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Pacific Safety of Navigation Project

Risk assessment for Luganville harbour, Espiritu Santo, Vanuatu

PACIFIC SAFETY OF NAVIGATION PROJECT

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Pacific Safety of Navigation Project: Risk assessment for Luganville harbour, Espiritu Santo, Vanuatu

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Executive summary

Vanuatu 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."

Vanuatu is one of the 13 targeted Pacific Islands 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 October 2019 Vanuatu identified Luganville harbour to be the second highest priority area for SPC to assist in conducting a risk assessment using the SIRA tool. The purpose of having the Department of Ports and Marine running the Luganville stakeholders meeting was to further assist the country in building their capacity to develop and maintain safety of navigation services, especially Aids to Navigation (AtoNs), after one of the Department of Ports and Marine staff from Port Vila had been trained by SPC in August 2019 for the IALA level 1 Manager course.

This report details the risks identified, the estimated costs in the event of an incident, the risk control options suggested, and their costs associated with the Luganville harbour.

Within Vanuatu the regulatory aspect of AtoN falls within the Ministry of Infrastructure and Public Utilities, while the operational implementation and maintenance of AtoN comes under the Department of Ports and Marine.

Luganville harbour consists of an international and two domestic wharves. There are currently a number of AtoNs in and around the harbour that are managed by the Department of Ports and Marine. Luganville's maritime stakeholders identified eight scenarios for Luganville harbour: two for collision between small boats and larger vessels; three for grounding on the reefs and rocks in and around the harbour; one allision of small boats with AtoNs; and two foundering of domestic vessels and small boats.

For each scenario, 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 of small fishing vessels in Segond Channel at night	6	Enforce Regulation of Small Craft (<10 m). Conduct more safety awareness workshops in communities (Office of The Maritime Regulator (OMR) to liaise with Sanma Provincial Council and the Maritime College). Conduct periodic survey checks for safety compliances	2
Collision of small boats with larger vessels between Aore and Luganville in daytime	12	Conduct more safety awareness workshops in the communities (OMR to liaise with the Provincial Council and the Maritime College). Establish a 24/7 VHF harbour radio station with radar and personnel.	4
Grounding of domestic vessels at night on east coast of Aore Island, Guyon Reef, and at the Mel Cofe wharf	9	Acquire the land title so that trees that obstruct the sector light on Aore east can be cut. Build a new tower and install new light (Aore west). Purchase and install 2 lateral lights at the entrance to Georges Philippar Passage and a set of lead lights at the main wharf. Replace existing AtoN on Guyon Reef with four new cardinal marks.	3
Grounding of domestic vessels in and around Luganville harbour	12	Purchase and install new AtoN at Palikulo. Purchase and install new AtoNs at north and south Tutuba Island. Purchase and install new AtoN at Wombwanavua point, Malo west. Purchase and install a south cardinal mark around the mouth of the Sarakata River.	3
Grounding of domestic vessels in the Marine Protected Area (MPA)	9	Purchase and install 4 special marks at the boundaries of the MPA and send a Hydrographic Note (H Note) to the Primary Charting Authority (PCA).	3
Allision of small boats with AtoN	6	Conduct safety awareness workshops in communities (OMR to liaise with Provincial Council and the Maritime College).	2
Foundering of domestic vessels and small boats due to overloading cargo and personnel	12	Implement Standard Operating Procedures (SOPs)	8
Foundering of domestic vessels and small boats due to environmental conditions	8	Distribute safety booklets promoting awareness of the tide, current and weather to all domestic vessels and small boats.	4

The main outcome of the risk assessment process in Luganville harbour was eight recommendations, which aim to reduce the risks to safety of navigation to an acceptable level for stakeholders. The recommendations and costs of their implementation are outlined below.

Recommendation 1	**Amount (vatu)**
To reduce the risk of small fishing boats colliding with each other in the Segond Channel at night, it is recommended that the Regulation of Small Craft be enforced, and safety awareness programmes be carried out together with periodic survey checks on these fishing vessels.	500,000

Recommendation 2	**Amount (vatu)**
To reduce the risk of small boats colliding with larger vessels while crossing from Aore Island to Luganville, it is recommended that safety awareness workshops be carried out and a 24/7 VHF radio station with radar and personnel be established.	2.1 million
Maintenance cost[1]	**105,000**

Recommendation 3	**Amount (vatu)**
To reduce the risk of grounding of domestic vessels at night on east coast of Aore Island, Guyon reef, and at the Mel Cofe wharf, it is recommended that:	
1. government acquire the land title so that trees that obstruct the sector light on Aore east can be cut. Latitude: 15-32.004234S; Longitude:167-12.832535E	0
2. a new tower be built and new light installed (Aore west). Latitude: 15-35.049932S; Longitude: 167-07.908600E	6 million
3. the following be purchased and installed: • 2 lateral buoys (starboard and port) at entrance to Georges Philippar Passage. **Port buoy positions** Latitude: 15-35.941836S Longitude: 167-06.941948E **Starboard buoy positions** Latitude: 15-36.008866S Longitude: 167-07.276226E • 2 lead lights at main wharf. (Positions TBD)	800,000

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

4. the existing AtoN on Guyon Reef be replaced with 4 new cardinal marks. **North cardinal position** Latitude:15-31.559140S ; Longitude: 167-09.493310E **South cardinal position** Latitude: 15-31.681001S; Longitude: 167-09.481112E **East cardinal position** Latitude: 15-31.626498S; Longitude:167-09.552177E **West cardinal position** Latitude: 15-31.606445S; Longitude: 167-09.396258E	1.5 million
Total cost	**8.3 million**
Maintenance cost	**415,000**

Recommendation 4	**Amount (vatu)**
To reduce the risk of grounding of domestic vessels in and around Luganville harbour, it is recommended that:	
1. a new tower at Palikulo be purchased and installed. Latitude: 15-28.472673S; Longitude: 167-15.348961E	6 million
2. new towers at north and south Tutuba Island be purchased and installed. North Tutuba, Latitude: 15-32.291245S; Longitude:167-17.202403E South Tutuba, Latitude: 15-35.591501S; Longitude: 167-16.051203E	12 million
3. a new tower at Wombwanavua point, Malo be purchased and installed. Latitude: 15-38.797915S; Longitude: 167-05.360795E	6 million
4. a south cardinal mark be installed around the mouth of the Sarakata River. Latitude: 15-31.394321S; Longitude: 167-10.272094E	500,000
Total cost	**24.5 million**
Maintenance costs	**1.225 million**

Recommendation 5	**Amount (vatu)**
To reduce the risk of grounding of domestic vessels in the MPA area, it is recommended that:	
1. four special buoys be purchased and installed at the following positions: 1. 15-37.067S; 167-06.984E 2. 15-35.916S; 167-06.966E 5. 15-36.294S; 167-14.718E 6. 15-37.208S; 167-14.718E	1.5 million
2. spare emergency wreck-marking buoy be purchased and installed.	600,000
3. H Notes be sent to PCA.	0
Total cost	**2.1 million**
Maintenance cost	**110,000**

Recommendation 6	Amount (vatu)
To reduce the risk of allision of small boats with AtoNs, it is recommended that safety awareness workshops be delivered to the communities and small-boat safety stickers and manuals be provided.	500,000

Recommendation 7	Amount (vatu)
To reduce the risk of foundering of domestic vessels and small boats due to overloading cargo and personnel, it is recommended that Standard Operating Procedures (SOPs) be implemented.	500,000

Recommendation 8	Amount (vatu)
To reduce the risk of foundering of domestic vessels and small boats due to environmental conditions, it is recommended that awareness of the tide, current and weather be raised, and safety booklets distributed to all domestic vessels and small boats.	200,000

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)[2]. The project aims to improve safety of navigation in the Pacific region through enhanced aids to navigation (AtoN) capacity and systems, and hence 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 safety of navigation policy and a legal framework; improving budgetary management; and supporting regional coordination related to safety of navigation in the Pacific.

In September 2019, the Department of Ports and Marine of the Ministry of Infrastructure and Public Utilities of Vanuatu invited SPC to assist in conducting a risk assessment of Luganville harbour, which is the country's second international port. A field visit was also organised by the Department of Ports and Marine in Santo to look at the AtoNs in the Luganville harbour.

This report details the risks identified, the estimated costs in the event of an incident, the risk control options suggested, and the costs associated using the SIRA methodology for the Luganville harbour.

Vanuatu is a maritime nation, with a large percentage of citizens working in or around the maritime industry. Shipping is critical to the economic and social welfare of the people of Vanuatu, and safe navigation is vital to secure this welfare and to protect the environment.

Vanuatu is a signatory to the International Maritime Organization (IMO) Safety of Life at Sea (SOLAS) Convention. 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 standardised management or systems analysis approach:

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

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

SIRA is intended as a basic tool to identify risk control options for potential undesirable incidents that Vanuatu should address as part of its obligation under SOLAS Chapter V Regulations 12 and 13. The assessment and management of 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 the Luganville harbour from those directly involved with or affected by AtoN service provision. Information provided by this step was then used by Mr Terry Ngwele, Harbour Master of the port of Santo; by Mr Charles Maniel, Manager Operations (and IALA level 1 AtoN qualified manager) of the Port Vila Department of Ports and Marine; and by SPC to complete the full risk assessment matrixes based on eight possible scenarios identified for Luganville harbour.

