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Pacific Safety of Navigation Project

Risk assessment for the Port of Majuro, Republic of the Marshall Islands

November 2019

PACIFIC SAFETY OF NAVIGATION PROJECT

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Pacific Safety of Navigation Project: Risk assessment for the Port of Majuro, Republic of the Marshall Islands

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Executive summary

The Republic of the Marshall Islands (RMI) is a signatory to the International Convention for the Safety of Life at Sea (SOLAS), of which Chapter V Regulation 13.1 requires the contracting governments to provide "such Aids to Navigation (AtoN) as the volume of traffic justifies and the degree of risk requires."

RMI is one of the 13 targeted Pacific Island countries and territories of the Pacific Safety of Navigation Project implemented by the Pacific Community (SPC) and funded by the International Foundation for Aids to Navigation (IFAN), whose aim is to improve safety of navigation in the Pacific region through enhanced AtoN capacity and systems.

During Phase 1, in 2017, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and SPC developed the simplified IALA risk assessment tool (SIRA), a simple qualitative tool to enable smaller states to meet their international obligation of providing AtoN by conducting waterways risk assessments.

During Phase 2 of the project, in June 2019, RMI identified a priority area and SPC conducted a risk assessment of that area, using the SIRA tool. This report details the risks identified, the estimated costs in the event of an incident, the risk control options suggested, and their costs.

The Port of Majuro is the major port in RMI and was, therefore, identified by the Ministry of Transportation, Communication and Information Technology (MTC&IT) as a priority for the risk assessment. The RMI Ports Authority (RMIPA) is within the Department of Transport under the Ministry of Infrastructure, and is responsible for the development, maintenance and operations of all seaports, including Uliga and Delap on Majuro Atoll.

The Uliga dock is primarily used for interisland cargo and passenger vessels, while the Delap dock is mainly used for international cargo. The Port of Majuro is the hub of the Marshall Islands' economy. Majuro's maritime stakeholders identified eight scenarios for Majuro's harbor:

1) collision of fishing vessels at the anchorage area,

2) collision between vessels entering the Delap and Uliga dock at night;

3) grounding of fishing vessels on the reef at the entrance to Calalin Channel;

4) grounding of fishing vessels in Calalin Channel;

5) grounding of a small boat on a wreck at Uliga dock;

6) vessels alliding with AtoN in Majuro Lagoon and Calalin Channel;

7) foundering of small boats at the passage into Majuro Lagoon at the bridge;

8) structural failure of domestic vessels.

For each scenario in each area, the cost of the incident was estimated and a risk score was given, taking into account the probability of the incident happening and its potential impact on the country. Risk control options were then identified. The risk scores for the scenarios under the current situation were then compared with the new risk scores if the risk control options were put in place.

Scenario	Risk score	Risk control option	New risk score
Collision between two fishing vessels in the anchorage area	6	Upgrade ship-to-ship radio communications and increase the number of awareness program	3
Collision between two vessels approaching Dalap dock at night	12	Install new lead lights to Dalap dock and seven lateral buoys to mark the passage to Dalp dock.	3
Grounding of fishing vessels on reef at the entrance of Calalin Channel	9	Install new IALA-compliant lit AtoN at the entrance to Calalin Channel	3
Grounding of vessel in Calalin Channel	9	Install new IALA-compliant lit AtoN in Calalin Channel	3
Grounding of small boats on the wreck at Uliga dock	9	1. Mark the wreck with an emergency wreck marking buoy (EWMB) 2. Remove the wreck	3
Allision of vessels with AtoN	9	Install dayboards on AtoN and increase public awareness of safety at sea	3
Foundering of small boats at Majuro bridge channel	9	Install IALA-compliant AtoN on either side of the passage, and increase the number of small boat safety awareness program	6
Structural failure of domestic vessels	15	Enforce strict Port State Control measures	10

The main outcome of the risk assessment for Majuro's harbor was eight recommendations that aim to reduce the risks to safety of navigation to an acceptable level for stakeholders. To address all of the recommendations, a cost estimate[1] was provided by MTC&IT. The recommendations and costs of their implementation are outlined below.

Recommendation 1	
To reduce the risk of collision between two fishing vessels in the anchorage area, it is recommended that: 1) ship-to-ship radio communications be upgraded, and 2) more awareness programs be delivered.	
Action	**Cost to implement (USD)**
Upgrade ship-to-ship radio communications	5000
Deliver more awareness programs	2000

[1] Cost estimate for installing new navigational buoys.

Recommendation 2	
To reduce the risk of collision between two vessels approaching Dalap dock at night, it is recommended that: 1) seven new lateral buoys be installed to mark the passage from Calalin Channel to the Delap and Uliga docks, 2) reduce light intensity and direction of lights on port buildings, and 3) submit a hydrographic note (H-note) to the Principal Charting Authority (PCA), informing it of changes to the chart.	
Action	**Cost to implement (USD)**
Install seven buoys	164,005.19
Reduce light intensity and direction	216.00
Submit H-note	0
Maintenance costs[2]	8.211.06

Recommendation 3	
To reduce the risk of fishing vessels grounding on reef at the entrance of Calalin Channel, it is recommended that: 1) new IALA-compliant lit AtoN be installed at the entrance of the channel and a light on the tower at Eroj Island, and 2) submit an H-note to the Principal Charting Authority (PCA) afterward, informing them of these changes.	
Action	**Cost to implement (USD)**
Install new IALA-compliant lit AtoN at the entrance to Calalin Channel and a light on the tower at Eroj Island	2242.74
Submit H-note(s)	0
Maintenance costs	112.137

Recommendation 4	
To reduce the risk of vessels grounding in Calalin Channel, it is recommended that: 1) new IALA-compliant AtoN – together with lights and dayboards – be installed in the channel, and 2) H-notes be submitted to the Principal Charting Authority (PCA) afterward, informing them of these changes.	
Action	**Cost to implement (USD)**
Install new IALA-compliant AtoN, together with lights and dayboards	2.683.14
Submit H-note(s)	0
Maintenance costs	134.16

[2] The annual cost of maintenance for AtoN is estimated at 5% of the the initial cost of purchase.

Recommendation 5	
To reduce the risk of small boats grounding on the wreck at Uliga dock, it is recommended that: 1) the wreck be marked with an emergency wreck marking buoy (EWMB), and 2) the wreck be removed.	
Action	**Cost to implement (USD)**
Mark wreck with an EWMB	86,622.40
Remove wreck	TBD
Maintenance costs	4331.12

Recommendation 6	
To reduce the risk of allision of vessels with AtoN, it is recommended that: 1) day boards be installed on all AtoN, and 2) more public awareness programs be delivered.	
Action	**Cost to implement (USD)**
Install dayboards on AtoN and deliver more public awareness programs	5000
Maintenance costs	250

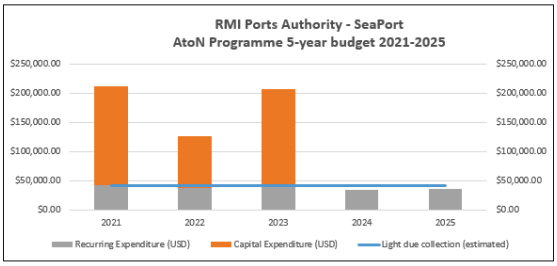
Recommendation 7	
To reduce the risk of small boats foundering at the Majuro bridge channel, it is recommended that: 1) two lit port-hand markers and one lit starboard marker be installed in the channel entrance, 2) a new starboard light be installed on the existing structure, and 3) a small boat safety awareness program be delivered to users of the channel.	
Action	**Cost to implement (USD)**
Install two lit port-hand makers and one lit starboard marker	163,244.79
Install a new starboard light on the existing structure	1085.37
Deliver a small boat safety awareness programme	2000
Maintenance costs	8216.51

Recommendation 8	
To reduce the risk of structural failures of domestic vessels, it is recommended that strict Port State control measures be put in place	
Action	**Cost to implement (USD)**
Implement Port State Control measures	5000

As part of the Pacific Safety of Navigation's work on supporting the Ports Authority's SeaPort Division, an AtoN programme five-year budget plan for the delivery of safety of navigation services for the whole of RMI was drawn up to assist in the Ministry's budget planning process (Annex E). The budget plan demarcates spending according to capital expenditure and recurring expenditure.

RMI Ports Authority - SeaPort
AtoN Programme 5-year budget 2021-2025

	Light due collection (estimated)	Capital Expenditure (USD)	Recurring Expenditure (USD)	Total Expenditure (USD)
2021	$42,324.48	$169,075.07	$42,097.75	$211,172.83
2022	$42,324.48	$87,702.40	$38,470.12	$126,172.52
2023	$42,324.48	$164,330.16	$42,764.56	$207,094.72
2024	$42,324.48	$0.00	$35,034.25	$35,034.25
2025	$42,324.48	$0.00	$35,544.77	$35,544.77
	$211,622.40	$421,107.63	$193,911.45	$615,019.08



* Costings of risk control options covered under Majuro Safety of Navigation Risk Assessment have been factored in:
In 2021, the installation of 7 new lateral buoys marking the passage from Calalin channel to Delap and Uliga docks will reduce the risk of collisions.
In 2021, the adjustment of existing lights intensity and direction on ports to reduce risk of collisions
In 2021, the installation of IALA compliant lit AtoN at the entrance channel (No.1) and light on tower at Eroj Island, and at beacon 3 on Calalin channel will reduce the risk of grounding
In 2022, the installation of an Emergency Wreck Marking Buoy (EWMB) to mark the small wreck near Uliga dock to reduce the risk of grounding
In 2022, the construction and installation of dayboards on all 20 structures will reduce risk of allision
In 2023, the construction of lit markers at the port side of Majuro bridge will reduce the risk of foundering of small vessels
In 2021, the installation of a new light on the current starboard structure of Majuro bridge will reduce the risk of foundering of small vessels
In 2021, 2022, 2023, 2024, & 2025, an annual awareness program on ship to ship communication to reduce risk of collisions
In 2021, 2022, 2023, 2024, & 2025, the strengthening of port state control enforcement will help reduce risk of structural failure

1 Background

In early 2016, with support from the International Foundation for Aids to Navigation (IFAN), the Pacific Community (SPC) started the Pacific Safety of Navigation Project in 13 Pacific Island countries and territories (PICTs)[3]. The project aims to improve safety of navigation in the Pacific region through enhanced aids to navigation (AtoN) capacity and systems, and hence to support economic development, shipping and trade in the Pacific region through safer maritime routes managed in accordance with international instruments and best practices.

