Environmental Impact Assessment

Project Number: 52320-002
July 2021
Final

Timor-Leste: Presidente Nicolau Lobato
International Airport Expansion Project

Volume 2 Appendices (Part 1)

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Appendix A – Borehole Logs
### Environmental Impact Assessment – Appendix A

#### Presidente Nicolau Lobato International Airport Expansion Project, Timor-Leste

**Drilling Method:** Mud Rotary  
**Diam.:** 90 mm  
**Sheet:** 2 of 3

<table>
<thead>
<tr>
<th>SHEET</th>
<th>DEPTH</th>
<th>DESCRIPTION</th>
<th>INDEX</th>
<th>MC (%)</th>
<th>VM (%)</th>
<th>DTC (%)</th>
<th>Specific Gravity</th>
<th>LL (%)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.50</td>
<td>Medium dense to dense greyish black clay, Gravely fine to coarse SAND (SM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.50</td>
<td>Greyish light black, 11.20 m to 12.30 m, dense below 11.20 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.20</td>
<td>Greyish white, 12.30 to 12.75 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.75</td>
<td>Blackish grey below 12.75 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>3.00</td>
<td>Greyish black, fine sand, gravel, silt, sand and gravel, fine to silt, dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3.50</td>
<td>Greyish black, fine sand, gravel, silt, sand and gravel, fine to silt, dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>4.00</td>
<td>Greyish brownish black, fine sand with gravel, gravel, and silt, dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>4.50</td>
<td>Dense fragments of phyllite, sub-rounded to sub-angular, dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>5.00</td>
<td>Dense fragments of phyllite, sub-rounded to sub-angular, dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
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</table>

#### Standard Penetration Test

- **N SPT Graph:**

#### Date and Boring Details

- **Date:** 28-Sep-20
- **Time:** 1:30PM
- **Boring Depth:** 25.7m
- **Casing Depth:** 23.75m
- **Water Depth:** 0.00
- **Remarks:** Logger: N. A. RIDVI

---

**PLATE:** 3b

---

A-3
### Standard Penetration Test Results

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>DENSITY (%)</th>
<th>WATER (m)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.99-22.09</td>
<td>Very dense greyish black Silty fine to coarse SAND (SM), weakly cemented</td>
<td>92.0</td>
<td>8.75</td>
<td>Logger N.A. RIZVI</td>
</tr>
<tr>
<td>22.09-23.10</td>
<td>Very dense greyish light black Silty, Quartze fine to coarse SAND (SM) Gravelly / Quartz fragments (5-25mm), weakly cemented</td>
<td>93.0</td>
<td>10.25</td>
<td></td>
</tr>
<tr>
<td>23.10-24.20</td>
<td>Very dense greyish black Silty fine to coarse SAND (SM), weakly cemented</td>
<td>94.0</td>
<td>15.75</td>
<td></td>
</tr>
</tbody>
</table>

**DATE**: 26-09-2023<br>**TIME**: 03:00 PM<br>**BORING DEPTH (m)**: 22.00<br>**CASING DEPTH (m)**: 23.75<br>**WATER DEPTH (m)**: 6.00
<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>SUMPROVISION</th>
<th>DENS.</th>
<th>DRAKE</th>
<th>LL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>Very stiff greyish white Lean CLAY (CL) with low plasticity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>Brownish yellow below 1.50 m</td>
<td>17.0</td>
<td>7.2</td>
<td>2.70</td>
<td>NP</td>
</tr>
<tr>
<td>2.00</td>
<td>Medium dense to dense greyish brown Silt, gravel line to coarse SAND (SM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>Greyish fragments (5-25mm), silt-sand &amp; gravel matrix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.00</td>
<td>Dense brownish light black, 4.90 to 6.10 m</td>
<td>97.1</td>
<td>31.8</td>
<td>2.20</td>
<td>LL: 37.0, PI: 28.0, PI: 11.5, CL:</td>
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<tr>
<td>5.00</td>
<td>Soft to stiffish yellowish white Lean CLAY (CL) with low plasticity</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6.00</td>
<td>Soft to 8.00 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.00</td>
<td>Wet, 8.00 to 9.06 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.00</td>
<td>Firm yellowish grey below 0.00 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>BORING DEPTH (m)</th>
<th>CASING DEPTH (m)</th>
<th>WATER DEPT (m)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-02-20</td>
<td>9:00 AM</td>
<td>25.55</td>
<td>25.00</td>
<td>0.00</td>
<td>Logger: N.A. RIZVI</td>
</tr>
<tr>
<td>15-02-20</td>
<td>5:30 AM</td>
<td>25.55</td>
<td>25.00</td>
<td>0.00</td>
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### Table: Soil Testing Results

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample No.</th>
<th>Description</th>
<th>Moisture Content (%)</th>
<th>Silt (%</th>
<th>Clay (%)</th>
<th>LL (%)</th>
<th>PI (%)</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>111-14/16</td>
<td>Medium dense to dense greyish white clay. Gravelly fine to coarse SAND (30%) Gravel is Phyllite / Quartz fragments (1 mm), sub-rounded to sub-angular, Silt, Sand &amp; Gravel matrix.</td>
<td>10.30</td>
<td>11.0/0.7/0.12</td>
<td>12.00</td>
<td>11.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>13</td>
<td>111-15/16</td>
<td>Still greyish white Lean CLAY (CL) with low plasticity.</td>
<td>12.00</td>
<td>12.0/0.2/0.10</td>
<td>14.00</td>
<td>13.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>14</td>
<td>111-16/16</td>
<td>Dark greyish below 13.55 m</td>
<td>14.00</td>
<td>14.0/0.2/0.10</td>
<td>14.00</td>
<td>13.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>15</td>
<td>111-17/16</td>
<td>Medium dense to dense brownish grey clay. Gravelly fine to coarse SAND (30%) Gravel is Phyllite / Quartz fragments (1 mm), sub-rounded to sub-angular, Silt, Sand &amp; Gravel matrix.</td>
<td>15.00</td>
<td>15.0/0.5/0.10</td>
<td>15.55</td>
<td>16.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>16</td>
<td>111-18/16</td>
<td>Brownish yellow, 15.55 to 16.55 m</td>
<td>16.00</td>
<td>16.0/0.5/0.10</td>
<td>16.55</td>
<td>16.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>17</td>
<td>111-19/16</td>
<td>Dense below 16.55 m</td>
<td>17.00</td>
<td>17.0/0.5/0.10</td>
<td>17.55</td>
<td>17.55</td>
<td>87.2</td>
<td>34.6</td>
</tr>
<tr>
<td>18</td>
<td>111-20/16</td>
<td>18.00</td>
<td>18.0/0.5/0.10</td>
<td>18.55</td>
<td>18.55</td>
<td>87.2</td>
<td>34.6</td>
<td>2.07</td>
</tr>
</tbody>
</table>

### Boring Information

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Boring Depth (m)</th>
<th>CASING DEPTH (m)</th>
<th>WATER DEPT H (m)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-10-20</td>
<td>9.30AM</td>
<td>25.55</td>
<td>25.00</td>
<td>8.00</td>
<td>Logger: N.A. RIZW</td>
</tr>
<tr>
<td>DEPTH (m)</td>
<td>DESCRIPTION</td>
<td>CDR (%)</td>
<td>Mean Moisture Content (%)</td>
<td>Liquid Limit (%)</td>
<td>Relative Density</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------</td>
<td>--------------------------</td>
<td>------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>22</td>
<td>Low dense greyish brown silty clayey fine to coarse silt (SM)</td>
<td>64.18</td>
<td>24.65</td>
<td>12.5</td>
<td>2.54</td>
</tr>
<tr>
<td>23</td>
<td>Sub-rounded to sub-angular, Gravel &amp; Clay matrix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Medium dense greyish brown silty clayey fine to coarse silt (SM)</td>
<td>64.18</td>
<td>24.65</td>
<td>12.5</td>
<td>2.54</td>
</tr>
<tr>
<td>25</td>
<td>Sub-rounded to sub-angular, Gravel &amp; Clay matrix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Very stiff greyish brown clay (CL) with low plasticity, 20.05 to 24.25 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Medium dense blackish grey below 24.25m</td>
<td>64.18</td>
<td>24.65</td>
<td>12.5</td>
<td>2.54</td>
</tr>
</tbody>
</table>

**DATE & TIME**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
<th>BORING DEPTH (m)</th>
<th>CASING DEPTH (m)</th>
<th>WATER DEPTH (m)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-03-20</td>
<td>9:00AM</td>
<td>25.55</td>
<td>25.00</td>
<td>2.00</td>
<td>Logger: N. A. RIZVI</td>
</tr>
<tr>
<td>15-03-20</td>
<td>3:00PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B – Biodiversity Action Plan
TA-9925 REG: Southeast Asia Transport Project
Preparatory Facility Phase 2

Presidente Nicolou Lobato International Airport Expansion
Project: Biodiversity Action Plan

*Drafted for the Asian Development Bank by John Pilgrim Limited – 25th February 2021*
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1 Executive Summary

This document is a draft Biodiversity Action Plan (BAP) for an expansion of the Presidente Nicolau Lobato International Airport (PNLIA), comprising in particular an extension of the runway to 2,100 m, a minimum Runway End Safety Area (RESA) of 90 m on each side, taxiways, an apron, an air traffic control tower, and other ancillary facilities (hereafter “the Project”). It is situated on the west side of Dili, Timor-Leste. An Environmental Impact Assessment has been developed for the Project (Nippon Koei 2021).

The Asian Development Bank (ADB) is considering financing the Project, and has identified it as a potential Category A project because it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the project footprint. This draft BAP has been developed to implement good-practice mitigation and demonstrate Project compliance with ADB biodiversity safeguards (ADB 2009). There is little information on the status, distribution and ecology of biodiversity in the Project landscape, particularly marine areas, so this BAP has taken a precautionary approach. It is a living document and can be adapted during the Project life in response to new information on the scale or significance of Project impacts or the effectiveness of mitigation measures.

The Project is located in largely Modified Habitat on land, but extends into marine Natural Habitat. A full Critical Habitat Assessment (Appendix B) identified the broader Project area to be Critical Habitat for an unusual soft coral-dominated reef in Tasitolu Bay. A number of “priority biodiversity” features in the Project area are nationally-protected, including this coral reef, smaller coral patches, seagrass, the Comoro Estuary, several bird species, all cetaceans and sea turtles, Dugong, Whale Shark, and Egg Cowry (Table 1; Section 3).

Most of these biodiversity values are restricted to areas beyond the likely reach of the majority of significant Project impacts. Nonetheless, without mitigation, the Project might possibly have significant impacts on some Critical Habitat-qualifying biodiversity (Section 4).

A number of general or standard mitigation/enhancement measures relevant to biodiversity have already been outlined in the Project EIA (Nippon Koei 2021). This BAP includes three additional mitigation measures (Section 5) necessary to reduce residual impacts on Critical Habitat-qualifying biodiversity to levels in line with the ADB Safeguard Policy Statement (ADB 2009):

- Minimize marine construction activities in the peak cetacean migration season, by starting marine construction activities in February and finishing in/before August the next year (Section 5.2);
- Take care to avoid introduction of invasive alien species to the Project area through: washing of vehicles, equipment and supplies before entry to the Project area; monitoring for invasive species; and control/eradication of invasive species where found (Section 5.3); and
- Update and implement the airport’s Wildlife Hazard Management Plan (Section 5.4).

Some uncertainty remains about one potential Project risk to biodiversity. A 30-year hydrodynamic model suggests that the solid revetment for the runway extension will result in sediment build-up extending over 1 km to the west and thus potentially impacting the coral reef Critical Habitat in Tasitolu Bay. However, given COVID-19 constraints on collection of primary data, this model is necessarily simplistic and based upon secondary data. It is quite possible that incorporation of data on the short-term but intense impacts of the north-western monsoon, and swells from Indian Ocean storms, into a more sophisticated model may demonstrate less sediment build-up to the west of the runway. Nonetheless, in the absence of primary data, a precautionary approach has been taken. A large culvert is planned underneath the revetment (c.20 m from shore and parallel to the coast) to allow flow of sediment from the west to the east. Careful monitoring of sediment build-up will allow...
adaptive management during the Project operation phase. Should the culvert become blocked, it can be cleared by suction pipe dredging from the east side, to avoid any risk of sediment plumes from dredging impacting the Tasitolu Bay reefs.

Related to biodiversity, but most relevant from a human safety perspective, the Project will also undertake two additional mitigation actions to reduce wildlife hazards, specifically related to the risk of bird collisions with aircraft:

- Avoid key bird flight times in the morning and evening (Section 5.5.1); and
- Require minimum flight height to the west of the airport (Section 5.5.2).

For the most part, the mitigation measures detailed in this BAP are not anticipated to result in any significant Project time delays. Even complete avoidance of key bird flight times would only restrict airport operations by four hours per day. Implementing the Wildlife Hazard Management Plan is anticipated to require a budget of up to $32,500 USD (Section 5.4).

After these general and specific mitigation measures, the Project is not expected to have significant impacts on any priority biodiversity, including Critical and Natural Habitat (Section 5.6).

To ensure Project mitigation is successfully implemented and impacts avoided or minimized, the Project will undertake a program of monitoring and evaluation (Section 6).

In summary, this Project will be compliant with ADB biodiversity safeguards (ADB 2009) because it is in place mitigation (Section 5) to address potential impacts on Natural and Critical Habitat that is anticipated to result in:

(i) no measurable adverse impacts on Critical Habitat that could impair its ability to function; and

(ii) no reduction in the population of any recognized Endangered or Critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.
2 Introduction

2.1 Purpose and objectives

This document is a draft Biodiversity Action Plan (BAP) for the Presidente Nicolau Lobato International Airport (PNLIA) Expansion Project (hereafter “the Project”), on the west side of Dili, Timor-Leste. This Project will include an extension of the runway to 2,100 m, a minimum Runway End Safety Area (RESA) of 90 m on each side, taxiways, an apron, an air traffic control tower, and other ancillary facilities (Nippon Koei 2021). Two future expansion stages are also being considered by the Government of Timor-Leste, to a 2,500 m runway with a minimum Runway End Safety Area (RESA) length of 90 m on each side, and to 2,500 m using a full RESA length of 240 m. Ancillary infrastructure such as a new passenger terminal and power house are also planned during future stages. Future stages are considered as options here and in (Nippon Koei 2021).

The Asian Development Bank (ADB) is considering financing the Project. Under the ADB Safeguard Policy Statement (SPS: ADB 2009), this has been identified as a Category A project because it has the potential for significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the project footprint. As such, it is subject to an Environmental Impact Assessment (EIA: Nippon Koei 2021).

The ADB SPS requires projects in Natural Habitat to design mitigation measures to achieve at least no net loss of biodiversity. It requires projects in Critical Habitat to demonstrate ‘no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function’, no ‘reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised’, and mitigation of any lesser impacts. This BAP assesses these risks and presents the Project’s strategy for alignment with the ADB SPS.

Following the draft ADB Environmental Safeguards Good Practice Sourcebook (ADB 2012), this BAP assesses the presence of Critical and Natural Habitat in the Project area (Section 3; Appendix B), evaluates potential impacts on priority biodiversity (Section 4), outlines Project commitments to mitigation and management measures to achieve at least no net loss for Critical and Natural Habitat (Section 5), and summarizes an approach to monitoring and evaluation to give assurance of Project performance (Section 6). It is a living document and can be adapted during the Project life in response to new information on the scale or significance of Project impacts or mitigation and management measures.

2.2 Approach

This BAP was developed through site surveys and interviews in March 2020, a review of existing Project documentation, consideration of other existing grey and published literature, and consultations with stakeholders in Timor-Leste (Appendix C). It builds upon several previous reports, in particular a detailed marine survey report by Lovell & Pilgrim (2021; summarized in Appendix A) and a wildlife hazard assessment report by Pilgrim (2020c). It aligns with the ADB SPS (ADB 2009) and International Finance Corporation Performance Standard 6 and its accompanying Guidance Note (IFC 2012, 2019).

Except where necessary, this document does not repeat extensive information available in other key project documents developed as part of the process of compliance with the ADB SPS, such as the main EIA within which this appendix sits (Nippon Koei 2021).
2.3 Key information gaps

There is very limited information on the status, distribution and ecology of biodiversity in most of the Project area, particularly the marine section, although there is good information available on the biodiversity of Tasitolu. This BAP has thus been developed on a precautionary basis, assuming – where there is doubt – that species may be present in the Project area and may be affected by the Project.

COVID-19 travel restrictions have meant that collection of some primary environmental data has not been possible (Nippon Koei 2021). As such, some impact models have a higher degree of uncertainty than normal – notably the construction-phase sediment plume model and the operation-phase hydrodynamic model (Section 4.3). Where current information is constrained, this assessment has relied on current models but noted the need to refine these in future with primary data.

3 Biodiversity

3.1 Context

On land, the Project area falls within the Timor and Wetar Deciduous Forests ecoregion (Wikramanayake et al. 2002). This is a seasonally dry habitat which has been extensively cleared for agriculture. Endemism is high, with – for example – three mammal species restricted to this ecoregion (Wikramanayake et al. 2002) and over 30 restricted-range species of birds present (BirdLife International 2019a).

From a marine perspective, Timor-Leste falls within the Coral Triangle, and the Project area falls within the Fatu Reefscape (DeVantier et al. 2008). A rapid assessment of corals in north-east Timor-Leste identified high coral diversity, and estimated c.400 reef-building species likely to be present nationwide (Turak & Devantier 2012). Despite this, Boggs et al. (2009) consider the overall extent of coral on the north coast of Timor-Leste to be limited. Coral condition in the north-east was considered to be moderate to good, with some evidence of destructive fishing practices but no evidence of coral bleaching (Turak & Devantier 2012). Seagrass beds are variously reported to be limited (Boggs et al. 2009) or extensive (Government of Timor-Leste 2013) on the north coast, perhaps because of their extensive but sparse nature. Mangrove habitats are limited (e.g., Boggs et al. 2009; Government of Timor-Leste 2013).

3.2 Priority biodiversity

A full Critical Habitat Assessment (Appendix B) used broad marine and terrestrial Areas of Analysis (AoAs) to assess Project risks (Figure 1). This assessment identified the marine AoA to be Critical Habitat for coral reefs (Table 1). The terrestrial AoA, although containing Lagao Tasitolu Peace Park, is considered to represent a mix of Modified and Natural Habitat. Although these conclusions could be refined by further studies, they have a high level of confidence: it is unlikely that additional Critical Habitat-qualifying biodiversity occurs in these AoAs. Table 1 also contains species protected by recent national legislation (Government of Timor-Leste 2020) and ecosystems listed in national legislation as special priorities, for which the Government will require strong mitigation (C. Da Cunha Barreta, Director of Fisheries, pers. comm. 2020). The features listed in Table 1 should thus be considered priority biodiversity for the Project to avoid, mitigate and – if necessary – offset impacts upon.
Table 1. Summary of priority (Critical Habitat-qualifying or nationally-protected) biodiversity in the Project area

<table>
<thead>
<tr>
<th>Biodiversity type</th>
<th>Biodiversity</th>
<th>Critical Habitat criterion qualified</th>
<th>Nationally-protected</th>
<th>Justification</th>
<th>Present in Project impact area?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem</td>
<td>Tasitolu Bay soft coral reef</td>
<td>✓</td>
<td>✓</td>
<td>High-quality soft coral-dominated beachrock, a globally and regionally uncommon ecosystem.</td>
<td>No*</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Coral patches</td>
<td>✓</td>
<td></td>
<td>Some species are protected, and ‘coral and coral reefs’ is a special priority ecosystem in law.</td>
<td>✓</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Seagrass</td>
<td>✓</td>
<td></td>
<td>A special priority ecosystem in law.</td>
<td>✓</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Comoro Estuary</td>
<td>✓</td>
<td></td>
<td>‘Estuaries’ are a special priority ecosystem in law.</td>
<td>✓</td>
</tr>
<tr>
<td>Mollusc</td>
<td>Egg Cowry <em>Ovula ovum</em></td>
<td>✓</td>
<td></td>
<td>All Cypraidae are protected in law.</td>
<td>No*</td>
</tr>
<tr>
<td>Mammal</td>
<td>Dugong <em>Dugong dugon</em></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Mammals</td>
<td>Whales and dolphins</td>
<td>✓</td>
<td></td>
<td>All species are protected in law.</td>
<td>Probably</td>
</tr>
<tr>
<td>Reptiles</td>
<td>Sea turtles</td>
<td>✓</td>
<td></td>
<td>All species are protected in law.</td>
<td>Probably</td>
</tr>
<tr>
<td>Fish</td>
<td>Whale Shark <em>Rhincodon typus</em></td>
<td>✓</td>
<td></td>
<td></td>
<td>Probably</td>
</tr>
<tr>
<td>Bird</td>
<td>Drab Swiftlet <em>Collocalia neglecta</em></td>
<td>?</td>
<td></td>
<td>Government of Timor-Leste (2020) lists Glossy Swiftlet <em>Collocalia esculenta</em>, but this should presumably, after recent taxonomic changes, refer to Drab Swiftlet.</td>
<td>✓</td>
</tr>
<tr>
<td>Bird</td>
<td>Brahminy Kite <em>Haliastur indus</em></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Bird</td>
<td>Spotted Kestrel <em>Falco moluccensis</em></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

*pending refinement of construction-phase plume model and operation-phase hydrodynamic model with primary data (Section 4.3).

Terrestrial areas potentially impacted by the Project are extensively Modified Habitat (Pilgrim 2020b). Based on surveys detailed in Lovell & Pilgrim (2021; summarized in Appendix A), Figure 1 summarizes the location of near-shore marine Critical, Natural and Modified Habitat in the Project area (all Critical Habitat here is also Natural Habitat). Figure 2 provides a closer view of Tasitolu Bay, the area of most biodiversity conservation significance near to the Project site.

1. Surveys by Lovell & Pilgrim (2021; Appendix A) found *Heliopora coerulea*, corals in the family Milleporidae, and corals in the genus *Millepora*. These are all on CITES Appendix II, so de facto nationally protected (Government of Timor-Leste 2020).
Coastal marine areas immediately adjacent to the airport, c.500 m to the west, and some distance to the east represent Natural Habitat. From c.500 m to the west of the airport, beachrock occurs, and is associated with coral reef almost continuously to Dili Rock. This reef is of varying quality, owing to ongoing nearby land-based impacts, and so mostly represents a mix of Natural and Critical Natural Habitat. In only one location, near to a drain at the eastern side of Tasitolu Bay, is the inshore area sufficiently affected by land-based impacts to represent Modified Habitat.

Following these maps are a set of brief profiles for priority biodiversity, focusing on where and when each is likely to occur in the Project area. More extensive details of consideration under Critical Habitat criteria are given in Appendix B.

Figure 1. Coarse-scale marine habitat map of the Project vicinity, showing Natural, Modified and Critical Habitat.
Figure 2. Coarse-scale marine habitat map of Tasitolu Bay, showing Natural, Modified and Critical Habitat.
Figure 3. High benthic coverage of soft and hard coral at Tasitolu subtidal reef.

