Ngesaol Road and Housing Development
Koror State

April 21, 2017

Ngesaol road, west end, showing Sngal Ridge in background, and taro gardens in foreground and mangroves to far right
August 3, 2016
Proposed Ngesaol Road
Koror State
The Environment, Inc.

August 4 2016

TEIPublication#080416

Prepared for:
Koror State Public Works
Koror, Palau
Koror, Palau 96940

Prepared by:
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1. Executive Summary

The Applicant, the Koror State Public Works, is a local State Government with extensive construction experience in Ngesaol Koror State. The Applicant plans to redesign and re-construct access roads in Ngesaol Koror State. The project will cover approximately 170,000 square meters of land in Ngesaol. The Goal of the project is to design and construct lease units and access roads for Ngesaol community that will provide the community with safe access to and from their homes and businesses. Furthermore, the project is designed to meet the housing needs crisis through displacement in Koror. The objectives are to meet all necessary requirements for an earthmoving permit from EQPB. The total project cost is dependent on supply cost and availability upon approval.

An estimated 117,850 cubic meters of fill will be used and approximately 8,800 cubic meters dredge will occur to re-establish mangrove channels. There are no plans to dispose materials or wastes on site. Any wastes will be taken to a designated site by Koror State. The area has been farmland, homestead and mangrove area and has an existing road. Approximately 75% of the project will be built on existing road. The site is bounded by an extensive mangrove forest to the north and south with wetlands and taro gardens along its immediate south. There is reclaimed reef along the alignment as well to the East and west with a large steep limestone ridge called Sngall Ridge to the south of the road. The potential value of this site if it was reforested and or maintained as mangroves and wetlands rather than developed over the next 99 years can be estimated using a value of wetlands at $25,681/ha/yr; mangroves at $193,843/ha/yr and urban area at 6,661/ha/yr (Costanza et al., 2017). If these values coincide with approximately 1.8ha of wetland and 2.7ha of mangroves the estimated ecosystem service value per year would be: 523,376.10 + 46,225.80 = 569,601.90/year versus the value of homes in new fill area and 29,974.50/year in ecosystem value of urban areas.

The Ngesaol road alignment transect through wetland and agroforest revealed over 146 species of plants from over 72 Families were found at or near the proposed road alignment including at least 103 native plants of which 16 are endemic native trees and shrubs and 43 introduced trees and shrubs along the alignment (Endemic means a plant is only found in Palau). A total of 572 trees representing 51 species were measured for diameter at breast height and heights measured along either side or proposed road alignment. The total volume of measured trees along the road alignment was 176.78m³. Fourteen species of trees represented 69% of all trees and shrubs measured and 92% of the total volume. Coconut, Cocos nucifera, mahogany, Swietenia macrophylla, mango, Mangifera indica and betelnut Areca catechu represented the top volume of biomass. The most common trees in along the proposed road alignment were Areca catechu, Cocos nucifera, banana, Musa sp. and Swietenia macrophylla. In 2017 an additional 66 mangrove trees were measured representing 5 species of mangroves within an area of 328 m² along the western end of the road by the main road. The mangrove trees covered a volume of 41.52m³. This is a mean volume of about 0.12 m³/m².

Over 100 birds were either seen or heard during January 25, 2016 morning count. During the 8 minute count a total of 128 birds were counted same morning count for an additional 7 minutes or a full 15 minute count, a total of 16 species of birds were either seen or heard, which is considered the threshold for concern. The birds seen or heard during the bird counts, terrestrial transects and walks through the site included the following five endemic species: the fruit dove, Ptilinopus pelewensis (biib), the fantail, Rhipura lepida (melimdelebdeb), the morning bird,
Colluricincla tenebrosa (tutau), and the white eye, Zosterops finscii (chetialial), and the swiftlet, Aerodramus pelewensis (chesisekiid). Four endemic subspecies: the honeyeater, Myzomela rubratra kobayashii, a kingfisher, Todiramphus chloris teraokai, the starlings- Aplonis opaca orii, and the Nicobar pigeon, Caloenas nicobarica pelewensis (laib). No endangered species were seen or heard on site however all the native birds are threatened by habitat loss. The Nicobar pigeon is a threatened species and was seen during this assessment. The team also observed the endemic fruit bat, Pteropus pelewensis and the Emballonura semicaudata (chesisualik). During April 11, 2017, 15 species of birds were counted during the 8 minute count and double the number of fruit doves (34) were counted for an additional 7 minutes. Therefore for both dates in 2016 and 2017 the number of bird species seen or heard was considered the threshold of concern.