2 Description of the waterway

Luganville harbour is the major port in Santo and was therefore identified by the Department of Ports and Marine as a second priority for the risk assessment, after Port Vila. Within Vanuatu, the regulatory aspect of AtoN falls within the Ministry of Works, Transport and Infrastructure (MWTI), while the operational implementation and maintenance of AtoNs comes under the jurisdiction of the Department of Ports and Marine.

Luganville harbour consists of one international wharf and two domestic wharves, Simonsen and Mel Cofe. There are currently a number of AtoNs in and around the harbour that are managed by the Department of Ports and Marine.

There are three main entrances into the Luganville harbour. The Scorff Passage is through the northeast and is approximately 2900 metres wide with a depth of around 200 metres leading into the Segond Channel. The southeast Dives Passage, between the islands of Tutuba and Abokisa, which is approximately 700 metres wide and with a depth of around 100 metres, also leads into the Segond Channel. The Georges Philippar Passage to the southwest is around 400 metres wide and with a depth of around 24 metres. A maximum tidal flow of 3 to 4 knots can be expected at the entrance of Georges Philippar Passage, usually during new and full moon.

The average predicted visibility is around 4 nautical miles but this can be reduced to 0.7 nautical miles in bad weather conditions, which normally occur between the months of November and April. A maximum predicted swell of 1.5 metres can be expected in the harbour during bad weather conditions. There are a few hazards present at the harbour such as lack of AtoNs, shallow areas, strong winds, currents and waves that can pose problems for the maritime traffic.

Chart BA 1638_2 covers Luganville harbour at a scale of 1:20,000 (Figure 1).

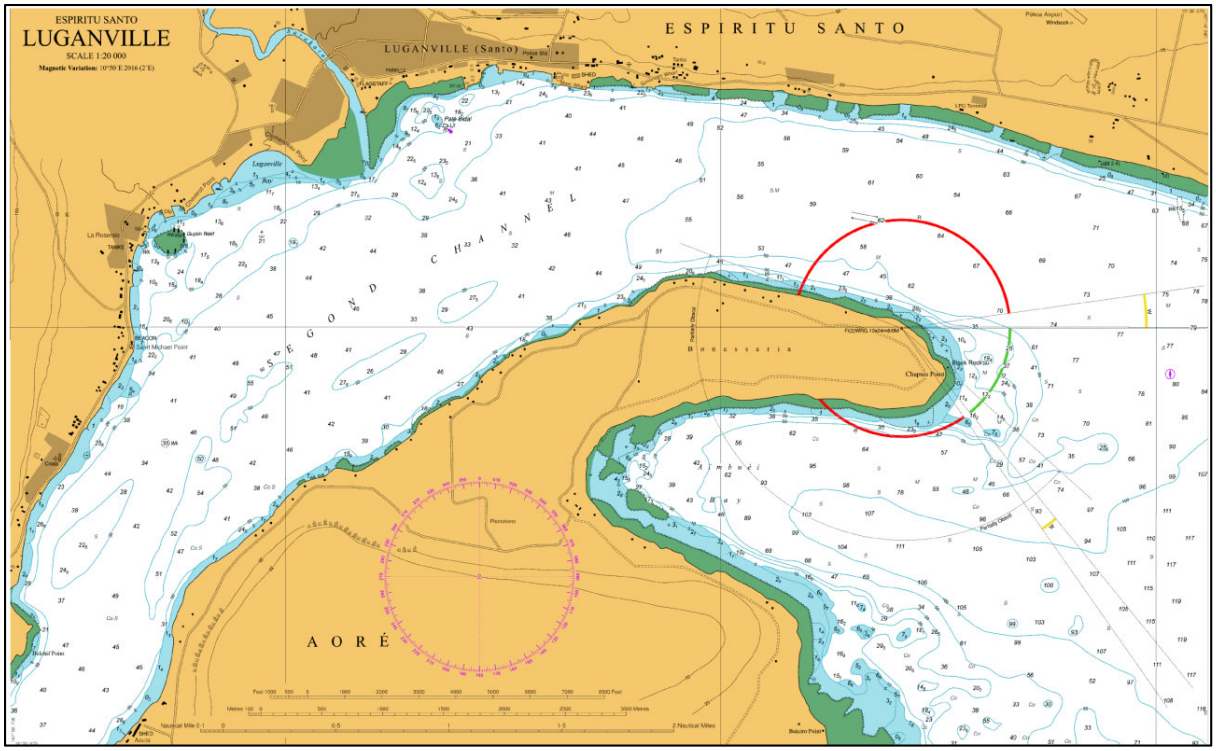

Figure 1: Chart BA 1638_2 of Luganville harbour at 1:20,000 scale.

3 Stakeholder meeting

As the first step of the SIRA process, a stakeholder meeting was organised in Luganville on 31 October 2019 at the Department of Ports and Marine conference room by Mr Terry Ngwele, Harbour Master of Luganville port.

This meeting aimed to gather the points of view of individuals, groups and organisations involved with or affected by AtoN service provision in Luganville harbour. The stakeholders (Figure 2) in Luganville included the staff from the Luganville Department of Ports and Marine, the Public Works Department, the Police Maritime Wing, resort owners, ship captains and many more (Annex A). During the meeting, the participants were divided into two groups according to their experience and background. They then helped identify potential hazards and possible scenarios in the Luganville harbour using the latest chart of the area and their experience.

Figure 2: Stakeholders at the Santo meeting.

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 prioritised list of hazards specific to the Luganville harbour. For the risk assessment, SPC and the Manager Operations of the Port Vila Department of Ports and Marine worked together with the Santo Harbour Master to discuss the risks associated with the identified hazards and to identify risk control options and recommendations.

The list of hazards identified for Luganville harbour is given in Annex B.

4.1 Types of hazard

Twenty-four hazards were identified for Luganville harbour, which were grouped into the following six categories:

- natural hazards, such as storms, earthquakes, safe minimum depth, proximity to danger, minimum visibility, low sun issues 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, sub-standard 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 MSI, poor response to marking new dangers and ramp launching area; and
- maritime space hazards, such as crowded waterways and wrecks and missing light issues.

The above six types of hazard have the capability to generate seven different 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 organisation 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 organisation;
- 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 marine 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 VTS	Passenger ships	Ice conditions	Stability (siltation)		Reef damage
		Background lighting	AtoN mix and configuration		Economic impacts
		Debris	Quality of hydrographical data		

Risk is evaluated to allow attention to be focused on high-risk areas, and to identify and evaluate factors which influence the level of risk. Once all 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 realised, 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; Figure 3).

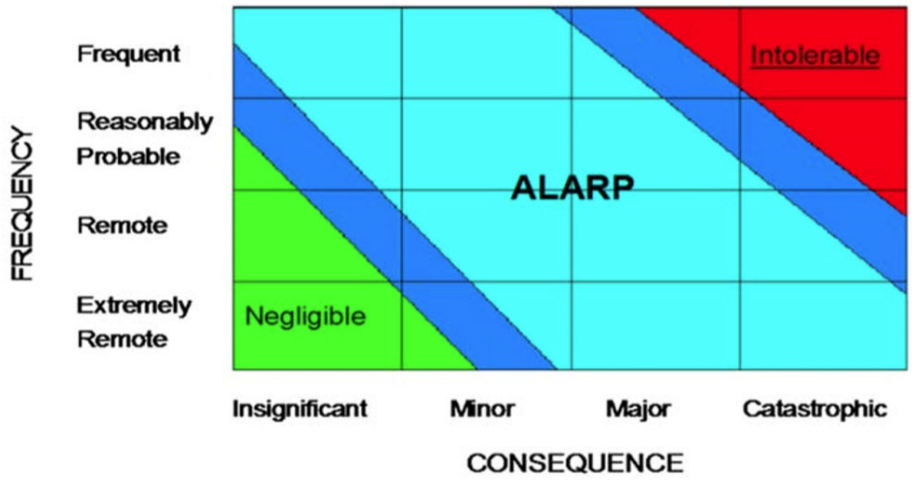

Figure 3: Graphical representation of the levels of risk. The risk level boundaries (negligible/ALARP/intolerable) are purely illustrative.

It is important to remember that, when communicating with stakeholders about risk, perception is usually different to 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 things, including age, gender, level of education 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 Manager Operations of the Port Vila Department of Ports and Marine and with the Santo Harbour Master, various hazards were identified for Luganville harbour, which could lead to a number of different incidents or scenarios. Each hazard was considered carefully and the scenarios it could cause were identified and recorded.

The scenarios for Luganville harbour were classified into four categories: collision, grounding, allision, and foundering.

Annex C lists the identified scenarios for Luganville harbour.