During Phase 1, which ended in July 2018, SPC worked in close collaboration with the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to conduct technical, legal and economic assessments in the 13 PICTs to identify needs and gaps in these areas. Another significant output of Phase 1 was the development of a new tool for risk assessment in small island developing states, the simplified IALA risk assessment tool (SIRA). In June 2018, IALA trained personnel in 12 of the 13 PICTs on the use of SIRA to conduct AtoN risk assessments in their countries.

Phase 2 of the project builds on the Phase 1 assessments and tools developed, to further assist in building capacity to develop and maintain AtoN in PICTs. Activities include conducting risk assessments (as required by Regulation 13 of the International Convention for the Safety of Life at Sea – SOLAS); developing a safety of navigation policy and legal framework; improving budgetary management; and supporting regional coordination related to safety of navigation in the Pacific.

In June 2019, the Ministry of Transportation, Communications and Information Technology (MTC&IT) of the Republic of the Marshall Islands (RMI) invited SPC to assist in conducting a risk assessment of Majuro's harbor where the country's main port is situated.

This report describes the risk assessments that were carried out using the SIRA methodology.

[1] Cook Islands, Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Niue, Palau, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.

RMI is located approximately midway between Hawaii and the Philippines. It is made up of 29 atolls (each with many islets), and 5 islands that are arranged in two chains that are approximately 125 miles (200 kilometers) apart. The Ratak (Sunrise) chain to the east comprises 15 atolls and 2 islands, while the Ralik (Sunset) chain to the west comprises 14 atolls and 3 islands. The Port of Majuro is located in Majuro Atoll within the Ratak Chain. In 1986, RMI attained independence under a Compact of Free Association with the United States.

RMI joined the International Maritime Organization (IMO) in 1998 and is a signatory to a number of its conventions and protocols, including: the International Convention for the Safety of Life at Sea (SOLAS); the International Regulations for Preventing Collisions at Sea (COLREGS); the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW); the International Convention for the Prevention of Pollution from Ships (MARPOL); the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA); and the Nairobi International Convention on the Removal of Wrecks. RMI is not a signatory to the Search and Rescue (SAR) Convention.

RMI has the world's second largest ship registry, which is administered by the American company International Registries Inc (IRI). IRI works through the RMI Trust Company, located on Majuro.

Regulation 13 of Chapter V of the 1974 SOLAS Convention (as amended) states that "each Contracting Government undertakes to provide, as it deems practical and necessary either individually or in co-operation with other Contracting Governments, such aids to navigation as the volume of traffic justifies and the degree of risk requires."

The SIRA risk control process comprises five steps that follow a standardized management or systems analysis approach:

1. Identify hazards
2. Assess risks
3. Specify risk control options
4. Make a decision
5. Take action.

SIRA is intended as a basic tool for identifying risk control options for potential undesirable incidents that RMI should address as part of its obligation under SOLAS Chapter V Regulations 12 and 13. The assessment and management of a risk is fundamental to the provision of effective AtoN services.

The assessment involved a stakeholder meeting as a first step, to gather the views on hazards and risks in Majuro's Harbor from those directly involved with or affected by AtoN service provision. Information provided by this step was then used by the Port Authority Manager, Mr Thomas Maddison, and SPC to complete the full risk assessment matrixes based on eight identified possible scenarios, for Majuro's harbor.

2 Description of the waterway

Majuro is the major port in RMI and was, therefore, identified by the Ministry of Transportation, Communication and Information Technology (MTC&IT) as a priority for the risk assessment. The RMI Ports Authority (RMIPA), which sits within the Department of Transport under the Ministry of Infrastructure is responsible for the development, maintenance and operations of all seaports, including Uliga and Delap docks located within Majuro Atoll. The Uliga dock is primarily used for interisland cargo and passenger vessels, while the Delap dock is primarily used for international cargo. The Port of Majuro is the hub of RMI's economy.

There are currently a number of AtoN in and around the harbor. Within the current practice of the Port of Majuro, the RMI Ports Authority is undertaking the role of AtoN management within RMI. RMI has adopted the IALA system A for all buoys and beacons in its waterways.

The main entrance into Majuro Atoll is through Calalin Channel on the atoll's north side. The channel is approximately 1476 feet (450 meters) in width between buoys no. 3 and 4, the narrowest place in the channel, and approximately 12 nautical miles to the port, with depths ranging from 65 to 200 feet (20 to 60 meters). Currents of 0.5 knots can be expected during incoming and outgoing tides. This channel is mostly used by a combination of domestic and international cargo ships, fishing vessels, occasionally by warships and cruise liners, and interisland cargo and passenger vessels.

There are several AtoN marking the channel and the harbour, with the majority of them in need of urgent maintenance.

The average predicted visibility in Majuro lagoon is around 13 nautical miles but this can be reduced to 0.02 nautical miles in bad weather, which typically occurs between the months of July and October. A maximum predicted swell of 16 feet (5 meters) is expected during cyclones, and a maximum tidal flow of 0.5 knots can be expected around the channel entrance during a new and full moon. There are a several hazards present along the channel to the harbor such as a lack of sufficient AtoN marking the route from the channel to the port, strong winds, currents, waves, all of which can pose problems for maritime traffic.

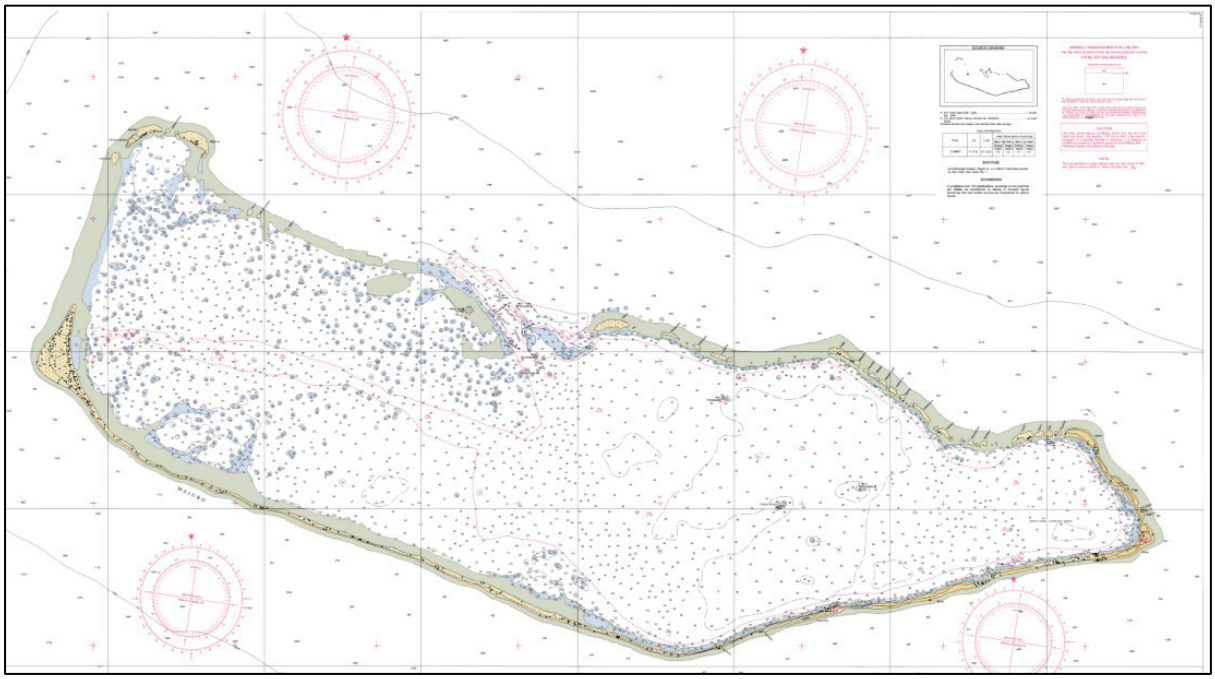


Figure 1. Chart 81782 of Majuro Atoll at a scale of 1:30,000.

3 Stakeholder meeting

As the first step of the SIRA process, a stakeholder meeting was organized in Majuro on 12 July at the airport conference room by Mr Thomas Maddison, manager of the Seaports Division of RMI's Ports Authority.

This meeting aimed to gather the points of view of individuals, groups and organizations involved with or affected by AtoN service provision in Majuro's harbor. Stakeholders (Fig. 2) in Majuro included staff from the RMI Ports Authority, Majuro Local Government, MTC&IT Ministry of Transport and Communication, Marshall Islands Police Department, and others (Annex A). During the meeting, participants were divided into two groups according to their experience and background. They then

helped identify potential hazards and possible scenarios in Majuro Harbor using the latest chart of the area, Google Earth screen shots of the area, and their experience.

Figure 2. Stakeholders meeting in Majuro.

4 Hazards and risks

A hazard is something that may cause an undesirable incident. Risk is the chance of injury or loss as defined as a measure of "probability or likelihood" and "severity or impact". Examples of injury or loss include an adverse effect on health, property, the environment or other areas of value.

