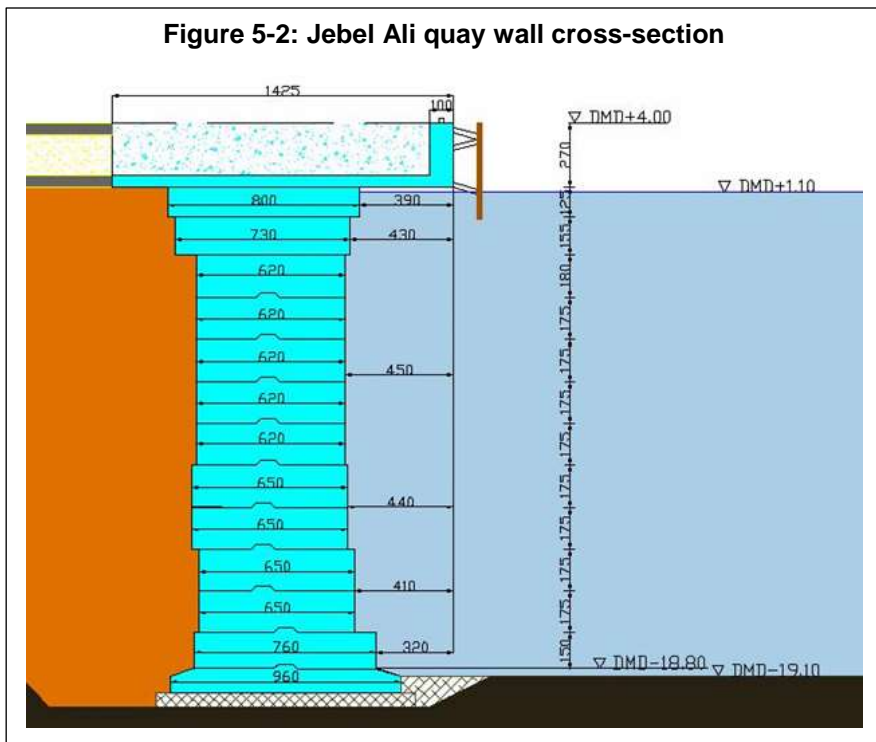


Figure 5-2: Jebel Ali quay wall cross-section

structures in Dubai, constructed over 30 years ago. This construction technique is expected to be used again for the upcoming expansion of the port at Jebel Ali. A typical cross-section of the Jebel Ali quay wall is shown in Figure 5-2.

While this site is considered to be well suited to this method of quay wall construction, some of the possible risks include:

- The possibility that the reef will be too weak to support the mass concrete structure. This must be thoroughly investigated as part of the geotechnical investigations for the project;
- The cost of a large floating crane to lift the concrete blocks into place will be too costly for this method to be cost-effective (the cost estimates in Section 6 use crane costs drawn from port projects in the Cook Islands and Vanuatu).

This same construction method (i.e., mass concrete block quay wall) has been adopted for all Options investigated in this study. The risks highlighted above will therefore be common to all options and will have a limited influence on the relativity of costs and economic viability between the options.

JICA (2014) proposed a different construction method for the quay wall. They showed a quay wall with the front and rear wall of concrete blocks with infill between these walls of compacted general rubble fill. This general rubble fill would be sourced from the material excavated from the reef and from a general fill source on the island.

While this construction method recommended by JICA has merits, its disadvantages include:

- (i) A slower method of construction with little or no cost reduction over the concrete block wall method (Section 6.8 and Appendix C provide a high level comparison of the proposed project's cost estimates compared with JICA's previous cost estimates for a similar infrastructure solution);
- (ii) The potential for the fill between the walls to settle over time, thereby resulting in an uneven trafficked surface which would need regular maintenance;
- (iii) The need to source suitable fill from onshore, since excavation of the reef will not generate adequate quantities of suitable fill material;
- (iv) Substantial temporary earthworks to provide access platforms for placing concrete walls and general fill.

5.5. Quay wall foundations

The proposed concrete block quay wall will require a sound foundation on the excavated reef edge. It has been assumed, based on observation of the reef and on advice from Lloyd Honeycombe (pers com) that an excavated shelf along the edge of the reef, either north of or south of the existing Boat Harbour, will provide a sound foundation capable of supporting the considerable load imparted by the concrete block quay wall.

This assumption will need to be testing during the PPTA by undertaking extensive geotechnical investigations along the edge of the reef to determine the underlying strength of this foundation.

5.6. Wave Climate and Sea Level Rise

A preliminary analysis of the wave climate and sea level rise predictions for the Nauru region has been undertaken. A full report of this task is presented in Appendix B.

5.6.1. Wave climate

Observational data contributing to an understanding of Nauru's wave climate are, generally speaking, sparse over the relevant time frame (decades), collected by instruments that are not

regularly maintained, and although difficult to access in situ, are available online. Wind-wave buoys are rare in the Pacific and contain very short records; it is believed that the only operational wave measuring buoy is in the vicinity of Guam. Model and reanalysis (hindcast) data are needed to understand the local wave climate. Meteorological data, which contribute to an understanding of the climate regime, are collected on Nauru from two automatic weather stations and a manual rain gauge near Yaren. Rainfall data are available from 1893 to present and air temperature from 1951 to present, however significant gaps exist in both data records.

Climate projections for Nauru and the Pacific through to 2080 have been prepared by the Pacific-Australia Climate Change Science Adaptation Planning program (PACCSAP) using rigorously assessed models. The U.S. National Center for Environmental Prediction (NCEP) developed the Climate Forecast System Reanalysis to deliver a high resolution hourly surface wind product for 1979-2009. Wave climate statistics were extracted from the Reanalysis by the Centre for Australian Weather and Climate Research (CAWCR) and serve as a baseline for recent past conditions.

Wave climate and climate change trends around Nauru are affected by processes occurring over large areas of the Pacific Ocean, from the northern to the southern subtropical zones (35°N to 35°S), and across the equator, so it is instructive to understand the regional patterns that affect local conditions around Nauru, especially when designing for a 50 year lifespan.

Cyclones do not occur within a band of approximately +/- 5 deg of the equator. No cyclone activity has been reported for Nauru based on data dating from 1969 in the Southern Hemisphere and 1977 for the Northern Hemisphere. However recent research has indicated that extra-tropical cyclones from as far away as 35 N can bring extreme sea swells leading to destructive impacts on some equatorial islands thousands of kilometres away from the storm origin (Walsh et al 2001). Such an effect was observed in Nauru around the time of the development of Cyclone Pam which devastated Vanuatu in March 2015.

At Nauru's port, wave and swell conditions disrupting port operations occur year-round and intensify during the monsoon (December to March) season. Within the context of this assessment, 'waves' will refer to wind-generated waves, while 'swell' will refer to non-local waves that have travelled to Nauru from great distances.

Throughout the tropical western Pacific, a multi-modal wave spectrum is observed, with contributions from locally trade wind-generated seas, swell waves generated in both the northern and southern hemisphere extra-tropical storm belts, and episodic tropical cyclone events.

As noted, swell can arrive near Nauru from thousands of kilometres away with little dissipation of energy. Once a series of long-period swell reaches the rapidly shallowing bathymetry of Nauru's reef edge, significant wave heights can quickly reach disruptive levels and remain problematic for days.

The mean wave climate in the equatorial Pacific has the following dominant features:

- Northerly swell contributions occurring in December to March from North Pacific extra-tropical storms.
- Southern Ocean generated swell is present year round, peaking in June to September.
- Locally generated trade wind waves typically peak in the winter of the respective hemisphere, but are affected by movement of the Inter-tropical Convergence Zone (ITCZ) and South Pacific Convergence Zone (SPCZ).

- The West Pacific Monsoon can produce locally generated westerly waves in the western Pacific.
- Many locations observe extreme waves due to tropical cyclones.
- Interannual variability is frequently linked to the El Niño Southern Oscillation (ENSO), which can affect movement of the ITCZ and location of tropical cyclones.

Mean wave heights, wave periods, and wave directions are summarized in Table 5-2.

Table 5-2: Wave parameters at Nauru

Wave parameter	Season	Hindcast result (1979 – 2009)	Climate model simulation from PACCSAP (1986 – 2005)
Mean wave height, m	Dec – March	1.5	1.7
	June - Sept	1.2	1.2
Mean wave period, sec	Dec – March	9.3	8.4
	June - Sept	8.6	7.9

Swell directionality is clearly bimodal. Swells arrive from NNW with a probability of approximately 12% and wave heights up to 2 m, likely leading to a coastal current from North to South in the vicinity of the port. Swells also arrive from NE with a probability of 20% and wave heights up to 1.5 m, which, when diverted around the coast of the island would likely result in non-laminar flows in the port area. These have implications for ship and small boat handling, as well as for seiching effects in any semi-enclosed basin.

Waves from the west (resulting from the West Pacific Monsoon), are nearly perpendicular to the proposed quay wall orientations, occurring only 1% of the time, with wave heights up to 2 m. Waves from the N through NE directions are more likely to occur (up to 5% probability), and with similar wave heights. Again, implications for ship handling and seiching effects exist under these conditions.

5.6.2. Seiching effects in a semi-enclosed basin

Photos taken during the February 2015 field mission show a pronounced seiche (a standing wave in an enclosed or semi-enclosed basin of water) that was generated by swells entering the narrow entrance of the existing Boat Harbour. In a photographic time series seiche waves could be seen reflecting off the landward wall of the basin and being reflected back out through the Harbour entrance, as well as against the other walls and corners of the Harbour. The turbulence caused by the seiche temporarily halted all traffic, and similar seiching would be likely to occur in any proposed harbour option considered.

5.6.3. Sea level rise

Australian BOM has issued monthly reports on sea level rise (SLR) for all islands containing a SEAFRAME gauge from 2006 through August 2014, including Nauru. Adhering to 50-yr design specifications for quay walls, basins, roads, and any other structures that will be on or near the coast implies a project lifespan through approximately 2070. When citing projected sea level rise, it is recommended that 58 cm be used as the nominal, representing 2070 sea level rise under the highest greenhouse gas emissions scenario.

5.6.4. Potential Further Wave Climate Investigations

The wave climate study conducted for this Study (refer Appendix B) has provided a regional assessment of the wave climate in the vicinity of Nauru. However, further work is needed to determine with confidence the wave climate occurring at the proposed port redevelopment site,

to determine more accurately the capacity of any new development to accommodate the berthing of ships in moderate to marginal wave conditions. This will provide important data to support a calculation of the likely non-operational days per year when ships will not be able to berth due to the incident wave and wind conditions.

A detailed numerical modelling exercise of Nauru's western coastline will need to be undertaken to confidently predict the wind and wave conditions generated by severe weather conditions, and the response of any proposed maritime structure (e.g., quay wall) to these conditions. Proposed additional investigations are outlined in more detail in Section 11.

5.7. Options for Redevelopment of the Port

5.7.1. No Project Option

Reeves (2009) and ADB (2009) considered measures needed to allow the port to continue operating in its current mode of operation – mooring general cargo vessels offshore and transferring containers and general cargo to the boat harbour by sea mules and barges. Reeves estimated the cost of their recommended measures to be A\$2.27 million (\$1.8 million) for their Option 2 which primarily involves demolition of unserviceable building, some of which were deemed in 2009 to be a dangerous safety threat to personnel. This option would free up land for more efficient storage of containers and increase the port's capacity to store empty containers awaiting export. ADB (2009) considered a similar option (Development Scenario 1) which was estimated to cost A\$2.7 million (\$2.2 million) to improve the container yard and provide necessary utilities.

In the intervening six years, none of the recommendations in the Reeves report have been implemented. Inspections of the port during this Study's field visit have revealed that the port buildings have deteriorated further in comparison to their condition in 2009, and now pose critically serious safety and operational concerns. These buildings must be demolished immediately, before they collapse, endangering lives. For completeness, and in the expectation that this work will not eventuate before implementation of the new facility, demolition of these building has been included in the scope for each development option.

It is also apparent that the sea mules and the remaining barge used to transfer containers and cargo from offshore are in very poor condition and need to be substantially refurbished to improve their operational reliability.

A "no-project" options therefore needs to include measures and improvements to the port just to maintain the current operational productivity in general cargo, container handling, fuel deliveries and phosphate loading. These improvements include:

- Demolition of the Barge Shed and Hardware and Bulkstore building;
- Major maintenance or replacement of the mule boats and barges for container and general cargo unloading;
- Demolition and replacement of the Harbourmaster's office;
- Provision of an ablution block;
- Provision of a perimeter security fence and single entry/exit gate;
- A fire protection facility.

These improvements are needed to comply with the IMO's ISPS Code, to improve occupational health and safety in the port, and to maintain the loading/unloading productivity needed to keep pace with the forecast volume of imports and the export of empties.

5.7.2. Option 1- Quay wall north of the port

(i) Description

Option 1 is illustrated in Figure D2 in Appendix D. The main features of this option include:

- j) A concrete block quay wall located on the outer edge of the reef, north of the Boat Harbour; 80m long and 25m wide, to accommodate the design general cargo and fuel vessels (Table 5-1). The deck level of the quay wall will need to be set at or above +4.0 m (Nauru Datum) to suit the berthing of general cargo vessels, as well as accommodating sea level rise over the next 50 years of 0.6 m. Hence the total height of the concrete block quay wall is expected to be about 6 m from the base of the wall on the reef foundation up to the deck level.
- k) A rock causeway joining the port land adjacent to the Boat Harbour with the southern end of the quay wall, for access to move containers and general cargo directly from ship to shore, and to support fuel pipelines to the tank farm;
- l) Installation of new fuel pipelines to replace the pipelines on the cantilevers. It would be prudent, however, to retain the existing pipelines on the cantilevers, to provide a back-up facility for unloading fuels during times when the new quay wall is occupied by a general cargo ship;
- m) Supply of three tractor-trailer units for transferring containers to/from the container yard (containers can be loaded directly to tractor-trailers by ship's gear, thereby removing the need for a mobile crane at this interface);
- n) Demolition of old and derelict sheds and buildings, including disposal of asbestos cement cladding;
- o) Heavy duty pavement across the entire container yard area;
- p) New Harbourmaster's office and administration;
- q) New ablution block;
- r) New plant workshop;
- s) Site power reticulation, including reefer points and security lighting;
- t) Fire ring main and hydrants.

It should be noted that this Option also provides the potential for future expansion by forming the first phase of the construction for Option 2. Hence, this Option can be constructed now, in the knowledge that it can be further expanded in the future with a second phase to construct the remaining works needed to complete Option 2.

(ii) Operation

The facility provided by Option 1 will permit all vessels visiting Nauru except dry bulk phosphate vessels to be relocated to the dedicated berth north of the Boat Harbour. This new berth will provide a facility which is adequate for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. These tractor-trailers will then transfer containers to the container yard where the large forklift truck places each container into the yard stack awaiting pick-up by the customer.

Berthing of vessels at this quay wall is expected to be reasonably straight-forward for most weather conditions. The vessel will approach from the north under power and come alongside at a slow speed to allow the final along-side manoeuvre to be completed using the ship's mooring lines to ease the vessel onto the berth.

When departing, the vessel should be able to swing off the berth with the assistance of the bow thruster and depart after releasing its mooring lines under their own power. Particular care will

be needed during westerly (monsoon season) weather as the prevailing wind will tend to push the vessel onto the berth. The vessel's bow thruster should be capable of pushing the vessel off the berth enough to allow the vessel to align at an angle to the berth face so that departure under power can be made.

At times when a general cargo or container ship is not occupying the berth, there are opportunities for other vessels such as the fuel ship or international fishing vessels to utilise the berth.

The phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring/buoy system. Hence, the Port Authority must continue to maintain the moorings and buoys to maintain this phosphate loading capability.

(iii) Construction

The sequence of construction of this Option is critical to the timely delivery of the new facility. Since the severely restricted space within the existing container yard limits accessibility for construction plant required for construction of the quay wall, it is imperative that the derelict buildings be demolished before any other work commences. During this demolition phase, the large floating plant (barge-mounted excavator, barges) should be mobilised from overseas.

The detailed demolition procedure for these buildings has been described in previous studies (Reeves, 2009; ADB, 2009). The asbestos cement roof cladding will need to be removed in accordance with proper safety procedures. Suitable methods for the disposal of asbestos cement cladding will need to be investigated during the PPTA phase.

Once demolition is complete, the area for construction of the quay wall will require a flat and level shelf to be excavated into the edge of the reef, to provide a firm foundation for the quay wall structure. In addition, a section of the reef edge will need to be excavated to form a berth box along the edge of the reef. Geotechnical conditions are not yet known, so it has been assumed that the material making up the reef is readily excavated using a large barge-mounted backhoe, equipped with both a jackhammer attachment and a large bucket to remove the reef material. This excavated material will be used as core fill to construct the causeway, which will be finished with an outer layer of armour rock, sourced from rock available from the pinnacles in the phosphate mining area.

Following excavation of the flat foundation in the reef, the quay wall will be constructed using precast concrete blocks craned into position using a barge-mounted crane. These blocks can be constructed in a pre-casting yard on the island, using local water and aggregates and imported cement. The blocks will be profiled with keys so they stack and interlock together to adequately resist wave and ship berthing loads. The block wall will be finished with a concrete surface finish to provide a running surface for cargo operations.

Vessels moored at the quay wall will occasionally be subjected to swell wave action, which will tend to move the vessel around at the berth. To minimise the impact of this, fendering will need to be carefully designed to absorb both the energy transmitted by the ship into the quay wall and the motion of the ship. Pneumatic fenders or another fender type with a low reaction to energy absorption ratio (fender factor) should be considered as a preferred solution for this unusual berthing situation. The quay wall will also be fitted with bollards for safe mooring of the vessel, and navigation aids as required by international standards for a facility of this kind.

5.7.3. Option 2 – Semi-enclosed harbour north of the port

(i) Description

Option 2 is illustrated in Figure D2 in Appendix D. The main features of this option include:

- g) A concrete block quay wall located on the outer edge of the reef, north of the Boat Harbour, 80m long and 25m wide, to accommodate general cargo and fuel vessels (identical in arrangement to Option 1);
- h) A rockfill causeway joining the port land adjacent to the Boat Harbour with the southern end of the quay wall, for access to move containers and general cargo directly from ship to shore, and to support fuel pipelines to the tank farm (identical in arrangement to Option 1);
- i) A rockfill seawall along the outer edge of the reef, extending north from the end of the quay wall for a further 160m long;
- j) A rockfill seawall at the northern end, from the shoreline to the edge of the outer reef, for a length of 150m to enclose a new harbour basin;
- k) Dredging and excavation of the harbour basin to form a basin measuring 400m long by 250m wide to a depth of 10 metres, with a swing basin to accommodate 100m LOA general cargo and fuel vessels;
- l) Installation of new fuel pipelines to replace the pipelines on the cantilevers. It would be prudent, however, to retain the existing pipelines on the cantilevers, to provide a back-up facility for unloading fuels during times when the new quay wall is occupied by a general cargo ship;
- m) Supply of three tractor-trailer units for transferring containers to/from the container yard;
- n) Supply of two tug boats, for manoeuvring the ships into and inside the basin;
- o) Demolition of old and derelict sheds and buildings, including disposal of asbestos cement cladding and salvage of materials;
- p) Heavy duty pavement across the entire container yard area;
- q) New Harbourmaster's office and administration;
- r) New ablution block;
- s) New plant workshop;
- t) Site power reticulation, including reefer points and security lighting;
- u) Fire ring main and hydrants.

(ii) Operation

The facility provided by Option 2 will permit all vessels visiting Nauru except dry bulk phosphate vessels to be located to the dedicated berth inside the harbour basin north of the Boat Harbour. This new berth will provide a facility adequate for loading/unloading containers and general cargo using ship's gear directly to the quay or loaded directly onto tractor-trailers. These tractor-trailers transfer containers to the container yard where the large forklift truck places each container into the yard stack awaiting pick-up by the customer. Ships will enter the harbour basin and swing in the turning basin before berthing at the berth located in the south-east corner of the basin. Two tug boats will need to be provided to assist vessels to enter the harbour basin, swing in the turning basin and berth at the harbour wharf. The tug boats will need to each have a bollard pull of about 30 tonnes for this operation.

The plan dimensions of the harbour basin have been selected on the basis of a concept design to accommodate a design vessel as described in Table 5-1, and in accordance with the guidelines set out in PIANC Report No. 121-2014. The basin is 400m long and 250m wide to provide a 200m diameter turning basin. It will be dredged to a depth of 8m below Chart Datum.

The harbour wharf is 120 m in length to readily accommodate the design general cargo and bulk fuel vessels (refer Table 5-1), with some capacity to accommodate vessels up to 130 m LOA in the future. The wharf return provided along the south end of the harbour basin is 60 m long, to accommodate smaller vessels such as commercial fishing vessels, the tug and pilot boat. The inner walls of the harbour basin will need to be lined with shallow-sloping armour rock so that any wave energy entering the harbour from the west is absorbed and not reflected to cause wave seiching (harmonic oscillation of waves) within the harbour.

A significant benefit from this Option is the availability of the outer reef berth to provide a second berth in the event that two ships are in port concurrently. The outer berth could even accommodate a waiting dry bulk phosphate vessel, avoiding the necessity for the ship to drift offshore while waiting for the cantilever berth.

The phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring/buoy system. Hence, the NPA must continue to maintain the moorings and buoys to retain this phosphate loading capability. While the NPA will have the benefit of the use of the two tug boats, it would be prudent to maintain the mooring system in place as support and back-up for the phosphate vessels.

(iii) Construction:

The construction procedure outlined in Section 5.7.2 for Option 1 applies also to the first stage of this Option.

Excavation of the reef flat will be needed to provide a flat foundation for the two seawalls forming the outer perimeter of the harbour basin, as well as extensive excavation to create the harbour basin to the design depth. The excavated material will be used as core material to form the seawalls, which will be surfaced with armour rock. Any excess excavated material can safely be disposed of offshore at a depth of at least 300m. In similar manner to excavation for the quay wall foundation, an excavator mounted on a floating barge, equipped with both a jackhammer and bucket, will be needed for this large excavation.

The inner harbour wharf will be constructed in the same manner as the reef-edge quay wall using precast concrete blocks craned into place.

5.7.4. Option 3 – Quay wall south of the port

(i) Description

Option 3 is illustrated in Figure D2 in Appendix D. The main features of this option include:

- f) A concrete block quay wall located on the outer edge of the reef, south of and between the Boat Harbour and the north cantilever, 80m long and 25m wide, to accommodate dry bulk (phosphate), general cargo and fuel vessels. The average depth of the reef where this quay wall will be constructed is expected to be about 20 metres;
- g) A rock causeway joining the port land adjacent to the Boat Harbour with the northern end of the quay wall, for access to move containers and general cargo directly from ship to shore;
- h) Two concrete block mooring dolphins beneath and between the foundations of the two cantilevers, for safer berthing of dry bulk vessels for phosphate loading;
- i) Retention of the anchored mooring buoys, including relocation of A1 (combination) and A2 (span) buoys;
- j) Supply of two or three tractor-trailer units for transferring containers to the container yard;
- k) Demolition of old and derelict sheds and buildings;

- l) Heavy duty pavement across the entire container yard area;
- m) New Harbourmaster's office and administration;
- n) New ablution block;
- o) New plant workshop;
- p) Site power reticulation, including reefer points;
- q) Fire ring main.

(ii) Operation:

The facility provided by Option 3 will permit all vessels visiting Nauru, including dry bulk phosphate vessels, to share the dedicated berth and adjoining berthing dolphins south of the Boat Harbour. This new berth will provide a facility which is adequate for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. These tractor-trailers will then transfer containers to the container yard where the large forklift truck places each container into the yard stack awaiting pick-up by the customer. Bulk fuel ships will also use this berth, including the existing fuel transfer pipelines located on the cantilever.

Berthing of vessels at this quay wall is expected to be reasonably straight-forward for most weather conditions. The vessel will approach from the north or south under power and come alongside at a slow speed to allow the final along-side manoeuvre to be completed using mooring lines to bring the vessel onto the berth. When departing, the vessel should be able to swing off the berth with the assistance of their bow thruster and depart after releasing mooring lines under their own power. However, particular care will be needed during westerly (monsoon season) weather as the prevailing wind will tend to push the vessel onto the berth. The vessel's bow thruster should be capable of pushing the vessel off the berth enough to allow the vessel to align at an angle to the berth face so that departure under power can be made.

Phosphate ships will also utilise the berth, and in calm conditions it is expected that little or no use of the mooring system will be required. Instead, phosphate ships will berth safely against the southern end of the new quay wall and the two berthing dolphins located between and beyond the cantilever foundations. In windy conditions it will be necessary to utilise the mooring system to assist with keeping the phosphate ship positioned during loading and for heaving off to reposition the ship when the cantilever spouts change hatches. Hence, it is essential that the mooring system be maintained in full operational condition at all times by the NPA as part of the facility for berthing and mooring all vessels. It cannot be assumed that this quay wall and berthing dolphins configuration can operate safely in all permissible conditions without the availability of the mooring system.

(iii) Construction

Construction of this Option will be similar in detail to Option 1.

The area needed for construction of the quay wall is occupied by the two most northerly mooring buoys – the A1 combination buoy and the A2 span buoy. These buoys will need to be relocated further offshore, or be replaced by new anchor staples attached to the quay wall to maintain the capacity of the mooring system. Advice from the designer of the mooring system, Dr Terry O'Brien, is that these buoys can be removed and the mooring system re-designed with new staples attached to the reef and concrete quay wall to substitute for these buoys.

The new quay wall will require a flat and level shelf to be excavated into the edge of the reef, to provide a firm foundation for the quay wall structure. In addition, a section of the reef edge will need to be excavated to form foundations for the two berthing dolphins. These flat foundations

will be required at a depth of about 20m just beyond the edge of the reef. Without the benefit of any geotechnical investigations on the reef, it has been assumed that the material making up the reef is readily excavated using a large barge-mounted backhoe, equipped with both a jackhammer attachment and a large bucket to remove the reef material. This excavated material will be used as core fill to construct the causeway, which will be finished with an outer layer of armour rock, sourced from rock available from the pinnacles in the phosphate mining area.

Following excavation of the flat foundations in the seabed beyond the reef edge, the quay wall and the two berthing dolphins will be constructed using precast concrete blocks craned into position using a barge-mounted crane. These blocks can be constructed in a precasting yard on the island, using local aggregates and imported cement. The blocks will be profiled with keys so they stack and interlock together to adequately resist wave and ship berthing loads. The block wall will be finished with a concrete surface finish to provide a running surface for cargo operations.