5.1 Collision

Collision is defined as striking or being struck by another ship, regardless of whether under way, anchored or moored. The probability of collision depends on navigational conditions, waterway configuration, and type and volume of traffic. The basic types of collisions are head-on, overtaking, bending, merging and crossing collisions. An analysis of the routes and their geometry, combined with the volume and mix of traffic for Luganville harbour, resulted in two probable collision scenarios: a head-on collision where small fishing vessels can collide with each other in the Segond Channel while fishing at night, and a head-on collision of small boats with larger vessels, including domestic vessels, while en route from Aore Island to Luganville. This is attributed to the lack of navigational aids on small boats, crew competency and lack of a harbour VHF radio station.

5.2 Grounding

Grounding is defined as a boat running aground or hitting/touching shore or sea bottom or underwater objects (wrecks, etc.). Three grounding scenarios were identified for the Luganville harbour, which would happen on the reef at the entrance to the harbour and by the wharf:

- domestic vessels running aground near the east coast of Aore Island due to unlit AtoNs, lack of AtoNs and poor performance of existing AtoNs
- domestic vessels running aground on Guyon Reef while entering the Mel Cofe wharf due to poorly marked reef
- domestic vessels running aground in the MPA area at Malo Passage due to lack of special marks marking the area, and no updates of the MPA in the current charts.

5.3 Allision

Allision is defined as a boat striking a fixed human-made object such as a wharf, mooring buoy or fish aggregating device (FAD) depending on the position of such structures along the route and the density of traffic. One allision scenario was identified for the Luganville harbour: allision with a floating AtoN at Paté Bidal when vessels manoeuvre in and around this buoy. This is usually caused by the lack of safety awareness, poor safety culture, low crew competency and AtoN failure.

5.4 Foundering

Foundering is defined as a boat sinking that is not the result of an earlier collision; for example, a vessel might founder if its cargo shifts during bad weather. Foundering of domestic vessels and small boats at the entrance to Georges Philippar Passage can occur due to the natural conditions such as wind and wave direction, strong currents and tide, normally during bad weather conditions, and during new and full moon and king tides, together with overloading of cargo and personnel on domestic and small boats.

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 Operations of the Port Vila Department of Ports and Marine and the Harbour Master.

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 2months
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	Environment 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 port or waterway for 4–24 hours	Injuries to several individuals requiring hospitalisation	Loss, including third-party losses, of USD 50,000–5,000,000	Short-term damage to the environment 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 The 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 colour-banded levels of risk (Table 5). These colours 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;
- installation of new AtoNs;
- 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 Luganville harbour with new risk scores if the risks are mitigated. The detailed risk control options for Luganville harbour are shown in the risk assessment matrix in Annex D.

Table 6. Risk control options for Luganville harbour, and changes in risk score.

Scenario	Risk score	Risk control option	New risk score
Collision of small fishing vessels in Segond Channel at night	6	Enforce Regulation of Small Craft (<10 m). Conduct more safety awareness workshops in communities (Office of The Maritime Regulator (OMR) to liaise with Sanma Provincial Council and the Maritime College). Conduct periodic survey checks for safety compliances.	2
Collision of small boats with larger vessels between Aore and Luganville in daytime	12	Conduct more safety awareness workshops in the communities (OMR to liaise with the Provincial Council and the Maritime College). Establish a 24/7 VHF harbour radio station with radar and personnel.	4
Grounding of domestic vessels at night on east coast of Aore Island, Guyon Reef, and at the Mel Cofe wharf	9	Acquire the land title so that trees that obstruct the sector light on Aore east can be cut. Build a new tower and install new light (Aore west). Purchase and install 2 lateral lights at the entrance to Georges Philippar Passage and a set of lead lights at the main wharf. Replace existing AtoN on Guyon Reef with four new cardinal marks.	3
Grounding of domestic vessels in and around Luganville harbour	12	Purchase and install new AtoN at Palikulo. Purchase and install new AtoNs at north and south Tutuba Island. Purchase and install new AtoN at Wombwanavua point, Malo west. Purchase and install a south cardinal mark around the mouth of the Sarakata River.	3
Grounding of domestic vessels in the Marine Protected Area (MPA)	9	Purchase and install 4 special marks at the boundaries of the MPA and send a Hydrographic Note (H Note) to the Primary Charting Authority (PCA).	3
Allision of small boats with AtoN	6	Conduct safety awareness workshops in communities (OMR to liaise with Provincial Council and the Maritime College).	2
Foundering of domestic vessels and small boats due to overloading cargo and personnel	12	Implement Standard Operating Procedures (SOPs).	8
Foundering of domestic vessels and small boats due to environmental conditions	8	Distribute safety booklets promoting awareness of the tide, current and weather to all domestic vessels and small boats.	4

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 prioritised 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, labour 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 Recommendations

A key outcome of the risk assessment undertaken at Luganville Harbour 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 potential collisions of small fishing vessels in the Segond Channel at night due to lack of navigation aids (lights) on these boats.

It is recommended that the current regulation on small craft be enforced; that OMR liaise and work with the Provincial Council and the Maritime College to conduct more safety awareness workshops; and that periodic checks be carried out for all safety compliance on board small fishing vessels.

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

The costs to implement this recommendation are as follows:

Recommendation	**Amount (vatu)**
Enforcement of regulation on small craft; safety awareness programmes and periodic survey checks	500,000

Recommendation 2 (addressing collision scenario)

This recommendation addresses potential collision of small boats with larger vessels while crossing between Aore Island and Luganville. This is mainly due to crew competency and lack of a 24/7 VHF harbour radio station for broadcasting messages. It is recommended that more safety awareness workshops be delivered to the communities identified by OMR, the Provincial Council and the Maritime College and that a 24/7 VHF radio station be established with personnel.

The costs to implement this recommendation are as follows:

Recommendation	**Amount (vatu)**
Safety awareness workshops and establishment of a 24/7 VHF radio station with personnel	2.1 million
Maintenance cost	**105,000**

Recommendation 3 (addressing grounding scenario)

This recommendation addresses potential grounding of domestic vessels at night on the east coast of Aore Island and on Guyon Reef at the Mel Cofe wharf. This is mainly due to the lack of AtoNs and to land issues. There is an area of overgrown trees in front of the Aore east (Chapius point) light that obstructs the light into the Dives Passage. The light from Aore west is also obstructed by vegetation growth, obstructing the light into the Georges Philippar Passage. The following recommendations are made:

Recommendation	Amount (vatu)
5. Acquisition by the government of the land title so that trees that obstruct the sector light on Aore east can be cut (Figures 1 and 4). Latitude: 15-32.004234S; Longitude:167-12.832535E	0
6. Building of a new tower and installation of new light (Aore west) (Figure 6). Latitude: 15-35.049932S; Longitude: 167-07.908600E	6 million
7. Purchase and installation of: • 2 lateral buoys (starboard and port) at entrance to Georges Philippar passage. **Port buoy positions** Latitude: 15-35.941836S Longitude: 167-06.941948E **Starboard buoy positions** Latitude: 15-36.008866S Longitude: 167-07.276226E • 2 lead lights at main wharf (Positions TBD)	800,000
8. Replacement of existing AtoN on Guyon Reef with 4 new cardinal marks. **North cardinal position** Latitude:15-31.559140S; Longitude: 167-09.493310E **South cardinal position** Latitude: 15-31.681001S; Longitude: 167-09.481112E **East cardinal position** Latitude: 15-31.626498S; Longitude: 167-09.552177E **West cardinal position** Latitude: 15-31.606445S; Longitude: 167-09.396258E	1.5 million
Total cost	**8.3 million**
Maintenance cost	**415,000**