The purpose of the stakeholder meeting was to generate a prioritized list of hazards specific to Majuro's harbor. For the risk assessment, SPC and the seaport manager worked together to discuss the risks associated with the recognized hazards and identified risk control options and recommendations.

The list of hazards identified for Majuro's harbor is given in Annex B.

4.1 Types of hazards

Twenty five hazards – grouped into the following six categories – were identified for Majuro:

- natural hazards, such as storms, earthquakes, safe minimum depth, proximity to danger, minimum visibility, low sun angle, and other natural phenomena;
- economic hazards such as insufficient AtoN funding;
- technical hazards such as system or equipment failure, quality and validity of charted information, substandard ships, and failure of communications systems;
- human factors such as crew competency, safety culture, influence of alcohol and/or drugs, and, linguistic challenges;
- operational hazards such as seasonal activities, poor promulgation of maritime safety information, poor response to marking new dangers, and ramp launching area; and
- maritime space hazards, such as crowded waterways and wrecks and missing lights.

The above six types of hazards have the capability to generate seven types of losses:

- health losses, including death and injury;
- property losses, including real and intellectual property;
- economic losses, leading to increased costs or reduction of revenues;

- liability loss, resulting when an organization is sued for an alleged breach of legal duty; such cases must be defended even if no blame is assigned. Liability losses are capable of destroying or crippling an organization;
- personnel loss when services of a key employee are lost;
- environmental losses (negative impact on land, air, water, flora or fauna); and
- loss of reputation or status.

4.2 Risk factors

Any risk analysis needs to consider the range of factors that contribute to the overall risk exposure. Table 1 lists some of the factors that could be taken into consideration when identifying hazards for waterways and ports.

Table 1. Risk factors relating to maritime navigation.

Ship traffic	Traffic volume	Navigational conditions	Waterway configuration	Short-term consequence	Long-term consequence
Quality of boats	Deep draught	Night/day operations	Depth/draft/under-keel clearance	Injuries to people	Health and safety impacts
Crew competency	Shallow draught	Sea state	Channel width	Oil spill	Lifestyle disruptions
Traffic mix	Commercial fishing boats	Wind conditions	Visibility obstructions	Hazardous material release	Fisheries impacts
Traffic density	Recreational boats	Currents (river, tidal, ocean)	Waterway complexity	Property damage	Impacts on endangered species
Nature of cargo	High speed craft	Visibility restrictions	Bottom type	Denial of use of waterway	Shoreline damage
Participation rate in routing systems, such as vessel traffic system (VTS)	Passenger ships	Background lighting	Stability (siltati on)		Reef damage
		Debris	AtoN mix and configuration		Economic impacts
			Quality of hydrographical data		

Risk is evaluated to allow attention to be focused on high-risk areas, and to identify and evaluate factors that influence the level of risk. Once all of the risks have been assessed, they are then evaluated in terms of the documented needs, issues and concerns of the stakeholders, and the benefits and costs of the activity, to determine the acceptability of the risk.

Zero risk is not often realized, unless the activity generating the risk is abandoned. Rather than striving to reduce the risk to zero, authorities should reduce the risk to "as low as reasonably practicable" (ALARP; Fig. 3).

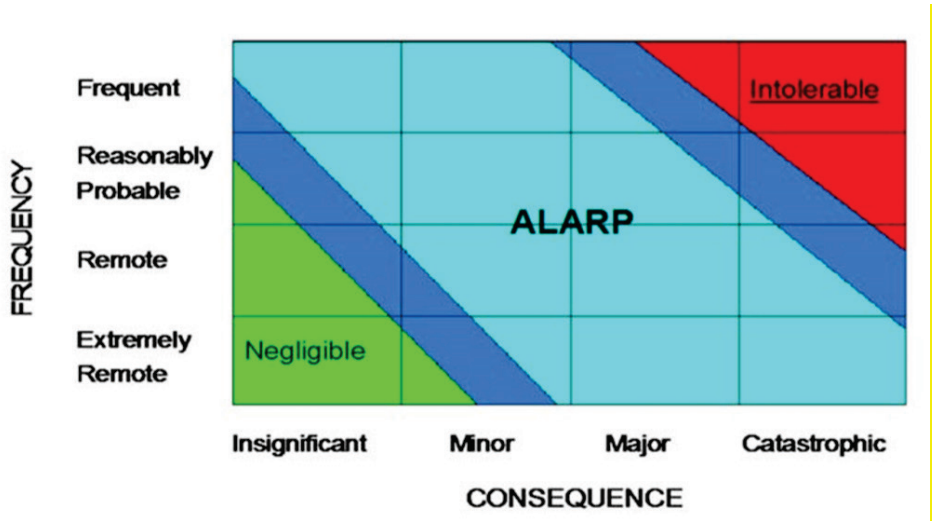


Figure 3. Graphical representation of the levels of risk. The risk level boundaries (negligible/ALARP/intolerable) are purely illustrative.

It is important to remember that when communicating with stakeholders about risk, perception is usually different from reality. People make judgements of the acceptability of a risk based on their perceptions, rather than on scientific factors such as probability. The public's perception of a risk may be influenced by many factors, including their age, gender, education level and previous exposure to information on the hazard. Public perceptions of risk may, therefore, differ from those of technical experts.

5 Scenarios

During the stakeholder meeting and discussions with the seaports manager, various hazards were identified for Majuro's harbor that could lead to a number of incidents or scenarios. Each hazard was considered carefully and the scenarios it could cause were identified and recorded. The scenarios for Majuro's harbor were classified into five different categories: collisions, groundings, allisions, founderings and structural failures. Annex C lists the identified scenarios.

5.1 Collision

Collision is defined as striking or being struck by another ship, regardless of whether either ship is underway, anchored or moored. The probability of collision depends on navigational conditions, waterway configuration, and type and volume of maritime traffic. The basic types of collisions are head-on, overtaking, bend, merging and crossing collisions. An analysis of the routes and their geometry, combined with the volume and mix of traffic for Majuro's harbor, resulted in two probable head-on collision scenarios: 1) two fishing boats colliding in the anchorage area, and 2) two boats colliding at Delap dock at night. These scenarios are attributed to the lack of lALA-compliant AtoN leading into Delap dock, and engine failures of fishing boats within the anchorage area.

5.2 Grounding

Grounding is defined as a boat being aground by hitting or touching the shore, sea bottom or underwater objects (e.g. a wreck). Three grounding scenarios were identified for Majuro's harbor: two of the groundings were on the reef at the entrance to Calalin Channel, and one grounding was on a wreck at Uliga dock. All three scenarios were attributed to the lack of IALA-compliant lit AtoN marking the entrance to the channel and the lack of a buoy marking the wreck at Uliga dock.

5.3 Allision

The possibility of a boat striking a fixed human-made object such as a wharf, mooring buoy or fish aggregation device (FAD) depends on the position of such structures along the navigation route and

the density of maritime traffic. One allision scenario was identified for Majuro's harbor: vessels alliding with AtoN due to sun glare, the AtoN being unlit, thus making them inconspicuous.

5.4 Foundering

Foundering is when a boat sinks but not as a result of an earlier collision; for example, a boat might founder if its cargo shifts during bad weather. Foundering of small boats at Majuro bridge channel can occur due to strong currents, lack of IALA-compliant AtoN, and lack of crew competency.

5.5 Structural failure

Structural failure is defined as a failure of the vessel itself or a feature external to the vessel. This can be caused by extreme environmental conditions, poor maintenance, or even malicious interference. One such scenario was identified during the risk assessment, whereby the structure of a ferry fails, causing it to sink.

6 Probability and impact

SIRA specifies five levels of probability (Table 2) and five levels of impact that each type of scenario would create (Table 3). Each scenario is allocated a score for both probability and impact, and the risk value is calculated from the product of these scores. In this step of the process, the probability and consequences associated with each scenario were estimated and discussed with the manager of the Seaports Division of RMI's Ports Authority. .

Table 2. Levels of probability specified for the simplified IALA risk assessment tool (SIRA).

Classification	Score	Probability
Very rare	1	Very rare or unlikely, will occur only in exceptional circumstances and not more than once in 20 years
Rare	2	Rare, may occur every 2–20 years
Occasional	3	Occasional, may occur every 2 months to 2 years
Frequent	4	Frequent, may occur once every weekly to every 2 months
Very frequent	5	Very frequent, may occur at least once every week

Table 3. Levels of impact specified for the simplified IALA risk assessment tool (SIRA).

Description	Score	Service disruption criteria	Human impact criteria	Financial criteria	Environmental criteria
Insignificant	1	No service disruption apart from some delays or nuisance	No injury to humans; possible significant nuisance	Loss, including third-party losses, of less than USD 1000	No damage
Minor	2	Some non-permanent loss of services such as closure of a port or waterway for up to 4 hours	Minor injury to one or more individuals, may require hospitalisation	Loss, including third-party losses, of USD 1000–50,000	Limited short-term damage to the environment
Severe	3	Sustained disruption to services such as closure of a	Injuries to several individuals requiring hospitalization	Loss, including third-party losses, of USD	Short-term damage to the environment

		port or waterway for 4–24 hours		50,000–5,000,000	over a small area
Major	4	Sustained disruption to services such as closure of a major port or waterway for 1–30 days or permanent or irreversible loss of services	Severe injuries to many individuals or loss of life	Loss, including third-party losses, of USD 5,000,000–50,000,000	Long-term to irreversible damage to the environment over a limited area
Catastrophic	5	Sustained disruption to services such as closure of a major port or waterway for months or years	Severe injuries to numerous individuals and/or loss of several lives	Loss, including third-party losses, of over USD 50,000,000	Irreversible damage to the environment over a large area

7 Acceptability of risk

Having determined probability and impact scores by consensus, the risk values are calculated by multiplying these scores, as shown in the matrix in Table 4. To determine whether the risks are acceptable or not, SIRA specifies four color-banded levels of risk (Table 5). These colors are superimposed on the matrix in Table 4.