Vessels moored at the quay wall will occasionally be subjected to swell wave action, which will tend to move the vessel around at the berth. To minimise the impact of this, fendering will need to be carefully designed to absorb both the energy transmitted by the ship into the quay wall and the motion of the ship. Pneumatic fenders or another fender type with a low reaction to energy absorption ratio (fender factor) should be considered as a preferred solution for this unusual berthing situation. The quay wall will also be fitted with bollards for safe mooring of the vessels, and navigation aids as required by international standards for a facility of this kind.

One important constraint to construction of this option is the need to either keep the phosphate ship berth operational during construction, or alternatively close the phosphate berth while construction is completed as rapidly as possible. The second alternative is more likely to be feasible.

5.7.5. Option 1A – North quay wall plus berthing dolphins beneath the cantilevers

(i) Description

This “hybrid” Option combines the quay wall north of the boat harbour as proposed in option 1, plus three berthing dolphins for the dry bulk phosphate ships as described for Option 3. This separates the phosphate vessels from the general cargo and bulk fuel vessels, with its inherent benefits, and provides more secure berthing for the dry bulk phosphate vessels.

However, as has already been ascertained, the dry bulk phosphate vessels cannot safely operate without the mooring system. Hence, the added cost of providing three berthing dolphins, at an estimated cost of A\$3,750,000 is not considered to be economically feasible.

5.8. Alternative Project Options

5.8.1. New harbour on the east side of the island

Anibare Bay potentially offers a feasible alternative site for a new harbour. During the monsoon months, this side of the island is generally more sheltered than the western side, and the Anibare Boat Harbour is occasionally used by the Port Authority to unload cargo from general cargo vessels during this season. Since there is no mooring system available in Anibare Bay, this requires the ship to drift offshore while containers and general cargo are unloaded to the sea mules and towed barge, which are then brought ashore into the harbour for unloading using the all-terrain crane. There is very limited space on the hardstand at Anibare Boat Harbour so containers are usually loaded as promptly as possible onto the side-lifter trucks for delivery to

the customer. This slows the turnover/unloading productivity rate but is effective when no operation is possible at the port at Aiwo.

There are, however, a number of factors to be considered when assessing the viability of a fully developed port on the eastern side of the island.

Firstly, deep sea bathymetric investigations (SOPAC, 2005) have identified a large subsea landslide which has created Anibare Bay. This has been further investigated by Kruger, et al (2014) who have concluded that geological instability has caused this subsea landslide. Similar subsea landslide sites have been identified on Banaba (Ocean Island) and Niue. Consequently, knowing this eastern side of Nauru is prone to instability, it would not be wise to construct a harbour within the bay.

Secondly, as noted in Section 9, the marine ecosystem along the eastern side of the island is in significantly better condition than of the western side. Any port development will place this ecosystem at risk, with the potential to cause significant damage to the coral reef and associated fish and fauna habitat.

Thirdly, as discussed in Section 5, the prevailing weather in Nauru during the trade winds period (April to October) comes from the south-east and the wave climate similarly comes from the south-east. While wave heights during the trade wind season are smaller in height, their significant wave height still reaches more than 1.2m which is large enough to disrupt shipping operations. Only a fully-enclosed harbour basin, similar in configuration to Option 2, would protect ships from this wave climate for more than half of the year.

For these three reasons, a new port located on the eastern side of Nauru is not recommended.

5.8.2. Enhanced facility at Anibare Harbour

However, this side of the island provides some shelter from the monsoon season westerly winds and the wave climate generated by that season's weather. Operations for unloading general cargo and containers are occasionally relocated to Anibare Harbour, which involves moving sea mule vessels, barges and the mobile crane to the eastern side of the island. The ship is held in position offshore from the Harbour using its own power and unloaded with ship's gear to the sea mules in similar fashion to operation off the Aiwo Boat Harbour. Containers and general cargo is unloaded at the small wharf inside Anibare Harbour using the mobile crane. Containers and cargo is then loaded directly onto side-lift trucks for delivery directly to customers. There is very limited space on the hardstand at this harbour. A large area is occupied by the unserviceable pilot boat and what appears to be a commercial fishing boat. The remaining space provides area to store only a few containers at any one time, so the operation's productivity is highly dependent on the availability of the island's two side-lift trucks (one owned by NPA, the other by Capelles).

Productivity of this operation would be significantly improved if the hardstand was increased in size and the two vessels removed.

5.8.3. Land Reclamation for hard stand area in vicinity of existing Phosphate Cantilevers

Additional container yard area could be obtained by constructing additional reclamation across the reef flat south of the Boat Harbour. While adequate container yard area should be available as shown in Figure D4 in Appendix D, if a larger container yard is needed, then this area is a logical location for expansion. Each additional hectare of reclamation developed into container yard is estimated to cost about \$5 million.

As previously discussed, a container yard of 2.1 hectares is expected to be more than adequate for the predicted container and general cargo traffic predicted for the next 25 years, so this additional reclamation and container yard development is not considered to be necessary nor cost-effective.

5.8.4. Floating Harbour

The concept of a floating port moored permanently off the coast of Nauru is understood to have been suggested by one or more non-PRIF development partners as a viable solution to Nauru's port problem. This idea is presumed to include a nest of large floating pontoons linked together to form a large floating "island", where ships could berth alongside for unloading their cargoes. If an adequate berth length of at least 80 metres was provided, the floating harbour would provide reasonable shelter for vessels in marginal wind and sea conditions. The single greatest disadvantage of this concept arises from the great water depth beneath the floating pontoons. Assuming the inner berth of the floating harbour was located 500 metres offshore, the water depth will be 500 metres, therefore requiring very long mooring lines attached to anchors located at 500 to 1000 metres depth. The maintenance of the mooring system for a floating boat harbour would be prohibitive.

For this reason alone, this Study has not given any consideration to a concept of this nature.

5.9. Removal of the Mooring System

The mooring system described in Section 3.5.3 has operated successfully for more than 80 years. However, the annual maintenance cost of about A\$1 million (\$800,000) per year has prompted the Government to request that alternatives be considered for replacing the mooring system. The Government's intent is to avoid the high cost of maintaining these mooring buoys. It should be noted that the three options assessed in this Study all require that the mooring system be retained for anchoring the phosphate ships for loading phosphate, and in Option 3 for anchoring the general cargo and fuel ships as well. The mooring system is used for berthing ships under all favourable sea conditions (refer Box 3-1 in Section 3), and is essential when conditions approach the limiting wind and wave states. The mooring system provides important security for preventing ships from drifting onto the reef edge during onshore monsoon season wind conditions.

The options incorporating a reef-edge quay wall will not provide adequate capability on their own to permit vessels to berth safely. As noted above, it is essential that vessels berthed beneath the phosphate cantilevers can be manoeuvred away from the berth (heaved off) so that the cantilever spouts can be repositioned above each ship's hold in turn.

In all three options discussed above, the mooring system must be retained, both to moor the dry bulk vessels (Options 1 and 2) and to moor both dry bulk and general cargo vessels (Option 3). In all three options, the phosphate ships will need to utilise the mooring system to manoeuvre during phosphate loading.

Alternatively, to ensure that vessels can be safely operated beneath the cantilevers, the only other method of controlling these ships is to provide two tug boats capable of holding the dry bulk ships in the westerly monsoon wind and wave climate. Tug boats of this capability need to provide a bollard pull of about 80 tonnes (8,000 hp capacity).

The capital cost of a tug of this size is estimated to be \$1.5 million, with an associated annual operating and maintenance cost in the order of \$900,000. Research into the availability of tugs of this size indicates that second-hand tugs should be readily available for acquisition. The tugs will need to be fully supported by four fully qualified crews of three personnel each, a standing

maintenance schedule and a store of appropriate spare parts to ensure the tugs' availability around the clock.

In the event that this option is adopted, it would be prudent to retain the mooring buoys as a back-up facility in the event that one of the tug boats is not available for controlling a vessel at the cantilevers.

5.9.1. New Quay Wall at Anibare Bay

A new harbour development at Anibare Bay has been suggested by some. However, there are a number of sound reasons why this is not viable, including:

- The area is exposed to easterly Trade winds and adverse wave climate for about 9 months of the year;
- The sub-sea geology comprises an unstable submarine landslip, thereby presenting a high risk for a new harbour development where further sub-sea instability may severely damage harbour infrastructure;
- The reef and marine ecosystem around and within Anibare Bay is relatively pristine and any harbour development would place this ecosystem at high risk of irreversible damage;
- Most industrial and commercial activity occurs on the western side of the island, close to the existing port. Moving the port away from this activity would increase transport costs.

Hence, any major port development in Anibare Bay (other than an enlarged hardstand) is not recommended.

5.10. Immediate Activities for Continued Operation and Project Preparation

In the immediate future, before any new port development can commence, the port must continue to operate and provide the essential services of transferring cargoes from container ships, and continue to load phosphate to the bulk carriers.

Immediate action is needed to allow these services to continue. This includes:

- (i) Maintenance and servicing of the port sea mules and barges to minimise downtime;
- (ii) Repair of the port pilot boat to return this into service, and continue with maintenance and servicing to ensure it's consistent availability;
- (iii) Staged demolition of port buildings, including the proper handling and disposal of asbestos cladding;
- (iv) Removal of obsolete and derelict plant and equipment;
- (v) Expansion of the container yard following building demolition, to provide expanded storage capacity;
- (vi) Focus on exporting empty containers from the port to clear the container storage area for improved efficiency to handle imported containers.

5.11. Preparatory Activities for Project Implementation

Regardless of which Option is adopted for implementation, there are a number of activities and tasks which are needed to prepare for implementation (detailed planning, design and construction) of the port redevelopment. These tasks should be undertaken as soon as possible so that outputs from these tasks become available without delay to the main activity of detailed design. These tasks include:

- (i) A detailed hydrographic survey of the entire offshore area of the port, extended beyond the edge of the reef to a depth of at least 100m, and to ascertain whether any reef undercut cavities exist beneath the reef's edge;
- (ii) A detailed terrestrial level and feature survey of the entire port site, using Universal Transverse Mercator (UTM) coordinates for horizontal control and Chart Datum for level control;
- (iii) A detailed geotechnical site and laboratory investigation, to determine the sub-surface geotechnical conditions across the port site and across the reef to the reef edge;
- (iv) Hydrodynamic modelling of the port site to determine the extreme wave climate which can be applied to detailed design;
- (v) A more detailed localised analysis of the wave climate at Nauru, to provide wave climate details for detailed design of the quay wall and other components of the development;
- (vi) The appointment of a quantity surveyor to assist with advice on construction methods and construction costs for improved budget cost estimation.

5.12. Engineering Risks

5.12.1. Option 1 – the Need for a Tug Boat

Option 1 has been developed on the assumption that general cargo vessels will be able to berth and depart from the proposed quay wall without assistance. In most conditions, this is likely to be possible. However, during more marginal monsoon season (westerly) wind and sea conditions, it may not be possible to adequately control a vessel using only its own engines and steering to approach the berth safely and depart from the berth unaided.

Accordingly, there is a small risk that a tug boat may be needed for these berthing operations in such marginal conditions. This risk needs further investigation by an experienced ship-handling specialist.

5.12.2. Hardness of the Reef

For all three options, excavation of the reef is required to provide sound foundations for the reef-edge quay wall and, for Option 2, excavation of the harbour basin. It has been assumed, both in this Study and in the previous ADB and JICA studies, that the reef material can be readily excavated by a large barge-mounted excavator, most likely with the assistance of a jack hammer attachment to break up the reef before using an excavator bucket to remove the large reef fragments. It has also been assumed that the reef has adequate strength to support the mass concrete block quay wall.

Accordingly, blasting of the reef to achieve the necessary excavated profiles for each option is assumed to be unnecessary. This is a risk to the project since excavation of the reef is essential and blasting will add cost to the budget, as well as compromising, to a minor extent, the environmental damage to the reef edge and marine environment.

In the event that the reef is found to be too soft to support the loads imposed by the concrete block quay wall structures, then the alternative available for constructing a quay wall on the reef edge will be to utilise a concrete quay deck supported on piles driven into the seabed.

The need to blast the reef to complete the required excavations, or the use of a piled quay deck if the reef foundation is too soft, will be adequately addressed during geotechnical investigations to be conducted at the start of the next phase of the project.

5.12.3. Reef cavities

While the existence of cavities beneath the front edge of the reef, caused by wave undercutting, are not expected to exist (based on observations and discussions with dive contractors working on the mooring system maintenance) there may be a risk if cavities do exist that larger excavations for concrete block quay walls will be needed to ensure that a firm foundation is provided for these heavy structures. This is not likely to be a significant risk.

5.12.4. Option 3 – Depth of Water

Bathymetric information available for this Study included a plan of the mooring system showing seabed contours at 20 m intervals up to the reef edge (initial data source unknown) and a bathymetric survey conducted by SOPAC for the entire seabed surrounding Nauru, with seabed contours at 50 m intervals from the 50 m contour. This survey was conducted on 30 September 2005.

The depth of water offshore from the reef's edge for the three development options has been estimated from these two data sets. For Option 3, the quay wall and berthing dolphins need to be positioned and aligned so that dry bulk vessels can be accurately positioned directly beneath the cantilever spouts. The depth of water along this alignment has been estimated to be 20 m, based on these bathymetric surveys. A risk arises if the water depth proves to be deeper than this, as deeper water significantly increases the quantities associated with the proposed concrete block quay wall with the attendant cost implications.

An accurate bathymetric survey of the construction sites at the start of the next phase of the project will provide greater certainty of water depths and hence quay wall quantities.

6. Cost Estimates

6.1. General

Detailed cost estimates have been prepared for each of the three proposed development options, as well as for the additional option of replacing the mooring system with a tug boat capable of attending to dry bulk vessels berthed at the cantilevers (as applies variously for all three options). Detailed cost estimates are attached in Appendix E. A comparison of costs estimated for this Study and by JICA (2014) is also provided in Appendix E. Summaries for each option are presented below.

All costs are expressed in Australian dollars (AUD), being the applicable currency for Nauru.

Work item unit rates have typically been sourced in Australian dollars, being the native currency for Nauru. Occasionally, unit rates have been sourced in another currency, typically where the task is expected to be sourced from a location other than Nauru or Australia. For example, mobilisation and excavation unit rates have been sourced from New Zealand in New Zealand dollars. When this has been done, the currency exchange rate current for March 2015 has been used to convert the foreign currency to Australian dollars.

6.2. Development of estimate unit rates

6.2.1. General

Determining unit rates for construction tasks in a remote location such as Nauru is a difficult task, since there is likely to be little or no previous similar construction work of this scale to use as a guide for setting unit rates. Furthermore, the construction tasks typical of a maritime project of this nature are highly specialised, requiring specific plant, materials and labour skills.

It is possible to use previous maritime projects successfully completed across the Pacific, including Papua New Guinea, Vanuatu, the Solomon Islands and the Cook Islands, to estimate typical rates for heavy construction tasks, keeping cognisant of the relative similarities of maritime and port projects in different locations, with varying scope for each project and availability of suitable plant, materials and skilled labour. These locations have seen major port development in recent years and provide a bench mark for selecting suitable unit rates for various construction activities.

The base date for these cost estimates is March 2015.

The cost estimate for each Option includes allowances for Preliminaries (provision of performance guarantee/security, insurance of the Works, site office and services for the Contract Supervisor, Contractor's site facilities & maintenance thereof, site supervision/management costs, other fixed charges) and a percentage equal to 10% of the total project cost has been used for these items. A separate item has been created for mobilisation and demobilisation costs. For a remote location such as Nauru, where large and specialised construction plant such as heavy-lift crawler cranes and barge-mounted backhoe dredges are not available and need to be mobilised from locations such as New Zealand or Australia, mobilisation costs are typically significant. An amount equal to 15% of the total project cost has been used for these items.

6.2.2. Costs for preliminary and mobilisation activities

Allowances have been made in the cost estimates for preliminary items and for mobilisation/demobilisation. Typically for large projects of this nature (remote location, little or no local construction expertise, contractor mobilised from outside the country) preliminary items will add about 10% of the construction cost to the overall project cost. Preliminary items include insurances, professional supervision of construction, offices for the supervising engineer and staff, temporary environmental management works, traffic management and similar items.

Costs for mobilisation and demobilisation for a large project of this nature will be high, knowing that large imported floating plant will be needed to construct quay walls and excavate the reef. In these cost estimates, an allowance of 15% of the construction cost has been added.

6.2.3. Costs for engineering and contingencies

Engineering costs include both design costs (including survey and geotechnical investigations) and construction supervision costs. An allowance of 10% of the project cost has been added for engineering.

Physical contingency has been added to the cost estimates, at an amount of 15% of the total project cost. Physical contingencies represent the estimated costs of the additional real resources expected to be required to complete the project. This moderately high contingency compared with standard ADB contingency of 5%-10% reflects the inherent uncertainty in the works given the early stage of the project (i.e., it would be too costly to further refine the quantities and cost estimates at this stage), the nature of marine work, the potential difficulties with the foundation materials, and the difficult climatic and access conditions.

Price contingency is not included in the cost estimates for each option. Price contingency allows for inflation from the base date of the cost estimate, so is an item dealt with in the economic analysis.

6.2.4. Dredging and excavation costs

Dredging unit costs have been calculated using unit rates for similar projects in Port Vila (Vanuatu) and Avatiu Harbour (Cook Islands). Dredging is assumed to be by large backhoe dredge mounted on a barge and anchored at the edge of the reef. To enable the hard reef coral rock to be dredged, a backhoe with a bucket of at least 4 m³ is likely to be needed, to provide sufficient power and capacity to excavate the reef material. It may, however, be necessary to utilise some blasting to loosen the harder materials encountered. This will need to be investigated in more detail at design stage, with support from geotechnical testing of the hardness and excavatability of the rock in the reef.

The unit cost also includes the need to transfer the dredged material to shore for use as fill in the approach causeway and/or the rockfill breakwater structures. Excess excavated material, especially for Option 2, will be disposed of at sea, well offshore from the port to avoid any environmental damage to the seabed. The dredge unit rate includes disposal of excess material.

6.2.5. Concrete quay wall blocks

The concrete blocks required to construct the quay walls in each option comprise large precast mass concrete blocks of an approximately cubic shape. The estimated cost of these units has been derived on the assumption that these blocks will be cast on the island. If they are constructed elsewhere, the cost will increase substantially because of the very high transport costs which will be incurred. The capacity to construct these blocks on Nauru is evident, with the ready availability of sound limestone aggregate already being produced on the island. Cement will need to be imported, together with materials for constructing the forms for the blocks. These blocks will not contain steel reinforcing, being manufactured in mass concrete. The other ingredient will be fresh water, which should be available by tank collection on the island, supplemented if necessary with desalinated water. Hence, this construction activity has been allocated a reasonably high proportion of local content (50/50).

6.2.6. Operation and maintenance costs

Costs for operations and maintenance are not included in the cost estimates. These are dealt with separately in Section 8. Operational and maintenance costs have been estimated from the current NPA budget (refer Appendix C4), which allocates \$1.2 million per year for operations and \$400,000 for maintenance and capital works. For Options 1 and 3, these operations and maintenance costs apply for year 1, rising by \$200,000 each year to be \$1.6 million in years 3 and 4. For Option 2, the operations cost is estimated to be \$1.5 million per year, and the maintenance cost will start at \$0.5 million in year 1, rising each year by \$200,000 each year to reach \$0.9 million in year 4. The higher costs for Option 2 are mainly due to the high operating cost of the two tugs required in this option.

6.3. Local and foreign contributions

Each construction activity for each option has been allocated a foreign/local ratio, depending on several factors including the proportion of imported and locally-sourced materials, the capacity for local labour to contribute to the activity, and other factors affecting the proportion of local and foreign contribution.

6.4. Option 1 – cost estimate

For the project scope for Option 1 as described above, the estimated cost is summarised in Table 6-1.

Table 6-1: Cost estimate - Option 1

Description	Foreign component	Local component	TOTAL
Preliminaries & mobilisation			3,500,000
	3,000,000	500,000	
Excavation			927,000
	788,000	139,000	
Quay wall	2,499,500	2,260,000	4,759,500
Building demolition	437,550	812,550	1,250,100
Access causeway	131,200	586,800	718,000
Expanded container yard	1,943,300	1,329,300	3,272,600
Buildings	1,208,750	1,208,750	2,417,500
Utilities	733,200	394,800	1,128,000
Additional equipment	380,000	20,000	400,000
Sub-Total	11,121,500	7,251,200	18,372,700
Engineering	900,000	940,000	1,840,000
Physical Contingency	2,000,000	760,000	2,760,000
TOTAL	14,021,500	8,951,200	22,972,700

6.5. Option 2 – cost estimate

For the project scope for Option 2 as described above, the estimated cost is summarised in

Table 6-2.

Table 6-2: Cost estimate - Option 2

Description	Foreign component	Local component	TOTAL
Preliminaries & mobilisation			17,030,000
	13,200,000	3,830,000	
Excavation	24,883,200	4,391,200	29,274,400
Outer quay wall			4,759,500
	2,499,500	2,260,000	
Building demolition	437,500	812,500	1,250,000
Access causeway	131,200	586,800	718,000
Outer breakwater	198,500	1,124,500	1,323,000
Northern breakwater	317,500	1,799,300	2,116,800
Harbour basin revetment	177,600	1,006,300	1,183,900
Harbour wharf			8,115,500
	4,574,000	3,541,500	
Fishing boat wharf			2,427,500
	1,373,900	1,053,600	
Expanded container yard	1,817,300	1,203,300	3,020,600
Buildings	1,539,500	878,000	2,417,500
Utilities	733,200	394,800	1,128,000
Additional equipment			3,400,000
	3,230,000	170,000	
Sub-Total	55,112,900	23,051,800	78,164,700
Engineering	6,000,000	1,820,000	7,820,000
Physical Contingency			11,720,000
	7,000,000	4,720,000	
TOTAL	68,112,900	29,591,800	97,704,700

6.6. Option 3 – cost estimate

For the project scope for Option 3 as described above, the estimated cost is summarised in Table 6-3.

Table 6-3: Cost estimate - Option 3

Description	Foreign component	Local component	TOTAL
Preliminaries & mobilisation	4,500,000	530,000	5,030,000
Mooring buoy relocation	220,000	130,000	350,000
Excavation	1,318,000	232,600	1,550,600
Quay wall			7,774,000
	4,088,800	3,685,200	
Berthing dolphins	500,500	339,500	900,000
Access causeway	160,000	706,700	866,700
Building demolition	437,500	812,500	1,250,000
Expanded container yard	2,374,700	1,405,400	3,780,100
Buildings	1,539,500	878,000	2,417,500
Utilities	390,000	210,000	600,000
Additional equipment	380,000	20,000	400,000
Sub-Total	15,909,000	9,010,000	24,919,000
Engineering	1,400,000	1,090,000	2,490,000
Physical Contingency	2,800,000	940,000	3,740,000
TOTAL	20,109,000	11,040	31,149,000

6.7. Tug Boats – cost estimate

For all three development options, a further scenario has been investigated, to address the request by the GoN Cabinet that the mooring system be abandoned and replaced with a viable alternative arrangement for the safe berthing of dry bulk ships beneath the cantilevers, as discussed in detail in Section 5.9 above.

The only viable replacement for the mooring system is the acquisition of two tug boats. These tug boats will need to be of an adequate size to hold a fully laden phosphate ship off the reef and be able to heave off the vessel from the cantilevers during loading, as loading switches from one hold to another. These tug boats will need to be adequately maintained in pristine operating condition and operated by a team of highly skilled crew members who are all internationally qualified to operate a vessel of this type. Each vessel will need to be kept in annual survey and a set of spare parts kept in inventory for immediate attention to breakdowns and routine maintenance.

The estimated capital cost of two suitable new tug boat vessels is \$3.0 million, together with an annual operation and maintenance cost of \$1.8 million.

However, abandoning the mooring system in its entirety is considered to be highly risky, and it is recommended that this system be retained as a back-up for the tug boats. This is prudent for the possible event that one of the tug boats is unavailable due to breakdown or during the vessel's time away from the island for annual survey. It would be unwise to place complete reliance on tug boats to replace the capability which the mooring system currently provides.

6.8. Comparison of Cost Estimates with JICA Estimates

A detailed comparison of the cost estimate for Option 1 and the cost estimate developed in the JICA (2013) report is provided in Appendix E. For a similar infrastructure solution, JICA estimated a total project cost of A\$40,950,000, compared to the estimate for Option 1 of A\$22,973,000.

The total cost estimated by JICA is significantly higher than the estimate prepared under this study. In order to understand the key drivers for the significant variation, Appendix E compares the two (2) cost estimates by individual line item. Once scope items are standardised, the JICA estimate for a similar scope of work is only A\$28,9M, which is closer to the consultants' estimates in the study.

The key reasons for the significant difference include:

- JICA's dredging quantity is substantially larger than assumed for the Option 1 under this study, attributable to the different construction method;
- The JICA berth (quay wall) is 140m in length, compared to 80m for Option 1;
- JICA's scope includes replacement of the mooring system which is not included and not needed in the scope for Option 1.

These differences account for the significant difference between the two estimates.

7. Options to Improve the Port Facility

7.1. Introduction

This Section of the Pre-Feasibility Study focuses on a critical assessment of the options proposed for future development of the port, in particular, the benefits, advantages and disadvantages of the three options cited in the Study's ToR.

Reference documents are listed in Section 12.

This analysis takes into consideration all aspects of the port's operation, each option's contribution to improving the value of port services and infrastructure, and their contribution and potential to improving the general economic prosperity of Nauru. This includes impacts on environmental and social issues, direct and indirect economic benefits and engineering aspects of the three options.

7.2. Port Management

While the ToR for this Study does not specifically require an assessment of the current management practices within the port's organisation, it must be stated that the Study Team, during their field visit, observed a distinct absence of management expertise within the entire Nauru Port Authority organisation. While The Port Act 2014 stipulates that the Harbourmaster is head of the Port Authority and operates with directive assistance from the Board of Directors, this level of authority and its application does not exist. This severely limits the capacity of the NPA to operate viably in terms of both physical operation and financial capacity to generate revenue commensurate with its operating and maintenance budget. There is a culture endemic within the NPA that financial assistance from aid agencies and the GoN will continue to support this loss-making SOE.

Bench and Kelly (2012) made the following observations:

"Preliminary review of the financial robustness (see Section 6) of Nauru's port activities reveal an interesting potential which, under appropriate institutional set up of Port Management structures, could lead to more effective business planning and budget management. The Mission identified that there may be sufficient port revenue generation potential to attend reasonable investment needs and operational improvements. A more detailed and comprehensive assessment of this Port revenue and investment capacity would better inform GoN's maritime transport sector development planning and decision making.