**Soft coral reef in Tasitolu Bay**

A soft coral-dominated reef adjacent to the foreshore of Tasitolu beach extends to c.500 m from the Project site at its nearest extent (Appendix A). A rim of beachrock lines the shore, extending >1.5 km along the beach front and descending to a depth of c.2 m at low water. Beachrock forms in the presence of freshwater percolating into the marine environment through coastal sediments. This phenomenon results in rock structures which are the result of the cementing of the beach sediments by algal/microbial action in the presence of marine and freshwater (Vousdoukas et al. 2007). In this location, the persistent sources of freshwater (or, at least, brackish water) are the inland Tasitolu lakes proximal to this area. Elsewhere in Timor-Leste, most reefs are hard coral-dominated assemblages residing on carbonate substrates created by the coral/coralline algal concretions (Turak & DeVantier 2012). Other surveys found that most soft coral reefs on the north coast appear to be transient features occurring on rubble beds resulting from destructive fishing, coral predation or storm damage (Turak & DeVantier 2012).

In Tasitolu Bay, the hard beachrock substrate has been colonized by a healthy assemblage of hard and soft corals, with large colonies and showing very little sign of bleaching (e.g., Figure 3). Though diversity was lower than can be found in offshore reefs, it was high considering the environmental limitations of a near-shore existence. Fish and a variety of associated invertebrates were evident. The reef was dominated in abundance by soft corals. This is unusual, as hard corals usually dominate over time. The dominance of soft corals in this area is likely maintained in this particular area by regular freshwater (brackish) flooding from Tasitolu, and a degree of sedimentation from strong wave action.
Figure 4. *Acropora* sp./*Porites* assemblage at 6 m depth off the end of the airport runway.

**Coral patches**

In addition to the soft coral-dominated reef near the shore of Tasitolu Bay, scattered coral outcrops are present throughout the Project area (including the direct impact zone), up to c.100 m depth (Appendix A). They occur where fixed hard substrate has given them an opportunity to colonize (e.g., Figure 4). More extensive hard coral-dominated reef exists to the west of Tasitolu Bay (e.g., around Dili Rock) and to the east of Dili town (e.g., around Cristo Rei). There is less coral near the Comoro River, where it is limited in extent by natural sedimentation and freshwater outflow from the river and – further east – by sediment disturbance from the port in Dili Bay (Figure 1).

**Seagrass**

*Halophila ovalis* seagrass patches occur sparsely over much of the shallow marine area, though never in high densities (Appendix A). The most extensive patch in the east of Tasitolu Bay is labelled in Figures 1 and 2 as “seagrass patch”, and is home to Dugong. There is less seagrass near the Comoro River, where it is limited in extent by natural sedimentation and freshwater outflow from the river and – further east – by sediment disturbance from the port in Dili Bay.

**Comoro Estuary**

The Comoro River estuary lies directly east of the Project. It is quite limited in extent, comprising some small mud and sand flats, constrained by a stony beach on both sides. It produces an extensive
plume of sediment into the nearshore marine area, where small-scale fishermen are very active (Appendix A). Just upstream, the river is heavily disturbed by aggregate mining. As a result of its limited extent, this disturbance, and disturbance from the adjacent Dili town, the estuary appears to hold only small numbers of waterbirds.

**Egg Cowry (Ovula ovum)**

This globally widespread and common coral-associated mollusc was found commonly on the reef in Tasitolu Bay (Appendix A). It is likely to be found on/near any extensive areas of coral in the vicinity of the Project.

**Dugong (Dugong dugon)**

Multiple informants during surveys (Appendix A) reported Dugong from the eastern part of Tasitolu Bay, with most informants only reporting one individual, but one informant suggesting there was a regular group of three Dugong, and perhaps more (Appendix C). During surveys, a single Dugong was observed feeding for some time in this area (Appendix A). One informant suggested that Dugong regularly travel through the Project (marine) area to the east.

**Whales and dolphins**

Surveys by Dethmers *et al.* (2012) suggest that a high diversity of cetaceans occurs in the northwestern coastal waters of Timor-Leste, peaking in abundance with large numbers of dolphins and small whales around November. Their observations in the vicinity of the Project included dolphins in May 2008, and sightings of large whales (including Blue Whale *Balaenoptera musculus*) c.10 km to the east and west of the Project area in November 2008. The proximity of these animals to the Project area will depend upon individual species’ ecology, and weather conditions, but will be relatively close as the channel between the Project and Atauro Island is only c.25 km wide.

**Sea turtles**

Local dive operators state that turtles are not regularly seen in the vicinity of Dili. Signs on Tasitolu beach warn against disturbance of sea turtle nests, but local interviewees did not appear familiar with these species. Surveys by Dethmers *et al.* (2012) found turtles present in the general area in May, but found turtle numbers to peak in Timorese waters in November. Eisemberg *et al.* (2014) found some limited occurrence and nesting of sea turtles in the west side of Tibar Bay, and to the west of that bay, and interviewed two fishermen who reported sea turtle nesting at Tasitolu. Nippon Koei (2019a) also state turtles to ‘regularly’ nest at Tasitolu, though without clarifying the basis of that statement. It seems likely that turtles may occur irregularly in small numbers in the vicinity of the Project. Green Turtle (*Chelonia mydas*) and Hawksbill turtle (*Eretmochelys imbricata*) are likely to be the most regularly occurring species (Eisemberg *et al.* 2014).

**Whale Shark (Rhincodon typus)**

Surveys by Dethmers *et al.* (2012) included a Whale Shark sighting in May 2008. It is likely that the species regularly, seasonally occurs in the vicinity of the Project, in low numbers. This species may occur quite close inshore.

**Drab Swiftlet (Collocalia neglecta)**
This bird is likely to occur commonly across the (terrestrial) Project area, as it is not very habitat specific when feeding. Although restricted to Timor, Wetar, Alor and nearby islands, it is usually common where it occurs, nesting in caves and buildings.

**Brahminy Kite (Haliastur indus)**

This common and widespread bird occurs in low numbers in the Project area. It feeds on carrion, fish and insects, so is predominantly associated with coastal and riverine areas, and open habitats. It is thus regularly seen at the airport and in the Tasitolu area, searching for food over grassland and the shore, and has been involved with at least one collision with an aircraft at PNLIA (Pilgrim 2020c).

**Spotted Kestrel (Falco moluccensis)**

This bird occurs widely in small numbers in open habitats from Java to Tanimbar, and north to Sulawesi and Halmahera. It has been seen at PNLIA and Tasitolu, and likely occurs there regularly in small numbers, hunting in grassland.
4 Potential impacts on priority biodiversity

4.1 Overview

Following a standardized impact assessment methodology (Nippon Koei 2021), pre-mitigation impacts on Critical and Natural Habitat, including all priority biodiversity (Table 1), are assessed in Table 2. These are detailed in Sections 4.2-4.9.

The Project AoA only represents Critical Habitat for the soft coral-dominated reef in Tasi-tolu Bay (Table 1). The magnitude of potential risks to this reef is Major, given its rarity, threatened status, conservation importance, and level of public concern about this ecosystem (Table 2).

Owing to the potential for preparation and construction phase degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution, the overall significance of potential Project construction phase habitat degradation impacts on the reef is assessed as Medium (Table 2). Likewise, the significance of potential Project construction phase habitat degradation impacts on coral patches and Egg Cowry is also assessed as Medium (Table 2). However, operation phase sediment build-up to the west of the runway has potential to impact the coral reef, coral patches and Egg Cowry, and is thus assessed as of High Significance.

The magnitude of potential impacts to other priority biodiversity (Table 1) ranges from Minor-Major, depending upon its rarity, threatened status, conservation importance, and level of public concern (Table 2). All of these impacts are considered likely to have a Low or Medium significance for priority biodiversity (Table 2).

4.2 Direct habitat loss through marine reclamation

Project reclamation for the runway extension into the sea will directly impact Natural Habitat, largely represented by small/soft marine sediment but also with some small coral patches (Section A.3). On two sides, the reclamation area will be bordered by revetment, and on the third side by the shore. The overall footprint of reclamation approximately represents a triangle 130 m by 242 m by (along the coast) 275 m, a total marine footprint of c. 13,850 m² (Nippon Koei 2021). While this is a permanent loss of almost 1.4 hectares of Natural Habitat, it is of a very widespread habitat type (both nationally and regionally) which is of limited biodiversity value. As such, the loss of c.1.4 hectares of this habitat is not considered “significant conversion” in the sense of the ADB SPS (2009).

Some areas will be lost under the direct Project footprint on land, but these are low quality Modified Habitat and so this impact is not considered significant.
Table 2. Key potential Project impacts on priority biodiversity (including Critical Habitat) and Natural Habitat (Impact Significance Rating Methodology follows Nippon Koei 2021).

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Aspect</th>
<th>Project Phase</th>
<th>Impact</th>
<th>Sensitivity of Receptors</th>
<th>Level of Public Concern</th>
<th>Severity or Degree of Change to the Receptor</th>
<th>Magnitude</th>
<th>Timeframe</th>
<th>Spatial Scale</th>
<th>Consequence</th>
<th>Probability</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral patches</td>
<td>Habitat</td>
<td>C</td>
<td>Direct habitat loss through marine reclamation</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>MOD</td>
<td>LT</td>
<td>SMALL</td>
<td>M</td>
<td>DEFINITE</td>
<td>M</td>
</tr>
<tr>
<td>Small/soft sediment</td>
<td>Habitat</td>
<td></td>
<td></td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>MIN</td>
<td>LT</td>
<td>SMALL</td>
<td>M</td>
<td>DEFINITE</td>
<td>M</td>
</tr>
<tr>
<td>All priority marine</td>
<td>Habitat</td>
<td>P, C</td>
<td>Introduction of invasive alien species</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>MAJ</td>
<td>LT</td>
<td>EXTENSIVE</td>
<td>H</td>
<td>UNLIKELY</td>
<td>M</td>
</tr>
<tr>
<td>biodiversity</td>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>L</td>
<td>H</td>
<td>MOD</td>
<td>ST</td>
<td>INTER</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>MAJ</td>
<td>ST</td>
<td>INTER</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through disturbance of currents by reclamation area, altering local sediment transfer and deposition</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>MOD</td>
<td>ST</td>
<td>INTER</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td>Seagrass</td>
<td>Habitat</td>
<td></td>
<td></td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>MOD</td>
<td>ST</td>
<td>INTER</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td>Dugong</td>
<td>Habitat</td>
<td>C, O</td>
<td>Habitat fragmentation</td>
<td>L</td>
<td>H</td>
<td>L</td>
<td>MIN</td>
<td>LT</td>
<td>INTER</td>
<td>M</td>
<td>UNLIKELY</td>
<td>L</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>O</td>
<td>Habitat degradation through disruption of currents by reclamation area, altering local sediment transfer and deposition</td>
<td>L</td>
<td>M</td>
<td>H</td>
<td>MOD</td>
<td>LT</td>
<td>SMALL</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>MAJ</td>
<td>LT</td>
<td>SMALL</td>
<td>H</td>
<td>POSSIBLE</td>
<td>H</td>
</tr>
<tr>
<td>Protected bird species (including Drab Swiftlet, Brahminy Kite &amp; Spotted Kestrel)</td>
<td>Distribution</td>
<td>P, C</td>
<td>Displacement of species due to construction activity and noise</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>MIN</td>
<td>ST</td>
<td>SMALL</td>
<td>L</td>
<td>POSSIBLE</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>O</td>
<td>Displacement of species due to increased operational air traffic</td>
<td>L</td>
<td>M</td>
<td>L</td>
<td>MIN</td>
<td>MT</td>
<td>SMALL</td>
<td>L</td>
<td>POSSIBLE</td>
<td>L</td>
</tr>
<tr>
<td>Dugong, whales, dolphins, turtles &amp; Whale Shark</td>
<td>Distribution</td>
<td>C</td>
<td>Displacement of species due to underwater noise or vibration</td>
<td>H</td>
<td>H</td>
<td>M</td>
<td>MAJ</td>
<td>ST</td>
<td>INTER</td>
<td>M</td>
<td>POSSIBLE</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>C</td>
<td>Mortality or injury due to underwater noise or vibration</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>MAJ</td>
<td>ST</td>
<td>SMALL</td>
<td>M</td>
<td>UNLIKELY</td>
<td>L</td>
</tr>
</tbody>
</table>

*P = Preparation; C = Construction; O = Operations. Unlike some impact tables in the main EIA (Nippon Koei 2021), number of receptors and risk of exceeding legal threshold are not relevant to biodiversity in Timor-Leste, so are not considered here.*
4.3 Habitat degradation

Terrestrial habitat in the Project area is already highly degraded. However, the Project may result in marine habitat degradation during construction in several ways. Primarily, direct introduction of marine reclamation materials into the sea has the potential for release of suspended sediment and release of nutrients and contaminants from suspended sediments. Additional habitat degradation impacts may result from poor management of construction waste and pollution, including run-off and dust from the Project site during construction. Considering not only the magnitude of impacts to priority biodiversity, but also their timeframe, scale and likelihood, the most significant potential impact is considered to be on coral patches (and associated Egg Cowry). Release of suspended sediment can also significantly impact seagrass habitat.

Dugong are also sensitive to pollution and habitat degradation (as well as disturbance; Section 4.5), and have a high level of public concern – given this species’ current limited presence in the area, it may be eradicated altogether if Project impacts are not mitigated.

During project operation, the reclaimed area extending into the sea has the potential to change local current sediment transfer, potentially resulting in additional impacts. Some uncertainty remains about this risk. A 10-year hydrodynamic model suggests that the solid revetment for the runway extension will result in sediment build-up extending c.400 m to the west, a little short of the coral reef in Tasitolu Bay. However, a 30-year hydrodynamic model suggests sediment build-up over 1 km to the west, thus potentially impacting the coral reef. Given COVID-19 constraints on collection of primary data, this model is necessarily simplistic and based upon secondary data. It is quite possible that incorporation of data on the short-term but intense impacts of the north-western monsoon, and swells from Indian Ocean storms, into a more sophisticated model may demonstrate less sediment build-up to the west of the runway.

4.4 Habitat fragmentation

Extension of the Project runway into the sea, via marine reclamation, has the potential to interrupt movement of marine species which travel along the coast. During the baseline study, Dugong was the only species identified as potentially regularly travelling along the coast, but it is possible that other species also do so. For stage 1 of the Project, however, this extension will only extend <150 m perpendicular to the coast. Even considering some alteration in currents as a result of the extension, this diversion of movement routes is relatively minor, and fragmentation is consequently considered unlikely.

4.5 Displacement of species due to construction activity and noise

The terrestrial impact of construction activity and noise is anticipated to be low. Protected bird species are widespread, fairly common, and are only likely to suffer limited temporary displacement or behavioral impacts from Project construction or operational noise and disturbance.

There is greater potential for displacement of marine species such as Dugong, whales, dolphins, turtles and Whale Shark owing to marine reclamation. Underwater noise or vibration, particularly from any piling or blasting, can have a significant and far-reaching disturbance effect on marine species, dependent on the species and the duration, pitch and frequency of the noise. Such disturbance can impact the behavior of affected animals and so result in fitness costs, for example through interrupted communication, reduced ability to feed, stress, movement into suboptimal habitats, etc. Blasting produces loud and sudden bursts of sound that are of particular concern for marine biodiversity. Even rockfill by bulldozer for reclamation may cause disturbance effects up to 4 km away (Nippon Koei 2021). However, these effects will be temporary (lasting c.1.5 years).
4.6 Mortality or injury to species due to underwater noise or vibration

At extremes, construction noise or vibration/pressure changes during marine reclamation have the potential to not only disturb marine species (Section 4.5), but also to cause injury or even mortality (e.g., Keevin & Hempen 1997). Such extremes usually stem from the most significant noise impacts, i.e. blasting or piling in this type of project. The most common injury is acoustic trauma (Southall et al. 2019).

4.7 Displacement of species due to increased operational air traffic

The disturbance impact of increased operational air traffic on biodiversity is anticipated to be low. It is not expected to translate into significant underwater noise. Protected bird species in the Project area are fairly common, tolerant of a level of disturbance, and are only likely to suffer limited temporary displacement from aircraft operations.

4.8 Mortality or injury to species due to increased operational air traffic

Air traffic has the potential to kill or injure animals present in the Project area (Pilgrim 2020c, Appendix D). Given the habitat and species’ presence in the Project area, the greatest risk to wild animals is to birds (domestic dogs and goats are also currently at risk). A number of bird-aircraft collisions have occurred at the airport, resulting in bird mortality and damage to aircraft but fortunately to date no human injuries.

Bird collision risks are expected to increase as a result of the Project. For example, annual air traffic movements are anticipated to double by about 2045 and, without any new wildlife hazard management, bird collision risks could be expected to increase proportionate to flight frequency.

4.9 Introduction of invasive alien species

A potentially significant indirect project impact on the reef is the introduction of invasive alien species (IAS). The Global Invasive Species Database (http://www.iucngisd.org/gisd) does not identify any marine IAS currently in Timor-Leste. However, this database has records for seven marine IAS in neighboring Indonesia, including species with the potential to rapidly modify reef habitats – such as red algae and invasive corals. IAS can spread rapidly once introduced, significantly modifying habitat for forest-dependent species, and present a very high risk to biodiversity globally. There is potential for imported construction machinery, equipment or materials to introduce IAS to the Project site, from where they could easily spread.

On land, the Project area is extensively Modified, and thus no significant additional impact from IAS is anticipated. Nonetheless, monitoring will be needed to assess whether any novel highly invasive alien species are introduced, which may spread beyond the Project area.
5 Mitigation and conservation measures for impacts on priority biodiversity

5.1 Overview

The mitigation hierarchy is defined as (BBOP 2012):

i. **Avoidance:** measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity;

ii. **Minimization:** measures taken to reduce the duration, intensity and/or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible;

iii. **Rehabilitation/restoration:** measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimized;

iv. **Offset:** measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimized and/or rehabilitated or restored, in order to achieve no net loss or a net gain of biodiversity. Offsets can take the form of positive management interventions such as restoration of degraded habitat, arrested degradation or averted risk, protecting areas where there is imminent or projected loss of biodiversity.

These steps should be followed in turn, to the maximum extent possible, with offsets remaining as a last resort after all other mitigation options have been attempted.

A number of general or standard mitigation measures related to biodiversity are described in the Project EMP (Nippon Koei 2021). Table 3 summarizes general/standard mitigation measures relevant to key potential Project impacts on Critical and Natural Habitat, including all priority biodiversity (Table 1), as well as three biodiversity-specific mitigation measures necessary to reduce this Project’s impacts on Critical and Natural Habitat (Section 4) to levels in line with the ADB Safeguard Policy Statement (ADB 2009), based on a precautionary approach. The specific mitigation measures are elaborated in Sections 5.2-5.5.

This Section assumes that the Project, as outlined in (Nippon Koei 2021), will avoid all marine and coastal piling and blasting, and so does not include mitigation measures which would be essential for such activities (soft starts, exclusion zones, etc.).

The only specific mitigation measure anticipated to result in any significant Project time delays or costs is full implementation of the airport’s Wildlife Hazard Management Plan (Section 5.4), which might potentially cost up to $32,500 USD.

Residual impacts after general and specific mitigation are discussed in Section 5.6.

Table 3 focuses on significant impacts on biodiversity, and so does not include general or standard environmental mitigation/enhancement measures included elsewhere in the Project EIA (e.g., general noise, dust and pollution controls). It does, however, note the need to implement the existing PNLIA Wildlife Hazard Management Plan (discussed further in Section 5.4). Additional mitigation measures for wildlife hazards are discussed in Section 5.5. While largely a safety – rather than biodiversity – issue, mitigation of these impacts needs to be led by sound biodiversity science (Pilgrim 2020c).
Table 3. Mitigation and management measures for priority biodiversity (including Critical Habitat) and Natural Habitat.

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Aspect</th>
<th>Project phase</th>
<th>Impact</th>
<th>Mitigation action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral patches</td>
<td>Habitat</td>
<td>C</td>
<td>Direct habitat loss through marine reclamation</td>
<td>Ensure that the area of seabed disturbed does not extend any further than that required in the detailed design in order to minimize the footprint of the revetment and reclaimed area.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Small/soft sediment</td>
<td>Habitat</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All priority marine biodiversity</td>
<td>Habitat</td>
<td>P, C</td>
<td>Introduction of invasive alien species</td>
<td>Take care to avoid introduction of invasive alien species to the Project area through: washing of vehicles, equipment and supplies before entry to the Project area; monitoring for invasive species; and control/eradication of invasive species where found.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td></td>
<td></td>
<td></td>
<td>Prepare and implement a Waste Management Plan and Pollution Prevention Plan.</td>
<td>EPC Contractor, PIC and PMU to review and approve Plan</td>
</tr>
<tr>
<td></td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>As far as practical, rubble should be free of earth and sand before it is placed into the water</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>Type III silt curtain installed around the work zone. The EPC Contractor shall select an experienced silt curtain manufacturer to design and install the most appropriate type of silt curtain that provides at least 75% effectiveness. Routine maintenance of the curtain shall be undertaken in accordance with manufacturers specifications. If at any time the silt curtain fails, works will cease until the curtain is repaired to the satisfaction of the PIC.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>To prevent impacts from reclamation area two temporary spillways will be placed at the locations shown in the figure below. The spillways will be constructed to prevent high levels of silts in the reclaimed areas discharging into the area between the revetment and silt curtain.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Seagrass</td>
<td></td>
<td></td>
<td></td>
<td>Vehicles carrying fine aggregate materials will be sheeted to help prevent dust blow and spillages.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Dugong</td>
<td></td>
<td></td>
<td>C, O</td>
<td>Treated waste water will be used for damping down road surfaces to mitigate dust generation.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Geotextile will be placed on the inside wall of the rubble mound to reduce sedimentation via the reclaimed land fill material (sand).</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>O</td>
<td>Habitat degradation through disruption of</td>
<td>Inclusion of a large sediment culvert in the runway extension revetment, to allow sediment passage from west to east.</td>
<td>EPC Contractor, PIC</td>
</tr>
<tr>
<td>Environmental Component</td>
<td>Aspect</td>
<td>Project phase</td>
<td>Impact</td>
<td>Mitigation action</td>
<td>Responsibility</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td></td>
<td>currents by reclamation area, altering local sediment transfer and deposition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protected bird species (including Drab Swiftlet, Brahminy Kite &amp; Spotted Kestrel)</td>
<td>Distribution</td>
<td>P, C</td>
<td>Displacement of species due to construction activity and noise</td>
<td>Negligible impact.</td>
<td>n/a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>O</td>
<td>Displacement of species due to increased operational air traffic</td>
<td>Negligible impact.</td>
<td>n/a</td>
</tr>
<tr>
<td>Mortality</td>
<td>O</td>
<td></td>
<td>Mortality or injury to species due to increased operational air traffic</td>
<td>Update and implement the airport’s Wildlife Hazard Management Plan.</td>
<td>ANATL</td>
</tr>
<tr>
<td>Dugong, whales, dolphins, turtles &amp; Whale Shark</td>
<td>Distribution</td>
<td>C</td>
<td>Displacement of species due to underwater noise or vibration</td>
<td>Avoid any marine piling or blasting, and any transport of reclamation material by sea. Place rubble material into the seabed using a crane with a claw rather than pushing the rubble into the seabed thereby avoiding the noise generated by rocks grinding against each other.</td>
<td>EPC Contractor</td>
</tr>
<tr>
<td></td>
<td>Mortality</td>
<td>C</td>
<td>Mortality or injury due to underwater noise or vibration</td>
<td>Minimize marine construction activities in the peak cetacean migration season, by starting marine construction activities in February and finishing in/before August the next year.</td>
<td>EPC Contractor</td>
</tr>
</tbody>
</table>
5.2 Minimize marine construction activities in the peak cetacean migration season

Cetaceans and other large marine species can be sensitive to displacement (or even injury) by marine noise (Sections 4.4 & 4.5), and occur seasonally in the Project area. The Project will not involve any marine or coastal piling or blasting, thus minimizing the possibility of severe noise impacts in marine areas. The only piling will be for the Air Traffic Control Tower, c.900 m from the coast.