Table 4. Risk value matrix.

		PROBABILITY / (LIKELIHOOD)				
		Very Rare (1)	Rare (2)	Occasional (3)	Frequent (4)	Very frequent (5)
CONSEQUENCE (IMPACT)	Catastrophic (5)	5	10	15	20	25
	Major (4)	4	8	12	16	20
	Severe (3)	3	6	9	12	15
	Minor (2)	2	4	6	8	10
	Insignificant (1)	1	2	3	4	5

Table 5. Categories of risk, and action required.

Risk Value	Risk Category	Action Required
1 – 4	Green	Low risk not requiring additional risk control options unless they can be implemented at low cost in terms of time, money and effort.
5 – 8	Yellow	Moderate risk which must be reduced to the *"as low as reasonably practicable"* (ALARP) level by the implementation of additional control options which are likely to require additional funding.
9-12	Amber	High risk for which substantial and urgent efforts must be made to reduce it to "ALARP" levels within a defined time period. Significant funding is likely to be required and services may need to be suspended or restricted until risk control options have been actioned.
15-25	Red	Very high and unacceptable risk for which substantial and immediate improvements are necessary. Major funding may be required and ports and waterways are likely to be forced to close until the risk has been reduced to an acceptable level.

8 Risk control options

The objective of the risk assessment was to identify risk mitigation options for each undesirable incident that would, if implemented, reduce the risk to a level as low as reasonably practicable (ALARP) and which would be acceptable to stakeholders. Before any risk control decisions were made, they were communicated through the stakeholder consultation process. The risks were evaluated in terms of the overall needs, issues and concerns of the stakeholders. The mitigation options include:

- new or enforcement of existing rules and procedures;
- improved and charted hydrographical, meteorological and general navigation information;
- enhanced AtoN service provision;
- improved radio communications; and
- improved decision support systems.

Table 6 shows the risk scores for the scenarios under the current situation at Majuro's harbor, and the new risk scores after mitigating the risk. The detailed risk control options for Majuro's harbor is shown in the risk control matrix in Annex D.

Table 6. Risk control options for Majuro's harbor, and new risk scores.

Scenario	Risk score	Risk control option	New risk score
Two fishing vessels colliding in the anchorage area	6	Upgrade ship-to-ship radio communications and deliver more awareness programs	3
Two vessels colliding while entering Dalap dock at night	12	Install new lead lights into Dalap dock and install seven lateral buoys marking the passage into Dalp dock.	3
Fishing vessels grounding on the reef at the entrance of Calalin Channel	9	Install new IALA-compliant lit AtoN at the entrance to Calalin Channel	3
Vessel grounding in Calalin Channel	9	Install new IALA-compliant lit AtoN in Calalin Channel	3
Small boats grounding on the wreck at Uliga dock	9	1. Mark the wreck with an emergency wreck marking buoy (EWMB) 2. Remove the wreck	3
Vessels alliding with AtoN	9	Install dayboards on AtoN and conduct more public awareness programs	3
Small boats foundering at Majuro bridge channel	9	Install IALA-compliant AtoN on either side of the passage and conduct small boat safety awareness programs	6
Structural failure of domestic vessels	15	Enforce strict Port State Control measures	10

9 Costing the risk control options

The outcomes of the risk assessment are essentially qualitative and subjective, based on the expert opinions of the stakeholders. The next step is to reach consensus on which risk control options to action. The risk control options are prioritized to facilitate the decision-making process.

Costing of the options is part of the decision-making process. Most of the control options identified require funding. Costs must cover capital, labor and other resources needed for planning and implementation, as well as costs of operation and maintenance throughout the life cycle under consideration. Maintenance is important to ensure that AtoN equipment and systems continue to perform at the levels required for mariners to safely navigate the waterways.

The control measures need to be both effective in reducing risk, but also cost-effective. The cost of the measures should not normally exceed the reduction in the expected value of the loss.

The cost of the options should be evaluated over a time frame equivalent to the economic or useful life of the facilities and assets associated with the option.

10 AtoN budgeting and resourcing

In order for the Sea Ports Division under RMI's Ports Authority to provide excellent AtoN services in RMI, it is important that an adequate level of resources be allocated towards AtoN installment,

maintenance and management. During the visit, meetings were held with a range of stakeholders to improve the allocation of resources and management of the Sea Ports Division's AtoN budget.

To improve the Sea Ports Division's budgetary planning of AtoN, an AtoN programme five-year budget (2021–2025) was drawn up in consultation with Mr Thomas Madison, manager of the division. The budget disaggregates between capital expenditures and ongoing expenditures, which is expected to assist the division with better planning and prioritizing of its AtoN budgetary needs.

The budget sets out what it would cost RMI to fund a dedicated AtoN maintenance program under its workplan. It shows that the program would mainly consist of hiring a dedicated staff technician, plus the cost of fuel, paint, and equipment procurement. An annual awareness program on ship-to-ship communication – at the cost of approximately USD 2000 – is also planned. The recurring expenditure is expected to cost the Ports Authority approximately USD 42,098 every year.

Capital expenditure shows the level of investment needed to carry out the recommended risk control options within this risk assessment. Given the substantial costs involved, the procurement and installation of items is recommended to be staggered over the five-year budget period. Expenditures include the following:

- In 2021, the installation of seven new lateral buoys marking the passage from Calalin Channel to Delap and Uliga docks will reduce the risk of collisions, the adjustment of existing light intensity and direction on ports to reduce the risk of collisions, and the installation of IALA-compliant lit AtoN at the entrance channel (No. 1), and a light on the tower at Eroj Island and at beacon 3 on Calalin Channel will reduce the risk of grounding.
- In 2022, the installation of an emergency wreck marking buoy (EWMB) to mark the small wreck near Uliga dock will reduce the risk of grounding, and the construction and installation of dayboards on all 20 structures will reduce the risk of allision.
- In 2023, the construction of lit markers on the port side of Majuro bridge will reduce the risk of foundering of small boats, and the installation of a new light on the current starboard structure of Majuro bridge will also reduce the risk of foundering of small vessels. This total cost of risk control options is estimated to cost USD 421,107.63 over the five-year period.

11 Recommendations

A key outcome of the risk assessment undertaken in Majuro is eight recommendations that aim to reduce the risks to safety of navigation to an acceptable level for stakeholders.

Recommendation 1 (addressing collision scenario)

This recommendation addresses the potential collision of two fishing boats in the anchorage area, mainly due to engine failures and poor ship-to-ship radio communications.

It is recommended that ship-to-ship radio communications be upgraded and more awareness programs be delivered. These recommendations should potentially help to reduce the risk to as low as reasonably practicable.

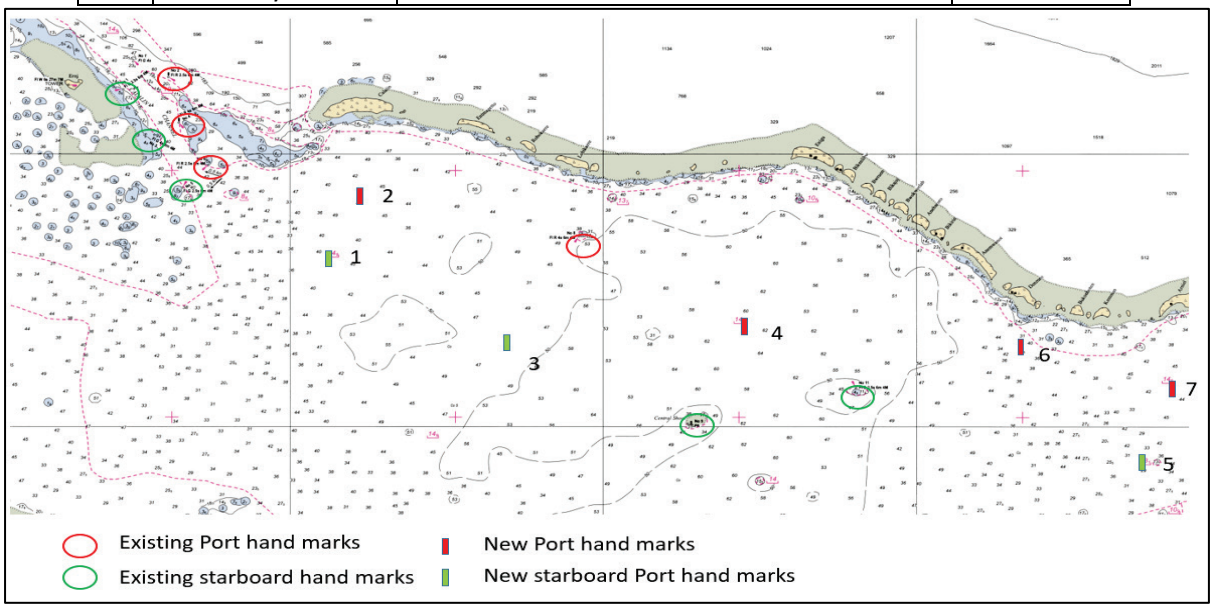
Action	**Cost to implement (USD)**
Upgrade ship-to-ship radio communications	5000
Deliver awareness programs	2000

Recommendation 2 (addressing collision scenario)

This recommendation addresses the potential collision between vessels entering the Dalap and Uliga docks at night. This scenario is due mainly to the lack of IALA-compliant AtoN marking the channel to the docks and the intensity of background light on buildings at the docks.