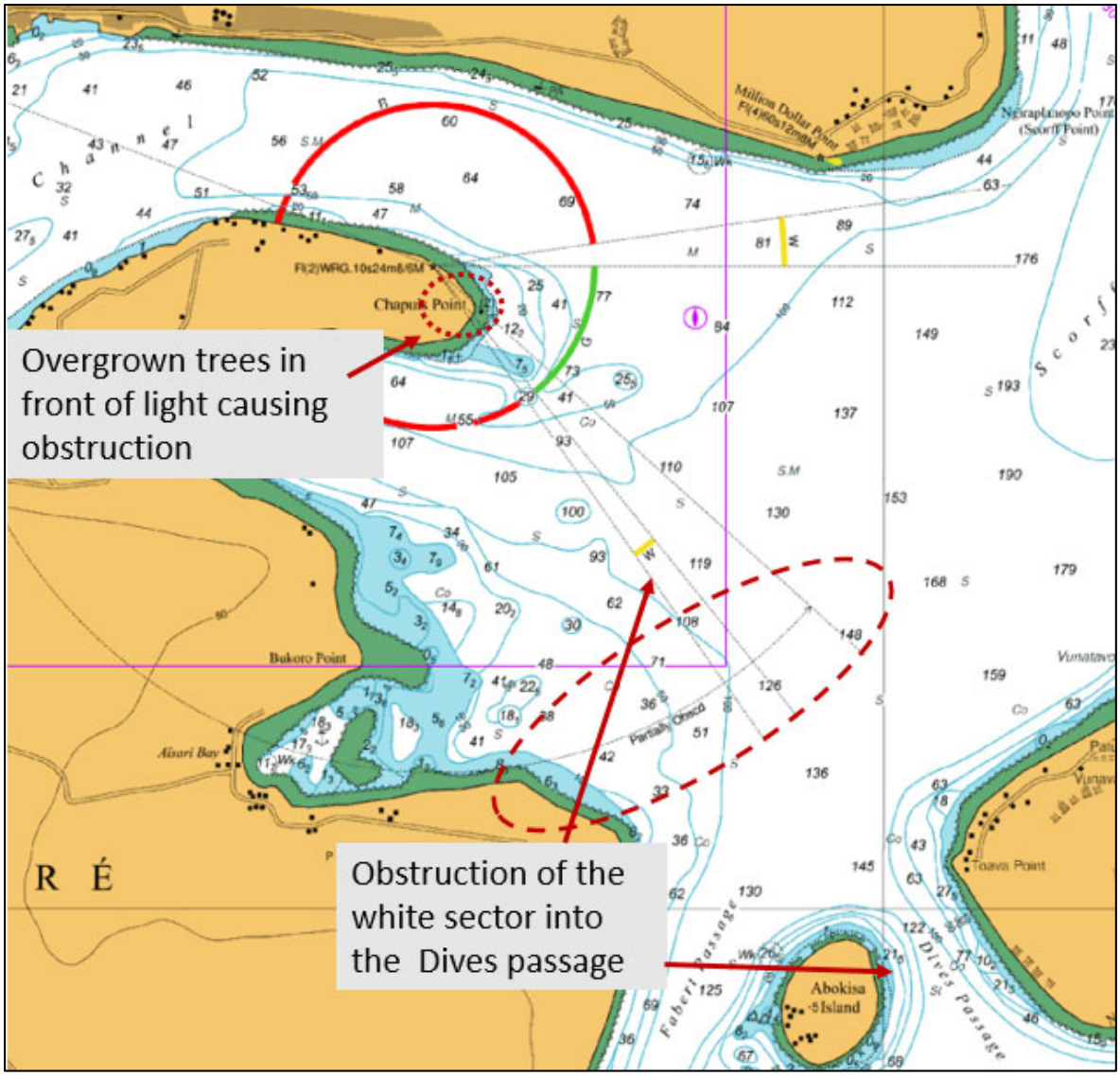

Figure 4:. Chart BA 138_1 showing the sector light obstruction details

Figure 5: View from the top of the sector light tower showing the trees obstructing the light.