Two community hearings were completed on June 25, 2016 and September 20, 2018 with KSPLA and KSG Public Works; concerns raised were mainly with safety of the community on the roads, preservation of land area for food security and cultural practices (especially the taro patches along the initial access road). There was hesitation about how much of property would be needed for the road expansion but most people present mentioned that they would be willing to give it up if it was for safety, especially sidewalks and bike paths. There was overall good community buy in on the project.
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3. Introduction

3.1 Identification of the Applicant
The Applicant Koror State Public Works is a local state government with extensive engineering and construction experience in Palau. The Applicant proposes to design the road and housing system covering a total area of approximately 170,000 m² on a land called Ngesaol: approximately 77,000 m² of new lots, 1,500 m² for playground, 9,000 m² of mangrove and wetland estuary, 82,500 m² for existing road and developed area. Additionally, approximately 8,800 m³ of mangrove channel dredge will occur to re-establish flow and offset fill volume and avoid inundation.

3.2 Identification of the Environmental Assessment Company that Prepared this EA
The Environment, Inc. was founded in 1993 by Clarence and Ann Kitalong. “The environment is our business.” Christopher Kitalong is a plant ecologist and chemist who research includes the terrestrial ecosystems of the Koror State Rock Islands. He has two MSc degrees and a PhD. Clarence is a fisherman, hunter, master diver, and overall naturalist of his islands. Clarence was a board member for the Palau Conservation Society. Ann is a biologist with a MSc degree in biology from the University of Guam, a MSc degree in zoology for the University of Hawaii, and a PhD in Business Management. Ann was coordinator for Reef Check in Palau and taught at the Palau Community College on a part-time basis. She has acted as special assistant to the Vice President of Palau and worked for the Office of Environmental Response and Coordination under the Office of the President as an assistant Environment Coordinator. This team has worked together in Palau, Guam, and Hawaii for more than 30 years. The goals of TEI are to understand natural and man-made changes to Palau’s surroundings, develop ways to optimize the use of its resources, and share our findings with others. To accomplish these goals, TEI assesses the environment, surveys and monitors Palau’s resources and conducts training workshops. TEI has helped develop National and State management plans in Palau. The Environment, Inc. (TEI) has worked on several major projects for fifteen years that reflect relevant corporate experience in environmental management and protection. The Environment, Inc. team has worked on both government and non-government projects in Palau. We are committed to economic development that is environmentally sound.

3.3 EA Process Documentation

Summary/Timetable of Activities Performed for the EA of the Project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meet with Koror State and conduct a site visit</td>
<td>December 2015</td>
</tr>
<tr>
<td>Meeting with EQPB</td>
<td>December 10, 2015</td>
</tr>
<tr>
<td>Qualitative walks at the site</td>
<td>January 25, 2016</td>
</tr>
<tr>
<td>Bird Count</td>
<td>January 25, 2016</td>
</tr>
<tr>
<td>Tree volume measurements along road alignment</td>
<td>December 2015- January 2016</td>
</tr>
<tr>
<td>Work with PALARIS on maps for vegetation, soil and buffer zones and contour maps.</td>
<td>January-February 2016</td>
</tr>
<tr>
<td>Interviews with community</td>
<td>June 2016</td>
</tr>
<tr>
<td>Town meeting with Ngesaol Community</td>
<td>June 25, 2016</td>
</tr>
<tr>
<td>Write up of initial EA for Phase 1-3</td>
<td>July 6, 7, 28; August 7, 8, 2016; April 20, 21, 2017</td>
</tr>
<tr>
<td>Received Additional Plans from Applicant</td>
<td>November 25, 2016</td>
</tr>
</tbody>
</table>
Summary List of assessment methodology used for the land-based and water-based assessment of the project.

The Environment, Inc. conducted 6 site visits to assess existing physical and biological conditions on site. The TEI team used digital 1983 USGS and USDA Soil and Topographic Maps, Arts and Culture Maps, a 1994 Site Aerial, and a 2006 QuickBird Satellite Imagery provided by Google earth and PALARIS to delineate habitats including wetland areas, soil types, and cultural sites. Furthermore, aerial drone shots were used to get closer views habitat.

**Terrestrial and Freshwater**
1. Preliminary walk along the site and adjacent areas and an assessment by foot to record the biota observed.
2. Qualitative assessment of vegetation on site photographing vegetation and generating a checklist of species
3. Water quality testing of water in mangrove and immediately across mangrove.
4. Bird protocol of EQPB
5. Terrestrial survey within _ meter of the existing road
6. Four transects perpendicular to the existing road 382m²

**4.1 Goal and Objective**
Koror State Public Works, requested The Environment, Inc. to conduct an Environmental Assessment. The Applicant plans to redo roads by expanding and providing sidewalks (See Figure 3); and develop housing units in Ngesaol Koror State. The project will cover approximately 170,000 square meters of land in Ngesaol, The Goal of the project is to design and construct lease units and access roads for Ngesaol community that will provide the community with safe access to and from their homes and businesses. Furthermore, the project is designed to meet the housing needs crisis through displacement in Koror. The Objectives are to meet all necessary requirements for an earthmoving permit from EQPB.

a) General Distribution of Habitats and Habitat map.
b) Limited water quality
c) Information on species abundance and status
d) An assessment of sensitive habitats and corridors
e) Sensitive species
f) Impacts on the site
g) Alternatives
h) Mitigation measures

4.2 Location of project
Ngesaol is located at the northern end of Koror State. This area is a disturbed coastal area with homes, commercial and industrial activities, and farms. The existing road is bounded by mangroves along its north side and wetlands to the south. The area is surrounded by steep limestone forest with steep slopes to the east and north with a with blue line streams bordering the north and south boundary. Refer to Figures 1.

