Environmental Impact Statement for The Proposed National Landfill

Imul Hamlet, Aimeliik State

Alternate Site A at Ongerarekieu, Imul Hamlet Aimeliik in 2009

Proposed National Landfill Alternative Site B at Ngeruchael, Imul Hamlet Aimeliik in 2017

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Prepared for:
Capital Improvement Project

Koror, Palau 96940

Prepared By:
The Environment, Inc.
Box 1696
Koror, Palau 96940
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2. Executive Summary

In 2004, Aimeliik State has addressed two alternative sites for the National Landfill (Telesource International and Winzler and Kelly 2004) which would also serve Aimeliik State. However both sites were not chosen because one site was within the conservation area near the Tabechding and another was a homestead site. In 2016, Site A at Ongerarekieu was designated as the National Landfill site by a taskforce that included the former Governor of Aimeliik, Leilani Reklai. The goal of the project is to provide the Aimeliik community and the Palau Community with a national landfill that will have a minimal impact to the surrounding environment. In 2016, a public hearing was led by Governor Obak Demei in Aimeliik state regarding a landfill at the designated Site A at Ongerarekieu in Imul Hamlet, Aimeliik State. The Governor and participants requested that the national government assess an alternative.

The purpose of this EIS study is to assess the two alternative sites, Site A at Ongerarekieu and Site B at Ngeruchael as a suitable national landfill site within the Tabechding Watershed and do a comparative analysis of the two alternative sites A and B. The Objective is to successfully complete all national requirements to implement this project through the completion of an Environmental Impact Statement (EIS). This EIS is building upon a 2009 Environmental Assessment for a proposed 2009 Aimeliik State Solid Waste Disposal Site and the 2016 assessment of Site A in Ongerarekieu as an expanded National Landfill.

The two alternative sites, Site A in Ongerarekieu and Site B in Ngeruchael, were assessed as potential sites for the National Landfill in Aimeliik State. TEI recommends Site A for a National Landfill. Site B will directly impact two blue line streams of the upper tributary of the Tabechding River. Site A will indirectly impact an upper tributary that is 132m away from the site. Site B will impact more forest area (15,500 m²) compared to Site A (6,500 m²). Both sites have high diversity of plants and animals. Site A is at a higher elevation and over 58% of initial phase is on savanna with few trees. Site A is also closer (430m) to the compact road than Site B (2,130m) will therefore be less costly for road construction and long term transport of wastes to the site. Both sites have soil types with severe conditions for landfill construction. Site A is 2, 689 m from the nearest dwellings and Site B is 1, 651 m from the nearest dwelling. Therefore less impact to residents as home are further from the site.

Site A

During February 2009, Governor Leilani Reklai requested a proposal from The Environment, Inc. to conduct a biological assessment of a proposed solid waste site at an area called Ongerarekieu within Imul Hamlet, Aimeliik State. This project was planned for implementation through the Aimeliik State office for several years. The existing solid waste site is contaminating the nearby waters and overflowing into the street (cover photo). The project has been delayed due to lack of funding to implement it. Aimeliik State planned to work with the Bureau of Public Works National Landfill and Solid Waste Management office to develop the design for this site. The National Solid Waste Task Force recommended that the National Landfill be at the proposed Aimeliik Solid Waste Disposal Site in Ongerarekieu, Imul Hamlet, Aimeliik State. During 2016, a public hearing was held in Aimeliik regarding Site A, during this meeting an alternative site, Site B in Ngeruchael was recommended.

The 2009, Site A was proposed as a State Solid Waste Disposal site. Site A is located at the southwest end of Babeldaob in Aimeliik State within the Tabechding watershed and consists of grasslands and riverine forest with tributaries. The proposed location for the solid waste disposal site will directly impact an area of 5,282m² of which 1584.6 m² is forest and 3, 697.4 m² is savanna. An eroding access road covers an area of 420m² of savanna vegetation and bare soil. The compact road is about 430m from the access road. The distances of three tributaries of the Tabechding River from proposed site are as follows: 244m to the NE tributary, 247m to NW tributary and 132m to the SE tributary. We propose shifting in the location of the solid waste disposal site towards the northwest to move it further from the SE tributary and forests and more within 405 type soils are less steep. These streams flow north 2.6 km into at mangrove channel or
“taoch” that flows into the Ngermeduu Bay. This site is not within the Ngaremeduu Conservation Area or the national land set aside for forestry and agriculture.

The newly proposed 2016 National Landfill in Aimeliik State at either Site A or Site B would impact an area of 80,000m². At Site A in Ongerarekieu, least 45,000m² or 56% of the area is forested along an estimated 30 to 60 m width of the boundary in all directions. An estimated 35,000m² of this site (44%) is savanna, which is mainly the central area where most of the earthmoving is proposed. The NE area of the site will impact more forest for the proposed berm and leaching treatment zone. The compact road is about 430m from the access road. The distance of a NW tributary of the Tabechding River from the proposed leachate pond and treatment site was 85 meters. In 2016, the proposed project for this initial phase will impact approximately 5,300 m² of forest for the disposal area and leaching pond and 1,200 m² of forest for the access road. The area of savanna that will be directly impacted will be at least 8,000 m² for the disposal area and 1,000 m² for the access road. Therefore, at least 6,500m² of forest and 9,000m² of savanna will be impacted for the initial phase of the proposed landfill. This is an estimated 15,500m². As other infrastructure is incorporated in later phases of the proposed landfill, more of the 80,000 m² habitat will be directly impacted.