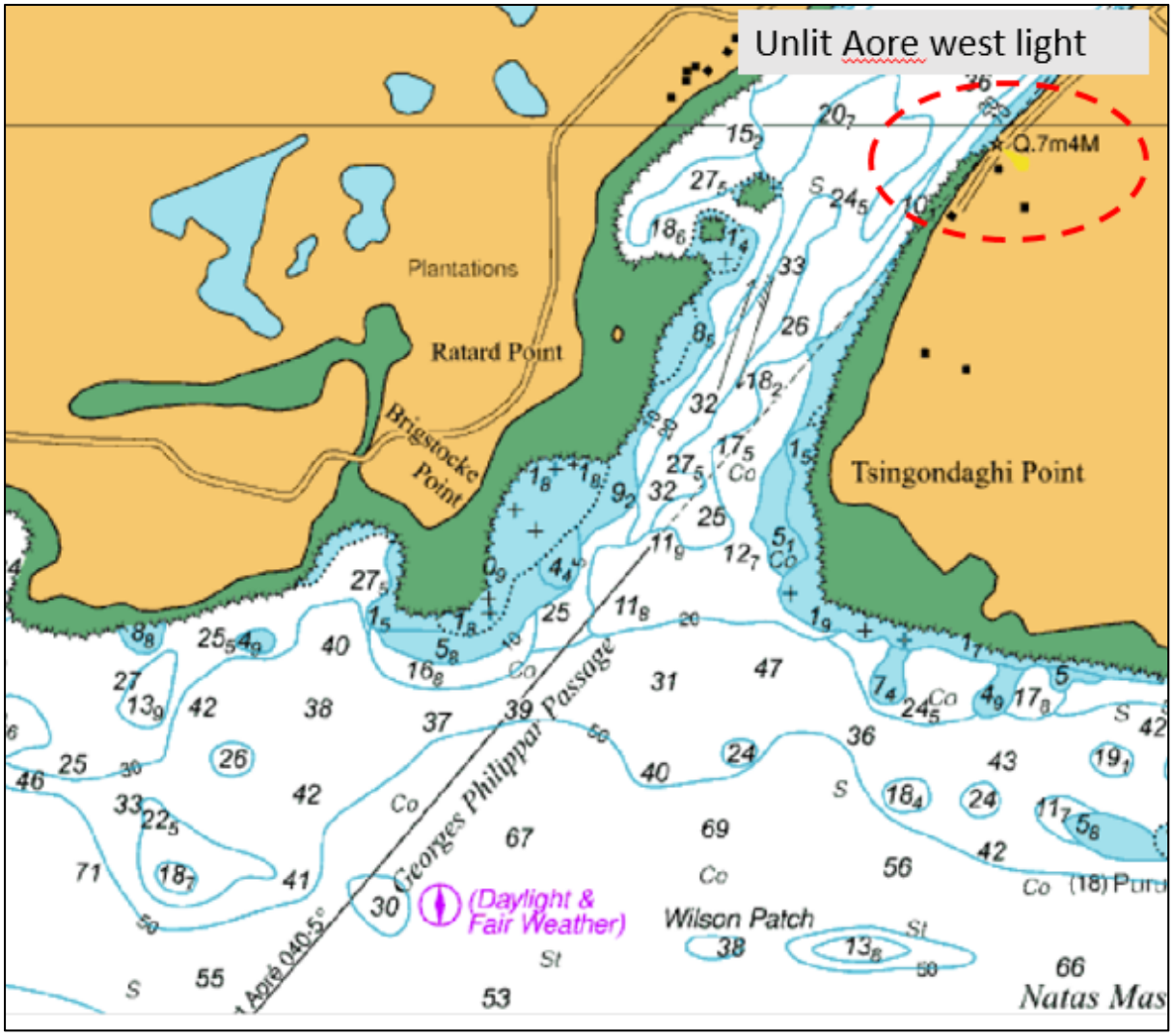

Figure 6: New tower and light at Aore west

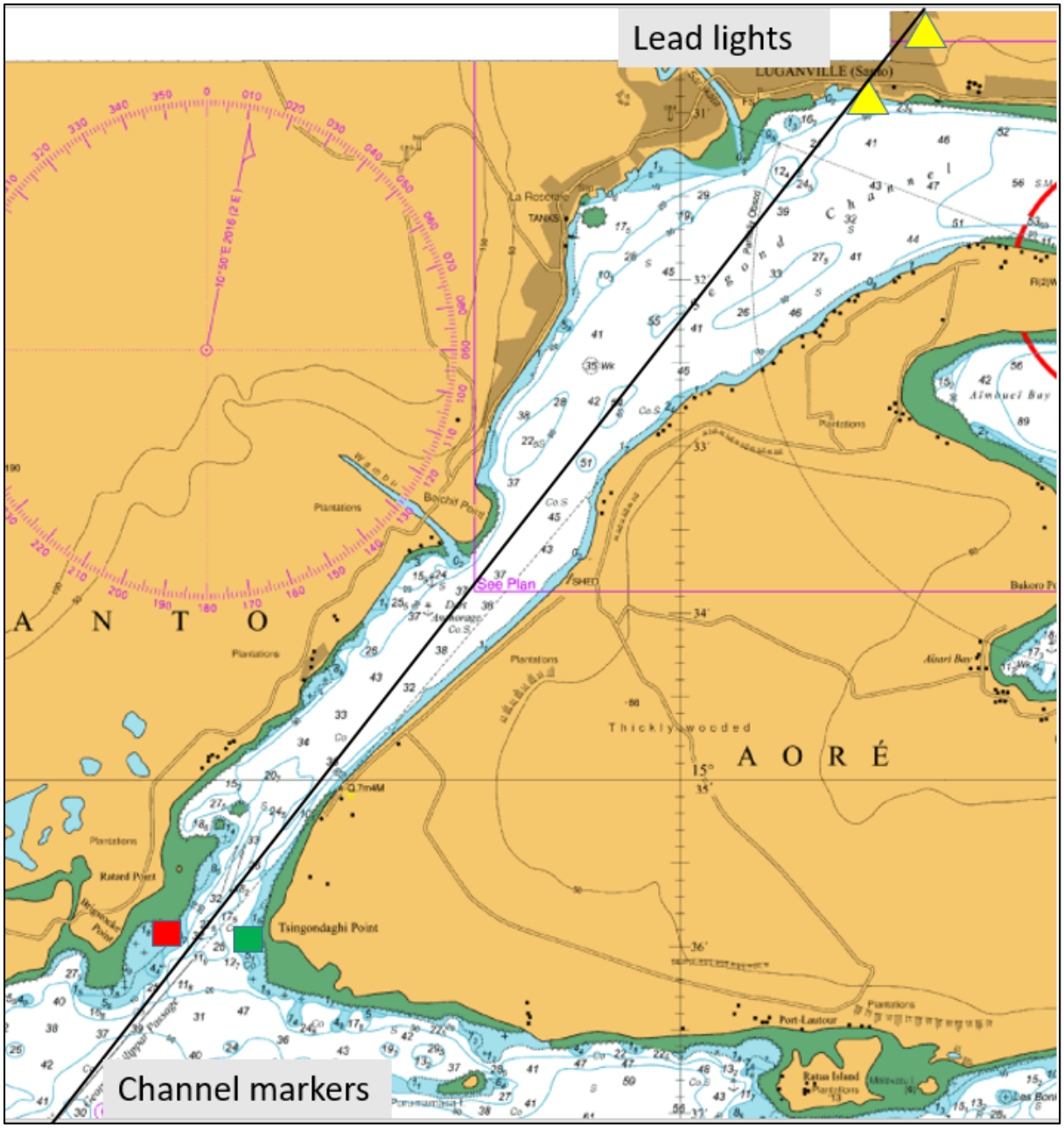

Figure 7: New channel markers and lead lights

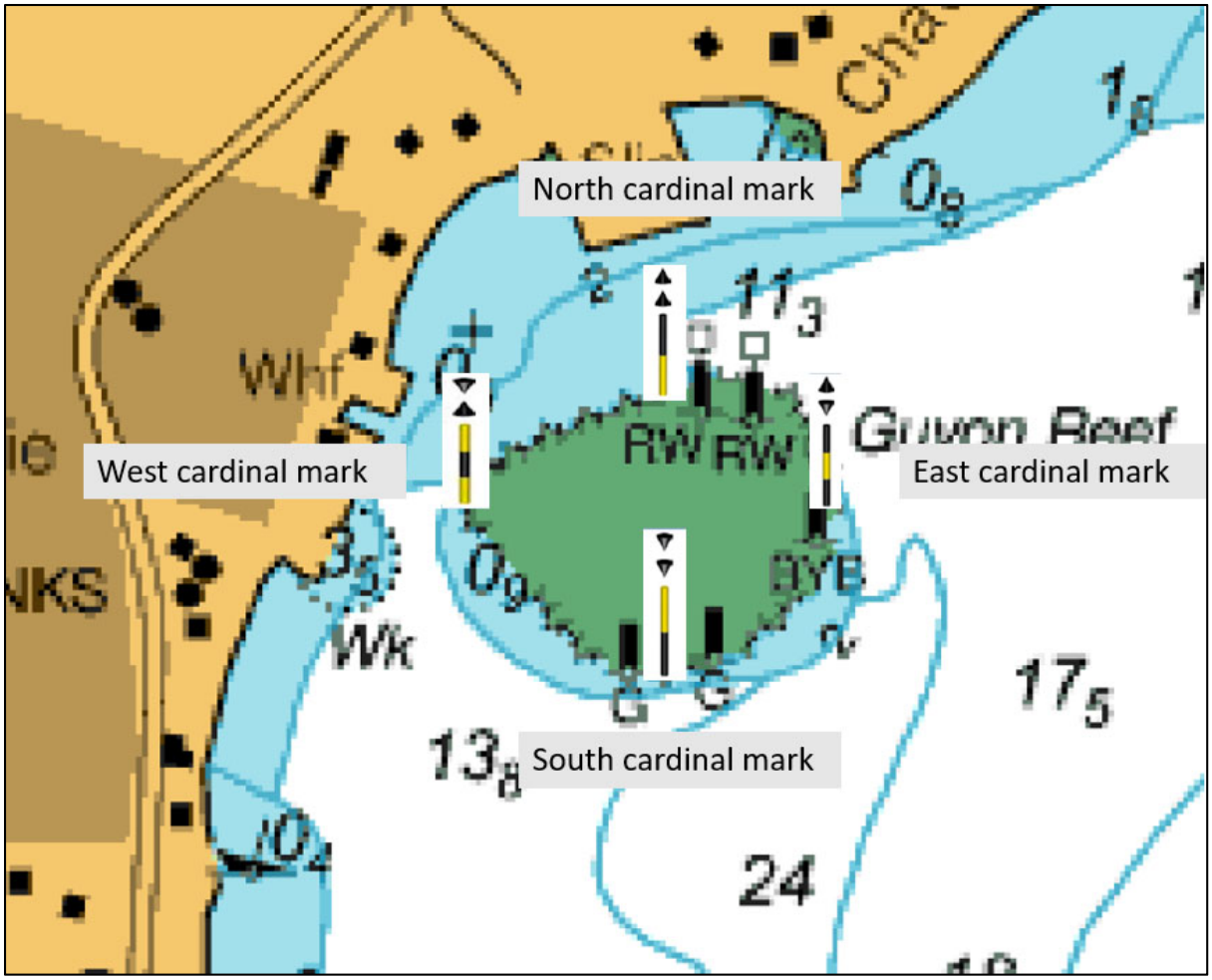

Figure 8: Four new cardinal marks with lights around Guyon Reef

Recommendation 4 (addressing grounding scenario)

This recommendation addresses potential grounding of domestic vessels navigating in and around Luganville harbour, mainly due to lack of AtoNs. It is recommended that a number of AtoNs be purchased and installed.

The costs to implement this recommendation are as follows:

Recommendation	Amount (vatu)
5. Purchase and installation of new tower at Palikulo (Figures 1 and 9). Latitude: 15-28.472673S; Longitude: 167-15.348961E	6 million
6. Purchase and installation of new towers at north and south Tutuba Island (Figure 10). North Tutuba, Latitude: 15-32.291245S; Longitude:167-17.202403E South Tutuba, Latitude: 15-35.591501S; Longitude: 167-16.051203E	12 million

7.	Purchase and installation of new tower at Wombwanavua point, Malo. Latitude: 15-38.797915S; Longitude: 167-05.360795E	6 million
8.	Purchase and installation of a south cardinal mark around the mouth of the Sarakata River. Latitude: 15-31.394321S; Longitude: 167-10.272094E	500,000
	Total cost	**24.5 million**
	Maintenance costs	**1.225 million**

