



October 2016

## SEYCHELLES FISHING AUTHORITY

# Cultural Heritage Impact Assessment for the Proposed Seychelles Mariculture Master Plan

**Submitted to:**  
Seychelles Fishing Authority

**DRAFT FOR COMMENT**



REPORT



**Report Number: 1543656-308206-10**

**Distribution:**

- 1 copy - Ministry of Environment, Energy and Climate Change
- 1 copy - Seychelles Fishing Authority
- 1 copy - Golder Associates Ltd.





## Table of Contents

**1.0 INTRODUCTION.....3**

**2.0 TERMS OF REFERENCE AND CULTURAL HERITAGE TERMINOLOGY .....5**

    2.1 Terms of Reference .....5

    2.2 Terminology .....5

**3.0 DUE DILIGENCE REVIEW .....6**

    3.1 Cultural Heritage Overview Assessment .....6

        3.1.1 CHOA Methods.....6

            3.1.1.1 Criteria for Estimating Ship and Aircraft Wreck Locations Based on Historical Record Review ....13

        3.1.2 Potential Assessment for Cultural Heritage.....13

            3.1.2.1 Terrestrial Archaeological Potential .....13

            3.1.2.2 Historical Wreck Potential .....13

        3.1.3 Reporting, Recommendations and Options for Further Survey.....14

        3.1.4 CHOA Gap Analysis.....14

**4.0 HERITAGE BASELINE.....15**

    4.1 CHOA Recommendations .....15

    5.1 Relevant Legislation .....20

        5.1.1 National Monuments Act.....20

        5.1.2 International Law.....20

        5.1.3 United Nations Convention on the Law of the Sea.....21

        5.1.4 UNESCO Convention on the Protection of the Underwater Cultural Heritage .....21

    5.3.1 Significance Criteria for Cultural Heritage .....24

    5.4 Impact Assessment and Mitigation Measures.....24

        5.4.1 Construction / Implementation .....24

    5.5 Operation.....25

    5.6 Decommissioning .....26

        5.6.1 Mitigation Measures .....26

            5.6.1.1 Dive Survey .....27

            5.6.1.2 Chance Find Procedure.....27



**6.0 ENVIRONMENTAL MANAGEMENT PLAN FOR CULTURAL HERITAGE.....28**

**7.0 LIMITATIONS .....30**

**8.0 REFERENCES.....30**

**TABLES**

**Table 1:** Impact ranking matrix. ....23

**Table 2:** Significance ratings.....23

**Table 3:** Impact significance determination for Cultural Heritage during the construction phase.....25

**Table 4:** Impact significance determination for Cultural Heritage during the operation phase. ....26

**Table 5:** Impact significance determination for Cultural Heritage during the operation phase. ....26

**Table 6:** Cultural Heritage EMP .....28

**FIGURES**

Figure 1: Seychelles EEZ and island groups.....7

Figure 2: Land-based aquaculture zone.....8

Figure 3: R&D Facility, Anse Royale, Mahé. ....9

Figure 4: R&D Facility with water intake pipe, Anse Royale, Mahé.....10

Figure 5: Broodstock acclimation facility, Providence, Mahé.....11

Figure 6: Pilot Project, Providence, Mahé. ....12

Figure 7: Aquaculture development zones. ....16

Figure 8: Underwater cultural heritage locations: Mahé. ....17

Figure 9: Underwater cultural heritage locations: Praslin and La Digue.....18

Figure 10: Underwater cultural heritage locations: Silhouette and North Islands. ....19

Front cover image credit: Enikő Torneby, 2011. (<http://www.panoramio.com/photo/503501370>).



## 1.0 INTRODUCTION

### 1.1 Background

Golder Associates (Golder) have been appointed by the Seychelles Fishing Authority (SFA) as independent environmental assessment practitioners (EAPs) for the purpose of conducting an Environmental and Social Impact Assessment (ESIA) for the proposed implementation of the Seychelles Mariculture Master Plan (MMP).

This cultural heritage impact assessment (CHIA) is one of the specialist studies conducted in support of the ESIA which has been compiled in line with the requirements of local Seychelles legislation and aligned with international best practice.

### 1.2 Project Description

The Mariculture Master Plan (MMP), which would guide the development of a Mariculture (also known as Aquaculture) sector in the Seychelles, comprises four main zones, namely:

- Land-Based Zone Aquaculture;
- Inshore Zone Aquaculture (not covered by this ESIA);
- Aquaculture Development Zones (ADZs); and
- Offshore Zone Aquaculture (not covered by this ESIA).

Carrying capacity scenarios were created based on a high-level assessment of potential factors that would determine the potential expansion of the industry. These included, conflict with existing resource users, market demand and availability, infrastructure, and innovative technology in other aquaculture industries, e.g., the salmon industry in Norway.

Three possible carrying-capacity scenarios with different aquaculture development opportunities have been identified:

- The low-road scenario;
- The mid-road scenario; and
- The high-road scenario.

This ESIA focuses on finfish cage culture within the ADZs, which makes up a component of the mid-road scenario.

During the site selection and evaluation process of potential ADZs, a number of sites were identified and initially 16 were shortlisted. After a thorough analysis of the prevailing bio-physical and social receptors at each site, the number was reduced to 12 ADZs which were taken forward in this ESIA.

Due to the nature of the industry development, operators may end up using different cages, feeding technologies as well as other support infrastructure, i.e., well boats or workboats.

The project components covered under this ESIA and assessed in this CHIA are all located in the Inner Islands of the Seychelles (Figure 1), constitute the Project area, and are presented below:



### 1.2.1 Land-Based Zone Aquaculture

As part of land-based aquaculture, a Research & Development (R&D) Facility and Broodstock Quarantine & Acclimation Facility (BQAF) will also be built on Mahé. Both facilities will be multipurpose buildings and will be important for sustainable growth and development of the MMP.

#### **Research and Development (R&D) Facility:**

The R&D Facility is located at Anse Royale, 8 km from the Mahé International Airport, and 18 km from the capital Victoria (Figure 2). The site is on the southern grounds of the University of Seychelles (UNISEY) and is easily accessible and well serviced by road networks. The area has a very gentle slope and is situated next to an artificial canal. The canal leads under the East Coast Road, into the sea, offering good access for water supply and waste discharge pipes from the facility into the sea with minimal environmental or aesthetic impacts (Figure 3 and Figure 4).

The facility has two distinct sites: the “inland” area (where two sites/positions are being considered in close proximity to each other) adjacent to the University of Seychelles where the R&D centre is proposed to be situated, and the “beach” area 200 m east, adjacent to the SFA ice plant. The beach site links the R&D centre to the sea and the Pilot Project cage operation at Providence, which will be developed and operate in conjunction with the R&D Facility.

As part of the R&D Facility, the water storage reservoir and water abstraction and discharge pipe will be assessed for impact. The R&D Facility cannot function without a constant supply of water.

#### **Broodstock Quarantine and Acclimation Facility:**

The BQAF is located in Providence, Mahé (Figure 2 and Figure 5). The site is located at the Providence Harbour adjacent to the shoreline providing convenient access to water supply and cost-effective pumping with minimal head (water pressure). Bulk infrastructure including port infrastructure, unused existing warehousing, electricity and fresh water is available at this site, which also has existing road access. Facilities including ablutions and offices are also available on site. This site also has the benefit of being located adjacent to the SFA Providence Office.

#### **Pilot Project Cage Site:**

The planned Pilot Project forms a strategic link between the activities of the R&D Facility and the commercial scale projects. The Pilot Project is scaled at 200 tonnes per annum and aims to grow-out candidate species to a marketable size for sale in the domestic market and for shipment as product samples to target international markets.

The Pilot Project cage site will be located at Providence, Mahé as indicated in Figure 6.

### 1.2.2 Aquaculture Development Zones (ADZs)

Aquaculture Development Zones (ADZs) refers to identified finfish cage culture zones as part of the MMP. Individual fish farms with floating cages will operate inside ADZs. These cages will be serviced daily from land and will be located at a distance greater than 2 km from land (the 2 km distance from shore criterion was applied only where the shore (in direct line of sight) was inhabited. The site selection criteria is discussed further in the main ESIA Report). In-depth analysis and research has been undertaken in order to select each ADZ based on environmental and ecological criteria. The proposed ADZs are shown in Figure 7.



The 12 zones provide a total of 53.2 km<sup>2</sup> for the initial development of the sector. At each location floating finfish cages along, with a yet to be determined, amount of floating infrastructure (i.e., service vessels, and possibly on-site feed barges) will be anchored to the seabed. In some cases or at some times the lead lines of the cage nets may contact the seabed. Eight of the 12 sites are relatively well sheltered from the SE Monsoon, one is partly sheltered and three are not protected.

## 2.0 TERMS OF REFERENCE AND CULTURAL HERITAGE TERMINOLOGY

### 2.1 Terms of Reference

The terms of reference for this CHIA build on the results of the previously completed cultural heritage overview assessment (CHOA) (Golder 2016), which can be found under APPENDIX A. The objectives and methodology of the CHOA are detailed in Section 3, and the results of the CHOA, or baseline data, are summarized in Section 4. In addition to background and baseline data, the CHOA assessed for the presence, and the potential presence, of cultural heritage, including shipwrecks and other archaeological sites, to be present within the Project area.

The terms of reference for this CHIA may be summarized as follows:

- Quantify the potential (probability) for the presence of cultural heritage;
- Describe the nature of possible impacts from Project-related activities on cultural heritage potentially present; and,
- Recommend measures to reduce or mitigate the possible impacts caused by Project-related activities.

### 2.2 Terminology

Cultural heritage is a non-renewable resource. According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), cultural heritage “is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations”. Cultural heritage can be tangible or intangible. Examples of tangible cultural heritage are:

- Movable cultural heritage such as paintings, sculptures, coins or manuscripts, and historic ships;
- Immovable cultural heritage such as monuments and archaeological sites; and,
- Underwater cultural heritage such as shipwrecks and submerged ruins.

Examples of Intangible cultural heritage include oral traditions, performing arts and rituals.

Given the location of the Project area and the results of the background review (Golder 2016), the type of cultural heritage which may be potentially present in different component areas of the Project area may be defined as follows:

#### **Sites related to shipwrecks (and aircraft wrecks):**

These archaeological sites are often recorded historically as accident events, but only infrequently are these events associated with recorded wreck site locations. Abandonments are less likely to be recorded. Wreck sites are typically located underwater, but may be found buried at inshore locations, particularly when the result of abandonment.



### Sites related to maritime archaeology:

For the purposes of this assessment, maritime archaeological sites may comprise buried artifacts, ruins, or structures more likely to be found in the terrestrial context, but also potentially found in the intertidal and shallow sub-tidal areas. The key for estimating potential for maritime archaeological sites is the coastal setting, and an assumed maritime orientation of the culture, so that key predictors for site location include favourable boat landing sites, locations within natural harbours or behind offshore islands, and proximity to navigable breaks in reef systems, a fresh water outlet, or other coastal resource.

## 3.0 DUE DILIGENCE REVIEW

At the outset of the ESIA, Golder understood that one or more relevant archaeological studies were available for the Project area. Subsequently, it became apparent that no previous studies had been conducted. This was the critical gap that was partially addressed through the completion of the CHOA (Golder 2016).

### 3.1 Cultural Heritage Overview Assessment

The CHOA was completed with the following objectives in support of the ESIA:

- 1) Identify known cultural heritage sites in the Project area, to the degree possible, using existing records;
- 2) Identify and evaluate the potential for archaeological sites, including ship and aircraft wrecks within of the Project area; and,
- 3) Assess the need for more detailed heritage investigations related to the Project.

#### 3.1.1 CHOA Methods

To achieve the preceding objectives, the CHOA employed desk-top review methodologies to conduct a review of available background sources, including selected field data previously collected, that were relevant to the assessment of cultural heritage, with a focus on ship and aircraft wrecks, within the Land-Based Zone (BQAF, R&D facility, associated water intake pipelines and pilot project cage site) and the ADZs.

During the desk-top review, readily available historical and archaeological sources describing the settlement and development of the region, including reports and other evidence of vessels and aircraft lost or abandoned in the vicinity of the Project area, were reviewed and summarized. As human use of the region is, in large part, dictated by the environment, Project area information related to the physical landscape, geology, oceanography, and associated resources was also reviewed and summarized.

Sources consulted or reviewed included:

- Published information available locally and on-line related to the geology, biogeography, oceanography, archaeology, history, and industrial development of the Project area;
- Previous Project-related studies;
- Marine charts;
- Local historians and researchers; and,
- Local dive tour companies.



# MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

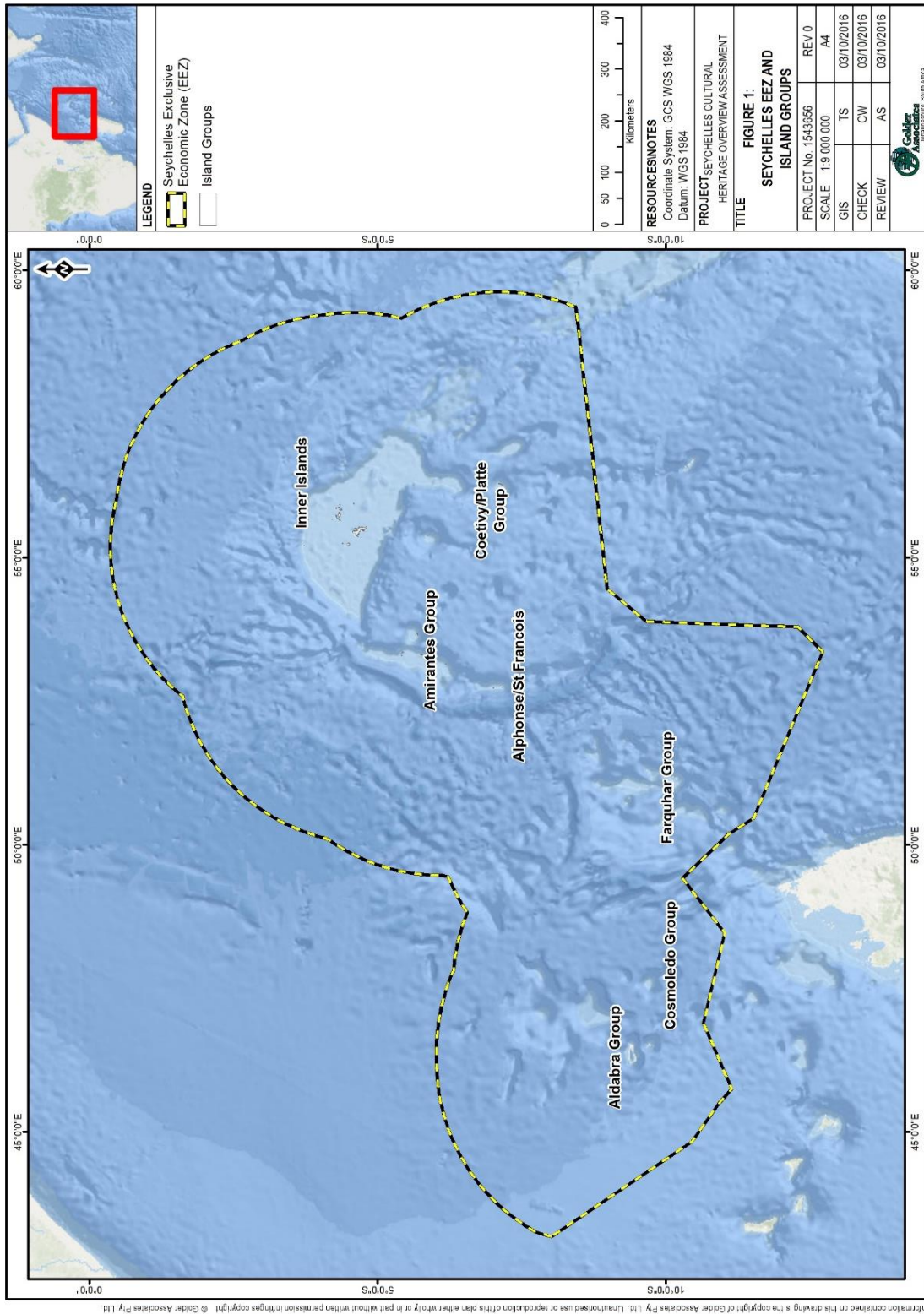


Figure 1: Seychelles EEZ and island groups.





Figure 2: Land-based aquaculture zone.

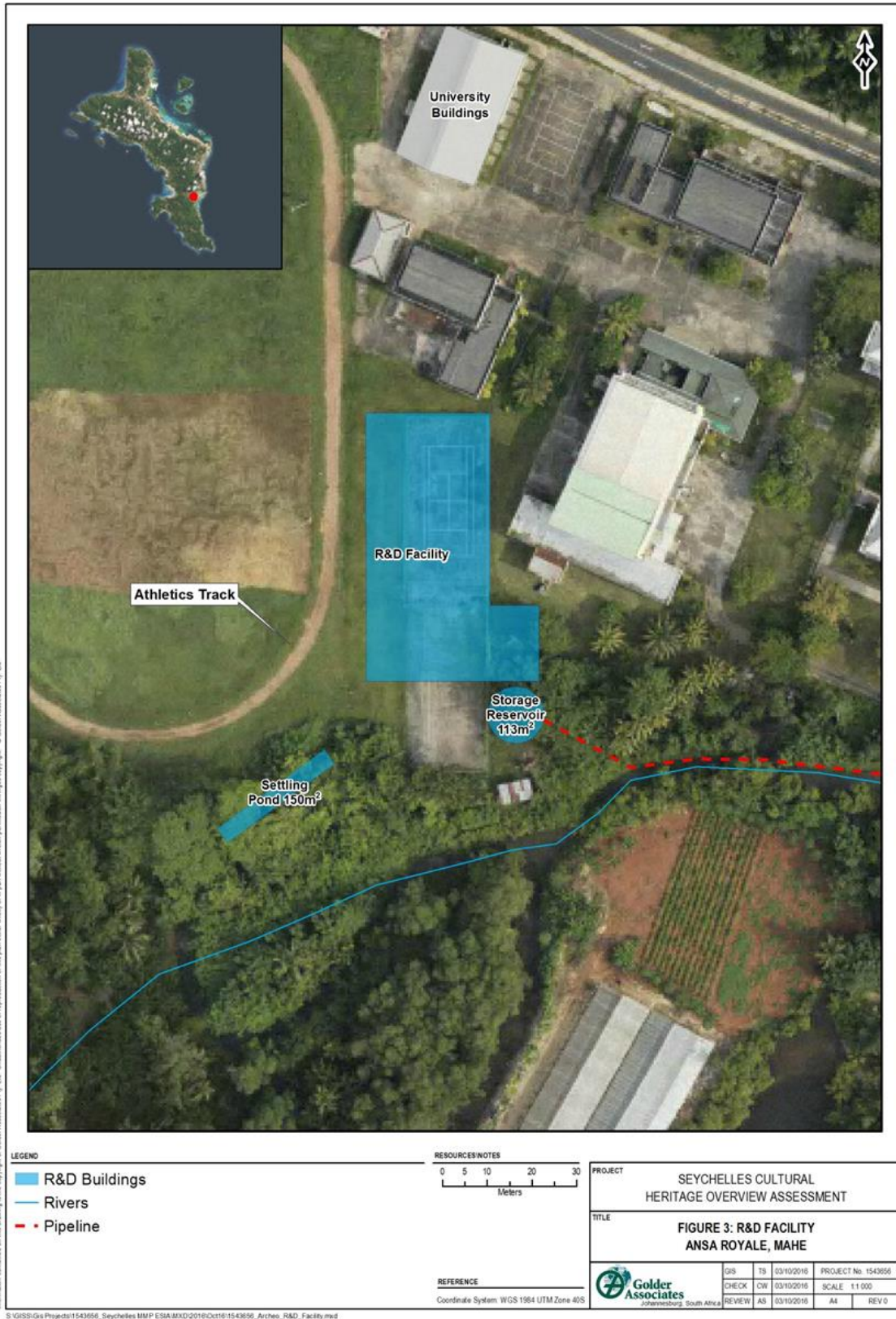


Figure 3: R&D Facility, Anse Royale, Mahé.



Figure 4: R&D Facility with water intake pipe, Anse Royale, Mahé.



Figure 5: Broodstock acclimation facility, Providence, Mahé.



Figure 6: Pilot Project, Providence, Mahé.



### **3.1.1.1 *Criteria for Estimating Ship and Aircraft Wreck Locations Based on Historical Record Review***

Few wrecking events that are known to have occurred historically are currently associated with documented wreck remains on the sea bed. Estimating the likelihood of a reported historical casualty being represented today by physical remains of the wreck, or underwater historical resource, existing on the seabed within a Project area based on archival information alone, involves cross-checking available records and reliance on informed assumptions.

Historical wreck records are often vague in location, unless there is a very close correlation between the wrecking event and a known landmark. Before the advent of radio communications and radar or other forms of electronic navigation, the farther from land the more approximate the description. For an archipelago such as the Seychelles which is comprised of numerous islands extending over nearly 1.5 million square kilometres, a ship or aircraft wrecking event that is described as having occurred in the Seychelles requires further research to possibly determine a more precise location and potential relationship to the Project area.

### **3.1.2 *Potential Assessment for Cultural Heritage***

The Project area was classified as having either 'potential for cultural heritage' or 'low potential for cultural heritage'. Areas designated with low potential for cultural heritage are locations where the discovery of an archaeological site or historic wreck is considered to be unlikely. In contrast, areas classified with potential for cultural heritage are locations where the criteria above suggest that the discovery of an archaeological site or historic wreck is more likely.

#### **3.1.2.1 *Terrestrial Archaeological Potential***

To assess the potential presence of terrestrial archaeological sites within the Project area, factors such as the proximity to known archaeological sites and landscape characteristics that are favourable for human occupation within coastal environments are considered. Within the terrestrial component of the Project area, located as it is in coastal environment, landscape characteristics that are favourable for human occupation, thereby increasing archaeological potential, include; access to freshwater and food resources, embayment's or protected shorelines where watercraft can land, as well as areas adjacent to protected anchorages and reef breaks.