Figure 1 Site Map, showing road alignment in Ngesaol
4.3 Total Area to be disturbed by the project

The Ngesaol Road project will include the following activities and infrastructure (Shown in snapshot below):

1) Survey completed
2) Construction access/work land on each side of existing road (1.5m); for intermittent lane work/closure and single lane access in current residential area.
3) Construction of raised area fill area with culverts on new lot fill areas.
4) Site grading on existing road, used as fill for new lots.
5) Fill and raise road alignment near new lots.
6) Channel dredge/development for flow and pressure reduction to avoid inundation.
4.3.1 Volume of soil to be used as Fill
The volume of fill proposed for this project is 117,850 m³ for approximately elevating the new lot areas and road to 2.5 meters.

4.3.2 Source of fill materials to be used for the project
The source of the fill materials for this project will be from: cut from currently existing road plus other KSG project material and commercially available sources.

4.3.3 Soil disposal site and method to dispose soil/waste material
Soil materials will be disposed in to fill area while any non-fill determined wastes will be brought to National Land Fill, by Koror State.

4.4 Detailed description including site development plan for all physical facilities to be constructed
New structures will be sidewalks, playground and lease lots with estuary.

4.5 Description of Project Phases

A. Initial Phase will be the re-grading/paving of road and access roads towards the interior of Ngesaol hamlet (Figure 3).

B. Phase 1: Access Road and Channel Development.

Phase 1 – Access Road

To begin, an access road will be made from the main road into Ngesaol to the location of the future channel. An access road will be routed along the future channel to ensure the channel is filled correctly.
4.5.1 Pre Construction Phase

Phase 2: Channel Development and Sediment Blocking.

Phase 2 - Dredge Channel

After completion of the access road, the channel will be dredged for fill material. As the channel is being dredged, SEDIMENT FENCES will be placed along both sides of the channel to stabilize it as the mangroves edge to the channel. This will be done only in the project to minimize the end of the filled area, so when they begin to be filled, the lots will already be settled against the channel.

4.5.2 Construction Phase

Phase 3: Culvert development and Fills for Lots in Phases: average lot size will be approximately 1,400 m².

Phase 3 - Fill Lots with Culverts

Lessee lots should be developed consecutively to ensure culvert and drainage system is properly constructed and maintained. Lots will be filled starting with those closest to the already developed parts of Ngesaol and closest to the road expanding out towards the main road, as shown in the pattern.

4.5.3 Operational Phases

Phase 4: Will be the broadening of channel after fill sediment has settled.
4.5.4 Abandonment Phase
No abandonment phase is planned. A legally binding contract between and the contractor and applicant will be draw up.

4.6 Project Schedule/Duration of activity
Dependent on Availability of Material and Equipment:
   a. Approximately 3-5 months for work on existing roads.
   b. Approximately 3-5 months for lease area pre-construction preparations; access road and channel development.
   c. Approximately 4-6 months for culvert and fill process.
   d. Approximately 6-8 months for road and lot and simultaneous channel development.
   e. Approximately 3-5 months for final structure and estuary modeling/development.

4.7 Project Cost.
The total project cost will be determined upon approval of permit based on available materials.

5. Project Alternatives
Access Roads have no alternatives at this time; housing project can be done in Babeldoab only as Koror is nearing capacity for population and development.

Comparisons of Project Alternatives for each significant Biological Resource Impact

5.1 The alternative of no action
This would result in leaving the site as is that the existing road will be inadequate for the growing Ngesaol Community.

5.2. The alternative of development of the site
Develop a road system for Ngesaol that is structurally sound and safe for transportation needs and in size that is suitable for the existing and projected population of Ngesaol. This road system should include renewable streetlights, sidewalks and green belts and gardens and parks for recreation and safety to promote healthy lifestyles in Ngesaol, as provided in concept and design. For the sites, if leachate were seen as a problem from regular testing, it would be advised to look at expanding treatment line for sewer from Ngesaol to the main, or have a smaller treatment facility created for the area.

5.3 Alternative sites
This is site specific for the Ngesaol community. Therefore no alternative site was considered; housing can be done in Babeldoab but it is outside the jurisdiction of applicant, as they are limited to Koror State Government Lands.

5.4 Alternative and equally suitable projects, methods or processes
The project is similar to existing activities and zoning as it currently serves as an area for homes, businesses and farms. However, filling mangroves is never encouraged but there are no other sites available for lease due to issues of displacement due to land ownership changes. It is important to try to preserve natural habitat so the design of areas should blend with landscape and if encroaching on habitat should try to utilize methods so that the remaining habitat is becomes more efficient. Creating and maintaining mangrove channels is important to maintain sandflats which are important food source for Palauans, so this should be incorporated in to the process of development.