Information on cetacean presence in the waters of Timor-Leste is sparse. Surveys by Dethmers et al. (2012) identified a peak cetacean abundance (across all species) in November, but did not cover the period from December-March. Conversely, tracking of Blue Whale (Balaenoptera musculus) identified peak presence in Timorese waters in June (Double et al. 2014). In the north-west of Timor-Leste, near the Project area, Dethmers et al. (2012) found much lower numbers of cetaceans in April-August, compared to September and November. However, abundance and distributions varied significantly from month-to-month, suggesting potential movements of animals in response to weather conditions or food resources.

Cetaceans are not the only potential consideration in managing disturbance. Although Dethmers et al. (2012) found numbers of sea turtles in Timorese waters to peak in November, numbers observed in the north-west were fairly consistent from April-November. The breeding and calving season for Dugong in Australia is focused in June-December (Australian Government 2016), and is likely to be similar in Timor-Leste.

Revetment work is anticipated to take c.1.5 years. Necessarily, marine construction will have to take place when some cetaceans are present in north-west Timorese waters, near to the Project. To minimize displacement impacts, marine construction activities should be minimized in the peak cetacean migration season and, ideally, key breeding times for Dugong. Peak cetacean migration season is believed to occur from September-November, and can be expected to continue into at least January (possibly to March). The optimum time for marine construction is thus April-August (possibly February/March-August, but there are no data from February or March). This period also avoids half of the predicted Dugong breeding season, including the main sensitive calving period. As such, marine construction work will be initiated in February and – lasting 1.5 years – continue until August the following year. The Project will thus only disturb marine species during one peak cetacean migration and Dugong calving period. This mitigation measure will not have any additional cost, and – with forward planning – need not cause any time delays.

5.3 Take care to avoid introduction of invasive alien species to the Project area

In order to manage the risk of introducing invasive species to, or spreading them within, the Project area, a number of measures will need to be taken. This will include at minimum: inspection and pressure washing of vehicles, equipment and supplies at or near the entrance to the Project boundary; monitoring for invasive species across the Project area; and control/eradication of invasive species where found in the Project area.

Before entry to construction areas, Project vehicles, equipment, supplies and materials will be inspected for obvious signs of invasive alien species (e.g., presence of rodents or insects). Vehicles and equipment (and supplies and materials wherever feasible) will then be pressure washed. The area of pressure washing must be away from any parking, storage or camp areas, and must only be visited by vehicles entering the core location, not leaving it (i.e., a one-way system is necessary). Otherwise, invasive species washed from vehicles entering the area may be picked up again on the
tires of vehicles leaving the area. Washing need not use substantial amounts of water, and can be replaced by brushing in any areas of limited water supply.

Such preventative measures are generally considerably less costly than measures to control or eradicate invasive species. Where monitoring finds invasive species in, or spreading from, Project areas, the contractor will eradicate those species where introduced by the Project.

5.4 Update and implement the airport’s Wildlife Hazard Management Plan

Aircraft operations have an existing risk of mortality or injury for a number of nationally-protected bird species, and these will be increase in line with greater volumes of air traffic as a result of the Project (Section 4.8). PNLIA has an approved wildlife hazard management plan to tackle such issues (ANATL 2018). The main focal areas are wildlife control (directly encouraging wildlife – particularly birds – away from high-risk areas during operations) and habitat modification, water management and vegetation management (all to reduce attractiveness of the site to wildlife).

The existing Wildlife Hazard Management Plan is largely appropriate for the airport’s context, though could be improved in a few areas (Section 5.5, Appendix D). There has, however, been no significant implementation of the plan to date, owing to capacity and budget constraints (Pilgrim 2020c, Appendix D). Bird collisions are expected to increase as a result of the Project (Section 4.8). With implementation of the PNLIA Wildlife Hazard Management Plan, such collisions would increase at a lower rate or – more likely – only increase after an immediate and substantial drop in bird collisions owing to implementation of systematic tailored habitat management and other measures.

Despite capacity and budget constraints, key areas of the current plan could already be quickly and effectively initiated (Pilgrim 2020c, Appendix D). Significant progress could readily be made in recording wildlife hazards, systematically displacing identified hazards, integrating wildlife hazard management into ongoing vegetation management, and systematically recording collision and near-miss incidents (Pilgrim 2020c, Appendix D).

Other areas of the plan will require additional financial investment, notably installing a wildlife-proof fence around the airport perimeter, wildlife deterrent equipment, and a training/capacity-building program for airport staff (Pilgrim 2020c). The cost of a secure fence around the airport perimeter is already costed as part of the Project. Wildlife deterrent equipment could cost in the order of $2,500, comprising shell launching pistols and caps (c.$200 for two), a propane cannon (c.$500), a green laser gun (c.$1,000), and import fees (c.$800). Ideally, the International Environmental Specialist (IES) will have the relevant expertise to conduct some or all of the wildlife hazard training program for airport staff. Should this not be possible, a reasonable cost estimate would be c.$30,000.

5.5 Additional mitigation for wildlife hazards

Wildlife hazards in the Project area do represent Project interaction with priority species (Sections 4.8 & 5.4). They are likely, however, to represent risks from a human safety perspective, rather than significant impacts on biodiversity (Pilgrim 2020c, Appendix D). Nonetheless, they are addressed in this BAP since mitigation of these impacts needs to be led by sound biodiversity science (Pilgrim 2020c).

Most of the appropriate general or standard mitigation/enhancement measures to manage wildlife hazards have already been outlined in an airport Wildlife Hazard Management Plan (ANATL 2018). Pilgrim (2020c) recommended minor adjustments to some of these measures, notably handling of domestic mammal incursions and avian nest intervention (Appendix D.5.2.1-D.5.2.4). Pilgrim (2020C) also recommended two additional mitigation measures, which are elaborated in Sections 5.5.1-5.5.2. These measures are not anticipated to result in any significant Project time delays or costs.
5.5.1 Avoid key bird flight times in the morning and evening

Currently, the airport is only operational during the day, and the number of commercial flights is limited. Even with projected increases in air traffic (Nippon Koei 2021) as a result of the Project, the total number of flights will be limited for some time in comparison to the overall capacity of the airport. Unlike some airports, this gives an opportunity to limit flights to times of the day outside those with the highest bird collision risks. According to observations by Pilgrim (2020c), times of significant movement of large birds are very limited, to an hour near sunrise and an hour a little while before sunset. Bird movements at the airport itself are also generally likely to be highest in the earliest and latest hours of daylight. Avoiding – or at least limiting as much as possible – flights between 0515-0730 and 1630-1815 would significantly reduce risks of serious collisions (Appendix D), particularly in combination with restrictions on aircraft flight height near major bird flight paths (Section 5.5.2).

5.5.2 Require a minimum flight height to the west of the airport

Collision risks away from the airport remain largely theoretical because ANATL were not able to comment on the range of trajectories taken by aircraft when approaching or departing west of the airport, and discussions with airlines and pilots were not possible (Pilgrim 2020c, Appendix D). Nonetheless, on the basis of current information and on a precautionary basis, airport regulations should require aircraft to be travelling above 300 m a.s.l. when within 500 m of the peninsula directly west of the airport (Pilgrim 2020c, Appendix D). This would drastically reduce risks of aircraft collision with regular flight paths of flocks of medium-large birds near this peninsula (Pilgrim 2020c, Appendix D), particularly in combination with restrictions on time of day of operations (Section 5.5.1).

5.6 Residual impacts

5.6.1 Summary

Following the impact assessment methodology used in (Nippon Koei 2021), residual impacts on Critical and Natural Habitat, including all priority biodiversity (Table 1), after the application of Project mitigation (Section 5.1) are assessed in Table 4. Only a few measurable impacts are anticipated after mitigation. None of these are considered significant, given their scale. For example, the largest measurable impact is loss of c.1.4 ha of small/soft sediment. This is a widespread habitat near the Project site, nationally, and regionally, and is not of particularly high value for biodiversity. As such, this minor loss of habitat is not considered significant.

The Project is compliant for biodiversity with the ADB Safeguard Policy Statement (2009) because, after mitigation, it is anticipated that: (i) there will be no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function, and (ii) the project will not lead to a reduction in the population of any recognized Endangered or Critically Endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.

5.6.2 Critical Habitat

Specific focus has been given to potential impacts on the Critical Habitat present in Tasitolu Bay. The dominant reef fauna at Tasitolu is soft coral, which has a relatively high tolerance to sedimentation, and this reef is open to the Wetar Strait, so is always subject to at least minor wave action which transports sediments off the diverse portion of the beach rock reef into deeper or shallower environments. A plume model for the construction phase suggests that, with mitigation, sediment deposition on the nearest part of the Tasitolu Bay coral reef could be in the region of 0.00092
kg/m²/day from rubble and stone armor works and 0.0027 kg/m²/day from reclamation works (Nippon Koei 2021). Both of these values are well below internationally-accepted levels of concern for impacts upon coral. Pending refinement of the model through collection of primary data (not currently feasible owing to COVID-19 restrictions), it thus does not appear likely that the Project will have significant sediment impacts upon the Tasitolu Bay reefs during the construction period.

Some uncertainty remains about one potential Project risk to biodiversity. A 30-year hydrodynamic model suggests that the solid revetment for the runway extension will result in sediment build-up extending over 1 km to the west and thus potentially impacting the coral reef Critical Habitat in Tasitolu Bay (Nippon Koei 2021). However, given COVID-19 constraints on collection of primary data, this model is necessarily simplistic and based upon secondary data. It is quite possible that incorporation of data on the short-term but intense impacts of the north-western monsoon, and swells from Indian Ocean storms, into a more sophisticated model may demonstrate less sediment build-up to the west of the runway. Pending refinement of the model through collection of primary data (not currently feasible owing to COVID-19 restrictions), the Project is taking a precautionary approach to mitigation and will need to have a careful focus on monitoring and adaptive management (Section 6). In the longer-term, the government hopes to maintain or extend the runway further. In such cases, there is a high risk of sedimentation impacts on the Tasitolu Bay reefs, which would be difficult to mitigate further than planned in the current EIA.
Table 4. Residual impacts after mitigation for priority biodiversity (including Critical Habitat) and Natural Habitat.

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Aspect</th>
<th>Project phase</th>
<th>Impact</th>
<th>Significance of impact without mitigation</th>
<th>Residual impact after implementation of mitigation measures</th>
<th>Key Residual Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral patches</td>
<td>Habitat</td>
<td>C</td>
<td>Direct habitat loss through marine reclamation</td>
<td>M (Medium)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>Negligible number and area of coral patches.</td>
</tr>
<tr>
<td>Small/soft sediment</td>
<td>Habitat</td>
<td></td>
<td></td>
<td>M (Medium)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>c.1.4 ha (non-significant in context of overall habitat distribution)</td>
</tr>
<tr>
<td>All priority marine biodiversity</td>
<td>Habitat</td>
<td>P, C</td>
<td>Introduction of invasive alien species</td>
<td>M (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>M (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through disruption of currents by reclamation area, altering local sediment transfer and deposition</td>
<td>H (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Seagrass</td>
<td></td>
<td></td>
<td></td>
<td>M (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Dugong</td>
<td>C, O</td>
<td></td>
<td>Habitat fragmentation</td>
<td>L (Low)</td>
<td>Day 1: Low, Year 30: Low</td>
<td>Negligible fragmentation impacts possible.</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>O</td>
<td>Habitat degradation through disruption of currents by reclamation area, altering local sediment transfer and deposition</td>
<td>H (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td></td>
<td></td>
<td>M (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Protected bird species (including Drab Swiftlet, Brahminy Kite &amp; Spotted Kestrel)</td>
<td>Distribution</td>
<td>P, C</td>
<td>Displacement of species due to construction activity and noise</td>
<td>L (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Dugong, whales, dolphins, turtles &amp; Whale Shark</td>
<td>Distribution</td>
<td>C</td>
<td>Displacement of species due to underwater noise or vibration</td>
<td>M (Negligible)</td>
<td>Day 1: Negligible, Year 30: Negligible</td>
<td>n/a</td>
</tr>
<tr>
<td>Dugong, whales, dolphins, turtles &amp; Whale Shark</td>
<td>Mortality</td>
<td>C</td>
<td>Mortality or injury due to underwater noise or vibration</td>
<td>L (Low)</td>
<td>Day 1: Low, Year 30: Low</td>
<td>n/a</td>
</tr>
</tbody>
</table>
6 Biodiversity monitoring

The Project will undertake a general program of monitoring during site preparation, construction and worksite closure to confirm presence of effective mitigation (Nippon Koei 2021). Most of this general monitoring is response monitoring (i.e., checking appropriate, timely and effective implementation of mitigation actions) or pressure monitoring (i.e., measuring sedimentation or pollutant levels from the Project).

Some additional state monitoring (i.e., measuring the condition of receptors) will also be necessary for biodiversity, as outlined in Table 5 and described in Sections 6.1-6.4. Wildlife hazard monitoring in Sections 6.3-6.4 is already part of ANATL responsibilities and plans, so should incur no additional cost (beyond some training: see Section 5.4). Biodiversity monitoring outlined in Sections 6.1-6.2 is cost-efficient. At a maximum of $5,000/survey, all specific coral and invasive species monitoring will cost an absolute maximum of $125,000, and potentially considerably less.

6.1 Coral reef condition surveys

Following the methodology used in baseline surveys by Lovell & Pilgrim (2021), Pacific Point Intercept Transects (PPITs) will be carried out to assess condition of the Tasitolu Bay coral reefs (in areas 5 and 6 as described in Appendix A). Monitoring surveys should aim to follow, as much as possible, transects established during baseline surveys (Appendix A). Nonetheless, the methodology allows that repeat surveys cannot guarantee precisely identical transect routes: the aim of these surveys is to assess overall cover, in each area, of hard coral, soft coral, algae, rock, etc.

Higher proportions of live coral broadly represent better condition reef. Minor changes are not important – these may represent real change, or represent slight variations in transect route – unless they show a continued trend over several surveys. Significant or continued declines in coral cover should be investigated to assess their cause. Although this may be the Project, it may also be related to weather, non-Project land-based outflows, etc.

Surveys should take place quarterly during the Project construction phase, annually for the first five years of the operation phase, and thereafter every five years. In-country capacity exists to conduct such surveys, via local dive operators, even if they may require initial remote training by an expert in PPITs. As such, costs are likely to be very low – estimated here at <$5,000 per survey.
Table 5. Key areas of monitoring necessary to assess changes in the state of priority biodiversity (including Critical Habitat) and Natural Habitat, changes in impacts, and progress of project mitigation.

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Aspect</th>
<th>Project phase</th>
<th>Impact</th>
<th>Mitigation action</th>
<th>What parameter is to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored?</th>
<th>When is the parameter to be monitored (frequency)?</th>
<th>Institutional responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coral patches</td>
<td>Habitat</td>
<td>C</td>
<td>Direct habitat loss through marine reclamation</td>
<td>Ensure that the area of seabed disturbed does not extend any further than that required in the detailed design in order to minimize the footprint of the revetment and reclaimed area.</td>
<td>General response and pressure monitoring will be sufficient to assess effective mitigation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small/soft sediment</td>
<td>Habitat</td>
<td>P, C</td>
<td>Introduction of invasive alien species</td>
<td>Take care to avoid introduction of invasive alien species to the Project area through: washing of vehicles, equipment and supplies before entry to the Project area; monitoring for invasive species; and control/eradication of invasive species where found.</td>
<td>Presence, abundance and distribution of any non-native species listed in the Global Invasive Species Database</td>
<td>PNGLIA</td>
<td>Invasive alien species surveys during the main flowering season</td>
<td>Annually during the Project construction phase and first five years of the operation phase</td>
<td>External botanical consultant, overseen by CSC (during construction) and airport operator (during operation)</td>
</tr>
<tr>
<td>All priority marine biodiversity</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>Prepare and implement a Waste Management Plan and Pollution Prevention Plan. As far as practical, rubble should be free of earth and sand before it is placed into the water.</td>
<td>Coral cover and reef condition.</td>
<td>Tasitolu Bay coral reefs</td>
<td>Coral reef condition surveys.</td>
<td>Quarterly during the Project construction phase, annually for the first five years of the operation phase, and thereafter every five years.</td>
<td>External marine biodiversity consultant, overseen by CSC (during construction) and airport operator (during operation)</td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation throughrelease of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>Prepare and implement a Waste Management Plan and Pollution Prevention Plan. As far as practical, rubble should be free of earth and sand before it is placed into the water.</td>
<td>Coral cover and reef condition.</td>
<td>Tasitolu Bay coral reefs</td>
<td>Coral reef condition surveys.</td>
<td>Quarterly during the Project construction phase, annually for the first five years of the operation phase, and thereafter every five years.</td>
<td>External marine biodiversity consultant, overseen by CSC (during construction) and airport operator (during operation)</td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td>P, C</td>
<td>Habitat degradation through release of suspended sediment, release of nutrients and contaminants from suspended sediments, construction waste, and/or pollution</td>
<td>Prepare and implement a Waste Management Plan and Pollution Prevention Plan. As far as practical, rubble should be free of earth and sand before it is placed into the water.</td>
<td>Coral cover and reef condition.</td>
<td>Tasitolu Bay coral reefs</td>
<td>Coral reef condition surveys.</td>
<td>Quarterly during the Project construction phase, annually for the first five years of the operation phase, and thereafter every five years.</td>
<td>External marine biodiversity consultant, overseen by CSC (during construction) and airport operator (during operation)</td>
</tr>
</tbody>
</table>
## Environmental Component

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Aspect</th>
<th>Project phase</th>
<th>Impact</th>
<th>Mitigation action</th>
<th>What parameter is to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored?</th>
<th>When is the parameter to be monitored (frequency)?</th>
<th>Institutional responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seagrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>To prevent impacts from reclamation area two temporary spillways will be placed at the locations shown in the figure below. The spillways will be constructed to prevent high levels of silts in the reclaimed areas discharging into the area between the revetment and silt curtain.</td>
<td>Design appropriate temporary drainage system to accommodate, treat and filter water run-off from land-based construction (including existing airport drains).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dugong</td>
<td>C, O</td>
<td>Habitat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coral patches &amp; Egg Cowry</td>
<td>Habitat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tasitolu Bay soft coral reef</td>
<td>Habitat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### General response and pressure monitoring will be sufficient to assess effective mitigation.
### Environmental Component: Protected bird species (including Drab Swiftlet, Brahminy Kite & Spotted Kestrel)

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Project phase</th>
<th>Impact</th>
<th>Mitigation action</th>
<th>What parameter is to be monitored?</th>
<th>Where is the parameter to be monitored?</th>
<th>How is the parameter to be monitored?</th>
<th>When is the parameter to be monitored (frequency)?</th>
<th>Institutional responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>P, C</td>
<td>Distribution</td>
<td>Displacement of species due to construction activity and noise</td>
<td>Negligible impact.</td>
<td>General response and pressure monitoring will be sufficient to assess effective mitigation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>Displacement of species due to increased operational air traffic</td>
<td>Negligible impact.</td>
<td>General response and pressure monitoring will be sufficient to assess effective mitigation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Mortality

<table>
<thead>
<tr>
<th>O</th>
<th>Mortality or injury to species due to increased operational air traffic</th>
<th>Update and implement the airport’s Wildlife Hazard Management Plan.</th>
<th>Risk evaluation process completed during pre-construction phase.</th>
<th>Desktop</th>
<th>ANATL reports on Wildlife Hazard Management Plan implementation.</th>
<th>Once, after completion, before the end of the pre-construction phase.</th>
<th>CSC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>International-standard wildlife hazard management training completed for all relevant staff.</td>
<td>Desktop</td>
<td>ANATL reports on Wildlife Hazard Management Plan implementation.</td>
<td>Once, after completion, before the end of the first year of the construction phase.</td>
<td>CSC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Update of Wildlife Hazard Management Plan completed.</td>
<td>Desktop</td>
<td>ANATL reports on Wildlife Hazard Management Plan implementation.</td>
<td>Once, after completion, before the end of the first year of the construction phase.</td>
<td>CSC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Five-yearly budget produced for Wildlife Hazard Management Plan implementation, and at least first year budget approved.</td>
<td>Desktop</td>
<td>ANATL reports on Wildlife Hazard Management Plan implementation.</td>
<td>Once, after completion, before the end of the first year of the construction phase.</td>
<td>CSC</td>
</tr>
<tr>
<td>Environmental Component</td>
<td>Aspect</td>
<td>Project phase</td>
<td>Impact</td>
<td>Mitigation action</td>
<td>What parameter is to be monitored?</td>
<td>Where is the parameter to be monitored?</td>
<td>How is the parameter to be monitored?</td>
</tr>
<tr>
<td>------------------------</td>
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<td>----------------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Dugong, whales, dolphins, turtles &amp; Whale Shark</td>
<td>Distribution</td>
<td>C</td>
<td>Displacement of species due to underwater noise or vibration</td>
<td>Avoid any marine piling or blasting, and any transport of reclamation material by sea. Place rubble material into the seabed using a crane with a claw rather than pushing the rubble into the seabed thereby avoiding the noise generated by rocks grinding against each other.</td>
<td>General response and pressure monitoring will be sufficient to assess effective mitigation.</td>
<td>Visual inspection; ANATL reports on Wildlife Hazard Management Plan implementation.</td>
<td>Review of ANATL daily wildlife survey reports.</td>
</tr>
<tr>
<td>Environmental Component</td>
<td>Aspect</td>
<td>Project phase</td>
<td>Impact</td>
<td>Mitigation action</td>
<td>What parameter is to be monitored?</td>
<td>Where is the parameter to be monitored?</td>
<td>How is the parameter to be monitored?</td>
</tr>
<tr>
<td>Presidente Nicolau Lobato International Airport Expansion Project, Timor-Leste Environmental Impact Assessment – Appendix B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Component</td>
<td>Aspect</td>
<td>Project phase</td>
<td>Impact</td>
<td>Mitigation action</td>
<td>What parameter is to be monitored?</td>
<td>Where is the parameter to be monitored?</td>
<td>How is the parameter to be monitored?</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>--------</td>
<td>-------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Mortality</td>
<td>C</td>
<td></td>
<td></td>
<td>migration season, by starting marine construction activities in February and finishing in/before August the next year.</td>
<td>activities in the peak cetacean migration season, by starting marine construction activities in February and finishing in/before August the next year.</td>
<td>of marine construction, and within each of three months either side of the planned completion date for marine construction.</td>
<td></td>
</tr>
</tbody>
</table>
6.2 Invasive alien species surveys

Terrestrial surveys should aim to identify the presence within the Project boundary of any novel (i.e., potentially Project-introduced) non-native species listed in the Global Invasive Species Database (http://www.iucngisd.org/gisd). Given the Project context, these surveys should particularly focus on plant species, and should be general “searching” surveys that cover the broad Project area rather than small-scale surveys of plots or transects.