The 2009 proposed site is located at the southwest end of Babeldaob in Aimeliik State within the Tabechding watershed and consists of grasslands and riverine forest with tributaries. The proposed location for the solid waste disposal site will directly impact an area of 5,282m² of which 1584.6 m² is forest and 3,697.4 m² is savanna. An eroding access road covers an area of 420m² of savanna vegetation and bare soil. The compact road is about 430m from the access road. The distances of three tributaries of the Tabechding River from proposed site are as follows: 244m to the NE tributary, 247m to NW tributary and 132m to the SE tributary. We propose shifting in the location of the solid waste disposal site towards the northwest to move it further from the SE tributary and forests and more within 405 type soils are less steep. These streams flow north 2.6 km into a mangrove channel or “taoch” that flows into the Ngermeduu Bay. This site is not within the conservation areas yet it is in the upper watershed of the Tabechding and public land of Aimeliik State (Governor Reklai, pers. comm. 2016). This upper watershed of the Tabechding River is a sensitive area and proper design and placement of the National Landfill is critical.

Aimeliik State has addressed two alternative sites for the National Landfill (Telesource International and Winzler and Kelly 2004) which would also serve Aimeliik State. However both sites were not chosen because one site was within the conservation area near the Tabechding and another was a homestead site. This site is not within the conservation areas yet it is in the upper watershed of the Tabechding and public land of Aimeliik State (Governor Reklai, pers. comm. 2016). This upper watershed of the Tabechding River is a sensitive area and proper design and placement of the National Landfill is critical.

During 2009 and 2016, biological surveys were conducted at Site A at Ongerarekieu. Freshwater quality of the streams did not meet EQPB clean water standards for bacteria counts at Site A. Over 129 species including 106 terrestrial plants, 16 species of birds and at least 7 species of other wildlife were observed or heard on or adjacent to Site A. The 106 species of plants represented 59 families of which 97 native plant species were recorded including 23 endemic plant species. In addition, 6 introduced plant species and three species only identified to Genus were recorded. Proposed Site A had at least 17% of Palau’s endemic plants and its only endemic frog. The density of small trees and shrubs along the surveyed savanna areas was 12 trees/120m² equivalent to 0.10/m². A total tree and shrub volume of 6.8cm³ was calculated at Site A. The adjacent forest included large endemic trees of fruiting *Garcinia matsudai* (tilol), *Calophyllum pelewense* (chesemolech), *Fagraea ksid* (ksid), *Manilkara udoido* (udeuid) and *Gmelina palawensis* (blacheos). The smaller *Osmoxylon pachyphyllum* (kesiamel), and fern trees *Sphaeropteris nigricans* (cheluu) and *Pinanga insignis* (chebouch) were common understory trees. Ferns and saplings dominated the ground cover. Ferns, orchids, and vines were dominant epiphytes. During 2016, the team identified 5 additional plants not recorded in the 2009 survey at Site A including the native *Finschia chloroxantha* and the orchid *Spathoglottis carolinensis*. Three additional invasive species observed in 2016 included *Timonius timon* and *Leucaena leucocephala* along the access road; and the invasive herb, *Clidemia hirta* in the forest by the stream. Large fallen trees with large root systems were common at Site A. Large endemic trees had several new young trees growing from the fallen trunks. Indicating that fallen tree trunk open space and
enable new trees to grow from them rather than sprouting from seeds. This natural process of regeneration is important to consider when planning harvestable sizes and number of trees to harvest from a given forest.

During 2009, the TEI team observed or heard at least 12 species of birds in the forest that included 5 endemic bird species and 4 endemic subspecies at Site A in Ongerarekieu. During 2016, the TEI Team observed 14 species of birds including 5 endemic and 5 endemic subspecies at Site A. The number of bird species is considered a critical number based upon the National Bird Protocol. We observed the blue snake *Dendrelaphis lineolatus* (nguis) and the native frog *Platymantis pelewensis* at the forest edge for the first time during an environmental assessment. Most wildlife was seen in the forests rather than the savanna. An alternative configuration of the proposed location at Site A in Ongerarekieu of the National Landfill placed the landfill further south and a greater distance from the adjacent forest and stream on more suitable Type 405 soil. Site A is closer to the national highway or Compact Road, so it can service transfer stations throughout Babeldaob and Koror more effectively with lower costs.