The Mission recommends that any analysis of the Port's financial management potential, as normally prepared as part of a Port redevelopment feasibility study, should include a cost benefit analysis of the high maintenance costs associated with the existing Mooring System. This analysis should be conducted with a view to establishing any potential redundancy within the Mooring System components as part of an optimal design for a new rigid Port berthing facility."

It is clear that the NPA needs to be properly managed in a similar manner to the more successful SOEs in Nauru, such as Ronphos and NRC.

7.3. Port Elements which Require Improvement

Section 4 has described the existing infrastructure present within the port and the range of operations which are adopted for running the port. Inadequacies have been identified which constrain and limit the efficiency and productivity of the port's operation. Any options for redeveloping the port, its infrastructure and its methods of operation must seek to address these inadequacies as broadly and effectively as possible within budget constraints. Options which

provide the greatest benefits for the investment required will be identified in the Multi-Criteria Analysis as being the preferred option for adoption and implementation.

The elements which need to be improved within a port redevelopment option include:

- (i) Significant improvement in the productivity of cargo (especially containers) transfer to and from the cargo ship to the port gate, including transfer of cargo to/from the ship to the quayside, transfer to/from the quayside to the container yard and transfer from the container yard to the customer at the port gate;
- (ii) Significant improvement in the back-loading of empty containers onto the general cargo vessel after cargoes have been unloaded, to eventually clear the container yard of unprofitable empty containers out of the container yard;
- (iii) Expansion of the capacity of the container yard, by both the removal of empty containers and by removal of derelict buildings located within the port limits, to improve container and general cargo handling productivity;
- (iv) Improvement of the port's capacity to safely berth all vessels visiting Nauru, including dry bulk vessels exporting phosphate, bulk liquid vessels importing fuels and general cargo and container vessels importing general cargoes and containers and exporting empty containers. Export of bulk rock products such as large armour rock and processed aggregates is likely to continue at a dedicated loading facility located away from the port and need not be considered as a service to be accommodated by port improvement proposals;
- (v) Reduced reliance on the mooring system for anchoring ships visiting Nauru, with the expectation that maintenance costs associated with the mooring system will reduce over time as a consequence of reduced usage of the moorings;
- (vi) Recognition that the environmental impact from port improvements is minimised and confined to areas of Nauru's coastline where adverse environmental impact has historically occurred;
- (vii) Minimal adverse impact on the community and the social fabric of Nauru from port development works, together with a recognition to advance positive social impacts from port improvements;
- (viii) Improved capacity for NPA to comply with all of their obligations in relation to port and vessel security as a signatory to and within the requirements of the ISPS Code;
- (ix) Significant improvement in the management of NPA to ensure that new infrastructure is adequately maintained and operated in a manner which will achieve maximum operating efficiencies for the port. This is likely to lead to a significant improvement in the capacity of NPA to generate sustainable revenue commensurate with its operating and maintenance budget, instead of reliance on ongoing funding of their operation from the GoN and external funding agencies.

7.4. Improvements to the Container Yard

The three options proposed for improving the port's facilities and infrastructure focus on a berthing facility to allow general cargo vessels and fuel vessels to berth alongside a quay wall. All three options also require substantial improvements to the landside facilities within the port, to complement the ship-side improvements, and these improvements are common to all three development options.

7.4.1. Removal of derelict buildings

As recommended on a number of occasions over the past five or more years, the barge shed and the hardware & bulkstorage shed must be demolished to make an additional 8,000 m² of space available within the port for efficient container yard space. In demolishing these sheds,

proper care and the use of specialist contractors for the removal of asbestos cement roof and wall cladding must be utilised. The preferred method of disposal of this hazardous asbestos waste is by dumping at sea (refer Section 9). All other waste from demolition of these buildings should either be by recycling or by dumping at sea. The remnant concrete floors of these buildings also need to be demolished as they are mostly in very poor condition and are not in a condition to be recycled as part of the new heavy duty pavement in the new container yard.

7.4.2. Perimeter security fence

The port does not currently have the capacity to provide a secure port owing to the complete lack of a perimeter security fence and security gate. To comply with ISPS Code requirements for a secure port, it is essential that development of the landside port area starts with a security perimeter fence, a single entry/exit gate and a manned gatehouse. This will enable NPA security staff to properly control all entry and exit to/from the port. A security fence comprising a robust chain mesh fence with a barbed wire top is the minimum requirement to achieve adequate security. The fence should be at least 1.8 metres in height, with a three- strand barbed wire top is the minimum requirement. The preferred height is 2.0 metres. Security gates which are readily closeable and which provide a minimum trafficable width of 5.0 metres for each lane (entry and exit), at a height to match the fence and also with a barbed wire extension, should also be provided. This main security gate must be kept locked at all times except during port operating hours. It may be necessary to provide a second gate of 5 metres width at a suitable location for emergency exit purposes. This second gate must remain locked with secure chain and padlock at all times. The perimeter fence must be maintained in sound order. The security fence and gates should be designed in accordance with a recognised Standard such as AS 1725.

7.4.3. Buildings

Harbourmaster's Office: The Harbourmaster's office is verging on derelict and is no longer considered safe for occupancy as a habitable building. A new Harbourmaster's office building should be constructed at a suitable location within the port secure area, preferably where it won't interfere with normal port operations. Consideration should be given to the size of the office to accommodate NPA personnel, parking for vehicles, movement of personnel in a safe manner clear of operating container-handling plant, and ready access to amenities for personnel.

Ablution Block: At present there is no ablution facility within the port area. This leads to absenteeism and the possibility of health problems for NPA personnel. A new ablution block, possibly attached to the Harbourmaster's new office, must be constructed as part of the port area improvements. The ablution block must provide separate adequate ablution facilities (toilets, washing, showers, etc., for male and female personnel. The facilities must be connected to adequate sewerage infrastructure to ensure that the facility is low-maintenance. A cleaner's cupboard should also be provided so that regular cleaning of the ablution block is facilitated.

Plant Maintenance Workshop: NPA operates a range of plant and equipment which is currently maintained inside the Barge Shed. This shed is recommended for demolition so a new plant maintenance workshop, designed specifically for the purpose of maintaining heavy container-handling equipment, will be needed. The workshop will need to be an adequate size to accommodate large items of plant such as the 35 tonne FLT (with its spreader up), tractor-trailer combinations and the all-terrain mobile crane. A separate space is required for warehousing spare parts including tyres and other large items. The workshop may also include a separate space for personnel to occupy for meal breaks.

7.4.4. Stormwater drainage

A network of stormwater drainage piping and grated entry pits will be needed across the container yard to ensure that the entire area remains a free-draining as possible, in consideration of Nauru's rainfall climate. Drain outfalls will be directly to the sea to facilitate rapid discharge. The drainage pipes will need to be of robust construction to withstand the heavy wheel loads from the loaded FLT, as well as being durable in the marine environment. It is common for concrete drainage pipes to be manufactured with extra concrete cover to the reinforcement to extend the durable life of these pipes in this environment. Heavy grate covers to the stormwater pits are essential to carry the design wheel loads of the FLT and permit rapid drainage of the runoff from heavy rainfall.

7.4.5. Yard lighting

While it is unlikely that the port will operate at night in the future, it is essential for maintaining proper security, in compliance with the ISPS Code, that the container yard be illuminated at night to discourage the public from entering the yard and committing criminal activity such as pilfering and vandalism of port assets and stored cargoes. A small number of tall light poles carrying modest street light fittings will provide a low level of light which will act as a deterrent for illegal entry but will not interfere with or disturb neighbouring occupants of residences nearby. Typically a grid of light masts at about 50 metre centres will require about 12 light poles to light the entire container yard. Poles need to be at least 12 metres high to provide adequate spread of light across the yard. Detailed design of a lighting plan for the yard will determine the final number and height of light poles needed. The minimum vertical illuminance needed for security purposes is about 3 lux. Vertical illuminance should not exceed about 10 lux to avoid disturbing neighbouring residences.

7.4.6. Fire ring main and hydrants

The safety of the port and vessels berthed at the wharf is primarily determined by the facilities available for preventing or combating hazardous situations. Honiara will continue to be an important port for the export of copra, with the growth of export volume forecast to be just fewer than 4 % per year through to 2020. As previously noted, copra is a hazardous commodity when it is stored in jute bags or in bulk, due to its tendency for spontaneous combustion. In this Port, three sheds scattered across the port are used for copra storage, which poses a significant fire risk for the entire port footprint. This fire risk is significantly magnified by the fact that no fire mains or hydrants exist within the port limits.

It is essential that design of a suitable fire main and hydrants system within the Port be undertaken as soon as practical, so that an appropriate firefighting capability can be implemented, before a serious fire occurs. This fire main and hydrants should be designed to take into account any proposals and plans to relocate the copra handling to new storage facilities and a new berth in the future. A general cargo port is normally provided with a fire ring main which is located underground around the perimeter of the port. By adopting a ring main approach, redundancy is automatically available in the event that the main is damaged in any way, e.g. accidental breach by excavation. Fire hydrants are provided at designated spacing along the fire main to ensure that full coverage of all port facilities is achieved.

7.4.7. Reefer outlets

A significant proportion of goods entering Nauru by container is fresh produce transported in refrigerated containers (reefers). These reefers are kept cold using their self-contained refrigeration plants enclosed within one end of the container. These are electrically operated and while onboard ship are plugged into the ship's array of purpose-supplied electrical outlets.

For reefer containers waiting in the container yard for collection, it is essential that a similar facility is provided within a dedicated area of the yard for supplying reefers with the necessary power. This is done by installing a set of electrical reefer outlets. Typically these are installed in a set of pits below ground so that they are not exposed to damage while not being utilised. For an annual container throughput of 3,000 TEUs in this environment of high demand, about 10 reefer connection outlets should be provided. These reefer outlets will be proprietary IP67 plugs rated at 32 amps and 440VAC.

7.4.8. Removal of redundant and non-productive plant and equipment

Obsolete and non-functional items of plant and equipment are being retained and stored at various locations around the Port. Keeping these items is not useful to the operation of the Port. These plant and equipment will have been fully depreciated so retain no value to the Port. All surplus and non-productive items of plant and other scrap materials should be removed from the Port and sold to a scrap merchant or otherwise disposed of in Nauru. By doing this, it is estimated that at least 5,500 m² (0.5 hectare) of occupied land will be freed up for use as productive areas for container storage or other vital Port operations. This clean-up is likely to be cost-neutral, taking into account the likely sale of scrap metals to pay for the labour and plant costs incurred.

The primary purpose for removing these pieces of plant and equipment is to make additional land available for container yard operations.

7.5. Comparative Assessment of the Three Options

A summary of all the advantages and disadvantages of each of the three options is presented in Table 7-1.

Table 7-1: Advantages and Disadvantages of Options Investigated

	Option 1	Option 2	Option 3
Advantages	<ul style="list-style-type: none"> Physical separation of the dry bulk ships loading phosphate at the cantilevers and the other general cargo and bulk fuel vessels, thereby reducing the waiting time for ships to berth and load/unload their cargoes; Direct access between ships unloading cargo and the container storage yard, eliminating the need for sea-bound transfer of cargo and empty containers. This will significantly improve ship turnaround time and gradually reduce the backlog of empty containers stored in Nauru; Significant reduction in ship delays from slow loading/unloading cycle times, thereby reducing the cost of shipping; Reduced utilisation of the mooring system, leading to fewer failures and hence lower maintenance costs and less delay from non-availability of the mooring system; Could serve as Stage 1 of a medium- to long-term two-stage development project if paired with Option 2; Significant use of local construction resources (labour, plant and materials) for concrete block production. 	<ul style="list-style-type: none"> A well-protected berth is available for year-round operation for general cargo and bulk fuel ships; Physical separation of the dry bulk ships loading phosphate at the cantilevers and the other general cargo and bulk fuel vessels Direct access between ships unloading cargo and the container storage yard, eliminating the need for sea-bound transfer of cargo and empty containers; Significant reduction in ship delays from slow loading/unloading cycle times; Reduced utilisation of the mooring system, leading to fewer failures and hence lower maintenance costs and less delay from non-availability of the mooring system; Could serve as Stage 2 of a medium- to long-term two-stage development project if paired with Option 1; Significant use of local construction resources (labour, plant and materials) for concrete block production. 	<ul style="list-style-type: none"> Direct access between ships unloading cargo and the container storage yard, eliminating the need for sea-bound transfer of cargo and empty containers. This will significantly improve ship turnaround time and gradually reduce the backlog of empty containers stored in Nauru; Significant reduction in ship delays from slow loading/unloading cycle times, thereby reducing the cost of shipping; Significant use of local construction resources (labour, plant and materials) for concrete block production. For ships operating in calm conditions, use of the mooring system to moor vessels will be replaced by the direct berthing of the vessel alongside the quay wall and berthing dolphins. This will reduce wear and tear on the mooring system, thereby reducing maintenance costs.

	Option 1	Option 2	Option 3
Disadvantages	<ul style="list-style-type: none"> • The mooring system must be retained for dry bulk ship loading of phosphate; • The need to provide new tractor-trailer equipment to handle containers to/from the quay to the container yard; • The berth at the new quay wall will not be useable on some days during the westerly Monsoon season due to excessive wave conditions preventing safe berthing • The need to mobilise large dredging plant from overseas to excavate a relatively small quantity of reef material, hence attracting disproportionate mobilisation costs; • The need to mobilise large barge-mounted excavator for relatively small quantity of reef excavation, with attendant high mobilisation cost; • The need to mobilise large crane plant to lift concrete blocks into the quay wall. 	<ul style="list-style-type: none"> • The mooring system must be retained for dry bulk ship loading of phosphate; • The need to provide new tractor-trailer equipment to handle containers to/from the quay to the container yard; • The berth at the new quay wall will not be useable on some days during the westerly Monsoon season due to excessive wave conditions preventing safe berthing; • A large quantity of reef material must be dredged from the reef flat and coastline to form the harbour basin; • The need to mobilise large dredging plant from overseas to excavate the reef material for the harbour basin; • The need to mobilise large crane plant to lift concrete blocks into the quay wall. 	<ul style="list-style-type: none"> • The need to provide new tractor-trailer equipment to handle containers to/from the quay to the container yard; • The need to mobilise large dredging plant from overseas to excavate a relatively small quantity of reef material, hence attracting disproportionate mobilisation costs; • The need to mobilise large barge-mounted excavator for relatively small quantity of reef excavation, with attendant high mobilisation cost; • The need to mobilise large crane plant to lift concrete blocks into the quay wall. Construction of the concrete block quay wall along the alignment of the phosphate loading cantilevers will be highly disruptive to the normal cycle of phosphate loading. Alternatives are to identify and utilise windows between ship arrivals to construct the quay wall and berthing dolphins quickly, or close the phosphate berth for the duration of the construction project. • The mooring system must be retained for all ships operating at the berth. No opportunity is presented by this option to eliminate the need for the mooring system, particularly during the westerly monsoon season

8. Economic Analysis

8.1. Introduction

This Section of the Pre-Feasibility Study focuses on the economic analysis of the three proposed options for development. In particular, the estimated costs for each Option have been compared with the expected economic benefits associated with these Options to analyse which of these options can be expected to provide the greatest net benefit to the GoN and the Nauruan community.

This economic analysis forms one element of the Multi-Criteria Analysis for the three options, which is presented in Section 10 of this Report.

The purpose of the economic analysis of projects is to promote the identification and selection of public investments that will lead to a sustainable improvement in the welfare of beneficiaries, and to the country as a whole.

8.2. Economic Evaluation Methodology

Standard economic evaluation methodology is well developed and has been consistently applied to project evaluation for many years. As ADB is likely to be the lead PRIF partner in project preparatory work, the methodology for this project follows the ADB Guidelines² and assesses a range of socio economic costs and benefits according to each option. While specific investment parameters for other PRIF partners may vary, the principles espoused in the ADB Guidelines are generally consistent with those adopted by other PRIF partners.

Key points of the methodology are;

- The costs and benefits of any project are to be estimated on an incremental basis (i.e. the difference between the 'without' project scenario and the 3 'with' project options), and are valued from the perspective of the national economy.
- Costs and benefits (in monetary terms) are estimated together with incremental revenues. This contrasts with financial analysis where only costs and revenues are assessed.
- The analysis describes the rationale for the project and sets it in the context of the country's national and sector development.

8.3. Macro-economic background

8.3.1. Pacific Region Perspective

The outlook for the region's major economic partners³ remains relatively robust. Major economies grew more weakly than expected in the first three quarters of 2014, and global output is now expected to grow by 3.0% in 2014 (from an initial 3.5%) according to the average projections of the Economist Intelligence Unit, the International Monetary Fund (IMF), and the Organisation for Economic Co-operation and Development.

Global economic growth is projected to accelerate to 3.6% in 2015. Developing Asia, which has a major impact on the region, is still expected to grow by 6.2% in 2014 before slightly accelerating to 6.4% in 2015, according to the *Asian Development Outlook 2014 Update*.

² The *ADB Guidelines for the Economic Analysis of Projects* was published in 1997 to guide practitioners. This was updated by Economic Analysis Of Projects Operations Manual Bank Policies (OM Section G1/BP), Issued on 15 December 2003

³ Pacific Economic Monitor, December 2014 ADB. The major economic partners include USA, Japan, Australia and New Zealand.

The average price of crude oil fell to \$86 per barrel in October from \$108 in June, while food prices fell by 6.7% over the first 3 quarters of 2014 (year on year). The IMF projects continuing declines in international food (–7.9%) and fuel (–3.3%) prices through 2015. Inflation in Australia is running at under 2% and regionally (Asia Pacific) inflation is low and falling at about 1% or less⁴.

8.4. Nauru National Development

8.4.1. National Economic Development

Data on the national economy is generally limited and not up to date. The following has been gleaned from various external agency reports⁵, and the most recent Budget papers,⁶ based on estimates of revenue and expenditure.

Nauru exhibits most of the constraints of underlying fragility which emphasizes the need for a flexible approach to development including a longer-term engagement and the need for capacity development⁷.

8.4.2. Economic Structure

Nauru's economy has experienced substantial volatility over the last ten years⁸. It has been traditionally based on phosphate mining, and phosphate revenues have given the country a relatively high per capita income (though limited reliable economic data is published). Phosphate reserves are not, however, expected to last for more than another 10-20 years⁹, and the government has developed other sources of income (for example, fishing licences). Budget support from development partners is also significant.

GDP fell by about a third between 2005 and 2007¹⁰ owing to a fall in public expenditure and suspension in phosphate mining following storm damage to the island's port facilities. The recovery that was under way with the resumption of phosphate mining in mid-2006 was stopped in its tracks by the world economic downturn and the consequent collapse of demand for phosphate in 2008–09. The economy shrank by 19 per cent in 2009, was stagnant in 2010. The growth post 2011 can mostly be attributed to the re-opening of the Refugee Processing Centre (RPC) in 2012.

According to ADB estimates, GDP grew by about 10% in 2014 and is expected to grow by 8% in 2015, boosted by the RPC, fishing licences, phosphate sales and other income sources. Analyses by the United Nations (Refer footnote 13) for previous years indicates volatile macro-economic growth but averaging about 2% per year over the 5 years up to 2013.

The average annual per capita expenditure for the average Nauruan was found to be AUD\$3,151 according to the Household Income and Expenditure Survey findings in

⁴ The Japanese economy, for example, has been experiencing deflation.

⁵ Nauru Infrastructure Sector Review, GoN, March 2013

⁶ Republic of Nauru 2014-15 Budget and Estimates of Revenue and Expenditure Budget, Papers 1 and 2

⁷ Working differently in fragile and conflict-affected situations—The ADB experience: A staff handbook, ADB 2012.

⁸ ADB Country Operations Business Plan October 2014, Nauru 2015–2017

⁹ It is highlighted that estimates of remaining commercially viable phosphate vary significantly but are not anticipated to be more than 20 years.

¹⁰ UNData, Country Profile, Nauru, 2014. These data show a GDP of \$34.4m in 2005 (in 2005 current prices).

2012/13. The average household on Nauru in terms of consumption (or expenditure) consumes on average 43% of its budget on food and non-alcoholic beverages, all of which are imported.

Distribution of household income shows income from wages and salaries as the key income source for the average household in Nauru. Property income is the second major source of income with its linkages to phosphate land ownership and dwelling rentals on the island.

The statistics office of GoN uses secondary sources which shows the value of merchandise imports by dutiable and non-duty goods from its primary trading partners namely Australia, New Zealand and Fiji. Imports in 2013 showed an increase of over 400% from the previous year, which can be mainly attributed to introduction of the RPC and its need for construction materials and furnishings, and through their multiplier effects.

Increases in money supply through the disbursement of various payments has also prompted increases in spending by households and raising demands on imports. Imported motor vehicles have featured prominently in household budgets. Non-dutiable merchandise imports such as fruit, vegetables product and water remain very low among imported commodities.

There is very limited potential for agriculture, and the country is dependent on imports for basic necessities such as food, consumer and capital goods.

In January 1999 Nauru signed its first loan agreement with the Asian Development Bank, under which the government was to diversify the economy to prepare for the exhaustion of phosphate reserves and to embark on a programme of economic reforms, including a sharp reduction in public sector expenditure and rises in taxes and duties.

From 2001, when the RPC was first established, Australia made substantial contributions to government revenues and there was for several years a boost to the catering sector. By 2007 revenues generated by the processing centre amounted to around a fifth of the country's GDP. Following its decision to close the centre during 2008, the new administration in Australia committed itself to maintaining its aid programme, which was worth about US\$31.8 million by 2012/13. In September 2012 Australia re-opened the RPC which accommodates up to 1,500 asylum-seekers, and by 2013 employed some 600 Nauruans.

The GoN is the major employer on Nauru, employing some 41% of the total labour force, followed by significant SOEs e.g. Ronphos 9%, Eigigu with 7% and the NRC with 5%. The RPC employs about another 30%. 'Other' i.e. the private sector and other small SOEs employed a further 8%.

The economy has also been boosted recently by substantial payments to Nauruan landowners from final liquidation of the Nauru Phosphate Royalties Trust.

Following 65% growth in domestic revenue in FY2014 (the FY ends on 30th June), the government expects this to plateau at \$104 million in FY2015. Overall, a surplus of \$0.4 million is expected in FY2015.

Since the early 2000s, Nauru has been without a financial institution¹¹ capable of providing commercial banking services. Based on an ADB Private Sector Development Initiative

¹¹ ADB Pacific Private Sector Development Initiative Progress Report 2013–2014

assessment of financial requirements in 2012, the establishment of a domestic financial institution has made progress and will be implemented in FY 2015/16, which will help support continued economic growth.

The government is holding discussions with development partners to establish a new Nauru Trust Fund. The FY14/15 budget sets aside a contribution of \$5 million to the fund. This follows the earlier setting aside of \$5 million for the fund in FY13/14.

In the latest FY14/15 Budget, economic growth is forecast to be about 8%. It is expected that non RPC related imports will grow following the payments of Bank of Nauru and other debt liabilities to the citizens of Nauru, but may not fully offset the impact of reduced activity due to the completion of the investment phase associated with the RPC.

8.4.3. Population and Labour Force

Table 8-1 shows the population up to 2011 with the GoN's projection for 2014/15. Between 2002 and 2011 the population growth was negligible but the GoN is projecting over 1.75% growth from 2011 to 2014/15.

Table 8-1: Population and Labour Force, 2002 to 2014/15

Working Age (15+)	Census Y2002	Census Y2006	Census Y2011	Projections Y2014/15 (000s)		
				Male	Female	Total
Total Population	10,065	9,086	*10,084	5,470	5,337	10,807
Labour Force	3,280	4,106	3,952	2,677	1,673	4,349

Source: 2014/15 National Budget paper 2

Note: *Including Total Persons in Institutions

Employment is said by Government¹¹ to be 'virtually' full with some pressure being felt in Government recruitment, and in wages competition with the private sector beginning to be felt across the economy. Skills shortages are now appearing in several areas and require some short and long term responses, within the fiscal and other constraints. There does however appear to be surplus unskilled labour, and certainly underemployment, especially related to younger people.

8.4.4. Inflation

Consumer prices have been fairly volatile since 2008, although between 2010 and 2013 quarterly prices changes jumped between small positive and negative price changes. From December 2013 prices have climbed steadily upwards and the 14% increase reported in late 2014 accompanies a 7% rise in government salaries. Between 2008 and 2013 inflation averaged 3.2%. However, inflationary pressure is rising and the Budget estimates it will now probably reach in the order of 5.3 % in 2015.

8.4.5. International Support

Nauru receives considerable aid from various bilateral sources. Australia is the largest development partner supporting programmes to strengthen public sector management, increase private sector growth, improve health, improve education services and help develop power, water and related infrastructure. Recent funding has amounted to \$8.4m in 2014/15 out of a rolling programme which the Budget papers indicate will continue at about \$30m per year in total. RPC visa income is projected to amount to some \$13m in 2014/15.

Since joining the Asian Development Bank (ADB) in 1991, one loan worth \$5 million, one grant for \$4 million, and nine technical assistance projects for \$2.65 million have been provided to Nauru. One technical assistance project, with financing of \$0.50 million, and one grant, totalling \$4 million are active. ADB is also supporting governance reform, private sector development and a number of other initiatives including support to the NUC (with EU). ADB is also co-financing infrastructure support and sustainable development planning. ADB is continuing to support the reintroduction of banking services to Nauru through the development of a new banking act. This will enable a community bank to begin operations in Nauru in 2015.

Taiwan has been providing support amounting to US\$9.3m for budget support and overseas representation.

Japan has also been a regular large donor with programmes totalling US\$16.6m between 2005 and 2009. Recent programmes include support to the development of a fish market, a solar water project and the JICA Port Study in 2014. Previously the Japanese Government funded the new fish harbour at Anibare in 2002.

The New Zealand government is funding programmes that totalled over \$5m over recent years in Justice, Education and Fisheries.

The Russian Federation has also funded some small programmes including a small rescue vessel at the port and in health services.

The 2013/14 Budget shows total Budget support of some \$7.4m and in 2014/15 some \$4.7m, although contributions from the development partner to the specific programmes noted above are much more substantial.

8.4.6. Economic Development Challenges

Nauru faces many serious development challenges. It has almost no private sector, little arable land, limited fresh water supply, extremely high levels of debt, and limited sources of government revenue. Education outcomes are improving, but are still poor by international standards and have contributed to high rates of youth unemployment. Levels of non-communicable diseases (i.e., diabetes and cancer) are among the highest in the world. The reopening of the RPC is providing a boost to the economy but has also given rise to challenges such as the areas of skilled labour shortages, economic management, and logistical issues for other operations on the island. The long-term future of the RPC is uncertain.