Marine construction is planned entirely from land, and no marine vehicles will be used by the Project (aside from imports of equipment to Dili harbor), so Project risks of introduction of marine IAS are negligible. As such, specific marine IAS surveys are not necessary, although marine IAS may be detected in coral reef condition surveys (Section 6.1).

If any invasive alien species are detected during surveys, these should be removed and destroyed (or controlled if removal is not possible).

Surveys should take place during the main flowering season (as invasive plants represent the most significant risk), annually during the Project construction phase and first five years of the operation phase. Assuming no continued presence of invasive alien species introduced by the Project is detected after the fifth year of the operation phase, surveys can then be discontinued. It is not known whether in-country capacity exists to conduct such surveys. If not, it is available in neighboring countries. As such, costs are likely to be very low – estimated here at <$5,000 per survey.

6.3 Airport wildlife surveys

As described in the PNLIA Wildlife Hazard Management Plan (ANATL 2018), wildlife data should be collected by airport staff trained in wildlife data collection, during daily runway checks. This should include:

- Date and time when the recorded wildlife species is initially observed;
- Weather;
- Grid location where the species was first observed, using the grid system in the Wildlife Hazard Management Plan. When wildlife is observed moving through multiple grids, the first grid location is always recorded;
- Species observed, using letter codes for ease if/when these have been assigned. More specific information on plumage/age should be collected on raptors to identify individuals that are then classified as resident or non-residents. If a species is observed multiple times throughout the day in the same location and is exhibiting the same behavior, it is to be recorded as one observation. If a species is observed multiple times throughout the day in various locations, exhibiting different behavior, or if dispersal techniques are conducted, it is then recorded as an additional observation;
- Number of individuals for each species observed, including estimates for the total number of individuals in a flock;
- Attractant that the observed species appears to be attracted to (e.g., water, type of food, resting area). These assumptions should be based on the behavior of each individual species (e.g. feeding, breeding, resting/loafing, territorial, etc.);
• Activity, i.e. behavior of the species when associated with the attractant. The initial activity of observed species is recorded. If there is a notable change in the species activity during the observation, additional information is recorded in the “notes” section of the datasheet;

• Dispersant equipment or method used to disperse wildlife from the airfield; and

• Result of wildlife dispersal attempt.

6.4 Wildlife strike recording

As described in the PNLIA Wildlife Hazard Management Plan (ANATL 2018), if a species is involved in an aircraft strike, additional information will be collected and sent to the ANATL Wildlife Manager for the preparation and submittal of a strike report to the AACTL’s wildlife strike database. In the incidence of an aircraft strike, the following information should be recorded:

• Species, number and size category of the species struck;

• Name of the airline (when applicable), type of aircraft, and registration number;

• Flight number (when applicable);

• Phase of flight;

• Part(s) of aircraft struck;

• Damage or no damage;

• Effect on flight; and

• Any other pertinent information.
7 References


Appendix A. Summary of marine biodiversity surveys

This summary is adapted from Lovell & Pilgrim (2021).

A.1 Introduction

A.1.1 Purpose and objectives

This document is a Marine Biodiversity Survey Report for TA-9925 REG: Southeast Asia Transport Project Preparatory Facility Phase 2 - Biodiversity Specialist (52084-002). It represents part of Activity 4 of Phase 2 of this work. This study relates specifically to expansion of the Presidente Nicolau Lobato International Airport (“the Project”) runway to 2,100 m, and some associated modifications to airport buildings and infrastructure. Further expansion up to 3,000 m is being considered for the future. The Asian Development Bank (ADB) is considering financing the 2,100 m phase, which is thus the focus of this study. This study will, however, also consider the 2,500 m and 3,000 m expansion phases. Figure A1 shows the Project context.

Figure A1. Project context, in relation to areas and landmarks mentioned in this report.

Under the ADB Safeguard Policy Statement (SPS: ADB 2009), this is likely to be identified as a Category A project because it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the project footprint. As such, it is subject to an Environmental Impact Assessment (EIA).

Two Critical Habitat Screenings (Crute 2019; Pilgrim 2020a) and a Site Verification (Pilgrim 2020b) identified marine Critical Habitat risks in the Project Area of Assessment (AoA). As such, detailed marine surveys were undertaken by Ed Lovell to understand the extent and quality of Natural and Critical Habitat present in the AoA, current impacts, key potential project impacts, appropriate mitigation and opportunities for enhancement. These surveys focused on biodiversity per se, rather
than human uses of biodiversity. It was beyond the scope of these surveys to collect information on ecosystem services, which principally require social expertise for assessment.

The ADB SPS requires projects in areas of Natural Habitat to design mitigation measures to achieve at least no net loss of biodiversity. It requires projects in areas of Critical Habitat to demonstrate ‘no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function’, no ‘reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised’, and mitigation of any lesser impacts. This Marine Survey Report lays the foundation for a Biodiversity Action Plan to ensure this Project can align with these SPS requirements.

A.1.2 Project Area of Influence

The Project Area of Influence (AoI) is the broadest realistic area in which the Project may have impacts – here, specifically impacts upon biodiversity. The AoI is identified here based on the 2,100 m phase, since that is the forthcoming programmed phase. These are considered in turn below. Pilgrim (2020a) preliminarily identified the Project marine AoI as likely to extend out to the 100 m bathymetry contour (to encompass reclamation and noise impacts) and to c.500 m along the shore in either direction of the Project (to encompass impacts from sedimentation and altered marine flows). Based on this survey’s findings, the marine AoI is extended west to the end of the contiguous soft coral reef in Tasitolu Bay.

Further noise modelling, bathymetric studies and hydrological/current models will be necessary to understand the precise extent of possible Project impacts and thus to refine the Project AoI for the 2,100 m phase. Such studies and modelling are undertaken during the full Project EIA.

A.1.3 Project Area of Assessment

Pilgrim (2020a) identified a marine AoA that extended out to 100 m depth (incorporating potential noise impacts), as far as the airport in the east, and as far west as the western edge of Lagao Tasitolu Peace Park). Based on this survey’s findings, the marine AoA is extended slightly further west to the end of the discontinuous soft coral reef in Tasitolu Bay (Figure A2).
A.1.4 Future phases

In the future, larger AoIs and AoAs will need to be identified for the 2,500 m and 3,000 m phases. For biodiversity, these will mostly differ in the marine realm. This is because these next two phases largely differ in their further extension of the runway into the sea, with concomitant potential for westwards extension of direct habitat loss and noise, and (potentially much more significant) modification of marine flows, sediment transfer and biodiversity movements to the west and east. Further, any terrestrial noise impacts to the east will affect the town of Dili (containing no significant biodiversity).

Further noise modelling, bathymetric studies and hydrological/current models will be necessary to understand the precise extent of possible Project impacts in future phases and thus to identify appropriate Project AoIs for future phases. Such studies and modelling are undertaken during the full Project EIA.

A.1.5 National Biodiversity Law

A new national biodiversity law was issued just before this survey (Government of Timor-Leste 2020). This has two significant implications for the Project.

First, according to Article 26, the government body responsible for environment may – bearing in mind the precautionary principle - place restrictions on activities which may have a negative impact...
or damage priority and special ecosystems, including estuaries, coral and coral reefs, and seagrass. The implication of this Article is unclear, since it is not clear whether such restrictions would actually be put in place (only that they may be), at what stage those restrictions may be put in place, and what those restrictions would or could be. It was not possible to meet with the Environment Department to seek clarity on this law during these surveys (Appendices A, E).

Second, according to Article 30, it is strictly prohibited to kill, uproot, cut, destroy or remove all or part of protected species; or to disturb protected species during gestation, child rearing, migration and overwintering, including degradation (in any form) of breeding and resting areas. Of particular relevance to the Project, these protected species are listed in the law’s Annex I to include some corals (including *Heliopora coerulea* and *Millepora* spp.), the mollusk family Cypraidae (including white cowries *Ovula ovum*, which were common in Tasitolu Bay), Dugong, all sea turtles, all whales and dolphins, and Whale Shark (as well as at least three species of bird recorded at the airport: Pilgrim 2020c). It will thus be incumbent on the Project to mitigate with an intention to avoid or minimize impacts on these species as much as possible.

### A.2 Survey methods

A rapid Site Verification survey was first conducted adjacent and near to the airport (Pilgrim 2020b). Reconnaissance swims near the proposed airport runway extension revealed little in the way of corals, with only small isolated patches observed. Much of the area was characterized by soft sediments of terrestrial origin and the diversity of biota influenced by the Comoro River outflow. This environment extended to the east, until reefal areas were observed near Dili Harbour. To the southwest, reefs were found in Tasitolu Bay. Limited seagrass was found.

![Figure A3. Areas surveyed to characterize the marine environment (see detailed descriptions in Appendix B and GPS locations in Appendix C). The Project seaward extension is at the boundary of Areas 3 and 4. Data: Google Earth.](image-url)
As a result of the site verification, further surveys were undertaken – with two main goals. First, reconnaissance swims over a broad area (Figure A3) aimed to develop a coarse-scale understanding and habitat map of the marine environment near the Project, highlighting areas of Natural and Critical Habitat (Figure A5). Second, for areas of identified Critical Habitat in Tasitolu Bay, much more detailed survey was conducted via Pacific Point-Intercept Transects (PPITs; Section A.2.1), in order to provide higher resolution data and baseline for future monitoring of any potential Project impacts.

A.2.1 Pacific Point Intercept Transects (PPITs)

To assess the type and quality of current reef habitats in Tasitolu Bay, and to provide a baseline against which any potential future Project impacts can be monitored, detailed and systematic survey was necessary. This focused on estimates of the relative proportions of living organisms and physical attributes within the Tasitolu reef (in areas 5 and 6), which extends along the foreshore of the bay. The reef was divided into sections and then assessed using the Pacific Point Intercept Transect (PPIT) method (English et al. 1994; Hill & Wilkinson 2004), to quantify the percentage cover of the various types of organisms and substrate (Table A1). A 20 m incremented tape was laid along the reef surface (Figure A4). The diver swam along the tape, and at 0.5 m intervals, recorded the substrate type under the tape and at points 1 m either side of the tape (such that 120 points were sampled in a 20 m transect). The transect was positioned in the middle of the zone of maximum living cover in each area of reef surveyed.

Table A1. Definition of transect attributes (following English et al. 1994; Whippy-Morris2009).

<table>
<thead>
<tr>
<th>Survey attributes</th>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Coral</td>
<td>HC</td>
<td>Scleractinian corals characterised by having six tentacles, or multiples of such, and a hard skeleton.</td>
</tr>
<tr>
<td>Soft Coral</td>
<td>SC</td>
<td>Alcyonarian corals with eight tentacles or multiples with a hydrostatic skeleton with spicules.</td>
</tr>
<tr>
<td>Blue Coral</td>
<td>CHL</td>
<td>Blue coral (<em>Heliopora coerulea</em>) non-scleractinian with a hard skeleton. Nationally protected (Government of Timor-Leste 2020).</td>
</tr>
<tr>
<td>Sponge</td>
<td>SP</td>
<td>Colonial, attached invertebrate organisms of the Phylum Porifera.</td>
</tr>
<tr>
<td><em>Millepora</em> (fire)</td>
<td>CME</td>
<td><em>Millepora</em> spp. Also known as fire coral due to its stinging nematocysts. It has a hard skeleton. Nationally protected (Government of Timor-Leste 2020).</td>
</tr>
<tr>
<td>Coralline Algae</td>
<td>CA</td>
<td>A calcifying, cementing red marine algae which is generally encrusting and hard.</td>
</tr>
<tr>
<td><em>Halimeda</em></td>
<td>HA</td>
<td>A calcifying green marine algae, with a soft skeleton within its thalli (leaves).</td>
</tr>
<tr>
<td>Macro-algae</td>
<td>MA</td>
<td>Larger fleshy algae (seaweeds), generally brown but of all colour categories, comprising four different phyla.</td>
</tr>
<tr>
<td>Turf algae</td>
<td>TA</td>
<td>A broad category of non-calcareous algae consisting of many different forms (e.g., finely branched delicate structures; short and stubby tubular forms; thick grass-like mats; small clumps).</td>
</tr>
<tr>
<td>Other</td>
<td>OT</td>
<td>Anything not in the above categories and/or unknown to the surveyor.</td>
</tr>
<tr>
<td>Rock</td>
<td>RC</td>
<td>Bare rock surfaces without sessile benthos (attached organisms).</td>
</tr>
<tr>
<td>Sand</td>
<td>SD</td>
<td>Fine grain sediments.</td>
</tr>
</tbody>
</table>

The PPIT method has its origins in the Point Intercept Transect method described by English et al. (1994). It is widely used by Reef Check and the Global Coral Reef Monitoring Network (GCRMN) in
surveying coral reefs. It is a simple and efficient method which can be modified to accommodate any researcher’s taxonomic ability. A variation on this method was used in the most detailed surveys to date of Timor-Leste’s coral reefs (Turak & Devantier 2012; Erdmann & Mohan 2013).

Figure A4. The 20 m transect tape laid over the reef surface.

A.3 Survey results

A.3.1 Biodiversity

A.3.1.1 Overview of habitats

Previous marine habitat maps have necessitated interpretation of remote sensing imagery, and been too imprecise to support Project management planning (e.g., Boggs et al. 2009; Torres-Pulliza et al. 2013). Broad-scale rapid surveys here enabled construction of a coarse-scale habitat map (Figures A5&A6). Coastal marine areas immediately adjacent to the airport, c.500 m to the west, and some distance to the east represent Natural Habitat. Descriptions and additional photographs of survey areas, along with more detailed survey data summaries from Areas 5 and 6, can be found in Appendix B.

From c.500 m to the west of the airport, beachrock occurs, and is associated with coral reef almost continuously to Dili Rock. This reef is of varying quality, owing to ongoing nearby land-based impacts, and so mostly represents a mix of Natural and Critical Natural Habitat. In only one location, near to a drain at the eastern side of Tasitolu Bay, is the inshore area sufficiently affected by land-based impacts to represent Modified Habitat.
Figure A5. Coarse-scale habitat map of the Project vicinity, showing Natural, Modified and Critical Habitat.
Figure A6. Coarse-scale habitat map of Tasitolu Bay, showing Natural, Modified and Critical Habitat.

To the east of the airport, the first substantive areas of coral occur in Dili Bay offshore of the center of town. These areas are likely sufficiently degraded that they represent Natural Habitat but not Critical Habitat. Further east, to the west and east of Cristo Rei, extensive coral reefs may represent Critical Habitat (but were not surveyed during this assessment). Lack of coral directly east of the airport and, indeed, around the airport itself, is likely attributable to the Comoro River outflow – sediment and freshwater from which would likely prevent nearby coral reef development.

Seagrass occurs sparsely over much of the area, though never in high densities. The most extensive patch in the east of Tasitolu Bay is labelled in Figures A5 and A6 as “seagrass patch”, and is home to Dugong. The scale and density of this seagrass is not significant in a national or international context, and so should not be considered Critical Habitat.

A.3.1.2 Critical Habitat

Tasitolu Bay has little infrastructure, other than a recently-upgraded road on the landward side (Figure A7; represented by a thick gray line on Figures A5&A6). A soft and hard coral reef adjacent to the foreshore of Tasitolu beach (Areas 5-7 in Figure A3) extends to c.500 m from the Project site at its nearest extent (Area 5 in Figure A3). A rim of beachrock lines the shore, extending >1.5 km along the beach front and descending to a depth of c.2 m at low water. Beachrock forms in the presence of freshwater percolating into the marine environment through coastal sediments. This phenomenon results in rock structures which are the result of the cementing of the beach sediments by algal/microbial action in the presence of marine and freshwater (Vousdoukas et al. 2007). In this location, the persistent sources of freshwater (or, at least, brackish water) are the inland Tasitolu lakes proximal to this area. Elsewhere in Timor-Leste, most reefs are hard coral-dominated assemblages residing on carbonate substrates created by the coral/coralline algal concretions (Turak & DeVantier 2012). Other surveys found that most soft coral reefs on the north coast appear to be transient features occurring on rubble beds resulting from destructive fishing, coral predation or storm damage (Turak & DeVantier 2012).
In Tasitolu Bay (Areas 5-7 in Figure A3), the hard beachrock substrate has been colonized by a healthy assemblage of hard and soft corals, with large colonies and showing very little sign of bleaching (e.g., Figure A8). Though diversity was lower than can be found in offshore reefs, it was high considering the environmental limitations of a near-shore existence. Fish and a variety of associated invertebrates were evident. The reef was dominated in abundance by soft corals. This is unusual, as hard corals usually dominate over time. The dominance of soft corals in this area is likely maintained in this particular area by regular freshwater (brackish) flooding from Tasitolu, and a degree of sedimentation from strong wave action. Dive operators also noted the presence of regular freshwater inflows as maintaining an unusual marine environment here. The reef is approximately 30 m in width, with a sandy substrate extending seaward from the margin.
Assessment of this coral reef against detailed Critical Habitat criteria (IFC 2019) is challenging, since the habitat has not undergone an IUCN threat assessment and there has been no relevant-scale systematic conservation planning for the area. Based on previous Critical Habitat criteria (IFC 2012), Martin et al. (2015) considered coral reefs globally to comprise “Likely Critical Habitat”. In this particular case, the extent, diversity, quality and – particularly – unusual structure and composition of this coral reef are sufficiently significant to be considered Critical Habitat. Although Timor-Leste has extensive high-quality coral reefs, particularly in the north-east (Turak & DeVantier 2012), and does have other soft coral-dominated reefs, these remain globally and regionally uncommon. In Tasitolu Bay, the presence of the nearby lakes is unusual within Timor-Leste and has likely determined the presence of both beachrock substrate and dominant soft coral cover. This reef area is also unusual in its proximity to the capital of Timor-Leste, meaning it has importance both as a subsistence fishery and for tourist dive operations.

Eisemberg et al. (2014) and Eco Logical Australia (2014) found seagrass to be limited in and around Tibar Bay, and not to represent Critical Habitat – a finding with which we agree for the Tasitolu Bay area (e.g., Appendix B). As explained by Pilgrim (2020a), this area of seagrass – despite being identified as a Key Biodiversity Area – does not meet Critical Habitat thresholds (per IFC 2019).

A.3.1.3 Direct impact zone

The substrate underwater at the end of the current runway – and up to at least c.500 m to the east and west – is comprised of loose stones and gravel (Figure A9; Areas 3&4 in Figure A3), merging to finer sand and silt at greater depth. Scattered coral outcrops are present, where fixed hard substrate...
has given them an opportunity to colonize (e.g., Figure A10). These outcrops are sometimes single species and sometimes multispecies assemblages, but are all quite small (<2 m in diameter). Density of coral outcrops was lower near the end of the runway (which already represents something of a point, with a stronger current). While there has been some human disturbance owing to protection of the shoreline with boulders and a cement wall, this mix of substrates with patchy coral cover appears to be broadly Natural Habitat.

Figure A9. Mixed sand and stones comprise the general substrate offshore from the runway.

At about 100-150 m from shore, the water deepens to >10 m and there is a stronger current perpendicular to the shore. Deeper dives were not undertaken beyond this point, on the basis of information from local dive operators who stated no coral to be present in deeper areas here. Given inshore coral cover and significant depths further from shore, it is unlikely significant coral cover exists >100 m offshore of the airport.
A.3.1.4 Species of note

Pilgrim (2020a) highlighted seven globally Endangered coral species which may occur in this area, and may qualify it as Critical Habitat. Despite searching, none of these species were found during surveys. While it is possible that these species do occur here, as surveys were not comprehensive, it is unlikely that sizeable colonies are present in the surveyed area. It is thus not likely that any threatened species of coral (or other threatened marine species, per Pilgrim 2020a) qualify the Project area as Critical Habitat.

Surveys did not search for nationally protected corals (Government of Timor-Leste 2020), as they were outside the scope of this work, not directly relevant to identification of Natural or Critical Habitat (per ADB 2009; IFC 2019), and the protected species list was only published a month before surveys started (and only obtained toward the end of surveys; government officials consulted were not aware of its existence). However, some were incidentally recorded – namely *Heliopora coerulea* and *Millepora* spp. (Appendix C). The latter were in Area 5 (Figure A3), within the Project AoA. The mollusk family Cypraidae is also listed as nationally protected (Government of Timor-Leste 2020); white cowries (*Ovula ovum*) were common in Tasitolu Bay (within the Project AoA).

Signs on Tasitolu beach warn against disturbance of sea turtle nests, but local interviewees did not appear familiar with these species. Eisemberg *et al.* (2014) found some limited occurrence and nesting of sea turtles in the west side of Tibar Bay, and to the west of that bay, and interviewed two fishermen who reported sea turtle nesting at Tasitolu. Nippon Koei (2019a) also state turtles to ‘regularly’ nest at Tasitolu, though without clarifying the basis of that statement. Whether turtles
currently nest at Tasitolu or not, it is very unlikely that they occur in numbers sufficiently high to qualify the area as Critical Habitat (per IFC 2019; Pilgrim 2020a).

Surveys by Dethmers et al. (2012) suggest that a high diversity of marine megafauna (cetaceans, sharks, turtles and dugongs) in Timor-Leste occurs in north-western coastal waters, peaking in abundance with large numbers of dolphins and small whales around November. Their observations in the vicinity of the Project included dolphins, turtles, a Whale Shark (*Rhincodon typus*; globally Endangered) in May 2008, and sightings of large whales c.10 km to the east and west in November 2008.

None of the information presented above on marine megafauna suggests that the Project area represents Critical Habitat for marine megafauna (see also Pilgrim 2020a), but their presence does indicate the need for appropriate mitigation of potential Project noise impacts.

### A.3.2 Non-project impacts

As the most important habitat in the vicinity of the Project, impacts considered below focus on the Tasitolu Bay coral reef. Impacts on these reefs are, however, pertinent to the whole nearshore marine ecosystem in the Project area.

The Tasitolu Bay coral reef lies within the Lagao Tasitolu Peace Park, which is mainly terrestrial but also has an adjoining coastal marine component. The lakes within this park have likely been instrumental in creating and sustaining this unusual habitat (Section A.3.1.2). However, this is currently little more than a “paper park”. It has been colonized by hundreds of households over the last decade, with self-built houses now surrounding all but a small portion of the shores of the three lakes (Figure A11). Extensive rubbish – and presumably pollution and sewage effluent – has accumulated in the lakes. The lakes still appear productive, harboring a diversity of fish-eating birds, but the surrounding land areas have been heavily modified.

![Figure A11. Extensive housing that has developed in the Tasitolu area.](image)
The coral reef has been subject to some impacts owing to settlement directly along the shore west of the airport (outside of the peace park), with no/limited sewage or pollution control. Uncontrolled waste outflows likely explain some of the barren areas and prevalence of macroalgae offshore of the settlement. At the west end of this settlement, and east end of Tasitolu Bay, a large drain also appears to have resulted in barren rock.

Very limited coral bleaching due to regional temperature elevation was observed in some hard corals and anemones. This is in contrast to ASPEC (2018), who reported substantial dead coral in the west of Tasitolu Bay. Turak & DeVantier (2012) believed relatively cool sea temperatures and strong currents to likely confer strong climate change resilience on reefs on the north coast of Timor-Leste.