Alternate Site B Ngeruchael

During 2017, alternate Site B at Ngeruchael over 105 species including 84 terrestrial plants, 15 species of birds and at least 6 species of other wildlife were observed or heard on or adjacent **Site B at Ngeruchael**. The 106 species of plants, representing 51 families were found on or near the site. A total of 78 native plants were recorded including 26 plant endemic species at least 4 introduced species of which three are invasive ant other species identified to Genus. This proposed Site A and adjacent forest have at least 19% of Palau’s endemic plants. Water quality had relatively high E.coli bacteria (210-370 MPN) and was turbid (NTU33-36) on February 14, 2017 a day after heavy rain. The streams did not meet EQPB clean water standards for bacteria and turbidity. A total of 129 trees representing 18 species of plants were measured along the transect lines covering an area of 365.76 m². The estimated density of small trees and shrubs was 0.35/m². A total tree and shrub estimated volume of 0.26m³/m². This swamp forest included large *Campnosperma brevipetiolata* (kelelacharm); the ten trees represented 38% of the total tree volume measured. The palm, *Pinanga insignis* (chebouch) was the common understory tree, the 69 trees measured represented 29% of the total volume. Large less common trees were bkau (*Maranthes corymbosa*), chersachel (*Horsfieldia palawensis*), chemeridech (*Cephalomanes nigricans*), tonget (*Semecarpus venenosa*), ngmui (*Stemonurus ammui*), and dekemirr Elaeocarpus joga. Endemic trees and shrubs included tilol (*Garcinia matsu*) Chesemoech (*Calophyllum pelewense*) chelilai (*Fagraea beteroana var. galilai*), udeuid (*Manilkara udoido*), blacheos (*Gmelina palawensis*), kesiku (*Astronidium palawense*) and kesiemel (*Osmyxylon pachyphyllum* and *Osmyxylon truncatum*). Ground cover was dominated by seedlings of chersachel (*H. palauensis*), chebouch (*P. insignis*) and the highly invasive *Heterotis rotundifolia* and *Clidemia hirta*. The small grassy open area leading into Site B and before the forest and near the road was dominated by the grass, *Ischaemum ciliare*, and the ferns *Dicranopteris linearis var. ferruginea* and *Nephrolepis biserrata*. The most common epiphytes were iul, the climbing Pandanus, (*Freycinetia villalobosii*), the liana, toilalech (*Epipremnum carolinense*), and the filmy ferns, *Cephalomanes* genus and the fern *Antrophyum* We observed large tree ferns *Sphaeropteris nigricans* up to 10 m high and 0.7m in diameter. Site B was a typical swamp forest association with similar species as Site A. During 2017, the TEI team observed or heard at least 15 species of birds in the forest that included 7 endemic bird species and 4 endemic subspecies at Site B. The number of bird species is considered a critical number based upon the National Bird Protocol. Native skinks, the native boa snake, *Candoia carinata* and olik, the native fruit bat *Pteropus pelewensis*.

Implementing an effective and successful recycling program through an integrated solid waste plan will reduce the volume of solid waste that enters the proposed National Landfill Site and provide a healthier and cleaner environment to the community. The goal should be zero waste as all materials we use and produce can be reused in Palau or elsewhere in the world. The establishment of a new and well-managed solid waste disposal site in Aimeliik will serve as an incentive for the community to aim towards zero waste. Through a conscientious effort of each resident, most waste can be recycled- if not all. A nation-wide ban on plastic bags will greatly reduce waste entering the proposed National Landfill. The existing unpermitted solid waste sites should be closed immediately with proper capping and physical removal of any wastes that can be recycled while implementing all safety precautions.
No alternative configuration of the proposed location of the National Landfill at Site B was considered as the proposed site includes two blue line streams. Due to the wetness of the area, the design would call for an impermeable contained landfill. This site is near an unpaved secondary that will require a major upgrade to enable transport of waste from transfer stations throughout Babeldaob and Koror. It is important for Palau to aim towards a zero waste policy in which all resources are recycled, reused, and reduced waste. Implementation of the mitigation measures recommended in this assessment will help ensure that the project will have minimal impacts to the Tabechding watershed. Water quality should be monitored regularly to prevent irreversible damage to these freshwater ecosystems.

Implementing an effective and successful recycling program through utilizing the integrated solid waste plan will reduce the volume of solid waste that enters the proposed National Landfill Site and provide a healthier and cleaner environment to the community. The establishment of a new and well-managed solid waste disposal site in Aimeliik will serve as an incentive for the community to aim towards zero waste. Through a conscientious effort of each resident, most waste can be recycled- if not all. A nation-wide ban on plastic bags would greatly reduce waste entering the proposed National Landfill. The existing unpermitted solid waste sites should be closed immediately with proper capping and physical removal of any wastes that can be recycled while implementing all safety precautions.

During a community meeting and a state-wide survey in 2016, there were mixed responses to the Landfill. Some community members only wanted a State landfill and no National Landfill. Others supported the National under the condition that it is built with minimal environmental impacts with financial support and employment priority to Aimeliik State. During the second public hearing, held on July 4, 2017, concepts, designs, biological site assessments and data from social-economic assessment were presented to the community (Appendix 6). During this meeting there was positive response to the development with concerns of quality of life addressed by engineers and members of Public Works, ROP; additional concerns were brought up over land ownership/access that were addressed by the office of the president. The most important factor for people outside Aimeliik was cost of transport of trash to a site further away; and the main concerns brought about by residents of Aimeliik was quality of life issues, such as smell and pestilence. These were addressed through discussion on collection system, ROP-wide; as well as proper management of the facility through Fukuoka method and onsite equipment and daily maintenance, respectively.

3. Introduction

3.1 Identification of the Applicant
The Applicant is the Capitol Improvement Project (CIP) under the Ministry of Public Infrastructure, Industry and Commerce. The proposed National Landfill is at Ngeruchael, Imul Hamlet in Aimeliik State and funded by the National government through JICA funding mechanism.