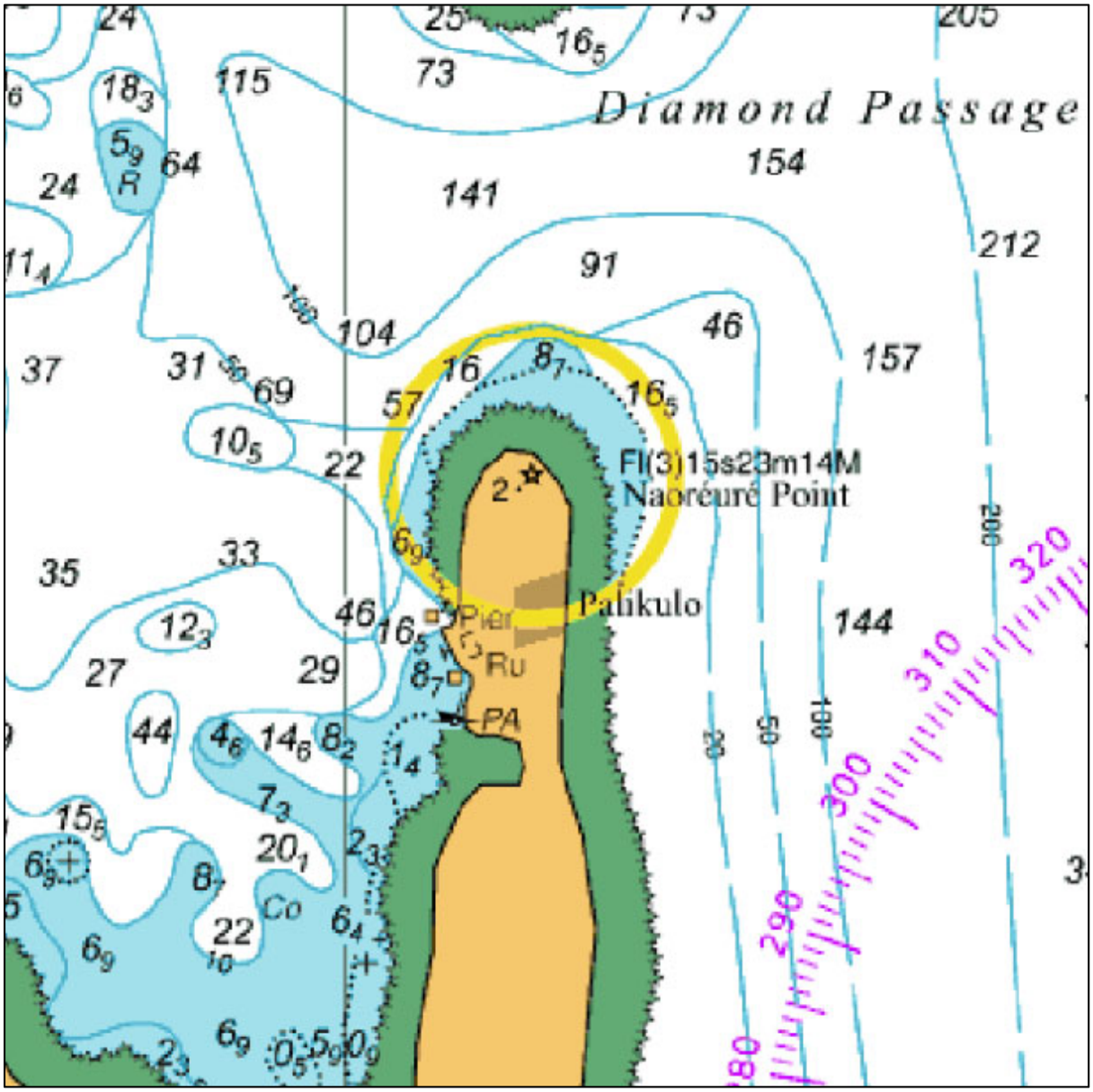

Figure 9: Palikulo light

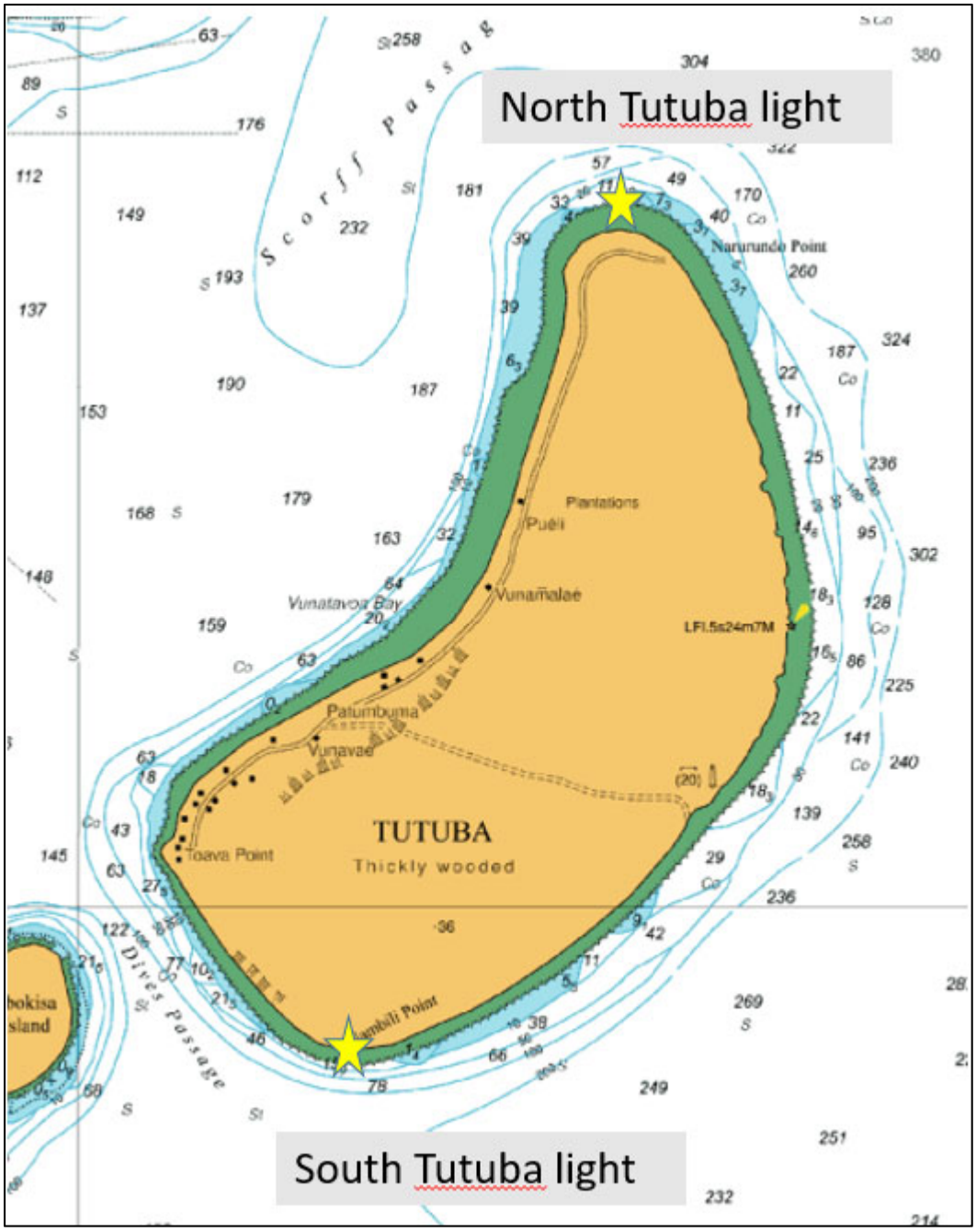

Figure 10: North and south Tutuba light

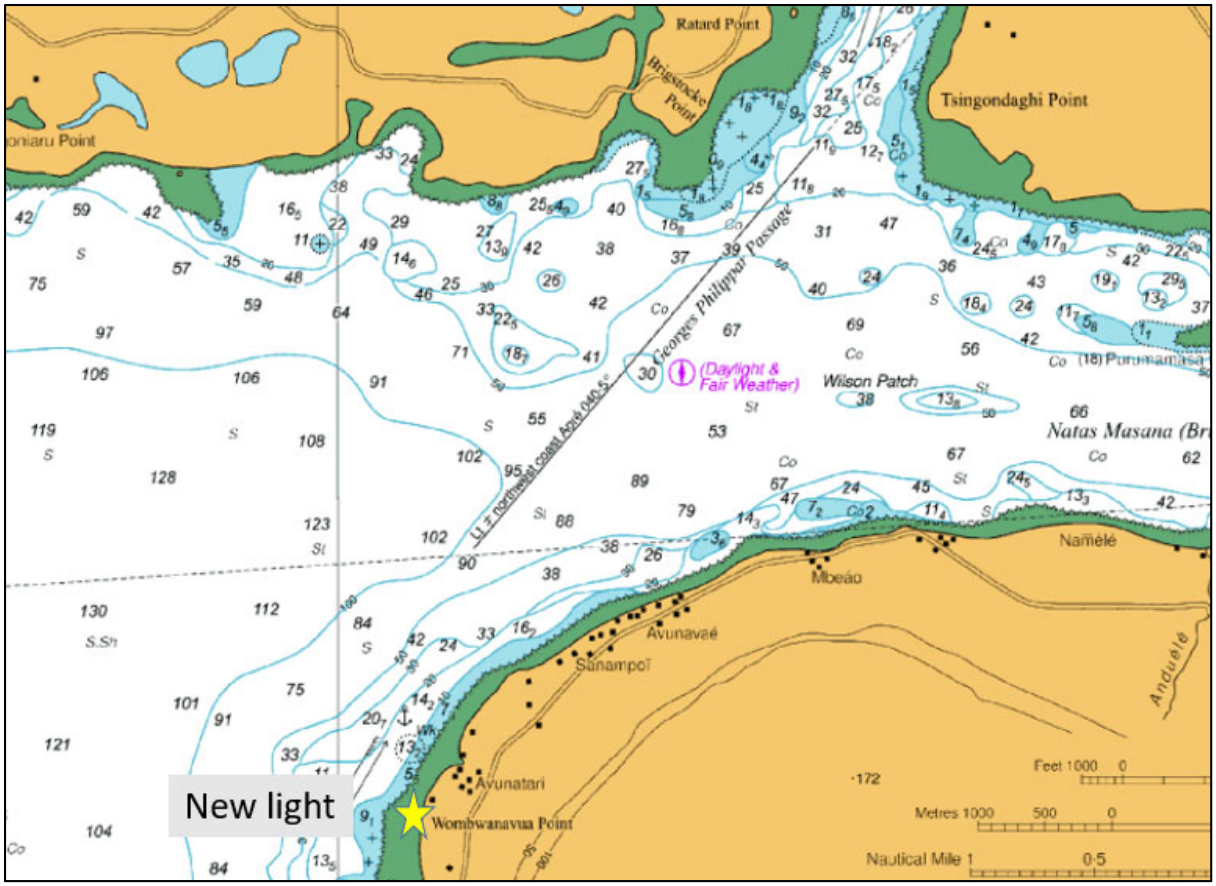

Figure 11: Wombwanavua light

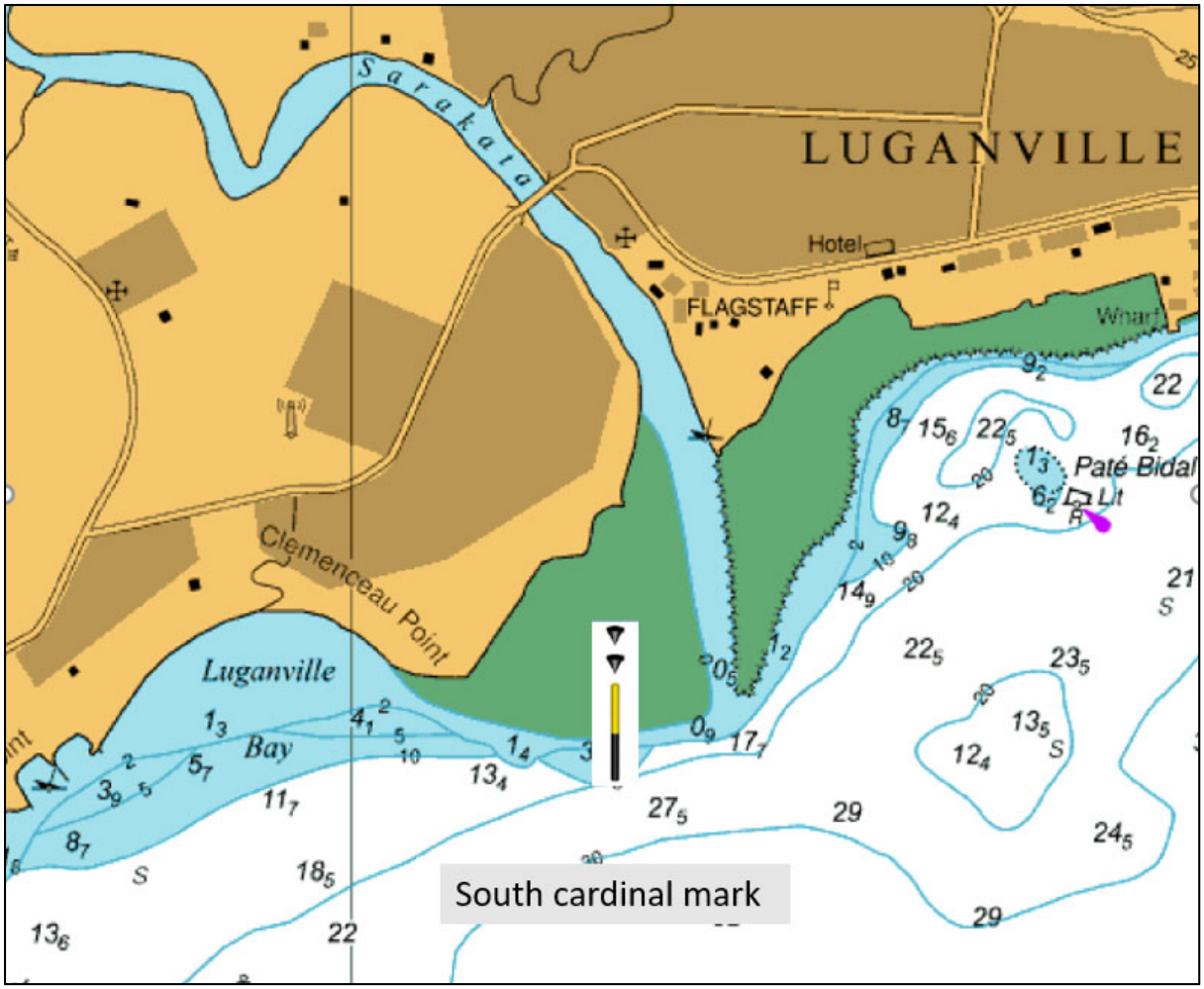

Figure 12: Sarakata River mouth cardinal mark

Recommendation 5 (addressing grounding scenario)

This recommendation addresses potential grounding of domestic vessels in the Marine Protected Area (MPA) in the Malo Passage.

This is mainly due to the lack of special AtoNs marking the boundaries of the MPA area. It is recommended that the boundaries at positions 1, 2, 5 and 6 of the MPA area be clearly marked with special buoys. An H Note should be sent to the charting authorities informing them of the new MPA to be updated on the new edition of charts.

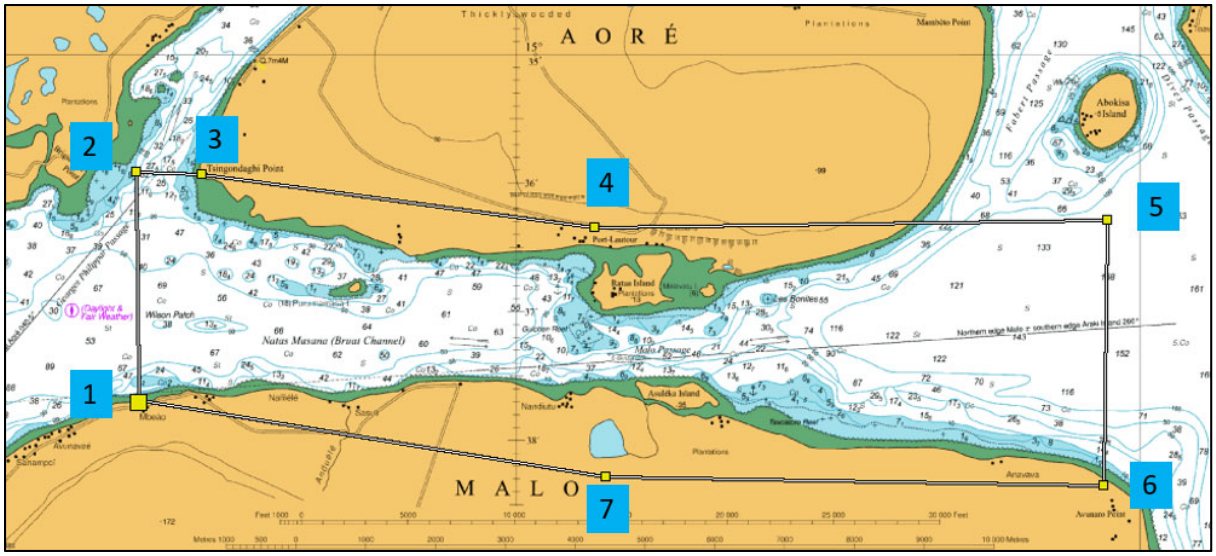

Figure 13: Chart showing the boundary of the MPA.

The costs to implement this recommendation are as follows:

Recommendation	Amount (vatu)
Purchase and installation of 4 special buoys at the following positions: 1. 15-37.067S; 167- 06.984E 2. 15-35.916S; 167-06.966E 5. 15-36.294S; 167-14.718E 6. 15-37.208S; 167-14.718E	1.5 million
Purchase and installation of spare emergency wreck-marking buoy.	600,000
Send H Notes to PCA	0
Total cost	**2.1 million**
Maintenance cost	**110,000**

Recommendation 6 (addressing allision scenario)

This recommendation addresses potential allision of small boats with AtoNs in the harbour, mainly due to crew competency and AtoN failures (lack of lights).