#### **3.1.2.2 *Historical Wreck Potential***

To assess the potential presence of wrecks located underwater within a Project area, a list of aircraft and vessels understood through archival research to have been casualties resulting in total loss in an area was assembled. Patterns of loss locations over time which are evident in the record of casualties contribute to the understanding of where, when and how (causes) vessels have most frequently been lost. Environmental factors may create hazards to navigation including: exposure to long fetches (where waves may propagate without barriers) and strong winds; strong tidal currents; reefs and jutting headlands. Human factors play into the natural environment primarily with shipping volume correlating with hazardous areas, but also to less exposed areas where port or other shore facilities were located.

Even in protected waters, vessels that were moored or anchored unattended or short-crewed might be vulnerable to sudden winds blowing them ashore, or to fire. As well, abandonments may be expected, resulting in derelict boats sinking at anchor or being intentionally sunk (Muckelroy 1978; Richards 2008). Vessel abandonments are less likely to be represented in the historic record, owing to the lack of a single dramatic event like a wrecking, but are more likely to occur in shallow and protected water, and therefore more likely to



be found in a terrestrial context provided shoreline progradation over the site through natural sediment accumulation or the placement of artificial fill for land reclamation.

### 3.1.3 Reporting, Recommendations and Options for Further Survey

In the event that cultural heritage is located where Project-related impacts are anticipated, the preferred course of action is avoidance, which may require project redesign. When and where avoidance is not possible, the recommended mitigation will likely include systematic recording (e.g., documentation, excavation, recovery and analysis of materials at the site) to offset the Project-related impacts.

Where the potential for the presence for cultural heritage has been identified there are a number of strategies available for investigating for the presence of cultural heritage, thereby mitigating against the unexpected discovery, and unmitigated impacts, during construction and operation of the Project. In terrestrial areas where the cultural heritage potential was identified, recommendations for further investigative work may include pedestrian survey, subsurface testing, or construction monitoring.

In an underwater context, the equivalent of a pedestrian survey is a visual investigation conducted by diver or by camera mounted on an underwater remotely operated vehicle (ROV). The disadvantage in the underwater environment is that the visual range while highly variable is comparatively limited. Geophysical survey methods available for use, and which may cover a larger area underwater, include acoustic data collection from side scan sonar, synthetic aperture sonar, or multi-beam bathymetry. These methods may provide images of wrecks showing above the surface of the seabed (analogous to aerial LiDAR survey over land). Sub-bottom profiling and magnetometry may provide data regarding material buried in the sea bed. The geophysical survey for submerged cultural heritage should be the first phase of an investigative program, followed by ground-truthing, or a visual investigation, of targets or anomalies identified in the geophysical record.

Where the potential for a cultural heritage has been identified but the potential is considered relatively low, the implementation of a **chance find procedure** may be recommended whereby direction will provided to the Seychelles Fishing Authority for distribution to individual aquaculture developers on how to recognize an archaeological site on land or on the seabed, and how to report on its chance find in the Project area.

Where the potential for a cultural heritage site has not been identified, the recommendation would be for no further study or mitigation.

### 3.1.4 CHOA Gap Analysis

The following summarizes some gaps and limitations identified as part of the CHOA:

- As a desk-top study the CHOA did not benefit from pedestrian or other visual survey of the Project area which could result in refinement to the potential assessment;
- During the background review, it was not possible to access the Seychelles Natural History Museum or the National Archives due to their closure resulting from a fungus infestation;
- A representative of the Seychelles Ministry of Tourism and Culture was contacted to discuss whether a list of monument or relics, as described in the NMA, other than those identified as National Monuments is maintained by the Ministry or National Monuments Board. Unfortunately, the representative was not able to reply to this query in time for the completion of this study;
- No published reports regarding terrestrial based archaeological investigations in the Seychelles were identified during the CHOA. If terrestrial archaeological investigations have been undertaken in the



Seychelles, a review of the results of these investigations would be beneficial in determining terrestrial archaeological potential and site types;

- Some underwater video was collected during the conduct of other studies for this project. The video was not reviewed as it would not add value to establishing the potential for the presence of a wreck site. If a possible wreck site were located, it would be of benefit to view the features of interest, even remotely by video; and,
- Access to marine geophysical data was not available for this review. Marine geophysical data appropriate for archaeological review is commonly acquired via magnetometry, sidescan sonar and sub-bottom profiling surveys of a Project area. These data are beneficial to assess for anomalies which may correspond with submerged wrecks, particularly over a large area and where buried wrecks may be present.

### 4.0 HERITAGE BASELINE

The CHOA (Golder 2016) resulted in the identification of 20 vessels and 2 aircraft reported wrecked in the vicinity of the Project. The CHOA did not result in the identification of cultural heritage located within the Project area (Figures 8 – 10).

Areas considered to have potential for cultural heritage were identified within the Land-based Aquaculture Zone and the ADZs. Within the Land-based Aquaculture Zone, the potential exists for cultural heritage material to be encountered in terrestrial areas close to the shore at the proposed R&D Facility for both shipwreck and maritime archaeological sites, although the CHOA concluded that the potential is considered insufficient to warrant further investigation.

The offshore portions of the BQAF and the R&D Facility are located in shallow water, in proximity to reefs, and, in the case of the BQAF and nearby Pilot Project Cage Site, are located in a harbour area where a number of wreck events have been reported. **The CHOA concluded that the potential for the presence of wrecks is sufficient in these specific areas to warrant further investigation.**

There is potential for previously unreported wrecks to be found, in various levels of probability, in all the ADZs in the Project area. Because of their locations somewhat offshore, on sandy seabeds, away from known wreck sites, however, the CHOA concluded that the wreck potential **does not warrant further archaeological investigation.**

### 4.1 CHOA Recommendations

The CHOA provided recommendations for additional archaeological work or mitigation for the potential presence of cultural heritage sites as follows:

- Further investigation by diver survey conducted prior to construction by a qualified archaeologist of the Project footprint of the offshore components at the R&D Facility, the BQAF (water intake pipelines respectively), and the Pilot Project Cage Site; and,
- For the remaining parts of the Project area including the ADZs, where a lower potential for the presence of cultural heritage is identified and further investigations are not recommended, a chance find procedure be implemented, supported by a chance find document specific to the Project.





# MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

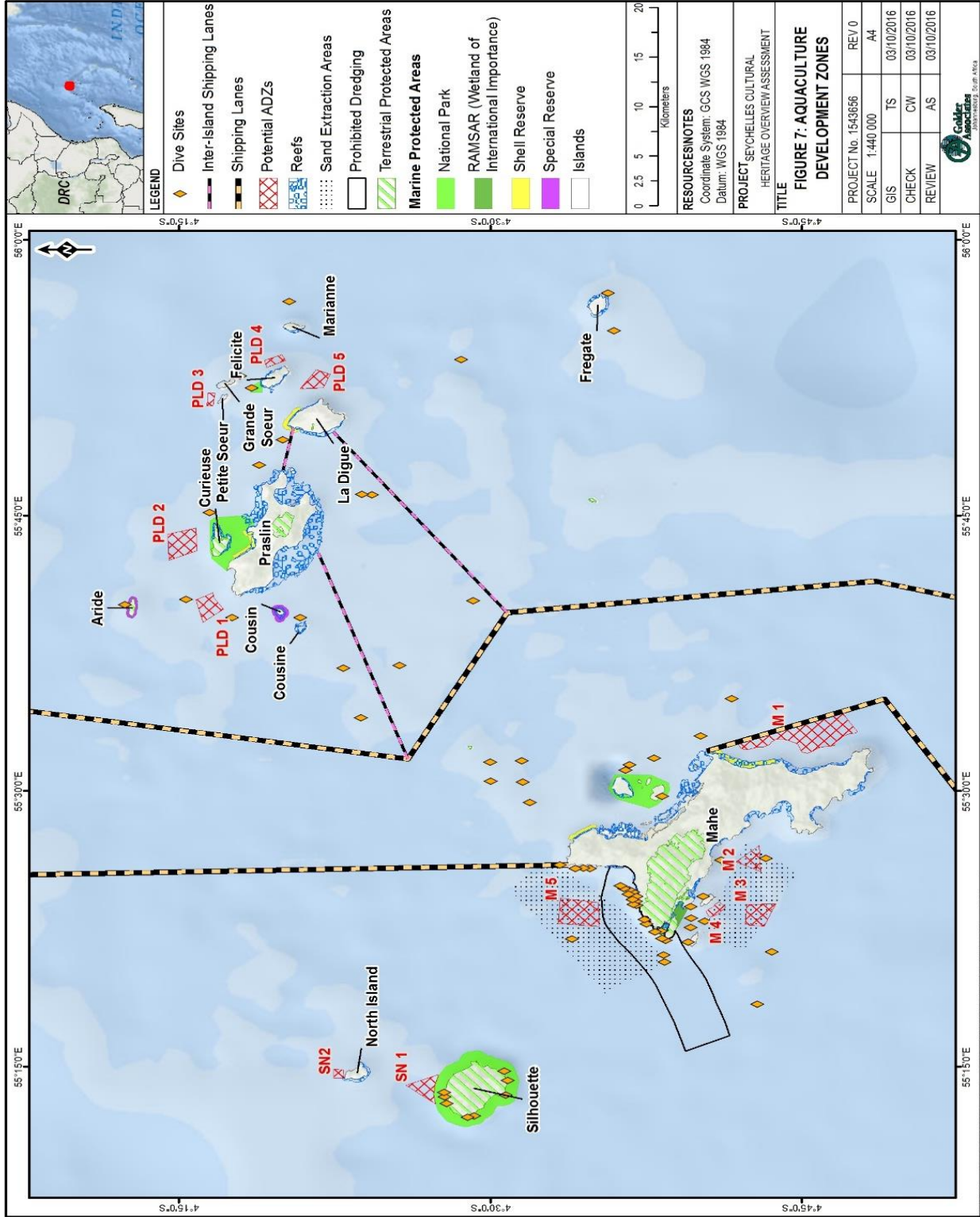


Figure 7: Aquaculture development zones.



# MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

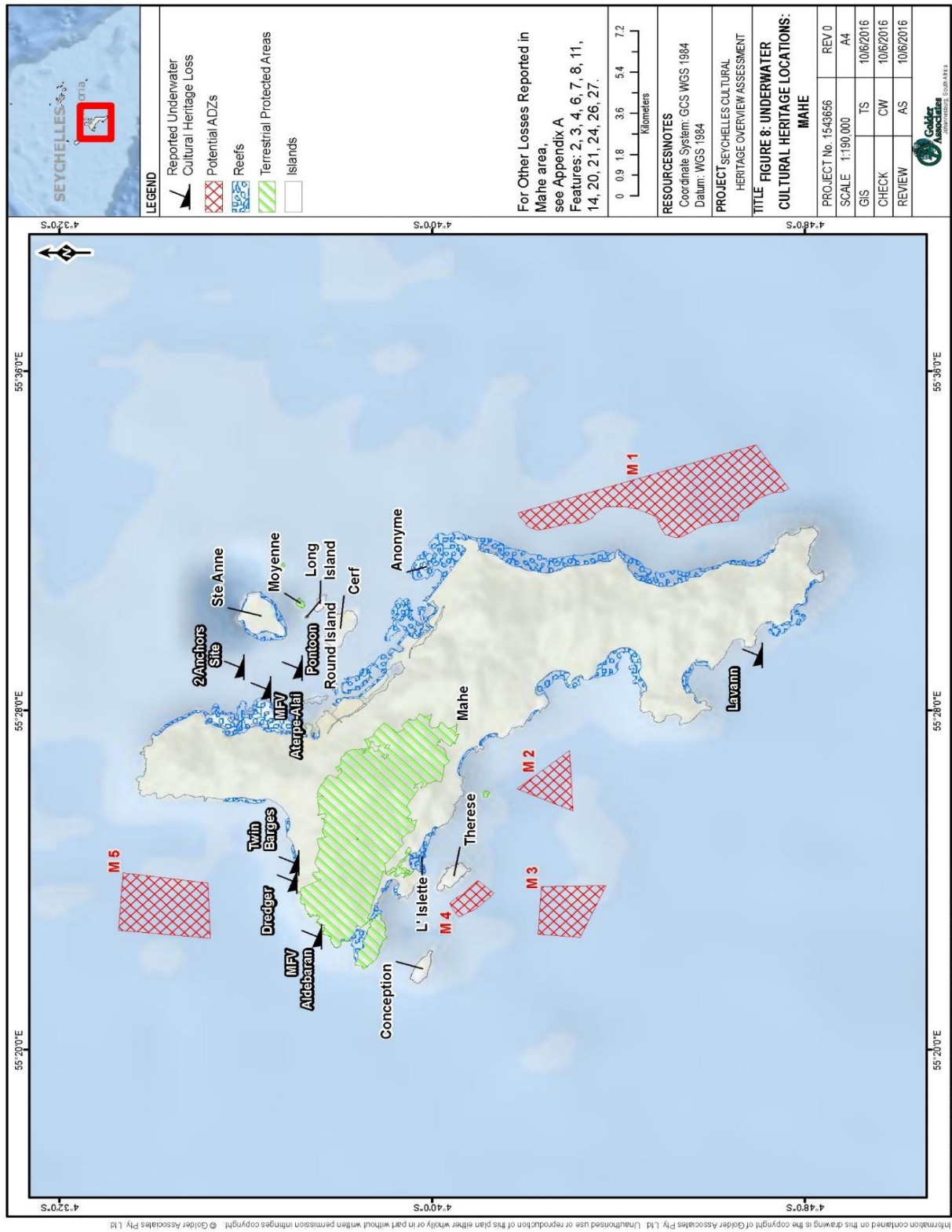


Figure 8: Underwater cultural heritage locations: Mahé.



# MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

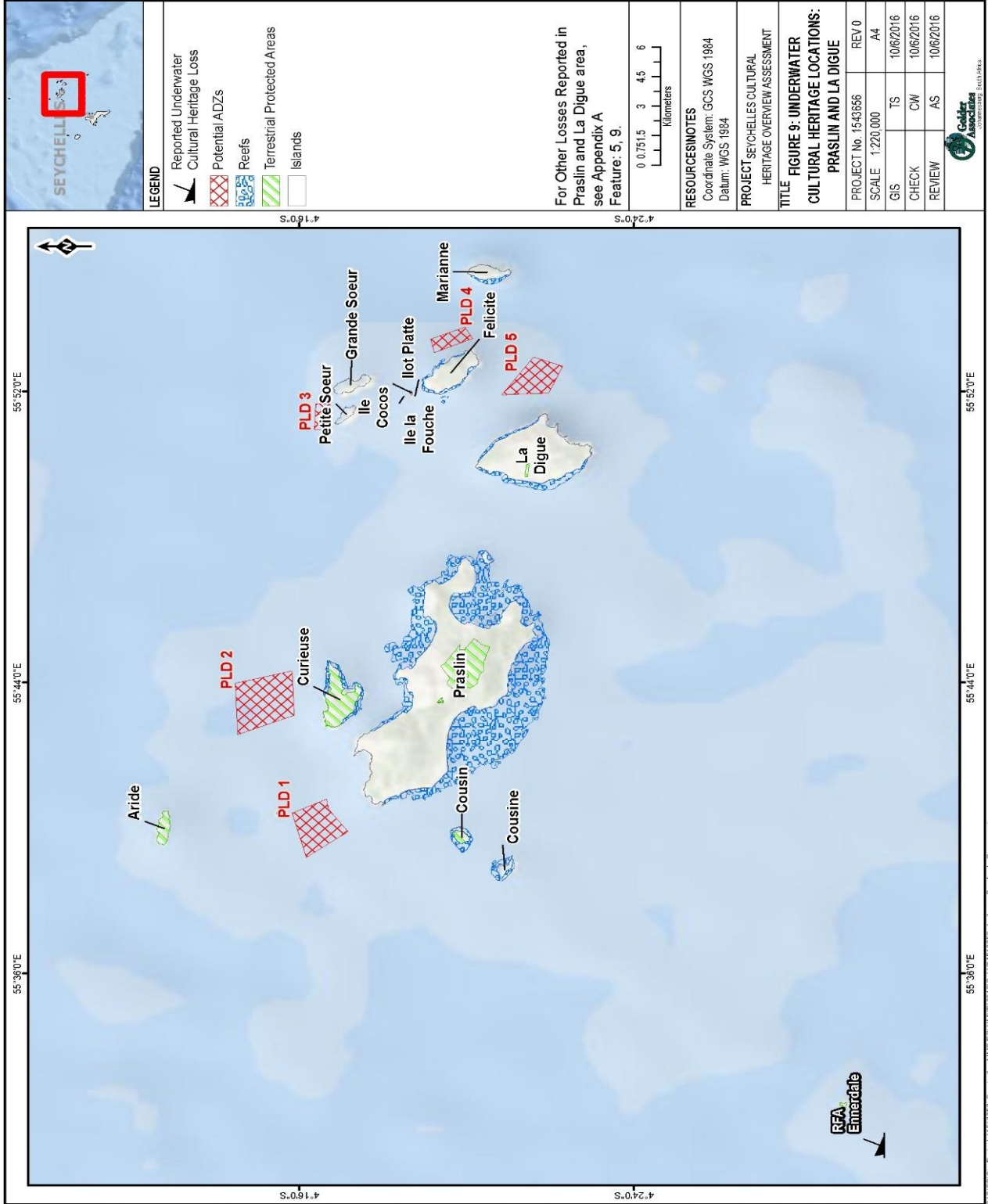


Figure 9: Underwater cultural heritage locations: Praslin and La Digue.



# MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

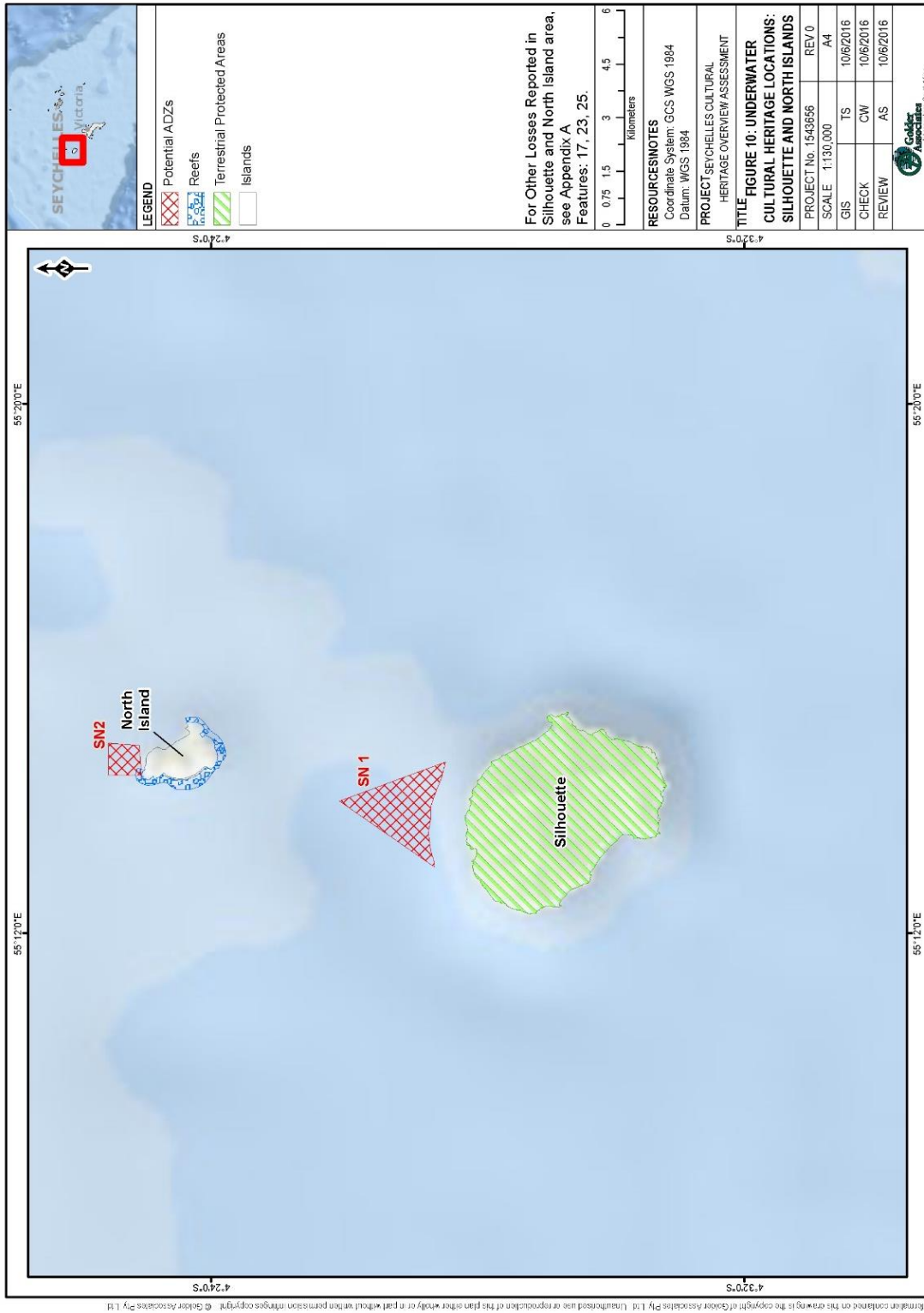


Figure 10: Underwater cultural heritage locations: Silhouette and North Islands.



### 5.0 IMPACT ASSESSMENT

The impact assessment for cultural heritage which follows begins with a review of the relevant legislation and conventions, followed by potential impacts of the Project should cultural heritage be present, and methodology of the assessment.

#### 5.1 Relevant Legislation

The International Finance Corporation requires as part of its Sustainability Framework that, in addition to applicable laws (national and international), the host nation comply with international conventions (i.e., Convention Concerning the Protection of the World Cultural and Natural Heritage [UNESCO 1972]) “to ensure that internationally recognized practices for the protection, field-based study and documentation of cultural heritage are implemented” (IFC 2012). Relevant national and international law, as well the UNESCO convention guiding best practice for underwater cultural heritage, are presented below.