Nauru exhibits most of the characteristics of underlying fragility¹². This highlights the importance of consultative and participatory arrangements to ensure ownership by stakeholders. Given the country's large debt, state of economic distress, weak performance and frequent changes in government, flexibility a high degree of cooperation with other development partners, will be needed to address issues that arise.

8.5. Infrastructure

During the past three years the performance of Nauru's infrastructure providers has improved but there are still serious constraints in a number of sub-sectors relating to

¹² ADB Country Operations Business Plan October 2014, Nauru 2015–2017

inadequate governance, a lack of sector strategies, poor cost recovery, a lack of managerial and skilled staff and overstaffing¹³.

The poor performance of infrastructure providers also contributes to the very poor condition of infrastructure facilities in a number of the sub sectors, including the maritime sub sector, due to the lack of adequate maintenance of assets.

Institutional and management issues related to the port have been discussed in various reports including the above referenced report and also within the Nauru Port Infrastructure Priority Needs Assessment¹⁴. That Mission noted that:

“...an appropriate institutional set up of Port Management structures, could lead to more effective business planning and budget management. There may be sufficient port revenue generation potential to support reasonable investment needs and operational improvements. A more detailed and comprehensive assessment of the port’s revenue and investment capacity would better inform GoN’s maritime transport sector development planning and decision making”.

The Mission also recommended that an analysis of the Port’s financial management potential be prepared during the PPTA.

The following extract shows the key actions for the maritime sub sectors to achieve the strategic objectives and realize the NEISIP priority investments were identified as follows:

Responsible Body:	Department of Maritime Transport/Nauru Port Authority
Recommended Action	<ul style="list-style-type: none"> • GoN with support of JICA to assess feasibility of long term port facilities and the need for co-financing • Prepare medium term Operational Master Plan for the Port • Prepare Corporate Strategy and Performance Improvement Plan

Source: NAURU Infrastructure Sector Review March 2013

The infrastructure sector in Nauru has received considerable support from development partners to an average amount of about \$13-\$14 million per year. Moreover from the National Economic Infrastructure Strategic Investment Plan (NEISIP) review in 2013 it is noted that 5 out of the 12 priority proposed investments are currently underway. This current study is a major step forward to help implement a long term solution in the maritime sector as described in the NEISIP.

Utility services remain unreliable and exposed to ageing equipment, poorly maintained infrastructure in both the electricity and the highly power dependent reverse osmosis water supply system, although these infrastructure are being progressed under various ADB¹⁵ and other Technical Assistance (TA) projects.

¹³ NAURU Infrastructure Sector Review March 2013

¹⁴ Draft Aide Memoire, Author Reynaldo Bench Senior Ports Specialist World Bank, In collaboration with Peter Kelly ,Senior Infrastructure Specialist, AusAID, 27 September 2012

¹⁵ For example, Technical Assistance to Nauru for Regulatory and Governance Reform for Improving Water and Electricity ADB. 2011.

8.6. The Transport Sector

8.6.1. Introduction

Small Island Developing States' (SIDS) maritime transportation systems have common features that hinder their sustainable development and growth. These include remoteness, a narrow resource base, lack of capacity and infrastructure to support international shipping, a narrow range of export commodities, high reliance on imported fossil fuels, low transport connectivity and high transport costs.

These factors increase socio-economic vulnerability, which is further amplified by fragile ecosystems, high exposure to natural disasters and climate change risks, combined with little resilience and low adaptive capacity. Achieving greater sustainability and resilience in the maritime transport sector and building adaptive capacity and climate resilience of coastal transport infrastructure, including ports, is of paramount importance¹⁶.

The port is the major vulnerability for almost all economic activity on Nauru, with recent equipment failures inhibiting import and export activity and imposing continuing high costs on shippers, individuals and thus the community¹⁷ at large. Simply refurbishing the port through minor investments still exposes the economy to potential major disruption to fuel, food and export movement and will not overcome the existing problems resulting from the lack of adequate port infrastructure facilities.

These risks are exacerbated by the potential for further increases in population at the RPC and, in the short/medium term, in the general community itself, as some or all of the refugees were assimilated into the community.

As part of its risk mitigation strategy the Government has placed the port facility at the top of its list of economic priorities. Next, the government is committed to maintaining a tight fiscal stance and exploring a small number of options for shifting spending to infrastructure and skill building investment while trying to restrain recurrent expenditure to very slow expansion.

8.6.2. The Maritime Sector

The maritime sector comprises the Department of Maritime Transport and the NPA. Figure 8-1 shows the structure of the Ministry of Transport, Department of Maritime Transport and the NPA.

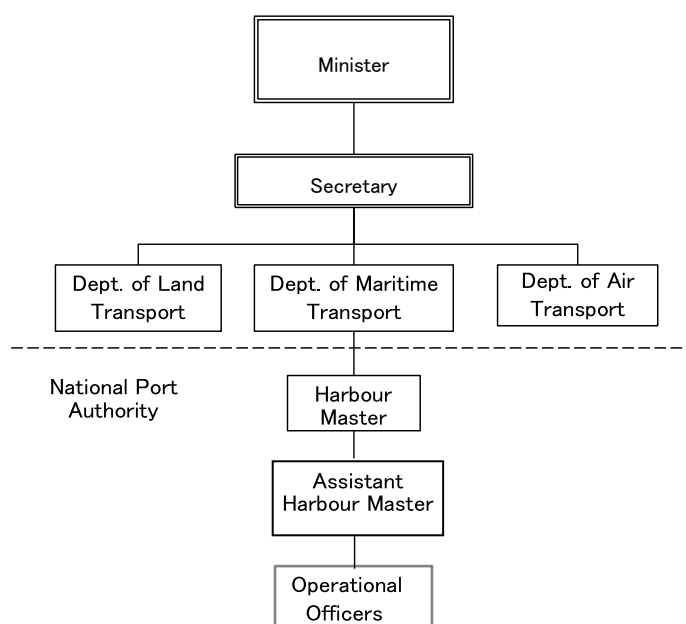
The Director¹⁸ of Maritime Transport is the only staff member in the Department and he is currently seconded to the NPA to help manage this operational body.

Information provided by the Department indicates various major issues with the operation and management of the sector which it is not within the scope of this Study. Clearly the Department is going to have difficulty to function effectively with only one person, and when that resource is seconded to NPA it is difficult to see how any effective planning and overall oversight can take place within the maritime sub sector.

¹⁶ 'The Oceans Economy: Opportunities and Challenges for Small Island Developing States (UNCTAD/DITC/TED/2014/5) 27 Aug 2014'.

¹⁷ We have not been able, due to lack of data, to assess the impact of the inadequate and costly arrangements for phosphate handling for example on Nauru as a whole. It is possible that better facilities, as included under one of the options to be discussed in this study, would not only reduce transport costs but could also improve the price received for phosphate.

¹⁸ His support during our visit is gratefully acknowledged

Figure 8-1: Structure of the Ministry of Transport, Nauru

Source: JICA Report on Aiwo port 2014

The NPA itself has difficulty performing well with its limited physical and operational assets combined with, and possibly resulting in, management (especially human resource management) and operational issues that were communicated to the Consultants during our many visits to the port office.

According to the FY14/15 Budget figures (Table 8-2), and shown for the past 4 years in Appendix C, annual port operational costs are about \$200,000 higher than revenue. Revenue is provided by port users through the 2011 Port Tariff regulations (Appendix C). As shown in the Appendix, until recently the NPA made a surplus on operations.

If capital items are included, such as contributions to mooring buoy costs, the shortfall will be almost \$1.9m in 2014/15. Labour costs are a large component of operational costs including a substantial overtime component.

Table 8-2: Current NPA Budget

2014-15 Budget*	Amount, A\$
Revenue	+1,000,461
Staff and related Costs	-918,695
Sundry Items	-191,235
Fuel and Energy Costs	-48,434
Other Costs	-45,000
Total Operational Costs	1,203,364
Operational Surplus/Deficit	-202,903
Capital Budget	1,673,750
Grand Total Expenditure	2,877,114
Balance	-1,876,653

*Including supplementary Budget as of 16/2/2015

Issues with physical assets are addressed elsewhere in this report but many of the other issues are related to labour, including staff numbers, productivity and labour relations.

For example, the number of staff within the NPA has been increasing rapidly in recent months. In mid-2014 there were 89 staff in the NPA, but the total by February 2015 had risen to 111 with a few establishment positions vacant. Most of the increase appears to be in a major increase in the number of raft boys, possibly aimed at reducing youth unemployment.

As has been noted by the Department, lack of fencing and the lack of proper toilet and washing facilities prejudices health and safety and makes management tasks even more difficult, as staff enter and exit the port area, without any control, to undertake these functions outside the port. Port areas should be closed off to the general public in any case.

Implementation of this project will require a more effective maritime sector. We therefore suggest that the maritime sector would benefit from a management and operational review to (i) improve the overall planning of the sub sector, (ii) consider where private sector involvement would ensure the sustainability of facilities and (iii) improve the port organization itself.

The PPTA could set out a range of options for private sector participation. This could consider for example performance based contracting (PBC) to operate and maintain the port including financing some elements of cost e.g. equipment. The modality of private sector participation and experience from the private sector operation of the Tank Farm could be useful input to the PPTA.

A number of objectives for the review of the NPA's port management could be envisaged as follows;

Berth/Vessel and Landside Management: In order that the estimated benefits of the project are actually generated, port management will need to focus on two broad areas of (i) berth management and (ii) landside operations. Procedures and staffing will need to be overhauled to meet the objectives of the new facilities.

Lower operating costs: The overall goal of many management review schemes is to reduce costs and to help make the (port) enterprise sustainable. Ideally this implies that it can minimise all costs.

Increased Revenue: The development of the port will allow and encourage new and increased revenue streams. This should encourage a review of both the tariff structure and tariff levels.

Sustainability: Lowering costs and increasing revenue will support achieving sufficient levels of operational profitability to ensure ongoing investment in maintenance and in the replacement of equipment i.e. that the operation is sustainable. This is not happening at present.

A major element of the port's productivity and financial issues relate to staffing. The review could also examine:

Surplus labour: This can reflect the inability or failure of management to respond to changing circumstances and requirements; but surplus labour needs to be addressed if future port operations are to become more efficient and safer in operating the new port facilities.

Better skills mix: A better work force, perhaps one with fewer people who are better paid, better trained, and more capable would be a desirable objective. With the new port

infrastructure, there may be staff with skills that have become redundant and there will be a shortage of other skills.

A more adaptable work force: In addition to skill improvements there should be greater labour flexibility in work hours, work practices, or the structure of the work force allied with much better pay as well as better and safer working conditions with more job security.

Better labour relations: Given that labour relations within NPA are not ideal with various conflicts in the past couple of years, there may be a need for changes in both management and working practices including new negotiation frameworks and/or new labour contracts.

8.7. Existing and Future Port Traffic

8.7.1. Background to Nauru Cargo Operations for the Economic Analysis

The country is currently not well served in terms of port facilities for international trade. Two small harbours are located on the western and eastern sides of the island (at Aiwo and Anibare respectively). Both of these are only designed for small craft, with mainly small domestic fishing vessels using the eastern harbour¹⁹. A small jetty is currently under construction by Ronphos/NRC to export aggregate and rock near to the fishing harbour at Anibare and this will be completed in 2015²⁰.

There are seven main types of international seaborne traffic; exports of (i) phosphate and (ii) empty containers, and imports of (iii) full containers, (iv) fuel and (v) break bulk goods. There are (vi) minor exports of coconut products and scrap metal and growing exports of (vii) building materials such as aggregate and rock. There are a few other ad hoc ship arrivals. Other seaborne traffic in the Nauru maritime zone includes foreign fishing vessels (licenced by Nauru²¹), although none currently stop at the island due to lack of port facilities even though transshipment is contractually required in Nauru.

As there are no port infrastructure facilities capable of handling the size of cargo vessels that visit Nauru, a major buoy system is located near to the Aiwo harbour which is used to moor all vessels loading or discharging cargoes, mainly phosphate, containers, break bulk and fuel.

Only one vessel can be attached to the mooring system at any one time and generally, phosphate and fuel vessels have to queue to moor at the buoy system as they are constrained by the capacity of the mooring system. Container vessels can unload or load without mooring at the buoys but prefer to use the buoy system as the alternative is to unload or load while 'drifting'. This is slower and operationally more difficult and expensive as they have to stabilise their position using engine power.

Priority at the anchorage is given to the vessel types the government considers a priority at that time e.g. if Nauru needs fuel, tankers will get priority. It is not unknown for vessels already tied up to the mooring system to be moved temporarily for higher priority vessels to load or unload.

¹⁹ The eastern harbour, Anibare, is used for international trans-shipment of container and general cargoes when bad weather prevents the use of the cargo transfer operations at Aiwo

²⁰ A temporary jetty was previously constructed near to the phosphate cantilevers but this was severely damaged in a storm in January 2015.

²¹ A description of the fishing arrangements with foreign fishing fleets is provided in 8.7.3 (v) below.

Phosphate is loaded via a fixed cantilever system adjacent to (and on the south side of) Aiwo harbour and fuel is pumped ashore using fuel lines located on the cantilever system.

General cargo vessels carrying containers and break bulk traffic also moor to the same mooring system with queuing at times. Cargoes are transhipped to small barges, which need constant maintenance, carrying up to 5 containers at a time, depending on the weather/sea state. Damage to cargoes appears to occur most often at the transhipment stage²².

This procedure takes place mainly in the Aiwo area but in bad weather, vessels tranship through the small harbour at Anibare. There are no mooring buoys at Anibare so transhipment there always takes place with vessels 'drifting' under their engine power to maintain position during cargo transfer. 'Drifting' also takes place at Aiwo if vessels are unable to moor to the buoys due to their unavailability²³. After containers or cargoes are lifted from the barges onto the harbour side, they are then deposited in the congested landside container storage area.

Traffic and vessel data received from the NPA is quite detailed and for this study's purpose appears broadly reliable, however the last 4 months data relating to 2014 was not provided.

It should be noted that due to issues with the mooring system from August 2014 (and ongoing at the time of writing) data that includes the last 4 months of 2014 would probably be misleading in any case. Hence in the projections we have made 2015 the standardised or base year.

Vessel sizes in 2014 at Nauru are shown in **Table 8-3**.

Table 8-3: Visiting Vessel Characteristics

Ship Type	2013/2014
Container/General Cargo	9,600 DWT/6,000 GRT
Phosphate	25,000 DWT /15,000 GRT
Fuel	7,000 DWT/5,500 GRT

Source: NPA Traffic Data and Consultants

*TEUs for container ships and metric tonnes for other

Max GRT and Max Cargo are actual data

Analysis of the traffic data (Summary shown in Table 8-4 and full analysis included in Appendix C in Table C6) shows in general quite dramatic changes in traffic volumes of container, break bulk and fuel starting in 2012, almost entirely due to the reopening of the RPC in the second half of 2012.

²² Anecdotally, as no data was available from the NPA

²³ Breakdown or maintenance of the buoys or a vessel already occupying the buoy system.

Table 8-4: Summary of Historic Traffic Data (2011 to 2014)

Traffic Type/Calendar Years	2011	2012	2013	2014 (Jan-Aug)
Containers (TEUs-Full/Discharged only)	721	944	2,485	1,835
Fuel (metric tonnes)	7,000	17,000	18,000	15,500
Break bulk (tonnes)	n/a	12,000	31,700(a)	14,300 (b)
Vehicles (units)	n/a	n/a	328	418
Phosphate (metric tonnes-FY Jun-May for all years)	386,000	538,000	381,000	285,000

Notes: Source: NPA and Consultants

(a) This traffic excludes cargoes on 3 RPC chartered vessels (but tonnage not quantified).

(b) Plus 23,500 tonnes of specific RPC cargoes

The table shows the significant impact of the RPC. Specific RPC vessels carried much of the building materials for the expanded RPC²⁴ which are unlikely to continue although more general fuel, food and day to day items will continue. The Consultants consider that therefore while the RPC is still fully operational, container and fuel traffic is likely to continue at a higher level than previously while break bulk and vehicles may well decline to nearer pre RPC levels.

Specific RPC cargoes have been separated out where stated in the NPA records but RPC bound supplies have not been excluded where these are included in the general traffic volumes. Nearly all containers are 20' (TEU) and the average weight of the containers based on an analysis of some manifests is about 10 tonnes²⁵.

Container vessel calls reached 30 in 2013 and if the January-to-August 2014 rate of ship calls had continued, there would have been up to 20 ship calls in the whole of 2014 which would be consistent with 2010 to 2012 figures (Table 8-5).

Table 8-5: Ship Calls at Nauru 2009-2014

Ship Types	2009 (6 months)	2010	2011	2012	2013	2014 (to August)
Container Ship Calls per Year	10	20	21	18	32	14
Phosphate Ship Calls per Year	not available	17	18	19	15	7(a)
Fuel Ship Calls per Year	3	5	8	11	10	8

Source: NPA and Consultants

(a) According to Ronphos only one more call between August and December 2014 due to damage to the moorings.

Fuel vessels call just under once per month and deliver petrol, diesel and jet fuel in various combinations. Phosphate vessel calls reached 19 per year in 2012 but fell back to 15 in 2013 and 8 in 2014. There are very few other types of major vessels but these include tugs and ad hoc (small) passenger ships. Small domestic fishing vessels use the Anibare

²⁴ It should be noted that in July 2013 there was a serious incident at the RPC necessitating further and considerable importation of more materials for rebuilding work.

²⁵ This average is based on wide ranging differences in the contents and weights of individual containers.

harbour²⁶ and there is a small fishing vessel launching facility at Aiwo town, south of the Ronphos area.

The Aiwo harbour is small and the landside port facilities, mostly built 50 years ago, are in an extremely poor state. There is also a lack adequate space for containers and cargoes, and port operations generally. Funds are currently allocated by the GoN to demolish the port sheds which are falling down and to upgrade the port office (shed) into a proper operational facility, although this expenditure has not happened yet.

The mooring system has been out of action since August 2014 due to damage by a container vessel. Phosphate ships must moor so there have been almost no phosphate exports for 8 months, and fuel imports have been limited. However, container ships can offload at sea without mooring (although this is a more difficult, more expensive and slower procedure than at the moorings).

The lack of port facilities to handle general cargo, fuel and phosphate vessels results in higher transport costs and various other costs²⁷ and restraints upon economic development generally²⁸. The current situation with the mooring system out of action for many months has had a negative impact upon the Nauru socio-economy. Running out of basic foodstuffs, fuel and other necessities and the inability to export phosphate are a few of the direct impacts of the deficient cargo handling arrangements in Nauru.

Analysis of the traffic data provided by the NPA also indicates that the productivity performance of the cargo handling arrangements is declining even excluding the impacts of the current mooring buoy situation. Table 8-6 and Figure 8-2 demonstrates this increase in days per ship call over recent years.

Such extending, and apparently increasing, number of ship days moored or 'drifting' for cargo loading or unloading at Nauru has an impact on transport costs. Various previous studies and Ronphos (for phosphate) indicated that maximum days for these amounts of cargo at well-functioning port facilities should be considerably below the figures shown in Table 8-6. This is discussed further within the sections on the evaluation of each Option.

Table 8-6: Days per Ship Call

Cargo Type/Year	2011	2012	2013	2014 (Jan-Aug)
Container Vessels (days)	2.8	5.1	9.0	12.9
Fuel Vessels (days)	2.3	1.9	3.0	2.9
Phosphate Vessels (days)	6.0	4.6	4.8	8.9

Source: NPA and Consultants

NB Days are calculated on a total basis i.e. days waiting to moor and days moored.

²⁶ The harbour facility at Anibare was supported by JICA funds and was built in 2000.

²⁷ We have estimated those costs that can be quantified e.g. additional ship costs, delayed sales of phosphate and other cost savings and benefits in the evaluation of each Option

²⁸ JICA Report Appendix Supplementary Report August 2012

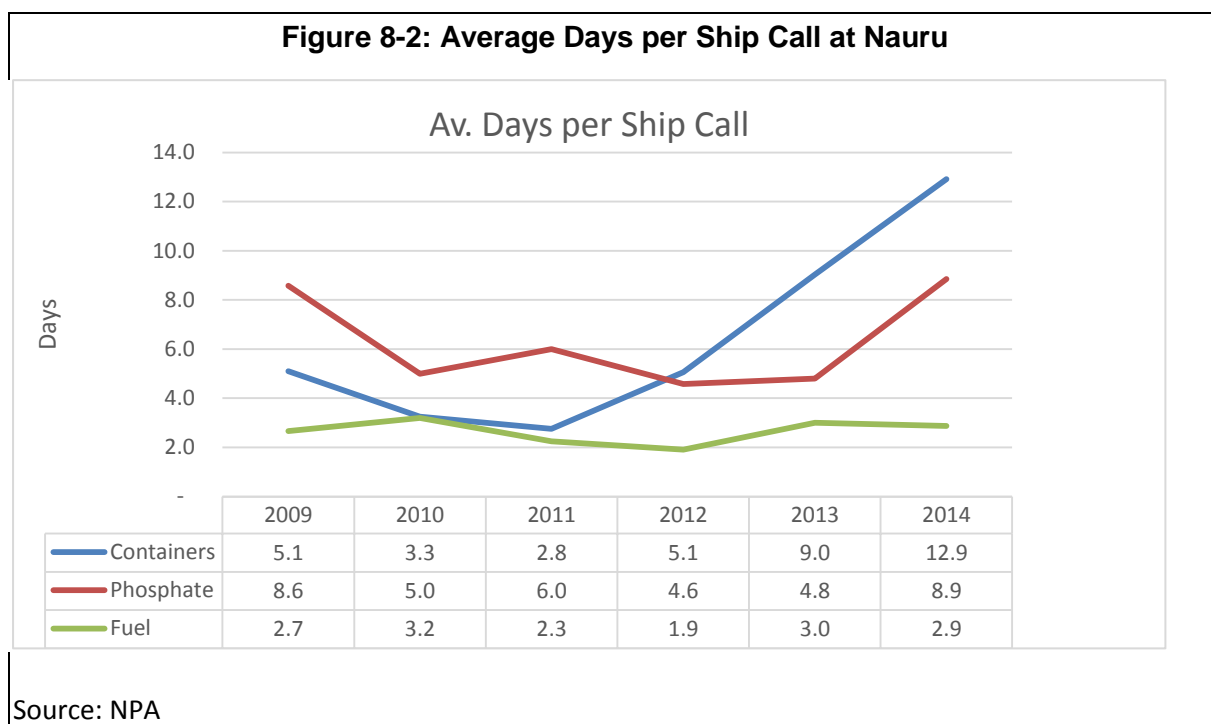


Table 8-7 shows container movements per day, per ship call and the maximum movements per day. As it shows productivity, it is not so significant whether the data is based on full or part years. The table shows the changing and falling productivity per day over the past 4 years even when one might expect that larger consignments of cargo might show slightly increased productivity over smaller consignments.

Table 8-7: Container Movements and Productivity

	2009	2010	2011	2012	2013	2014
Av. TEU Movements Per Ship Day	15.0	19.2	24.5	18.3	14.0	18.4
Av. TEU Movements Per Ship Call	76	62	68	93	126	286
Max. TEU Movements per Ship Call in one year (in and out)	173	164	131	214	324	343

Source: NPA and Consultants

Various studies have been undertaken previously and various engineering/technical solutions proposed to overcome the deficiencies of the current cargo transfer arrangements. These are detailed in Section 5.

In 2014 JICA undertook a preliminary study²⁹ of a number of port development options including the without-project scenario. Their study was the first recent study to include an economic assessment but its remit was extremely limited and this preliminary study expands considerably upon that limited scope.

²⁹ JICA, The Preparatory Study on the Project of Constructing Reef-Edge Quaywall and Causeway at Aiwo Harbour Final Report March, 2014

8.7.2. Future traffic projections

(i) Introduction

Studies related to the development of ports and freight shipping indicate that future traffic volumes increase through (i) growth related to GDP and population which can be projected through statistical/econometric analysis or trends and (ii) through the development of specific import/export industries. The economic benefits and justification for the proposed port investment will be analysed³⁰ over 25 years from the anticipated commencement of the project in 2019, with construction expenditure assumed to be incurred between 2016 and 2018.

Future traffic needs are based on the analysis of recent trends and specific trade projections relevant to Nauru. For a small community like Nauru, with volatile recent maritime traffic trends, such projections may be speculative but are as robust and practical as can be developed in a study of this nature. As 2014 traffic data was affected by both RPC traffic and damage to the moorings, we have developed 'standardised' 2015 base year traffics³¹ and projected traffic for three dates, 2015 (base), 2019 (first year of operation) and for ten years to 2029. For economic evaluation purposes we have not increased traffic beyond 2029 levels and so for years 2030 onward traffic (and benefits) remain at a constant level.

(ii) Growth related to GDP and Population

Growth in demand for basic infrastructure capacity and services is driven by population growth and economic activity. In addition, the services delivered by economic infrastructure are an intermediate input into production, and affect business efficiency and economic growth. There is general international consensus that there is a positive correlation between infrastructure and economic outcomes and that investment in infrastructure is a major driver of productivity.

However, statistically, given the fluctuations in growth in recent years and the reopening of the RPC, it is difficult to relate port traffic to these macro indicators. National development reports and other sources³² indicate that GDP has grown by an average of 2% in recent years but has experienced wide swings in any individual year. The population of Nauru is estimated to be growing by about 0.5% per year. Anecdotal evidence seems to point to a positive elasticity of demand for goods related to GDP and population, and hence we have estimated a growth rate in demand for general cargo at 2% per year related to both the economy and population for the next 10 years.

(iii) Imports and Exports

An upgraded port could encourage industrial and commercial development and promote trade for Nauru by improving sea transport access, reducing transport costs and generally improving reliability in getting goods to and from the island.

³⁰ The analysis through discounting needs to be over 25 or 30 years but normally traffic projections are made for an initial period and then kept constant to avoid overestimation.

³¹ For only container, fuel and phosphate traffic for the base year (forecasts for new traffic are also developed from 2019 when the project is assumed to open)

³² The National Sustainable Development Strategy (NSDS) 2005-2025 (revised 2009) and Nauru Economic Infrastructure Strategy and Investment Plan November 2011

In terms of specific export industries a number of possibilities have been cited in previous studies and these potential exports, and any other likely traffic, were discussed with relevant government departments while in Nauru.

(iv) Fuel and Bunkering

During our field work in Nauru, the GoN were in the process of finalizing an agreement with a private company to transfer the fuel storage facilities to a private sector operation, which would enhance the prospect of developing an expanded fuel farm. However, given that the contract was still under discussion, no details of this arrangement were available to the Consultants³³.