Though suitable as habitat, such aquatic genera as *Tridacna* and *Hippopus* were not found in Tasitolu Bay, likely due to being collected for food. Heavy inshore fishing pressure is also the likely cause of the absence of any fish of medium or large size. Small-scale low-density fishing (spearfishing or net fishing from the shore) was ever present during this survey.

In the longer term, the Pelican Paradise resort and golf course has been planned across the whole landward part of Tasitolu Bay (ASPEC 2018). This has been planned for many years, and construction recently started in an area west of Dili Rock (onshore from Area 8 in Figure A3). Although mitigation has been proposed, significant potential marine biodiversity impacts from this development include pollution (including from sewage treatment, and pesticides and fertilizers from a golf course) and release of hypersaline water from a desalination plant (ASPEC 2018).

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Further west, Tibar Port is under construction. That project again includes a program of mitigation, but has potential risks to marine biodiversity that include increased turbidity, changed hydrology, noise from construction activities, and introduction of invasive alien species (Advisian 2017).

### A.3.3 Key information gaps

Our marine biodiversity surveys were not comprehensive, but are sufficient and appropriate to assess impacts and design mitigation for the Project. It was clear during our surveys that the Project area was of value for subsistence fishing and dive tourism.

Significant gaps remain in understanding of relevant marine physical processes in the vicinity of the Project. Specifically, hydrological/current modelling will be undertaken during the full Project EIA, in order to understand potential impacts of the Project of release of suspended sediments (during construction) and altered coastal profile (during operation). These represent the most significant potential marine biodiversity impacts, by affecting the amount of sediment reaching habitats to the west and east of the Project.

Some key aspects of Phase 1 Project implementation currently remain unclear. Of most relevance, the source of the reclamation fill and reclamation construction method remain unclear. Both of these may substantially affect, for example, the type and amount of suspended sediment released during construction. Likewise, we have assumed here that construction will take place from land; sea-based construction may introduce additional impacts not considered here. Further, at the time of this survey, the construction method for High Intensity Approach Lighting (HIAL) at the western end of the runway – the Project infrastructure extending most out to sea – had also not been confirmed (Nippon Koei 2019b; Landrum & Brown 2020).

Even more substantial design and implementation aspects of Phase 2/3 remain unclear.
A.4 Mission schedule

The mission core to this assessment was intended to take place from 11-25 March, but was curtailed to 11-19 March owing to travel restrictions imposed as part of the global response to the COVID-19 crisis. Mission activities were further restricted owing to (i) involvement of government bodies in discussions on the national emergency response, and (ii) government declaration of tolerance days on 17 and 18 March to allow for participation of government staff to assist recover efforts for severe floods in Dili (which destroyed c.200 homes). The actual mission schedule was as presented in Table A2.

Table A2. Mission schedule

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<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Consultants</th>
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<tbody>
<tr>
<td>11 March</td>
<td>Arrive, internal meetings</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td>12 March</td>
<td>Kick-off meeting with Technical Working Group for Dili Airport Upgrading Project (TWG) and ANATL</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td></td>
<td>Planning meeting with ANATL</td>
<td>JP</td>
</tr>
<tr>
<td></td>
<td>Coral reef &amp; seagrass surveys near airport</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td></td>
<td>Informal discussion with local people</td>
<td>JP</td>
</tr>
<tr>
<td></td>
<td>Bird surveys at Tasitolu</td>
<td>JP</td>
</tr>
<tr>
<td>13 March</td>
<td>Coral reef &amp; seagrass surveys near airport</td>
<td>EL &amp; JP</td>
</tr>
<tr>
<td></td>
<td>Bird surveys at airport</td>
<td>JP</td>
</tr>
<tr>
<td></td>
<td>Writing site verification report</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td>14 March</td>
<td>Coral reef &amp; seagrass surveys</td>
<td>EL</td>
</tr>
<tr>
<td></td>
<td>Bird surveys at Tasitolu</td>
<td>JP</td>
</tr>
<tr>
<td></td>
<td>Consultations with Aquatica and Dive Timor Lorosae</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td>15 March</td>
<td>Coral reef &amp; seagrass surveys at Tasitolu</td>
<td>EL</td>
</tr>
<tr>
<td></td>
<td>Bird surveys at Tasitolu</td>
<td>JP</td>
</tr>
<tr>
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<td>Discussion of bird collision data with ANATL; site visit around airport grounds</td>
<td>JP</td>
</tr>
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<td>Informal discussion with local people</td>
<td>JP</td>
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<tr>
<td></td>
<td>Bird surveys at Tasitolu</td>
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</tr>
<tr>
<td></td>
<td>Consultations with Compass Diving</td>
<td>JP &amp; EL</td>
</tr>
<tr>
<td>17 March</td>
<td>Coral reef &amp; seagrass surveys at Tasitolu</td>
<td>EL</td>
</tr>
<tr>
<td></td>
<td>Discussion of bird collision data and wildlife hazard management plan with ANATL</td>
<td>JP</td>
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<td></td>
<td>Informal discussion with local person</td>
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<td></td>
<td>Consultation with La'o Hamutuk</td>
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</tr>
<tr>
<td>18 March</td>
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<tr>
<td></td>
<td>Compilation of data</td>
<td>EL &amp; JP</td>
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<tr>
<td>19 March</td>
<td>Departure</td>
<td>JP &amp; EL</td>
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A.5 Survey area descriptions

This Appendix contains descriptions and photographs of areas surveyed using reconnaissance swims and PPITs, in order to produce a coarse-scale habitat map (Figure A5). Where species are nationally protected, their status is noted. No globally threatened species were observed.

A.5.1 Area 1 - Adjacent to Dili lighthouse near the entrance of Dili Bay

This was similar to Area 2. The beach has been replaced by a boulder-armored foreshore. The subtidal flat exhibited poor visibility over a mud/rock bottom (Figure A12a). At the seaward margin (Figure A12 b, c), a coral reef is relatively more developed than in Area 2. The impact of run-off from nearby municipal drains was evident in reducing visibility.

![Figure A12. a) Inshore reef flat dominated by macro-algae with few corals. b) The calcifying green algae *Halimeda* sp. is common on the outer reef flat. c) The outer coral reef with soft, hard and Blue (*Heliopora coerulea*) coral (nationally protected: Government of Timor-Leste 2020).](image)

A.5.2 Area 2 – Adjacent to the fish market

This area had a sandy foreshore transitioning into a subtidal flat characterized by poor visibility and a substrate of fine sediments and rocks (Figure A13 a). This extended offshore c.145 m to a margin of sporadic coral occurrence with progressively increased relief (Figure A13 b, c), as the reefal structure became more evident with increasing depth (6-8 m). Due to the turbid conditions, the visibility was only 3 m.

![Figure A13. a) Inshore reef flat environment. b) & c) Fringing reef offshore.](image)
A.5.3 Area 3 – Seaward end of the airport runway to the Comoro River mouth

Coral patches are evident just to the east of the seaward (western) end of the runway in depths of 6-10 m. From the seaward end of the runway eastwards to the Comoro River (Figure 14 a), the subtidal nature of the inshore area was similar to the area directly off the end of the runway, though with fewer isolated coral patches (Figure A14 b). This survey was conducted during a period of limited visibility, due to the presence of the Comoro River plume, which prevented detailed inspection of the eastern third of this area. It was evident that the steep beach was composed of gravels of terrestrial origin, likely the result of flood transport from the Comoro River and redeposited on the beach.

Figure A14. a) View of the beach, north of the airport, looking to the western end of the runway. Note the gravel beach and plume from the airport drain. b) The subtidal substrate is composed of sand, gravel and stones.

Throughout this site visit, local fishermen were active around the edge of the plume at the mouth of the Comoro River (Figure A15).

Figure A15. Fishing the edge of the plume at the mouth of the Comoro River.
A.5.4 Area 4 - Seaward end of the airport runway, to the southwest

This survey area extended from the seaward end of the runway c.500 m to the southwest.

The foreshore to the southwest of the runway terminus is a brown sandy beach composed of course to fine sands. The color reflects the large terrestrial component. At the foreshore there is consistent wave action which resuspends the sediments.

The supra-tidal area at the end of the runway is armored by large boulders and a cement wall. With increased northern exposure, the shorebreak increases in intensity with the consequence of resuspending sediment and affecting visibility. Visibility was 8 m to the southwest of the runway and 5 m to the northeast.

Single large Porites colonies are common in this area, though occur as isolated colonies on a sand sediment and pebble bottom (Figure B5). These are not nationally protected or globally threatened.

![Figure A16. a) General soft sediment environment. b) & c) Large Acropora isolates amongst the soft sediments.](image)

Towards the southernmost end of this area, there are larger patches of relic beachrock areas in deeper water, with substantial assemblages of soft and hard corals, and other benthic organisms (Figure A17). This represents a deeper water extent of the inshore Area 5. No nationally protected or globally threatened species were observed.

![Figure A17. a) Soft coral assemblage on an isolated rock outcrop. b) Hard and soft corals. c) Deeper water (8 m) assemblage.](image)
A.5.5 Area 5 – Eastern extent of Tasitolu Bay coral reefs

This area is just within the eastern extent of the Tasitolu Lagao Peace Park. It holds the easternmost inshore section of a soft and hard coral reef, which extends into Areas 6 and 7. This assemblage occurs on a platform of beachrock which lines the shore of the bay from approximately 500 m west of the end of the airport runway extending to the southwest, around the bay and adjoining the Dili Rock reef (Figure A18). The rock substrate extends from the intertidal zone, descending to a depth of 2-3 m at low water and is c.800 m in extent in total (including Area 6).

The coastal land to the west of the airport has been settled, appearing to be largely by immigrants from across Timor-Leste. Beachrock extends along the subtidal shore in front of these settlements, ending in a barren area, resulting from a drain under the newly-upgraded road on the landward edge of Tasitolu Bay (Section B.5.4). For the purposes of this survey, the beachrock zone was divided into three contiguous sections with varying characteristics of dimension and diversity (Sections B.5.1-B.5.3).

Figure A18. Google Earth view of Area 5 with beachrock substrate located subtidally.

The reef is approximately 30 m in width, with the seaward edge of the coral/rock reef being margined by a sandy substrate that extends seaward. The apron of beachrock has been colonized by a diverse and abundant assemblage of hard and soft corals (Figure A19). Dominated in abundance by soft corals, it represents a thriving coral assemblage. Fish and a variety of associated invertebrates are evident. The sand area is characterized by coral reef isolates composed of one to several colonies. Sparse seagrass _Halophila ovalis_ is common.

![Image of seagrass](image_url)
Figure A19. a) High benthic coverage of soft and hard coral. b) Young lobster (*Panulirus* sp.). c) Large anemone (*Stichodactylus* sp.) with anemone fish.

A.5.5.1 Section 1

This section is located at the northeastern extent of the inshore beachrock coral assemblages. The coral coverage was generally sparse, with much of the rock surfaces barren (Figures A20, A21; Table A3). The most dominant life form was turfing algae with the presence of green *Halimeda* colonies. Unlike most of the beachrock reefs, the proportion of hard corals was greater than that of soft corals. The low percentages of live coral cover and high proportions of algae may well be a result of adjacent settlements with no/limited sewage treatment or pollution controls, as well as a small seasonal creek reaching the shore in this area. Reefs very close to shore (as in Areas 5-7) are already under significant natural pressure from onshore run-off and wave action resuspending sediments.

Figure A20. a) Barren subtidal beachrock near the beach. b) Sparse coral cover. c) Soft coral colony.
Table A3 & Figure A21. Turfing algae and bare rock substrates dominate this section, followed by coralline algae and *Halimeda*.

<table>
<thead>
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</thead>
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<tr>
<td>Soft coral SC</td>
<td>4</td>
<td>1.3</td>
</tr>
<tr>
<td>Sponge SP</td>
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<td>0.7</td>
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<tr>
<td>Coralline algae CA</td>
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<td>1.3</td>
</tr>
<tr>
<td><em>Halimeda</em> HA</td>
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<td>Macroalgae MA</td>
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</tr>
<tr>
<td>Turfing algae TA</td>
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<tr>
<td>Other reef biota OT</td>
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<tr>
<td>Rock RC</td>
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² The standard deviation is a statistic that measures the dispersion of a dataset relative to its mean and is calculated as the square root of the variance. It is calculated as the square root of variance by determining the variation between each data point relative to the mean. If the data points are further from the mean, there is a higher deviation within the data set; thus, the more spread out the data, the higher the standard deviation.
A.5.5.2 Section 2

Living coral cover increased in this central section of beachrock (Figures A22, A23; Table A4). Soft corals dominated, followed by turfing algae (Figure A22a,c). There was good coral diversity, with hard corals (Figure A22b) and the uncommon blue coral.

![Figure A22. a) Beachrock colonized by mainly soft corals. b) Mixed hard corals on the seaward rim of the substrate. c) Expanses of soft coral dominating the living substrate.](image)

Table A4 & Figure A23. Soft corals dominate the substrate with 50% coverage. Turfing algae occupy 20% cover.

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<td>Millepora coral CME³</td>
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<td>Rock RC</td>
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<tr>
<td>Total</td>
<td>120</td>
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</table>

³ Nationally protected (Government of Timor-Leste 2020).
A.5.5.3 Section 3

This is the westernmost section of the Area 5 reef, near the western end of the settlements onshore. Initially there is good soft coral cover (Figures A24, A25; Table A5), but this attenuates with the approach to the non-reefal area next to the drain (Section B.5.4). Overall, turfing algae thus dominated this section (Figure A25; Table A5).

![Figure A24. a) Soft coral assemblage. b) Hard corals flourishing in the reef edge. c) The predominant soft coral (*Lobophyllia* sp.).](image)

At about 100-200 m offshore, seagrass *Halophila ovalis* was quite extensive, and less sparse than in other locations surveyed, but still very sparse from a regional context. Multiple informants reported Dugong from this area, with most informants only reporting one individual, but one informant suggesting there was a regular group of three Dugong, and perhaps more (Appendix E). During surveys, a single Dugong was observed feeding for some time in this area.

![Table A5 & Figure A25. Turfing algae was the dominant life form, followed by soft and hard corals.](image)

<table>
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<th>Survey attributes</th>
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<tr>
<td><em>Halimeda</em> HA</td>
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<tr>
<td>Macroalgae MA</td>
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</tbody>
</table>
A.5.5.4 Drain area

This is a largely sandy area with limited beachrock. On the landward side, a drain extends under the newly-upgraded road, terminating close to the sea. The subtidal area has a few species of coral resistant to the periodic freshwater influx resulting from proximity to the drain (Figure A26).

![Figure A26. a) Soft sediments colonized largely by Halimeda sp. b) The sediment environment opposite the drain. c) The hard coral Leptastrea sp. is resistant to salinity and siltation.](image)

A.5.6 Area 6 - Eastern side of Tasitolu Bay

This area is all within the marine section of the Lagao Tasitolu Peace Park (Figure A27). The reefs are the most luxuriant of the reef assemblages surveyed. The total reef (including Area 5) is c.800 m long (with a break before Area 7) and is less impacted by settlements to the east than Area 5. For the purposes of this survey, the beachrock zone was divided into five contiguous sections with varying characteristics of dimension and diversity (Sections B.6.1-B.6.5).

![Figure A27. Google Earth view of the soft coral-dominated beachrock areas in the coastal-marine section of the Lagao Tasitolu Peace Park.](image)
A.5.6.1. Section 1

The first section of Area 6 is in the east of the area; the first occurrence of beachrock following the hiatus of soft sediments separating this area from Area 5. This section does not host the luxuriance of sections more central to Area 6 (Figures A28, A29; Table A6). It is a transitional area from the soft sediment zone, which is periodically affected during times of terrestrial runoff.

A well-known dive site is situated offshore here. This is particularly noted for high quality “muck diving” frequented by dive operators and tourists. It is clear there is strong support for conservation of this area from dive operators, who considered this a unique site nationally, and tourists (particularly from Japan) who regularly visit to search for Dugong in nearby seagrass (Section B5.3).

Figure A28. a) A large Lobophytum colony amongst other soft corals. b) A hard coral (Favites sp.) surrounded by soft corals. c) Among soft sediments, off the reef edge, a small patch reef with soft and hard corals, and a bleached anemone.

Table A6 & Figure A29. Soft corals are dominant, with 50% cover. Turfing algae and macroalgae are the next most dominant, followed by sandy substrate.

<table>
<thead>
<tr>
<th>Survey attributes</th>
<th>Mean (average) occurrences per transect</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coral HC</td>
<td>7</td>
<td>2.33</td>
</tr>
<tr>
<td>Soft coral SC</td>
<td>60</td>
<td>20.00</td>
</tr>
<tr>
<td>Halimeda HA</td>
<td>3</td>
<td>1.00</td>
</tr>
<tr>
<td>Macroalgae MA</td>
<td>15</td>
<td>5.00</td>
</tr>
<tr>
<td>Turfing algae TA</td>
<td>21</td>
<td>7.00</td>
</tr>
<tr>
<td>Rock RC</td>
<td>2</td>
<td>0.67</td>
</tr>
<tr>
<td>Sand SD</td>
<td>12</td>
<td>4.00</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>
A.5.6.2. Section 2

This section hosted the greatest luxuriance of soft coral development, with many large colonies (Figures A30, A31; Table A7). It also has a large algal component.

![Figure A30](image1.png)

Figure A30. a) Reef edge dropping two meters on to an expanse of sand that extends to depth. b) Luxuriant reef area with transect line in place. c) A hard and soft coral assemblage.

Table A7 & Figure A31. Turfing algae and soft coral dominated this central section, followed by isolated areas of sandy substrate.

<table>
<thead>
<tr>
<th>Survey attributes</th>
<th>Mean (average) occurrences per transect</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coral HC</td>
<td>4</td>
<td>1.33</td>
</tr>
<tr>
<td>Soft coral SC</td>
<td>19</td>
<td>6.33</td>
</tr>
<tr>
<td>Halimeda HA</td>
<td>3</td>
<td>1.00</td>
</tr>
<tr>
<td>Macroalgae MA</td>
<td>3</td>
<td>1.00</td>
</tr>
<tr>
<td>Turfing algae TA</td>
<td>21</td>
<td>7.00</td>
</tr>
<tr>
<td>Sand SD</td>
<td>10</td>
<td>3.33</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

- HC: 4, 6%
- SC: 19, 32%
- TA: 21, 35%
- MA: 3, 5%
- HA: 3, 5%
- SD: 10, 17%
A.5.6.3. Section 3

This area was similar to Section 2 in its luxuriance, though with a greater proportion of soft corals (Figures A32, A33; Table A8).

Figure A32. a) A large colony of *Sinularia* sp. surrounding a hard coral. b) Another species of *Sinularia*. c) A *Lobophytum* colony surrounding a *Montipora* branching hard coral.

Table A8 & Figure A33. This section was dominated by soft coral, with turving algae sub-dominant.
A.5.6.4. Section 4

With the approach of the western end of the beachrock in Tasitolu Bay, the algal component became dominant, with soft coral subdominant (Figures A34, A35; Table A9).

![Reefscape on the western portion of Section 4. b) Reef edge characterized by a 2m face dropping from the reef flat; anemones and associated fish line the base of the rock face. c) Reefscape showing the nature of the reef with open areas hosting turfing and macroalgae.](image)

Table A9 & Figure A35. Algal coverage here was nearly three times that of soft coral cover.

<table>
<thead>
<tr>
<th>Survey attributes</th>
<th>Mean (average) occurrences per transect</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard coral HC</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Soft coral SC</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>Sponge SP</td>
<td>2</td>
<td>0.67</td>
</tr>
<tr>
<td>Halimeda HA</td>
<td>19</td>
<td>6.33</td>
</tr>
<tr>
<td>Macroalgae MA</td>
<td>8</td>
<td>2.67</td>
</tr>
<tr>
<td>Turfing algae TA</td>
<td>43</td>
<td>14.33</td>
</tr>
<tr>
<td>Other biota OT</td>
<td>1</td>
<td>0.33</td>
</tr>
<tr>
<td>Rock RC</td>
<td>3</td>
<td>1.00</td>
</tr>
<tr>
<td>Sand SD</td>
<td>8</td>
<td>2.67</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>
A.5.6.5. Section 5

This site represents the western extent of Area 6. It was largely algal covered, predominantly by turving algae (Figures A36, A37; Table A10).

Figure A36. a) & b) Dominant macroalgae *Turbinaria* sp., with small *Lobophytum* colonies. c) Largely barren substrate at the western end of Area 6.

Table A10 & Figure A37. The algal component of living cover is 84%, with turving algae covering the rock substrate and limited soft and hard coral.

<table>
<thead>
<tr>
<th>Survey attributes</th>
<th>Mean (average) occurrences per transect</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hard Coral HC</strong></td>
<td>10</td>
<td>3.33</td>
</tr>
<tr>
<td><strong>Soft Coral SC</strong></td>
<td>10</td>
<td>3.33</td>
</tr>
<tr>
<td>Halimeda HA</td>
<td>15</td>
<td>5.00</td>
</tr>
<tr>
<td><strong>Macroalgae MA</strong></td>
<td>10</td>
<td>3.33</td>
</tr>
<tr>
<td><strong>Turfing algae TA</strong></td>
<td>75</td>
<td>25.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

HC, 10, 8%  
SC, 10, 8%  
HA, 15, 13%  
HA  
MA  
TA, 75, 63%  
MA, 10, 8%
A.5.7 Area 7 – Western side of Tasitolu Bay

This area is still within the marine part of the Lagao Tasitolu Peace Park. It has a similar beachrock perimeter to Areas 5 and 6, but is slightly separated and runs for c.400 m westwards to the Dili Rock reef. It was similar to Area 6, with a beachrock substrate and soft coral-dominated assemblage. Approaching the Dili Rock reef, the substrate relief increases seaward and hard corals become dominant. While percentage cover of corals was lower than in the east of the bay, and degradation higher, levels of degradation and dead coral cover were not seen to approach those identified by ASPEC (2018) in their transects 1 and 3. From our observations, it appears that the ASPEC transect lines may have been placed beyond the reef where talus material and sand are a poor substrate for coral colonization and growth.

A.5.8 Area 8 - West of Dili Rock

This area is just west of the western-most extent of the marine section of the Lagao Tasitolu Peace Park. The foreshore in this area is a sand beach comprised of carbonate skeletons of coral and shell, as well as sand and gravel. Intertidally, the gently sloping rock substrate is covered with Padina and other turfing algae. At 50-80 m offshore, the reef ledges from 4-6 m depth to 6 m depth and coral becomes more prolific. This extends with substantial diversity to 10 m and deeper.

Figure A38. a) Substantial relief in the reef topographic profile. b) Soft and hard coral cover on the reef face. c) A large expanse of a branching Acropora colony represents the transition to the hard coral-dominated Dili Rock reef.

Figure A39. a) Hard and soft coral cover. b) The reef slope illustrating the proliferation of corals. c) The reef face with high coral cover descends 2.5 m to the sand.
A.6 GPS locations for survey areas

Table A11. GPS locations for survey areas (area numbers as in Appendix B).