##### 5.1.1 National Monuments Act

In the Seychelles, cultural heritage may be afforded protection under the 1980 *National Monuments Act* (NMA) through designation as a monument or relic (Government of Seychelles 1980). The NMA defines a monument as “any ancient or national monument; any area of land which is of archaeological or historical interest or which contains objects of such interest; any old building or other structure; any other object (whether natural or constructed by man) of aesthetic, archaeological, historical or scientific value or interest”. A relic is defined as “any fossil of any kind; any object of aesthetic, archaeological, historical or scientific value or interest; any anthropological or archaeological contents of any monument.” An ancient monument is considered to be “any building, ruin, pillar, statue, grave or other site or thing of a similar kind, or any remains thereof, which is known or believed to have been erected, constructed or used before 1st January, 1900”, while a national monument is any monument declared to be a national monument by the National Monuments Board pursuant to Section 5 of the NMA.

Section 8 of the NMA prohibits a person from altering, destroying, damaging, moving from its original site, exporting from the Seychelles or carrying out work that may cause injury or disturbance to any ancient monument, national monument or relic, or any part thereof without written consent from the National Monuments Board. Contravention of the NMA can result in a fine of SCR.5,000 and imprisonment for 2 years.

##### 5.1.2 International Law

In addition to state law, international laws related to, or providing provision for the protection of underwater cultural heritage have been established primarily through treaty. These laws include the 1982 United Nations Convention on the Law of the Sea (UNCLOS 1982), and the UNESCO Convention on the Protection of the Underwater Cultural Heritage (UNESCO 2001a). Established admiralty laws such as those regarding salvage may also be applicable to situations involving the protection of underwater cultural heritage and have been adopted internationally through the International Maritime Organization’s 1989 International Salvage Convention which provides a State the option to not apply the provisions of the Convention in instances where “maritime cultural property of prehistoric, archaeological or historical interest and is situated on the sea-bed” is involved.

Further, the concepts of the sovereign immunity of warships and state ships on non-commercial services, whether sunken or not, primarily on the basis that the State has not relinquished rights to the vessel (Roach 1996; Harris 2001) and of sunken warships as gravesites that are afforded the traditional protection thereof (Harris 2002) may also be applicable statutes for the protection of underwater cultural heritage. Legislation



such as the British *Protection of Military Remains Act* (1986) further asserts the protection of sunken warships and aircraft as a war grave (Government of England 1986).

### 5.1.3 United Nations Convention on the Law of the Sea

During the latter half of the 20<sup>th</sup> Century, three conferences on the Law of the Sea were held by the United Nations (Dromgoole 2013). The most pertinent of which to the protection of underwater cultural heritage was the third conference, which began in 1973 and resulted in the United Nations 1982 Convention on the Law of the Sea (UNCLOS 1982). Containing 320 articles, the UNCLOS is rooted in historical custom and practice and is primarily concerned with establishing a legal order for the seas; including defining the legal status of the sea-bed, subsoil and air space above. The UNCLOS was ratified by the Seychelles in 1991 (UNCLOS 2008).

Two articles within the UNCLOS, Article 149 and Article 303 directly confer limited protection to underwater cultural heritage. Article 96 reinforced the notion of sovereign immunity for State owned or operated ships on government non-commercial service, however, it does not address the relationship of sovereign immunity and sunken vessels. Article 149, affords protection to archaeological and historical objects found within the Area, ostensibly, the deep sea by stating that such objects be preserved or disposed of for the benefit of mankind as a whole. Unfortunately, no qualification as to what is considered an archaeological or historical object is provided within the UNCLOS and the implementation of the protection afforded to these objects as a result of Article 149 is unclear as no responsible oversight body is declared (Dromgoole 2013). With respect to underwater cultural heritage located outside of the Area, no reference is made, implying that national jurisdiction would apply. Article 303 declares that States have the duty to protect objects of an archaeological and historical nature found at sea.

### 5.1.4 UNESCO Convention on the Protection of the Underwater Cultural Heritage

Resulting from an awareness that emerging technologies were making the depths of the oceans more accessible to human exploration than at any time in the past, and realizing the threat to underwater cultural heritage resulting from that exploration, the UNESCO Convention on the Protection of the Underwater Cultural Heritage (CPUCH) entered into force in 2009 (UNESCO 2001a). The Seychelles is not one of the 55 countries that, at present, has ratified the CPUCH, however, the convention has provided the framework for opportunities for international collaboration in underwater cultural heritage resource management in the western Indian Ocean region (Lane 2007).

The CPUCH defines underwater cultural heritage as “all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years.” Comprising 35 articles and an annex containing 36 rules, the CPUCH is considered to be international best practice with respect to the protection of underwater cultural heritage and contains language protecting sunken warships however it does not go as far as confirming sovereign immunity (Dromgoole 2013). The CPUCH does not prohibit disturbing or damaging underwater cultural heritage it does presume that underwater cultural heritage will be preserved in-situ unless required for scientific or protective reasons and that activities impacting underwater cultural heritage will be done following the archaeological standards and methods outlined in the annex (UNESCO 2001b).

## 5.2 Impact Identification

The following potential impacts to cultural heritage may occur during the construction, operational and decommissioning phases of the proposed MMP.



### 5.2.1 Construction Phases

It is anticipated that the construction of the Land-based Aquaculture Zone components will result in impact to surface and subsurface sediments within the Project area. These sediments may contain cultural heritage.

The cage components for the Pilot Project and fish farms within ADZs as well as work boats will require anchorage. The anchors and chains associated with these equipment will result in impact to the seabed and underwater cultural heritage, if present.

### 5.2.2 Operational Phase

The MMP will have a lifespan of 25 years at least, possibly much longer. Potential impacts to cultural heritage, if present, during the operation of the MMP are considered to be limited to sea bed impacts as a result of anchors and chains associated with the cages and work boats servicing the Pilot Project and ADZ.

### 5.2.3 Decommissioning Phase

It is assumed that potential impacts to cultural heritage during the decommissioning phase will be limited to anchors and chains associated with work boats dismantling the Pilot Project and ADZ cages.

### 5.2.4 Cumulative impacts

As there are no known cultural heritage resources or archaeological features in or adjacent to the Project area, no cumulative impacts are considered.

## 5.3 Methods

From a technical, conceptual or philosophical perspective the focus of impact assessment ultimately narrows down to a judgment on whether the predicted impacts are significant or not. The concept of significance is at the core of impact identification, prediction, evaluation and decision-making. The determination of significant impacts relates to the degree of change in the environmental resource measured against some standard or threshold. This requires a definition of the magnitude, prevalence, duration, frequency and likelihood of potential change. The following criteria are used for the description of the magnitude and significance of impacts.

The consequence of impacts can be derived by considering the following criteria:

- Extent or spatial scale of the impact;
- Intensity or severity of the impact;
- Duration of the impact;
- Potential for mitigation;
- Acceptability;
- Degree of certainty/probability;
- Status of the impact; and
- Legal requirements.

Potential impacts were assessed using the calculations and rating system, as provided in **Table 1** and **Table 2**.



**Table 1:** Impact ranking matrix.

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Magnitude (severity) of impact	Scale / extent of impact

Note: To assess each impact, the following four ranking scales are used

PROBABILITY	DURATION
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8-15 years)
2 - Low probability	2 - Short-term (0-7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
SCALE	MAGNITUDE
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

The significance of the two aspects, occurrence and severity, is assessed using the following formula:

$$SP \text{ (significance points)} = (\text{magnitude} + \text{duration} + \text{scale}) \times \text{probability}$$

The maximum value is 100 significance points (SP). The impact significance points are assigned a rating of high, medium or low with respect to their environmental impact as follows (**Table 2**):

**Table 2:** Significance ratings.

<b>SP &gt;75</b>	Indicates <b>high</b> environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
<b>SP 30 – 75</b>	Indicates <b>moderate</b> environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
<b>SP &lt;30</b>	Indicates <b>low</b> environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
<b>+</b>	Positive impact	An impact that is likely to result in positive consequences/effects.





### 5.3.1 Significance Criteria for Cultural Heritage

The assessment of impacts to cultural heritage, a resource which is non-renewable and not known to exist within the Project area, requires the further refinement to the methods outlined above, through criteria listed as follows:

#### Impact Probability Criteria:

The presence/absence of cultural heritage is unknown in that no known cultural heritage exists within the Project area, however, some potential for the presence of unrecorded archaeological sites has been assessed. Rather than identify the level of Probability at 10 (“don’t know” in Table 1 above), this assessment will equate a **variable rank of Probability** with a rank of potential, (or the likelihood, probability), that an archaeological site may be located in the specific area.

#### Impact Duration Criteria:

As an archaeological site is a non-renewable resource, any impacts may be taken to be irreversible and permanent (**Duration rank of 5**).

#### Impact Scale Criteria:

For an unknown resource, it is not possible to determine scale, however, the range of impacts to an archaeological site could range from regional to international significance. International significance (**Scale rank of 5**) is therefore assumed in absence of more information.

#### Impact Magnitude Criteria

For an unknown resource, it is also not possible to determine scale, however, as a “don’t know” level for magnitude is listed in Table 1, the corresponding **Magnitude level 5** will be selected.

#### Degree of confidence in prediction of impact:

The degree of confidence for the impact predictions listed below is **Medium** to reflect both the low certainty regarding the presence of cultural heritage to be impacted with relatively high confidence regarding the impacts to cultural heritage if present.

## 5.4 Impact Assessment and Mitigation Measures

### 5.4.1 Construction / Implementation

Impacts to cultural heritage, if present, during the construction and implementation phase will vary according to type of equipment and depth of subsurface disturbance (into ground or seabed). Generally, impacts may be expected on land and inter-tidal areas from excavations for pipes, and services and foundations related to the building construction. In the sub-tidal areas impacts may be expected to cultural heritage, if present, from excavations (if required for pipes offshore), the placement of structure (intake pipes), and the placement of anchors and ground tackle for vessel engaged in constructing of intake pipes and the cages.

The potential impact of construction for the offshore components (intake pipes) of the proposed BQAF and Aquaculture R&D Facility sites, the Pilot Project Cage Site was assessed as being of **moderate (SP = 60)** significance (Table 3). The following mitigation measures are recommended to reduce the impact assessment to **moderate (SP = 36)** significance reflecting no change in probability but a magnitude reduced to low:



- A diver survey by a qualified archaeologist to determine the presence/absence of a submerged archaeological site within the Project area;
- If an archaeological site is observed, this assessment assumes it will be small enough that construction impacts may be avoided through Project redesign; and,
- Even with Project redesign there remains some potential (probability to reduce to improbable [1]) for impacts to an unrecorded archaeological site, to be addressed with chance find procedures.

The potential impact of construction for the ADZ components was assessed as being of **moderate (SP = 40)** significance (Table 3). The following mitigation measure is recommended to reduce the impact assessment to **low (SP = 24)** significance, reflecting no change in probability but magnitude reduced to low:

- The possibility of encountering archaeological materials may be addressed with implementation of chance find procedures with the chance find document tailored to ship and aircraft wreck remains.

The potential impact of construction at the R&D Facility where archaeological potential has been determined (where the intake pipe extends from the sea and where the water pipe parallels the stream/canal) was assessed as being of **moderate (SP = 40)** significance (Table 3). The following mitigation measure is recommended to reduce the impact assessment to **low (SP = 24)** significance, reflecting no change in probability but magnitude reduced to low:

- The possibility of encountering archaeological materials may be addressed with implementation of chance find procedures with the chance find document tailored to buried archaeological materials and structural foundations.

**Table 3:** Impact significance determination for Cultural Heritage during the construction phase.

POTENTIAL ENVIRONMENTAL IMPACT: CONSTRUCTION	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Offshore impacts from excavations, pipe placement, and anchoring for Project construction and pilot project cage place placement.	10	5	5	3	60	Mod	2	5	5	3	36	Mod
Impacts from anchoring for Project construction/ placement of cages in ADZs.	10	5	5	2	40	Mod	2	5	5	2	24	Low
Subsurface impacts in the close to the shore at the proposed R&D Facility	10	5	5	2	40	Mod	2	5	5	2	24	Low

## 5.5 Operation

Potential impacts to cultural heritage, if present, during the operation phase will be limited to ADZs and Pilot Cage Project location. These impacts may occur as a result of anchors and ground tackle associated with the cages and work boats servicing the cages. Mobility of the sandy seabed as well as on-going penetration and scouring of the seabed by the anchors and tackle may lead to the exposure of wreck materials previously buried or unnoticed.



The potential impact of operation at the proposed ADZ and Pilot Project Cage locations was assessed as being of **moderate (SP = 40)** significance. The following mitigation measure is recommended to reduce the impact to one of **low (SP = 24)** significance, reflecting no change in probability but magnitude reduced to low:

- The possibility of encountering archaeological materials may be addressed with implementation of chance find procedures with the chance find document tailored to ship and aircraft wreck remains.

**Table 4:** Impact significance determination for Cultural Heritage during the operation phase.

POTENTIAL ENVIRONMENTAL IMPACT: OPERATION	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Impacts from anchoring of cages and service vessels.	10	5	5	2	40	Mod	2	5	5	2	24	Low

## 5.6 Decommissioning

Potential impacts to cultural heritage, if present, during the decommissioning phase are considered the same as operations. This assumes the decommissioning of the terrestrial components and pipes will not impact a greater area than was disturbed during construction. Decommissioning of the ADZs and Pilot Project Cage location will continue the potential impacts (as previously noted for operation) may occur as a result of anchors and ground tackle associated with the cages and work boats servicing the cages. Mobility of the sandy seabed as well as on-going penetration and scouring of the seabed by the anchors and tackle may lead to the exposure of wreck materials previously buried or unnoticed.

The potential impact of decommissioning at the proposed ADZ and Pilot Project Cage locations was assessed as being of **moderate (SP = 40)** significance. The following mitigation measure is recommended to reduce the impact to one of **low (SP = 24)** significance, reflecting no change in probability but magnitude reduced to low:

- The possibility of encountering archaeological materials may be addressed with implementation of chance find procedures with the chance find document tailored to ship and aircraft wreck remains.

**Table 5:** Impact significance determination for Cultural Heritage during the operation phase.

POTENTIAL ENVIRONMENTAL IMPACT: OPERATION	ENVIRONMENTAL SIGNIFICANCE											
	Before mitigation						After mitigation					
	M	D	S	P	SP	Rating	M	D	S	P	SP	Rating
Impacts from anchoring of cages and service vessels.	10	5	5	2	40	Mod	2	5	5	2	24	Low

### 5.6.1 Mitigation Measures

Mitigation measures which may be employed to address the possibility of Project-related impacts to cultural heritage are detailed below.



### 5.6.1.1 Dive Survey

The CHOA (Golder 2016) recommended that a dive survey be conducted by a qualified archaeologist in marine areas of the Project where the potential for cultural heritage was identified. The dive survey may consist of divers operating with snorkel on the surface and/or SCUBA underwater, depending on water depth and visibility, while conducting systematic traverses of the Project area where the potential for an underwater archaeological site was identified. Traverses would be recorded via GPS mounted to a surface float towed by a diver. The location of confirmed and suspected archaeological material would be recorded via GPS. Confirmed cultural heritage encountered underwater would be photographed and if considered necessary by the archaeologist, mapped.

In the event that underwater archaeological site is encountered during the dive survey, it is anticipated that a Project redesign would be recommended to avoid Project-related impacts to the site. If Project-related impacts cannot be avoided, appropriate mitigation recommendations would be provided (e.g. documentation, excavation etc.).

### 5.6.1.2 Chance Find Procedure

Project-related activity within areas that were determined during the CHOA to not require further inspection may rely on a Project-specific chance find procedure. The chance find procedure is laid out in a document that would be distributed to the SFA, Project developers and their subcontractors. This document would provide the following to help people in the field recognize a possible archaeological site or materials:

- An illustrated description of what a ship or aircraft wreck might look like in an environment like the Seychelles;
- A brief description with illustrations of a variety of artefacts which might be associated with a shipwreck or other archaeological site in the region;
- An illustrated description of structures such as building foundations which might be found buried within the Project area.

In the event that archaeological materials are encountered, the chance find document would outline the next steps, including who to notify, (i.e., a qualified archaeologist and the appropriate local authorities) depending on the nature of the find, including whether human remains are discovered or considered potentially present.



## 6.0 ENVIRONMENTAL MANAGEMENT PLAN FOR CULTURAL HERITAGE

The EMP and specific mitigation measures for the identified impacts are summarized in this section. The mitigation measures associated with each of the construction/implementation, operational and decommissioning phases are described in **Table 6**.

**Table 6:** Cultural Heritage EMP

Section No	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Time-frame	Monitoring and Reporting Frequency
<b>CONSTRUCTION / IMPLEMENTATION PHASE</b>								
5.4.1	Cultural Heritage (Archaeological site, if present)	Offshore impacts from excavations, pipe placement, and anchoring for Project construction and pilot project cage place placement.	To avoid impacts to unidentified archaeological resources.	The <i>National Monuments Act</i> , applicable international law, and, international conventions to guide internationally recognized practices (section 5.1)	<ul style="list-style-type: none"> <li>Conduct a dive survey in identified Project areas (section 5.6.1.1).</li> <li>If an archaeological site is observed, this assessment assumes it will be of small enough size that construction impacts may be avoided through Project redesign; and,</li> <li>Even with Project redesign there will remain some potential for impacts to an unrecorded archaeological site, to be addressed with chance find procedures.</li> </ul>	Qualified Archaeologist	Prior to Construction Activities	Field survey followed by report with recommendations for Heritage Resource Management.
5.4.1	Cultural Heritage (Archaeological site, if present)	Impacts from anchoring for Project construction/ placement of cages in ADZs.	To observe and avoid further impacts to unidentified archaeological resources.	The <i>National Monuments Act</i> , applicable international law, and, international conventions to guide internationally recognized practices (section 5.1)	<ul style="list-style-type: none"> <li>Implement chance find procedure (section 5.6.1.1).</li> </ul>	SFA, Developers and their sub-contractors, and a qualified consulting archaeologist	Duration of Construction Activities	Chance find.



## MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

Section No	Aspect (of Activity Service or Product)	Potential impact	Objectives	Performance Criteria	Mitigation measure(s)	Responsible person / party	Time-frame	Monitoring and Reporting Frequency
5.4.1	Cultural Heritage (Archaeological site, if present)	Subsurface impacts on land close to the shore at the proposed R&D Facility	To observe and avoid further impacts to unidentified archaeological resources.	<i>The National Monuments Act</i> , applicable international law, and, international conventions to guide internationally recognized practices (section 5.1)	<ul style="list-style-type: none"> <li>Implement chance find procedure (section 5.6.1.1).</li> </ul>	SFA, Developers and their sub-contractors, and a qualified consulting archaeologist	Duration of Construction Activities	Chance find.
<b>OPERATIONAL PHASE</b>								
5.4.1	Cultural Heritage (Archaeological site, if present)	Impacts from anchoring of cages and service vessels.	To observe and avoid further impacts to unidentified archaeological resources.	<i>The National Monuments Act</i> , applicable international law, and, international conventions to guide internationally recognized practices (section 5.1)	<ul style="list-style-type: none"> <li>Implement chance find procedure (section 5.6.1.1).</li> </ul>	SFA, Developers and their sub-contractors, and a qualified consulting archaeologist	Duration of the Operation	Chance find.
<b>DECOMMISSIONING PHASE</b>								
5.4.1	Cultural Heritage (Archaeological site, if present)	Impacts from anchoring of cages and service vessels.	To observe and avoid further impacts to unidentified archaeological resources.	<i>The National Monuments Act</i> , applicable international law, and, international conventions to guide internationally recognized practices (section 5.1)	<ul style="list-style-type: none"> <li>Implement chance find procedure (section 5.6.1.1).</li> </ul>	SFA, Developers and their sub-contractors, and a qualified consulting archaeologist	Duration of decommissioning activities	Chance find.



### 7.0 LIMITATIONS

This report was prepared for the exclusive use of the Seychelles Fishing Authority. Any use, reliance, or decisions made by third parties on the basis of this report are the responsibility of such third parties.

### 8.0 REFERENCES

- Dromgoole, S. 2013. *Underwater Cultural Heritage and International Law*. Cambridge University Press. Cambridge.
- Golder Associates Ltd. 2016. Cultural Heritage Overview Assessment for the Seychelles Mariculture Master Plan. Draft report submitted to the Seychelles Ministry of the Environment, Energy and Climate Change, October 5, 2016.
- Government of England. 1986. *Protection of Military Remains Act*, 1986. Chapter 35. London, England <http://legislation.data.gov.uk/ukpga/1986/35/contents/data.htm?wrap=true>.
- Government of Seychelles. 1980. *National Monuments Act*, 1980. Chapter 140. Consolidated to 30 June 2012. Victoria, Mahé <http://www.seylli.org/sc/legislation/consolidated-act/140>
- Harris, Jason R. 2001. The Protection of Sunken Warships as Gravesites at Sea. *Ocean and Coastal Law Journal*. Volume 7:1.
- Harris, Jason R. 2002. Protecting Sunken Warships as Objects Entitled to Sovereign Immunity. *33 U. Miami Inter-Am. L. Rev.* 101 (2002) Available at: <http://repository.law.miami.edu/umialr/vol33/iss1/4>.
- International Finance Corporation (IFC). 2012. Cultural Heritage. Performance Standard 8 (January 1, 2012). On-line resource at [http://www.ifc.org/wps/wcm/connect/dd8d3d0049a791a6b855faa8c6a8312a/PS8\\_English\\_2012.pdf?MOD=AJPERES](http://www.ifc.org/wps/wcm/connect/dd8d3d0049a791a6b855faa8c6a8312a/PS8_English_2012.pdf?MOD=AJPERES).
- Lane, Paul J. 2007. New International Frameworks for the Protection of Underwater Cultural Heritage in the Western Indian Ocean. *Azania* 41:115–136.
- Muckelroy, Keith. 1978. *Maritime Archaeology*. Cambridge University Press. New York.
- Richards, Nathan. 2008. *Ships' Graveyards*. University Press of Florida. Gainesville.
- Roach, J. Ashley. 1996. Sunken warships and military aircraft. *Marine Policy*. Volume 20, No. 4, pp. 351-354.
- United Nations Convention on the Law of the Sea (UNCLOS). 1982. United Nations Convention on the Law of the Sea. Accessed on line October 3, 2016 at [http://www.un.org/depts/los/convention\\_agreements/convention\\_overview\\_convention.htm](http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm).
- United Nations Convention on the Law of the Sea (UNCLOS). 2008. Joint Submission to the Commission on the Limits of the Continental Shelf concerning the Mascarene Plateau region. Submission was prepared by the Government of the Republic of Seychelles and the Government of the Republic of Mauritius jointly. Accessed on line October 3, 2016 at [http://www.un.org/depts/los/clcs\\_new/submissions\\_files/musc08/sms\\_es\\_doc.pdf](http://www.un.org/depts/los/clcs_new/submissions_files/musc08/sms_es_doc.pdf).
- United Nations Educational, Scientific and Cultural Organization (UNESCO). 1972. Convention Concerning the Protection of the World Cultural and Natural Heritage. Accessed on-line October 7, 2016 at <http://whc.unesco.org/archive/convention-en.pdf>.