TEI has the following recommendations for methods and processes: 1) Develop within the existing footprint of the Ngesaol road area and avoid disturbance of the agroforest and wetlands; 2) It is recommended to have routine water sampling of the marine waters within a few hundred meters of this site. 3) Develop the site in phases and solar street lights and sidewalks the project for safety and promotion of community recreational activities. 4) Develop community programs to develop gardens and vegetative buffers along the road for homes and businesses. 5) Construction should account for existing natural freshwater drainage from the Sngall ridge and not block natural tidal exchange for the extensive mangrove system 5) Mangrove Channel development and channel along the edge of development should be made to offset pressure of fill and avoid inundation.

6. Description of Environmental Setting
Without (Before) the Project (including conditions on and adjacent to the proposed site)

6.1 Physical Environment

Previous Impacts
The proposed project site is savanna grassland with farmland adjacent to the south and lowland forest to the east, west and north. Furthermore, the mangrove area is located to the north of the current road alignment where new development is suggested; and wetland is located to the south of this road alignment adjacent the limestone ridge.

Physical structures
The site is adjacent to a community farming site. Refer to Figure 4.
6.2 Biological Environment

A Biological Overview
The land was formerly a lowland forest cleared for homes and of Koror State. The vegetation is typical agroforest, coastal forest and mangrove with limestone forests along the southwest section (Table 1). Forests and farmlands and mangroves serve as carbon sinks, important habitat for flora and fauna and a nursery area for many juvenile organisms. Forests provide resources for food, shelter, medicine and simple enjoyment. The wetlands and forests of Koror are under a great deal of stress due to infringement from the demand for more infrastructure to accommodate its increasing population. Currently much of the forests and farmland adjacent to this project site has been impacted by residential and commercial development. These impacts occurred over at least a 100 years of development in Koror. The adjacent mangroves provide additional habitat for, fish and invertebrates. However the natural productivity and inhabitants of this habitat have been either diminished due to past impacts to this site. Koror has very limited alterative areas commercial development.

Water
There are no blue line streams crossing the proposed road. However there is drainage from the Sngall Ridge along its southern boundary as well as mangrove and marine waters along its northern boundary. Refer to Figure 1. It is critical that natural drainage is not altered for the extensive wetlands to the proposed road currently transects and that there are adequate culverts to enable water exchange.

Soils
There are ten types of soils found on this site (Figure 4) of which (617) Ilachetomel-Naniak complex, represent about one-half of the area that will be disturbed. Dechel Series (616) makes up the majority of the rest of the area to be disturbed. The ten soil types on the area to be disturbed/filled are as follows:
TABLE 1a. Soil types, area and suitability

The table 1a above indicates the area each soil type covers and its suitability for development including sanitary facilities or septic systems—taken from the Palau Soil Survey available on the following website: http://soils.usda.gov/survey/printed_surveys/. The survey indicates that most of the soil is very limited and requires proper engineering to overcome the soil limitations. The majority of the soil is deposits as it is wetland area and fill material will have to be chosen that will address issues of soft soil retraction and water flow.

Terrestrial
Habitat
About 75% (125,000 m²) of the site is existing road, 10% (18000 m²) is freshwater wetland and taro gardens; and 27,000 m² mangroves. Refer to Figure 1.

Figure 9 Vegetation Map for the site

Terrestrial Species Diversity
Over 141 species of plants from over 63 Families were found at or near the site including 77 native of which 20 were endemic species: chersachel, Horsfieldia palawensis and kesiamel Osmoxylon oliveri, etc. (Endemic means a plant is only found in Palau. In addition to the native species, 9 introduced species were found (Tables 2). This high biodiversity is due to the agroforests, wetlands, mangroves and limestone forests of Ngesaol (Figures 1). No endangered species is on the site. However the lowland and swamp forests and mangrove forest are home to populations of the threatened endemic plants and birds that require regular monitoring and protection with limited access.