<table>
<thead>
<tr>
<th>Area No.</th>
<th>Area Name</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adjacent to Dili lighthouse near the entrance of Dili Harbour</td>
<td>8°32.806'S</td>
<td>125°34.059'E</td>
</tr>
<tr>
<td>2</td>
<td>Adjacent to the fish market</td>
<td>8°32.465'S</td>
<td>125°32.746'E</td>
</tr>
<tr>
<td>3</td>
<td>Seaward end of the airport runway to the Comoro River mouth</td>
<td>8°32.264'S</td>
<td>125°32.068'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8°32.918'S</td>
<td>125°30.921'E</td>
</tr>
<tr>
<td>4</td>
<td>Seaward end of the airport runway, to the southwest</td>
<td>8°32.932'S</td>
<td>125°30.896'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8°33.160'S</td>
<td>125°30.670'E</td>
</tr>
<tr>
<td>5</td>
<td>Eastern extent of Tasitolu Bay coral reefs</td>
<td>8°33.177'S</td>
<td>125°30.680'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8°33.328'S</td>
<td>125°30.521'E</td>
</tr>
<tr>
<td>6</td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.349'S</td>
<td>125°30.500'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8°33.439'S</td>
<td>125°30.298'E</td>
</tr>
<tr>
<td>7</td>
<td>Western side of Tasitolu Bay</td>
<td>8°33.425'S</td>
<td>125°30.096'E</td>
</tr>
<tr>
<td>8</td>
<td>West of Dili Rock</td>
<td>8°33.326'S</td>
<td>125°29.059'E</td>
</tr>
</tbody>
</table>

Table A12. GPS locations for detailed PPIT survey sections in Areas 5 and 6.

<table>
<thead>
<tr>
<th>Area No.</th>
<th>Section</th>
<th>Area Name</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>Eastern extent of Tasitolu Bay coral reefs</td>
<td>8°33.177'S</td>
<td>125°30.680'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.230'S</td>
<td>125°30.615'E</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Eastern extent of Tasitolu Bay coral reefs</td>
<td>8°33.230'S</td>
<td>125°30.615'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°32.273'S</td>
<td>125°30.581'E</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Eastern extent of Tasitolu Bay coral reefs</td>
<td>8°32.273'S</td>
<td>125°30.581'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.328'S</td>
<td>125°30.521'E</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.346'S</td>
<td>125°30.518'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.346'S</td>
<td>125°30.518'E</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.346'S</td>
<td>125°30.518'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.416'S</td>
<td>125°30.401'E</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.416'S</td>
<td>125°30.401'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.433'S</td>
<td>125°30.350'E</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.433'S</td>
<td>125°30.350'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.444'S</td>
<td>125°30.305'E</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Eastern side of Tasitolu Bay</td>
<td>8°33.444'S</td>
<td>125°30.305'E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8°33.451'S</td>
<td>125°30.271'E</td>
</tr>
</tbody>
</table>
A.7 Coral species checklist

Although not all observed corals were identified, as species inventory was not the purpose of these surveys, this Appendix contains a compiled list of coral species recorded in Areas 4, 5 and 6. Identification follows Veron and Stafford-Smith (2000); Wallace (1999). Where species are nationally protected (Government of Timor-Leste 2020), this is noted. No globally threatened species were observed.

Class Anthozoa

Subclass Hexacorallia

Family Pocilloporidae Gray, 1842

Genus *Pocillopora* Lamarck, 1816

*Pocillopora damicornis* (Linnaeus, 1758)
*Pocillopora meandrina* Dana, 1846

Family Acroporidae Verrill, 1902

Genus *Montipora* Blainville, 1830

*Montipora digitata* (Dana, 1846)
*Montipora monasteriata* (Forskål, 1775)

Genus *Acropora* Oken, 1815

*Acropora abrotanoides* (Lamarck, 1816)
*Acropora aculeus* (Dana, 1846)
*Acropora nobilis* (Dana, 1846)
*Acropora hyacinthus* (Dana, 1846)
*Acropora valenciennesi* (Milne Edwards and Haime, 1860)

Genus *Isopora* Studer, 1878

*Isopora palifera* (Lamarck, 1816)

Family Fungiidae Dana, 1846

Genus *Fungia* Lamarck, 1801

*Fungia danai* Milne Edwards and Haime, 1851
*Fungia granulosa* Klunzinger, 1879

Family Oculinidae Gray, 1847

Genus *Galaxea* Oken, 1815

*Galaxea fascicularis* (Linnaeus, 1767)
Family Dendrophylliidae Gray, 1847

Genus *Turbinaria* Oken, 1815

*Turbinaria mesenterina* (Lamarck, 1816)
*Turbinaria peltata* (Esper, 1794)
*Turbinaria reniformis* Bernard, 1896

Genus *Polyphyllia* Quoy and Gaimard, 1833

*Polyphyllia talpina* (Lamarck, 1801)

Genus *Goniastrea* Milne Edwards and Haime, 1848

*Goniastrea aspera* Verrill, 1905
*Goniastrea pectinata* (Ehrenberg, 1834)

Genus *Platygyra* Ehrenberg, 1834

*Platygyra daedalea* (Ellis and Solander, 1786)

Genus *Oulophyllia* Milne Edwards and Haime, 1848

*Oulophyllia crispa* (Lamarck, 1816)

Genus *Diploastrea* Matthai, 1914

*Diploastrea heliopora* (Lamarck, 1816)

Genus *Leptastrea* Milne Edwards and Haime, 1848

*Leptastrea purpurea* (Dana, 1846)

Genus *Lobophyllia* Blainville, 1830

*Lobophyllia corymbosa* (Forskål, 1775)

Genus *Symphyllia* Milne Edwards and Haime, 1848

*Symphyllia recta* (Dana, 1846)

Genus *Favia* Oken, 1815

*Favia favus* (Forskål, 1775)
*Favia matthaii* Vaughan, 1918

Genus *Favites* Link, 1807

*Favites abdita* (Ellis and Solander, 1786)
*Favites complanata* (Ehrenberg, 1834)

Family Poritidae Gray, 1842

Genus *Porites* Link, 1807

*Porites lobata* Dana, 1846

Genus *Goniopora* Blainville, 1830

*Goniopora lobata* Milne Edwards and Haime, 1860
Class Anthozoa
Subclass Octocorallia
Family Alcyoniidae Lamouroux, 1812
Genera:

*Briareum* Blainville, 1834
*Capnella* Gray, 1869
*Clavularia* Blainville, 1830
*Lobophytum* Marenzeller, 1886
*Palythoa* Lamouroux, 1816
*Sarcophyton* Lesson, 1834
*Sinularia* May, 1898
*Xenia* Lamarck, 1816

Family Helioporidae Moseley, 1876
Species *Heliopora coerulea* Pallas, 1766 (on CITES Appendix II, so de facto nationally protected: Government of Timor-Leste 2020)

Class Hydrozoa
Family *Milleporidae* Fleming, 1828 (on CITES Appendix II, so de facto nationally protected: Government of Timor-Leste 2020)

Genus *Millepora* Linnaeus 1758 (on CITES Appendix II, so de facto nationally protected: Government of Timor-Leste 2020)
Appendix B. Critical and Natural Habitat Assessment

The ADB Safeguard Policy Statement (ADB 2009) requires assessment of whether the project is planned in an area that may qualify as Critical Habitat or Natural Habitat. This assessment followed more detailed guidance in International Finance Corporation Performance Standard 6 and its accompanying guidance note (IFC 2012a, 2019). The assessment builds upon an earlier Critical Habitat Screening (Pilgrim 2020a) by incorporation of data from field visits (Pilgrim 2020b,c; Lovell & Pilgrim 2021).

B.1 Areas of analysis

Critical Habitat and Natural Habitat assessment ideally takes place across sensible ecological or political units that are sufficiently large to encompass all direct and indirect impacts from the project. These areas of analysis (AoAs) are thus often much broader than the direct project footprint and Area of Influence (Nippon Koei 2021). AoAs may be separate or combined, depending on the ecology of the biodiversity concerned.

Potential biodiversity risks associated with this Project relate to both the marine and terrestrial realms. Since most terrestrial Project impacts are likely to relate to waterbirds (Pilgrim 2020b,c), a single terrestrial AoA was identified that encompasses the Project itself, potential noise impacts to the east and west, the adjoining coastal strip, and the Lagao Tasitolu Peace Park – which is important for such waterbirds (Trainor 2005, 2011). This AoA is slightly larger than the anticipated terrestrial AoI, in order to be more ecologically appropriate. Marine AoAs are often more challenging to define ecologically. In this case, considering the area of direct impact (reclamation), the likely maximum depth of coral occurrence in the area (c. 30 m), and the maximum extent of potential noise impacts out to sea (Nippon Koei 2019a), a single marine AoA was identified that extends out to 100 m depth. This marine AoA was extended as far as the airport in the east, and as far west as potential noise impacts in the west (Figure B1). Together, the AoAs cover c.8 km².

Identification of these AoAs does not mean that the project has any obligations across them. The aim of this Critical and Natural Habitat Assessment is to identify whether the broad units qualify as Critical Habitat and, if so, for which biodiversity features. This information helps to prioritize impact assessment and to focus mitigation efforts.
B.2 Assessment of biodiversity which may qualify the area as Critical Habitat

Each of the following sections considers candidate Critical Habitat-qualifying biodiversity identified during recent surveys (Lovell & Pilgrim 2021 [Appendix A]; Pilgrim 2020c [Appendix D]), or within the Project consolidated survey report (Nippon Koei 2019a), Integrated Biodiversity Assessment Tool (IBAT), or other literature as actually or potentially present. In each case, reasons are identified for each biodiversity feature likely meeting or not meeting Critical Habitat. Two categories of biodiversity that might qualify the area as Critical Habitat were only considered briefly here, and should be assessed further by social experts – specifically areas that provide key ecosystem services and areas with biodiversity that has significant social, cultural or economic importance to local communities.

B.2.1 Critically Endangered and Endangered species
Critically Endangered, Endangered, and (per IFC 2019) Vulnerable species and relevant subspecies were included in an initial screening if they were found during surveys, there is indication of their presence near the Project site from literature, or their global range maps (IUCN 2020, as provided in IBAT) overlap the Project AoAs. Threat status is taken from the global IUCN Red List (IUCN 2019). An initial list of 250 such species (Table B1) was rapidly screened by comparing against quantitative thresholds for Critical Habitat (IFC 2019). This list contained 11 Critically Endangered (CR), 33 Endangered (EN), and 206 Vulnerable (VU) species, compared to nine CR, 24 EN, and 171 VU species listed by Crute (2019). Dusky Sea Snake (Aipysurus fuscus) and Roti Snake-necked Turtle (Chelodina mccordi) are not included in the screening as, contra Crute (2019), there is no evidence that they occur anywhere near the Project site.

Nationally-threatened species were not considered. Some species are nationally protected (Government of Timor-Leste 2020) or considered nationally Endangered according to UNTAET Regulation No. 2000/19, but this does not represent a national Red Listing exercise aligned with IUCN standards.

None of the 250 threatened species have more than 0.01% of their global range (Extent of Occurrence) in the AoAs. Even if some might possibly occur in high densities in the Project AoA, it is unlikely that any of the Critically Endangered or Endangered species have greater than 0.5% of their global population in the AoAs (the minimum threshold required to qualify an AoA as Critical Habitat). It is even more unlikely that any of the Vulnerable species have such a large population in the AoAs that the loss of that population would result in the change of the IUCN Red List status to Endangered (as required by IFC 2019 to qualify the area as Critical Habitat).

As noted by Crute (2019), the only threatened species which may potentially qualify the area as Critical Habitat are widespread but very rare and localized coral species. These comprise seven globally Endangered species (Table A1), of which three (Alveopora minuta, Lobophyllia serratus and Pectinia maxima) are confirmed from Timor-Leste and another, Porites eridani, has been reported (Turak & DeVantier 2012). Despite searching, none of these species were found during surveys (Appendix A). While it is possible that these species do occur here, as surveys were not comprehensive, it is unlikely that sizeable colonies are present in the surveyed area. It is thus not likely that any threatened species of coral (or other threatened marine species, per Pilgrim 2020a) qualify the Project area as Critical Habitat.

A few non-coral species are discussed in more detail in the boxes below, given indications in the literature that they may qualify the Project area, or other nearby areas, as Critical Habitat.

**Dugong (Dugong dugon)**

The Perairan Tasitolu Key Biodiversity Area (KBA) was identified on the basis of globally-important populations of this Vulnerable species. One individual was observed during recent surveys and up to three reported from the area (Appendix A).

To qualify as Critical Habitat for Dugong, the loss of the area would have to result in the change of the species’ Red List status to Endangered or Critically Endangered (IFC 2019). Given there are tens of thousands of Dugong in Australia/Papua New Guinea – and significant populations also in Bahrain, Qatar and the United Arab Emirates – it is implausible that the loss of even the entire Perairan Tasitolu KBA would result in a change in the species’ Red List status. The Project AoA does not thus represent Critical Habitat for Dugong.
Hawksbill Turtle (*Eretmochelys imbricata*), Green Turtle (*Chelonia mydas*) and Loggerhead Turtle (*Caretta caretta*)

Contra Crute (2019), Critically Endangered Hawksbill Turtles are regularly observed in Timor-Leste waters (particularly along the north coast), sea turtle eggs are regularly seen for sale in Dili (O’Shea et al. 2015), and there are reports of nesting, though these are considered likely to be low density and irregular (e.g., Hamann & Limpus 2019). Tibar Bay was identified as Critical Habitat by Eisenberg et al. (2014, in Trainor 2016) for Hawksbill Turtle and Endangered Green Turtle and Loggerhead Turtle. That site may have represented Critical Habitat for Hawksbill Turtle under previous IFC guidance (IFC 2012b), when only ‘regular occurrence of a single individual’ was necessary to qualify the area as Critical Habitat, but there is no indication that Tibar Bay holds ≥10% of the global population – or regionally-important populations – of any of these three species. It is thus not likely to qualify as Critical Habitat for threatened sea turtles under IFC (2019). The Project AoA is thus unlikely to represent Critical Habitat for sea turtles.

Far-Eastern Curlew (*Numenius madagascariensis*) and Great Knot (*Calidris tenuirostris*)

Tibar Bay (c. 5 km to the west of the Project) was identified as Critical Habitat by Trainor (2016) on the basis of regular occurrence of these two Endangered shorebirds. However, the area does not represent Critical Habitat for these species under IFC Critical Habitat Criterion 1 (IFC 2012b, 2019) because it holds <10% of their global populations and does not hold regionally-important populations. Likewise, the Project area is unlikely to represent Critical Habitat for these shorebird species.

Table B1. Globally threatened species with ranges overlapping Project AoAs

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### B.2.2 Endemic or restricted-range species

Following the IFC PS6 Guidance Note (IFC 2019), species were considered restricted-range if their global extent of occurrence was 50,000 km$^2$ or less (for terrestrial vertebrates) or, for riverine species, if their global range had less than 500 km linear geographic span. Species were included in an initial screening if they were found during surveys, there is indication of their presence from literature, or their global range maps (IUCN 2020, as provided in IBAT) overlap the Project AoAs. An initial list of 39 such species (Table B2) was rapidly screened by comparing against quantitative thresholds for Critical Habitat (IFC 2019).

None of the 39 restricted-range species have more than 0.02% of their global range (Extent of Occurrence) in the AoAs. It is thus extremely unlikely that any of them have greater than 10% of their global population in the AoAs (the minimum threshold required to qualify an AoA as Critical Habitat).

Tasitolu Important Bird Area was identified owing to the presence of 12 of the restricted-range birds listed in Table B2 (BirdLife 2020b). There is, however, no indication that any of these species are present at the site in concentrations sufficient to qualify it as Critical Habitat (per IFC 2019 guidance). Given the distribution of these species in suitable habitat on Timor, recent influx of people to live within the IBA, and the consequently limited habitat remaining in the IBA, it appears unlikely that Tasitolu qualifies as Critical Habitat for restricted-range birds (Pilgrim 2020a,b).

The biodiversity of Timor-Leste remains poorly-known, and a number of apparently endemic species have been identified in recent years. These include restricted-range species of fish to the north and east of the Project AoA (Greenfield & Erdmann 2013; Fricke & Erdmann 2017). It is thus possible that unidentified restricted-range species occur in the Project AoA, though this seems unlikely given the relatively high level of attention given to biodiversity in the vicinity of the national capital (including a well-visited dive site in the east of Tasitolu Bay, just to the west of the airport).

#### Table B2. Restricted-range species with ranges overlapping Project AoAs

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* Per IUCN (2020).
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<td>Timor Oriole</td>
<td>LC</td>
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<tr>
<td>Bird</td>
<td>Pachycephala orpheus</td>
<td>Fawn-breasted Whistler</td>
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<tr>
<td>Bird</td>
<td>Philemon inornatus</td>
<td>Timor Friarbird</td>
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<td>Bird</td>
<td>Phylloscopus presbytes</td>
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<td>LC</td>
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<tr>
<td>Bird</td>
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<td>Iris Lorikeet</td>
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<tr>
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<td>Bird</td>
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</tr>
<tr>
<td>Snail</td>
<td>Physastra moluccensis</td>
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<td>DD</td>
</tr>
</tbody>
</table>

**B.2.3 Migratory or congregatory species**

No Important Bird Areas have been identified for migratory or congregatory species in Timor-Leste (BirdLife 2020a).
Lake Tasitolu is considered to be the most important saline lake for migrant shorebirds in Timor-Leste (Trainor 2011). While nationally important, it does not appear to regularly hold any globally-significant numbers of migratory birds (per IFC 2019 thresholds).

Tibar Bay (c. 5 km to the west of the Project) was identified as Critical Habitat by Trainor (2016) on the basis of regular occurrence of migratory shorebirds – specifically, Far-Eastern Curlew (*Numenius madagascariensis*) and Great Knot (*Calidris tenuirostris*). However, the area does not represent Critical Habitat for these species under IFC Critical Habitat Criterion 3 (IFC 2012b, 2019) because it holds <1% of their global populations and does not regularly hold >20,000 waterbirds (<200 at the site itself, and low 1000s in nearby areas: Trainor 2016). The area was also identified as Critical Habitat by Eisemberg et al. (2014, in Trainor 2016) for migratory Hawksbill, Green and Loggerhead turtles, but it is not clear on what basis this identification was made as there does not appear to be any indication that Tibar Bay regularly holds ≥1% of any of these three species’ global populations.

**B.2.4 Unique assemblages of species that are associated with key evolutionary processes**

Trainor (2016) considered Tibar Bay to qualify as Critical Habitat owing to its role in a connected set of mangrove and intertidal wetland sites in the Tibar Bay-Tasitolu-Ulmera-Hera-Metinaro areas. By implication, Tasitolu – part of the Project AoA – would be considered in the same way. While clearly of national importance, these sites do not fit the usual approach to identifying Critical Habitat under IFC PS6/ADB SPS. While IFC (2019) identifies connectivity as a key factor underpinning evolutionary processes, this is in relation to *evolution* – by allowing species’ gene flow across altitudinal and climatic gradients, for example.

The mangrove in Tibar Bay was also recognized as Critical Habitat by Eisemberg et al. (2014, in Trainor 2016) because it is a highly threatened ecosystem in Timor-Leste, with loss of about 80% of mangrove cover since 1940 (Bogg et al. 2009). Globally, mangroves are also identified by Martin et al. (2015) as likely to represent Critical Habitat. Unlike Tibar Bay, however, the Project AoA does not contain any significant stands of mangroves.

Seagrass in the Project marine AoA is sparse and limited in extent (Appendix A). As such, and given presence of extensive seagrass elsewhere in Timor-Leste and neighboring Indonesia, seagrass in the Project AoA does not qualify the area as Critical Habitat.

Martin et al. (2015) considered coral reefs globally to comprise “Likely Critical Habitat”. Lovell & Pilgrim (2021: Appendix A) confirmed that the extent, diversity, quality and – particularly – unusual structure and composition of the soft coral-dominated reef in Tasitolu Bay are sufficiently significant to be considered Critical Habitat. Although Timor-Leste has extensive high-quality coral reefs, particularly in the north-east (Turak & DeVantier 2012), and does have other soft coral-dominated reefs, these remain globally and regionally uncommon.

The **soft coral-dominated reef in Tasitolu Bay qualifies the Project area as Critical Habitat**.

**B.2.5 Areas having biodiversity of significant social, economic, or cultural importance to local communities (including ecosystem services)**

Nippon Koei (2019a) briefly mention potential Project impacts on fisheries. Otherwise, available Project documents present very little information on ecosystem services. It is beyond the scope of this assessment to collect additional information on ecosystem services, and then to assess which may qualify the project area as Critical Habitat.

Opportunistic observations during recent surveys (Lovell & Pilgrim 2021 [Appendix A]; Pilgrim 2020c [Appendix D]) suggest that small-scale inshore coastal and – to a lesser extent – freshwater fisheries
are of importance to some local people, but that terrestrial biodiversity in the Project area is limited and not of significant importance to local livelihoods.

**B.2.6 Legally protected areas and international recognized areas**

There is one protected area in the vicinity of the Project – Lagao Tasitolu Peace Park – and one proposed marine protected area - Behau (Figure B1). Lagao Tasitolu is a 378 ha protected area, designated in 2002 and focused upon three saline lakes. Although designated for its cultural and historical importance, it does have biodiversity value (BirdLife 2002b). The status of Behau is unclear – it appears to have been proposed for protection in 2008 by the national government (Protected Planet 2020), but may actually instead represent a locally-managed marine protected area (Piludu 2019). This site is not currently considered to overlap the Project AoA.

The ADB SPS (2009) states that ‘Critical habitats include those areas either legally protected or officially proposed for protection’. IFC guidance (2019) states that ‘Certain internationally recognized areas of high biodiversity value may be recognized as critical habitats...[e.g.] Areas that meet the criteria of the IUCN’s Protected Area Categories Ia, Ib and II’. As the Lagao Tasitolu Peace Park was not designated for biodiversity reasons, and does not appear to have biodiversity values of international importance (per IFC 2019), it does not appear appropriate to consider it Critical Habitat.

The Tasitolu IBA does not appear to qualify as Critical Habitat (Section B.2.2) per IFC (2019). Likewise, the Perairan Tasitolu KBA does not appear to qualify as Critical Habitat (Section B.2.1).

**B.2.7 Summary**

The terrestrial Area of Analysis does not appear to contain Critical Habitat. The marine Area of Analysis qualifies as Critical Habitat owing to the presence of significant areas of high quality coral reef.

**B.3 Assessment of Natural Habitat**

Terrestrial habitats within the AoI are extensively Modified (Pilgrim 2020b). Areas within the airport fence are mostly grassy. The area surrounding the airport is grassy (to the south, next to the main entrance) or mostly houses and accompanying home gardens (bananas, papaya, maize, coconuts, etc.). Within the direct impact zone, only the beach could be considered broadly Natural, but is already somewhat disturbed by human activity and does not appear to have any significant biodiversity values.

The substrate underwater at the end of the current runway – and up to at least 500 m to the east and west – is comprised of loose stones and gravel, merging to finer sand and silt at greater depth, with scattered small coral outcrops (Appendix A). This is a Natural Habitat, albeit of limited biodiversity value. Likewise, marine areas to the east and west of the Project represent Natural Habitat (Figure B2). In only a handful of very limited locations, e.g., near to a drain at the eastern side of Tasitolu Bay, is the inshore area sufficiently affected by land-based impacts to represent Modified Habitat (Figure B2).
Figure B2. Coarse-scale marine habitat map of the Project vicinity, showing Natural, Modified and Critical Habitat.