---

## MMP - CULTURAL HERITAGE IMPACT ASSESSMENT

---

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2001a. Convention on the Protection of the Underwater Cultural Heritage (UNCPUCH). Accessed on-line October 3, 2016 at <http://unesdoc.unesco.org/images/0012/001246/124687e.pdf#page=56>.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 2001b. Convention on the Protection of the Underwater Cultural Heritage, Annex. Accessed on-line October 3, 2016 at <http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/2001-convention/official-text/#Annex>.

### **GOLDER ASSOCIATES LTD.**

Charles D. Moore, M.A., RPCA, RPA  
Senior Archaeologist

Andrew R. Mason, M.A., RPCA  
Principal/Cultural Heritage Specialist

Christopher Wylie, M.A. RPCA  
Archaeologist

CDM/ARM/

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

c:\users\lastoop\desktop\seychelles esia\specialist studies\1543656-308206-10\_seychelles mmp\_chia\_final.docx





# **APPENDIX A**

## **Cultural Heritage Overview Assessment**



October 2016

## CULTURAL HERITAGE OVERVIEW ASSESSMENT

# Seychelles Mariculture Master Plan

**Submitted to:**

Ministry of Environment, Energy and Climate Change  
Environment Department  
P.O. Box 445  
Victoria, Mahe  
Republic of Seychelles

**DRAFT FOR COMMENT**



REPORT



**Report Number: 1543656-308205-9**

**Distribution:**

- 1 copy - Ministry of Environment, Energy and Climate Change
- 1 copy - Seychelles Fishing Authority
- 1 copy - Golder Associates Africa (Pty) Ltd.
- 1 copy - Golder Associates Ltd.





## Executive Summary

Golder Associates Africa (Pty) Ltd. has been appointed by the Seychelles Fishing Authority as independent environmental assessment practitioners to provide this Cultural Heritage Overview Assessment in support of the Environmental and Social Impact Assessment for the proposed implementation of the Seychelles Mariculture Master Plan.

The Seychelles Mariculture Master Plan was established with the purpose of guiding the development of aquaculture (Project) in the Seychelles. This report assesses two of the four potential aquaculture zones (Project areas): the Land-Based Zone and the Aquaculture Development Zones (ADZs).

The Cultural Heritage Overview Assessment is a desk-top study with the objectives to:

- 1) Identify known cultural heritage sites in the Project area, to the degree possible, using existing records;
- 2) Identify and evaluate the potential for ship and aircraft wrecks within of the Project area; and
- 3) Assess the need for more detailed heritage investigations related to the Project.

To meet the objectives of the desk-top study, a review of available background information relevant to cultural heritage in the Project area and vicinity was conducted.

As a result of the review, it was determined that there are no known cultural heritage sites in the Project area. However, the review did identify 20 vessel and 2 aircraft wrecking events in the vicinity of the Project.

The potential for cultural heritage to be present within the Project area was assessed during the desk-top study. For Project components located within the terrestrial environment, the potential for cultural heritage was considered to be present in areas where the landscape characteristics were favourable for human occupation. For Project components located within the maritime environment, the potential for cultural heritage was considered to be present based on the identification of historic wrecks in the vicinity of the Project.

Recommendations for the management of cultural heritage resources within the Project area were formulated from the results of the Cultural Heritage Overview Assessment including the recommendation for archaeological investigations (i.e., diver survey by qualified archaeologist) in areas of higher potential for cultural heritage resources, and the development and implementation of a chance find procedures for areas where the potential was somewhat lower. The specific recommendations are outlined below:

- Due to the potential for the presence of cultural heritage within the inter-tidal and subtidal areas of along the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist along the entire offshore length of the Research & Development Facility water intake pipeline prior to construction.
- Due to the potential for the presence of cultural heritage within the inter-tidal and subtidal areas along the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist



along the entire length of the Broodstock Quarantine & Acclimation Facility water intake pipeline prior to construction.

- Due to the potential for the presence of cultural heritage within subtidal waters off of the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist throughout the anticipated area of impact associated with the construction, utilization and maintenance of the pilot project cage site prior to placement.
- To address the possibility of the identification of cultural heritage during Project development, it is recommended that a cultural heritage chance find procedure specific to the Project and both the marine and coastal terrestrial environments be developed by the Seychelles Fishing Authority, for distribution to subcontractors and to aquaculture developers prior to the commencement of aquaculture development construction activity.
- No further historical/archival investigation is recommended, except where it may be appropriate to identify and assess the significance of cultural heritage located as a result of Project development.

DRAFT



## Credits

Project Director	Brent Baxter, PhD.
Project Manager	Aiden Stoop, M.Sc.
Report Authors	Charles Moore, M.A., RPCA, RPA Christopher Wylie, M.A., RPCA
GIS and Mapping	Tracy Skinner, M.Sc.
Senior Technical Review	Andrew (Andy) Mason, M.A., RPCA

DRAFT



## Table of Contents

<b>1.0 INTRODUCTION</b>	<b>1</b>
1.1 CHOA Report Structure	1
1.2 Objectives	1
1.3 Definition of Cultural Heritage	2
<b>2.0 RELEVANT LEGISLATION</b>	<b>3</b>
2.1 National Monuments Act	3
2.2 International Law	3
2.2.1 United Nations Convention on the Law of the Sea	3
2.2.2 UNESCO Convention on the Protection of the Underwater Cultural Heritage	4
<b>3.0 PROJECT DESCRIPTION</b>	<b>5</b>
3.1 Land-Based Zone Aquaculture	5
3.2 Inshore Zone Aquaculture	5
3.3 Aquaculture Development Zones	6
3.4 Offshore Zone Aquaculture	6
<b>4.0 POTENTIAL PROJECT IMPACTS ON CULTURAL HERITAGE</b>	<b>7</b>
<b>5.0 METHODS</b>	<b>8</b>
5.1 Background Review	8
5.1.1 Criteria for Estimating Ship and Aircraft Wreck Locations Based on Historical Record Review	8
5.2 Potential Assessment for Cultural Heritage	9
5.2.1 Terrestrial Archaeological Potential	9
5.2.2 Historical Wreck Potential	9
5.3 Reporting, Recommendations and Options for Further Survey	9
<b>6.0 RESULTS</b>	<b>11</b>
6.1 Background Review	11
6.1.1 Physical Setting	11
6.1.1.1 Geology	11
6.1.1.2 Biogeography	12
6.1.1.3 Weather	13



6.1.1.4 Marine Conditions..... 13

6.1.2 Historic Setting..... 14

6.1.2.1 Exploration and Colonization ..... 14

6.1.2.2 The Battle of Mahé (1801) ..... 15

6.1.2.3 World War 1..... 16

6.1.2.4 World War 2..... 16

6.1.2.5 Mining and Resource Exploration ..... 16

6.1.2.6 Agriculture ..... 17

6.1.2.7 Fishing..... 17

6.1.2.7.1 Whaling ..... 18

6.1.2.7.2 Artisanal Fishery..... 18

6.1.2.7.3 Semi-industrial and Industrial Fishery ..... 19

6.1.2.8 Sea Travel ..... 19

6.1.2.9 Air Travel ..... 19

6.1.3 Archaeological Setting ..... 20

6.1.3.1 Maritime and Shipwreck Archaeology in the Western Indian Ocean Region ..... 20

6.1.3.2 Maritime Archaeology and Recorded Shipwreck Sites in Seychelles ..... 22

6.2 Review of Reported Wrecks in the Vicinity of the Project ..... 23

6.3 Cultural Heritage Sites within the Project Area ..... 23

**7.0 CULTURAL HERITAGE POTENTIAL ..... 24**

7.1 Cultural Heritage Potential in the Terrestrial Environment ..... 24

7.2 Underwater Cultural Heritage Potential ..... 24

7.2.1 Wreck Potential..... 24

7.2.2 Non-Wreck Related Underwater Cultural Heritage Potential..... 25

**8.0 GAP ANALYSIS ..... 26**

**9.0 RECOMMENDATIONS..... 27**

**10.0 LIMITATIONS AND USE OF THE REPORT ..... 28**

**11.0 CLOSURE..... 29**

**12.0 REFERENCES..... 30**



**TABLES**

Table 1: Summary of ship and aircraft wrecking events reported in the vicinity of the Project .....23

**FIGURES**

- Figure 1: Seychelles EEZ and Island Groups
- Figure 2: Land Based Aquaculture Zone
- Figure 3: R&D Facility Ansa Royale, Mahe
- Figure 4: R&D Facility Ansa Royale, Mahe
- Figure 5: Broodstock Quarantine & Acclimation Facility Providence, Mahe
- Figure 6: Pilot Project Providence, Mahe
- Figure 7: Aquaculture Development Zones
- Figure 8: Underwater Cultural Heritage Locations: Mahe
- Figure 9: Underwater Cultural Heritage Locations: Praslin and La Digue
- Figure 10: Underwater Cultural Heritage Locations: Silhouette and North Islands

**APPENDICES**

**APPENDIX A**

Table: Reported Underwater Cultural Heritage in Project Vicinity.

DRAFT





### 1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd. has been appointed by the Seychelles Fishing Authority (SFA) as independent environmental assessment practitioners (EAPs) for the purpose of conducting an Environmental and Social Impact Assessment (ESIA) for the proposed implementation of the Seychelles Mariculture Master Plan (MMP).

The MMP was established with the purpose of guiding the development of aquaculture (Project) in the Seychelles and identifies four potential aquaculture zones (Project area):

- Land-Based Zone Aquaculture
- Inshore Zone Aquaculture
- Aquaculture Development Zones (ADZs)
- Offshore Zone Aquaculture.

The ESIA focuses on three components that have been identified within the Land-Based Zone as well as the ADZs. It does not assess the Inshore Zone nor the Offshore Zone. As a component of the ESIA, the cultural heritage overview assessment (CHOA) of the MMP is similarly focussed on the three identified components within the Land-Based Zone and the ADZs. The CHOA has been compiled following international best practice.

### 1.1 CHOA Report Structure

This report summarizes the results of the CHOA. Section 2.0 reviews existing relevant national and international legislation. Section 3.0 provides a description of the Project while Section 4.0 discusses potential Project impacts to cultural heritage. Section 5.0 outlines the methods employed to complete the CHOA, and Section 6.0 summarizes the results of the CHOA. Section 7.0 summarizes the results of the potential assessment, and Section 8.0 provides a gap analysis. Section 9.0 includes recommendations for additional work. Maps of the assessed area and the results of the assessment are found at the end of the report. Appendix A contains a summary table of the underwater cultural heritage identified during the CHOA.

### 1.2 Objectives

The objectives of the CHOA were to:

- 1) Identify known cultural heritage sites in the Project area, to the degree possible, using existing records;
- 2) Identify and evaluate the potential for ship and aircraft wrecks within the Project area; and
- 3) Assess the need for more detailed heritage investigations related to the Project.



### 1.3 Definition of Cultural Heritage

According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), cultural heritage “is the legacy of physical artefacts and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations”. Cultural heritage can be tangible or intangible. Examples of tangible cultural heritage are:

- Movable cultural heritage such as paintings, sculptures, coins or manuscripts, and historic ships;
- Immovable cultural heritage such as monuments and archaeological sites; and
- Underwater cultural heritage such as shipwrecks and submerged ruins.

Examples of Intangible cultural heritage include oral traditions, performing arts and rituals.

DRAFT



## 2.0 RELEVANT LEGISLATION

### 2.1 National Monuments Act

In the Seychelles, cultural heritage may be afforded protection under the 1980 *National Monuments Act* (NMA) through designation as a monument or relic (Government of Seychelles 1980). The NMA defines a monument as “any ancient or national monument; any area of land which is of archaeological or historical interest or which contains objects of such interest; any old building or other structure; any other object (whether natural or constructed by man) of aesthetic, archaeological, historical or scientific value or interest”. A relic is defined as “any fossil of any kind; any object of aesthetic, archaeological, historical or scientific value or interest; any anthropological or archaeological contents of any monument.” An ancient monument is considered to be “any building, ruin, pillar, statue, grave or other site or thing of a similar kind, or any remains thereof, which is known or believed to have been erected, constructed or used before 1st January, 1900”, while a national monument is any monument declared to be a national monument by the National Monuments Board pursuant to Section 5 of the NMA.

Section 8 of the NMA prohibits a person from altering, destroying, damaging, moving from its original site, exporting from the Seychelles or carrying out work that may cause injury or disturbance to any ancient monument, national monument or relic, or any part thereof without written consent from the National Monuments Board. Contravention of the NMA can result in a fine of R.5,000 and imprisonment for 2 years.

### 2.2 International Law

In addition to state law, international laws related to, or providing provision for the protection of underwater cultural heritage have been established primarily through treaty. These laws include the 1982 United Nations Convention on the Law of the Sea (Section 2.2.1), and the 2001 UNESCO Convention on the Protection of the Underwater Cultural Heritage (Section 2.2.2). Established admiralty laws such as those regarding salvage may also be applicable to situations involving the protection of underwater cultural heritage and have been adopted internationally through the International Maritime Organization’s 1989 International Salvage Convention which provides a State the option to not apply the provisions of the Convention in instances where “maritime cultural property of prehistoric, archaeological or historical interest and is situated on the sea-bed” is involved.

Further, the concepts of the sovereign immunity of warships and state ships on non-commercial services, whether sunken or not, primarily on the basis that the State has not relinquished rights to the vessel (Roach 1996; Harris 2001) and of sunken warships as gravesites that are afforded the traditional protection thereof (Harris 2001) may also be applicable statutes for the protection of underwater cultural heritage. Legislation such as the British *Protection of Military Remains Act* (1986) further asserts the protection of sunken warships and aircraft as a war grave (Government of England 1986).

#### 2.2.1 United Nations Convention on the Law of the Sea

During the latter half of the 20<sup>th</sup> Century, three conferences on the Law of the Sea were held by the United Nations (Dromgoole 2013). The most pertinent of which to the protection of underwater cultural heritage was the third conference, which began in 1973 and resulted in the United Nations 1982 Convention on the Law of the Sea (UNCLOS). Containing 320 articles, the UNCLOS is rooted in historical custom and practice and is primarily



concerned with establishing a legal order for the seas; including defining the legal status of the sea-bed, subsoil and air space above. The UNCLOS was ratified by the Seychelles in 1991 (UNCLOS 2008).

Two articles within the UNCLOS, Article 149 and Article 303 directly confer limited protection to underwater cultural heritage. Article 96 reinforced the notion of sovereign immunity for State owned or operated ships on government non-commercial service, however, it does not address the relationship of sovereign immunity and sunken vessels. Article 149, affords protection to archaeological and historical objects found within the Area, ostensibly, the deep sea by stating that such objects be preserved or disposed of for the benefit of mankind as a whole. Unfortunately, no qualification as to what is considered an archaeological or historical object is provided within the UNCLOS and the implementation of the protection afforded to these objects as a result of Article 149 is unclear as no responsible oversight body is declared (Dromgoole 2013). With respect to underwater cultural heritage located outside of the Area, no reference is made, implying that national jurisdiction would apply. Article 303 declares that States have the duty to protect objects of an archaeological and historical nature found at sea.

### 2.2.2 UNESCO Convention on the Protection of the Underwater Cultural Heritage

Resulting from an awareness that emerging technologies were making the depths of the oceans more accessible to human exploration than at any time in the past, and realizing the threat to underwater cultural heritage resulting from that exploration, the UNESCO Convention on the Protection of the Underwater Cultural Heritage (CPUCH) entered into force in 2009 (UNCPUCH 2001a). The Seychelles is not one of the 55 countries that, at present, has ratified the CPUCH, however, the convention has provided the framework for opportunities for international collaboration in underwater cultural heritage resource management in the western Indian Ocean region (Lane 2007).

The CPUCH defines underwater cultural heritage as “all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years.” Comprising 35 articles and an annex containing 36 rules, the CPUCH is considered to be international best practice with respect to the protection of underwater cultural heritage and contains language protecting sunken warships however it does not go as far as confirming sovereign immunity (Dromgoole 2013). The CPUCH does not prohibit disturbing or damaging underwater cultural heritage it does presume that underwater cultural heritage will be preserved in-situ unless required for scientific or protective reasons and that activities impacting underwater cultural heritage will be done following the archaeological standards and methods outlined in the annex (UNCPUCH 2001b).



### 3.0 PROJECT DESCRIPTION

The development of an aquaculture sector is a core component of the Seychelles Blue Economy Strategy that would take advantage of the Seychelles 1,340,000 km<sup>2</sup> exclusive economic zone (EEZ) (Figure 1). The Project consists of the development of aquaculture within four zones; the Land-Based Zone, the Inshore Zone, the Aquaculture Development Zones and the Offshore Zone.

Three carrying capacity scenarios for the development of aquaculture have been identified; the low-road, the mid-road, and the high-road. Each of these scenarios results in a differing level of aquaculture zone development. At present, the Project is conceptual and no decision has been made regarding which road will be taken and within which zones, if any, aquaculture will be pursued. As such, the location of specific components within these zones has not been finalized.

#### 3.1 Land-Based Zone Aquaculture

Aquaculture development within the Land-Based Zone would involve the construction of land-based cultivation systems. These systems would require pumping ocean water onshore for use in either a Recirculating Aquaculture System (RAS) or a flow-through system if sufficient land was available. Sea urchins, pearl oyster spat (oyster larvae which permanently attach to a surface), ornamental finfish and finfish fingerlings could all be cultivated within a land-based system.

Additional infrastructure that would be constructed on Mahé as part of a land-based aquaculture program would include a Research & Development Facility located at the University of Seychelles and a Broodstock Quarantine & Acclimation Facility (BQAF) located in Providence (Figures 2-6). The Research & Development Facility and the BQAF require the construction of a water supply pipeline into the ocean (Figures 4 & 5). These facilities would be multipurpose and necessary for the sustainable growth and development of the MMP. Additionally, a pilot project cage site would be constructed immediately off Providence shore, approximately 1 km east of the BQAF (Figure 6).

*Note:* Consistent with the ESIA, this CHOA only assesses the Research & Development Facility, the BQAF and the pilot project cage site within the Land-Based Zone.

#### 3.2 Inshore Zone Aquaculture

Subject to the carrying capacity scenario chosen, Inshore Zone Aquaculture would be developed in areas that are located within 2 km of the islands of Mahé, Praslin, La Digue, and potentially Silhouette and Romainville that have been identified as suitable for aquaculture development. Inshore Zone Aquaculture would comprise of small-scale projects operated by local Seychellois which would have exclusive access to the domestic market. Pearl oysters and finfish could be cultivated as a product of Inshore Zone Aquaculture.

*Note:* Consistent with the ESIA, this CHOA does not assess the inshore zone.



### 3.3 Aquaculture Development Zones

Aquaculture development within the ADZs would involve the construction of cages that are anchored to the seabed and serviced daily from land. Twelve ADZs, located almost exclusively at a distance greater than 2 km from shore (Figure 7), have been selected based on environmental and ecological criteria. There are five ADZs located off the coast of Mahé (Figure 8), five ADZs off of the coasts of the islands of Praslin, La Digue and Felicite (Figure 9), one ADZ off the coast of Silhouette (Figure 10), and one ADZ off the coast of North Island (Figure 10). The ADZs range in area from 0.4 km<sup>2</sup> to 15 km<sup>2</sup> and within them, finfish such as brown-marbled grouper, mangrove river snapper, snubnose pompano and emperor snapper could be cultivated.

### 3.4 Offshore Zone Aquaculture

Offshore Zone Aquaculture would be comprised of fully industrialized operations located within the Seychelles EEZ and at a distance greater than 5 km from land. Various species of finfish could be cultivated.

*Note:* Consistent with the ESIA, this CHOA does not assess the offshore zone.

DRAFT



## 4.0 POTENTIAL PROJECT IMPACTS ON CULTURAL HERITAGE

Land-based Zone Aquaculture and ADZ development may impact cultural heritage located in terrestrial and underwater contexts. Cultural heritage that may be impacted whether it is submerged, partially submerged, or buried (possibly within or below landfill) as a result of Land-based Zone Aquaculture and ADZ development include:

- Monuments and relics as defined and protected under the *NMA*;
- Ship wrecks that are at least 100 years old;
- Artifacts that have been jettisoned or lost that are at least 100 years old;
- Infrastructure such as harbour facilities that are at least 100 years old; and
- Military vessels and aircraft of any age.

Specific to the Project, these impacts may result from:

- Ground disturbance related to the construction of the proposed Research & Development Facility located at the University of Seychelles;
- Ground disturbance within terrestrial, inter-tidal and sub-tidal areas related to the construction and maintenance of the proposed water supply pipeline for the proposed Research & Development Facility;
- Ground disturbance related to the construction of the proposed BQAF in Providence;
- Ground disturbance within terrestrial, inter-tidal and sub-tidal areas related to the construction and maintenance of the proposed water supply pipeline for the BQAF;
- The placement of anchors and, the movement of anchor chains along the seabed associated with the construction, utilization and maintenance of the proposed pilot project cage site; and
- The placement of anchors and, the movement of anchor chains along the seabed associated with the construction, utilization and maintenance of cage sites within the ADZ areas.

Examples of impacts to cultural heritage as a result of Project activity could include damage to submerged wreck sites of aircraft and vessels (including canoes, boats and ships), however, other forms of cultural heritage related to the pre-colonial and colonial history of the Seychelles may also be impacted.