However, we understand that in broad terms, the GoN intends that the party securing the tank farm management role will be responsible for the end to end purchase of fuel (from the appointed supplier if the roles are split) and sale to market segments (including operation/maintenance) and will recover all costs via a specific formula.

The contract will also include the opportunity to improve processes over time (e.g. discounts as volumes improve, changing shipping dynamics etc.) and that the selected bidder (whichever company it is) will provide commitment for continuous improvement and benefits to GoN including operating Nauru as a hub, with more efficient shipping capacity.

It also seems clear that a bunkering service would also encourage more (non-fuel) ship calls to the island especially fishing vessels.

There is potential for Nauru to provide bunkering services and over time this is anticipated to occur, and being beneficial to the economy. Additionally, fewer larger vessels to cater for this traffic would reduce potential berthing conflicts.

It would not seem unreasonable to assume fuel imports growing at twice the rate of general cargo i.e. at 4% per annum by 2018 (opening of the new port) given the increased economic activity on Nauru. However, it is not obvious from the NPA fuel tanker ship data whether there is capacity in the tanker supply vessels and if so there would not be an immediate increase in the tanker ship calls.

It has therefore been assumed that a 2% per annum increase in ship calls with the likely possibility, say within 2 years of operation of the new quay, that bunkering services could generate incremental revenue³⁴ based on bunkering and serving the expanded fishing fleet calls.

(v) Aggregates and Rock

The Nauru Rehabilitation Corporation (NRC) is already exporting crushed lime/coral aggregates and rock armour products extracted from the coral pinnacles to neighbouring pacific islands, bringing added revenue and employment to the island. However, NRC is building its own jetty in the Anibare area, following major damage from westerly waves to their landing located south of the Aiwo port, and thus they have said that they will not use the proposed port for the export of such commodities³⁵.

³³ It is not clear if the contract is privatization (which is the term used by Government) or merely operation under a private sector management contract or some other form of private sector participation.

³⁴ Detailed under the Options

³⁵ NRC draft budget figures indicate they will start earning up to \$20m per year from FY 2016/17 from the sale of aggregate and rock exported through their new jetty facility.

(vi) Fishing related benefits

Nauru benefits from selling fishing licences through a Vessel Day Scheme (VDS) which is a scheme under the Palau Arrangement for the Management of the Western Purse Seine Fishery (PNA, 2004), which establishes a system of tradable fishing days allocated to the Parties as Party Allowable Effort (PAE).

The Arrangement regulates the total allowable effort by purse seine vessels licensed by the Parties at any one time, in response to scientific advice on resource sustainability and provides a basis for increasing economic benefits to resource-owning states and economic returns to participating vessel owners.

Nauru closed its marine exclusive economic zone to fishing by bilaterally licensed foreign tuna purse-seiners in November 2010, in order to avoid exceeding its national allowable effort limit for the 2010 fishing season. The same situation happened in November 2011. Currently Nauru is at the limit of its sale of fishing days which will generate about \$18-20 million in future years from 2014/15.

A fish processing plant has been suggested and discussed for some years on Nauru. A fish processing plant would also be expected to attract overseas-based fishing vessels for off-loading their catches while the fuel farm is expected to attract fishing vessels as a refuelling hub. However, a processing plant would require a large and skilled labour supply, reliable water and power supplies and be competitive with other existing or potential future regional processors. According to both public and private sector sources on Nauru and our own views on all these grounds, Nauru is unlikely to develop this industry and this proposed activity is not being considered further as likely by the GoN or the private sector.

However, a potential source of revenue and benefit to Nauru could come from fishing vessels transshipping at Nauru. According to the Nauru Fisheries & Marine Resource Authority (NFMRA), as a condition of the fishing licence, fishing vessels are legally bound to tranship in Nauru and not at sea. As there is no port, the GoN cannot enforce this condition but could in future as in other Pacific Island States such as Kiribati and PNG. According to data from FFA Vessel Day Scheme the average GRT of fishing vessels is 1,500 tonnes.

Anecdotally, the CEO of NFMRA considered that some 20 vessels could tranship with a direct revenue impact of \$8,500 per vessel. However, further information³⁶ on likely revenues indicates, on average, a gross revenue per transshipment call similar to the NFMRA estimate although actual revenues vary by Pacific island location. This information source shows that the average revenue per transshipment call was \$9,425³⁷ in 2010. In 2015 Australian Dollar prices this would be over \$10,000³⁸ by 2015. However, in order to be conservative we have assumed \$9,425 per call.

It should be noted that total revenue generated by transshipment calls by purse seine fishing vessels amounted to \$267,000 at Tarawa, \$350,000 at Pohnpei, \$472,000 at Majuro and \$367,000 in 2010. More detailed fish transshipment data is shown in Appendix C.

³⁶ A Survey of Tuna Transshipment in Pacific Island Countries: Opportunities for Increasing Benefits and Improving Monitoring Mike A. McCoy July, 2012 Gillett, Preston and Associates for FFA and Devfish II

³⁷ Actual data were: Tarawa, \$11,700; Pohnpei, \$10,400; Majuro, \$6,500, Honiara, \$9,000, per visit.

³⁸ According to the RBA inflation indicator

Although somewhat older, a report from Kiribati Department of Fisheries³⁹ notes that transshipment is becoming an important revenue generator for Kiribati and other benefits include charging for water and fuel provision and crew spending money buying local products.

(vii) Phosphate

Phosphate exports are likely to decline and probably cease in the next twenty years according to Ronphos and Government sources. Profitability has declined due to mining becoming more difficult between the rock pinnacles. However, while NRC the mining subcontractor to Ronphos can generate revenue and can employ people to produce the phosphate rock for export, mining is likely to continue.

It should be noted that only Option 3 benefits phosphate traffic in our analysis and under Option 3 benefits from savings to phosphate transport are assumed to cease in 2035.

The Consultants understand that there is a complex shipping arrangement for phosphate which may not only incur high transport costs but may also impact the price Nauru manages to negotiate on its phosphate sales.

(viii) Other

It is difficult to establish whether any other products or goods might be exported and no products have been seriously mentioned by Government or other parties.

Any local fishing initiatives would likely be marginal compared to our estimates of the impact of foreign fishing transshipment. We did also discuss fish farming with NFMRA as this does already occur on a small scale for local consumption. However, major developments that would impact the port seem remote at this stage, although both these initiatives could make an important local economic impact in the short/medium term.

If any products were to be produced for export in the short term they would likely be low volume goods and not impact port traffic.

However, the development of the port will assist Nauru in encouraging a medium term trade strategy. Sound economic resilience requires the building of links between transport, trade and domestic capacities.

A recent UN sponsored conference noted 'One of the main reasons for the high cost of shipping in the Pacific is that containers come back empty from most islands. This means that there is a need to expand productive capacity and business opportunities to fill those containers with locally grown and produced products'. Maritime transport is the lifeline of SIDS in supporting economic performance, trade and productive sectors, such as fisheries, agriculture and tourism, noting there is a current boom in the cruise sector in the Pacific⁴⁰.

(ix) Traffic Projections

The basis for future demand is shown in Table 8-8.

As mentioned, the first year of project operation is assumed to be 2019 and, for the economic evaluation, traffic increases are only assumed for the first ten years of operation up to 2029, being static in subsequent years.

³⁹ Report on Foreign Fishing Vessels Transshipments in Kiribati, (undated-1990's), Fisheries Division, Kiribati

⁴⁰ Third International Conference on Small Island Developing States, UNCTAD September 2014.

Table 8-8: Future Trade Volume Cases – Annual Throughput Assumptions-All Options

Main Cargoes	General Cargo Growth (Containers/Break Bulk)	Fuel	Fish Transshipment	Phosphate
Growth Envisaged	+2% pa	+4% pa	20 vessels in 2019	380,000 tonnes pa on average
Comments	Large increase in empty containers returned must happen in the next few years	Based on incentives through privatisation, and increase in bunkering and supply to fishing vessels	Traffic and Port Revenue builds up to a maximum amount by 2012	Fixed volume as advised by Ronphos and previous 5 years

NB: Growth rates are only applied for the first ten years of port operation

Traffic is only assumed to grow by the growth rates indicated for the first 10 years of the project and are then static in order not to overestimate the benefits.

The benefits of the project are shown in considerable detail in the economic analysis of each option. However, Table 8-9 also shows in broader terms the impact of the project on cargo handling efficiency. For example, in the projected years the number of days per call is expected to reduce, the volume of traffic per call will increase and overall the productivity of both shipping transport and port operations is expected to increase, reducing costs for users and those sending or receiving cargoes. Another gain will be that in 2019 and beyond, containers coming in and going out should be in balance thus improving efficiencies on the island by reducing the adverse impact of empty containers.

Table 8-9 shows the traffic projections for 2015, 2019 and 2029 based on historic data and assumptions related to traffic growth indicated above.

As 2014 data is not complete and the moorings were damaged and out of action for 4 months of 2014, 2014 data will be in any case not representative and so we have produced data for 2015 as a 'standardised' traffic year representing a base situation which tries to omit the one-time impacts of the RPC but includes the need to service the RPC population (staff and refugees) on an ongoing basis. 2019 is the proposed first year of the project i.e. when increased or new sources of traffic can be anticipated to start.

The forecast period for growth projections is ten years from 2019. The impact of future fish and phosphate activity on port activity are basically static as shown in 8-9. The estimated impacts of future fuel and container cargoes result from applying the growth rates from Table 8-9 to 2019 benefits.

Traffic is only assumed to grow by the growth rates indicated for the first 10 years of the project and are then static in order not to overestimate the benefits.

The benefits of the project are shown in considerable detail in the economic analysis of each option. However, Table 8-9 also shows in broader terms the impact of the project on cargo handling efficiency. For example, in the projected years the number of days per call is expected to reduce, the volume of traffic per call will increase and overall the productivity of both shipping transport and port operations is expected to increase, reducing costs⁴¹ for users and those sending or receiving cargoes. Another gain will be that in 2019 and beyond, containers coming in and going out should be in balance thus improving efficiencies on the island by reducing the adverse impact of empty containers.

⁴¹ Competitive pressure should help the reduction in transport costs being passed on to the people of Nauru but this process will take a transition period to be realized (ie, efficiency gains are not anticipated to be immediate).

Table 8-9: Basis of the Port Traffic and Projections for the First Year of the Project

	2015 (est.) Standardised ⁴² Year	2019 (projected) First Year of Project	2029 (projected) (and 2030 onward)
Container Traffic			
TEUs In	2,061	2,230	2,883
TEUs out (a)	1,157	2,500	2,883***
Total	3,217	4,730	5,766
Calls	20	21	26
Vessel-Days	120	84	51
Per day	161	225	225
Days	6	4	2
Phosphate			
Volume	380,000	380,000	380,000
Calls	20	20	20
Vessel-Days	100	60	60
Days	5	3	3
Tonnes/day	3,800	6,333	6,333
Fuel (Volume-all Types)	17,000	19,888	29,438
Calls	10	11	13
Vessel-Days	27	17	20
Days	3	1.5	2
Tonnes/day	630	1,205	1,464
Fish Transhipment			
Vessels	-	-	-
Calls	-	20	20
Days	-	3	3
Vessel-Days	-	60	60
Total Vessel-Days (Days the Berth is Occupied⁴³)	247	221*	191

Source: NPA. (a) At some point the number of empty containers on the island must start to equal (over time) those already those already on Nauru and those newly incoming

*This would be be a fairly high berth occupancy (in %) and would need to be managed professionally

** Traffic assumed to remain constant after 2029

*** Assumed by 2029 that there will be a balance of in and out containers

⁴² Traffic in 2013 and 2014 was subject to various positive and negative impacts. We have therefore developed a standardised year as a 'normal' base year in 2015 from which to project future traffic

⁴³ Occupied either fully or partly

(x) Future Year Traffic by Option

Traffic forecasts are generally common across options. Options 1 and 3 are identical in terms of potential traffic, and at this level of detail, we have not felt it useful to prepare a different forecast for Option 2, although Option 2 generates somewhat higher benefits/revenue reflecting its more extensive facilities e.g. for fishing transshipment.

8.8. Economic Analysis of Option 1-North Quay

8.8.1. Introduction

The facility provided within this option will permit most vessels visiting Nauru including container, fuel and fishing vessels to berth at a dedicated berth separate to the existing berth for the phosphate vessels. This new berth will provide a facility which is adequate for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. Bulk fuel ships will also use this new berth, as the existing fuel transfer pipelines located on the phosphate cantilevers will be moved to this berth. Fishing vessels will be able to tranship at the quay side. Berthing of vessels at this quay wall is expected to be reasonably straight-forward for most weather conditions.

Phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring/buoy system. Hence, the NPA and Ronphos must continue to maintain the moorings and buoys to maintain this phosphate loading capability.

Container storage will now be adequate at the port, with the redevelopment of the container yard.

Its key Engineering Features⁴⁴ comprise;

- i. Quay Wall - 80 m
- ii. Access Causeway - 100 m
- iii. Expanded Container Yard
- iv. Fuel pipelines, 2 no. x 150mm
- v. Tractor-trailer set
- vi. Perimeter security fence and Security gates
- vii. Demolition of derelict buildings, and new Harbourmaster's Office Building, Gatehouse, Ablution Block and Plant Workshop
- viii. Reefer points.

8.8.2. Economic Costs

The financial cost of this option is \$22.97 million as at January 2015 prices as shown in

⁴⁴ This is not a comprehensive list but key elements of the project from the evaluation perspective

Table 8-10. It is assumed for the purposes of evaluation that the first year of expenditure will be 2016 and the construction cost will be incurred over 3 years as shown in Table 8-11.

Table 8-10: Option 1 Financial Costs

Item	A\$ million
Costs*	18.37
Physical Contingency and Engineering	4.60
Total Financial Costs	22.97

*Source: Section 6 Cost Estimates. Costs before physical contingency and engineering/studies

Conventionally, local inputs are also adjusted, or shadow priced, to reflect real resource costs. All taxes and duties are excluded from economic costs as they do not constitute the consumption of real resources but are transfers. Economic costs have been calculated on the basis of import duties averaging 10%. Financial costs have therefore been reduced by this amount.

Unskilled labour is often priced above a free market resource cost basis due to rigidities in the labour market. Our research in Nauru shows that labour is sometimes described by government as in short supply but statistics also show unemployment and certainly underemployment. As mentioned above, NPA is increasing its labour force substantially and seems to have no problem in so doing. On balance therefore it would seem that labour is not priced on a resource basis and there is therefore scope to shadow price labour costs for the purposes of the economic evaluation⁴⁵.

Given that we have no statistical basis on which to apply shadow prices, we have made a nominal adjustment on the basis that the project cost analyses indicate that some 30% of the local portion of the project is related to unskilled labour and this has been discounted by applying a 95% shadow wage rate factor⁴⁶. The overall impact of resource cost pricing related to the original January 2015 costs

We have assumed a residual value of the assets to be 50% of the original 2015 project cost.

Table 8-11: Project Economic Costs by Year

Year	Percent Cost in Year	Project Cost in Year
2016	13%	2.78
2017	39%	8.33
2018	48%	10.05
Total	100%	21.16

⁴⁵ We have noted above the need for a better paid and more productive labour force within NPA.

⁴⁶ The economic analysis is based on world/border price numeraire, so the value of non-tradables (labour) are converted to economic prices using an assumed standard conversion factor (SCF).

8.8.3. Avoided Capital Costs

As discussed in Section 5.7.1 if the project does not proceed the Government of Nauru will spend \$2m and \$3m in years 2017 and 2018. If the project proceeds these amounts will be saved and are an incremental benefit.

8.8.4. Operational and Maintenance Costs

Operational and maintenance costs of the project are assumed to stabilise after 3 years of operation at \$1.6m each year. If the project does not proceed the government will be liable for the ongoing costs of maintaining the current system estimated as \$1.8m. This provides an incremental saving of \$0.2m per year, except in the years as noted following. However, we also have allowed \$1.5m for replacement of equipment and plant every ten years from 2019.

8.8.5. Economic Benefits

The impact and benefits resulting from the development of any of the options will be considerable. This evaluation concentrates on quantified benefits but the economic consequences of the current inadequate cargo handling arrangements are felt island-wide beyond increased transport costs. Government revenue is lost, additional expenditure is required, trade related employment is affected, trade related investment is discouraged, some goods are not available and prices for basic, standard and luxury goods are higher than necessary affecting all of the community. At this Pre-Feasibility stage, we have measured and quantified many of these impacts but there remain a considerable amount of unquantified and intangible benefits.

8.8.6. Quantified Economic Benefits

(i) Transport Cost Savings/Savings to ships

Savings in ship time are the predominant (69%) quantified benefits under this study for Option 1. By avoiding using the mooring buoy and transshipment at sea procedure, vessels will save time either through reduced (or no) queueing⁴⁷ and avoiding the current inefficient transshipment procedure using barges. Table 8-6 showed the current days⁴⁸ that vessels are registered by the NPA as being at Nauru. Based on the current average days queueing or unloading, savings in ship time could be anticipated as shown in Table 8-12. For cargo ships, the current average days adopted is based on a 4 year average of 8 days per container vessel, to reflect the increasing inefficiency of operations over recent years.

The average days required for vessels to stay at berth have been based on container rates and average interchange from JICA-2014⁴⁹, ADB 2009 and various other sources. Some conservatism has been incorporated into the figures to avoid being overly ambitious and overstating the potential savings. Required days for phosphate loading was obtained from Ronphos and Oldfield, 2009 and required fuel unloading rates are based on data analysis of actual queuing time and berthing time at Nauru. Fewer days may be required into the future,

⁴⁷ The upgraded management system of the port should coordinate ship calls

⁴⁸ Total time queueing offshore and moored to the buoy system

⁴⁹ Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

once institutional reform and capacity building are effective, and therefore additional savings may occur in the future.

It should be noted that the savings in time saved for container vessels appears quite conservative given that in 2013 and 2014 container ships were staying for periods of 9 and 13 days respectively and 2 days could be sufficient⁵⁰ to unload the average number of containers if very well managed.

However, traffic related to the RPC has expanded over these years and is unlikely to continue at such a rate but we consider that container traffic will stabilise at a reasonably high level and continue to increase moderately as discussed in the Bases Section, and as the increased number of the people on the island will still need serving with consumables while the RPC centre remains open.

Table 8-12: Savings in Ship Costs Per Call

	General Cargo/ Container Vessels	Fuel Vessels
Current Average Days	8	3
Days Required	4	1.5
Days Saved per Call	4	1.5
Charter Cost per Day ⁵¹	\$13,000	\$10,000
Savings per call	\$52,000	\$15,000
First Year Savings	\$983,000	\$150,000

Source: Consultants based on NPA data; See also Tables 8-6, 8-9

In order to reflect periods of bad weather, when the new facilities will not benefit some ships, we have reduced the container benefits by an indicative 10%.

Given the relatively low volumes of traffic, the estimated 'days required' for all cargo types are conservative.

(ii) Incremental Port Revenue

We have not undertaken a financial analysis of the existing NPA nor assessed comprehensively the financial impact of the new port infrastructure facilities. There will be opportunities to both increase port revenue as a benefit to the Government and reduce port charges as a benefit to users (and hopefully consumers). This detailed assessment should be undertaken in the PPTA⁵². However, we identify various financial benefits that the new port facilities should generate.

a. Container Yard Revenue

There are various inefficiencies with regard to container handling in the port area at present. There is insufficient space within the port so containers are parked around the island, and

⁵⁰ Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

⁵¹ See Economic Analysis in the Appendix for details. Sources include UNCTAD 2014 Review of Maritime Transport and various ship broker web sites. We note that the JICA report on Nauru port (2014) estimated that total ship cost per day is of the order of Y1.79 m or \$19,000/day (June 2015 exchange rate) and have given some weight to this in estimating an average cost per day from our various sources.

⁵² Draft requirements for the PPTA are found in Section...

within the various and crowded port areas containers are often hard to find and sometimes lost (and pilfered⁵³).

The proposed container yard is required to efficiently handle the container throughput, limit the number of containers scattered around the island and generate some revenue.

Given the current informal arrangements for container storage, currently there appears to be no related revenue even though there is a port tariff for container storage. Current port rates indicate storage charges for 1 TEU of \$10/day after 7 days. We have assumed 10% of TEU throughput is stored in the port for a further 5 days after the free period. First year benefits amount to some \$10,000.

b. Savings in Port Charges

For vessels that will be able to berth at the quay, the use of water craft and barges will no longer be necessary. The charges currently levied per ship call for the use of water craft and barges vary considerably. Our analysis of invoices show that such charges range from zero⁵⁴ cost to almost \$8,000 per call related to container vessels and tankers. We have assumed a \$1,000 per call saving for container vessels and \$3,000 saving per tanker. Based on an average of 20 container ships and 10 fuel ships, the savings would be \$50,000 per year.

c. Other port revenue

Most commercial ports charge for vehicular access and Kiribati port, for example, charges the equivalent of \$5 per heavy vehicle entering the port. There are various minor charges that could be applied once there is proper port security and secure fencing. We have not included these charges in the analysis.

(iii) Fishing vessels

As indicated above, we estimate that some 20 fishing vessels would tranship, generating revenues of \$9,425 per vessel. We assume that annual income will build up to \$190,000 by 2021.

(iv) Fuel Imports and Bunkering

The import of fuel has been increasing with the development of the RPC and this seems unlikely to continue at recent levels (18,000 tonnes in 2013) but the demands of the island and the ongoing operation of the RPC suggests a level higher than pre RPC levels (8,000 tonnes in 2010). We have therefore considered that a base year demand of 17,000 tonnes. would be appropriate for this evaluation.

Currently, there is no wharfage fee on fuel but after it is delivered over the proposed quay, a tariff⁵⁵ of \$10/tonne is recommended, which would provide an additional revenue of \$130,000 per year from year 1 of operation.

(v) Reduced injury and damage

It appears that no records are kept of injuries to staff or damage to goods, or at least that was the response from NPA to our questions on these subjects. During our visit on one day

⁵³ Anecdotal

⁵⁴ Not explained

⁵⁵ Example of Kiribati Port Regulation, 2010-\$10 per tonne (handling by the port authority). However, all of the Nauru tariff regulations should be revised and updated at least for the opening of the new port facilities if not before.

in February a port worker was injured and a container and contents damaged in one accident. There were anecdotal reports of container damage and occasionally containers falling into the sea during offloading. Other isolated records noting damage to container contents include:

- Feb: 2014, Damage to boat and trailer being offloaded to a barge at sea
- Dec 2014: All contents of container destroyed (cause not clear)-value \$45,000.

We are not able to assess the costs of personal injuries but the incident above this year, and another incident in which a port worker suffered severe injuries, suggests that like damage incidents, these occur occasionally but regularly. It should also be noted that observed unsafe port operational practices during our field research will also contribute to the ongoing occurrence of accidents without the project. It should be noted that transshipment at sea is an intrinsically unsafe procedure. The Consultants have therefore assumed that the project would avoid such injury and damage incidents amounting to \$50,000 in the first year of operation.

(vi) Labour Cost Savings

As described above, the labour force appears to be overstaffed and the quay operation would not require barge handling and transshipment workers. All three Options would allow reorganization of the port management and operations which appears much needed. Labour costs as shown in recent Budgets (see summarised data from Appendix C2) are over \$900,000 per year both in 2013/14 and estimated 2014/15.

Based on analysis of staffing records and overall reduction in workers back to early 2014 levels, basic payroll costs (before overtime and benefits) would fall by about \$100,000 per year. Reduction in barge operators could save another \$50,000 but we consider that improving productivity could result in higher pay levels, so that we have limited the saving to \$125,000 per year.

(vii) Air Freight Savings

It appears that during short supplies of goods due to issues with the moorings, some goods are air freighted into Nauru. Milk was in short supply during our field research and limited amounts were available at Eigigu supermarket for 10 times the normal price as it had been brought in by airfreight. This was confirmed by Ronphos. The volumes of goods air freighted is probably low but at times the value could be significant. We were not able to access air freight data and so we have not included any value of this aspect.

8.8.7. Indirect and Intangible Economic Benefits

It is difficult to overemphasize the importance of the development of efficient and reliable sea transport infrastructure serving Nauru.

The lack of port facilities to handle general cargo, fuel and phosphate vessels results in higher transport costs and various other costs⁵⁶ on the population and results in restraints upon economic development generally⁵⁷. The current situation with the mooring system out of action for many months has had a negative impact upon the social and economic life in Nauru with shortages and reported power cuts. The problem with the mooring system is

⁵⁶ We have estimated those costs that can be quantified e.g. additional ship costs, delayed sales of phosphate and other cost savings and benefits in the evaluation of each Option

⁵⁷ JICA Report Appendix Supplementary Report August 2012

likely to continue indefinitely into the future until a system that can solve or partially overcome the issues that accompany such a mooring system.

Running out of basic foodstuffs, fuel and other necessities and the inability to export phosphate are a few of the direct impacts of the deficient cargo handling arrangements in Nauru.

A new port development would help generate various other benefits. These are quite substantial benefits but difficult to quantify and include;

- i. New Trading Opportunities
- ii. Security of Island access and providing an island lifeline

8.8.8. Environmental Benefits/Disbenefits

These have been discussed in Section 9. In summary, Option 1 is expected to produce the greatest extent of environmental degradation (relative to the baseline), since this will impose the impacts of port construction and operations on an area that is relatively immune to environmental degradation at present.

(a) Social Benefits/Disbenefits

There are no impositions on local populations or social conditions in the area to be developed for Option 1. There are however a number of aspects of the environmental and social evaluation that should also be mentioned:

- (i) Benefits resulting from lower transport costs should impact all consumers but should benefit low income people and families the most through lower food prices, if lower transport costs work through the economy.
- (ii) The port development should lead to a more qualified, better trained and higher paid workforce.
- (iii) Containers are blighting the island and are stored or just placed in any location that the owner can. Development of an adequate container yard would contribute to tidying up and beautifying areas.
- (iv) Environmental improvement of the run down port area would also be of benefit with possible opportunities for “greening” the land side, mostly for visual aesthetics.
- (v) The potential for oil spills would be mitigated by improving the oil discharge system.
- (vi) Another benefit of Option 1 would be keeping port development away from the nearby housing area, although Option 1 in the longer term could develop within, or adjacent to, this housing area.

8.8.9. Summary - Option 1

The detailed economic analysis is presented in Appendix C2.

- (i) Option 1 is primarily the development of a quay to the north side of Aiwo harbour and will benefit all cargo and fishing vessels visiting Nauru, except phosphate vessels. However, phosphate vessels will benefit indirectly from being able to berth undisturbed by other vessels. Further, other vessels will not disturb or damage the mooring system as has happened previously.
- (ii) The January 2015 financial cost is \$22.97 million which will be expended over 3 years between 2016 and 2018. The first year of operation is assumed to be 2019.