Imagery Sources: Esri; Protected Area and Key Biodiversity Area data downloaded from the Integrated Biodiversity Assessment Tool (IBAT). Provided by BirdLife International, Conservation International, IUCN and UNEP-WCMC.
Appendix C. Targeted stakeholder consultations

In addition to meetings listed below, we also met several times with Airports and Air Navigation of Timor-Leste (ANATL) as part of an airport wildlife hazard assessment (Pilgrim 2020c), and attempted to meet with some other organizations. Unfortunately, the global response to the COVID-19 crisis curtailed our mission before some meetings could take place, and so two consultations occurred electronically (10 & 11 below). It has not, however, been possible to establish contact with two relevant non-governmental organizations: Conservation International and Haburas Foundation. The former has previously been consulted on this Project by Nippon-Koei (2019a), who state that ‘They object to reclamation work in Tasi Tolu because of poor control measures of soil and sediment in any construction work in Timor-Leste. If the airport runway is constructed by jetty structure, enough buffer zone should be secured between construction area and dugong’s habitat.’

1. Kick-off meeting, 12 March 2020

   **Attendees:**
   1. Mr José Abel, Adviser to Ministry of Finance (MoF); President of Technical Working Group for Dili Airport Upgrading Project (TWG);
   2. Mr Romualdo da Silva, President of ANATL; Vice President of TWG;
   3. Mr Armando da Silva, Civil Aviation Authority of Timor-Leste (ACCTL), TWG member;
   4. Mr Jondino da Costa, Project Coordinator, Major Project Secretariat, TWG member;
   5. Mr Sabino Henriques, Technical Adviser to ANATL;
   6. Mr Dominos Ximenes, Adviser to AACTL;
   7. Ms Antonia de Oliveira, Director of Infrastructure, ANATL;
   8. Mr Pedro Aquino, Senior Project Officer (Infrastructure), Timor-Leste Resident Mission, ADB;
   9. Mr Edward Lovell, consultancy team;
   10. Mr John Pilgrim, consultancy team.

   **Summary of discussions:**

   JP outlined the work to be undertaken by the consultancy team, and how it fitted within the ADB process. Logistical arrangements for the work were discussed among attendees.

   A number of questions from the consultancy team were deferred to the Environment Department, which was not represented at the meeting.

   In terms of cumulative impacts, attendees highlighted the planned Pelican Paradise resort at Tasitolu, at which construction has just started. Construction is expected to take at least five years.

2. Informal discussion with local people, coast just west of airport, 12 March 2020

   **Attendees:**
   1. Family of three local residents;
   2. Mr Edward Lovell, consultancy team;
   3. Mr John Pilgrim, consultancy team.
**Summary of discussions:**
A few Dugong occur towards Tasitolu Bay where there is more seagrass, not near the airport. There are few turtles seen in the area.

3. **Aquatica (dive company), 14 March 2020**

*Attendees:*
1. Mr Desmond Lee, Owner, Aquatica;
2. Mr Edward Lovell, consultancy team;
3. Mr John Pilgrim, consultancy team.

*Summary of discussions:*
A few Dugong regularly occur west of the airport, near Tasitolu, but probably travel back and forth past the airport towards Dili Bay. Turtles are not regularly seen around Dili.

There is little seagrass or coral near the airport.

4. **Dive Timor Lorosae (dive company) meeting, 14 March 2020**

*Attendees:*
1. Ms Kate Barker, Instructor, Dive Timor Lorosae;
2. Mr Edward Lovell, consultancy team;
3. Mr John Pilgrim, consultancy team.

*Summary of discussions:*
Up to three Dugong regularly occur at Tasitolu Bay; they appear to be resident. Turtles are not regularly seen around Dili.

There is little coral or seagrass near the airport. The next significant habitat to the east is extensive seagrass in Dili Bay, and then coral either side of Cristo Rei (further east).

The discharge pipe at the east end of Tasitolu Bay has recently been completed, and is having a negative effect on coral.

5. **Compass Diving (dive company) meeting, 16 March 2020**

*Attendees:*
1. Mr Cássio Schumacher, Compass Diving;
2. Mr Edward Lovell, consultancy team;
3. Mr John Pilgrim, consultancy team.

*Summary of discussions:*
There may be only one Dugong regularly at Tasitolu, and it may travel back and forth to Atauro. The only significant population they are aware of is much further east at Com.

The “muck diving” at Tasitolu, from 5 m depth, is world class owing to ease of access and good diversity of uncommon species. However, muck diving is very much an emerging hobby, and so there could be many similar sites.
The soft coral in Tasitolu Bay is good, but more extensive areas of this habitat occur further east along the coast (towards the east of the country). There is little coral or seagrass between the airport and the pinnacle just off Dili (where there is some coral). Either side of Cristo Rei (further east), there is good coral, though more on the east side.

6. Informal discussion with local people, just east of Tasitolu Beach, 16 March 2020

Attendees:
1. Six local residents;
2. Mr John Pilgrim, consultancy team.

Summary of discussions:
The people living in the area between the airport and Tasitolu Bay are not local, but come from all over Timor-Leste (one of the residents was originally from Indonesia, with a Timorese wife). People living in this area mainly come from inland and don’t have the skills or experience of fishing. Most fishing in this area is carried out by people from Atauro Island, who regularly visit.

Dugong regularly occur offshore in this area (one was showing repeatedly during this discussion) and towards Tasitolu Beach, but not towards the airport. They are not aware of turtles from this area.

7. Informal discussion with local person, just east of Tasitolu Beach, 16 March 2020

Attendees:
1. A spear fisherman from Atauro Island;
2. Mr John Pilgrim, consultancy team.

Summary of discussions:
Only relatively small fish occur in the area between the airport and Tasitolu Bay. Dugong occur offshore in this area. He was not aware of turtles from this area.

8. Informal discussion with local person, Tasitolu Beach, 17 March 2020

Attendees:
1. Local hand cast net fisherman;
2. Mr John Pilgrim, consultancy team.

Summary of discussions:
Only relatively small fish occur in the area between the airport and Tasitolu Bay. He was not familiar with Dugong. He stated that turtles nest on this beach and nearby. Owing to language difficulties, this discussion was unclear, but this local person appeared less familiar with local wildlife than other local people interviewed. It is possible that his comment on turtles was based not on first-hand knowledge, but instead on a signboard on the beach which forbids the collection of turtle eggs.

9. La’o Hamutuk (non-governmental organization) meeting, 17 March 2020

Attendees:
1. Adilson da Costa, La’o Hamutuk;
2. Febe Gom ez, La’o Hamutuk;
3. Bree Ahrens, La’o Hamutuk;
4. Mr John Pilgrim, consultancy team.

**Summary of discussions:**

La’o Hamutuk was established in 2000, focusing on transparency in international aid. In 2004, as the country started to receive revenues from oil and gas, La’o Hamutuk also started focusing on government policy advocacy and monitoring. They focus on five main areas: economy and finance; land rights and sustainable agriculture; megaprojects, environmental issues and governance; natural resources; and human rights.

Their main concern was that, despite some good national and international regulations, implementation in Timor is often weak, and enforcement capacity (e.g., from the Environment Department) is very low. They cited, as an example, the recent (ADB-funded) improvement of the Dili-Liquica road which runs just inland from Tasitolu Beach, with allegations of no dust control and significant (anecdotal) impacts on coral reefs\(^6\), and poor maintenance after completion of construction. A large drainage channel in the east of Tasitolu Bay runs under the road, was reportedly recently constructed, and appears to have significantly degraded the coral reef near its outlet\(^7\). Owing to the timing of construction, L’ao Hamutuk associate this drainage channel with the Dili-Liquica road project, but its association remains unclear.

Specific concerns about this Project were related to impacts on fisheries, noise and air pollution, increased road traffic during construction and operation, and resettlement. Other concerns were raised about secondary impacts from contractor influx (likely from Indonesia or People’s Republic of China) and impacts from rock/aggregate mining from the coast and rivers in Timor-Leste (including concern that the mining industry in Timor-Leste employs a lot of children). It was considered that most major quarry materials would come from Indonesia, as only a couple of quarries are currently operational in Timor-Leste and are mainly export-oriented.

A strong request was made for regular information sharing about the Project with local communities, including environmental impact statements and environmental management plans to be translated (to Tetun) and considerably simplified (since few technical terms exist in Tetun anyway). Discussion was had on the potential for graphical information boards in affected communities.

10. Biodiversity Department discussion, 25 August 2020

**Participants:**

1. Martinha Amaral, on behalf of Rui dos Reis Pires, Director of Biodiversity, National Environmental Licensing Agency, [Agência Nacional de Licenciamento Ambiental (ANLA)];
2. Mr John Pilgrim, consultancy team.

**Summary of discussions:**

The Director explained that the Biodiversity Law is only currently at a general level, and the Fisheries and Forestry Department under the Ministry of Agriculture and Fisheries specifically manage marine

\(^6\) No significant impacts across the reef in Tasitolu Bay were identified during our surveys.
\(^7\) Confirmed during our surveys.
biodiversity. He also clarified his interpretation that developments will necessarily impact natural resources, but that these impacts should be mitigated.

**11. Fisheries Department meeting, 4 December 2020**

*Attendees:*
1. Mr Celestino Da Cunha Barreta, National Director of Fisheries and Aquaculture;
2. Mr John Pilgrim, consultancy team;
3. Mr Pedro Aquino, ADB;
4. Mr Nurlan Djenchuraev, ADB.

*Summary of discussions:*
It was explained that all coral (reefs and small outcrops) were protected by law, but that the expectation was not total protection but mitigation from impacts. A similar expectation was expressed regarding prohibitions on harm or disturbance to protected species. Regarding the marine component of Lagao Tasitolu Peace Park, it was explained that there were currently no restrictions on use of this area (though that may change in future).
Appendix D. Summary of Wildlife Hazard Assessment

This summary is adapted from Pilgrim (2020c).

D.1 Executive Summary

This study relates specifically to expansion of the Presidente Nicolau Lobato International Airport (PNLIA) (“the Project”) runway, and some associated modifications to airport buildings and infrastructure. The Asian Development Bank (ADB) is considering financing the Project.

This report follows on from a Site Verification Report (Pilgrim 2020b), in order to provide an assessment of wildlife hazards, current and planned wildlife hazard management, and opportunities for improvement. Wildlife hazards at this site – in the broad sense – particularly comprise birds, but also some domestic mammals. There are no marine wildlife hazards.

As noted by Pilgrim (2020a,b), Project wildlife hazards are not primarily a biodiversity issue – none of the likely affected species are sufficiently rare or likely to be affected in sufficiently high numbers to be of conservation concern. Nonetheless, wildlife hazards are a significant safety concern.

A number of bird collisions have been recorded at the airport, and other risks identified. Collisions related to birds at the airport are considered likely, but severe damage unlikely owing to the small size of most species at the airport (Sections D.4.2 and D.6.2.1). Conversely, collisions away from the airport are less likely, but severe damage more likely if they occur (Sections D.4.3 and D.6.2.1). Waterbirds moving to and from Tasitolu lakes present the biggest collision risk away from the airport.

The airport has an approved wildlife hazard management plan (Section D.5.1). This is largely appropriate for the airport’s context, though could be improved in a few areas. In particular, consideration should be given to ensuring approach/take-off trajectories to the west of the airport are sufficiently steep to avoid major bird flight paths, and to preventing or limiting flights during very restricted times of day (about four hours in total, near sunrise and before sunset) that appear to present much higher collision risks.

There has, however, been no significant implementation of the plan to date, owing to capacity and budget constraints (Section D.6.1).

A number of identified collision risks can be expected to increase as a result of the Project (Section D.4.5). For example, annual air traffic movements are anticipated to double by about 2045. Without implementation of the airport’s wildlife hazard management plan, collision risks could be expected to increase proportionate to flight frequency. With implementation of the plan, risks would increase at a lower rate or – more likely – only increase after an immediate and substantial drop in risks owing to implementation of systematic tailored habitat management and other measures.

This report contains a first draft collision risk evaluation in order to prioritize implementation (Section D.6.2.1). Despite capacity and budget constraints, key areas of the current plan could be quickly and effectively initiated. Significant progress could readily be made in recording wildlife hazards, systematically displacing identified hazards, integrating wildlife hazard management into ongoing vegetation management, and systematically recording collision and near-miss incidents (Section D.6.2). Operationalization of the wildlife management plan in this way is an urgent priority.
D.2 Introduction

D.2.1 Purpose and objectives

This study relates specifically to expansion of the Presidente Nicolau Lobato International Airport (PNLIA) (“the Project”) runway to 2,100 m, and some associated modifications to airport buildings and infrastructure. The Asian Development Bank (ADB) is considering financing the Project. ADB financing will be for the 2,100 m phase, which is thus the focus of this study.

Under the ADB Safeguard Policy Statement (SPS: ADB 2009), this is likely to be identified as a Category A project because it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented, and may affect an area larger than the project footprint. As such, it is subject to an Environmental Impact Assessment (EIA).

Previous assessments have noted the potential for bird collision risks at the site, without collecting any primary data on the reality or scale of those risks (e.g., Nippon Koei 2019a,b). A Site Verification Report (Pilgrim 2020b) noted reports of several previous bird collisions with aircraft at the Project site, and presence of a wildlife hazard management plan. Given these, ADB required more detailed assessment of current wildlife hazards, potential impacts of airport expansion on future wildlife hazards, documentation of the current wildlife hazard management plan and its implementation status, and recommendations for improvement of the plan. This document provides that assessment.

D.2.2 Project area

For context, Figure D1 shows key sites discussed in this report.

![Figure D1. Project area, showing key sites mentioned in this report.](image)

The Project Area of Influence (AoI) is the broadest realistic area in which the Project may have significant impacts – here, specifically impacts upon biodiversity. The AoI is first identified here based on the 2,100 m phase, since that is the forthcoming programmed phase.
Pilgrim (2020a) preliminarily identified a terrestrial AoI extending east to beyond the Comoro River (to the extent of the DNL 55 noise model), and west and south-west to include the Lagao Tasitolu Peace Park. Bird collisions with aircraft may occur outside of this AoI, realistically up to c. 2-3 km from the airport in the zone where aircraft remain at relatively low altitudes during take-off or landing (Section D.4.3). Such hazards are very important from a safety perspective but will be very rare and, in terms of biodiversity, are thus extremely unlikely to result in any significant impact. It is thus not appropriate to extend the AoI further from the airport to encompass bird collision risks.

Further noise modelling, bathymetric studies and hydrological/current models will be necessary to understand the precise extent of possible Project impacts and thus to refine the Project AoI for the 2,100 m phase. Such studies and modelling should be undertaken during the full Project Environmental Impact Assessment.

D.2.3 Future phases

In the future, larger AoIs will need to be identified for the 2,500 m phases. For biodiversity, these will mostly differ in the marine realm (Pilgrim 2020a). This is because these next two phases largely differ in their further extension of the runway into the sea, with concomitant potential for westwards extension of direct habitat loss and noise, and (potentially much more significant) modification of marine flows, sediment transfer and biodiversity movements to the west and east. On land, there are not likely to be any significant differences between phases in area or scale of biodiversity impacts; the layout is similar for all phases, and any increased terrestrial noise impacts to the east will affect the town of Dili (containing no significant biodiversity).

Further noise modelling, bathymetric studies and hydrological/current models will be necessary to understand the precise extent of possible Project impacts in future phases and thus to identify appropriate Project AoIs for future phases. Such studies and modelling should be undertaken during the full Project Environmental Impact Assessment.

D.3 Assessment methods

Pilgrim (2020a) clarified that no terrestrial biodiversity, including birds, qualify the Project area as Critical Habitat. Pilgrim (2020a) and Lovell & Pilgrim (2021: Appendix A) identify coral reef Critical Habitat in Tasitolu Bay, but this does not present a direct wildlife hazard to aircraft operations. Nonetheless, Pilgrim (2020b) identified regular bird movements to/from the Lagao Tasitolu Peace Park, and records of bird collisions with aircraft at the Project site. This wildlife hazard assessment thus focuses on:

(i) Potential for bird collisions: identification of major bird flight paths; timings of frequent flight; species involved; and potential for interaction with aircraft flight paths;

(ii) Management of wildlife hazards: documentation of the current airport wildlife hazard management plan; discussion of its current status with staff from the Administration of Airports and Air Navigation of Timor-Leste (ANATL) staff; and identification of areas for improvement.

Assessment of the potential for bird collisions included consideration of existing data (from published and grey literature, as well as www.eBird.org) and direct surveys during an in-country mission led by John Pilgrim, with support from Edward Lovell in March 2020.

Assessment of wildlife hazard management relied on existing documentation (particularly the current airport wildlife hazard management plan: ANATL 2018), discussion with ANATL staff (primarily Mr. Sabino Henriques, nominated by ANATL to discuss these issues), and review against
international best practice. ANATL is responsible for airports and air navigation nationally, with staff stationed around the country but with nationally-focused staff based at PNLIA. Stakeholder discussions did not raise issues of wildlife hazards, so are instead documented in Appendix A.

**D.4 Potential for wildlife hazards**

**D.4.1 Introduction**

Data from other countries demonstrate the potential risk to aviation in Timor-Leste from wildlife collisions. For example, in the USA, nearly 120,000 wildlife collisions were reported from 1990-2011, causing damage totaling c.$480 million (Airports Council International [ACI] 2013). Since 1988, wildlife collisions have destroyed over 220 aircraft and resulted in the deaths of 231 people (ACI 2013). ANATL (2018) report the main wildlife safety risk in the Project area to be related to bird collisions.

Bird collision risks are highest for flocking species with low maneuverability, which are less able to avoid collisions. The severity of collisions is, unsurprisingly, related to bird weights, with species weighing >1.8 kg posing the greatest risk (ACI 2013). Dependent on the location at which birds strike aircraft, some collisions may cause little or no damage.

Globally, the majority of bird collisions occur at low altitudes, where aircraft and birds are most likely to interact. For example, American data show 92% of collisions to occur below 3000 ft (c. 900 m) above ground level, 74% to occur below 500 ft (c. 150 m), and 61% to occur below 100 ft (c. 30 m) (Cleary & Dolbeer 2005). As such, most bird collisions with aircraft occur during take-off and – particularly – landing. For example, American data show only 39% of collisions during take-off compared to 58% during landing (Cleary & Dolbeer 2005).

Given these global data, most bird collisions with aircraft using the Project site are anticipated to occur with species using the airport (Section D.4.2), with some others occurring owing to species using nearby areas (Section D.4.3).

**D.4.2 Bird collision risks at the airport**

No systematic records have been kept of bird collisions with aircraft at the Project site. Information was thus compiled from incomplete paper records and discussions with ANATL staff at PNLIA (Table D1). As these data are partly from memory, they are incomplete. Based on the information available, it appears that approximately six bird-aircraft collisions may have occurred between about 2014 and the time of this survey. As far as staff were aware, all collisions occurred during landing rather than take-off, and most occurred in the morning. The latter information is, however, biased by the fact that most flights to/from the airport are in the morning. Airport staff stated that any obvious presence of bird risks before take-off was notified to the control tower by pilots, and airport staff then sent to the runway area to clear birds (S. Henriques, ANATL pers. comm. 2020). This may partially explain the absence of collisions during take-off, though global data also show greater collision risk during landing (Section D.4.1).

While data on bird collisions and overall air traffic volumes are limited, the number of collisions per flight appear broadly in line with data elsewhere (Pilgrim 2020b). There is thus no reason to suspect – despite limited current wildlife hazard management – that this airport is a particularly high (or low) risk facility.
Table D1. Compiled information on collisions between birds and aircraft at the Project site.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Airline</th>
<th>Aircraft</th>
<th>Landing/ Take-off</th>
<th>Species</th>
<th>Number</th>
<th>Damage</th>
<th>Airport location</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/8/2018</td>
<td>am</td>
<td>Airnorth</td>
<td>?</td>
<td>landing</td>
<td>Brahminy Kite</td>
<td>1</td>
<td>None</td>
<td>Runway 08 = 2E</td>
</tr>
<tr>
<td>May 2017</td>
<td>pm</td>
<td>Sriwijaya</td>
<td>737-800</td>
<td>landing</td>
<td>Australian Pratincole</td>
<td>1</td>
<td>Body near wing, no damage</td>
<td>7D; body found 4D</td>
</tr>
<tr>
<td>?</td>
<td>am?</td>
<td>Airnorth</td>
<td>Embraer 170</td>
<td>landing</td>
<td>?</td>
<td>?</td>
<td>None</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>am?</td>
<td>Airnorth</td>
<td>Embraer 120</td>
<td>landing</td>
<td>?</td>
<td>?</td>
<td>None</td>
<td>?</td>
</tr>
<tr>
<td>?</td>
<td>am?</td>
<td>Airnorth</td>
<td>Embraer 120</td>
<td>landing</td>
<td>?</td>
<td>?</td>
<td>Damage to wing; grounded for 2? days until mechanic could come to fix</td>
<td>?</td>
</tr>
<tr>
<td>2014 or earlier</td>
<td>am?</td>
<td>Silk Air</td>
<td>Airbus 319/320</td>
<td>landing</td>
<td>?</td>
<td>?</td>
<td>None</td>
<td>?</td>
</tr>
</tbody>
</table>

Other than wild birds, bird collision hazards at the airport are also presented by domestic pigeons (kept for food by residents of surrounding areas) and chickens (e.g., Figure D2). Chickens frequently stray onto airport property owing to the low height of the airport fence in some locations (e.g., Figure D3; c. 1 m height), and a state of disrepair in other locations.

The reasons for wild bird collisions at the airport are likely to be largely related to available bird habitats at or neighboring the site. On the positive side, the airport appears to have good drainage and so no significant permanent or temporary water bodies, which can otherwise attract birds. There are few trees or bushes on airport property near the runway, but a high cover of trees and bushes in nearby neighboring agricultural and village land (e.g., Figures D4 and D5). This provides habitat for a variety of bird species, being particularly important for nesting. The area surrounding the current airport runway largely comprises grass of varying heights (e.g., Figures D4 and D5).

Short grass is attractive to some bird species for feeding or, particularly, resting. Such species might include (seasonally) terns, Little Curlew *Numenius minutus*, larger plovers *Pluvialis* spp., Oriental Pratincole *Glareola maldivarum* and Australian Pratincole *Stiltia isabella*. The latter species has been involved in at least one collision with an aircraft at the Project site (Figure D6), and possibly more (Sabino Henriques, ANATL, pers. comm. 2020).

Long grass can produce seed (e.g., Figure D7), and thus food for granivorous bird species. Such species were consequently found in abundance on airport property, particularly munias *Lonchura* spp. and doves such as Barred Dove *Geopelia mauegeus*. An abundance of seed usually also attracts rodents. Plentiful small birds and rodents in turn attract predators. Of particular concern in this regard is Brahminy Kite *Haliastur indus*, which is regularly observed at the airport (pers. obs.; S. Henriques, ANATL, pers. comm. 2020) and has been involved in at least one collision with an aircraft at the Project site (Figure D8). Airport staff refer to these kites as “eagles” (e.g., S. Henriques, ANATL, pers. com. 2020; ANATL 2018).