3.2 Identification of the Environmental Assessment Company that prepared the EA.
The Environment, Inc. was founded in 1993 by Clarence and Ann Kitalong. “The environment is our business.” 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 and a MSc in zoology for the University of Hawaii and a Doctorate from Atlantic International University. Ann has served as project manager since 1993, and also works part-time as Curator of the Belau National Museum herbarium. She has served as 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 26 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 EIS of the Project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>During February 6, 2009, Ann and Clarence Kitalong met Governor Reklai at Aimeliik State. The Governor explained the project and showed the TEI team the location of the proposed solid waste site at Site A Ongerarekieu. We walked along the access from the main road and through the savanna area where the project will be located</td>
<td>February 6, 2009</td>
</tr>
<tr>
<td>Ann Kitalong met with Governor Reklai who provided maps and background information about the proposed Site A Ongerarekieu and existing site for waste disposal.</td>
<td>August 13, 2009</td>
</tr>
<tr>
<td>Qualitative walks around the circumference of the Site A Ongerarekieu and terrestrial surveys using transect lines and walk through adjacent forest and mark location of closest stream and collect water samples.</td>
<td>February 6 and September 1, 2009</td>
</tr>
<tr>
<td>Bird counts and final assessment of forests and streams adjacent to the Site A Ongerarekieu</td>
<td>September 10, 2009</td>
</tr>
<tr>
<td>Status meeting with CIP regarding a national land fill at Site A Ongerarekieu</td>
<td>June 24, 2016</td>
</tr>
<tr>
<td>Field trip to assess freshwater streams and forest especially leachant pond drainage area Site A Ongerarekieu</td>
<td>July 9, 2016</td>
</tr>
<tr>
<td>Water sampling with EQPB and TEI at NE streams Site A Ongerarekieu</td>
<td>July 16, 2016</td>
</tr>
<tr>
<td>Bird Counts, terrestrial assessment, collect GPS coordinates from survey markers Site A Ongerarekieu</td>
<td>August 16, 2016</td>
</tr>
<tr>
<td>Write up EIS report Site A Ongerarekieu</td>
<td>July-August 2016</td>
</tr>
<tr>
<td>Public hearing regarding the proposed National Land fill at Ongerarekieu, Aimeliik State where Site B Ngeruchael was proposed as an alternative Site B Ngeruchael</td>
<td>November 15, 2016</td>
</tr>
<tr>
<td>Clarence Kitalong went to proposed alternative Site B at Ngeruchael with Governor Obak Demei, Director of the Bureau of Public Works (BPW) , Brian Melairei and BPW staff</td>
<td>November 2016</td>
</tr>
<tr>
<td>Preliminary visit to Site B By TEI</td>
<td>January 12, 2017</td>
</tr>
<tr>
<td>Bird Count at Site B Ngeruchael By TEI BY TEI</td>
<td>January 24, 2017</td>
</tr>
<tr>
<td>Qualitative walks through the Site B Ngeruchael</td>
<td>February 6, 2017</td>
</tr>
<tr>
<td>Christopher Kitalong met with Brian Melairei regarding Site A at Ongerarekieu and Site B Ngeruchael</td>
<td>February 2017</td>
</tr>
<tr>
<td>Set transect from start of forest to running water source Site B Ngeruchael</td>
<td>February 8, 2017</td>
</tr>
<tr>
<td>Collect water samples at two stations at Site B Ngeruchael</td>
<td>February 14, 2017</td>
</tr>
<tr>
<td>Ground cover and final plant checklist</td>
<td>February 15, 2017</td>
</tr>
<tr>
<td>Write up EIS report Site B Ngeruchael</td>
<td>March 2017</td>
</tr>
<tr>
<td>Japan engineering group site assessment/design review (topography,geology,design)</td>
<td>June 2017</td>
</tr>
<tr>
<td>Japan engineering meeting to discuss design options</td>
<td>July 2017</td>
</tr>
<tr>
<td>Final community consultation</td>
<td>July 4, 2017</td>
</tr>
<tr>
<td>EIS review and incorporation of addition data and socio-economic information</td>
<td>August, 2017</td>
</tr>
<tr>
<td>Japanese Engineering Design received</td>
<td>December 2017</td>
</tr>
</tbody>
</table>

### 3.4 Summary List of assessment methodology used for the land-based and water-based assessment of the project.

During 2016, the CIP office of MPIIC awarded TEI with a contract to conduct and Environmental Impact Statement for a proposed National Landfill at the original Site A at Ongerarekieu in Imul Hamlet, Aimeliik
State. The TEI team conducted 3 site visits to expand upon the 2009 species checklist, conduct additional water testing, and survey the community regarding the national landfill. In 2016, the TEI Team worked with EQPB laboratory to measure temperature, turbidity, salinity, Total Dissolved Solids, Total coliform, and E.coli. A public hearing was held on November 15, 2016 in which an alternative Site B at Ngeruchael was suggested. During January and February 2017, the alternative site was assessed. Both Site A at Ongerarekieu and Site B, Ngeruchael are located within the upper watershed of Ngeremeduu Bay. Refer to Figures 1a-b. Additional water quality information is provided in appendix performed by Japanese engineering group.

Figure 1a Satellite image showing Site A at Ongerarekieu outlined in sky-blue labelled Location A, the alternative Site B Ngeruchael outlined in red and approximately 1,000 m to the Northwest of Site
4. Detailed Project Description

The proposed project description is given below. Refer to the Site Maps (Figure 1a-d, 2-9, 10a-d.)

A. The construction of a 235-meter long by 5-meter high earth berm with slope formation.
   1. Site Limit Fence shall be built to delimit entire Solid Waste site.
   2. Slope formation shall be built using on site earth materials.
   3. Gravel capped 1.2-meter wide earth swale at the toe of the slope lined with 10 cm thick gravel. There would be drop inlets, cross drains, riprap linings to direct the run-off to natural waterways from the site.
   4. Hydro seeding and/or planting of vegetation on slope formations to absorb nutrients and stabilize slopes.

B. Construction of a 450 meter by 5-meter wide gravel capped access road.
   1. The road shall start from the State main road to the disposal area following the perimeter of site.
   2. Capping material shall be 15 cm thick with base course.
   3. Berms shall be built on the highly sloped areas with cut materials to divert flow towards the Leaching Pond (plant material will be planted to stabilize berms).