### 5.0 METHODS

This study employed desk-top review methodologies to conduct a review of available background sources that were relevant to the assessment of cultural heritage, within the Land-Based Zone and the ADZs, with a focus on ship and aircraft wrecks.

#### 5.1 Background Review

Readily available historical and archaeological sources describing the settlement and development of the region, including reports and other evidence of vessels and aircraft lost or abandoned in the vicinity of the Project area, were reviewed and summarized. As human use of the region is, in large part, dictated by the environment, Project area information related to the physical landscape, geology, oceanography, and associated resources was also reviewed and summarized.

Sources consulted or reviewed include:

- Published information available locally and on-line related to the geology, biogeography, oceanography, archaeology, history, and industrial development of the Project area;
- Previous Project-related studies;
- Marine charts;
- Local historians and researchers; and
- Local dive tour companies.

Attempts to access the Seychelles National Archives and National Library as were not successful as both were closed due to a serious outbreak of fungal infestations.

##### 5.1.1 Criteria for Estimating Ship and Aircraft Wreck Locations Based on Historical Record Review

Few wrecking events that are known to have occurred historically are currently associated with documented wreck remains on the sea bed. Estimating the likelihood of a reported historical casualty being represented today by physical remains of the wreck, or underwater historical resource, existing on the seabed within a Project area based on archival information alone, involves cross-checking available records and reliance on informed assumptions.

Historical wreck records are often vague in location, unless there is a very close correlation between the wrecking event and a known landmark. Before the advent of radio communications and radar or other forms of electronic navigation, the farther from land the more approximate the description. For an archipelago such as the Seychelles which is comprised of numerous islands extending over nearly 1.5 million square kilometres, a ship or aircraft wrecking event that is described as having occurred in the Seychelles, requires further research to determine to possibly determine a more precise location and potential relationship to the Project area.





## 5.2 Potential Assessment for Cultural Heritage

Each study area, or portion thereof, within the Project area was classified as having either ‘potential for cultural heritage’ or ‘low potential for cultural heritage’. Areas designated with low potential for cultural heritage are locations where the discovery of an archaeological site or historic wreck is considered to be unlikely. In contrast, areas classified with potential for cultural heritage are locations where the criteria above suggest that the discovery of an archaeological site or historic wreck is more likely.

### 5.2.1 Terrestrial Archaeological Potential

To assess the potential presence of terrestrial archaeological sites within the Project area, factors such as the proximity to known archaeological sites and landscape characteristics that are favourable for human occupation within coastal environments are considered. Within the terrestrial component of the Project area, located as it is in coastal environment, landscape characteristics that are favourable for human occupation, thereby increasing archaeological potential, include access to freshwater and food resources, embayments or protected shorelines where watercraft can land, as well as areas adjacent to protected anchorages and reef breaks.

### 5.2.2 Historical Wreck Potential

To assess the potential presence of wrecks located underwater within a Project area, a list of aircraft and vessels understood through archival research to have been casualties resulting in total loss in an area is assembled. Patterns of loss locations over time which are evident in the record of casualties contribute to the understanding of where, when and how (causes) vessels have most frequently been lost. Environmental factors may create hazards to navigation including: exposure to long fetches (where waves may propagate without barriers) and strong winds; strong tidal currents; reefs and jutting headlands. Human factors play into the natural environment primarily with shipping volume correlating with hazardous areas, but also to less exposed areas where port or other shore facilities were located.

Even in protected waters, vessels that were moored or anchored unattended or short-crewed might be vulnerable to sudden winds blowing them ashore, or to fire. As well, abandonments may be expected, resulting in derelict boats sinking at anchor or being intentionally sunk (Muckelroy 1978; Richards 2008). Vessel abandonments are less likely to be represented in the historic record, owing to the lack of a single dramatic event like a wrecking, but are more likely to occur in shallow and protected water, and therefore more likely to be found in a terrestrial context provided shoreline progradation over the site through natural sediment accumulation or the placement of artificial fill for land reclamation.

## 5.3 Reporting, Recommendations and Options for Further Survey

An overview assessment report may include recommendations for additional investigations or resource management strategies based on the assessed potential for specific parts of the Project area to contain cultural heritage.



In terrestrial areas where the archaeological potential assessment has been identified archaeological potential recommendations for further work may include pedestrian survey, subsurface testing, archaeological excavations or construction monitoring.

In marine areas where the archaeological potential assessment has identified archaeological potential recommendations for further underwater investigations may consist of marine geophysical survey, or “ground-truthing”, typically with visual data gathered by divers or by cameras mounted on an underwater remotely operated vehicle (ROV). Marine geophysical data collection is typically gathered with instruments mounted on a vessel, or towed astern of a vessel in a housing known as a tow fish. Some data collection methods which may be recommended are as follows:

- Collection of acoustic data (side scan sonar [SSS], synthetic aperture sonar [SAS], or multi-beam bathymetry) may provide imagery of any wreckage that protrudes above the surface of the seabed and is not masked by natural features such as bedrock or coral (Klein 2002; Lawrence 2011).
- Subbottom profilers may be employed to acoustically image a narrow vertical slice beneath the seabed where the potential for buried wrecks has been identified. Different densities of materials within the seabed including some hull materials, ballast, heavy machinery, or scours may be evident in a subbottom (Chirp) profile record (Green 1990; Klein 1982,1997; Quinn 2006).
- Magnetometry consists of measuring magnetic field variation, with local “anomalies” potentially representing ferro-magnetic materials, such as iron, contained in wrecks. Magnetometers are typically employed in areas where the potential for buried wrecks has been identified, and integrated magnetometer data may also facilitate the identification of acoustic targets. Where the instrument is towed sufficiently close to the seabed and with adequately close track spacing it is possible through a magnetometer survey to identify the signatures from relatively small wooden vessels (due the presence of anchors, chains, ferrous equipment, and iron fastenings) or light aircraft (Bowens 2009; Breiner 1999; Murphy and Saltus 1990; Shope 1997).
- Visual data provides ground-truthing for targets observed acoustic the record where the target is at least partially exposed above the seabed, and may also be employed as a preliminary search method within a small development footprint where underwater visibility is favourable. In relatively shallow water (typically 30 m or less), visual data may be provided by divers on SCUBA, with the benefit that direct measurements may also be gathered. An ROV may provide visual data from virtually any depth. These visual data may be used to simply determine the presence of a wreck, and provide further diagnostic information to facilitate identification with respect to general type, vintage, or the identification of a specific vessel or aircraft based on a correlation with archival data (Bowens 2009; Rothberg 1993).

Where the potential for a cultural heritage site has not been identified there may be no recommendation for further study. Alternatively, the implementation of a Chance Find Procedure may be recommended whereby direction will be provided to the Seychelles Fishing Authority for distribution to individual aquaculture developers on how to recognize an archaeological site on land or on the seabed, and how to report on its chance find in the Project area.



## 6.0 RESULTS

### 6.1 Background Review

This section summarizes readily available information regarding the environment, history and archaeology of the Seychelles.

#### 6.1.1 Physical Setting

An understanding of the physical setting is important for developing an appropriate heritage resource investigation strategy. Factors that generally influence archaeological site location in a marine environment can include climate, exposure to the open ocean and prevailing winds, depth of shoreline (i.e., deep harbours for larger vessels and sheltering coves for small vessels and aircraft) and the productivity of areas for seasonal and perennial resources (e.g., fishing grounds, material for vessel construction and maintenance).

The Seychelles Archipelago consists of a group of 115 granitic and coralline islands located in the western Indian Ocean. The islands comprising the archipelago are separated by vast distances from each other and the closest continental landmasses. They can be divided into two groups, the Inner Islands and the Outer Islands based primarily on location and composition (Figure 1). The Inner Islands are situated in the northern portion of the archipelago and are primarily granitic in composition. Among the 45 islands comprising the Inner Island group are Mahé, Silhouette and Praslin. The Outer Islands, which are primarily uninhabitable or sparsely inhabited, as they are comprised of sand cays and raised coral reefs, are located in the southern portion of the archipelago. These islands include among others, Amirantes, Alphonse, Aldabra and Farquhar (Stoddart 1984a).

The island of Mahé upon which the city of Victoria, the capital of the Seychelles is situated, is located approximately 1800 km east of Kenya, 1000 km north-northeast of the Island of Madagascar and 2700 km southwest of India (Figure 2).

##### 6.1.1.1 Geology

A review of the geology of the Seychelles provides context in which to understand the circumstances surrounding the late occupation of the islands by humans for the geological history of the Seychelles describes how the granitic islands of the archipelago became isolated in the middle of the Indian Ocean.

As the largest land masses associated with the Seychelles, the granitic islands are unique oceanic islands in that they were not formed as a result of volcanism associated with an oceanic hotspot (Stoddart 1984a; Braithwaite 1984; Plummer 1998). Continental in origin, the granite that comprises the primary constituent of these islands is dated to the Neoproterozoic era approximately 755 million years ago (Stoddart 1984a; Stephens 1996; Ganerød et al. 2011).

The granitic Inner Islands represent the highest points of the Seychelles microcontinent (Plummer 1998). During the Paleozoic era and into the Mesozoic era, the Seychelles microcontinent was part of the supercontinent Gondwana (Stephens 1996; Ganerød et al. 2011). During the Jurassic period, tectonic rifting resulted in the separation of Gondwana into two landmasses consisting of (1) Africa and (2) East Antarctica, Australia, India, Seychelles and Madagascar (Stephens 1996; Plummer 1998; Ganerød et al. 2011) and began the formation of the Indian Ocean. Further tectonic rifting during the Cretaceous period resulted in the divergence of India, Seychelles and Madagascar from East Antarctica and Australia approximately 120 million years ago (Plummer



1998) and then the separation of India and the Seychelles from Madagascar between 91.6 and 83.6 million years ago (Ganerød et al. 2011).

By approximately 65 million years ago, the Seychelles were located in their present relative position to Madagascar (Plummer 1998). Still attached to India, large scale volcanism associated with the Réunion hotspot resulted in the formation of the Deccan Traps in India and the deposition of corresponding Deccan basalts in the Seychelles (Ganerød et al. 2011). Ensuing tectonic activity related to the Carlsberg ridge began the separation of India and the Seychelles (Stephens 1996; Plummer 1998), essentially stranding the Seychelles microcontinent in the middle of the Indian Ocean.

The sand and coralline islands of the Seychelles are considerably younger than their granitic counterparts. Formed between 6,000 and 125,000 years ago, they have been subject to the vagaries of Pleistocene sea level change and have at times, been entirely submerged (Stoddart 1984a). Due to their isolated location and the late human occupation of the islands, Pleistocene sea level changes are not archaeologically relevant to the Seychelles.

### 6.1.1.2 Biogeography

As with most oceanic islands, the biota present on the Seychelles is primarily the result of dispersal from Africa and Asia (Proctor 1984) by agents such as wind, sea or birds, however, owing to the unique geological history of the Seychelles granitic islands, it is possible that some of the indigenous flora and fauna on these islands have their roots in species that were present when the Seychelles were part of Gondwana (Stoddart 1984a).

As the remoteness of the Seychelles isolated the archipelago from human occupation, the indigenous flora and fauna were left alone to evolve and flourish. Due to their isolation, the Seychelles are home to many species of unique flora and fauna including the coco de mer (*Lodoicea maldivica*), the jellyfish tree (*Medusagynne oppositifolia*), the black parrot (*Coracopsis Nigra*), and, the giant tortoise (*Geochelone gigantea*) which has been directly, negatively, impacted by the arrival of humans and is now limited to the island of Aldabra (Stoddart 1984a). The Nile crocodile (*Crocodylus niloticus*) has become extinct in the Seychelles as a result of human activity (Stoddart 1984a and 1984c).

The granitic Inner Islands are dominated by rainforest vegetation. Historically, these islands were thickly vegetated and in an account by John Jourdain (Foster 1905), the islands are described as a good place to replenish wood as the trees are big and straight. This unique environment has been irreversibly altered since the permanent arrival of humans in the latter half of the 18<sup>th</sup> Century. Great tracts of land have been cleared for agricultural exploitation and the island's primary vegetation has all but been wiped out (Proctor 1984).

For the granitic Inner Islands, Proctor (1984) has described the existence of three distinct habitats, moist forest, dry forest and coastal which are based on the environmental needs of the vegetation that is present within them. These habitats were then further split by Proctor (1984) into subdivisions of four and five, respectively, based on defining characteristics such as topography, exposure, soil development and drainage. The subdivisions of the moist forest habitat comprise boulder/peat, glacis, ravines, and slopes and valleys. The subdivisions of the dry forest habitat comprise glacis, ravines, slopes and valleys, and denuded slopes. The coastal subdivisions comprise mangrove swamps, swamps and lagoons, plateaux, littoral, and promontories and low granitic islands. Descriptions of these subdivision and the vegetation species that are present within them are provided by Proctor (1984). Of note and relevance to this discussion, despite the impact of humans, is the perseverance within the plateaux area of the takamaka tree (*Calophyllum inophyllum*), commonly used for boat construction (Proctor 1984).



### 6.1.1.3 Weather

The Seychelles climate is humid tropical and is characterized by approximately 700 to 800 millimetres (mm) of precipitation, in the form of rain, per year and a mean annual temperature greater than 20 degrees Celsius. Air temperature in the Seychelles is moderated by the presence of the ocean and on the granitic islands, can be inversely impacted by elevation (Walsh 1984).

Two seasons, summer and winter are recognizable in the Seychelles with short transition periods (April and November) present between them. Located south of the Equator, the winter months from May to October are typified by constant southeast trade winds blowing at 6 to 9 metres (m) per second that result in dry weather and low rainfall amounts (Walsh 1984; Stoddart 1984b). The summer months, December to March, are considered the rainy season and northwest monsoons are present. The northwest monsoons are slightly lighter than the winter southeast trades while the winds observed during the transition months are the lightest and most variable. Relative humidity is consistently high however during the summer dry season, the ocean and constant southeast trade winds have a moderating effect that prevent the relative humidity from climbing or falling significantly (Walsh 1984).

The Inner Islands are located close enough to the Equator that tropical cyclones are not a threat though increased quantities of precipitation have been noted to fall on the Inner Islands as a result of cyclone activity to the south. Located further south, cyclone activity has been recorded on the Outer Islands such as Aldabra and Assumption (Walsh 1984).

### 6.1.1.4 Marine Conditions

The Project area is located offshore of the granitic Inner Islands of Mahé, Therese, Silhouette, North Island, Praslin, Curieuse, Felicite and La Digue. The tidal range within the Project area can reach approximately 2 m. South of the Equator in the Indian Ocean, the westerly South Equatorial Current which runs at between 0.5 and 1.5 knots towards the west has developed as a result of the constant trade-winds.

An extensive network of fringing reefs has developed around the granitic Inner Islands, in particular, around the islands of Mahé and Praslin. These systems are generally quite wide and can range between 380 m and 2850 m in width. Along the southeast coast of Mahé, the reef systems are continuous but not as wide, generally only up to approximately 750 m in width, as the opposite side of the island as a result of the southeast tradewinds. On the northwest side of the island, the reef system is more protected and the reef system in width up to approximately 1500 m. Along the west coast of Mahé, the reef system is not as large and is sporadic, found generally in sheltered bays owing to the presence of steep cliffs located along the shore. At Praslin, the reef system is widest along the west side of island where it extends up to 2850 m, while at La Digue, the widest reefs are located along the west and southeast coastlines (Stoddart 1984b). Owing to the shallow nature of the surrounding ocean, the coral reef fronts extend to about 20 m and in areas of exposed coastline, reef slopes of 30 to 40 degrees are common and can become near vertical in sheltered areas (Stoddart 1984b; Braithwaite 1984).

The approach to the Inner Islands can be hazardous as a result of the presence of fringing reefs. Lighthouses have been constructed on the islands of Denis, Praslin and La Digue, as well as at the entrance to Victoria Harbour to aid nighttime navigation (Admiralty Chart 716). Reefs notwithstanding, only at Mahé (Victoria Harbour) and Praslin (south of the Island of Curieuse) are there anchorages for ships to safely lie in both prevailing wind systems.



The Seychelles would constitute a lee shore threat, primarily during the age of sail, to vessels passing to the east, or approaching from the east during the winter months, and to vessels north passing to the north, or approaching from the northwest during summer months.

### 6.1.2 Historic Setting

The following sections summarize some of the historical developments, activities and industries of the Seychelles beginning with the archipelago's exploration and colonization by humans. Emphasis is placed on the developments, activities and industries that contain maritime elements that may manifest themselves in the archaeological record pertinent to the Project.

#### 6.1.2.1 Exploration and Colonization

Due to its isolation, the history of human occupation in the Seychelles is tied to the history of seafaring in the Indian Ocean. While evidence exists that points towards human awareness of the Seychelles during the 10<sup>th</sup> Century by Arab seafarers (Benedict 1984), it is possible that humans visited the archipelago much earlier. It is known that Phoenician sailors circled the continent of Africa in the middle of the first millennium BCE and palaeontological, linguistic, genetic research points toward a peopling of Madagascar by Austronesian migrants from Indonesia approximately two thousand years ago (Dahl 1951; Burney et al. 2004; Kusuma et al. 2015). These migrants could have sailed either a coastal route along the shores of Asia, India and Africa or along an equatorial route, taking advantage of favourable winds and currents to traverse the width of the Indian Ocean in what were likely extended logboats with double outriggers. If taking this dangerous and long (up to six weeks) voyage, the possibility exists that Austronesian migrants sailing an equatorial route could have encountered, and taken advantage of the abundant resources present on the Seychelles to replenish supplies in much the same way that the English East India Trading Company vessel *Ascension* did in 1609 before being lost on the Malacca Banks off the coast of western India (McGrail 2004; Wrecksite.eu 2016a).

European exploration of the Seychelles began in 1502 when the Portuguese explorer Vasco da Gama charted the Amirantes group during a voyage from India to East Africa (see Figure 1) (Galvano 1862; Stoddart 1984). The Portuguese established an early pattern of preying on Arab and other non-European trading vessels, particularly in the Red Sea and the Malabar Coast of India. Rulers of other European nations, for instance James I (England) in the 1630s, sent ships to capture rich cargos from local vessels as it was not considered piracy if the vessel's owners and occupants were not Christian (Biddulph 1907). Around 1685, buccaneers or freebooters, from countless nations but with perhaps the largest number from New England, expanded their operations into the Indian Ocean and targeted both local vessels and various East India company ships. Pirate "settlements" were established, including at Sainte Marie (off Madagascar) and "Johanna" in the Comoros Islands, both located about 1500 km south of Mahé (Richie 1986). It is perhaps surprising that the Seychelles Islands were not used more frequently as a source of supplies and shelter by pirates given their central location in an otherwise largely open ocean along the route of European vessels travelling to and from the East Indies, and located about 1300 km southeast of Mogadishu (the Somali Coast), 2300 km southeast of Babs-al-Mandab Strait (the entrance to the Red Sea), and 2800 km southwest of the Malabar Coast (Biddulph 1907). The Seychelles were certainly used to some degree in the 17<sup>th</sup> and early 18<sup>th</sup> centuries (Benedict 1984) and legend has it that the pirate Olivier Levasseur ("The Buzzard") buried his treasure on Mahé (Behar 2004).



In 1742, French explorer Lazare Picault arrived in the Seychelles. During the course of two expeditions between 1742 and 1744, Picault mapped and named many of the granitic islands however; the Seychelles remained unclaimed until 1756 when France formally took possession. They remained uninhabited until French settlers from Mauritius arrived on Ste. Anne Island in 1770. The French continued to colonize the inner islands throughout the latter part of the 18<sup>th</sup> Century and early 19<sup>th</sup> Century. As on Mauritius, the plantations on the Seychelles thrived until infested by non-native rat populations. The islands were surrendered to the British in 1810 during the Napoleonic Wars and under the terms of the Treaty of Paris (1814), the British were formally given to the Seychelles. In 1903, the Seychelles became a colony of the British Empire of which it remained until 1976 when the British granted the Seychelles independence within the Commonwealth of Nations and the Seychelles formed a republic (Sparks 2016).

### 6.1.2.2 The Battle of Mahé (1801)

Near the end of the French Revolutionary War, a naval battle between the British Empire and the Republic of France was fought in Victoria Harbour. The battle commenced on August 19, 1801 as the frigate HMS *Sibylle*, which had been captured by the British in 1794 during the Battle of Mykonos, and her 38 guns opened fire on the 36-gun French frigate *Chiffonne* while the *Chiffonne* was at anchor near Pointe Conan undergoing repairs and replacement of the foremast (Maurel 2016).

The *Chiffonne* had been sent to the western Indian Ocean to engage British ships that were in the process of supplying the British forces in the Red Sea (James 2002). During her voyage from Nantes, the *Chiffonne* captured the Portuguese schooner *Parachi Pachia* off the coast of Brazil on May 15, 1801 and defeated the Portuguese frigate *Andorinha* on May 18, 1801. On June 16, 1801, *Chiffonne* captured the East India Company ship *Bellona*, crewed her and sent her to Mauritius while the *Chiffonne* and the captured *Parachi Pachia* continued to Mahé.

The battle between *Sibylle*, captained by Charles Adam, and *Chiffonne*, captained by Pierre Guiyesse, lasted less than half an hour and resulted in *Sibylle* sinking *Parachi Pachia* and Guiyesse striking the colors and cutting anchor to ground *Chiffonne* on a reef. The fate of *Parachi Pachia* is uncertain. Maurel (2016) states that the vessel could not be refloated while Pollock (1841) states that following the battle, the *Parachi Pachia* was sold to merchants for cattle while it was still sitting on the bottom. The *Chiffonne* was dragged off the reef, repaired and sailed to India.

Less than a month later, a second naval battle took place in Victoria Harbour on September 6 and September 7, 1801. This battle pitted the 18-gun French brig *La Flèche*, which had sailed from Nantes and was captained by Lieutenant Jean-Baptiste Bonami against the 18-gun British sloop *Victor* which was captained by George Ralph Collier and had been dispatched from the Red Sea fleet in search of the raiding *La Flèche*. An initial engagement between the two vessels began at sea a few days previous on September 2, 1801 which resulted in damage to the rigging of the *Victor* and provided *La Flèche* with the opportunity evade *Victor* and sail to Mahé (James 2002).