It is recommended that the intensity of the lights on building at the docks be reduced and that their direction be changed, and that seven new lit lateral buoys be installed between Calalin Channel and the docks. Once new buoys are installed, the numbering of all the buoys should be revised accordingly and a hydrographic note (H-note) should be submitted to the charting authorities, informing them of the changes to the chart.

	Lateral mark	Position (Latitude, Longitude)	Depth (m)
1	Starboard buoy	07-07.905831N 171-12.400305E	14.9
2	Port buoy	07-08.421327N 171-12.657742E	36.0
3	Starboard buoy	07-06.993184N 171-14.071213E	45.0
4	Port buoy	07-07.183476N 171-16.305586E	14.9
5	Starboard buoy	07-05.615761N 171-20.320901E	13.1
6	Port buoy	07-06.823901N 171-19.026926E	23.5
7	Port buoy	07-06.508487N 171-20.397836E	14.9



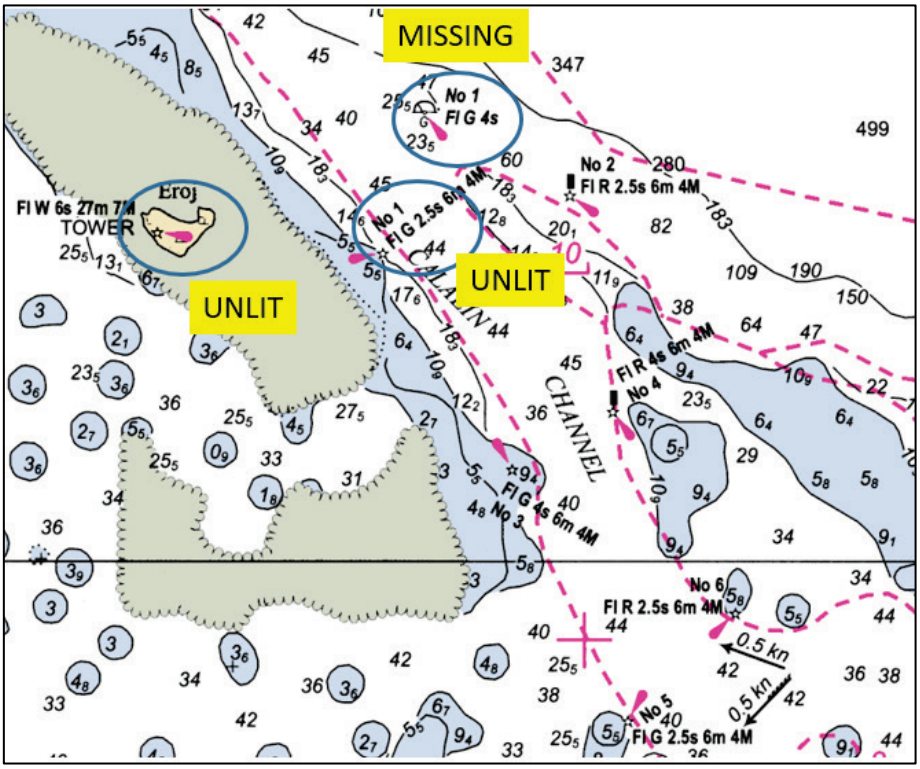
The above recommendations should potentially help to reduce the risk to as low as reasonably practicable.

Action	Cost to implement (USD)
Install seven new lateral buoys marking the passage from Calalin Channel to Delap and Uliga docks.	164,005.19
Reduce light intensity and direction of lights on port buildings	216.00
Submit H-note(s)	0
Maintenance costs	8211.06

Recommendation 3 (addressing grounding scenario)

This recommendation addresses the potential grounding of fishing vessels on the reef at the entrance to Calalin Channel. This scenario is mainly due to the lack of IALA-compliant lit AtoN marking the channel's entrance. The starboard buoy marked no. 1 on the chart at the entrance is missing, while the lights on the tower at Eroj Island and the light on starboard beacon no. 1 are unlit.

It is recommended that IALA-compliant lit AtoN be installed in the entrance of the channel. This includes the light on the tower at Eroj Island and the light and dayboards on beacon no 1. An H-note should be sent to the (PCA) informing it of changes to the chart.



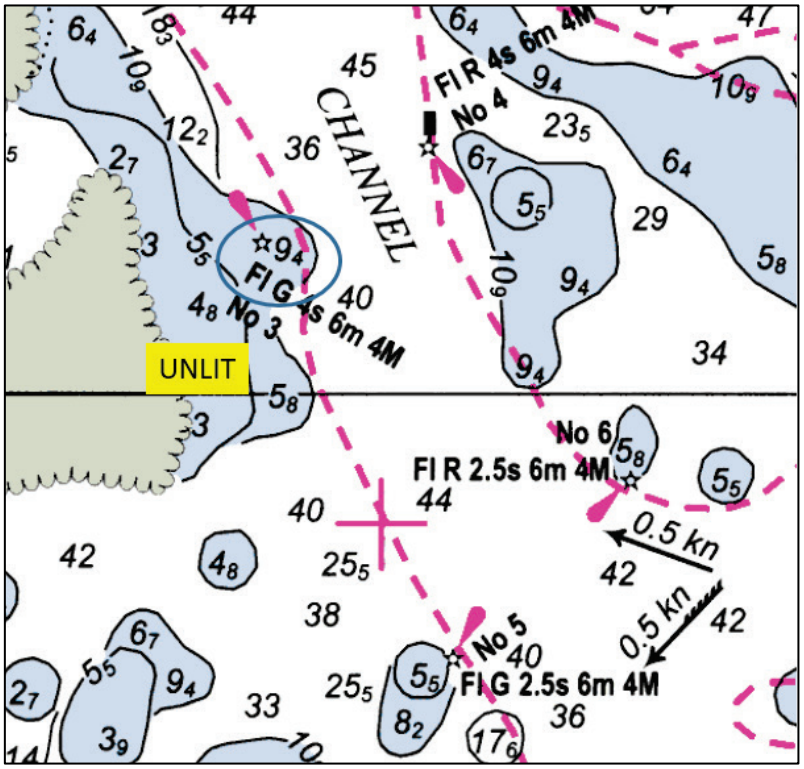
The above recommendations should potentially help to reduce the risk to as low as reasonably practical.

The costs to implement this recommendation are as follows:

Action	Cost to implement (USD)
Install new IALA-compliant lit AtoN at the entrance to Calalin Channel and a light on the tower at Eroj Island	2242.74
Submit H-note(s)	0
Maintenance costs	112.137

Recommendation 4 (addressing grounding scenario)

This recommendation addresses the potential grounding of fishing vessels in Calalin Channel due to the lack of IALA-compliant lit and conspicuous AtoN marking the channel. Starboard beacon no. 3 is unlit. It is recommended that a IALA-compliant light and new dayboards be installed on beacon no. 3 in Calalin Channel, and an H-note be submitted to the PCA, informing it of changes to the chart.



The above recommendations should potentially help to reduce the risk to as low as reasonably practical.

Action	Cost to implement (USD)
Install new IALA-compliant AtoN, together with lights and dayboards	2683.14
Submit H-note(s)	0
Maintenance costs	134.16

Recommendation 5 (addressing grounding scenario)

This recommendation addresses the potential grounding of small boats on the wreck at Uliga dock.

It is recommended that the wreck to be marked with an emergency wreck marking buoy (EWMB) until the wreck can be removed. This should potentially help to reduce the risk to as low as reasonably practicable.

Action	Cost to implement (USD)
Mark the wreck with an EWMB Remove the wreck	86,622.40 TBD
Maintenance costs	4331.12

Recommendation 6 (addressing allision scenario)

This recommendation addresses the potential allision of vessels with AtoN, mainly due to sun glare, lack of dayboards on AtoN, and a lack of awareness of AtoN to harbor users.

It is recommended that IALA-compliant dayboards be installed on all AtoN. and that more awareness programs be delivered for maritime users.

The above recommendations should potentially help to reduce the risk to as low as reasonably practicable.

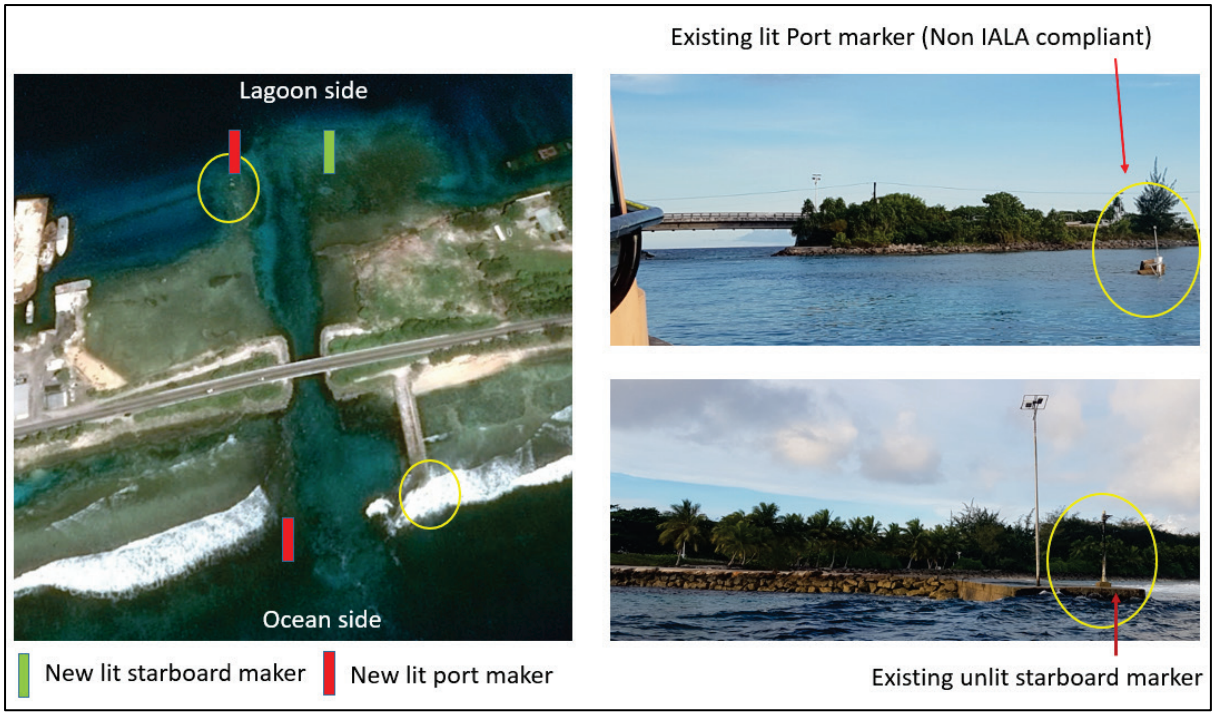
Action	Cost to implement (USD)
Install dayboards on AtoN and deliver more public awareness programs	5000
Maintenance costs	250

Recommendation 7 (addressing foundering scenario)

This recommendation addresses the potential foundering of small boats at the small boat crossing at the Majuro bridge channel.