Tree volume
A total of 572 trees representing 51 species and 25 families were measured for diameter at breast height and heights measured along either side or proposed road alignment. Refer to Summary table below and Table 2a. The total volume of measured trees along the road alignment was 176.78 m³. Fourteen species of trees represented 69% of all trees and shrubs measured and 92% of the total volume. Coconut, Cocos nucifera, mahogany, Swietenia macrophylla, mango, Mangifera indica and betelnut Areca catechu represented the top volume of biomass. The most common trees in along the proposed road alignment were Areca catechu, Cocos nucifera, banana, Musa sp. and Swietenia macrophylla. Other abundant and or large trees are shown in the summary table below.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name</th>
<th>Vol. m³</th>
<th>Freq</th>
<th>count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocos nucifera L.</td>
<td>lius</td>
<td>49.6</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Swietenia macrophylla (L.) Jacq.</td>
<td>mahogani</td>
<td>34.7</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td>Mangifera indica L.</td>
<td>mango</td>
<td>25.3</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Areca catechu L.</td>
<td>buuch</td>
<td>17.5</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Artocarpus altilis (Parkinson ex F.A.Zom) Fosberg</td>
<td>meduu</td>
<td>8.5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ficus microcarpa L. f. var. microcarpa (lulk)</td>
<td>lulk</td>
<td>6.8</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Premna serratifolia L.</td>
<td>chosm</td>
<td>3.8</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Musa spp.</td>
<td>tuu</td>
<td>3.7</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Morinda citrifolia L.</td>
<td>ngel</td>
<td>3.5</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>Averrhoa carambola L.</td>
<td>kemim</td>
<td>3.3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Terminalia catappa L.</td>
<td>miach</td>
<td>2.2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Averrhoa bilimbi L.</td>
<td>imekurs</td>
<td>1.6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Syzygium samarangense (Blume) Merr. &amp; L.M. Perry</td>
<td>rebotel</td>
<td>1.4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Leucaena leucocephala (Lam.) de Wil</td>
<td>telentund</td>
<td>1.0</td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td>162.86</td>
<td>396</td>
<td>396</td>
</tr>
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</table>
During April 19, 2017, a total of 66 mangrove trees were measured along the mangrove forest along the west end of the proposed road expansion. The area covered 328 m² for the four transects (T1=100m², T2=100m², T3=50 m² and T4=78m²). The mangrove trees has an estimated volume of 41.52m³. This is a mean volume of about 0.12 m³/m² within 78 to 100 meters from the road. The largest trees measured were *Lumnitzera littorea* and *Sonneratia alba*. Several large *Xylocarpus granatum* were also measured. The more abundant *Rhizophora* were smaller in size but more abundant. Beyond T3 and T4 and as seen in the satellite image is a large stand of *Rhizophora* with height of about 2 meters.

### Summary Table of plants measured along the mangrove transects

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Local name</th>
<th>Volume (m³)</th>
<th>Percent of Total Volume</th>
<th>Frequency count</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Lumnitzera littorea</em></td>
<td>mekekad</td>
<td>14.81</td>
<td>36%</td>
<td>9</td>
</tr>
<tr>
<td><em>Sonneratia alba</em></td>
<td>urur</td>
<td>11.15</td>
<td>27%</td>
<td>5</td>
</tr>
<tr>
<td><em>Xylocarpus granatum</em></td>
<td>meduulokebong</td>
<td>10.91</td>
<td>26%</td>
<td>21</td>
</tr>
<tr>
<td><em>Rhizophora mucronata</em></td>
<td>tebechel</td>
<td>4.28</td>
<td>10%</td>
<td>19</td>
</tr>
<tr>
<td><em>Ceriops tagal</em></td>
<td>biut</td>
<td>0.37</td>
<td>1%</td>
<td>12</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>41.52</strong></td>
<td></td>
<td><strong>66</strong></td>
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</tbody>
</table>

### Birds

During January 25, 2016, up to 128 birds from 16 species were either seen or heard during three 15-minute morning counts at three locations along the existing road. During the 8 minute count a total of 128 birds were counted during the same morning count for an additional 7 minutes or a full 15 minute count, a total of 16 species of birds were either seen or heard, which is considered
the threshold for concern. During April 11, 2017, 15 species of birds were counted during the 8 minute count and double the number of fruit doves (34) were counted for an additional 7 minutes. Therefore for both dates in 2016 and 2017 the number of bird species seen or heard was considered the threshold of concern.

The birds seen or heard during the bird counts, terrestrial transects and walks through the site included the following five endemic species: the fruit dove, *Ptilinopus pelewensis* (biib), the fantail, *Rhipura lepida* (melimdelebdeb), the morning bird, *Colluricincla tenebrosa* (tutau), and the white eye, *Zosterops finscii* (chetalial), and the swiftlet, *Aerodramus pelewensis* (chesisekiaid). Four endemic subspecies: the honeyeater, *Myzomela rubratra kobayashii*, a kingfisher, *Todiramphus chloris teraokai*, the starlings - *Aplonis opaca orii*, and the Nicobar pigeon, *Caloenas nicobarica pelewensis* (laib). No endangered species were seen or heard on site however all the native birds are threatened by habitat loss. The Nicobar pigeon is a threatened species and was seen during this assessment. The team also observed the endemic fruit bat, *Pteropus pelewensis* and the *Emballonura semicaudata* (chesisualik).

Wetland is approximately 18,000 sq. meters
Mangrove is approximately 27,000 sq. meters

**Economic Value of Forest**

Palau needs to establish values for habitats that include natural services as buffers and food source, carbon sinks, based upon the cost to build manmade structures to provide similar potential ecosystem services. The potential value of this site if it was reforested and or maintained as mangroves and wetlands rather than developed over the next 99 years can be estimated using a value of wetlands at $25,681/ha/yr; mangroves at $193,843/ha/yr and urban area at 6,661/ha/yr (Costanza et al., 2017). If these values coincide with approximately 1.8ha of wetland and 2.7ha of mangroves the estimated ecosystem service value per year would be:

523,376.10 + 46,225.80 = 569,601.90/year versus the value of homes in new fill area and 29,974.50/year in ecosystem value of urban areas. The long-term value of our resources and national policy for adaptation and vulnerability for Climate Change must be considered during planning of development. Current national policy is to protect our forests and farmlands for food security as Climate Change is predicted to cause more intense and frequent storms globally. Limited development that blends in with the forest and includes reforestation of urban area with native trees as part of the landscape is recommended for this site.