- The financial costs include physical contingency at 15% and engineering and studies at 10%.
- (iii) The financial cost has been subject to resource cost pricing by removal of taxes and duties and shadow pricing of the unskilled labour element of local costs. The economic cost is estimated to be some \$21.16m.
 - (iv) All of the options will have significant social and economic benefits lessening the cost of goods transported to and from the island, opening up new revenue streams such as related to the transshipment of fish and fuel and allowing more efficient port management.
 - (v) The quay and supporting facilities will overcome the need to tranship cargoes at sea saving ship time and reducing costs currently incurred in the slow and inefficient cargo handling operations
 - (vi) It will also have a number of other benefits including supporting transshipment of fish, promoting fuel bunker services and providing a much needed container stacking and storage area. These should substantially enhance the potential revenue generation by the port.
 - (vii) The proposed buildings and facilities related to the current port area will also help manage the port much more efficiently.
 - (viii) The development of the port will assist Nauru in encouraging a medium term trade strategy. Sound economic resilience requires the building of links between transport, trade and domestic capacity and potential.
 - (ix) The project overall will support a needed review and subsequent changes to the structure and management of the maritime sector, including both the Department of Maritime Transport and the National Port Authority to ensure its future sustainability. The Port Tariff should also be reviewed, both structure and level, to reflect current anomalies and potential new business opportunities.
 - (x) This option, like all options, will have considerable unquantifiable and intangible benefits for the country including supporting economic development and guaranteeing almost year round access.
 - (xi) The key features of the option is that it directly benefits all the large cargo vessels currently visiting Nauru, except phosphate vessels. However, by relieving demand and use of the mooring system, phosphate handling will also benefit indirectly to some extent.
 - (xii) Option 1 generates less economic benefits than Option 3 but is also less expensive than Option 3. It generates somewhat lower benefits than Option 2 but is less expensive than Option 2 by an extremely large margin.
 - (xiii) Option 1 is expected to produce the second greatest extent (after Option 2) of environmental degradation (relative to the baseline), since this will impose the impacts of port construction and operations on an area that is relatively immune to environmental degradation at present.
 - (xiv) There are no impositions on local populations or social conditions in the area to be developed for this option.

- (xv) The environmental and social impacts of this option have not been quantified because of their low impact
- (xvi) As the lowest cost Option, with considerable benefits, the EIRR on the project is 11.2%, and the ENPV at 10% discount rate is therefore positive at approximately \$ +1.47m. The evaluation spreadsheet is shown in the Economic Analysis section C of the Appendix.
- (xvii) Sensitivity analysis shows that a 10% increase in project costs reduces the EIRR to 9.9%. Reducing the 2% traffic growth factor to zero reduces the EIRR to 10.4%.

8.9. Economic Analysis of Option 2 - Enclosed Harbour North Quay

8.9.1. Introduction

This Option will permit all vessels visiting Nauru except phosphate vessels to be located to the dedicated berth inside the harbour basin north of the Boat Harbour. This new berth will provide a facility adequate for loading/unloading containers and general cargo using ship's gear directly to the quay or loaded directly onto tractor-trailers.

These tractor-trailers transfer containers to the container yard where the large forklift truck places each container into the yard stack awaiting pick-up by the customer. Ships will enter the harbour basin and swing in the turning basin before berthing at the berth located in the south-east corner of the basin. A tug boat will need to be provided to assist vessels to enter the harbour basin, swing in the turning basin and berth at the harbour wharf.

The plan dimensions of the harbour basin have been selected on the basis of a concept design to accommodate a design vessel as described in Table 5-1.

Table 5-1 The harbour would be dredged to a depth of 10m below Chart Datum. The wharf is proposed to be 120 m in length to readily accommodate the design general cargo and bulk fuel vessels, with some capacity to accommodate vessels up to 130 m LOA in the future. The wharf return provided along the south end of the harbour basin is 60 m long, to accommodate smaller vessels such as commercial fishing vessels, the tug and pilot boat.

A significant benefit from this Option is the availability of the outer reef berth to provide a second berth in the event that two ships are in port concurrently. The outer berth could even accommodate a waiting dry bulk phosphate vessel, avoiding the necessity for the ship to drift offshore while waiting for the cantilever berth.

The phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring system. Hence, the NPA must continue to maintain the moorings and buoys to retain this phosphate loading capability.

Container storage will be adequate at the port.

Its key engineering features⁵⁸ comprise;

- i. Quay Wall - 100 m long
- ii. Access Causeway - 100 m long

⁵⁸ This is not a comprehensive list but key elements of the project from the evaluation perspective

- iii. Western and Northern Seawalls
- iv. Harbour Wharf - 100m
- v. Fishing Boat Wharf - 60m
- vi. Container Yard
- vii. Buildings
- viii. Utilities: Fuel pipelines
- ix. Additional Equipment
 - a. Tractor-trailer sets
 - b. Two Tugs

8.9.2. Economic Costs

The financial cost of this option is \$97.70 million as at January 2015 prices.

It is assumed for the purposes of evaluation that the first year of expenditure will be 2016 and the construction cost will be incurred over 3 years as shown below.

Table 8-13 shows the financial costs of the Option.

Table 8-13: Option 2 Financial Costs

Item	A\$ million
Costs*	78.16
Physical Contingency and Engineering	19.54
Total Financial Costs	97.70

*Source: Section 6 Cost Estimates. Costs before physical contingency and engineering/studies

Conventionally, local inputs are also adjusted, or shadow priced, to reflect real resource costs. All taxes and duties are excluded from economic costs as they do not constitute the consumption of real resources but are transfers. Economic costs have been calculated on the basis of import duties averaging 10%. Financial costs have therefore been reduced by this amount.

Unskilled labour is often priced above a free market, resource cost, basis due to rigidities in the labour market. Our research in Nauru shows that labour is sometimes described by government as in short supply but statistics also show unemployment and certainly underemployment. As mentioned above, NPA is increasing its labour force substantially and seems to have no problem in so doing. On balance therefore it would seem that labour is not priced on a resource basis and there is therefore minor scope to shadow price labour costs for the purposes of the economic evaluation⁵⁹.

Given that we have no statistical basis on which to apply shadow prices, we have made a nominal adjustment on the basis that the project cost analyses indicate that some 30% of the local portion of the project is related to unskilled labour and this has been discounted by

⁵⁹ We have noted above the need for a better paid and more productive labour force within NPA.

applying a 95% shadow wage rate factor⁶⁰. The overall impact of resource cost pricing related to the original January 2015 costs as shown in Table 8-15 below.

We have assumed a residual value of the assets to be 50% of the original 2015 project cost.

Table 8-14: Project Economic Costs by Year

Year	Percent Cost in Year	Project Cost in Year A\$m
2016	13%	11.76
2017	39%	35.28
2018	48%	42.58
Total	100%	89.62

8.9.3. Avoided Capital Costs

As discussed in Section 5.7.1 if the project does not proceed the Government of Nauru will spend \$2m and \$3m in years 2017 and 2018. If the project proceeds these amounts will be saved and are an incremental benefit.

8.9.4. Operational and Maintenance (O&M) Costs

Operational and maintenance costs of the project are assumed to stabilise after 3 years of operation at \$2.4m each year. If the project does not proceed the government will be liable for the ongoing costs of maintaining the current system estimated as \$1.8m. This provides a net annual O&M cost of \$0.6m per year, except in the years as noted following. However, we have also allowed \$2.5m for replacement of equipment and plant every ten years from 2019.

8.9.5. Economic Benefits

The impact and benefits to Nauru resulting from the development of any of the options will be considerable. This evaluation concentrates on quantified benefits but the economic consequences of the current inadequate cargo handling arrangements are felt island-wide beyond increased transport costs. Government revenue is lost, additional government expenditure is required, trade related employment is affected, trade related investment is discouraged, some goods are not available and prices for basic, standard and luxury goods are higher than necessary affecting all of the community. We are not able to measure and quantify many of these impacts in this study.

8.9.6. Quantified Economic Benefits

- (i) Transport Cost Savings/Savings to ships

Savings in ship time are the predominant (70%) quantified benefits under this study for Option 2. By avoiding using the mooring buoys and avoiding the transshipment at sea

⁶⁰ The economic analysis is based on world/border price numeraire, so the value of non-tradables (labour) are converted to economic prices using an assumed standard conversion factor (SCF).

procedures, vessels will save substantial time both through reduced (or no) queuing⁶¹ and avoiding the current inefficient transshipment procedure using barges.

Option 2 also provides more sheltered berthing.

Based on the current average days queuing or unloading, savings in ship time could be anticipated as shown in

Table 8-15. For cargo ships, the current average days adopted is based on a 4 year average of 8 days per container vessel, to reflect the increasing inefficiency of operations over recent years.

The average days required for vessels to stay at berth have been based on container rates and average interchange from JICA-2014⁶², Oldfield 2009 and various other sources. Some conservatism has been incorporated into the figures to avoid being overly ambitious and overstating the potential savings. Required days for phosphate loading was obtained from Ronphos and Oldfield, 2009 and required fuel unloading rates are based on data analysis of actual queuing time and berthing time at Nauru. Fewer days may be required into the future, once institutional reform and capacity building are effective, and therefore additional savings may occur in the future.

It should be noted that the savings in time saved for container vessels appears quite conservative given that in 2013 and 2014 container ships were staying for periods of 9 and 13 days respectively and 2 days could be sufficient⁶³ to unload the average number of containers if very well managed.

However, traffic related to the RPC has expanded over these years and is unlikely to continue at such a rate but we consider that container traffic will stabilise at a reasonably high level and continue to increase moderately as discussed in the Bases Section, and as the increased number of the people on the island will still need serving with consumables while the RPC centre remains open.

Table 8-15: Savings in Ship Costs Per Call

	General Cargo/ Container Vessels	Fuel Vessels
Current Average Days	8	3
Days Required	4	1.5
Days Saved per Call	4	1.5
Charter Cost per Day ⁶⁴	\$13,000	\$10,000
Savings per call	\$48,000	\$15,000
First Year Savings	\$1,090,000	\$170,000

Source: Consultants based on NPA data; See also Tables 8-6, 8-9

⁶¹ The upgraded management system of the port should coordinate ship calls

⁶² Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

⁶³ Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

⁶⁴ See Appendix C for details. Sources include UNCTAD 2014 Review of Maritime Transport and various ship broker web sites. We note that the JICA report on Nauru port (2014) estimated that total ship cost per day is of the order of Y1.79 m or \$19,000/day (June 2015 exchange rate) and have given some weight to this in estimating an average cost per day from our various sources.

The benefits for this Option have not been reduced to reflect the negative impact of seasonal weather patterns, unlike in Options 1 and 3, because of the sheltered nature of Option 2.

8.9.7. Incremental Port Revenue

A financial analysis of the existing NPA has not been undertaken or assessed comprehensively the financial impact of the new port infrastructure facilities. There will be opportunities to both increase port revenue as a benefit to the Government and either reduce port charges as a benefit to users (and hopefully consumers). The project may allow the NPA's subsidy to be eliminated or at least reduced. This detailed assessment should be undertaken in the PPTA⁶⁵. However, we identify various financial benefits that the new port facilities should generate.

i. Container Yard Revenue

There are various inefficiencies with regard to containers handling in the port area at present. There is insufficient space within the port so containers are parked around the island, and within the various and crowded port areas containers are often hard to find and sometimes lost (and pilfered⁶⁶).

The proposed container yard is required to handle efficiently the container throughput, limit the number of containers scattered around the island and generate some revenue. Given the current informal arrangements for container storage, there appears to be no related revenue even though there is a port tariff for container storage. Current port rates indicate storage charges for 1 TEU of \$10/day after 7 days. We have assumed 10% of TEU throughput is stored in the port for a further 5 days after the free period. Total first year revenue is \$10,000.

ii. Savings in Port Charges

For vessels that will be able to berth at the quay, the use of water craft and barges will no longer be necessary. The charges currently levied per ship call for the use of water craft and barges vary considerably. Our analysis of invoices show that such charges range from zero⁶⁷ cost to almost \$8,000 per call related to container vessels and tankers. We have assumed a \$1,000 per call saving for container vessels and \$3,000 saving per tanker. Based on an average of 20 container ships and 10 fuel ships, the savings would be \$50,000 per year.

iii. Other port revenue

Most commercial ports charge for vehicular access and Kiribati port, for example, charges the equivalent of \$5 per heavy vehicle entering the port. There are various minor charges that could be applied once there is proper port security and secure fencing. We have not included these charges in the analysis.

iv. Fishing vessels

For Options 1 and 3 it has been estimated that some 20 fishing vessels would tranship, generating revenues of \$9,425 per vessel. However, Option 2 has a specific facility for

⁶⁵ Draft requirements for the PPTA are found in Chapter 11

⁶⁶ Anecdotal

⁶⁷ Not explained

fishing vessels and this should encourage further expansion of transshipment. We have assumed 50% greater impact on visits and revenue but we realise this is more speculative. We have therefore assumed that annual income could therefore build up to \$280,000 but somewhat later by 2023.

v. Fuel Imports and Bunkering

The import of fuel has been increasing with the development of the RPC and this seems unlikely to continue at recent levels (18,000 tonnes in 2013) but the demands of the island and the ongoing operation of the RPC suggests a level higher than pre RPC levels (8,000 tonnes in 2010). We have therefore considered that a base year demand of 17,000 tonnes would be appropriate for this evaluation.

Currently, there is no wharfage fee on fuel but after it is delivered over the proposed quay, we would suggest a tariff⁶⁸ of \$10/MT, which would provide an additional revenue of \$130,000 per year from year 3 (2012) of port operation.

vi. Reduced injury and damage

It appears that no records are kept of injuries to staff or damage to goods, or at least that was the response of NPA to our questions on these subjects. During our visit on one day in February a port worker was injured and a container and contents damaged in one accident. There were anecdotal reports of container damage and occasionally containers falling into the sea during offloading. Other isolated records seen by the Consultants noting damage to container contents include:

- Feb: 2014, Damage to boat and trailer being offloaded to a barge at sea
- Dec 2014: All contents of container destroyed (cause not clear)-value \$45,000.

The costs of personal injuries are unable to be assessed but the incident described above this year, and another incident in which a port worker suffered severe injuries suggests that like damage incidents, these occur occasionally but regularly. It should also be noted that observed unsafe port operational practices during our field research will also contribute to the ongoing occurrence of accidents without the project. It should be noted that transshipment at sea is an intrinsically unsafe procedure. It has therefore been assumed that the project would avoid such injury and damage incidents amounting to \$50,000 per year.

vii. Labour Cost Savings

The labour force appears to be overstaffed and the quay operation would not require barge handling and transshipment workers. All options would allow reorganization of the port management and operations which appears much needed. Labour costs as shown in recent Budgets (see summarised data from Appendix A2) are over \$900,000 per year both in 2013/14 and estimated 2014/15.

Based on analysis of staffing records and overall reduction in workers back to early 2014 levels, basic payroll costs (before overtime and benefits) would fall by about \$100,000 per year. Reduction in barge operators could add another \$50,000 but we consider that

⁶⁸ Example of Kiribati Port Regulation, 2010-\$10 per tonne (assuming handling by the port authority). However, all of the tariff regulations should be revised and updated at least for the opening of the new port facilities if not before too.

improving productivity could result in higher pay levels, so that we have limited the saving to \$125,000 per year.

viii. Air Freight Savings

It appears that during short supplies of goods due to issues with the moorings, some goods are air freighted into Nauru. Milk was in short supply during our field research and limited amounts were available at Eigigu supermarket for 10 times the normal price as it had been brought in by airfreight. This was confirmed by Ronphos. The volumes of goods air freighted is probably low but at times the value could be significant. We were not able to access air freight data and so we have not included any value of this aspect.

ix. Indirect and Intangible Economic Benefits

It is difficult to overemphasize the importance of the development of efficient and reliable sea transport infrastructure serving Nauru.

The lack of port facilities to handle general cargo, fuel and phosphate vessels results in higher transport costs and various other costs⁶⁹ on the population and results in restraints upon economic development generally⁷⁰. The current situation with the mooring system out of action for many months has had a negative impact upon the social and economic life in Nauru with shortages and reported power cuts. The problem with the mooring system is likely to continue indefinitely into the future until a system that can solve or partially overcome the issues that accompany such a mooring system.

Running out of basic foodstuffs, fuel and other necessities and the inability to export phosphate are a few of the direct impacts of the deficient cargo handling arrangements in Nauru.

A new port development would help generate various other benefits. These are quite substantial benefits but difficult to quantify and include;

- i. New Trading Opportunities
- ii. Security of Island access and providing an island lifeline

8.9.8. Environmental Benefits/Disbenefits

These have been discussed in Section 9.

The environmental and social impacts of Option 2 are complex and at this preliminary stage of evaluation of options, there is very little hard data and this would await the PPTA assuming this option is continued into that stage. Option 2 would involve incursion into the partly derelict housing area (forcing involuntary resettlement) would have negative impacts on a wide range of social criteria (many of which are already negative). With Option 2, involuntary resettlement, and no guaranteed investment in replacement housing in another suitable location in Nauru, or in the remaining adjacent derelict housing area, social conditions are expected to continue to deteriorate significantly.

The social and environmental costs and benefits of developing the port into this housing area have therefore not been quantified.

(i) Social Benefits/Disbenefits

⁶⁹ We have estimated those costs that can be quantified e.g. additional ship costs, delayed sales of phosphate and other cost savings and benefits in the evaluation of each Option

⁷⁰ JICA Report Appendix Supplementary Report August 2012

There are however a number of aspects of the environmental and social evaluation that should also be mentioned.

- a. Benefits resulting from lower transport costs should impact all consumers but should benefit low income people and families the most through lower food prices, if lower transport costs work through the economy.
- b. The port development should lead to a more qualified, better trained and higher paid workforce
- c. Containers are blighting the island and are stored or just placed in any location that the owner can. Development of an adequate container yard would contribute to tidying up and beautifying areas
- d. Environmental improvement of the run down port area would also be of benefit with possible opportunities for “greening” the land side, mostly for visual aesthetics
- e. The potential for oil spills would be mitigated by improving the oil discharge system
- f. Another potential benefit of Option 2 would be encouraging redevelopment of the nearby housing area.

8.9.9. Summary-Option 2

The detailed economic analysis for Option 2 is provided in viable socio economic scenario. in Appendix C2.

- (i) Option 2 is a major port development option. It is primarily the development of an enclosed harbour basin to the north side of Aiwo harbour and will benefit all cargo and fishing vessels visiting Nauru, except phosphate vessels.
- (ii) However, phosphate vessels will benefit indirectly from being able to berth undisturbed by other vessels. Further, other vessels will not disturb or damage the mooring system as has happened previously.
- (iii) All of the options will have significant social and economic benefits lessening the cost of goods transported to and from the island, opening up new revenue streams such as related to the transshipment of fish and fuel and allowing more efficient port management.
- (iv) Two tug boats will need to be provided to assist vessels to enter the harbour basin, swing in the turning basin and berth at the harbour wharf.
- (v) The harbour wharf is 120 m in length to readily accommodate the design general cargo and bulk fuel vessels with some capacity to accommodate vessels up to 130 m LOA in the future. The wharf provided along the south end of the harbour basin is 60 m long, to accommodate smaller vessels such as commercial fishing vessels, the tug and pilot boat.
- (vi) A significant benefit from this Option is the availability of the outer reef berth to provide a second berth in the event that two ships are in port concurrently. The outer berth could even accommodate a waiting dry bulk phosphate vessel, avoiding the necessity for the ship to drift offshore while waiting for the cantilever berth.
- (vii) The phosphate vessels will continue to operate at the existing cantilevers, using the existing mooring system. Hence, the NPA must continue to maintain the moorings and buoys to retain this phosphate loading capability.
- (viii) Container storage will now be adequate at the port.

- (ix) The January 2015 financial cost is \$97.70 million and is assumed to be expended over the 3 years between 2016 and 2018. The first year of operation is assumed to be 2019. The financial cost includes physical contingency at 15% and engineering and studies at 10%.
- (x) The financial cost has also been subject to resource cost pricing by removal of taxes and duties and shadow pricing of the unskilled labour element of local costs. The economic cost is estimated to be some \$89.62m.
- (xi) The quay and supporting facilities will overcome the need to tranship cargoes at sea saving ship time and reducing costs currently incurred in the slow and inefficient cargo handling operations
- (xii) It will also have a number of other economic benefits including supporting transshipment of fish, promoting fuel bunker services and providing a much needed container stacking and storage area. These should substantially enhance the potential revenue generation by the port.
- (xiii) The proposed buildings and facilities related to the current port area will also help manage the port much more efficiently
- (xiv) The project overall will support a needed review and subsequent changes to the structure and management of the maritime sector, including both the Department of Maritime Transport and the National Port Authority. The Port Tariff should also be reviewed, both structure and level to reflect the new business opportunities.
- (xv) This option, like all options, will have considerable unquantifiable and intangible benefits for the country including supporting economic development and guaranteeing almost year round access.
- (xvi) The key features of the option is that it directly benefits all the large cargo vessels currently visiting Nauru, except phosphate vessels. However, by relieving demand and use of the mooring system, phosphate handling will benefit indirectly to some extent.
- (xvii) Option 2 generates a considerable number of economic benefits, but only marginally more than Options 1 and 3 but is also substantially more expensive than Options 1 and 3.
- (xviii) In terms of environmental and social impacts, Option 2 would involve incursion into the partly derelict housing area (probably forcing involuntary resettlement) would have negative impacts on a wide range of social criteria (many of which are already negative in this location).
- (xix) With Option 2, involuntary resettlement, and no guaranteed investment in replacement housing in another suitable location in Nauru, or in the remaining adjacent derelict housing area, social conditions are expected to continue to deteriorate significantly.
- (xx) Due to the complexity of the social and environmental impacts which would result as a consequence of developing Option 2, the social and environmental costs and benefits of developing the port into this housing area have not been quantified.

As the highest cost Option, with not considerably higher benefits than Options 1 and 2, the EIRR (-0.43%) and ENPV (-\$55.77M) on the project are both negative. The evaluation spreadsheet is shown in Appendix C.

- (xxi) Given that the project is already not viable economically, sensitivity analysis was not undertaken on Option 2.

On both the economic and environmental/social basis, we would suggest that the PPTA does not consider this option further. If redevelopment of the housing area is subsequently proposed in the future, Option 1 might be considered as expanding into this area, although Option 3 could also be considered for expansion into the Ronphos area as phosphate mining declines. Option 2 at this stage does not appear to be a viable socio economic scenario. viable socio economic scenario.

8.10. Economic Analysis of Option 3-South Quay

8.10.1. Introduction

The facility provided within this option will permit all vessels visiting Nauru including dry bulk phosphate vessels to share the dedicated berth and adjoining berthing dolphins south of the Boat Harbour. This new berth will provide a facility which is adequate for loading/unloading containers and general cargo using ship's gear, directly to the quay or loaded directly onto tractor-trailers. Bulk fuel ships will also use this berth, including the existing fuel transfer pipelines located on the cantilever. Berthing of vessels at this quay wall is expected to be reasonably straight-forward for most weather conditions.

Phosphate ships will also utilise the berth, and in calm conditions it is expected that little or no use of the mooring system will be required. Instead, phosphate ships will berth safely against the southern end of the new quay wall and the two berthing dolphins located between and beyond the cantilever foundations. It cannot be assumed that this quay wall and berthing dolphins configuration can operate safely in all permissible conditions without the availability of the mooring system.

Its key features comprise;

- Mooring buoy relocations
- Quay Wall - 120 m
- Berthing Dolphins (2)
- Access Causeway - 160 m
- Demolition Of Barge Shed, Harbourmaster's Office, Hardware & Bulk Store Shed
- Expanded Container Yard
- Perimeter Security Fence, Security Gates, Reefer Points, Inc. Electrical Supply, Area Lighting
- Harbourmaster's Office Building And Gatehouse, Ablution Block, Plant Workshop
- Tractor-Trailer Set.

8.10.2. Economic Costs

The financial cost of this option is \$31.15 million as at January 2015 prices.

It is assumed for the purposes of evaluation that the first year of expenditure will be 2016 and the construction cost will be incurred over 3 years as shown in Table 8-16.

Table 8-16: Option 3 Financial Costs

Item	A\$ million
Costs*	24.92
Physical Contingency and Engineering	6.23
Total Financial Costs	31.15

*Source: Section 6 Cost Estimates. Costs before physical contingency and engineering/studies

Conventionally, local inputs are also adjusted, or shadow priced, to reflect real resource costs. All taxes and duties are excluded from economic costs as they do not constitute the consumption of real resources but are transfers. Economic costs have been calculated on the basis of import duties averaging 10%. Financial costs have therefore been reduced by this amount.

Unskilled labour is often priced above a free market, resource cost, basis due to rigidities in the labour market. Our research in Nauru shows that labour is sometimes described by government as in short supply but statistics also show unemployment and certainly underemployment. As mentioned above, NPA is increasing its labour force substantially and seems to have no problem in so doing. On balance therefore it would seem that labour is not priced on a resource basis and there is therefore scope to shadow price labour costs for the purposes of the economic evaluation⁷¹.

Given that there is no statistical basis on which to apply shadow prices, a nominal adjustment has been made on the basis that the project cost analysis indicates that some 30% of the local portion of the project is related to unskilled labour and this has been discounted by applying a 95% shadow wage rate factor⁷². The overall impact of resource cost pricing related to the original January 2015 costs as shown in Table 8-17 below.

We have assumed a residual value of the assets to be 50% of the original 2015 project cost.

Table 8-17: Project Economic Costs by Year

Year	Percent Cost in Year	Project Cost in Year
2016	13%	3.76
2017	39%	11.29
2018	48%	13.63
	100%	28.69

8.10.3. Avoided Capital Costs

If the project does not proceed the Government of Nauru will spend \$2m and \$3m in years 2017 and 2018. If the project proceeds these amounts will be saved and are an incremental benefit.

(i) Operational and Maintenance Costs

Operational and maintenance costs of the project are assumed to stabilise after 3 years of operation at \$1.6m each year. If the project does not proceed the government will be liable for the ongoing costs of maintaining the current system estimated as \$1.8m. This provides an incremental saving of \$0.2m per year. \$1.5m has been allowed for replacement of equipment and plant every ten years from 2019.

(ii) Economic Benefits

The impact and benefits resulting from the development of any of the options will be considerable. This evaluation concentrates on quantified benefits but the economic

⁷¹ We have noted above the need for a better paid and more productive labour force within NPA.