This is mainly due to strong currents at incoming and outgoing tides, lack of proper AtoN marking the channel extents, and lack of crew competency. Currently there is an unlit starboard marker on the edge of the breaker on the lagoon side. There is also a small port marker on the lagoon side that is non-IALA-compliant.

It is recommended that IALA-compliant AtoN be installed to mark the channel extents and that more small boat safety awareness programs be delivered.



The above recommendations should potentially help to reduce the risk to as low as reasonably practicable.

Action	Cost to implement (USD)
Install two lit port-hand makers and one lit starboard marker	163,244.79
Install a new starboard light on the existing structure	1085.37
Deliver a small boat safety awareness programme	2000
Maintenance costs	8,216.51

Recommendation 8 (addressing structural failure scenario)

This recommendation addresses potential structural failures of domestic ferries during heavy seas. This is mainly due to a lack of maintenance on the ferries, the lack of enforcement of Port State Control measures, and the lack of safety awareness onboard domestic vessels.

The above recommendations should potentially help to reduce the risk to as low as reasonably practicable.

Action	**Cost to implement (USD)**
Implement Port State Control measures	5000

12 Conclusion

This report completes the risk assessment process as required by Regulation 13 of the International Convention for the Safety of Life at Sea (SOLAS) and it is meant to guide MTC&IT in delivering compliant AtoN services within Majuro Lagoon.

SPC can provide further support in relation to capacity development, AtoN services, and the management, governance, and budget management to assist RMI in offering safe maritime routes and meeting the country's international obligations.

It is suggested that a consistent and wider approach be taken by RMI to include the delivery of hydrographic, marine meteorology, maritime safety information, and maritime search and rescue services in its governance processes.

Annex A: Stakeholders at the Majuro Harbor risk assessment.

Safety of Navigation Risk Assessment Stakeholder Meeting (Phase II) – Majuro, Marshall Islands, 2 July 2019				
	Name	**Job title**	**Organization**	**Email address**
1	Harris Kaiko	Engineer Surveillance	Sea Patrol	hkaiko2010@gmail.com
2	Ablow Jelmak	Assistant Police Commissioner	Marshall Islands Police Department	ajelmak19LL@gmail.com
3	Thomas Madison	Seaport Manager	RMI Port Authority	thomas.maddison@rmipa.com
4	Anram Kemem	Deputy Director	RMI Port Authority	anram.kemem@rmipa.com
5	James Bing	Director	RMI Port Authority	james.bing2@rmipa.com
6	Rod Kabua	Sheriff	Majuro Local Government	rodkabua@gmail.com
7	Allen Alex	Police boat captain	Majuro Local Government	allenalex@gmail.com
8	Kyle Allen	Maritime Safety	Ministry of Transportation, Communication and Information Technology	rkaliven@gmail.com
9	Jim Philippo	Deputy General Manager	Tobalar	jimphilippo@gmail.com

Annex B: Hazards identified for Majuro Harbor.

Hazards		Value	Remarks
Natural	Safe minimum depth (m)	10	
	Proximity of danger (nm)	0.4	
	Tide, wind, wave and tidal flow effect	3.17	
	Minimum visibility (NMnm)	0.02	
	Low sun issuesangle	Y	At sunrise and sunset
	Background lighting	Y	From port building
Economic	Insufficient AtoN funding	Y	
Technical	Shipborne navaid failure	Y	EPIRBs sometimes go off accidentally without properly triggering
	Quality and validity of charted information	Y	Current charts are outdated; new ones are expected to come out soon
	Loss of vessel control	Y	Purse-seiner collided with another purse-seiner in the harbor
	AtoN failures	Y	Certain lights are not working
	Substandard ships	Y	Fishing vessels in poor condition; it is the responsibility of Port State operations to ensure Port State Control is conducted
Human	Lack of crew competency	Y	Some crew members are experienced mariners but have not been properly trained
	Fatigue	Y	Crew tired after long trips between islands
	Safety culture	Y	Boat safety brochure shall be translated into Marshallese
	Influence of alcohol and/or drugs	Y	Alcohol consumption on boats
	Political issues	Y	Affects AtoN funding
	Culture or language issues	Y	Difficulties communicating with foreign fishing vessels
	Crew medical issues	Y	Sexually transmitted diseases from crew of foreign fishing vessels
Operational	Fishing activities	Y	During fishing tournaments
	Seasonal activities	Y	Canoe racing tournaments, sailboats
	Poor promulgation of marine safety information	Y	Charts are not updated
	Poor response to marking new dangers	Y	Chart changes yet to be sent to National Oceanic and Atmospheric Administration (NOAA)
Maritime space	The existence of wrecks and new dangers	Y	A wreck off Uliga dock needs to be removed or marked
	The existence of restricted areas	Y	Marine protected area near Anil

Annex C: Possible scenarios identified for Majuro Harbor.

Scenario		Remarks
Collisions	Head-on	Between two purse-seine vessels (bridge of ship hits the bow of anchored vessel)
	Head-on	Vessels coming to port at night colliding with other vessels
Groundings	Grounding on reef	Fishing vessels running aground on the reef at the entrance of Calalin Channel
	Grounding in channel	Fishing vessels running aground in Calalin Channel
	Grounding on wrecks	Small boats running aground on the wreck at Uliga dock
Allisions	Aids to Navigation (AtoN)	Longliner alliding with an unlit marker at night
		Ferry alliding with AtoN during the day due to sun glare
Founderings	Capsizing	Small boat capsizing at the bridge due to strong current and/or timing of passage is key (crew competency)
Structural failure	Structural failure of vessel	Ferry sank due to structural failure; vessel broke apart (Port State Control inspection is key to preventing this)

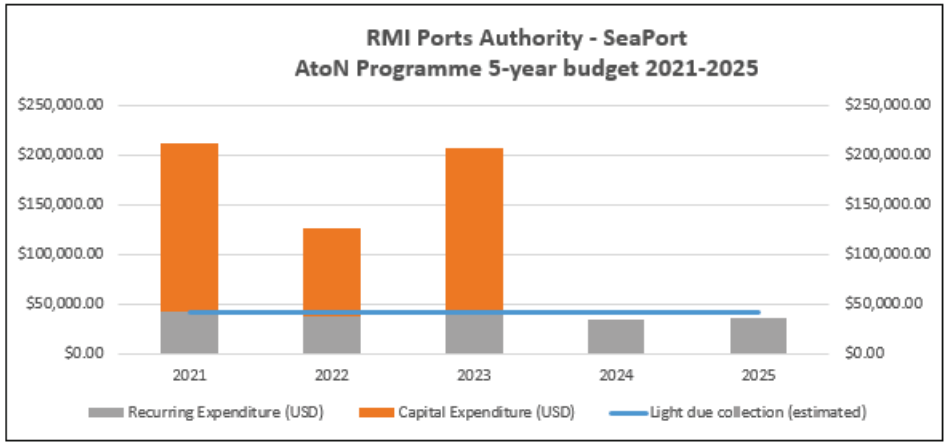
Annex D: Risk assessment matrix for Majuro Harbor