C. Construction of Leachate Collection Pond
   1. The leaching field shall extend along the NW side of the site and 4 meter deep
   2. The surface of the leaching pond shall be lined with non-woven geo-textile and 1-mm thick PVC lining
3. Aeration system shall be installed
4. Leachate circulation system with duplex submersible pump shall be installed including the control housing
5. The whole leaching pond shall be fenced with 1.8 meter high chain-link fence

D. Volume cuts.
1. Deposit site will be established on-site towards the opposite end of the leachate pond and sediment trapping/moats will be developed to reduce sediment run-off from material.
2. Cuts for landfill will begin from section closest to leachate pond and progress further away with vent pipe installations as well (In Concept design); Operational will either follow Phase I => Phase II => Phase III development or have a single cut phase and deposit site for all cut material to use in daily or weekly covers of solid waste material.
3. If excess volume cut material is made an offsite location will be identified by contractor and will follow strict sediment control guidelines.

E. Installation of leachate and vent pipes.
1. A 78 meter long 450 cm Ø HDPE main leachate pipes (perforated shall be installed at the middle of the disposal area to the leachate pond
2. Leachate pipes shall have 200 cm thick 50 mm gravel bedding and wrapped in a non-woven geotextile fabric. Geotextile fabric shall be Mirafi 180 N Nonwoven Polypropylene Geotextiles. Fabric overlap at the joints shall be at least 20-cm.
3. Two (2) each 3-meter high 30-cm Ø HDPE branch vent pipes (perforated) shall be installed on the main leachate pipe. Vent pipes shall be encased with perforated used 24 inch Ø used metal drum filled with 50 mm well-graded gravel. The top of the vent pipes shall be covered with geotextile fabrics.
4. Two (20 each 67 meter long 20-cm Ø HDPE branch leachate pipes (perforated) shall be installed on the main leachate pipe. Each branch pipe shall have two (2) vent pips
5. All Ø HDPE pipes shall be N-12 WT (water tight) IB (integral bell) or equivalent
6. Provide a reinforced concrete junction box at the connection points of branch pipes, vent pipe and leaching pipe.
Figure 1c Proposed design of landfill for Site A Ongerarekieu
4.1. Goals and Objective
The Goal of the project is to provide the Aimeliik community and Republic of Palau that will have a minimal impact to the surrounding environment. The purpose of this study is to assess the environmental impact of a national landfill to the upper tributary of the Tabechding River. The Objective is to successfully complete all national requirements to implement this project through the completion of an Environmental Assessment with the following scope of work includes the following deliverables:

a) General Distribution of Habitats and Habitat map. Refer to Section B and attached 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

General Site Description
The Sites A and B are located at the southwest end of Babeldaob in Aimeliik State (Figures 1-6). This watershed consists of grasslands, pastureland, agroforests and riverine forest with tributaries of the Tabechding River that flows to the north 2.6km into an adjacent mangrove channel or "taoch" that flows into the Ngeremeduu Bay. To the east, there is the Ngerderar River Watershed with mangroves 1.8km from the site. The Compact or National Highway is about 430m from the site making transport of recycled wastes more convenient by road. This site is not within of the Ngaremeduu Conservation Area or the national land set aside for forestry and agriculture.

Figure 1d. 1983 US Geological Survey Map showing the Tabechding Watershed circled in red and the site marked in a red square and Site A Ongerarekieu indicated with call out label and red square
Figure 2 2016 Satellite image of Babeldaob showing location of Site A on southwest part of island

Figure 3 Site map showing proposed national landfill site at Site A Ongerarekieu in red and Tabechding River and tributaries
Figure 4 Habitat map showing a satellite image (2006 ©QuickBird Satellite Imagery) with proposed 2009 Aimeliik State solid waste disposal site at Site A and an alternative configuration further from southeastern tributary. The Compact road is about 430m SE.

Figure 5 Bureau of Lands and Survey map of the proposed 2009 Aimeliik State Solid Waste Disposal Site at Site A Ongerarekieu.
Figure 6 Bureau of Lands and Survey Contour Map of Proposed 2009 Aimeliik State Solid Waste Disposal Site
Figure 7 Satellite image of site showing the 2009 proposed Aimeliik State Solid Waste Disposal site and alternate spot that is further from the stream and has more savanna buffer and no forest removal. W1 is at 07° 26.140, 134° 31.403 W2 is at 07° 26 140 134° 31.409
Figure 8 Satellite image of site showing newly proposed National Landfill at Site A Ongerarekieu
4.3 Total Area to be disturbed by the project

Site A Ongerarekieu and B Ngeruchael
The newly proposed 2017 National Landfill in Aimeliik State for both Sites A and B Ngeruchael would impact an area of 80,000m$^2$.

Site A Ongerarekieu
At Site A Ongerarekieu, at least 45,000m$^2$ of this site (56%) is forested along an estimated 30 to 60 m width of the boundary in all directions to. An estimated 35,000m$^2$ of this site (44%) is savanna which is mainly the central area where most of the earthmoving is proposed. The northeastern area of the site will impact more forest for the proposed berm and leaching treatment zone. The compact road is about 430m from the access road. The distance of a NW tributary of the Tabechding River from the proposed leachate pond and treatment site was 85 meters. In 2016, the proposed project for this initial phase will impact approximately 5,300 m$^2$ of forest for the disposal area and leaching pond and 1,200 m$^2$ of forest for the access road. The area of savanna that will be directly impacted will be at least 8,000 m$^2$ for the disposal area and 1,000 m$^2$ for the access road. Therefore, at least 6,500m$^2$ of forest and 9,000 m$^2$ of savanna will be impacted during the initial construction phase of the proposed landfill. This is an estimated 15,500m$^2$. As other infrastructure is incorporated in later phases of the proposed landfill, more of the 80,000 m$^2$ habitat will be directly impacted.
In 2009, the proposed location for the Aimeliik State solid waste disposal site would directly impacted an area of 5,282 m² of which at least one third of the area or 1,584.6 m² is forest and two thirds is savanna or 3,697.4 m². In addition, a badly eroding access road of 175 m was proposed to be further graded and widened to estimated width of 3m or 420 m² removing savanna vegetation: the total area of 5,702 m² of which 1,584.6 is forest and 4,117.4 is savanna with some barren soil along the existing access road. The proposed road and solid waste site is within savanna and forest habitat.