On September 6, 1801, *Victor* re-engaged *La Flèche* in Victoria Harbour. Following an exchange of cannon fire that lasted over two hours, the *La Flèche* began to sink and in response, Bonami sailed the ship onto a reef and set it ablaze. Despite a boarding party from the *Victor* extinguishing the blaze, *La Flèche* rolled off the reef and sank (*London Gazette* 1802). *La Flèche* was salvaged shortly after sinking (Mathiot 2016) and was purchased by a Portuguese merchant from East Africa (Maurel 2016).



### 6.1.2.3 World War 1

In 1914, the outbreak of World War 1 resulted in a call to arms across the British Empire, including the Seychelles. During the war, German warships were responsible for the sinking of several vessels in the western Indian Ocean (Northern Maritime Research 2002), none were very near to the Seychelles. While geographically isolated from conflict, the Seychelles were not isolated from the consequences of the war and 347 Seychellois lost their lives (Pillay and Uranie 2014).

### 6.1.2.4 World War 2

Following the outbreak of World War 2, the Imperial Japanese Navy (IJN) advanced into the Indian Ocean on its quest to expand the Japanese Empire. To combat this advancement, the British Royal Air Force (RAF) and the Royal Navy (RN) established bases throughout the Indian Ocean. These bases, constructed on strategically located British colonies and protectorates such as Diego Garcia in the Chagos Archipelago, Addu Atoll in the Maldives, and Ste. Anne Island in the Seychelles, provided safe harbour for the refueling and refitting of the naval vessels and aircraft operating in the region.

In the Seychelles, Victoria Harbour on the island of Mahé was fortified by the placement of a six inch artillery battery manned by the Ceylon Garrison Artillery on Pointe Conan and, in April 1941, the RAF established a seaplane base on the island of Ste. Anne. This base, known as RAF Seychelles would remain in operation until May 1945 by which time, the IJN had pulled back from the Indian Ocean to combat advancing American forces in the Battle of Okinawa.

While in operation, RAF Seychelles was manned by detached elements of RAF squadrons No. 205, 209, 259, 265 and Royal Canadian Air Force (RCAF) squadron No. 413 flying Consolidated Aircraft PBY Catalina's with missions primarily related to anti-submarine warfare, air to sea rescue, and transport (Halley 1988). These detachments were supported by HMS *Manela*, a passenger cargo vessel which the RN requisitioned in 1939 and converted into a seaplane depot (Clydebuilt Database 2016).

Although the aircraft stationed at RAF Seychelles saw little in the way of enemy action, they were not immune to losses. On July 8, 1944, Flight Sergeant William Hatton of RAF Squadron No. 209 (Commonwealth War Graves Commission 2016) perished and four other crew members were listed as missing and presumed dead following the crash landing at RAF Seychelles of Catalina 1B FP107. FP107 was not the only loss that Squadron No. 209 would experience at RAF Seychelles as records indicate that, in 1945, FP247 was able to be salvaged following its crash landing into the Indian Ocean, with no resultant loss of life, during takeoff. Further, a number of aircraft attached to RAF Seychelles, including W8415, W8427 and Z2142, were struck off charge during the war. Records relating to the circumstances surrounding the events necessitating these aircraft being struck off were not available for this review therefore it is unknown if these aircraft may represent wrecks present due to accident or abandonment within Seychellois waters.

### 6.1.2.5 Mining and Resource Exploration

Over millennia, the excrement of seabirds (guano) accumulated on the surfaces of the coralline and granitic islands of the Seychelles. Beginning in 1891, commercial mining of that guano, which has a high nitrogen content and is thus prized for use in fertilizer, commenced and continued into the late 1970's. During this time, over 700,000 tons





of guano was exported via ship from the Seychelles to markets around the world. The mining process was destructive and required the removal of large quantities of vegetation from the islands. It led to the extinction of four bird species on the island of Assumption and resulted in a significant reduction in the population of the Assumption green turtle (Stoddart 1984c).

In recent decades, offshore exploration for oil and natural gas deposits has occurred within the Seychelles EEZ that has resulted in the completion of 2D and 3D seismic surveys and the drilling of four exploratory wells. Three of the exploratory wells were drilled by Amoco in 1980 and 1981 and while they encountered oil and gas, they were not commercially viable. In 1995, an exploratory well was drilled by Enterprise Oil Plc, however, this well did not reach its target depth prior to being discontinued (Petroseychelles 2016). A 2012 United States Geological Survey (USGS) study suggests that the Seychelles contain hydrocarbon reserves of approximately 2,394 million barrels of oil, 20,736 billion cubic feet of gas and 739 million barrels of natural gas liquids. At present, Afren Plc has a petroleum agreement for the Seychelles EEZ and Japan Oil Gas and Metals National Corporation has an exploration license (Petroseychelles 2016).

### 6.1.2.6 Agriculture

Agricultural activity in the Seychelles began with the arrival of the first colonists in the 18<sup>th</sup> century and resulted in the widespread clearing of native forest. The harvesting of maize, rice and root crops were primarily for local subsistence with cotton subsequently being introduced as a cash crop. A shift in agricultural practice in the middle and late 19<sup>th</sup> century began with the creation of large scale coconut plantations that required even greater amounts of forest to be cleared. During this time, coconut oil was locally manufactured and exported. In the early 20<sup>th</sup> century, copra (dried coconut kernel) supplanted coconut oil as the primary export resulting from the coconut and by the 1950's, over 7,000 tons of copra was exported annually. During the early 20<sup>th</sup> century, vanilla and cinnamon joined the coconut as major agricultural crops in the Seychelles while small quantities of cloves, cacao, patchouli, coffee and tea were also produced and exported (Stoddart 1984c). All exports are carried by ships with the exception of light and valuable produce taken by air. Inter-island trade in produce is of necessity by boat or ship.

In addition to farming, seabird eggs were exploited for local subsistence and the export of yolk for pharmaceutical production. Giant tortoises were also locally consumed and used to replenish food stocks on passing ships while sea turtles were exploited for food and their shells (Stoddart 1984c).

### 6.1.2.7 Fishing

The absence of large indigenous mammals in the Seychelles necessitated that the Seychellois colonists become dependent on fish for their primary source of animal protein. To that end, an artisanal fishing industry developed that was conducted from locally produced pirogues (canoes) made from almond trees as well as whalers (an open canoe with sail) made from the takamaka tree, which is resistant to rot (Estridge 1885; Lagarde and Pommeret 2010).

Locally produced vessels that were primarily constructed in shipyards on Mahé, Praslin and La Digue were not restricted to just small fishing boats. The *Arpenteur*, a two masted 95 ton brig which foundered off on Cheynes Beach, Western Australia in 1849 was constructed in 1839 on Mahé (de L. Marshall 2001).



Many of the local shipyards ceased operations following the arrival of fiberglass vessels, ranging in length from 6 to 16 meters, manufactured in Sri Lanka (Lagarde and Pommeret 2010). Industrial fishing undertaken by primarily foreign-owned vessels commenced in 1983 (Lagarde and Pommeret 2010).

### 6.1.2.7.1 Whaling

During the 19<sup>th</sup> century, the northern regions of the Seychelles territory was subject to whaling by vessels from the United States and England (Stoddart 1984c). On December 17, 1828, the United States registered *Asp*, a 345 ton three-masted whaler sunk off Madge Rocks between Praslin and Mahé (Mathiot 2016). A whaling station operated on the island of Sainte Anne until 1915 (Stoddart 1984c).

### 6.1.2.7.2 Artisanal Fishery

Traditionally, artisanal fishing was confined to nearshore areas (Payet 1996). Artisanal fisherman are now able to take advantage of the availability of larger vessels with fish storage facilities and living quarters to venture, if they so choose to the edge of the continental shelf or further on excursions lasting up to twelve days (Lagarde and Pommeret 2010). The area within the continental shelf and areas with depths shallower than 200 m is reserved for the use of the artisanal fleet (Mees 1990).

In addition to the pirogue, artisanal fishing vessel categories tracked by the Seychelles Fishing Authority (SFA) for statistical use include Outboard, Inboard, Whaler and Schooner. An example of an Outboard vessel is the mini-Mahé; an approximately 5 m long fiberglass hull boat that is powered by a small outboard motor whereas an example of an Inboard vessel would be the *Lekonomi*; a simulated clinker fiberglass hulled vessel approximately 6.5 m in length that is equipped with a sloop rig and a small engine. Whalers, not be confused with the traditional whaler described above, are of wood clinker construction and are approximately 8 to 12 metres in length. They can be decked or open, possess an inboard motor and may be equipped for overnight trips. A Schooner is a 10 to 13 metres long wooden hulled vessel that is equipped with a diesel engine and is capable of extended trips (Seychelles Fishing Authority 2015a; Payet 1996). Payet (1996) describes another type of vessel, the *Lavenir* and *Nouvo Lavenir* which are constructed of fiberglass. The *Lavenir* is approximately 8.5 m in length and is equipped with an ice chest, small cabin and inboard motor while the *Nouvo Lavenir* is an extended version that has greater fish carrying capacity. The Whaler and *Lavenir* are similar in size and function therefore it is considered likely that the SFA considers the *Lavenir* and *Nouvo Lavenir* as a Whaler for statistical analysis.

Although artisanal fishermen practice a number of techniques including diving, net and trap, the most common practice is hook and line fishing (Payet 1996; Lagarde and Pommeret 2010) which provides for control of the size and type of fish caught (Payet 1996) and allows for sustainability of the resource (Lagarde and Pommeret 2010). Set bottom fishing, ball bottom fishing and bottom fishing adrift are the three main types of hook and line fishing (Lagarde and Pommeret 2010) and has centered on the capture of species such as red snapper, emperor, jobfish, groupers, mackerel, jack fish, tuna, sharks and octopus (Grandcourt 1993; Payet 1996; Lagarde and Pommeret 2010). On an annual basis, artisanal fishing lands over 4,000 tons of fish from the territorial waters of the Seychelles (Mees 1989; Grandcourt 1993; Seychelles Fishing Authority 2015b).



### 6.1.2.7.3 Semi-industrial and Industrial Fishery

Within the Seychelles EEZ, semi-industrial and industrial fishing is practiced by a combination of a fleet of local and foreign owned vessels primarily capturing Bluefin and Bigeye tuna. Semi-industrial fishing comprises locally owned longliners plying techniques such as longlining, handlining and droplining to land swordfish and tuna (Payet 1996) whereas industrial fishing is comprised of foreign owned long-liners and purse seiners. Over 110,000 tons of fish were landed by semi-industrial and industrial fishing within the Seychelles EEZ in 2013, the last year that the Seychelles Fishing Authority has published statistics (Seychelles Fishing Authority 2015b).

As a result of the semi-industrial and industrial fishery within the Seychelles EEZ, the second largest cannery in the world, Indian Ocean Tuna (Lagarde and Pommeret 2010), is the leading employer in the Seychelles with a workforce of over 2,500 (Seychelles Fishing Authority 2015b).

### 6.1.2.8 Sea Travel

Throughout its history, the sea has connected the Seychelles to the rest of the world. Prior to the twentieth century and the advent of the airplane, access to the Seychelles was restricted to boats and ships that could navigate the immense distances between the mainlands (e.g., Africa, India) and the Seychelles Archipelago. As discussed in Section 5.1.2.1, while evidence indicates that the islands among the Seychelles were known to seafarers in the 9<sup>th</sup> Century AD, and possibly earlier, confirmed widespread sea travel to the islands throughout the Seychelles archipelago did not begin until the arrival of European explorers (Stoddart 1984a). With the arrival of colonists, via ship, the Seychelles was able to begin producing exports, primarily agricultural (Section 5.1.2.3), which were required to travel over the sea to reach markets around the world. Section 5.1.2.2 described the importance the importance of the Seychelles to sea travel during World War 2 as a safe harbour for refueling and maintenance activities.

The sea continues to be an important aspect of life in the Seychelles. The ability to use the sea to move people and goods on vessels such as pirogues, whalers, schooners, interisland ferries, cruise ships and cargo ships is vital to the continued day to day operations of the country while, the sea provides further natural benefits to the country through tourism, food procurement and access to recreational activities such as sailing and diving. Shipwrecks are also beneficial to dive tourism, and multiple wrecks have been intentionally sunk in the Seychelles for that purpose (wrecksite.eu 2016b-f; Elizabeth Fideria, personal communication, September 20, 2016).

### 6.1.2.9 Air Travel

Prior to the opening of Seychelles International Airport in 1972 in Victoria, international air travel to the Seychelles was restricted to flying boats. There are only two documented instances of aircraft in the Seychelles prior to World War 2. The first documented aircraft to arrive in the Seychelles was in 1935 when a Royal Navy amphibious plane that had been launched from a passing cruiser landed in Victoria Harbour. The second documented instance occurred in 1939 when a Consolidated Model 28, the civilian version of a PBY, known as *Guba II* landed in Victoria Harbour while transiting the globe (Guttery 1998).

As discussed in Section 5.1.2.2, the commencement of World War 2 saw the arrival of RAF with Consolidated PBY Catalina's and between 1944 and 1946, the British Overseas Airways Corporation (BOAC) provided mail service to the Seychelles using a Short Brothers S.26 (G-class) flying boat. Following World War II, air travel to



the Seychelles remained restricted to flying boats and was poorly developed, with East African Airways briefly providing service between Victoria and Mombasa in 1953 and Trans-Oceanic Lines providing service between Nairobi and Mahé during the 1960's using surplus Consolidated PBY Catalinas. Between 1963 and 1970, Pan American World Airways provided support for a United States satellite tracking station as well as mail and medical evacuation service between Victoria and Mombasa with a Grumman Albatross flying boat (Guttery 1998).

With the opening of the Seychelles International Airport in 1972, flying boats were no longer required and commercial air traffic to and among the Seychelles archipelago increased as conventional long distance aircraft were able to land in Victoria. During the 1970's, interisland air travel throughout the Seychelles Archipelago was provided by Air Mahé and Inter-Island Airways until their merger in 1979 to form Air Seychelles (Guttery 1998). Air Seychelles continues to provide interisland and international flights.

During the 21<sup>st</sup> Century, the United States has been operating unmanned aerial vehicles (UAVs) from Seychelles International Airport in an effort to combat piracy in the Indian Ocean off the east coast of Africa. Since their deployment, there have been two recorded instances involving UAVs crashing into the ocean adjacent to the Seychelles International Airport (Gambino 2012).

Background review did not identify any instances of civilian aircraft losses in the seas among the islands of the Seychelles.

### 6.1.3 Archaeological Setting

In his seminal publication, maritime archaeology was defined by Muckelroy (1978:4) as the “scientific study of the material remains of man and his activities on the sea.” This definition is limiting however and subsequently, broader more holistic definitions have been developed describing a discipline that encompasses the entire maritime cultural landscape. Delgado (1997:259) defined maritime archaeology as “the study of human interaction with the sea, lakes, and rivers through the archaeological study of material manifestations of maritime culture, including vessels, shore-side facilities, cargoes, and even human remains.” In the sections which follow, the term maritime archaeology used to represent those aspects of maritime archaeology not represented by the archaeology of ship and aircraft wrecks.

#### 6.1.3.1 *Maritime and Shipwreck Archaeology in the Western Indian Ocean Region*

The western Indian Ocean region boasts an extensive bibliography related to coastal “Swahili” maritime archaeology (Kusimba 1999; Horton and Middleton 2000). The cultural area includes the African coast adjacent to the Seychelles from Somalia to Mozambique and including the Mafia archipelago as well as the Comoro Islands and the islands of Pemba, Zanzibar. Breen and Lane (2003) describe the dynamic relationship that the inhabitants of the East African coast have had with the sea over the last 2500 years, while the presence of more than four hundred sites comprising of stone built architecture along the coastline of East Africa from Mogadishu, Somalia to Nova Sofala, Mozambique (Breen and Lane 2003) can be construed to indicate that the utilization of marine resources as well as trans-Indian Ocean trade were significant aspects of Swahili culture (Prins 1965; Allen 1993; Pearson 1998; Horton and Middleton 2000).



Over the last decade, an increasing number of maritime cultural landscape studies have been conducted along the East African coast (Christie 2007; 2011, Pollard 2007, 2008; Rhodes 2010). These studies have generally centered on the exploitation of marine resources and the development of coastal facilities (Lane 2012). Perhaps the most comprehensive maritime cultural landscape study conducted along the East African coast was completed by Pollard during his doctoral research. Pollard (2007) examined the maritime cultural landscape around the communities of Bagamoyo, Kaole and Kilwa in Tanzania during the Iron Age with a focus on the maritime features of the society including nautical infrastructure (lighthouses, wharves), marine resources and the technology developed to exploit those resources (fish, shell fish, fish traps), transportation (shipwrecks and shipping routes), and features of maritime culture with social and religious contexts such as shrines.

Pollard's research combined inter-tidal and coastal survey with test-excavations and ethno-archaeological studies. The results of which included new understandings of the maritime landscape of southern Tanzania and the identification of coral causeways and platforms likely dating to the thirteenth-sixteenth century AD and have been postulated to be have been used to access marine resources or ships at low water. They may also have been used as navigational aids and breakwaters (Lane 2012; Pollard 2008).

There has not yet been any archaeological evidence of Swahili presence on any islands of the Seychelles.

Shipwreck archaeology predated the emergence of maritime archaeology in the western Indian Ocean by about a decade. Regional marine archaeological expertise is now being developed in Egypt, India and South Africa. Unfortunately, this increase in maritime and shipwreck archaeology has coincided with increased activity of treasure hunters (Lane 2012). Three examples of underwater archaeological excavations in the region and located closest to the Seychelles follow.

Perhaps the first instance of shipwreck archaeology in the western Indian Ocean was the underwater archaeological excavation of the Portuguese frigate *Santo António de Tanná* which had sailed from Mozambique to assist with the defence of Fort Jesus on Mombasa Island, Kenya from Omani forces (located about 1500 km south of Mahé). The *Santo António de Tanná* (also known as the Mombasa Wreck) sunk in Mombasa Harbour in 1697 after coming free of mooring lines and drifting onto a reef where it lost its rudder and took on water. The remains of the *Santo António de Tanná* were located during the 1960s by recreational divers (Lane 2012). Divers returned to the wreck in 1970 and during the dive collected artifacts including a bronze swivel gun which assisted in the positive identification of the wreck. In 1976, archaeologists from the Institute of Nautical Archaeology conducted an initial survey of the wreck and an underwater excavation and recording of the wreck was conducted between 1977 and 1980 and resulted in the recovery of over 6000 artifacts (Bass 1997; Green 1978; Piercy 1978, 1979, 1981, 1982, 1983, 1992, 2005; Sassoon 1978, 1979). Since the conclusion of the underwater excavation, two additional surveys have been conducted in the area of the Mombasa Wreck. In 2001, a marine geophysical survey comprising of magnetometry, side-scan sonar and bathymetric profiling identified targets of interest in the vicinity of the *Santo António de Tanná* which may represent additional wreckage (Quinn et al. 2007). Between 2005 and 2007, a maritime archaeologist from the National Museums of Kenya located and recorded timbers approximately 25 m from the Mombasa Wreck. These timbers have not been subject to further investigation though it is thought that they may represent a separate wreck (Sommer 2007; Lane 2012).

In 1999, the wreck of a wooden vessel believed to be HMS *Serapis*, a British warship captured by American naval commander John Paul Jones in 1779 during the American Revolution, was located following a magnetometry survey at Île Sainte Marie (located about 1500 km south south-west of Mahé). The ship had been lost in 1781 as a result of an onboard fire. A team comprising American maritime archaeologists and researchers at the University



of Madagascar conducted an excavation at the site in 2004 which resulted in the mapping of copper hull sheathing and a ballast pile. Material culture recovered during these investigations was analyzed and conserved at the University of Antananarivo's Museum of Art and Civilization (Lane 2012; Van den Boogaerde 2009).

Between 2006 and 2008, researchers affiliated with the French not-for-profit organization *Groupe de Recherche en Archéologie Navale* located and investigated *L'Utile*, a ship owned by France's *Compagnies des Indes Orientales* that wrecked near Tromelin Island (located about 1250 km south of Mahé) in 1761 while enroute from Madagascar to Mauritius. The project was part of a broader UNESCO initiative to research the history of slavery in the Western Indian Ocean. Remnants of the wreck site comprised a widely scattered artifact assemblage, including iron cannons and anchors. In conjunction with the shipwreck survey, excavations were conducted on Tromelin Island which resulted in the identification of the location of the *L'Utile's* survivors' camp. Analysis of artifacts recovered during the terrestrial excavations indicate that the survivors scavenged the remains of the wreck for materials that would be useful in ensuring their survival (Lane 2012; Marriner et al. 2010; Hunter 2014) while researchers have been able to examine the survivors diet through the analysis of faunal remains recovered from the terrestrial excavation. Faunal remains include almost 18,000 avian bones, primarily belonging to the sooty tern, as well as far lesser quantities of turtle and fish (Laroulandie and Lefevre 2014).

### 6.1.3.2 Maritime Archaeology and Recorded Shipwreck Sites in Seychelles

No records or publications of terrestrial or maritime archaeological work conducted in the Seychelles were located as part of this study, and no systematic study of the maritime cultural landscape of the Seychelles has been undertaken.

Across the Seychelles, shipwrecks have been recorded on many of the islands (Burrige 2016), however, there has been no comprehensive shipwreck survey completed. What is known regarding early shipwrecks within the territorial waters of the Seychelles is from historic charts and accounts from survivors. If accessible, fishermen are also good sources for the location of potential wrecks as they often encounter objects in their nets or lose nets after being snagged on undersea obstructions. More recent shipwrecks may be identified on charts, especially if they pose a hazard to shipping.

Within the Seychelles territorial waters, wrecks are primarily associated with early European activities in the region and include among many, a Portuguese wreck along the shore of Boudeuse Cay, the French frigate *L'Heureux* (1769) along the shore of Providence Island, the Portuguese frigate *Don Royal* (1760) along the shore of Astove, and the British sloop *Spitfire* (1801) along the shore of Remire Island (Burrige 2016). More recent wrecks (< 100 years old) are few and are primarily associated with the fishing industry or have been sunk on purpose as artificial reefs and SCUBA diving sites (Wrecksites.eu 2016b-f) with the British tanker *RFA Ennerdale* (1970) being perhaps the most conspicuous due to its size (216.4 m and 29,189 gross tons) and its location between Mahé and Praslin (Figure 9).