	Scenario	Description of incident	Root Cause(s) (Hazards)	Description of Consequences (Short term and long term)	Existing Risk Control Measures	Probability Score	Consequence Score	Risk Score	cost of Incident (USD)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	cost of RCO (USD)	Remarks
1. COLLISIONS															
1.1	Collision with fishing vessels	Pursiner to pursiner (bridge of ship hit the bow of anchored vessel)	Engine failure	Damage to vessel and personel	Ship to ship radio communications	2	3	6	720,000	Upgrade radio communications and more awareness	1	3	3	2,000	An annual awareness program on ship to ship communication
1.2	Collision with other vessels	Vessles entering Delap port at night collides with other vessels	Glare from background lights and lack of AtoNs to direct vessel into port	Damage to vessels, environmentat and personel	Pilotage service availabe	4	3	12	100,000	Reduce light intensity and direction of light from builings at the port, and Install 7 new lit lateral marks to guide ships in the Delap and Uliga ports	1	3	3	164,221.19	Installation of 7 new lateral buoys marking the passage from Calalin channel to Delap and Uliga docks,
2. GROUNDINGS															
2.1	Grounding on Reef	Fishing vessels grounds on reef at entrance of Calalin channel	Lack of Lit AtoNs at entrance	Damage to vessels underwater hull, environment and personel	Vessels only allowed to access Channel at daytime.Beacon in place but not lit	3	3	9	22.84 million	Install new lit AtoNs	1	3	3	2,242.74	Install new IALA compliant lit AtoN to be installed at the entrance channel (No.1) and light on tower at Eroj Island
2.2	Grounding in channel	fishing vessels ground in channel	Lack of Lit AtoNs	Damage to vessels underwater hull, environment and personel	Vessels only allowed to access Channel at daytime.Beacon in place but not lit	3	3	9	22.84 million	Install new lit AtoNs	1	3	3	2,683.14	Install new IALA compliant lit AtoN to be installed on beacon 3 on Calalin channel
2.3	Grounding on wreck	Small boat grounds on wreck at Uliga dock	Unmarked wreck	Loss of life, damage to boat and environment	non	3	3	9	10.37 million	Option 1:mark wreck with EWMB, Option 2; remove wreck	1	3	3	86,622.40	Mark the small wreck near Uliga dock with an Emergency Wreck Marking Buoy (EWMB) - Here the cost of the EWMB is assumed as roughly the same as the cost of installing a channel AtoN
3. ALLISIONS															
3.1	Allision with AtoNs	Vessels alliding with AtoNs	Sun glare, AtoNs unlit and not cospicuous	Damage to AtoNs, vessels and environment	AtoN in place	3	3	9	720,000	Install day boards on AtoNs, more public awareness	1	3	3	5,000	Install day boards on all 20 AtoNs - To construct, paint and install a tin dayboard on the 20 structures needing replacement. Approximating that it'll cost $250 per dayboard.
4. FOUNDERING															
4.1	Foundering at passage into lagoon at Majuro bridge	Small boat capsizing at passage into the lagoon	Strong currents, lack of proper AtoNs and crew competency	Damage to boat, personel and environment	Solar Lights installed on bridge to illuminate the channel and 2 AtoNs on the ocean side and 1 AtoN on the lagoon side. The AtoNs are not to IALA specification.	3	3	9	500,000	Install IALA standard AtoNs (2 port and 2 starboard)on either side of the passage and small boat safety awareness program.	2	3	6	164,330.16	Install 2 lit port hand makers and one lit starboard marker plus a new starboard light on the existing structure
5. STRUCTURAL FAILURE															
5.1	Structural failure of vessel	Ferries bow breaks and ferry sinks	Ferry sinks due to structural failure and heavy seas	Loss of vessel, cargo and environmental damage	Port state control	3	5	15	10.37 million	More awareness and strict Port state control	2	5	10	5,000.00	Strengthen the enforecment of port state control

RMI Ports Authority - SeaPort

AtoN Programme 5-year budget 2021-2025

	Light due collection (estimated)	Capital Expenditure (USD)	Recurring Expenditure (USD)	Total Expenditure (USD)
2021	$42,324.48	$169,075.07	$42,097.75	$211,172.83
2022	$42,324.48	$87,702.40	$38,470.12	$126,172.52
2023	$42,324.48	$164,330.16	$42,764.56	$207,094.72
2024	$42,324.48	$0.00	$35,034.25	$35,034.25
2025	$42,324.48	$0.00	$35,544.77	$35,544.77
	$211,622.40	$421,107.63	$193,911.45	$615,019.08



* Costings of risk control options covered under Majuro Safety of Navigation Risk Assessment have been factored in:

In 2021, the installation of 7 new lateral buoys marking the passage from Calalin channel to Delap and Uliga docks will reduce the risk of collisions.
In 2021, the adjustment of existing lights intensity and direction on ports to reduce risk of collisions
In 2021, the installation of IALA compliant lit AtoN at the entrance channel (No.1) and light on tower at Eroj Island, and at beacon 3 on Calalin channel will reduce the risk of grounding
In 2022, the installation of an Emergency Wreck Marking Buoy (EWMB) to mark the small wreck near Uliga dock to reduce the risk of grounding
In 2022, the construction and installation of dayboards on all 20 structures will reduce risk of allision
In 2023, the construction of lit markers at the port side of Majuro bridge will reduce the risk of foundering of small vessels
In 2021, the installation of a new light on the current starboard structure of Majuro bridge will reduce the risk of foundering of small vessels
In 2021, 2022, 2023, 2024, & 2025, an annual awareness program on ship to ship communication to reduce risk of collisions
In 2021, 2022, 2023, 2024, & 2025, the strengthening of port state control enforcement will help reduce risk of structural failure

2021				
	Unit cost (USD)	Estimated cost (USD)	Estimated cost (USD)	Notes
Capital expenditure				
Procurement				
Procurement of seven new lateral buoys	$19,131.08	$133,917.56		As part of Majuro SoN risk assessment recommendations, the installation of 7 new lateral buoys marking the passage from Calalin channel to Delap and Uliga docks will reduce the risk of collisions.
Installation costs for lateral buoys and adjustment of port lights		$10,216.00		Installation costs for the 7 new lateral buoys ($10,000) plus the costs of adjusting existing lights intensity and direction on ports by a 3 man team over 2 days (calculated using the annual salary for a technician)
Procure and install new lit AtoN – channel lights	$943.80	$1,887.60		As part of Majuro SoN risk assessment recommendations, the installation of IALA compliant lit AtoN at the entrance channel (No.1) and light on tower at Eroj Island will reduce the risk of grounding
Procure and install new lit AtoN – beacon	$2,333.17	$2,333.17		As part of Majuro SoN risk assessment recommendations, the installation of IALA compliant lit AtoN on beacon 3 on Calalin channel will reduce the risk of grounding
Freight costs		$20,720.74		Estimated freight costs for the 7 lateral buoys, channel lights and beacon
Total capital exp			$169,075.07	
Recurring expenditure				
Staff salaries		$8,400.00		The Department needs to have an additional AtoN technician to be able to have a fully fledged AtoN programme. Pay level rate of $8,400 plus 5% yearly increment
Boat maintenance		$1,500.00		According to past transactions, servicing cost of boat is approx $1,500
Fuel		$12,000.00		Fuel cost for boat. Approx. USD1,000 per month
Paint		$1,560.00		Cost of paint on the island: Approx $30 gallon of primer, $50 for gallon of ocean green, and $50 for gallon of ocean red. 12 gallons each needed
Bolts and nuts spares		$500.00		According to past use, bolts and nuts spare cost about $500
Reflector tapes		$1,320.00		Approx. 6m per board to be retaped every year: 10 markers*2 sides*3meters = 60 m. 3M reflector tape costs approx USD22 per meter
Awareness program		$2,000.00		An annual awareness program on ship to ship communication
Port State Control measures		$5,000.00		As part of Majuro SoN risk assessment recommendations, the strengthening of port state control enforcement will help reduce risk of structural failure
Contingency		$9,817.75		
Total recurring exp			$42,097.75	
Value added tax				
Total budgeted			$211,172.83	

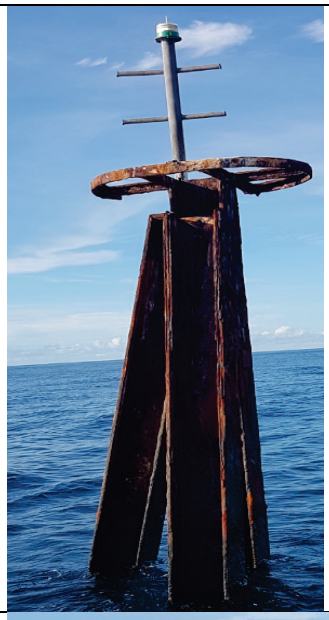
2022				
	Unit Cost	Estimated Cost (USD)	Estimated Cost (USD)	Notes
Capital expenditure				
Procurement				
Procurement and installation of EWMB		$68,734.65		As part of Majuro SoN risk assessment recommendations, the installation of an Emergency Wreck Marking Buoy (EWMB) to mark the small wreck near Uliga dock will reduce the risk of grounding. Plus installation costs of $5,000
Construction and installation of dayboards		$6,080.00		As part of Majuro SoN risk assessment recommendations, the construction and installation of dayboards on all 20 structures will reduce risk of allision. It is estimated that it'll cost approximately $250 to construct a single metalic dayboard. Plus the cost of installation (est. 10 wrk days for 3 staff) based on the daily rate of a technician.
Freight costs		$12,887.75		Estimated freight costs for the EWMB
Total capital exp			$87,702.40	
Recurring expenditure				
Staff salaries		$8,820.00		The Department needs to have an additional AtoN technician to be able to have a fully fledged AtoN programme. Pay level rate of $8,400 plus 5% yearly increment
Boat maintenance		$1,500.00		According to past transactions, servicing cost of boat is approx $1,500
Fuel		$12,000.00		Fuel cost for boat. Approx. USD1,000 per month
Paint		$1,560.00		Cost of paint on the island: Approx $30 gallon of primer, $50 for gallon of ocean green, and $50 for gallon of ocean red. 12 gallons each needed
Bolts and nuts spares		$500.00		According to past use, bolts and nuts spare cost about $500
Reflector tapes		$1,320.00		Approx. 6m per board to be retaped every year: 10 markers*2 sides*3meters = 60 m. 3M reflector tape costs approx USD22 per meter
Awareness program		$2,000.00		An annual awareness program on ship to ship communication
Port State Control measures		$5,000.00		As part of Majuro SoN risk assessment recommendations, the strengthening of port state control enforcement will help reduce risk of structural failure
Contingency		$5,770.12		
Total recurring exp			$38,470.12	
Value added tax				
Total budgeted			$126,172.52	