⁷² The economic analysis is based on world/border price numeraire, so the value of non-tradables (labour) are converted to economic prices using an assumed standard conversion factor (SCF).

consequences of the current inadequate cargo handling arrangements are felt island-wide beyond increased transport costs. Government revenue is lost, additional expenditure is required, trade related employment is affected, trade related investment is discouraged, some goods are not available and prices for basic, standard and luxury goods are higher than necessary affecting all of the community. We are not able to measure and quantify many of these impacts.

(iii) Quantified Economic Benefits

(a) Transport Cost Savings/Savings to ships

Savings in ship time are the predominant (70%) quantified benefits under this study for Option 3, as shown in Table 8-18. By berthing at the quay directly, vessels will save time either through reduced queuing⁷³ and avoiding the inefficient transshipment procedure. Table 8-6 showed the current days that vessels are registered as being at Nauru. For cargo ships, the current average days adopted is based on a 4 year average of 8 days per container vessel, to reflect the increasing inefficiency of operations over recent years.

The average days required for vessels to stay at berth have been based on container rates and average interchange from JICA-2014⁷⁴, Oldfield 2009 and various other sources. Some conservatism has been incorporated into the figures to avoid being overly ambitious and overstating the potential savings. Required days for phosphate loading was obtained from Ronphos and Oldfield, 2009 and required fuel unloading rates are based on data analysis of actual queuing time and berthing time at Nauru. Fewer days may be required into the future, once institutional reform and capacity building are effective, and therefore additional savings may occur in the future.

It should be noted that the savings in time saved for container vessels appears quite conservative given that in 2013 and 2014 container ships were staying for periods of 9 and 13 days respectively and 2 days could be sufficient⁷⁵ to unload the average number of containers if very well managed.

However, traffic related to the RPC has expanded over these years and is unlikely to continue at such a rate but we consider that container traffic will stabilise at a reasonably high level and continue to increase moderately as discussed in the Bases Section, and as the increased number of the people on the island will still need serving with consumables while the RPC centre remains open.

In order to reflect periods of bad weather, when the new facilities will not benefit some ships, we have reduced the container benefits above by an indicative 10%. Given the relatively low volumes of traffic, the estimated 'days required' for all cargo types are conservative.

⁷³ The upgraded management system of the port should coordinate ship calls

⁷⁴ Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

⁷⁵ Preparatory Study on the Project of Constructing Reef-Edge Quay Wall and Causeway at Aiwo Harbour Final Report, March, 2014, Japan International Cooperation Agency, based on experience in the Solomon Islands

Table 8-18: Savings in Ship Costs Per Call – Option 3

	General Cargo/ Container Vessels	Phosphate Vessels	Fuel Vessels
Current Average Days	8	5	3
Days Required	4	3	1.5
Days Saved per Call	4	2	1.5
Charter Cost per Day ⁷⁶	\$13,000	\$13,000	\$10,000
Savings per call	\$48,000	\$26,000	\$15,000
First Year Savings	\$983,000	\$390,000	\$150,000

Source: Consultants based on NPA data; See also Tables 8-6, 8-9

(b) Incremental Port Revenue

We have not undertaken a financial analysis of the existing NPA or assessed comprehensively the financial impact of the new port infrastructure facilities. There will be opportunities to both increase port revenue as a benefit to the Government and reduce port charges as a benefit to users (and hopefully consumers). This detailed financial assessment should be undertaken in the PPTA⁷⁷. However, we identify various financial benefits that the new port facilities should generate.

(iv) Container Yard Revenue

There are various inefficiencies with regard to containers at present. There is insufficient space within the port so containers are parked around the island and, within the various and crowded port areas containers get lost (and pilfered⁷⁸).

The proposed container yard is required to handle efficiently the container throughput, limit the number of containers scattered around the island and generate some revenue.

Given the current informal arrangements for container storage, there appears to be no related revenue even though there is a port tariff for container storage. Current port rates indicate storage charges for 1 TEU of \$10/day after 7 days. We have assumed 10% of TEU throughput is stored in the port for a further 5 days after the free period. Revenue is assumed to amount to \$10,000 per year.

(v) Savings in Port Charges

For vessels that will be able to berth at the quay, the use of water craft and barges will no longer be necessary. The charges currently levied per ship call for the use of water craft and barges vary considerably. Our analysis of invoices show that such charges range from zero⁷⁹ cost to almost \$8,000 per call related to container vessels and tankers. We have assumed a \$1,000 per call saving for container vessels and \$3,000 saving per tanker. Based on an average of 20 container ships and 10 fuel ships, the savings would be \$50,000 per year.

(vi) Other port revenue

⁷⁶ See Economic Analysis in the Appendix for details. Sources include UNCTAD 2014 Review of Maritime Transport and various ship broker web sites. We note that the JICA report on Nauru port (2014) estimated that total ship cost per day is of the order of Y1.79 m or \$19,000/day (June 2015 exchange rate) and have given some weight to this in estimating an average cost per day from our various sources.

⁷⁷ Draft requirements for the PPTA are found in Section...

⁷⁸ Anecdotal

⁷⁹ Not explained

Most commercial ports charge for vehicular access and Kiribati port, for example, charges the equivalent of \$5 per heavy vehicle entering the port. There are various minor charges that could be applied once there is proper port security and secure fencing. We have not included these charges in the analysis.

(vii) Fishing vessels

As indicated above, in Section 8 c, we estimate that some 20 fishing vessels would tranship, generating revenues of \$9,425 per vessel. We assume that annual income could therefore build up to \$190,000 by 2021 (third year of operation).

(viii) Fuel Imports and Bunkering

The import of fuel has been increasing with the development of the RPC and this seems unlikely to continue at recent levels (18,000 MT in 2013) but the demands of the island and the ongoing operation of the RPC suggests a level higher than pre RPC levels (8,000 MT in 2010). We have therefore considered that a base year demand of 17,000 tonnes. would be appropriate for this evaluation.

Currently, there is no wharfage fee on fuel but after it is delivered over the proposed quay, we would suggest a tariff⁸⁰ of \$10/tonne, which would provide an additional revenue of \$130,000 per year from year 1 of operation.

(ix) Reduced injury and damage

It appears that no records are kept of injuries to staff or damage to goods, or at least that was the response of NPA to our questions on these subjects. During our visit on one day in February a port worker was injured and a container and contents damaged in one accident. There were anecdotal reports of container damage and occasionally containers falling into the sea during offloading. Other isolated records seen by the Consultants noting damage to container contents include:

- Feb: 2014, Damage to boat and trailer being offloaded to a barge at sea
- Dec 2014: All contents of container destroyed (cause not clear)-value \$45,000.

We are not able to assess the costs of personal injuries but the incident above this year, and another incident in which a port worker suffered severe injuries, suggests that like damage incidents, these occur occasionally but regularly. It should also be noted that observed unsafe port operational practices during our field research will also contribute to the ongoing occurrence of accidents without the project. It should be noted that transshipment at sea is an intrinsically unsafe procedure.

The Consultants have therefore assumed that the project would avoid such injury and damage incidents amounting to \$50,000 per year.

(x) Inventory savings

The current cargo handling system is prone to substantial delays in importing and exporting goods. From August 2014 to April 2015, the buoy system has been out of action, and while container vessels can still offload while drifting (under power), phosphate vessels and fuel ships

⁸⁰ Example of Kiribati Port Regulation, 2010-\$10 per tonne (handling by port authority). However, all of the tariff regulations should be revised and updated at least for the opening of the new port facilities if not before.

cannot load or discharge. According to Ronphos accounting (email⁸¹ dated 18th March 2015) phosphate exports have been delayed again.

While the mooring system is still needed, Option 3 would minimize delays, also helping in some sea states, and the Consultants have included a benefit in terms of inventory savings i.e. sales revenue could otherwise earn interest or government would not need to borrow in lieu of the delayed revenue.

We assume 380,000 tonnes per year at a current value of \$150 tonne⁸² average delay 1 month per year at an interest rates of 5% per year⁸³ would result in an annual benefit of \$118,000 per year.

(xi) Labour Cost Savings

As described in Section above, the labour force appears to be overstaffed and the quay operation would not require barge handling and transshipment workers. All options would allow reorganization of the port management and operations which appears much needed.

Labour costs as shown in recent Budgets (see summarised data from Appendix A2) are over \$900,000 per year both in 2013/14 and estimated 2014/15.

Based on analysis of staffing records and overall reduction in workers back to early 2014 levels, basic payroll costs (before overtime and benefits) would fall by about \$100,000 per year. Reduction in barge operators could add another \$50,000 but we consider that improving productivity could result in higher pay levels, so that we have limited the saving to \$125,000 per year.

(xii) Air Freight Savings

It appears that during short supplies of goods due to issues with the moorings, some goods are air freighted into Nauru. Milk⁸⁴ was in short supply during our field research and limited amounts were available at Eigigu supermarket for 10 times the normal price as it had been brought in by airfreight. This was confirmed by Ronphos in communications. The volumes of goods air freighted is probably low but at times the value could be significant. We were not able to access air freight data and so we have not included any value of this aspect.

(vii) Indirect and Intangible Economic Benefits

It is difficult to overemphasize the importance of the development of efficient and reliable sea transport infrastructure serving Nauru.

⁸¹ "The importance of an effective mooring or port system cannot be further stressed. In August 2014, a ship berthed and damaged the Nauru Mooring System. 8 months later the moorings has not been repaired yet, so no phosphate export since August 14 (apart from a small shipment in Dec 14) though stock bins are full and ready for export. 3 phosphate ships have been cruising the horizon over a month now with demurrage costs almost certain.

Crucial supplies to the island are short as most supply ships cannot berth. The few (GC ships) that have berthed have taken the risks on themselves. Fuel rationing has been implemented throughout the island (power cuts/ limited fuel for transport). Mining production has been suspended for a few weeks due to fuel rationing. Lucky, air freight supplies are consistent but at a price!"

RONPHOS (estimates) close to \$3million for year to date expenses incurred so far for mooring repair works".

⁸² Index Mundi, April 2015-rock phosphate price- US\$115 per tonne

⁸³ Longer term (future) rates projected by Trading Economics, April 2015

⁸⁴ Milk, rice and various basic foodstuffs were not available or in short supply. In some cases, products were only available in small package sizes thus increasing the unit price to consumers.

The lack of port facilities to handle general cargo, fuel and phosphate vessels results in higher transport costs and various other costs⁸⁵ on the population and results in restraints upon economic development generally⁸⁶. The current situation with the mooring system out of action for many months has had a negative impact upon the social and economic life in Nauru with shortages and reported power cuts. The problem with the mooring system is likely to continue indefinitely into the future until a system that can solve or partially overcome the issues that accompany such a mooring system.

Running out of basic foodstuffs, fuel and other necessities and the inability to export phosphate are a few of the direct impacts of the deficient cargo handling arrangements in Nauru.

A new port development would help generate various other benefits. These are quite substantial benefits but difficult to quantify and include;

- i. New Trading Opportunities
- ii. Security of Island access and providing an island lifeline

8.10.4. Environmental Benefits/Disbenefits

These have been thoroughly discussed in the environmental impact assessment and based on the relatively low impact have not been quantified and included in the economic assessment.

The environmental assessment identifies Option 3 i.e. development in the area south of the boat harbour (where the cantilevers are operating) as having the poorest environmental conditions at present, due mostly to degraded coral reefs (from cantilever operations and mooring buoy anchor chains), reduced air quality (at times, from phosphate dust), less beach stability (relative to the other locations), and exposure of existing infrastructure to extreme sea states.

Option 3 would make the already degraded environmental conditions in the area south of the boat harbour somewhat worse.

8.10.5. Social Benefits/Disbenefits

There are no impositions on local populations or social conditions in the area to be developed for Option 3. There are however a number of aspects of the environmental and social evaluation that should also be mentioned.

- (i) Benefits resulting from lower transport costs should impact all consumers but benefit low income people and families the most.
- (ii) The port development should lead to a more qualified, better trained and higher paid workforce
- (iii) Containers are blighting the island and are stored or just placed in any location that the owner can. Development of an adequate container yard would contribute to tidying up and beautifying areas
- (iv) Environmental improvement of the run down port area would also be of benefit with possible opportunities for “greening” the land side, mostly for visual aesthetics
- (v) The potential for oil spills would be mitigated by improving the oil discharge system

⁸⁵ We have estimated those costs that can be quantified e.g. additional ship costs, delayed sales of phosphate and other cost savings and benefits in the evaluation of each Option

⁸⁶ JICA Report Appendix Supplementary Report August 2012

- (vi) Another benefit of Option 3 would be keeping port development away from the nearby housing area (unless this were comprehensively and sympathetically redeveloped in the medium/long term future).

8.10.6. Summary - Option 3

The detailed economic analysis of Option 3 is provided in Appendix C2.

- (xiii) Option 3 is primarily the development of a quay to the south side of Aiwo Boat Harbour and will benefit all vessels visiting Nauru including phosphate vessels.
- (xiv) The January 2015 financial cost is \$31.15 million and will be constructed over the 3 years between 2016 and 2018. The first year of operation is assumed to be 2019.
- (xv) The financial costs include physical contingency at 15% and engineering/studies at 10%.
- (xvi) After removal of taxes and duties and shadow pricing of the unskilled labour element of local costs the economic cost of the project is estimated to be \$28.69m.
- (xvii) All of the options will have significant social and economic benefits lessening the cost of goods transported to and from the island, opening up new revenue streams such as related to the transshipment of fish and fuel and allowing more efficient port management.
- (xviii) The quay and supporting facilities will overcome the need to tranship cargoes at sea saving ship time and reducing costs currently incurred in the slow and inefficient cargo handling operations.
- (xix) It will also have a number of other benefits including supporting transshipment of fish, promoting fuel bunker services and providing a much needed container stacking and storage area. These particular benefits will generate additional port revenue.
- (xx) It will also be a safer cargo handling operation reducing injuries and damage.
- (xxi) The proposed buildings and facilities related to the current port area will also help manage the port much more efficiently.
- (xxii) The project overall will support needed changes to the structure and management of the maritime sector, including both the Department of Maritime Transport and the National Port Authority.
- (xxiii) The key feature of the option is that it supports all the large cargo vessels currently visiting Nauru.
- (xxiv) This Option, like all options, will have considerable unquantifiable and intangible benefits for the country including:
- (xxv) This option generates more economic benefits than option 1 but is more expensive than option 1.
- (xxvi) The environmental assessment identifies this option is located in an area as having the poorest environmental conditions at present, due mostly to degraded coral reefs (from cantilever operations and mooring buoy anchor chains), reduced air quality (at times, from phosphate dust), less beach stability (relative to the other locations), and exposure of existing infrastructure to extreme sea states. It is therefore the least damaging option in relative environmental terms.
- (xxvii) However, this option would make the already degraded environmental conditions in the area south of the boat harbor somewhat worse in absolute terms.

- (xxviii) There are no impositions on local populations or social conditions in the area to be developed for this option.
- (xxix) The environmental and social impacts of this option have not been quantified because of their low impact
- (xxx) The relatively high cost of the project mean that the EIRR on the project is approximately 9.2% and the ENPV at 10% discount rate, is negative at approximately -\$1.32m.
- (xxxi) Sensitivity analysis shows that a 10% increase in project costs reduces the EIRR to 8.1%. Reducing the 2% annual growth to zero reduces the EIRR to 8.5%.

9. Environmental and Social Issues

9.1. Extent of Environmental and Social Assessment for this Study

A high level assessment of existing baseline environmental and social conditions was undertaken for this study (i.e., based on available literature, a short field visit and discussions with key stakeholders in Nauru). The projected impacts of the three (3) proposed options were also evaluated to: input to the multi-criteria assessment; identify and any 'fatal flaws' in any of the concepts; inform the selection of a preferred option; and, identify environmental and social risks and opportunities for future project stages.

The Safeguards specialist also completed a rapid environmental assessment (REA) checklist for ports and harbors for each option, which included an Involuntary Resettlement Impact Categorisation Checklist and a Checklist for Preliminary Climate Risk Screening. The assessments and checklists for each Option are included in Appendix F.

The REA and associated checklists were used to determine the appropriate environmental and social categories for all Options, in order to inform the activities and extent of further investigations during PPTA. Activities required during the PPTA phase were also identified and are outlined herein.

9.2. Environmental and Social Baseline Conditions

9.2.1. Context and Baseline Conditions - Physical and Biological Environment

Water quality. Marine water quality around Nauru is expected to be generally very good (especially water clarity), reflecting the lack of sediment inputs. Even near the port, water clarity is good. However, visual observations and anecdotal evidence suggest that there may be some transient contamination of near-shore water in the port area, due to phosphate dust and runoff (including hydrocarbon contaminants) from the port area.

The whole port area is also a continuous source of hydrocarbon residues (grease, oil, and fuel) which can be seen running off to near-shore water during heavy rains. The reef flat area north of the boat harbor has several old concrete sewer outfalls (apparently no longer used) and the intake for the cooling water for the power plant (and also the reverse osmosis desalination unit) is also located just near the boat harbor entrance.

Marine environment. There are no mangrove or seagrass beds in the area where the three options are located. The reef flat in the port area (the area between the high water mark and the crest of the fringing reef before descending down the reef slope, or outer reef) is quite devoid of live coral and other invertebrates, as there is very little complexity that is required to provide habitat for living coral colonies. At extreme low spring tides, most of the reef flat is dry and there are few residual tidal pools which could support fauna. The reef slope in Nauru has more complexity and vitality than the reef flat and viable reef is found in most areas around the Nauru coastline, although with different quality, diversity, and percentage live coral cover.

Nauru has a relatively low diversity of reef fish (407 species), compared to other Pacific islands. However, abundance of reef fish is quite high, evident on both the west and east coasts of Nauru, despite low levels of live coral cover in some areas; many fish are feeding on algae.

Terrestrial environment. Almost all of the natural backshore in the port area (the coastal fringe from the high water mark going inland beyond the influence of seawater) has been disturbed by dense infrastructure associated with port operations (over the last 100 years), construction of shore protection works, dumping of scrap metal and debris, and storage of empty containers. The foreshore areas (exposed to spring high tides) comprise a sand beach north of the boat harbor (not reported as a turtle nesting beach), which is backed by a seawall, and armour rock

protection and debris south of the boat harbor. There is no location anywhere near the port that has natural vegetation on a beach crest or dune that grades into the ocean.

The backshore vegetation (technically referred to as “coastal strand vegetation”) on the coastal terrace in the port area (from the high water mark to a point that is several meters above the high water mark) is quite sparse, since most of this area is developed with port-related infrastructure, armour rocks, seawalls, empty containers, scrap metal, garbage, and the derelict houses north of the boat harbor. There is no place that has a natural coastal vegetative habitat that is contiguous and provides suitable habitat for birds and small mammals. Within the three project option “footprints”, there is only beach pea (*Ipomoea* sp.) that actually adjoins the foreshore (mostly draped over the seawall north of the boat harbor and the armour rock south of the boat harbor).

Given the lack of natural habitats in the three project option footprints, there is a noticeable lack of fauna in the port area (with the exception of rats, dogs, cats, pigs, and chickens). Shorebirds are evident throughout Nauru, but are not commonly seen in the port area.

Protected areas. There are no protected areas in Nauru. The only current candidate is on the eastern side of the island (Anibare area); the port area is remote from this prospective conservation area. Department of Environment staff (February 2015) have indicated that they have no particular concern for protecting any environmental attributes in the port area, due to more than 100 years of industrial and shipping activity in the area.

9.2.2. Context and Baseline Conditions – Socio-economic Environment

Land use and ownership. All of Nauru land is owned by Nauruan families, although much is leased out to Government and other institutions/agencies for uses other than residential use. There are 630 individual plots of land in Nauru (Department of Lands and Survey).

The port area has a high density of settlements, extending inland at least 600 meters from the coastline and, in correlation, has a high density of buildings, including residential, industrial, and commercial. The existing port area includes at least 24 individual plots of land that are leased for various port operations, phosphate operations (i.e., by Ronphos), and for the derelict houses north of the boat harbor.

The area north of the boat harbor is very poorly serviced (lacking full water supply, and with septic tanks and cesspits that may be neglected), many buildings are in various states of destruction/decomposition, there is inadequate drainage, and garbage is evident everywhere. This part of Nauru is reportedly subject to land use pressures and ongoing legal disputes.

Most of the port area itself is taken up with buildings associated with the port operations, empty containers, debris, internal access roads, and such. Many of the buildings are in serious disrepair, suffering from corrosion of steel structural elements and loss of roofing materials.

Population and indigenous people. The overall demographic profile for Nauru is Nauruan making up 51% of the population, followed by Chinese (21%), other Pacific Islanders accounting for 20% (egg, many from Kiribati), and Europeans (8%). These figures exclude the residents of the RPC). Nauru’s population is quite young; 39% of the population is younger than 15, and many households (living in a single family dwelling or complex) have more than nine family members (significant crowding, in some cases). Life expectancy is quite low. Only 2% of the population is older than 60. The only residential area near the port is north of the boat harbor, where up to 2,000 people may be living, apparently renting from the landowners. The Chinese and Pacific Island groups have been heavily involved in phosphate mining.

Physical cultural resources. There are no physical cultural resources in the immediate port area. The locomotive from the old phosphate mine operations is near the southern port entrance, and there is a cemetery well north of the derelict housing area.

9.3. Comparison of Safeguards Issues with the Potential Port Development Options

Environmental safeguard issues. Each of the options will result in some net environmental degradation. Options 1 and 2 would produce the greatest change from the environmental baseline (i.e., when compared with the current environmental conditions), and Option 3 would make the already degraded environmental conditions in the area south of the boat harbor somewhat worse. The area south of the boat harbor (where the cantilevers are operating) currently has the poorest environmental conditions at present, due mostly to degraded coral reefs (i.e., resulting from long term cantilever operations, resultant phosphate dust, and mooring buoy anchor chains), reduced air quality (at times, from phosphate dust), poorer beach stability (relative to the other locations), and exposure of existing infrastructure to extreme sea states.

Taking all environmental criteria into account, including the current baseline conditions at the three option locations, and also the degree of expected environmental change associated with each of the three options, from an environmental impact perspective the preferred port development is option 3 (south of the boat harbor). This area is already environmentally degraded (more so than the other two locations) and can be considered to be able to accept some further environmental degradation without compromising adjacent areas.

Based on the classifications of potential impact included in the ADB Safeguard Policy Statement⁸⁷ (SPS), Options 1 and 3 would likely be Category B. Option 1 could require dredging of the reef in the order of 4,000 m³, although the reef in this area is barren and includes old concrete slabs and sewer outfalls. Option 3 could require removal of 5,000 m³ of reef, which is already flattened and destroyed by equipment movements associated with the phosphate shipping operations. Option 2 would likely be Category A due to the requirement for major reef blasting and dredging to create the harbor (approximately 1 million cubic meters of coral reef and backshore sand/rubble), therefore creating more significant environmental impacts as outlined in SPS⁸⁸.

Social safeguard issues. Options 1 and 3 create no apparent impositions on local populations or existing social conditions. Options 1 and 3 would not involve any involuntary resettlement of people (construction activities and infrastructure all expected to be within the current port “footprint”). Option 2, which would involve incursion into the derelict housing area (forcing involuntary resettlement), would have negative impacts on a wide range of social criteria. Option 2 would have significant negative social impacts in and adjacent to an area that is already socially stressed, and would require substantial investments land negotiations, development of alternative housing areas and livelihood restoration to mitigate negative social impacts associated with the option. Based on SPS, Options 1 and 3 can be categorized as Category C for involuntary resettlement, and Option 2 would be category A (i.e. 200 people or more would

⁸⁷ ADB, Safeguard Policy Statement, June 2009

⁸⁸ According to the SPS, an environmental Category A project is likely to have significant environmental impacts that are irreversible, diverse, or unprecedented, and the impacts may affect a larger area than the project site or facilities. A Category B project is likely to have site-specific impacts, few if any are irreversible, and in most cases mitigation measures can be more readily designed than for Category A projects.

require physical displacement). The categorization for indigenous people would likely be C for any of the options.

9.4. Safeguard Requirements during the PPTA

Environment. Each of the options will require environmental assessment. Based on the SPS classifications, Options 1 and 3 would require an initial environmental examination (IEE) and Option 2 would require an environmental impact assessment (EIA). In addition to the Option 2 (i.e., Category A) requiring more in-depth and detailed studies and investigations, the EIA would be required to be disclosed as a draft at least 120 days before ADB Board consideration.

The requirements listed below are intended to cover the needs related to all three options. These can then be filtered according to the selected option. While there is confidence in the field survey reconnaissance data, accounts in the primary and secondary scientific literature, and anecdotes and observations undertaken during the pre-feasibility study, the PPTA should fill some gaps, to ensure that environmental and social impact predictions (in the IEE or EIA) are robust and the required environmental management plan (EMP) is responsive to all potential negative impacts associated with the selected option.

Specific PPTA tasks are itemized below:

- An environmental compliance audit of the existing port facilities and operations to identify any past or present concerns or impacts and identify and plan appropriate measures to address outstanding compliance issues;
- Public consultations to inform stakeholders and local people of port development details, impacts and proposed mitigations, and to understand the views of any directly affected people and stakeholders;
- Visual/photographic transects (including fish counts) over the coral reef in the selected option area;
- Water quality analysis at selected sites just off the reef edge south of the cantilevers, at the cantilevers, at the boat harbor, and north of the boat harbor, as well as a control on the east side of Nauru (including nutrients, suspended particulate matter, turbidity, hydrocarbons);
- Detailed survey of all contaminant input sources to the marine environment in the port area (including waste oil from the power plant, use of sewage outfalls, septic tank seepage, runoff from the port);
- Detailed survey of active coastal erosion sites in the port area;
- Detailed typology of the reef flat materials and coastal sediments that will require blasting/dredging.

It is assumed that climate and physical oceanographic data requirements are addressed elsewhere; these will be provided to the environmental specialist conducting the IEE.

Social. Options 1 and 3 would require a Due Diligence Report (DDR) to be undertaken, which will include a social compliance audit and an action plan to address any outstanding issues. A resettlement plan (including relocation and livelihood restoration plans) would be required for Option 2. The resettlement plan would be based on an inventory of losses, socio-economic survey, consultations with directly affected people (relocating/resettling households and households living in the relocation area), and estimates of costs for compensation and livelihood restoration.

A cadastral survey should be undertaken as part of development of any of the options. The DDR (Options 1 and 3) or resettlement plan (Option 2) should include a review of land leases to provide clarity and certainty around the existing arrangements, this would form part of the social safeguards compliance audit of existing facilities, which would also identify corrective actions and measures as required.

10. Multi-Criteria Analysis

10.1. Introduction

This Section provides a detailed description of the multi-criteria analysis (MCA) which has been used to critically assess each port development option as outlined in Section 5.