Only the *Boudeuse Cay* wreck in the Seychelles has been subject to archaeological investigations. It was first located by fishermen in 1970 on the southwest side of the island that is located approximately 180 nautical miles (335 km) southwest of Mahé in the Amirantes Group (Figure 1). Following the discovery, fishermen and SCUBA divers removed many artifacts including cannon and copper ingots from the wreck (Hunter 2014).



Archaeological investigations were conducted at the *Boudeuse Cay* wreck in 1976 that included surveying and excavating with the objective of identifying the vessel (Blake and Green 1986). During the archaeological investigation, a sample of hull planking was taken for wood species identification. The sample was identified as larch, which leads Blake and Green (1986) to conclude that the vessel was built in Europe and to which they comment “presumably Portugal” based on the artifact assemblage which suggests wreck occurred in the mid- to late 16<sup>th</sup> century. Measurements of the thickness of the hull planking and attached frames point toward the vessel being a *nau* or *caravela* of the period. Approximately 30 cannon were removed from the wreck site prior to the archaeological survey by fishermen and SCUBA divers, some of which are present at the Carnegie Museum in Victoria, Mahé. The *Boudeuse Cay* shipwreck is commonly cited as representing the *Santo António* which was lost in 1589 (Lane 2012; Viera de Castro 2005), however, a diver who participated in salvage of the wreck believes it to be the *Nossa Senhora Da Conceicao* lost in 1555 (Peter Sachs, personal communication, September 28, 2016).

## 6.2 Review of Reported Wrecks in the Vicinity of the Project

No wrecking events are known to have been reported in the Project area. Background review has identified ship (20) and aircraft (2) wrecking events that occurred in the vicinity of various locations in the Project area. A summary of the ship and aircraft wrecking events in the vicinity of the Land based zones and to the various ADZs associated with specific islands is presented in Table 1. These reported wrecks would be in addition to what is likely numerous losses of smaller watercraft that have been used for artisanal fishing and short distance transportation during precolonial and colonial times that have gone unrecorded.

This total also does not include instances where underwater cultural heritage has been observed absent of vessel wreckage (see Section 7.2.2). A summary of all identified underwater cultural heritage within the vicinity of the Project area is presented in Appendix A.

**Table 1: Summary of ship and aircraft wrecking events reported in the vicinity of the Project**

Project Component	Location	Number of Ships Wrecked	Number of Aircraft Wrecked
Land-based Zone	Research & Development Site	0	0
	Broodstock Quarantine & Acclimation Facility and Pilot Project Cage Site	8	2
Aquaculture Development Zone	Mahé	8	0
	Silhouette & North Island	2	0
	Praslin & La Digue	2	0

## 6.3 Cultural Heritage Sites within the Project Area

The background review did not result in the identification of any cultural heritage sites within either the terrestrial or underwater components of the Project area.



### 7.0 CULTURAL HERITAGE POTENTIAL

Based on the criteria described in Section 5.2, the Project area is considered to have potential for cultural heritage. Although background review did not identify any archaeological sites or historic wrecks located within the Project area, landscape characteristics that are favourable for human occupation within coastal environments were identified in association with components of the Land-Based Zone, and historic wrecks were identified in the vicinity of the Project area.

#### 7.1 Cultural Heritage Potential in the Terrestrial Environment

The east coast of Mahé has been extensively altered as infrastructure has been constructed beginning with colonization of the island. Recent decades have seen extensive reclamation of land from the sea by dredging nearshore sea bed sediments and depositing them as fill material in shallow areas along the coast.

This activity has resulted in the disturbance of areas of seabed and the burying of the natural sea bed along portions of the coast of Mahé. Within these reclaimed lands, cultural heritage including wrecks may be present either in the deposited fill material that was dredged from the sea bed or within the natural sea bed located beneath the fill materials. Older infrastructure related to earlier buried shorelines may remain within and below the fill.

No information was readily available regarding the early historical uses of the land and shorelines along the east coast of Mahé in the vicinity of the proposed R&D Facility. Features of the landscape however, can suggest potential for the presence of archaeological sites. For instance, sites are more likely to exist in close proximity to a fresh water source. The water intake pipe for the R&D Facility parallels a small creek (Figure 4). The presence of a navigable break in a reef system may also be also increase potential for adjacent shoreline sites. The navigable reef break which appears to be present in Figure 4 could have allowed for a vessel to find shelter and anchor behind the reef while crew went ashore seeking fresh water, among other terrestrial resources.

The potential exists for archaeological material to be encountered in terrestrial areas close to the shore at the proposed R&D Facility, although the potential is considered insufficient to warrant further archaeological investigation. The chance find procedures should be understood by contractors who are excavating in the area (see Section 9).

#### 7.2 Underwater Cultural Heritage Potential

As described in Section 1.3, cultural heritage may be present underwater and can be associated with wrecks or be non-wreck related, therefore, the potential for underwater cultural heritage related to wrecks and non-wrecks is reviewed.

##### 7.2.1 Wreck Potential

As discussed, shipwreck and aircraft wreck events have been recorded in the Seychelles EEZ (Sections 6.1.2, 6.1.3.2 and 6.2).





These recorded wrecks whether the result of intention, or from weather, accident, equipment failure or the numerous natural hazards present amongst the islands of the Seychelles, provide incontrovertible evidence for the existence of Seychellois underwater cultural heritage. Corroborated by the review of the historic record which chronicles a continuous tale of vessel loss throughout the clear waters of the Seychelles over the last 350 years, the potential for as yet undocumented wrecks to be located within the Project area exists. These wrecks may be related to the earliest explorers or pirates seeking out the resources or safety of the islands, or warfare, colonization or trade and commercial activities from all periods. The relative lack of recorded wreck sites is not atypical, even in areas with such clear water. An older or smaller vessel may have deteriorated to present a very low profile which might be grown-over with coral, or partially or completely buried under a layer of sediments, whether the sediments are naturally shifting sand or man-made fills, which need not be very thick to obscure the wreck.

There is potential for previously unreported wrecks to be found, in various levels of probability, in all the ADZs in the Project area. Because of their locations somewhat offshore, on sandy seabeds, away from known wreck sites, however, the wreck potential does not warrant further archaeological investigation (see Section 9).

The offshore portions of the Broodstock and Acclimation Facility and the R&D Facility are located in shallow water, in proximity to reefs, and, in the case of the Broodstock Quarantine and Acclimation Facility and nearby Pilot Project Cage Site, are located in a harbour area where a number of wrecks have been reported. The potential for the presence of wrecks is sufficient in these specific areas **to warrant further investigation** (see Section 9).

### 7.2.2 Non-Wreck Related Underwater Cultural Heritage Potential

Underwater cultural heritage may be identified within the Project area that is not associated with a vessel which became a total loss (formed a wreck site). For example, observed underwater cultural heritage may be debris from a vessel that did not sink, or did sink and was subsequently salvaged, or may be the result of being lost overboard whether intentionally jettisoned or not. For instance, anchors and chain are common on the seabed and quite often are not associated with a wreck event, especially if they were jettisoned to avoid possibly wrecking or to quickly get underway if attacked when at anchor.

Further, cultural heritage related to the centuries of maritime activities that have transpired within the shallow sub-tidal and inter-tidal areas in the vicinity of the Project may be present.

The potential for these types of sites being encountered does not warrant further investigation (see Section 9).



## 8.0 GAP ANALYSIS

At the outset of the Project, Golder understood that one or more relevant archaeological studies were available for the Project area. Subsequently, it became apparent that no previous studies had been conducted. This was the critical gap that this study will close within the limits of its scope.

This CHOA is a desktop study and, as such, did not benefit from pedestrian or other visual survey of the Project area which could result in refinement to the potential assessment.

During the background review, it was not possible to access the Seychelles Natural History Museum or the National Archives due to their closure resulting from a fungal infestation.

A representative of the Seychelles Ministry of Tourism and Culture was contacted to discuss whether a list of monument or relics, as described in the NMA, other than those identified as National Monuments is maintained by the Ministry or National Monuments Board. Unfortunately, the representative was not able to reply to this query in time for the completion of this study.

No published reports regarding terrestrial based archaeological investigations in the Seychelles were identified during the CHOA. If terrestrial archaeological investigations have been undertaken in the Seychelles, a review of the results of these investigations would be beneficial in refining the assessment of terrestrial archaeological potential and site types.

Some underwater video was collected during the conduct of other studies for this project. The video was not reviewed as it would not add value to establishing the potential for the presence of a wreck site. If a possible wreck site were located, it would be of benefit to view the features of interest, even remotely by video.

Access to marine geophysical data was not available for this review. Marine geophysical data appropriate for archaeological review is commonly acquired via magnetometry, sidescan sonar and subbottom profiling surveys of a Project area. This data is beneficial to assess for anomalies which may correspond with submerged wrecks, particularly over a large area and where buried wrecks may be present.



## 9.0 RECOMMENDATIONS

Recommendations for the management of cultural heritage resources within the Project area are formulated from the results of the CHOA and are outlined below:

- Due to the potential for the presence of cultural heritage within the inter-tidal and subtidal areas of along the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist along the entire offshore length of the Research & Development Facility water intake pipeline prior to construction.
- Due to the potential for the presence of cultural heritage within the inter-tidal and subtidal areas along the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist along the entire length of the Broodstock Quarantine & Acclimation Facility water intake pipeline prior to construction.
- Due to the potential for the presence of cultural heritage within subtidal waters off of the northeast coast of Mahé, it is recommended that a diver survey be conducted by a qualified archaeologist throughout the anticipated area of impact associated with the construction, utilization and maintenance of the pilot project cage site prior to placement.
- To address the possibility of the identification of cultural heritage during Project development, it is recommended that a cultural heritage **chance find procedure** specific to the Project and both the marine and coastal terrestrial environments be developed by the Seychelles Fishing Authority for distribution its subcontractors and to aquaculture developers prior to the commencement aquaculture development construction activity.
- No further historical/archival investigation is recommended, except where it may be appropriate to identify and assess the significance of cultural heritage located as a result of Project development.



## **10.0 LIMITATIONS AND USE OF THE REPORT**

This report was prepared for the exclusive use of the Seychelles Fishing Authority. Any use, reliance, or decisions made by third parties on the basis of this report are the responsibility of such third parties.

DRAFT



## 11.0 CLOSURE

We trust the information in the document is satisfactory for your present needs. Should you require additional information or clarification, please do not hesitate to contact the undersigned at your earliest convenience.

### GOLDER ASSOCIATES LTD.

Christopher Wylie, M.A., RPCA  
Archaeologist

Charles D. Moore, M.A., RPCA, RPA  
Senior Archaeologist

Andrew R. Mason, M.A. RPCA  
Principal/Cultural Heritage Specialist

CW/CDM/ARM/lih

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

c:\users\lastoop\desktop\seychelles esia\specialist studies\1543656-308205-9\_seychelles mmp choa\_final.docx



### 12.0 REFERENCES

Admiralty Chart 716

2016 *Indian Ocean Seychelles Group to Madagascar and Alega Islands*. The United Kingdom Hydrographic Office. Taunton, Somerset, UK.

Allen, JdeV.

1993 *Swahili origins: Swahili culture and the Shungwaya phenomenon*. James Currey, London.

Bass, George F.

1997 Santo Antonio de Tanna. In: Delgado, J. (Ed). *Encyclopaedia of Underwater and Maritime Archaeology*. British Museum Press. London.

Behar, Michael

2004 Treasure Quest. *Smithsonian Magazine*. Retrieved March 31, 2016  
<http://www.smithsonianmag.com/travel/treasure-quest-97145764/?no-ist>

Benedict, B.

1984 The human population of the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 627-639). The Hague. Dr W. Junk Publishers.

Biddulph, John

1907 *Pirates of Malabar and an Englishwoman in India Two Hundred years Ago*. An annotated on-line edition posted by Prof. Frances W. Pritchett, Columbia University, accessed April 23, 2016 at:  
<http://www.columbia.edu/itc/mealac/pritchett/00generallinks/biddulph/Smithsonian Magazine>.

Blake W, and J. Green

1986 A mid-XVI century Portuguese wreck in the Seychelles. *The International Journal of Nautical Archaeology* 15:1–23.

Bowens, A.

2009 *Underwater Archaeology: The NAS Guide to Principles and Practice*. 2nd edition. The Nautical Archaeology Society, Portsmouth, U.K.

Braithwaite, C.J.R.

1984 Geology of the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 16-38). The Hague. Dr W. Junk Publishers.

Breen, C.P. and Lane, P.J.

2003 Archaeological Approaches to East Africa's Changing Seascapes. *World Archaeology*. Vol. 35, 3:469-489.

Breiner, S.

1999 *Applications Manual for Portable Magnetometers*. Geometrics, San Jose, CA.



Burridge, G.

2016 A Brief History of Wrecks in Seychelles – ‘Bones Beneath the Waves’. Accessed September 23, 2016 from <http://glynnburridge.com/blog/2012/06/hello-world/>

Burney, David A., Lida Pigott Burney, Laurie R. Godfrey, William L. Jungers, Steven M. Goodman, Henry T. Wright, A.J. Timothy Jull.

2004 A chronology of late prehistoric Madagascar. *Journal of Human Evolution*. 47: 25-63.

Christie, A.C.

2007 Maritime Archaeology: A New Approach for the Swahili Coast? Evaluating ‘Seamless’ Maritime Methodologies in East Africa. Unpublished MA thesis, Institute of Archaeology, UCL.

2011 Exploring the Social Context of Maritime Exploitation in the Mafia Archipelago, Tanzania: An Archaeological Perspective. Unpublished PhD dissertation, University of York.

Clydebuilt Database

2016 *SS Manela* retrieved March 14, 2016. <http://www.clydesite.co.uk/clydebuilt/viewship.asp?id=4361>

Commonwealth War Graves Commission

2016 *Hatton, William*. Retrieved March 14, 2016. <http://www.cwgc.org/find-war-dead/casualty/2223892/HATTON,%20WILLIAM>

Dahl, O.C.

1951 *Malgache et Maanyan: Une comparaison linguistique*. Egede Instituetett, Oslo.

de L. Marshall, G.

2001 *Maritime Albany Remembered*. Tangee Publishing. Albany, Western Australia, Australia

Delgado, James P.

1997 Maritime Archaeology. In *Encyclopaedia of Underwater and Maritime Archaeology*. Ed. James P. Delgado. British Museum Press. London.

Dromgoole, S.

2013 *Underwater Cultural Heritage and International Law*. Cambridge University Press. Cambridge.

Estridge, H.W.

1885 *Six Years in Seychelles; with photographs from original drawings*. Publisher not listed. Reprinted in 2011 by Nabu Press.

Foster, W., ed.

1905 *The Journal of John Jourdain 1608-1617, describing his experiences in Arabia, India and the Malay Archipelago*. London. Hakluyt Society.

Galvano, A.

1862 *The discoveries of the world, from their first originall unto the yeare of our Lord 1555*. London. Hakluyt Society (reprint of 1601 edition).



Gambino, Lauren

2012 US drone crashes at Seychelles airport. *The Telegraph*. Retrieved from <http://www.telegraph.co.uk/news/worldnews/africaandindianocean/seychelles/9188548/US-drone-crashes-at-Seychelles-airport.html>

Ganerød, M., T.H. Torsvik, D.J.J. Van Hinsbergen, C. Gaina, F. Corfu, S. Werner, T.M. Owen-Smith, L.D. Ashwal, S.J. Webb, B.W.H. Hendriks

2011 Palaeoposition of the Seychelles microcontinent in relation to the Deccan Traps and the Plume Generation Zone in Late Cretaceous-Early Palaeogene Time. In D.J.J. Van Hinsbergen, S.J.H. Buiter, T.H. Torsvik, C. Gaina & S.J. Webb (Eds.) *The Formation and Evolution of Africa: A Synopsis of 3.8 Ga of Earth History*. The Geological Society of London, Special Publications 357.

Government of England

1986 *Protection of Military Remains Act*, 1986. Chapter 35. London, England <http://legislation.data.gov.uk/ukpga/1986/35/contents/data.htm?wrap=true>

Government of Seychelles

1980 *National Monuments Act*, 1980. Chapter 140. Consolidated to 30 June 2012. Victoria, Mahé <http://www.seyllii.org/sc/legislation/consolidated-act/140>

Gerry, C.

2013 *Bio-Physical Assessment for the Mariculture Master Plan*. Seychelles Fishing Authority. Fishing Port. Mahé. Seychelles.

Grandcourt, E.M.

1993 *Seychelles Artisanal Fisheries Statistics for 1992*. Seychelles Fishing Authority. Fishing Port. Mahé, Seychelles.

Green, Jeremy.

1978 Appendix 1: The Survey Procedure in Mombasa Wreck Excavation: Second Preliminary Report, 1978 by Robin C. M. Piercy. *International Journal of Nautical Archaeology* 7:311-314.

1990 *Maritime Archaeology: A Technical Handbook*. Academic Press, Sidney, Australia.

Guttery, B.R.

1998 *Seychelles*. Encyclopedia of African Airlines. McFarlan & Company Inc. Publishers. Jefferson, North Carolina.

Halley, James J.

1988 *The Squadrons of the Royal Air Force & Commonwealth 1918-1988*. Air Britain (Historians) Ltd. Tonbridge, Kent.

Harris, Jason R.

2001 The Protection of Sunken Warships as Gravesites at Sea. *Ocean and Coastal Law Journal*. Volume 7:1

2002 Protecting Sunken Warships as Objects Entitled to Sovereign Immunity. *33 U. Miami Inter-Am. L. Rev.* 101 (2002) Available at: <http://repository.law.miami.edu/umialr/vol33/iss1/4>





Hunter, James W. III

- 2014 Indian Ocean: Maritime Archaeology. *Encyclopedia of Global Archaeology*, C. Smith (ed.). Springer Science and Business Media. New York. pp 3760-3770. Horton, M.C. and Middleton, J.  
2000 *The Swahili: The Social Landscape of a Mercantile Society*. Blackwell. Oxford.

James, William.

- 2002 *The Naval History of Great Britain. Volume 3, 1800-1805*. Conway Maritime Press. London.

Klein, Martin

- 1982 New Capabilities for Side-Scan Sonar. In *Underwater Archaeology: The Proceedings of the Eleventh Conference on Underwater Archaeology*, Calvin R. Cummings (ed.). Fathom Eight, San Marino, California.  
1997 Side Scan Sonar. In *The British Museum Encyclopaedia of Underwater and Maritime Archaeology*. James P. Delgado (ed.). British Museum Press, London.  
2002 *Side Scan Sonar*. In *International Handbook of Underwater Archaeology*, Carol V Ruppé, and Janet F. Barstad (eds). Kluwer Academic/Plenum. New York. Pp. 667-678.

Kusimba, C.M.

- 1999 *The Rise and Fall of Swahili States*. Altamira, Walnut Creek.

Kusuma, P., Murray P. Cox, Denis Pierron, Harilanto Razafindrazaka, Nicolas Brucato, Laure Tonasso, Helena Loa Suryadi, Thierry Letellier, Herawatic Sudoyo, Francois-Xavier Ricault

- 2015 Mitochondrial DNA and the Y Chromosome suggest the settlement of Madagascar by Indonesian Sea Nomad Populations. *BMC Genomics*. 16:191.

Lagarde, V. and M. G. Pommeret.

- 2010 *Labels from Paradise*. Samudra Report No. 56. International Collective in Support of Fishworkers.

Lane, Paul J.

- 2007 New International Frameworks for the Protection of Underwater Cultural Heritage in the Western Indian Ocean. *Azania* 41:115–136  
2012 Maritime and Shipwreck Archaeology in the Western Indian Ocean and Southern Red Sea: An Overview of Past and Current Research *Journal of Maritime Archaeology*. 17:9-41.

Laroulandie, V and Lefevre, C.

- 2014 The use of Avian Resources by the Forgotten Slaves of Tromelin Island (Indian Ocean). *International Journal of Osteoarchaeology*. 24:407-416.

Lawrence, Matthew S.

- 2011 Testing the Efficacy of Synthetic Aperture Sonar to Locate Historic Shipwrecks in the Stellwagon Bank National Marine Sanctuary. In *ACUA Underwater Proceedings 2011*, Philippe Castro and Lindsey Thomas (eds). An Advisory Council on Underwater Archaeology Publication. Pp. 23-28.



### London Gazette

1802 Issue 15498. Pages 757-758. Accessed September 22, 2016 from <https://www.thegazette.co.uk/London/issue/15498/page/757>

Mair, L. and Beckley, L.

2012 *Seychelles: the Bradt Travel Guide*. Edition 4. Bradt Travel Guides Ltd. UK.

Marriner, N., M. Guérout & T. Romon.

2010 The Forgotten Slaves of Tomelin (Indian Ocean): New Geoarchaeological Data. *Journal of Archaeological Science* 37: 1293-304.

Mathiot, T.

2016 *Our treasure at the bottom of the sea...* Seychelles Ministry of Tourism and Culture. Accessed April 7, 2016 from <http://www.pfsr.org/history-of-seychelles/our-treasure-at-the-bottom-of-the-sea-2/>.

Maurel, H.

2016 *Seafaring*. Accessed September 22, 2016 from <http://henri.maurel.pagesperso-orange.fr/seafaring%202.htm> and <http://henri.maurel.pagesperso-orange.fr/seafaring%203.htm>.

McGrail, S.

2004 *Boats of the World: From the Stone Age to Medieval Times*. Oxford University Press. Oxford.

Mees, C.C.

1989 *Seychelles Artisanal Fisheries Statistics for 1988*. Seychelles Fishing Authority. Fishing Port. Mahé, Seychelles.

1990 *The Fisherman of Seychelles: Results of a Socio-Economic Study of Seychelles Fishing Community*. Seychelles Fishing Authority. Fishing Port. Mahé, Seychelles.

Muckelroy, Keith

1978 *Maritime Archaeology*. Cambridge University Press. New York.