The compact road is about 430m from the access road. The distances of three tributaries of the Tabechding River from the proposed site are as follows: 244m to the NE tributary, 247m to NW tributary and 132m to the SE tributary. The distance of the water sampling stations from the site along the NE drainage were 88 m from W1, 201m from W2 and 169 from W3.

**Site B Ngeruchael**

4.3.1 Volume of soil to be excavated or used as Fill
Please refer to the attachments.

4.3.2 Source of fill materials to be used for the project
Please refer to the attachments.

4.3.3 Soil disposal site and method to dispose soil/waste material
Please refer to the attachments.

4.4 Detailed description including site development plan for all physical facilities to be constructed
Please refer to the attachments.

4.5 Description of Project Phases
Please refer to the attachments.

4.5.1 Pre Construction Phase
Please refer to the attachments.

4.5.2 Construction Phase
Please refer to the attachments.

4.5.3 Operational Phases
Please refer to the attachments.

4.5.4 Abandonment Phase
No abandonment phase is planned. A legally binding contract between Aimeliik State and the National Government will be drawn up.

4.6 Project Schedule/Duration of activity
Please refer to the attachments.

4.7 Project Cost.
To be determined after JICA feasibility study
5. Project Alternatives  
Comparisons of Project Alternatives for each significant Biological Resource Impact

Section I.

5.1 The alternative of no action.
This would result in leaving the site undisturbed. The existing community in Aimeliik would continue to use this watershed for sustainable harvest of wood and as a potential future water source.

5.2 Alternative sites
Aimeliik State has addressed alternative sites for the national landfill which would also serve Aimeliik State (Telesource International and Winzler and Kelly 2004). However both sites were not chosen because one site was within the conservation area near the Tabechding River and the second site was a homestead site. This site is not within the conservation areas yet it is in the upper watershed of the Tabechding and public land of Aimeliik State (Governor Reklai, pers. comm.). This upper watershed of the Tabechding River is a sensitive area and proper design and placement of the proposed National Landfill is critical.

In 2017, Aimeliik State is addressing two alternative sites for a national landfill. Site A was proposed for an Aimeliik State Landfill site in 2009 and then proposed by the former Governor of Aimeliik as a member of the Solid Waste Task Force as a potential site for a landfill. In 2016 Site A was reassessed for a large-scale landfill and EIS was drafted. During a public hearing an alternative site was suggested by the governor, Site B. During late 2016 and 2017 Site B was assessed for a landfill.

5.3 Alternative and equally suitable projects, methods or processes
TEI has the following recommendations for methods and processes:

1) TEI recommends Site A rather than Site B because Site B will directly impact two blue line streams of the upper tributary of the Tabechding River. Site A will indirectly impact an upper tributary that is 132m away from the site. Site B will impact more swamp forest area (15,500 m²) compared to Site A (6,500 m²). Both sites have high diversity of plants and animals. Site A is at a higher elevation and over 58% of initial phase is on savanna with few trees. Site A is also closer (430m) to the compact road than Site B (2,130m) d will therefore be less costly for road construction and long term transport of wastes to the site. Both sites have soil types with severe conditions for landfill construction. Refer to Table 1.

An alternative process would be to use the proposed site as a recycling center and transfer station. This site is near the main road and compact road so wastes can be transferred to the existing national landfill in Koror and the proposed national landfill in the future. This method will result in no wastes placed permanently in Aimeliik.

2) At Site A, the placement of the landfill could be reconfigured (shown in appendix as alternate design) so it is away from the northeastern tributary and the forests and partially placed within 405 type soil that is less steep. In addition, do not divert leachate to natural waterways, but contain all leachate on site and recycle through landfill. Site B would be difficult to reconfigure, as the site is a swamp forest that is low, wet and flat.

3) Implement the proposed National solid waste management plan developed Golder and Associates as well as Solid Waste Management Plan reviewed in 2015/2016. Secure funding and implement this plan before/during the development of the new national landfill to ensure that minimal to zero waste is placed at the National Landfill. The Program should include a full-scale community awareness and education program in partnership with all 16 States. The program should include community-based construction of receptacles for at least two types of recyclable waste- aluminum, plastics for each home, school and public facilities. State sanitation officers should be certified through a national program through EQPB in partnership with either national or international specialists in recycling, reusing and reducing waste management. Conduct a State-wide household and commercial sanitation inspections on an annual basis.
with prizes for the most beautiful and clean homes and businesses that demonstrate excellent recycling and composting in place. Prizes can be awarded during Earth Day each year. The following items can and should be recycled: branches less than 6 inch in diameter and leaves of trees, aluminum cans, plastics drinking bottles, other types of plastic, newspapers, cardboards, scrape metal, appliances an organic wastes. Private companies and the National Solid Waste Site are currently recycling many of these items. Set up a transfer station and recycling center in conjunction with the National Landfill. Developing a proper collection system that is managed by private contractor may allow for more accountability and create economic association with solid waste management. Furthermore, as provided for appendix a method for solid transfer and closure of state landfills will help to consolidate and properly manage waste will increase efficiency of solid waste management programs.