**Sensitive Habitats**

**Definition and Summary**

All of Palau’s habitats and species within these habitats fall into the broad definition of sensitive coastal areas because of Palau’s limited land mass. We prioritize sensitive areas based upon our evaluation of previous disturbance, integrity, biodiversity, representativeness, occurrence elsewhere and value of wildlife corridors. Our general definition of a sensitive habitat is an area that is rare in Palau or home to rare or endangered species. The sensitive areas include mangroves, wetlands, agroforests, coastal forests and native farmland. All habitats need
protection as Palau faces the impacts of climate change and climate variability. During two major super typhoons in 2012 and 2013 a large portion of forests were lost throughout Palau. The mangroves provided a buffer to the storm surges along the shoreline. However the area impacted was not estimated. Protecting our mangroves protects our coastlines from the predicted increased intensity of storms and sea level rise. Climate Change must be considered in all development activities along the coasts. The proposed project would mitigate impacts by avoiding the placement of infrastructure where forests are growing and transfer trees and saplings that are directly impacted. The road should also be elevated based on predicted sea level rise and include with adequate sizes and numbers of culverts to enable water exchange. Furthermore, mangrove channels in many areas have been abandoned and have therefore caused a higher volume of mud/sediment to build-up and increase water levels. These channels need to be developed, maintained and cleared for use in order to increase access of people to important food habitats as well as to provide nursery areas and prevent inundation of lands, farms and homestead adjacent the mangrove areas.

Corridors

The Ngesaol habitats serve as a corridor for birds and bats as well as marine fish and invertebrates within the extensive mangrove forest.

Rare, Endangered, Threatened, Sensitive or unique Species

All of Palau’s forests and wetlands are sensitive habitats with unique species. All native trees are considered threatened based upon land use change within three generations of these species (Costion et al. 2012). Terrestrial ecosystems are threatened in Ngesaol as a result of sedimentation from soil erosion, and contamination from waste and development. It is important to move native plants to another location or nursery on site before earthmoving and retain a buffer of native vegetation along the main road and adjacent farms and forests that border this site. A total of 19 bird species were observed or heard including 9 endemic birds and 5 endemic subspecies.

The applicant should work with Bureau of Agriculture Forestry Unit, Koror State and the farming community to transplant native tree saplings to the nursery or develop a nursery and a small farm on site. The applicant should work with Koror Conservation Officers to ensure the native plants along the buffer zone are effectively protected from public access and invasive species. If possible reduce the footprint of the earthmoving to avoid the loss of forest plants. Furthermore, wetland estuary should be preserved in at least a small part and mangrove areas should be managed to increase functionality (as a buffer and nursery).

6.3. Socio-cultural, economic and political environment

During June, 25, 2016, a community meeting was held. The preparer explained the project to the community. The Koror State Public Land Authority explained zoning regulations in this area. Concerns were raised about easement and distance of development from the road. The community exercise along the road, but were afraid of traffic. It was explained that bumps are standardized (based on slowing or stopping) to make sure people drive slow in order to have safe exercising and general safety. An idea for community exercise centers was suggested. The issue of the speed and size of roads was further discussed. Unleashed dogs were another issue raised.
Working in the mesei and its impact to the mesei was raised.

During the September 20, 2018, community meeting on full design, there was support for the project, but a concern about the conservation of the taro patches adjacent the current access road towards the south. Both the elder women and men in the community meeting touched upon the idea of remaking and maintaining. Additionally, the discussion of sewer was brought up and requests to add a sewer line in to the community but make sure it did not cause sewage problems like elsewhere in Koror hamlets. Additionally, there was discussion on size of road and size walk and effect on leases, however the majority were in favor of giving up enough to make the roads safer. Appendix A contains Questionnaire Form results and Transcript from final meeting and brief notes from initial meeting.

7. Impact Assessment

General physical, biological, health, and social impacts are the following:

1) Magnitude of Impact
2) Commercial development of forest, agroforest and farmland
3) Water quality
4) Sewage and Solid waste
5) Water and Land traffic
6) Aesthetics and land use planning
7) Introduced species
8) Health
9) Social-Economic

Impact 1. Magnitude of Project
The Applicant proposes to design a road covering a total area of approximately 170,000 m² of existing road, agroforestry, wetland and mangrove in Ngesaol.

Impact 2. Loss of mangrove and wetland and agroforest from potential development projects
The estimated area of wetland and mangrove habitat to be disturbed is approximately 45,000 m². While agroforestry area is mainly plants along alignment planted by residents past buffer. The project site and adjacent area supports over 100 terrestrial species of plants and birds. The site boundaries include over 77 native trees restricted to these limited habitats that require protection and management. The Palau Climate Change Policy supports farming for food security and prioritizing land for farming purposes and protection of mangroves and forests for coastal protection from storm surge and sea level rise.