It is recommended that safety awareness workshops be carried out in the communities identified by OMR, the Provincial Council and the Maritime College and that small-boat safety stickers and a safety manual be provided to small-boat operators.

The costs to implement this recommendation are as follows:

Recommendation	Amount (vatu)
Safety awareness workshops at communities and delivery of small-boat safety stickers and manuals.	500,000

Recommendation 7 (addressing foundering scenario)

This recommendation addresses potential foundering of domestic vessels and small boats due to overloading of personnel and cargo.

It is recommended that Standard Operating Procedures (SOPs) be implemented. Assistance in this implementation can be sought through the SPC Pacific Islands Domestic Ship Safety (PIDSS) programme.

The cost to implement this recommendation is as follows:

Recommendation	Amount (vatu)
Implementation of SOP	500,000

Recommendation 8 (addressing foundering scenario)

This recommendation addresses potential foundering of domestic vessels and small boats due to strong currents and tide, especially at the entrance to Georges Philippar Passage.

It is recommended that safety booklets promoting awareness of the tide, current and weather be distributed to domestic vessels and small boats.

The cost to implement this recommendation are as follows:

Recommendation	Amount (vatu)
Safety booklets on tide, current and weather awareness.	200,000

11 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 convention). It is also meant to guide the Ministry of Infrastructure and Public Utilities of Vanuatu in delivering compliant AtoN services in Luganville harbour.