4) Develop within the existing footprint of the access road and National Landfill Site. Minimize or avoid removal of vegetation and large native trees and bushes on site. The site should include a compost area, and recycling areas with roofing to keep items dry during heavy rains. There should be a gate and regular operating hours to avoid non-compliance of regulations about recycling and proper disposal. The site needs a designated stockpile area with proper containment for regular covering of materials that remain on site. The goal is to minimize this waste as much as possible through an efficient and successions 3R (recycle, reduce and reuse) program as is being implemented in Koror State.

5) Design a closed leachate system so all leachate remains on site and is removed from the site and does not enter the watershed adjacent to it. If funding is available, set up a leachate treatment system that has minimal maintenance requirements.

6) Design drainage that diverts rainwater away from the proposed National Landfill so that rain does not enter the site. In doing so, do not disrupt the natural drainage of the adjacent tributaries of the Tabechding River.

7) All sediment control infrastructure must be in place and monitored daily before construction begins.

8) Set up a stockpile site for soil for regular cover of waste and remove all excess soil or construction materials upon completion of the National Landfill and support Facility.

9) Set aside the surrounding upper watershed of this site for Aimeliik as a conservation area with support from the Watershed Alliance initiative in Babeldaob.

10) Implement the national management plan and secure finance for required budget to operate and maintain the landfill.

11) Conduct routine leachate measurements and water quality measurements to determine annual flow rates during dry and wet season.

12) Post public notices about water quality and warnings when necessary when water quality is unacceptable for use.

13) Inform the community by radio and meetings about the importance of doing their part at home to reduce the amount of solid waste site by practicing the three R’s – Reduce, Reuse and Recycle.

14) Close existing solid waste disposal sites in Palau immediately and set up a statewide transfer system for different types of wastes that can be transported by truck to the National Waste Center.

15) Incorporate more frequent weather extremes such as drought and flooding when designing the drainage systems for surface runoff from heavy rainfall, solid waste storage and leachate management.

16. Pave the badly eroding access road as sediment is flowing directly into the SE end of this site into the upper Tabechding Water shed.
17) Prioritize employment for Aimeliik state residents and have regular community meetings to assess long-term benefit of the facility and its impact on residents.

18) Set up a sustainable financing mechanism for the landfill through taxation in incoming materials to guarantee that what is brought in covers what is thrown away.

5.4. Matrix to Compare Two Sites in Aimeliik for National Landfill

<table>
<thead>
<tr>
<th>Parameters to compare</th>
<th>Site A - Initial Site</th>
<th>Site B new alternative site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from Blue line stream</td>
<td>The distances of three tributaries of the Tabcheding River from proposed site are as follows: 244m to the NE tributary, 247m to NW tributary and 132m to the SE tributary.</td>
<td>Streams are currently within the site.</td>
</tr>
<tr>
<td>Total distance from public drinking water source</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Distance from dwellings</td>
<td>2,689m</td>
<td>1,651m</td>
</tr>
<tr>
<td>Distance from fault lines</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Total area of site</td>
<td>80,000 m²</td>
<td>80,000 m²</td>
</tr>
<tr>
<td>Total area to be used for initial phase</td>
<td>15,500m²</td>
<td>15,500m²</td>
</tr>
<tr>
<td>Forest</td>
<td>6,500m²</td>
<td>15,500m²</td>
</tr>
<tr>
<td>Savanna</td>
<td>9,000m²</td>
<td>0</td>
</tr>
<tr>
<td>Total Area of Site to be directly impacted</td>
<td>5,702 m²</td>
<td>5,702 m²</td>
</tr>
<tr>
<td>Savanna directly impacted</td>
<td>4,117 m²</td>
<td>0</td>
</tr>
<tr>
<td>Forest directly impacted</td>
<td>1,584.6 m²</td>
<td>5,702 m²</td>
</tr>
<tr>
<td>Total area for each soil type on the site directly impacted</td>
<td>400 0</td>
<td>8627 m²</td>
</tr>
<tr>
<td></td>
<td>401 12532</td>
<td>63282</td>
</tr>
<tr>
<td></td>
<td>402 29615</td>
<td>7019</td>
</tr>
<tr>
<td></td>
<td>405 12455</td>
<td>708</td>
</tr>
<tr>
<td></td>
<td>406 25032</td>
<td>0</td>
</tr>
<tr>
<td>Total area for each vegetation site directly impacted</td>
<td>5,702 m²</td>
<td>5,702 m²</td>
</tr>
<tr>
<td>Volume for Landfill</td>
<td>1.5 million cu. meters</td>
<td>142,000 cu. meters</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>&gt;40 years (with new conceptual design)</td>
<td>&lt;10 years</td>
</tr>
<tr>
<td>Eroding Access road habitat type and area</td>
<td>Pre-disturbed Savanna area of 420m²</td>
<td>Forested Area at Site and &gt;10,200 m² of gravel access road development (6m x 1800 m distance extra)</td>
</tr>
<tr>
<td>Distance to Compact road</td>
<td>430m</td>
<td>2,130m</td>
</tr>
<tr>
<td>Total distance from site to Koror Waste disposal site</td>
<td>17,240m</td>
<td>18,940m</td>
</tr>
<tr>
<td>Total number of species recorded</td>
<td>129</td>
<td>105</td>
</tr>
<tr>
<td>Total species of plants/N/E/I</td>
<td>106 species: 74 Native/23 Endemic/6</td>
<td>85 species: 78 Native/5 endemic/1 introduced</td>
</tr>
</tbody>
</table>
### Total Species of Birds
- Proposed Site A: 16 endemic, 5 endemic subspecies
- Proposed Site B: 15/7 endemic and 4 endemic subspecies