To ensure that a robust and transparent assessment is applied to the selection of a preferred design solution, an MCA has been undertaken to compare the three identified options against pre-determined themes and criteria measured using a scoring and weighting method.

The methodology applied for the MCA comprises five key stages:

- (i) Stage 1 – Information and data review;
- (ii) Stage 2 – Selection/confirmation of alternative port options and concept designs;
- (iii) Stage 3 – Confirmation of MCA inputs and scoring;
- (iv) Stage 4 – Stakeholder consultation to discuss criteria selection, scoring and weightings;
- (v) Stage 5 – MCA component analysis and results.

A summary of each of these steps is provided below.

Stage 1 – Information and data review

Given the studies which have previously been undertaken for upgrading the port facilities in Nauru, the first stage of the MCA involves a review and analysis of these earlier studies, technical reports and data as well as acquisition and review of other research and studies. This stage will provide the necessary basis for the MCA, to ensure that the three options and subsequent scorings are considered against the unique social, environmental, technical and economic context of the port.

Stage 2 – Selection of design options

Three options have been identified for investigation to upgrade port facilities for Nauru.

Prior to the MCA, each of these options will be developed to concept level to allow a relative assessment of opportunities, costs and impacts. Concept sketches will be developed for each option. Major stakeholders (Ronphos, shipping companies, Department of Transport, the Nauru Port Authority) will be consulted to gain an initial understanding of how their operations may be affected. Stakeholder input may be used to refine the concept sketches.

Stage 3 – MCA inputs and scoring

The basis of the MCA is the ranking of the port development options against pre-determined criteria which are relevant to the decision making process for the project.

Step 4 – MCA analysis

The MCA scoring has been analysed by the Study Team, tabulated and weighted to provide a preliminary score for each option.

These results are then integrated to calculate a ranking for each port design option. This identifies the preferred option for development of the future port facility.

Stage 5 – Stakeholder consultation

Following the MCA scoring and weighting analysis, a stakeholder workshop was conducted, to obtain agreement with the methodology and scoring for the MCA. Stakeholders included

- Ministry/Department of Transport
- Ministry/Department of Finance
- Nauru Port Authority
- Ronphos
- Department of Commerce, Industry and Environment.

10.2. Stage 1 – Information and data review

This Stage of the MCA has been covered in detail in Sections 3 and 4.

10.3. Stage 2 – Selection of design options

While the Scope of the project nominated three preferred options for investigation within this Pre-Feasibility Study, a couple of hybrid options and a further option to completely relinquish the need for the mooring system have also been investigated in Section 5.

Section 5 provides details of how each option would be operated. In addition, that Section provides detailed descriptions of the construction methodologies, and Section 6 outlines the estimated cost of each option.

Section 8 provides a detailed analysis of the economic aspects of each option and Section 9 details the environmental and social issues affected by each option.

Hence, this MCA analyses the three nominated options, with scores and weighting of the criteria, as described in more detail below.

10.4. Stage 3 – MCA inputs and scoring

A description of the criteria categories identified for this project is provided in Table 10-1 below.

Table 10-1: Criteria for MCA

Indicators (from objectives)	Categories	Comments	Detailed Questions (Improvement on existing condition)
ECONOMIC CRITERIA			
1. Improve productivity (e.g. time/container or ship)	Direct Economic	ship turnaround access to shore; ease of berthing;	Time saving to general cargo/container ships Time saving to phosphate ships Time saving to fuel ships
2. Cost Savings/Minimize life cycle costs of the complete phosphate and cargo handling operation (including mooring buoys)	Direct Economic	construction cost;	Port cost savings – barges Port cost savings – labour Increased port revenue – fuel Increased port revenue – fish Increased port revenue – container storage Increased port revenue – phosphate inventory Economic Benefit – damage and safety
3. Maximise opportunity for future expansion	Indirect Economic	future expansion/ project phases; benefit to cost of investment	Other port revenues (not quantified) Future development activities Access to Nauru What is the life cycle cost? (cost/cost of cheapest option) Is there scope for future expansion?
4. Facilitate the maximum number/extent of future economic activities	Indirect Economic	flexibility of facility; cost-benefits	How much additional economic activity is expected/predicted? Improved employment conditions
TECHNICAL AND OPERATIONAL CRITERIA			

5. Maximise operational flexibility	Operations	multiple berthing; (i.e. unload both cargo and phosphate ships at the same time?)	Can 2 ships berth concurrently?
6. Accommodate sea level rise	Engineering	Sea level rise predicted to be 0.58m in 50 years	Do the quay walls, breakwaters, causeways, and other structures in direct contact with the open sea accommodate sea level rise?
7. Minimise construction risks (e.g. to an acceptable or tolerable level)	Engineering /Construction	construction components; constructability	What high-risk construction is involved? Are all project elements constructible?
TECHNICAL AND OPERATIONAL CRITERIA (continued)			
8. Maximise opportunity for local contractors in construction, operation and maintenance	Engineering /Construction	availability of local contractors;	What proportion of the construction can be executed by local contractors?
9. Improve safety of the port operations	Safety	marine; terrestrial;	Will on-water safety improve? Will land-based safety be improved?
ENVIRONMENTAL AND SOCIAL CRITERIA			
10. Minimise environmental impact	Environmental	terrestrial; marine; coastal; climate resilience	Coral reef condition? Fish population? Water Quality? Vegetation? Bird habitat? Air quality? Stable beach and backshore Integrity of structures
11. Minimise social impact or provide social opportunity	Social	quality of life land; public infrastructure; poverty reduction;	What land transfer is required? What resettlement is required? Is poverty improved?

10.4.1. Scoring

Using the MCA inputs listed above, each of the components were scored individually using scoring based on a score range of 7, from -3 to +3. Zero is considered to be the score for an outcome which is no improvement nor detriment from the existing situation (or for the without-project scenario). A plus score above zero is for an improved outcome and a negative score is for a detrimental outcome.

This scoring process was undertaken by project team members, and the results compiled into the final MCA weighting. The scores and weighting are presented in Appendix G.

The scoring process ensured that the responses are compared against project objectives and in a consistent format. The 'without-project' option was scored as 0 in the scoring scale. The use of negative scoring was adopted to penalise actions which are detrimental to the project.

10.4.2. Weightings

Recognising that each indicator has varying influence or importance to the decision making process, the weighting convention shown in Table 10-2 was applied to the MCA assessment.

Table 10-2: Importance weighting

Importance	Weighting
Very low	1
Low	2
Moderate	3
High	4
Very high	5

Step 4 – MCA analysis

The detailed analysis is provided in Appendix G. In summary, Table 10-3 outlines the overall weighted scores from the MCA.

Table 10-3: MCA Weighted Scores

DETAILED QUESTIONS	WEIGHTED SCORES		
	Option 1 – North Quay Wall	Option 2 – North Basin	Option 3 – South Quay Wall
Time saving to general cargo/container ships	+8	+8	+4
Time saving to phosphate ships	0	0	+5
Time saving to fuel ships	+8	+8	+4
Port cost savings – barges	+6	+6	+6
Port cost savings – labour	+6	+3	+6
Increased port revenue – fuel	+4	+4	+4
Increased port revenue – fish	+2	+3	+2
Increased port revenue – container storage	+6	+6	+6
Increased port revenue – phosphate inventory	0	0	+2
Economic Benefit – damage and safety	+8	+12	+8
Other port revenues (not quantified)	+6	+6	+6
Future development activities	+8	+12	+8
Access to Nauru	+6	+6	+6
What is the life cycle cost? (cost/cost of cheapest option)	+12	0	8
Is there scope for future expansion?	+6	+0	+4
How much additional economic activity is expected/predicted?	+6	+9	+6
Improved employment conditions	+4	+6	+6
Can 2 ships berth concurrently?	+6	+6	+0
Do the quay walls, breakwaters, causeways, and other structures accommodate sea level rise?	+9	+9	+9
What high-risk construction is involved?	-5	-15	-10
Are all project elements constructible?	+8	+4	+8
What construction can be executed by local contractors?	+4	-4	+2
Will on-water safety improve?	+8	+12	+4
Will land-based safety be improved?	+6	+6	+6
Coral reef condition?	-1	-1	-1
Fish population?	-1	-1	-1
Water Quality?	-4	-4	-4
Vegetation?	-2	-2	-2
Bird habitat?	0	-1	0
Air quality?	-1	-1	-1
Stable beach and backshore	0	+1	+1
Integrity of structures	+3	+6	+6
Quality of life	0	-6	0
What land transfer is required?	0	-21	0
Public infrastructure improvements?	0	-2	0
TOTAL WEIGHTED SCORES	126	75	106

10.5. Stage 5 – Stakeholder consultation

Consultation with Nauru-based and other stakeholders will be conducted using both workshop and review formats so that this MCA can be thoroughly examined, reviewed, discussed and concluded. A workshop in Nauru for the Nauru-based stakeholders will be used for this purpose.

11. Conclusions and Recommendations

11.1. General

This Pre-Feasibility Study has investigated a number of options for the development of port facilities in Nauru. The consulting team has considered the engineering, oceanographic, economic, environmental, social and risk aspects of the proposed development options, to assess the feasibility of one or more of these options. The feasibility has been tested using a multi-criteria analysis, in order to inform the selection of a preferred option.

For over a century, Nauru has been served by port facilities designed to provide a safe harbour for lighters, pusher boats and rafts, which have been used to transfer general cargo and containers from a vessel moored offshore, using ship's gear for unloading/loading. Export of phosphate has been via twin cantilevers supporting conveyors to load directly into dry bulk vessels moored beneath the cantilevers. A mooring system, comprising a complex but effective network of anchors, chains, cables and mooring buoys has been in place for many decades, to provide a safe anchorage for all vessels visiting Nauru.

The offshore topography of the island is unique in the Pacific region and possibly world-wide. From the shoreline of the essentially circular island, a narrow fringing reef transitions to a seabed which drops away at an abrupt 45 degree slope, down to depths of more than 3,000 metres offshore. Hence, the island is extremely exposed to Pacific Ocean swells and winds, particularly from the north-west during the monsoon season (October to March), and no natural harbour exists around Nauru's coastline. There has historically been no opportunity to construct a safe harbour capable of berthing ships carrying general cargo, fuels and for the export of phosphate. The mooring system has been the only method capable of mooring ships visiting Nauru.

The port is the major vulnerability for almost all economic activity on Nauru, with recent equipment failures inhibiting import and export activity and imposing continuing high costs on shippers, individuals and thus the community⁸⁹ at large. Simply refurbishing the port through minor investments still exposes the economy to potential major disruption to fuel, food and export movement and will not overcome the existing problems resulting from the lack of adequate port infrastructure facilities.

11.2. Objectives of the Study

The objectives of the study have been to:

- Determine a preferred port development option for implementation;
- Investigate the economic viability of the options to support partner investment;
- Provide information to guide future PPTA preparation.

11.3. Existing Operational Constraints

The existing port facilities are extremely run-down and in poor condition. Many infrastructure elements within the port are well beyond their design life and derelict. Most of the buildings within the port limits are in extremely poor condition and are in danger of collapsing. A lack of routine maintenance, driven by limited revenue and capacity within the Nauru Port Authority, is

⁸⁹ We have not been able, due to lack of data, to assess the impact of the inadequate and costly arrangements for phosphate handling for example on Nauru as a whole. It is possible that better facilities, as included under one of the options to be discussed in this study, would not only reduce transport costs but could also improve the price received for phosphate.

the primary cause of this situation. Investigations and studies over the past five or more years have made consistent recommendations for these buildings to be demolished. No action has been taken in this regard. Equipment such as pusher boats (“sea mules”), the pilot boat and barges, while having been procured as new in recent years, have not been adequately maintained, and are consequentially not able to provide the capability needed to transfer cargo efficiently to and from general cargo vessels.

Overzealous mooring practices when anchoring general cargo vessels to the outer buoys have occasionally caused damage to components of the mooring system, which then requires costly repair work to be requisitioned from specialist overseas-based contractors. These incidents result in unscheduled closure of the mooring system, thereby delaying the berthing of phosphate vessels, fuel ships and general cargo ships, which causes unnecessary delays to the delivery of essential supplies such as fuels and general cargo goods, as well as delaying the export of phosphate with resultant financial consequences.

While the land already available for container operations should be adequate for the size of the port and its cargo throughput, the failure over time to export empty containers has resulted in a critical overcrowding within the container yard with empty containers. The slow rate of container transfers from ship to shore and back, due to the poor productivity of the current cargo transfer operation is the cause of this backlog, since ships, bound by their sailing schedules, are unable to wait for empties to be back-loaded, once imported cargoes have been unloaded.

11.4. Options for Port Redevelopment

The three options for redeveloping the port have been assessed and compared to determine a preferred option for further detailed consideration under a potential PPTA. A summary of this assessment is provided in Table 11-2. The key features, key parameters from the economic evaluation and the ranking from the Multi-Criteria Analysis are included in the table.

Table 11-1: Summary of Options Features

Summary	Option 1 - North Quay	Option 2 - North Basin	Option 3 - South Quay
Key features	New quay wall constructed on the edge of the reef north of the existing harbour, which provides the initial stage of a future enclosed harbour.	New enclosed harbour basin excavated from the reef and coastal land north of the existing boat harbour, sized to accommodate most vessels except phosphate ships. Includes two tugboats.	New quay wall constructed on the edge of the reef south of the existing harbour, complemented by 2 x dolphins to assist phosphate ships in berthing.
Impact on phosphate operations	Phosphate ships continue to use southern cantilevers and mooring system	Phosphate ships continue to use southern cantilevers and mooring system	Phosphate ships continue to use southern cantilevers and mooring system, and cargo ships use the same system.
Impact on cargo operations	Significantly increased efficiency alongside quay wall	Significantly increased efficiency in most conditions in sheltered harbour.	Significantly increased efficiency alongside quay wall, although some conflicts with phosphate ships
Use of mooring system	Limited to phosphate ships until phosphate operations cease.	Limited to phosphate ships until phosphate operations cease.	Limited to phosphate ships until phosphate operations cease, but will continue to be used by cargo and fuel ships.

Table 11-2: Summary of Options Assessment

Summary	Option 1 - North Quay	Option 2 - North Basin	Option 3 - South Quay
Capital Cost	\$23.0 M	\$97.7M	\$31.2M
O&M Costs	\$1.6 M p.a.	\$2.4 M p.a.	\$1.6 M p.a.
30 year ENPV at 10% discount rate	+\$1.5M	-\$55.8M	-\$1.3M
EIRR	+11.2%	-0.4%	+9.2%
MCA Score	126	75	106
MCA Rank	1	3	2
Economic Criteria	1	3	3
Technical & Operational Criteria	2	1	3
Environmental and Social Criteria	2	3	1

11.5. Alternative Options

11.5.1. Removal of the Mooring System and Replacement with Tug Boats

The anchored mooring system is a complex arrangement of anchors embedded on the seabed at great depth, cables, chains, multi-point linkages and mooring buoys. This mooring system is maintained to ensure that ships can be safely and efficiently moored at Nauru to complete their cargo transfer operations. To remove the mooring system completely would not be wise because any alternative arrangement for anchoring or handling ships may fail, leaving a ships vulnerable to grounding on the reef edge. Maintaining even a reduced version of the mooring system would be prudent.

The only alternative for the mooring system which could provide a viable method for holding and maneuvering ships at the phosphate cantilevers is for two or more tug boats to be provided around the clock, operated and maintained by the port. The estimated capital cost of this alternative is A\$3.0 million, plus an annual operation and maintenance cost of A\$1.8 million.

11.5.2. Improvements to Existing Harbour in Anibare Bay

Anibare Bay, located on the eastern side of Nauru, offers sheltered waters during the monsoon season, when high waves and strong winds often prevent shipping operations at Aiwo. It would be prudent to invest a small amount in expanding the facility at Anibare Harbour, to provide a larger hardstanding area for unloading containers without the current congestion caused by very limited access at this location. While the general cargo ships can operate at this location by drifting, thereby precluding the need for a mooring system on this side of the island, productivity for unloading containers would be significantly enhanced if a larger hardstanding area was constructed adjacent to the harbour. An investment of about A\$300,000 would provide an expanded container-handling area of about 2,000 m².

11.5.3. New Quay Wall at Anibare Bay

A new harbour development at Anibare Bay has been suggested by some. However, there are a number of sound reasons why this is not viable, including:

- The area is exposed to Trade winds and wave climate for about 9 months of the year;
- The sub-sea geology comprises a submarine landslip, thereby presenting a risk for a new harbour development that further sub-sea instability may severely damage harbour infrastructure;

- The reef and marine ecosystem around and within Anibare Bay is relatively pristine and any harbour development would place this ecosystem at high risk of irreversible damage;
- Most industrial and commercial activity occurs on the western side of the island, close to the existing port. Moving the port away from this activity would increase transport costs.

Hence, any major port development in Anibare Bay (other than an enlarged hardstand) is not recommended.

11.6. Recommendations

The multi-criteria analysis and the economic assessment together demonstrate that Option 1, the Quay Wall located north of the existing Boat Harbour, provides the preferred option for redeveloping the port of Nauru to provide a new viable port facility for the community's benefit. This solution can likely be achieved within a five year period and has limited land and environmental issues based on preliminary assessment. It is recommended that this Option 1 is carried forward for further investigation.

On the basis of both the economic and MCA assessments, Option 2 (i.e., comprising the Harbour Basin located north of the Boat Harbour) in its entirety, should not be considered further for investment by PRIF partners. Option 2 at this stage is not considered to be an economically feasible scenario. Option 2 may be considered further by the Government of Nauru as a future stage of port development following the construction of Option 1 (i.e., supported by PRIF partners) and resolution of land issues, if GoN can access adequate funding from non-PRIF partners for this expanded development.

Regardless of the infrastructure option selected for further investigation, the mooring system must be retained and continue to be maintained in full operational capacity while the phosphate loading facilities remain active (i.e., for the life of the phosphate operations). Replacing the mooring system with tug boats is not recommended, owing to the high capital and operation/maintenance costs, together with the lack of capacity to adequately maintain sophisticated plant and equipment such as utility boats, as demonstrated by the current poor condition of relatively new marine plant and equipment in Nauru (egg, pusher boats, rafts, and barges).

Given the limited capacity to maintain sophisticated plant and equipment, and manage the port under commercial principles, it is also recommended that both PRIF partners and GoN support an intensive and effective institutional strengthening program for the NPA.

Finally, the hardstand area at Anibare Harbour should be expanded to provide a more efficient area for handling containers when this harbour is occasionally used during monsoon season periods of high winds and waves at Aiwo harbour.

11.1. Risks, Opportunities and Required Activities for PPTA Phase

Throughout this report, the key assumptions and risks are outlined. There are a number of critical areas requiring further, more detailed, investigation to minimize risks during future Project Preparatory Technical Assistance (PPTA). Key risks identified during the study and associated investigations and tasks required during PPTA are presented in Table 11-3.

Table 11-3: Key Risks, Opportunities and Proposed PPTA Activities

Key risk or opportunity	Required PPTA Activities to minimise risk or harness opportunity
<p>Geotechnical conditions of site and quay wall foundation, suitability of construction method, and cost estimates</p>	<p>Extensive geotechnical investigation of the entire development site, both on land and across the reef flat to the edge of the reef. These investigations should be aimed at determining the foundation materials beneath the surface for container park pavement design, hardness of the reef flat to ascertain the excavation parameters for concrete block quay wall construction and to confirm that concrete block quay wall loads can be adequately supported on the reef flat.</p> <p>These investigations should also include deeper investigations to determine the parameters of the underlying reef material, in the unlikely event that piled structures may need to be considered for quay wall/wharf construction. These deeper investigations would also be advisable to inform provide parameters to be used in the hydrodynamic modelling of the reef and proposed quay wall (e.g., drilling and extracting cores to assess the structure of the reef).</p>
<p>Uneven seabed contours for a foundation for mass concrete block quay wall construction</p>	<p>Site survey, both on land and across the reef flat and over the edge of the reef, to determine features and levels across the development site. All features including buildings, vegetation, underground services, mooring system components and the detailed topography of the reef flat and the edge of the reef need to be identified by the survey. This survey should include a high resolution cross-sectional survey of the seaward reef edge in the proposed port locations, to determine feasibility of proposed quay wall and road options.</p> <p>Anecdotal evidence suggests that the edge of the reef may be undercut by natural wave action. This should be investigated as part of this survey by undertaking a vertical survey of the profile.</p>
<p>Uncertainty of land ownership and lease arrangements which could present access and timing challenges for the project</p>	<p>A cadastral survey should be undertaken to accurately define the land ownership parcels within the port limits, and at its periphery. Once the land ownership parcels have been defined, the land proposed to encompass the port land, or the boundary of the port limits, can be defined (as is required under the Port Act).</p> <p>In parallel with the cadastral survey, a review of existing lease arrangements within the footprint of the proposed Option1 and at its periphery should also be undertaken. This will include a review of land ownership, original lease details such as how the land was originally obtained, and whether there are any outstanding issues.</p>
<p>On-going damage to the mooring system from poor ship-handling practices and consequent down-time while the damaged mooring system components are repaired</p>	<p>In order to better understand the current condition and impact of maintaining the mooring system on the economy of the NPA, Ronphos and the GoN, a detailed investigation into the maintenance costs experienced over the past ten years should be undertaken. This investigation will recognise that regular and reactive maintenance is a separate cost imposition compared to the high cost of replacing crucial components of the mooring system (such as anchors and deep-sea chains and cables) which is undertaken every five to ten years. A cost-benefit assessment of the mooring system would assist in demonstrating the ongoing viability of retaining this system as</p>

	<p>opposed to replacing it with two tug boats.</p> <p>This review of maintenance needs should be accompanied by a detailed independent investigation of the suitability of the existing mooring system and any design and operational improvements to reduce the ongoing cost.</p>
<p>Uncertainty of the cost estimates</p>	<p>Estimating construction costs for large unusual port development projects in remote locations such as Nauru is difficult, since similar comparable projects rarely exist for comparative purposes. To assist with project budgeting, it is recommended that the preferred design for any new port development be assessed either by a Quantity Surveyor or by an international civil engineering contractor with experience in port development in the region.</p> <p>The costs estimates are currently based on the mass concrete block construction method, with the blocks assumed to be cast on Nauru. A detailed review of the risks associated with this methodology should be undertaken, and should include an assessment of the availability of the skills (e.g., suitably skilled contractor), equipment (e.g., concrete batching) and materials (e.g., aggregate, fresh water) available on Nauru to cast the blocks.</p>
<p>Risk of attracting suitably qualified contractors to undertake the work while providing opportunity to the local private sector.</p>	<p>Consideration of appropriate procurement methods should be built into the PPTA, including potential for Design and Construct (D&C) contract, led by a suitably experienced international maritime contractor to bring innovation to the design solution and transfer design evolution risk to the contractor. Opportunities should also be explored during PPTA for local private sector participants to undertake elements of the work.</p>
<p>Impact of monsoon waves on a west-facing quay wall</p>	<p>A detailed investigation of the suitability of the proposed quay wall to the monsoon season wave climate and extreme events should be undertaken. It is anticipated that this investigation will include hydrodynamic modelling of the proposed arrangement, coupled with the existing bathymetry, and projected wave climate (i.e., extreme wave events), so the design can be verified and refined, as necessary. In particular, the this task will provide information to: determine the expected number of non-operational days which may occur on an annual basis; and inform the detailed design and selection of suitable energy-absorbing fendering for the quay wall to protect ships from impact damage when berthed in marginal sea conditions.</p> <p>Early discussions with SPC Geoscience Division reveal that the PACCSAP hindcast data set used for this study is the best available data currently. Further analysis of extremes generated from this data set are available from SPC Geoscience Division and can be used to develop an uncalibrated site specific hydrodynamic model.</p> <p>This hydrodynamic modelling should be coupled with the expertise and advice of an experienced mariner, to provide guidance on suitable berthing procedures and limitations during specific extreme climate events.</p>

<p>Sensitivity of key assumptions to the economic viability of the project.</p>	<p>More detailed economic analysis to confirm and refine the conclusions reached in this Pre-Feasibility Study. This should include sensitivity tests on some of the critical assumptions such as: continuity of revenue sources; long term maintenance costs of the mooring systems.</p>
<p>Uncertainty of environmental social conditions and understanding of mitigation measures during design, construction and operation</p>	<p>The Prefeasibility Study has determined that the preferred Option 1 or 3 is Category B for Environment. Key PPTA environmental safeguards activities should include: public consultation; visual/photographic transects of the reef; detailed survey of water quality and all contaminant input sources to the marine environment in the port area; detailed survey of active coastal erosion sites in the port area; detailed typology of the reef flat materials and coastal sediments that will require blasting/dredging.</p>
<p>Uncertainty of social conditions and potential mitigation measures during design, construction and operation</p>	<p>The Prefeasibility Study has determined that the preferred Option 1 or 3 is Category C for Involuntary Resettlement. Key PPTA social safeguards activities should include: public consultation; due diligence/social compliance audit (including an action plan to address any outstanding issues); review of land leases and outstanding issues.</p>
<p>Inappropriate demolition, handling and disposal of building materials and hazardous resulting in health, safety and environmental risks.</p>	<p>All the existing buildings within the port boundaries are in very poor or derelict condition and must be demolished as soon as possible. The PPTA should investigate in detail the sequencing and methodology for demolishing the existing buildings to minimize safety risks. This will likely require the skills of a structural engineer with demolition experience.</p> <p>In addition, the environmental specialist for the PPTA should also investigate appropriate methods for handling and disposal of building materials (e.g., asbestos roofing and walls), while opportunities to salvage materials which are in good condition (e.g., steel or aluminium) should also be explored.</p>
<p>Lack of operations and maintenance capabilities within Nauru Port Authority will prematurely undermine the efficiencies gained by new port infrastructure</p>	<p>Institutional reform within the Nauru Port Authority is essential to ensure that the capacity of the organization is commensurate with the value of the proposed investment in port facilities infrastructure. Some key areas for investigation include: financial management (collection of port fees and dues, and the associated accurate accounting); asset management (routine maintenance, management of stores and spares, availability of skilled maintenance personnel); and other critical management tasks, to ensure that the new facility delivers the improved outcomes envisaged in this Study.</p> <p>Institutional strengthening will need to include both (i) the Department of Maritime Transport (planning, financial and strategic management including change management) and (ii) the NPA (management and operational activities including staffing).</p>

Climate change risk and adaptation opportunities	The preliminary climate risk screening for each option reveals a high climate risk. A detailed climate risk and vulnerability assessment should be undertaken, which will include: impact assessment, identification of possible adaptation options; and incorporation of the adaptation measures into the economic analysis. The detailed investigation should include an assessment of the incremental elements of the design attributable to climate change adaptation to inform potential climate change funding opportunities.
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