Murphy, Larry E., and Allan R. Saltus

1990 Consideration of Remote Sensing Limitations to Submerged Historical Site Survey. In *Underwater Archaeology Proceedings from the Conference on Underwater and Historical Archaeology Conference*. Toni Carrell (ed.). Society for Historical Archaeology, Tucson, Arizona. Pp. 93-95.

Northern Maritime Research

2002 Northern Shipwrecks Database. Database on CD-Rom, Bedford, Nova Scotia.

*North Island Seychelles* [brochure]. (n.d.). <http://www.north-island.com>.

Payet, R.

1996 *Artisanal Fishing Boats in Seychelles*. Seychelles Fishing Authority. Fishing Port. Mahé, Seychelles.



Pearson, M.N.

1998 *Port Cities and Intruders: The Swahili Coast, India and Portugal in the Early Modern Period*. John Hopkins University Press. Baltimore.

Petroseychelles

2016 *Exploration History*. Accessed May 14, 2016 from <http://www.petroseychelles.com/index.php/geotechnical/exploration-history>.

Piercy, Robyn

1978 Mombasa Wreck Excavations, Second Preliminary Report. *International Journal of Nautical Archaeology*. 7:301-319.

1979 Mombasa Wreck Excavations, Third Preliminary Report. *International Journal of Nautical Archaeology*. 8:303-309.

1981 Mombasa Wreck Excavations, Fourth Preliminary Report. *International Journal of Nautical Archaeology*. 10:109-118.

1982 Excavation of a Shipwreck in Mombasa Harbor, Kenya. *National Geographic Society Research Reports, 1976 Projects* 17-30.

1983 The Mombasa Wreck Excavation. *Museum* 137:27-29

1992 The Wreck of the Santo Antonio de Tanna. *Archaeology*. 45(3):32-35.

2005 The Tragedy of the *Santo Antonio de Tanna*: Mombasa, Kenya. In, *Beneath the Seven Seas*, Bass, G. (ed). Thames & Hudson. London. Pp 172–179.

Pillay, G. and Uranie, S.

2014 Seychelles commemorates 100 years since the First World War in memory of Seychellois war victims. Seychelles News Agency. Victoria. Seychelles. Accessed September 19, 2016 from <http://www.seychellesnewsagency.com/articles/1098/Seychelles+commemorates++years+since+the+First+World+War+in+memory+of+Seychellois+war+victims>.

Pollard E.J.D.

2007 An Archaeology of Tanzanian Coastal Landscapes in the Middle Iron Age (6<sup>th</sup> to 15<sup>th</sup> Centuries AD). PhD Dissertation, University of Ulster.

2008 The Archaeology of Tanzanian Coastal Landscapes in the 6th to 15th centuries AD (the Middle Iron Age of the Region). British Archaeological Reports S1873 — *Cambridge Monographs in African Archaeology* 76, Oxford.

Pollock, A.W.A.

1842 The United Service Journal and Naval and Military Magazine. 1841. Part 1. Henry Colburn, Great Marlborough Street. London.

Plummer, P.

1998 Seychelles Geology and the Shiva Impact Crater Theory. *Phelsuma*. Volume 6. Pp.9-19.

Prins, A.H.J.

1965 *Sailing from Lamu: A Study of Maritime Culture in Islamic East Africa*. Van Gorcum. Assen.



Proctor, J.

1984 Vegetation of the granitic islands of the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 193-207). The Hague. Dr W. Junk Publishers.

Quinn, Rory

2006 The role of scour in shipwreck site formation processes and the preservation of wreck-associated scour signatures in the sedimentary record – evidence from seabed and sub-surface data. *Journal of Archaeological Science*. Vol. 33, Issue 10, Pp. 1419-1432.

Quinn, R., Forsythe, W., Breen, C., Boland, D., Lane, P., Omar, A.L.

2007 Process-based Models for Port Evolution and Wreck Formation at Mombasa, Kenya. *Journal of Archaeological Science*. 34:1449-1460.

Richards, Nathan

2008 *Ships' Graveyards*. University Press of Florida. Gainesville.

Roach, J. Ashley

1996 Sunken warships and military aircraft. *Marine Policy*. Volume 20, No. 4, pp. 351-354.

Rothberg, Robert H.

1993 *Diverless Subsea Systems New Features on ROV's and Control Systems add Flexibility and Cut Costs*. Oil and Gas Journal, April 5.

Richie, Robert C.

1986. *Captain Kidd and the War Against Pirates*. Harvard University Press, Cambridge Mass.

Rhodes, D.

2010 Historical Archaeologies of Nineteenth Century Colonial Tanzania: A Comparative Study. British Archaeological Report S2075 – Cambridge Monographs in African Archaeology 79. Oxford.

Sasson, H.

1978 Marine Thoughts of a Land Archaeologist derived from the Mombasa Wreck Excavation. In Arnold, J.B. (Ed) *Beneath the Water of Time: The Proceedings of the Ninth Conference on Underwater Archaeology*. Texas Antiquities Committee Publication No. 6. San Antonio. Pp. 33-37.

1979 The Santa Antonio Portuguese Wreck off Mombasa. *Kenya Past Present*. 11:29-36.

Seychelles Fishing Authority

2015a *Fisheries Statistical Report Year 2015 Semester 1*. Seychelles Fishing Authority. Fishing Port. Mahé. Seychelles.

2015b *Annual Report 2013*. Seychelles Fishing Authority. Victoria. Mahé. Seychelles.

Seychellesweekly.com

2016 The Sinking of "Ero". Retrieved October 5, 2016.

[http://www.seychellesweekly.com/2016/January%2018,%202016/soc2\\_sinking\\_of\\_ero.html](http://www.seychellesweekly.com/2016/January%2018,%202016/soc2_sinking_of_ero.html)



Shope, Steven

1997 Magnetometer. In *The British Museum Encyclopaedia of Underwater and Maritime Archaeology*. Edited by James P. Delgado. British Museum Press, London.

Sommer, H.P.

2007 A New Shipwreck off Fort Jesus, Mombasa: Preliminary Survey Report. Unpublished Report prepared for the Coastal Archaeology Unit, Fort Jesus Museum, Mombasa.

Sparks, D.L.

2016 *Seychelles*. Encyclopedia Britannica. Accessed March 30, 2016 from <http://www.britannica.com/place/Seychelles>.

Stevens, W.E.

1996 Geology of Silhouette Island. *Phelsuma*. Volume 4. Pp. 11-18.

Stoddart, D.R.

1984a Scientific Studies in the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 1-15). The Hague. Dr W. Junk Publishers.

1984b Coral reefs of the Seychelles and adjacent regions. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 63-81). The Hague. Dr W. Junk Publishers.

1984c Impact of man in the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 641-654). The Hague. Dr W. Junk Publishers.

United Nations Convention on the Law of the Sea (UNCLOS)

2008 Joint Submission to the Commission on the Limits of the Continental Shelf concerning the Mascarene Plateau region. Submission was prepared by the Government of the Republic of Seychelles and the Government of the Republic of Mauritius jointly. Accessed on line October 3, 2016 at [http://www.un.org/depts/los/clcs\\_new/submissions\\_files/musc08/sms\\_es\\_doc.pdf](http://www.un.org/depts/los/clcs_new/submissions_files/musc08/sms_es_doc.pdf).

United Nations Convention on the Protection of the Underwater Cultural Heritage (UNCPUCH)

2001a Convention on the Protection of the Underwater Cultural Heritage. Accessed on line October 3, 2016 at <http://unesdoc.unesco.org/images/0012/001246/124687e.pdf#page=56>

2001b Convention on the Protection of the Underwater Cultural Heritage Annex. Accessed on line October 3, 2016 at <http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/2001-convention/official-text/#Annex>

USGS

2012 *Assessment of Undiscovered Oil and Gas Resources of Four East Africa Geological Provinces*. World Petroleum Resources Project. United States Geological Survey. U.S. Department of the Interior. Washington.

Van den Boogaerde, P.

2009 *Shipwrecks of Madagascar*. Strategic Book Publishing, New York.



Viera de Castro, Filipe

2005 *The Pepper Wreck: A Portuguese Indiaman at the Mouth of the Tagus River*. Texas A&M University Press. College Station.

Walsh, R.P.D.

1984 Climate of the Seychelles. In D.R. Stoddart (Ed.) *Biogeography and Ecology of the Seychelles Islands* (pp. 39-62). The Hague. Dr W. Junk Publishers.

Wrecksite.eu

2016a *Ascension [+1609]* retrieved March 14, 2016. <http://www.wrecksite.eu/wreck.aspx?138967>

2016b ?04°35'XXXS-055°29'XXE [+1985] retrieved October 4, 2016. <http://wrecksite.eu/ukhoDetails.aspx?42629>

2016c *Lavann [+2008]* retrieved October 4, 2016. <http://www.wrecksite.eu/wreck.aspx?197852>

2016d *MFV Aldebaran [+2008]* retrieved October 4, 2016. <http://www.wrecksite.eu/wreck.aspx?137621>

2016e *MFV Aterpe-Alai [+1990]* retrieved October 4, 2016. <http://www.wrecksite.eu/wreck.aspx?102312>

2016f Unknown [1976] retrieved October 4, 2016. <http://wrecksite.eu/ukhoDetails.aspx?75051>

2016g *RFA Ennerdale (A213) [+1970]* retrieved October 4, 2016. <http://www.wrecksite.eu/wreck.aspx?102308>

DRAFT



# APPENDIX A

Table: Reported Underwater Cultural Heritage in Project Vicinity.

DRAFT



**APPENDIX A  
TABLE: REPORTED UNDERWATER CULTURAL HERITAGE IN PROJECT VICINITY: DESCRIPTION AND LOCATION**

FEATURE #	VESSEL AIRCRAFT OR SITE	REGISTRY	DATE OF LOSS	VESSEL/AIRCRAFT TYPE	LENGTH (M) & TONNAGE	MATERIAL	LOSS DESCRIPTION	POTENTIAL GRAVESITE (Y/N)	POSITION RELIABILITY	LATITUDE	LONGITUDE	REPORTED LOSS LOCATION	NOTES	DATA SOURCES
1	2 Anchors Site	N/A	N/A	N/A	N/A	N/A	N/A	N	Located	04°35.753	55°29.027	Victoria Harbour, Mahé	Located in 1985, possibly recovered.	Wrecksite.eu (2016b)
2	Anchor and Chain Site	N/A	N/A	N/A	N/A	N/A	N/A	N	General	-	-	Blanchisseuse Rocks	Located in depth 16-18 m. No wreck has been found in the vicinity of the anchor and chain.	Elizabeth Fideria, personal communication, September 20, 2016
3	Asp	United States	December 17, 1828	Whaler (ship)	N/A & 345	N/A	Sunk	Y	Estimated	-	-	Madge Rocks, Ste. Anne Island	Three-masted vessel originating from Nantucket Island.	Mathiot (2016)
4	Chiffonne	France	August 19, 1801	Frigate	N/A & N/A	Wood	Grounded on reef	Y	General	-	-	Victoria Harbour, Mahé	Dragged off reef by the crew of the HMS <i>Sibylle</i> and sailed to India. Remnants of the vessel or cargo may be present on the seabed.	Maurel (2016)
5	Ero	Seychelles	August 12, 1975	Schooner	N/A & N/A	Wood	Sunk	N	General	-	-	Between Praslin and Mahé, near Mamelles Islands	Took on water after suffering damaged in rough seas	Seychellesweekly.com (2016)
6	Flèche	France	September 7, 1801	Brig	N/A & N/A	Wood	Sunk	N	Estimated	-	-	Victoria Harbour, Mahé	Sunk by the HMS <i>Victor</i> . The ship was salvaged shortly after sinking, however remnants of the vessel or cargo may still be present on the seabed.	Mathiot (2016)
7	FP107	United Kingdom	July 8, 1944	British Royal Air Force Catalina 1B	19.5 & N/A	Metal	Crash	N	General	-	-	St. Anne Island	Stationed at RAF Seychelles as part of RAF Squadron No. 209.	Commonwealth War Graves Commission (2016)
8	FP247	United Kingdom	March 15, 1945	British Royal Air Force Catalina 1B	19.5 & N/A	Metal	Crash	N	General	-	-	St. Anne Island	Stationed at RAF Seychelles as part of RAF Squadron No. 209. May have been partially salvaged.	RoyalAirForce Commands Forum (2016) <a href="http://www.rafcommands.com/forum/showthread.php?4962-Catalina-FP247-Crash-15-03-1945">http://www.rafcommands.com/forum/showthread.php?4962-Catalina-FP247-Crash-15-03-1945</a>
9	La Digue gun site	N/A	N/A	N/A	N/A	N/A	N/A	N	Estimated	-	-	La Digue	11 bronze naval guns and iron ballast recovered in 1971 off the coast of La Digue. Evidence of a wreck was not encountered. These objects may have been jettisoned to float a ship off the coral.	Mathiot (2016)
10	Lavann	N/A	2008	Barge	N/A & N/A	N/A	Sunk	N	Located	04°46.88	55°29.31	Southwest coast of Mahé	Fuel barge sunk on purpose for a dive site.	Wrecksite.eu (2016c)
11	Lord of the Isles	N/A	1906	Coaster	N/A & N/A	N/A	N/A	Y	General	-	-	North coast of Mahé	Captained by Jacob Hoffman. No trace of wreckage observed.	Mair and Beckley (2012)
12	MFV Aldebaran	N/A	July 11, 2008	Fishing (Longliner)	45 & N/A	N/A	Sunk	N	Located	04°37.420	55°22.673	North coast of Mahé	Sunk on purpose in 2008. Currently a recreational dive site.	Wrecksite.eu (2016d)
13	MFV Aterpe-Alai	Spain	October 19, 1990	Fishing	59.4 & 988	N/A	Fire	N	Located	04°36.33	55°28.51	Victoria Harbour, Mahé	Caught fire while at berth, towed into Victoria Harbour and sunk.	Wrecksite.eu (2016e)
14	Parachi Pachia	N/A	August 19, 1801	Schooner	N/A & N/A	N/A	N/A	N/A	General	-	-	Victoria Harbour, Mahé	Sunk during battle between British frigate HMS <i>Sibylle</i> and the French frigate <i>Chiffonne</i> .	Mair and Beckley (2012), Maurel (2016)
15	Pontoon	N/A	May 6, 1976	Pontoon	N/A & N/A	N/A	Sunk	N	Located	04°37	55°29	Victoria Harbour, Mahé	Sunk while being towed. Located alongside jetty.	Wrecksite.eu (2016f)
16	RFA Ennerdale	United Kingdom	June 1, 1970	Royal Fleet Auxiliary Tanker	216.4 & 29,189	Steel	Grounded and subsequently sunk	N	Located	04°29.753	55°31.293	Southwest of Praslin	Grounded on rocks in 1970. Sunk in place by the Royal Navy. Currently a recreational dive site.	Wrecksite.eu (2016g)
17	Twin Anchors site	N/A	N/A	N/A	N/A	N/A	N/A	N	General	-	-	Off the north coast of Silhouette Island	Dive site frequented by divers from the resort on North Island. The location of this site could not be confirmed.	North Island Seychelles [brochure]. (n.d.)
18	Unidentified Barge #1	N/A	1989	Barge	N/A & N/A	N/A	Intentionally Sunk	N	Located	04°36.933	55°24.414	North coast of Mahé	Sunk on purpose in 1989. Currently a recreational dive site known as the "Twin Barges".	Dive Seychelles Underwater Centre. <a href="http://www.diveseychelles.com.sc/inshore%20sites%20nw.html">http://www.diveseychelles.com.sc/inshore%20sites%20nw.html</a>
19	Unidentified Barge #2	N/A	1989	Barge	N/A & N/A	N/A	Intentionally Sunk	N	Located	04°36.933	55°24.414	North coast of Mahé	Sunk on purpose in 1989. Currently a recreational dive site known as the "Twin Barges".	Dive Seychelles Underwater Centre. <a href="http://www.diveseychelles.com.sc/inshore%20sites%20nw.html">http://www.diveseychelles.com.sc/inshore%20sites%20nw.html</a>
20	Unidentified Barge #3	N/A	N/A	Barge	N/A & N/A	N/A	Intentionally Sunk	N	General	-	-	North coast of Mahé	On reef off Anse MarieLaure.	Elizabeth Fideria, personal communication, September 20, 2016





## APPENDIX A TABLE: REPORTED UNDERWATER CULTURAL HERITAGE IN PROJECT VICINITY: DESCRIPTION AND LOCATION

FEATURE #	VESSEL AIRCRAFT OR SITE	REGISTRY	DATE OF LOSS	VESSEL/AIRCRAFT TYPE	LENGTH (M) & TONNAGE	MATERIAL	LOSS DESCRIPTION	POTENTIAL GRAVESITE (Y/N)	POSITION RELIABILITY	LATITUDE	LONGITUDE	REPORTED LOSS LOCATION	NOTES	DATA SOURCES
21	Unidentified Barge #4	N/A	N/A	Barge	N/A & N/A	N/A	Sunk	N	General	-	-	Between the islands of St. Anne, Moyenne and Ile Seche	No information regarding the circumstances of the loss of this vessel could be found.	Elizabeth Fideria, personal communication, September 20, 2016
22	Unidentified Dredger	N/A	1989	Dredge	N/A & N/A	N/A	Intentionally Sunk	N	Located	04°36.8832	55°23.982	North coast of Mahé	Sunk on purpose in 1989 following construction of Victoria International Airport. Currently a recreational dive site.	Dive Seychelles Underwater Centre. <a href="http://www.diveseychelles.com.sc/inshore%20sites%20nw.html">http://www.diveseychelles.com.sc/inshore%20sites%20nw.html</a>
23	Unidentified Portuguese Clipper	Portugal	1784	Clipper	N/A & N/A	Wood	N/A	Y	General	-	-	North Island	Anchor recovered during construction of resort on North Island may be associated with this vessel.	<i>North Island Seychelles</i> [brochure]. (n.d.) Burridge (2016)
24	Unidentified Vessel #1	N/A	N/A	N/A	N/A & N/A	N/A	N/A	N/A	General	-	-	Ile aux Recife	Small vessel.	Elizabeth Fideria, personal communication, September 20, 2016
25	Unidentified Vessel #2	N/A	N/A	N/A	N/A & N/A	N/A	N/A	N/A	General	-	-	West of Silhouette	Sunk on purpose at a depth of 30 m.	Elizabeth Fideria, personal communication, September 20, 2016
26	Unidentified Vessel #3	N/A	N/A	N/A	N/A & N/A	N/A	N/A	N/A	General	-	-	South of Mahé	At a depth of 28 m.	Elizabeth Fideria, personal communication, September 20, 2016
27	<i>Voyageur</i>	N/A	N/A	N/A	N/A	N/A	N/A	N/A	General	-	-	Victoria Harbour, Mahé	No information regarding the circumstances of the loss of this vessel could be found.	Mair and Beckley (2012)

### TABLE KEY: LOSS DESCRIPTION AND LOCATION

**VESSEL AIRCRAFT OR SITE:** The name of the vessel or aircraft as registered prior to its loss, or the name of an unidentified wreck located by recreational divers or in sailing directions. Sorted alphabetically.

**DATE OF LOSS:** The date of loss as reported by archival sources.

**VESSEL/AIRCRAFT TYPE:** Description of the functional type or specific model (in the case of aircraft) where available. The type of vessel will be an important part of identifying any wrecks encountered that do not have clear identifiers. The number provided is the Official Number (ON) for vessels or registration number for aircraft (where known).

**LENGTH and TONNAGE:** The length provided is the greatest linear dimension available for the vessel or aircraft expressed in metres. For aircraft this dimension is often wingspan, but might be fuselage length. For vessels, the length is often the measured length used for tonnage calculations which is somewhat less but close to overall length. Tonnage is provided for vessels only and represents the volume calculation for interior space of the hull. Where the information is available for this table, tonnage is expressed as gross tonnage (**gt**), or if a figure for gross tonnage is not available as net tonnage (**nt**) which represents the volume available for cargo after certain spaces (e.g. crew accommodations and engine space) have been deducted.

**MATERIAL:** This is the principal material used in construction. For vessels this is the material used in the hull, typically wood (plank) or steel (plate). For aircraft it is the material used for aircraft skin, typically metal (aluminum) or fabric.

**LOSS DESCRIPTION:** Describes the circumstances of loss based on the source(s). Vessels with loss descriptions suggesting that the vessel or aircraft may have been recovered (e.g., "stranded", "grounded", or "leaking"), may not be included on the list unless other information in context indicates that the loss was total. Fire in wooden vessels typically results in a much lower wreck profile.

**POTENTIAL GRAVESITE:** Indicates the potential for human remains associated with a wreck site where life was presumed lost with the wrecking event due to at least one individual being reported missing, or one body not recovered.

**POSITION RELIABILITY:** Position reliability varies according to circumstances of loss and detail of records. Four levels of reliability are listed: RECORDED where the coordinates of loss location have been documented, this may include "last known" position, or location of sinking and is understood to reasonably represent potential wreck location; ESTIMATED, where a position has been roughly estimated based on the available combination of recorded positional data and written description relative to features, judged within the historical context and perceived reliability of the source; GENERAL, where the description places the loss only in a general area, without sufficient information to estimate a position; and, LOCATED where the location of a wreck site is known.

**LATITUDE:** Located distance measured north from the equator in degrees, minutes and seconds. The table data are expressed in degrees and decimal minutes.

**LONGITUDE:** Located distance measured in degrees, minutes and seconds west from the prime meridian at Greenwich, England. The table data are expressed in degrees and decimal minutes.

**REPORTED LOSS LOCATION:** Location descriptions are as reported for loss.

**NOTES:** Information regarding the nature of the vessel, aircraft or site.

**DATA SOURCES:** Sources of wreck data are listed in report Reference section.

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

For more information, visit [golder.com](http://golder.com)

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 44 1628 851851
North America	+ 1 800 275 3281
South America	+ 56 2 2616 2000

[solutions@golder.com](mailto:solutions@golder.com)  
[www.golder.com](http://www.golder.com)

**Golder Associates Ltd.**  
**Suite 200 - 2920 Virtual Way**  
**Vancouver, BC, V5M 0C4**  
**Canada**  
**T: +1 (604) 296 4200**