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8 Per crash grid on page 6 of ANATL (2018).
Figure D2. Domestic chicken inside the airport property.

Figure D3. Only a low border fence (c. 1 m) to the airport is present in some locations.
Figure D4. Short and medium-length grass near the airport runway, and trees immediately adjacent to the airport property.

Figure D5. Long grass near the airport runway, and trees immediately adjacent to the airport property.
Figure D6. Australian Pratincole *Stiltia isabella*, after collision with an aircraft in 2017 (photo from airport archives).

Figure D7. Long grass producing an abundance of seed near the airport runway.
D.4.3 Bird collision risks near the airport

Bird collision risks are not limited to the airport itself, because some aircraft will remain in the high risk zone (Section D4.1) for some time after take-off and before landing. The duration for which aircraft remain in this zone is related to their angle of take-off or approach, respectively. These vary depending on factors such as individual aircraft design, load on a particular flight, and wind conditions. At or near take-off and landing, at slow speeds, the angle of commercial passenger aircraft is often steep (c. 5-15°). Higher angles are technically possible for most aircraft, but usually not necessary and can be uncomfortable for passengers. At extreme angles, aircraft may stall. Further from the runway, the angle is more often c. 2-5°.

Aircraft take-off and land at the Project site westwards and eastwards, dependent on wind direction at the time. Away from the immediate vicinity of the airport (Section D4.2), aircraft flight paths to the east pose limited bird collision risk. Trainor (2005) suggests ecological links between Tasitolu lakes and the Comoro River estuary (and Dili and Cristo Rei foreshore), but limited numbers of waterbirds have been recorded in these latter locations. Closest to the airport, the Comoro River is heavily disturbed by aggregate mining and fishing, and appears to hold only small numbers of waterbirds (e.g., data from eBird). After crossing this river, aircraft travel directly over part of Dili, before rising to the north of the coast in front of Dili (where few birds appear to regularly fly at any significant altitude). The main risk to the east is thus likely presented by domestic pigeons, which are commonly kept for food and fly in flocks over this area (thus presenting a higher-than-average collision risk).

Aircraft flight paths to the west of the Project site head towards a peninsula, between Dili Rock and Tibar Bay (Figure D9). This peninsula, though rising to only <150 m in elevation, poses a (perceived or actual) obstacle for waterbirds moving between Tasitolu lakes and Tibar Bay. These birds thus fly at elevations of 10-200 m parallel to the coast, before passing around the peninsula (Figure D9). During this study, these birds mostly comprised Little Black Cormorant Phalacrocorax sulcirostris, Little Pied Cormorant Microcarbo melanoleucos and Greater Crested Tern Thalasseus bergii. Up to 186 cormorants (the vast majority Little Black Cormorant) and 33 terns were recorded during this rapid assessment, but up to c. 350 Little Black Cormorant and c. 380 Greater Crested Tern have been
previously recorded at Tasitolu (Trainor 2005). The “seagulls” referred to in the wildlife hazard management plan are likely to represent Greater Crested Tern (gulls do not regularly occur in Timor-Leste) (Sabino Henriques, ANATL, pers. comm. 2020).

All of the cormorants roosted in Tibar Bay in the evening, and moved to Tasitolu to feed during the day, with some of the terns following a similar pattern and others roosting at Tasitolu. However, Trainor (2005) has also noted cormorants roosting at Tasitolu. When at Tibar, during this rapid assessment, the cormorants roosted mainly in mangroves in the south of Tibar Bay, while the terns roosted mainly on man-made structures in the bay. Timing of bird movements will vary seasonally, with varying daylight, but during this assessment there was a clear and concentrated pattern of early morning (0600-0700, with very limited additional movement until 0730) and late afternoon (1715-1815) movements to and from roosting and feeding areas. For comparison, the start of daylight during this period was at 0641-0642 and the end at 1852-1853\(^9\).

During this assessment, Great Crested Tern had less regular movements than the cormorants, moving back and forth between Tasitolu and Tibar, but also heading directly out to sea from Tasitolu, or along the coast past the airport (Figure D8). Movements of terns were, as with cormorants, concentrated into the same early and late periods, but terns also occasionally moved throughout the day.

![Figure D9. Map of Project area, showing illustrative regular flight paths of birds (in yellow) to and from Tasitolu lake to the north-west (cormorants and terns) and north and north-east (terns), crossing illustrative westwards aircraft flight paths (in red). Imagery Source: Google Earth.](image)

The distance from the western end of the runway and the peninsula to the west is just over 2.5 km. All other factors aside, an aircraft over this peninsula during take-off or landing could be at an elevation of <100 m at an angle of 2\(^\circ\). It is unlikely that an aircraft would fly so low over the peninsula but this illustrates the considerable potential for interaction with bird flight paths in this area.

Despite the focus above on the three most common and mobile species observed during this rapid assessment, Tasitolu Lakes holds the most diverse waterbird assemblage in Timor-Leste (Trainor 2005).

\(^9\) Per [https://www.timeanddate.com](https://www.timeanddate.com).
This changes seasonally, both in species composition and abundance, with Trainor (2011) showing mean counts of shorebirds (not systematically censused during this rapid assessment) to peak in September-March at >150 individuals (up to 345 individuals in December 2003), declining in April-August to c. 25-85 individuals. Most, though not all, shorebirds occur in relatively low numbers, are relatively small, and are unlikely to cross aircraft flight paths regularly. Exceptions particularly include species that prefer short grass habitats which may be present on airfields (Section D4.2). Additional tern species are present at some times of year (Trainor 2011), with Little Tern *Sternula albifrons* and Gull-billed Tern *Gelochelidon nilotica* potentially flying past the airport, as are Australian Pelican *Pelecanus conspicillatus*. This latter species is heavy, flies in flocks, and has low maneuverability, so is potentially a significant collision risk for aircraft. Although only up to 29 were recorded at Tasitolu lakes during this rapid assessment, up to 123 have been previously recorded there (pers. obs.). Nonetheless, during this assessment, this species was not seen to undertake any movements away from Tasitolu lakes, so risks may ultimately be low.

In the longer term, it is worth noting that there are plans to build the Pelican Paradise resort and golf course around the Tasitolu Lakes area (ASPEC 2018), a development which is likely to reduce waterbird populations.

### D.4.4 Non-bird collision risks

Other natural collision hazards at the airport are presented by domestic animals entering the airport property, from neighboring village and agricultural areas. Dogs and goats regularly enter the property, and pigs are occasionally found there (S. Henriques, ANATL, pers. comm. 2020). This is not surprising, given the low height of the airport fence in some locations (e.g., Figure D3, c. 1 m height), and a state of disrepair in other locations.

### D.4.5 Increased collision risks owing to the Project

The main aspects of the Project which may alter collision risks (all of which have the potential to increase risks) are:

1. Extension of the runway into the sea, causing seabirds and shorebirds to divert around or over the end of the runway when following the coast;
2. Increased air transport movements, with growth predicted from 1.8-2.9% per annum (Landrum & Brown 2020);
3. A shift towards larger and heavier aircraft.

In relation to collision risks, the only one of these aspects which is readily quantifiable is increased annual air transport movements. These are, for example, anticipated to double by about 2045 (Landrum & Brown 2020). Without implementation of the airport’s wildlife hazard management plan, collision risks could be expected to increase proportionate to flight frequency. With implementation of the plan, risks would increase at a lower rate or – more likely – only do so after an immediate and substantial drop in risks owing to implementation of systematic tailored habitat management and other measures.

### D.5 Wildlife hazard management planning

#### D.5.1 Current status

Dili airport has a wildlife hazard management plan (ANATL 2018) which, at the time of this study, had been approved for about a year and a half. This plan was apparently developed by an international
consultant, as part of the requirements for certification of the airport (S. Henriques, ANATL, pers. comm. 2020).

The current plan covers key areas that would be expected (e.g., Cleary & Dolbeer 2005; ACI 2013), including a risk assessment, description of record keeping, documentation of responsibilities, identification of a staff training program, and outlining planned risk management in terms of manipulating habitats, actively deterring wildlife, and – as a last resort – removing wildlife. In general, the plan is well designed, appropriate to the airport and, if followed, could effectively manage wildlife hazards. Only a few significant areas require modification (Sections D.5.2.1-5.2.6). A few additional minor statements in the plan could usefully be changed (Section D.5.2.7).

All wildlife hazard management is about risk reduction, rather than risk elimination. When implemented, the actions in the current management plan (ANATL 2018) and below (Section D.5.2) should be sufficient to reduce risks to an acceptable level. Other actions may reduce risk further, but not be viable or cost-effective. For example, there has been discussion of management of vegetation outside the airport boundary in order to reduce wildlife hazards, but this is not realistic without purchase of that land or payment of compensation as it will impact local communities (e.g., through cutting of shade or fruit trees). As such, this is not a practical cost-effective measure.

D.5.2 Recommendations

D.5.2.1 Airport perimeter fence

The current fence around the airport perimeter is in some disrepair, and only c.1 m tall in places. The current wildlife hazard management plan needs to be edited to reflect this current situation (Section D.5.2.7). Instead, the wildlife hazard management plan should contain a specific action to install a wildlife-proof fence, of ≥2 m in height, around the airport perimeter.

D.5.2.2 Handling of domestic mammal incursions

There is a need to align the wildlife hazard management plan and current practice with regard to handling of domestic dog, goat and pig incursion (e.g., Section D.7.1.5.2 of ANATL 2018 states that best efforts will be made to return these animals to their owners) and the use of lethal control (e.g., Section 7.1.8 of ANATL 2018 states lethal control is only a last resort). At present, domestic mammal incursions are dealt with lethally by military police stationed at the airport using their guns (Sabino Henriques, ANATL, pers. comm. 2020). This may, or may not, be the most appropriate approach for the local context – whatever is the case, practice and the plan need to be brought into alignment.

D.5.2.3 Trapping and translocation of raptors

The management plan discusses raptor trapping and translocation as a management option (Section 7.1.6 of ANATL 2018). While recognizing that some larger raptors do pose a significant collision risk at the airport (Figure D8), they are protected under national law (Government of Timor-Leste 2020) and safe trapping of raptors is a specialized skill which is not likely to currently exist in Timor-Leste. Further, translocation of raptors is only likely to be effective for sub-adult birds – most adult raptors (including the key risk species here, Brahminy Kite) are territorial and can move long distances to return to their territories if moved away from them (Cleary & Dolbeer 2005). Even if that is not the case, vacant territories are likely to be rapidly filled by other individuals (DeVault et al. 2013). Realistically, trapping and translocation of raptors is thus not a viable management option at present. It is recommended that this section be removed from the current management plan.
D.5.2.4 Avian nest intervention

Section 7.1.7 of the management plan (ANATL 2018) suggests manipulation of raptor nests and removal of waterfowl eggs or nests. It is unclear what type of manipulation of raptor nests is intended, but removal of their eggs or nests is supported by the risks posed to both aircraft and raptors by regular presence at the Project site. Nonetheless, these species are nationally protected (Government of Timor-Leste 2020) so best efforts should first be made to dissuade nesting, and permits sought for any egg/nest removal. It is also unclear which waterfowl may attempt to nest at the airport, given that the ‘seagulls and geese’ mentioned do not regularly occur in Timor-Leste. However, as with raptors, removal of eggs or nests of any large birds is supported, subject again to the proviso that some such species are nationally protected (Government of Timor-Leste 2020) so best efforts should first be made to dissuade nesting, and permits sought for any egg/nest removal.

D.5.2.5 Time of day of operations

There is currently no discussion in the wildlife hazard management plan of time of day of operations. It is understood that Garuda Indonesia has requested use of the airport at night, which has not been possible owing to the lack of appropriate lighting (Sabino Henriques, ANATL, pers. comm. 2020), and the master plan (Landrum & Brown 2020) includes lighting which has the potential to allow early, late and night-time operations.

Currently, the airport is only operational during the day, and the number of commercial flights is limited. Even with projected increases in air traffic (Section D.4.5) after the Project, the total number of flights will be limited for some time in comparison to the overall capacity of the airport. Unlike some airports, this gives an opportunity to limit flights to times of the day outside those with the highest bird collision risks. At least according to observations during this rapid assessment, times of significant movement of large birds are very limited (Section D.4.3), to an hour near sunrise and an hour a little while before sunset. Bird movements at the airport itself are also generally likely to be highest in the earliest and latest hours of daylight. Avoiding – or at least limiting as much as possible – flights during these times would significantly reduce risks of serious collisions, particularly in combination with restrictions on aircraft flight height near major bird flight paths (Section D.5.2.6).

As Dili is close to the Equator, the annual range of sunrise/sunset times is limited. The start of daylight ranges from 0607-0653 and the end from 1824-1905\(^{10}\), i.e. a range of ≤47 minutes throughout the year. Although knowledge of bird movements near the Project site is incomplete, there is consequently no reason to expect substantially varied timing of these movements through the year. Sunrise/sunset-adapted airport operations times could be used through the year, but these are likely to cause confusion as flight schedules do not usually vary throughout the year. As such, fixed time restrictions are likely to be simpler and more effective. Risks of aircraft collisions with birds could be substantially lowered if there were no flights between 0515-0730 and 1630-1815. This is a loss of four hours of flights per day, which should pose no significant constraint in the near future. In the long term, complete avoidance of these time periods may not be viable, but these should remain priority times to avoid flights when feasible.

D.5.2.6 Approach/take-off trajectory

Collision risks away from the airport remain largely theoretical (Section D.4.3) because ANATL were not able to comment on the range of trajectories taken by aircraft when approaching or departing

\(^{10}\) Per https://www.timeanddate.com.
west of the airport. Discussions on this matter with airlines and pilots using the airport were not possible because the in-country mission was curtailed.

Observations during this study suggest that there is no reason, under normal weather conditions, for aircraft not to rise steeply enough to reduce the potential for any collisions with bird flight paths near the peninsula to the west. A consistent 7° trajectory is well within aircraft comfort zones (Section D.4.3) and would ensure aircraft are at >300 m above sea level at the peninsula, thus avoiding all observed bird flight paths there during this assessment. Airport regulations could easily require aircraft to reach a certain altitude (e.g., 300 m) before the peninsula. This would not eliminate risks, as a few bird flight paths more closely approach the airport, but would drastically reduce them – particularly in combination with restrictions on time of day of operations (Section D.5.2.5).

D.5.2.7 Additional minor changes

A few minor statements in the current plan could usefully be changed to reflect the current situation or improve the plan (Table D2).

Table D2. Minor recommended changes to text of current wildlife hazard management plan.

<table>
<thead>
<tr>
<th>Section</th>
<th>Current text</th>
<th>Proposed text revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>A 2.4 m high security fence surrounds the entire airfield.</td>
<td>A security fence, of c. 1-2.4 m, surrounds the entire airfield.</td>
</tr>
<tr>
<td>2</td>
<td>...foraging opportunities for raptors (e.g. eagles)...</td>
<td>...foraging opportunities for raptors (e.g. kites)...</td>
</tr>
<tr>
<td>2</td>
<td>...due to the vicinity of the sea the seagulls are often seen at PNLIA.</td>
<td>...due to the vicinity of the sea, terns are often seen at PNLIA.</td>
</tr>
<tr>
<td>7.4</td>
<td>...mowing itself can serve as an attractant... because food sources such as insects, seeds and small mammals become more readily available during and immediately after cutting.</td>
<td>Insert additional sentence after this text: For this reason, grass cuttings should be removed and disposed of immediately after mowing.11</td>
</tr>
</tbody>
</table>

D.6 Wildlife hazard management implementation

D.6.1 Current status

To date, there does not appear to have been any significant implementation of the plan – at least no significant change over pre-existing practices. For example, the initial risk evaluation process (Section 6.1 of ANATL 2018) has not yet been designed or implemented, and basic procedures such as recording of wildlife data as part of daily runway checks (Section 7.1.3 of ANATL 2018) are not yet undertaken.

Responsibilities for implementation of the plan are outlined in its Figure 1 (ANATL 2018). The PNLIA Director is Isolino Sarmento and the Chief of Airport Operations is José Perreira. The ANATL Wildlife

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11 The current wildlife hazard management plan (Appendix B) infers that grass will be cut to 15-30 cm height. This is appropriate to manage identified wildlife hazards at the Project site (Section 4.2), particularly the longer lengths within this range (Section 6.2.1). However, scientific knowledge on the best grass height to deter wildlife hazards will continue to improve, and so – as stated in the plan – the Aviation Wildlife Manager should continue to follow the most recent grass height studies and adapt cutting heights if necessary.
Manager is seen as a role within a position, rather than an entire position – it is a role that has been allocated to the airport Safety Manager, José Leon. The “PNLIA Wildlife staff” are also seen as roles for existing staff which have received appropriate wildlife hazard training.

Sabino Henriques has been brought back to ANATL (where he worked until 2016) from the Civil Aviation Authority (Autoridade da Aviação Civil de Timor-Leste; AACTL), as a Technical Advisor. He had only been in position for two weeks at the time of this assessment, so has not yet fully clarified the boundaries of his roles and responsibilities. Nonetheless, discussions during this assessment made clear that he saw one of his roles as operationalization of the wildlife hazard management plan (which he approved on behalf of AACTL while working there).

**D.6.1.1 Insufficient specific technical expertise**

Despite approval by both ANATL and AACTL, the current wildlife hazard management plan does not appear well understood by airport staff. Even those approving the plan have not fully read and understood the whole document.

Although allocated responsibility within the plan for technical guidance and operational direction of the wildlife hazard management program, the Safety Manager does not yet have the appropriate experience, training or technical expertise to be the technical area expert for this plan.

A training program for staff has been identified in the plan (Section 8 of ANATL 2018), but has not been initiated owing to lack of budget (Section D.6.1.4) and, perhaps, insufficient time from key staff to drive forwards basic training (Section D.6.1.2).

**D.6.1.2 Insufficient staff time**

It appears, but could not be confirmed, that the Safety Manager may not have had the time available – outside of other significant responsibilities – to move the plan from design to operation. This could potentially be remedied by substantial focus on operationalization of the plan by Sabino Henriques in the coming six to twelve months (see Section D.6.1).

**D.6.1.3 Insufficient equipment**

The plan notes a requirement for a set of appropriate equipment for management of wildlife hazards, including ‘vehicles should be equipped with a variety of hazing tools including but not necessarily limited to air horns, sirens, pyrotechnic devices, handheld lasers, and spotlights’ (Section 7.1.2 of ANATL 2018), hazing equipment such as ‘pyrotechnic devices (e.g., shell launching pistols), remote controlled propane cannons… visual deterrents (e.g. green laser), and paintball markers’ (Section 7.1.5 of ANATL 2018), and ‘nylon nets and perforated plastic shields’ (Annex 1, 2.2.4 of ANATL 2018).

At present, the only such equipment present at the airport – which is used at times to haze wildlife – comprises standard emergency sirens on vehicles and handguns belonging to airport police (which are occasionally shot into the air to scare wildlife away) (Sabino Henriques, ANATL, pers. comm. 2020). Other equipment has not been purchased owing to insufficient budget (Section D.6.1.4).

**D.6.1.4 Insufficient budget**

Budgets for wildlife hazard management training of staff or purchase of wildlife hazard management equipment should be proposed annually by the ANATL Wildlife Manager (= airport Safety Manager) to the PNLIA Director. No such budgets have yet been proposed because of perceived lack of availability and priority of funding within the overall airport budget (Sabino Henriques, ANATL, pers. comm. 2020). The airport budget has been extremely restricted owing to limited income – from
general landing fees, passenger service charges, check-in counter fees, etc. (Sabino Henriques, ANATL, pers. comm. 2020; Landrum & Brown 2020).

D.6.2 Recommendations

The airport’s wildlife hazard management plan is appropriate, but requires urgent implementation.

As wildlife hazard management is fundamentally a safety concern, it remains sensible that the airport Safety Manager retain oversight of this plan’s operationalization and operation. Given the Safety Manager’s other commitments, however, it may be appropriate for an additional staff person (such as Sabino Henriques) to first drive forward operationalization.

Implementation of some areas of the plan, such as those requiring purchase of equipment or specialist training, are currently constrained by budget. These areas might best be addressed by incorporation in Project plans and budget. Nonetheless, key areas of the current plan can be quickly and effectively initiated despite current constraints. These particularly comprise:

(i) A risk evaluation process to prioritize habitat management efforts (Section 4 of ANATL 2018) – see Section D.6.2.1 below;

(ii) Systematic recording of wildlife hazards, even if not identified to species owing to lack of staff training, during daily runway checks (Sections 7.1.3-7.1.4 of ANATL 2018);

(iii) Systematic hazing and harassment\(^\text{12}\) of recorded significant hazards (ii) using equipment and personnel currently available, however non-specialist (Section 7.1.5 of ANATL 2018);

(iv) Integrating wildlife hazard management into ongoing vegetation management (notably grass mowing) at the airport (Section 7.4 of ANATL 2018); and

(v) Systematic recording of collision and near-miss incidents (Section 7.1.4 of ANATL 2018).

D.6.2.1 Risk evaluation

As stated above, there is an urgent need to undertake the planned risk evaluation process (Section 6.1 of ANATL 2018), in order to prioritize habitat management efforts at the airport. ACI (2013: Sections D.3.1.1-3.1.4) gives good explanation of how to design and conduct a simple risk assessment. Since sufficient expertise does not currently exist within ANATL, that exercise is initiated here.

On the basis of the current rapid assessment, few heavy bird species are likely to interact with aircraft flight paths from the Project area. However, Little Black Cormorant and Little Pied Cormorant do pose a significant risk, given their regular flight paths, weight (c. 1 kg), flocking behavior, and relatively low maneuverability. Greater Crested Tern occurs closer to the Project area, but is much lighter (c. 340 g), occurs in smaller groups, and is much more maneuverable. Brahminy Kite also occurs on or over the Project area, has an intermediate weight (c. 600 g) and maneuverability, but only usually occurs singly. Other species regularly found on the airfield (Section D.4.2) can occur in large flocks, and thus have high strike probability, but are generally light (<100 g), and thus unlikely to cause severe strikes.

Based on survey findings and ACI (2013), an initial risk assessment matrix has been compiled (Figure D10). Prioritization of hazard management by way of such a matrix is critical: there are few universal habitat management measures that will deter all birds. For example, pratincoles prefer

\(^{12}\) i.e., where wildlife hazards are recorded on the airfield, they should be deterred and moved out of the area.
short grass; kites, doves and kestrels prefer intermediate length grass; and sparrows and munias prefer long grass. Understanding that the latter species present the lowest risks helps direct habitat management towards longer grass (i.e., closer to 30 cm, per Section 7.4 of ANATL 2018) to reduce overall risks (despite this being likely to increase munia and sparrow species, and thus potentially increase overall collisions).

This matrix is already sufficient to prioritize and design wildlife hazard management measures. It also, however, provides a framework into which ongoing monitoring results (Section 7.1.3 of ANATL 2018) can be included, to increase the robustness of risk assessment and wildlife hazard management over time.

<table>
<thead>
<tr>
<th>Probability of strikes</th>
<th>Severity of strikes</th>
<th>Catastrophic</th>
<th>Critical</th>
<th>Moderate</th>
<th>Minor</th>
<th>Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
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Figure D10. Initial draft risk assessment matrix for bird collisions at the Project site.