Impact 3 Water quality and quantity
The applicant will ensure that all used oil and fuel is properly stored and disposed according to EQPB specifications. Spills will be reported immediately to EQPB for appropriate mitigation action.

EQPB has an ongoing monitoring program for Ngesaol waters that can be modified to include this site to ensure water standards are adhered to for the length of the project. The greatest
potential discharge of sediment may occur during the initial construction phases. It is important that all sediment containment infrastructures are in place before any construction activities begin. The infrastructure should be fortified with a series of sediment fences and diversion to sediment traps along a 10-50 meter buffer zone that drains into wetlands. Throughout the duration of the project, strict sedimentation control practices must be implemented to protect the freshwater streams from an overload of sediments from the earthmoving proposed for the site. The applicant will provide a sediment control plan that will be reviewed by the EQPB. The sediment control plan must address a plan that includes regular maintenance and repair of sediment fences. Extra precaution is required as this site during heavy rains. The infrastructure needs to be reinforced and maintained according to the direction of the surface water flow. Furthermore it may be suitable to create a dredged channel, with silt fences on the outer boundary, along the limit of the mangrove areas to allow sediment trapping and inundation prevention. Water quality can be drawn from this area during construction and then the channel made permanent and samples drawn regular to determine water quality indefinitely. Water quality in the area near the mangrove had high Enterococci and low water quality.

### Palau EQPB Water Quality Laboratory Test Results

#### TEI Testing Ngersmid, Koror State

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<th>Location</th>
<th>Date</th>
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<th>Turbidity NTU</th>
<th>Temperature °C</th>
<th>Salinity ppt</th>
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#### Impact 4. Sewage and Solid Waste

Any and all solid waste recovered from site should be immediately recycled or disposed of at the National Land fill and documented. Furthermore, removable toilets should be utilized throughout construction to avoid contamination at site. New develops should place septic tanks in areas that allow for the largest leach field as well as in close proximity to the hook up. Storm water and other non-sewage water used should not be directed in to the septic tank to avoid overflow. All Solid Waste should be separated and stored for recycling and/or proper disposal in accordance with the National Solid Waste Management Plan guidelines as well as EQPB regulations.

#### Impact 5. Land Traffic and safety

During our assessment, there was road traffic at this site especially during early morning and evening traffic during rush hour for people going to and from Ngesaol to either Koror or the
capitol in Melekeok. We recommend that Koror State in cooperation with the National Public Safety Division begin to plan for safety measures during construction and place road signage and fence barriers around the area under construction, especially along the road side to prevent any materials from impacting the vehicles travelling along the main road. Vehicle drivers need to be advised to slow down while leaving and entering the area and caution signs and flagmen during times when site has more traffic due to transport of construction materials. Any persons participating in construction activities at or near the site should provide adequate warning signs and safety warnings for local residents. It is important that the types and regular scheduling of activities in this area are clearly understood and known between drivers, Koror State and the National Government. Furthermore, buffer areas should be set prior to construction phase on each side of the road and one lane should be developed at a time to avoid blocking regular commute through the hamlet.

Impact 6. Aesthetics and planning
Wherever possible do not remove trees from the site. Trees offer shade, habitat for wildlife beauty to the area, and serve as carbon sinks. The Ngesaol agroforests and wetlands are home to threatened native plants and birds. For both national and state planning it is important to take into account that there will be more intense droughts and heavy rain periods and super typhoon conditions than in the past century. The forests serve as habitat, buffers, source of food fish and contribute towards Palau’s unique biodiversity. We recommend that the applicant design structures that can withstand the predicted conditions of climate change with adequate water storage and waste treatment on site. The applicant should to establish a buffers zone along the wetland, agroforests and mangrove areas. It is further recommended that the applicant develop energy systems that are efficient and conservative in nature.

Long term planning for the Ngesaol area is ongoing with Koror State to accommodate more homes for its residents. This requires access roads. It is recommended to include in the designs solar lighting, sidewalks and green belts with gardens and parks for the community.

Impact 7 Introduced Species
Invasive species were observed on the site. Mikania or mile a minute was found and should be removed. It is important that any fill material for this project be carefully inspected by the Bureau of Agriculture to ensure that no invasive species are transported by the fill to this site. An invasive species inventory has been conducted at this site with the top invasive species being recommended for removal. Furthermore, the invasive coconut rhinoceros beetle was observed through coconut tree leaf damage and downed tree material and plant debris should be immediately used as fill material or brought as green waste to Koror State.

Impact 8 Human Health Impacts
During the town meeting, there were concerns about safety and traffic. Therefore it is recommended that this project include good lightening for the streets using solar light. It is further recommended to plant gardens and green belts and include forests and parks for the community. Issue with proper sewage management for housing is necessary to prevent heavy flow in to the very badly drained wetland and mangrove areas.