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

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

Annex A. Stakeholders in the Luganville harbour risk assessment

Safety of Navigation Risk Assessment Stakeholder Meeting (Phase II) - Luganville, Vanuatu, 30 October 2019			
Name	**Job Title**	**Organisation**	**Contact email**
Peter Terry	Owner	IISS	Pete4_terry@yahoo.com.au
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Kuck Antonio Masingie		VISSP	emassingiow@vanuatu.gov.vu
Leugkou Gratiano	Linesman		gratianoleugkou@vanuatu.gov.vu
Simon Battu	Linesman	Ports and Marine	
Paul Al Guel	Security	Ports and Marine	
Justino Ngcerde	Engineer pilot boat	Ports and Marine	
John Dingley	OIC Turoroa	Maritime Police	jdingley@vanuatu.gov.vu
Miller Toara	Assistant Harbour Master	Ports and Marine	mtoara@vanuatu.gov.vu
Manaseli Togag	OMR inspector	OMR	tmanaseli@omr.vu
Brett Fasher	Owner	Ratua Island Resort	brett@ratua.com
Reuben Fasher	Owner	Ratua Island Resort	reuben@ratua.com
Gilbert Erake	Captain	LC Blessing	
Vanua Pukoro	Owner	MV Jadkoro	
Timothy Nobel	Captain	MV Rosalie	
Sandy Seule	Customs Officer	Customs	sseule@vanuatu.gov.vu
Ettiano Tari	Captain	LC Blessing	

Annex B. Hazards identified for Luganville harbour

HAZARDS		Value	Remarks
Natural	Safe Minimum Depth (m)	11.9	Georges Philippar Passage entry
	Proximity of danger (NM)	0.2	Georges Philippar Passage entry
	Tide, wind, wave and tidal flow effect	2.5 knots	Increase during neap tides or full moon
	Minimum visibility (NM)	0.5	During stormy weather
	Low sun issues	Yes	Vessels approaching Luganville from the east during sunset might have low sun issues. Similarly, vessels getting out of Scorff Passage during sunrise might have low sun issues
	Other	Yes	River floods, floating logs, trees
Economic	Legal action problems	Yes	Land issues
	Insufficient AtoN funding issues	Yes	
Technical	Quality and validity of charted information	Yes	Latest information should also be on the raster chart (paper)
	AtoN failures	Yes	
	Substandard ships	Yes	SOP needs to be implemented
Human	Crew competency	Yes	Since there are no lights, domestic vessel crews have no familiarity with AtoN types
	Fatigue	Yes	Part of SOP
	Safety culture	Yes	Need more awareness programmes
	Influence of alcohol and/or drugs	Yes	
	Political issues	Yes	
	Culture or language issues	Yes	Complexity – more awareness
	Crew distractions	Yes	Mobile distractions

Operational	Impact of small vessels	Yes	Proper navigation lighting and enforcement of Regulation of Small Craft
	Fishing activities	Yes	Enforcement of Regulation of Small Craft
	Harbour radio station	Yes	Need to have a harbour radio station 24/7
	Seasonal activities	Yes	Yachts moored along the coast, navigational issues when container vessels come alongside
	Poor response to marking new danger	Yes	Need virtual AtoN created: purchase spare AtoN for emergency
Maritime space	The existence of restricted areas	Yes	Malo Bass (Marine Protected Area) needs to be on the charts

Annex C: Possible scenarios identified for Luganville harbour

SCENARIOS		Remarks
Collisions	Head-on	Fishing activities when small boats are in the channel especially at night-time.
	Crossing	Crossing from Aore Island to Luganville or vice versa between small boats and larger vessels
Groundings	Grounding on rock	1. At the Georges Philippar Passage due to lack of lights marking the entrance channel 2. Guyon Reef (Mel Cofe wharf), need to install AtoN (cardinal marks) 3. Install/repair AtoN: (EAST) Aore west light (existing but unlit), Palikulo light (not in place), north Tutuba Island (not in place) and Nambili point Tutuba (not in place) (WEST): Aore west (unlit), Wombwanavua point (not existing), Malo light house (not existing), Abokisa island (not existing), mouth of Sarakata River, need to install AtoN 4. Grounding in the MPA area at Malo Passage due to lack of AtoNs marking the boundary
Allision	Aids to navigation	Allision with floating AtoN due to lack of awareness/lack of safety culture/fatigue/etc.
Foundering	Capsizing	During the super moon/king tide

Annex D: Risk assessment matrix for Luganville harbour

Luganville AtoN risk assessment matrix

	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 (vatu)	Further Risk Control Options	New Probability Score	New Consequence Score	New Risk Score	Cost of RCO (vatu)	Remarks
1. COLLISIONS															
1.1	Small boat	Small fishing vessels in the Segond Channel may collide among themselves esp. during the night	Fishing activities, no proper navigational aids	Human injury, damage to property	Initial survey/inspection of safety of appliance by OMR (when purchased)	3	2	6	1.4 million (average cost of a banana boat) plus medical expense 50,000	1. Enforcement of Regulation of Small Craft (<10 m) 2. More safety awareness workshops in communities (OMR to liaise with Provincial Council and the Maritime College) 3. Periodic survey checks for safety compliances	1	2	2	500,000	
1.2	Small boat and larger vessels (including domestic vessels)	When larger vessels, especially domestic vessels, are about to disembark or come alongside both the international and the domestic wharf, there is possibility of small boats crossing and potentially a collision	Crew competency, no VHF harbour radio station	Loss of life, damage to property	None	3	4	12	1.4 million (average cost of a banana boat) plus loss of human life 20 million	1. More safety awareness workshops in the communities (OMR to liaise with Provincial Council and the Maritime College) 2. 24/7 VHF harbour radio station established with radar	1	4	4	2.1 million	2.1 million includes purchase of radio equipment, employment of 2 personnel (salary for a year) and conducting safety awareness periodically
2. GROUNDINGS															
2.1	Grounding on Rock 1 – Domestic vessels (<500 GT)	Domestic vessel coming at berth at night runs aground	AtoN failure, land issues	Damage to property, marine pollution, human injury	Existing AtoNs but not fulfilling the objective	3	3	9	1363.5 million (make reference to Pacific Safety of Navigation Phase 1, Economic Assessment Report)	1. Government to acquire the land title so that trees that obstruct the sector light on Aore east can be cut 2. Purchase and install a new tower and install new light (Aore west) 3. Purchase and install 2 lateral lights at entrance to Georges Philippar Passage and a set of lead lights at the main wharf 4. Replace existing AtoN on Guyon Reef with four new cardinal marks	1	3	3	8.3 million	1. Purchase and install a new tower and a new light (Aore west) – 6 million 2. Purchase and install 2 lateral lights at entrance to Georges Philippar Passage and a set of lead lights at the main wharf – 800,000 3. Replace existing AtoN on Guyon Reef with four new cardinal marks – 1.5 million
2.2	Grounding on Rock 2 – Domestic vessels (<500 GT)	Domestic vessels navigating into/around Luganville harbour	No AtoNs	Damage to property, marine pollution, human injury	None	4	3	12	1363.5 million (make reference to Pacific Safety of Navigation Phase 1, Economic Assessment Report)	1.Purchase and install a new AtoN at Palikulo 2. Purchase and install new AtoNs at north and south Tutuba Island 3. Purchase and install new AtoN at Wombwanavua point, Malo west 4. Purchase and install a south cardinal mark around the mouth of Sarakata River	1	3	3	24.5 million	1. Purchase and install new tower at Palikulo – 6 million 2. Purchase and install new towers at north and south Tutuba Island – 12 million 3 Purchase and install new tower at Wombwanavua point, Malo west– 6 million 4. Purchase and install a south cardinal mark around the mouth of Sarakata River – 500,000
2.3	Grounding on Rock 3 – Domestic vessels (<500 GT)	Domestic vessels navigating in the Marine Protected Area in Malo Passage	No AtoNs	Damage to property, marine pollution, human injury	Community awareness with local communities about MPA (registered as a Community Conservation Area with the Environment Department and launched in 2019)	3	3	9	1363.5 million (make reference to Pacific Safety of Navigation Phase 1, Economic Assessment Report)	1. Send Hydrographic Note on the MPA coordinates 2. Purchase and install four special mark boundaries 3. Purchase an emergency wreck-marking buoy	1	3	3	2.1 million	2. Purchase and install 4 special marks for MPA – 1.5 million 3. 600,000 for spare emergency wreck-marking buoy
3. ALLISIONS															
3.1	Allision of small boat with AtoN	Small boats hit AtoN	AtoNs' failure and crew competency	Damage to property (both AtoN and boat)	None	3	2	6	1.5 million (boat repair and AtoN)	Safety awareness workshops in communities (OMR to liaise with Provincial Council and the Maritime College)	1	2	2	500,000	Safety awareness workshops and small-boat safety stickers and manual
4. FOUNDERING															
4.1	Domestic vessels and small boats	Capsizing	Overloading of people and cargo; crew competency; SOPs are not followed	Damage to property, loss of life, marine pollution	Safe manning certificate on board	3	4	12	1363.5 million (make reference to Pacific Safety of Navigation Phase 1, Economic Assessment Report)	Implement Standard Operating Procedures (SOPs) on board domestic vessels	2	4	8	500,000	More assistance for SOP to be implemented. Assistance can be requested also on PIDSS programme
4.2	Domestic vessels and small boats	Capsizing	Strong current, tides and weather	Damage to property, loss of life, marine pollution	Safe manning certificate on board	2	4	8	1363.5 million (make reference to Pacific Safety of Navigation Phase 1, Economic Assessment Report)	Develop and distribute safety booklets on tide, current and weather awareness to all domestic vessels and small boats	1	4	4	200,000	Printing of safety booklets

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