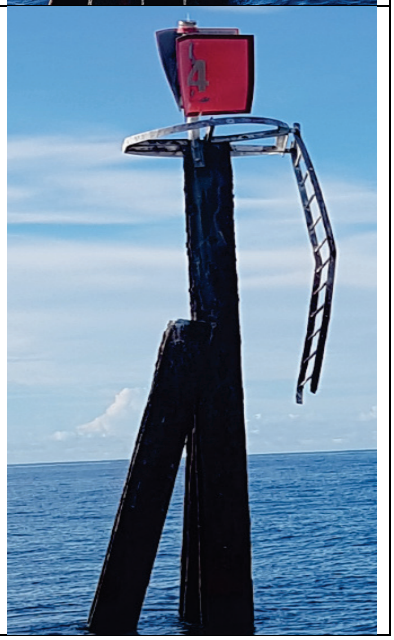
2023				
	Unit Cost	Estimated Cost (USD)	Estimated Cost (USD)	Notes
Capital expenditure				
Procurement				
Construction of two lit port-hand markers at Majuro bridge passage		$137,469.30		As part of Majuro SoN risk assessment recommendations, the construction of lit markers at the port side of Majuro bridge will reduce the risk of foundering of small vessels
Procure and install new lit AtoN – passage light		$943.80		As part of Majuro SoN risk assessment recommendations, the installation of a new light on the current starboard structure will reduce the risk of foundering of small vessels
Freight costs		$25,917.06		Estimated freight costs for the new lit markers and light
Total Capital exp			$164,330.16	
Recurring expenditure				
Staff salaries		$9,261.00		The Department needs to have an additional AtoN technician to be able to have a fully fledged AtoN programme. Pay level rate of $8,400 plus 5% yearly increment
Boat maintenance		$1,500.00		According to past transactions, servicing cost of boat is approx $1,500
Fuel		$12,000.00		Fuel cost for boat. Approx. USD1,000 per month
Paint		$1,560.00		Cost of paint on the island: Approx $30 gallon of primer, $50 for gallon of ocean green, and $50 for gallon of ocean red. 12 gallons each needed
Bolts and nuts spares		$500.00		According to past use, bolts and nuts spare cost about $500
Reflector tapes		$1,320.00		Approx. 6m per board to be retaped every year: 10 markers*2 sides*3meters = 60 m. 3M reflector tape costs approx USD22 per meter
Awareness program		$2,000.00		An annual awareness program on ship to ship communication
Port State Control measures		$5,000.00		As part of Majuro SoN risk assessment recommendations, the strengthening of port state control enforcement will help reduce risk of structural failure
Contingency		$9,623.56		
Total recurring exp			$42,764.56	
Value added tax				
Total budgeted			$207,094.72	

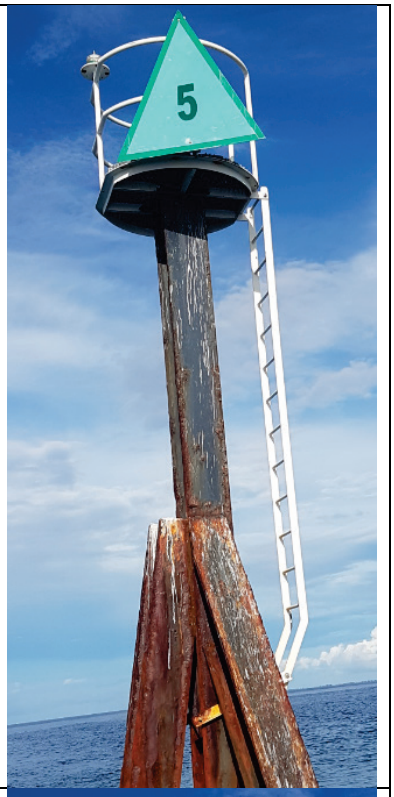
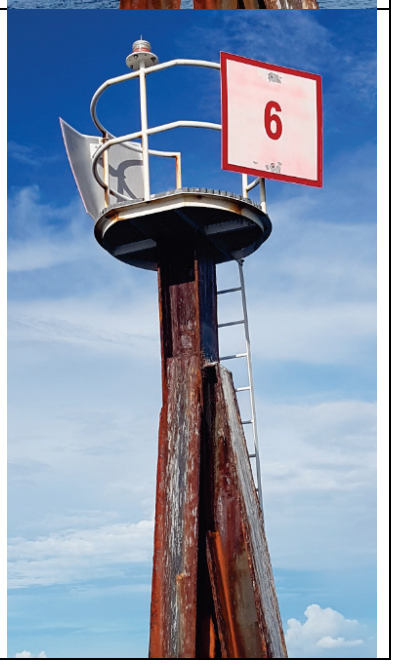
2024					
		Unit Cost	Estimated Cost (USD)	Estimated Cost (USD)	Notes
Capital expenditure					
Procurement					
	New AtoN				
	Freight/Customs				
Total Capital exp				$0.00	
Recurring expenditure					
	Staff salaries		$9,724.05		The Department needs to have an additional AtoN technician to be able to have a fully fledged AtoN programme. Pay level rate of $8,400 plus 5% yearly increment
	Boat maintenance		$1,500.00		According to past transactions, servicing cost of boat is approx $1,500
	Fuel		$12,000.00		Fuel cost for boat. Approx. USD1,000 per month
	Paint		$1,560.00		Cost of paint on the island: Approx $30 gallon of primer, $50 for gallon of ocean green, and $50 for gallon of ocean red. 12 gallons each needed
	Bolts and nuts spares		$500.00		According to past use, bolts and nuts spare cost about $500
	Reflector tapes		$1,320.00		Approx. 6m per board to be retaped every year: 10 markers*2 sides*3meters = 60 m. 3M reflector tape costs approx USD22 per meter
	Awareness program		$2,000.00		An annual awareness program on ship to ship communication
	Port State Control measures		$5,000.00		As part of Majuro SoN risk assessment recommendations, the strengthening of port state control enforcement will help reduce risk of structural failure
	Contingency		$1,430.20		
Total recurring exp				$35,034.25	
Value added tax					
Total budgeted				$35,034.25	

2025				
	Unit Cost	Estimated Cost (USD)	Estimated Cost (USD)	Notes
Capital expenditure				
Procurement				
New AtoN				
Freight/Customs				
Total Capital exp			$0.00	
Recurring expenditure				
Staff salaries		$10,210.25		The Department needs to have an additional AtoN technician to be able to have a fully fledged AtoN programme. Pay level rate of $8,400 plus 5% yearly increment
Boat maintenance		$1,500.00		According to past transactions, servicing cost of boat is approx $1,500
Fuel		$12,000.00		Fuel cost for boat. Approx. USD1,000 per month
Paint		$1,560.00		Cost of paint on the island: Approx $30 gallon of primer, $50 for gallon of ocean green, and $50 for gallon of ocean red. 12 gallons each needed
Bolts and nuts spares		$500.00		According to past use, bolts and nuts spare cost about $500
Reflector tapes		$1,320.00		Approx. 6m per board to be retaped every year: 10 markers*2 sides*3meters = 60 m. 3M reflector tape costs approx USD22 per meter
Awareness program		$2,000.00		An annual awareness program on ship to ship communication
Port State Control measures		$5,000.00		As part of Majuro SoN risk assessment recommendations, the strengthening of port state control enforcement will help reduce risk of structural failure
Contingency		$1,454.51		
Total recurring exp			$35,544.77	
Value added tax				
Total budgeted			$35,544.77	

Annex G: Majuro harbor AtoN summary

AtoN Number **Number on AtoN** **Feature name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	1 non Starboard-hand beacon Spar beacon with no dayboard Unlit Fl G 2.5s 6m 4M 07°09.7116'N 171°10.4012'E This is the starboard AtoN marking the entrance to the channel. The beacon needs urgent maintenance along with a dayboard and new light.	
AtoN Number **Number on AtoN** **Feature name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	2 2 Port-hand buoy Buoy Red Fl R 2.5s 6m 4M 07°09.8471'N 171°10.8385'E This is the port-hand buoy marking the entrance to the channel. The buoy is missing the top mark and needs urgent cleaning. Recommendation is to put bird spikes on buoy.	

AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	3 3 Starboard-hand beacon Spar beacon with triangular dayboard Green, Unlit Fi G 4s 6m 4M 07°09.2128'N 171°10.7029'E This is the starboard beacon that needs urgent maintenance along with new dayboards and a new light.	
AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	4 4 Port-hand beacon Spar beacon with square dayboard Red Fl R 4s 6m 4M 07°09.3444'N 171°10.9391'E This is the port-hand beacon that has been damaged due to waves and allision by vessels. This beacon needs urgent maintenance and new dayboards.	

AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	5 5 Starboard-hand beacon Spar beacon with triangular dayboard Green Fl G 2.5s 5m 4M 07°08.6280'N 171°10.9712'E This beacon was recently installed. It is in good condition, although the dayboard needs to be replaced.	
AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	6 6 Port-hand beacon Spar beacon with square dayboard Red Fl R 2.5s 6m 4M 07°08.8792'N 171°11.2195'E This beacon was recently installed. It is in good condition, although the dayboard needs to be replaced.	

AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	8 8 Port-hand beacon Spar beacon with square dayboard Red, missing Fl R 4s 6m 4M 07°08..0958'N 171°14.7701'E This port-hand beacon is in very poor condition and needs urgent replacement.	
AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	9 9 Starboard-hand mark Spar beacon with one triangular dayboard Green, missing Fl G 2.5s 5m 4M 07°06.0249'N 171°15.8470'E This starboard beacon is in fair condition but needs a new light and one dayboard	

AtoN Number **Number on AtoN** **Feature Name:** **Description:** **Light:** **Characteristics:** **Position (WGS84):** **Comments:**	11 11 Starboard-hand mark Spar beacon with triangular dayboard Green Fl G 2.5s 6m 4M 0706.4272°'N 171°17.4206'E This beacon has been damaged by a ship and now sits too close to the water level. It needs urgent maintenance.	
Note: The positions and light characteristics were taken from the chart.		

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