Impact 9 Social-Cultural, Economic and Political Impacts
This project is expected to have social-cultural, economic and political impacts. The magnitude of these impacts can be minimal with proper implementation and adherence to National and State laws and plans. Potential positive impacts are a well-designed eco-friendly road system that
promotes exercise and healthy lifestyles and safe vehicle movement in the community. Most of those interviewed were in support of this project because they would have an improved road system. Potential negative impacts are increased traffic, noise, and pollutants from sediments during earthmoving, increased pollutants from oil and fuel from vehicle and building maintenance, garbage and littering, overall degradation of the habitat. The loss of farmland, mangrove, and native plants for development has potential impact on food security. One person commented that the site is too close to the main road for potential escapees. Several women were concerned with an increase in criminal activities in the area. Proper traffic signs, good solar lightening along the roads and walkways with speed limits are recommended. Employment opportunities that prioritize workforce the communities of Ngesaol are recommended. Cooperative efforts between the applicant and community are important for successful implementation of the project.

During the scoping meeting, the issue of water supply, sewerage and septic systems performance were a main concern. In response to this concern, the applicant conducted a site visit with EQPB and CIP. Recommendations were made for the placement of the septic system.

8) Mitigation Measures for the Project

8.1 Brief Discussion
Below is a list of mitigation and enhancement measures for the project that would require partnerships and collaboration between the National, State and community.

a) The magnitude of the project is aligned with other activities adjacent and at this site which is primarily homes, businesses and farms.

b) The applicant should establish a buffer zone along the roadside in order to allow for new lease lots and existing housing to hook up to potential future public sewer, water and utilities systems. The existing native plants should be left intact to serve as this buffer wherever possible.

c) Avoid removal of large trees from the site. Plant native trees to landscape the road system using native saplings found on site as they provide coastal protection, shade, a wildlife refuge and aesthetic beauty. These are important attributes for tourism throughout Palau. If trees are removed replant native or endemic trees that are similar to those found on site. See Tables 2 and 3.

d) Remove invasive species on site. Any soil fill should be inspected for potential invasive species. All imported materials should also be inspected for invasive species by the Bureau of Agriculture before transfer to the site.

e) Work with the Koror community, PCS, Division of Agriculture, and the Division of Forestry to propagate or transplant native plants for this site. If native trees are removed, set up a small tree nursery to replant native trees for landscaping after the construction is complete. Avoid unnecessary disturbance of trees.

f) Develop and implement a monitoring plan that includes monitoring of water quality for bacteria, monitoring all sediment control infrastructure on land and within the surrounding
waters. Sediment fences must be maintained and are effective. Upon completion of the project, remove all sediment control infrastructure and dispose of according to EQPB regulations. Set up permanent storm drainage system on site that is properly maintained.

g) Ensure safety during construction and operations, road markers should be installed to direct local traffic. Signs and barriers will be in place along the main road and on site to direct the movement of vehicles during all phases of the project. Public notices will be given in either the local newspaper, radio or on public bulletin boards to inform the public of the proposed activities before and during construction. Koror State will work with the Bureau of Public Safety to plan how best to direct traffic activities during all phases of this project. Set a speed limit for this area for the long term to increase traffic safety.

h) Retain a biologist and engineer throughout the duration of the project. Their scope of work would include monitoring and maintaining sedimentation and erosion control structures, assisting with tree transplants, monitoring water quality, and assessing the overall health of the forests and streams and safety during all phases of this project. The engineer would ensure that all temporary ESC would be converted into effective permanent storm water drainage keeping adjacent stream waters clean and only discharging clean filtered water off site. The applicant should post a sign on site describing the project and the project manager name and contact information for the public.

i) Set aside funds for and /or participate in the following activities: road clean-ups, management activities for the buffer zone that would serve as a forest conservation area for sustainable use; develop eco-friendly nature trail along buffer zone for guests with educational signs about the importance of the forests, taro gardens and wetlands and mangroves.

j) Develop Standard Operation Procedures that include regular monitoring of environmental parameters that are available upon request by EQPB or Koror State or concerned citizens.

8.2 Summary Matrix of predicted environmental issues/impacts and proposed mitigation/enhancement measures and responsibilities

See Attachment (Table 4).

8.3 Environmental Management and Monitoring Plan

The terrestrial transects and the parameters measured or quantified for this assessment can serve as a baseline for a monthly monitoring program for the duration of the project. Erosion and sediment control infrastructure needs to be monitored on a daily basis and modified according to changing conditions on site. The frequency of inspections would be dependent upon weather conditions and effectiveness of the infrastructure based upon water quality measurements each month. If water quality parameters are unsatisfactory, infrastructure will be modified to address point sources of pollution identified on site under the guidance and approval of EQPB, the contractor and the leaseholder. Fresh water estuary and taro patch revival program will be made to offset habitat loss and allow for drainage.
References


Costion, C. 2012 Threatened Endemic Plants of Palau. Final Completion Report for CEPF.


Supreme Court of the Republic of Palau Appellate Division. Civil Appeal No 00-19, Case No. LC/N 00-276. Hearing No. LC/N05-98. Transcripts Filed May 12, 2003.