### Total estimated volume of tree
- Proposed Site A: 28% forested
- Proposed Site B: 100% forested

### Total estimated density of tree at site
- Proposed Site A: 0.10 per square meter
- Proposed Site B: 0.35 per square meter

### Other proposed or potential use of site
- Proposed Site A: Capital building
- Proposed Site B: Disposal area for old cars

### Past use of site
- Proposed Site A: Coconut farm, historical unknown
- Proposed Site B: Disposal area for old cars

### Water quality of adjacent stream
- Proposed Site A: Ecoli 460 to >2400 MPN
- Proposed Site B: Ecoli 210 to 370 MPN (not as polluted)

### Community support
- Proposed Site A: Majority of Aimeliik residents interviewed in favor
- Proposed Site B: n/a suggested from government as alternative site

### Total cost to construct land fill,
- Proposed Site A: Set Cost based on final design: conceptual design and basic cut completed (including survey)
- Proposed Site B: Additional, conceptual design and road/access development = approximately (pre-costing for conceptual design, full topo-survey wetland review (flow studies)

### Total cost to construct access road on site
- Proposed Site A: Semi built only needs to be paved and possibility recut
- Proposed Site B: No current access road

### Total cost of road to site
- Proposed Site A: Already built and paved
- Proposed Site B: Pave additional 1.8 km of road that is currently gravel

### Total annual cost to for operations and management of landfill
- Proposed Site A: Set cost based on final design
- Proposed Site B: Additional cost for transport and road maintenance

### Estimated additional cost:
- Proposed Site A: Set Cost based on design
- Proposed Site B: >500000 for conceptual design and extra access work and site preparation

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6. Description of Environmental Setting

Without (Before) the Project (including conditions on and adjacent to the proposed site)

**Previous Impacts**

**Site A Ongerarekieu** The proposed site has an existing access road. No previous impacts are known to TEI at this time.

**Site B Ngeruchael** previously used to dispose of old vehicles and drums
6.1 Photoplates of Sites

PHOTOPLATE 1 2009 ACCESS ROAD AND VIEW OF SITE
PHOTOPLATE 2 2009 SAVANNA HABITAT AND TRANSECTS at SITE A
Ongerarekieu, Aimeliik State
Highly eroding natural bank at forest edge  
*Platymantis pelewensis* endemic frog

PHOTOPLATE 3 2009 FOREST HABITAT TO THE NORTH OF THE SITE WITH WATER SAMPLING STATIONS for Site A Ongerarekieu
PHOTOPLATE 4 Site A Ongerarekieu access road, western and southeastern forests and streams on September 10, 2009
Photoplate 5  Overview of Site A Ongerarekieu National Landfill on July 9, 2016

Southern view with access road approaching site

Northern view from top of hill and CRP marker

Northeastern view

Northwestern View of site

View of Ngermeduu Bay in background with coconut plantation in foreground  Site A
<table>
<thead>
<tr>
<th>Photoplate 6</th>
<th>Water sampling stations at Site A Ongerarekieu National Landfill and native species on July 9, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE Stream by water sampling Station 1</td>
<td>NE stream by water sampling Stations 2 and 3 - with distinct depressions in volcanic rock</td>
</tr>
<tr>
<td><em>Spathoglottis carolinensis</em></td>
<td><em>Phyllanthus otobedii</em></td>
</tr>
<tr>
<td><em>Timonius subauritus</em></td>
<td><em>Finschia chloroxantha</em></td>
</tr>
</tbody>
</table>
### Photoplate 7 Invasive Species at Site A Ongerarekieu

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Timonius timon</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Leucaena leucocephala</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Clidemia hirta</strong></td>
<td></td>
</tr>
</tbody>
</table>
Photoplate 8 Site B Ngeruchael showing forest habitats and plants February 2017

- Transect into forest showing invasive *Clidemia* in foreground from road to
- Local boa snake, *Candoia carinata*
- Large kelelacharm, *Campnosperma brevipetiolata*
- Large tree fern *Sphaeropteris nigricans*
- *Pinanga insignis* seedlings
- Invasive *Heterotis rotundifolia*
Photoplate 9 Water sampling stations for Site B Ngeruchael
6.2 Physical Environment

Physical structures
There are no existing physical structures on site.

Soils

Site A Ongerarekieu
The main soil types are 406 on which the proposed site is on shown in light brown. Soil type 405 is immediately adjacent to the northern end of the site. The soil types 401 and 402 are near to the site (Figure 7). Below is a listing of these soil types and area covered by site. The information about these soil types is taken from: Smith C. W. 1983. Soil survey of Islands of Palau Republic of Palau. Soil Conservation Service USDA.

![Soil map of Site A Ongerarekieu in 2016 at waypoints through drainage.](image)
Site B Ngeruchael
The soil types at Site B included some similar soil types (401, 402, 405) however Site B had Soil Types 400 and no soil type 405. The main difference was that Site B has less sloped soil with the majority of the land with 12 to 30% slopes.

Proposed National Landfill, Site B
Figure 10c Soil types for proposed Site B Ngeruchael with design overlaid on soil map and blue line streams.
Figure 10d Alternate configuration with landfill further west of the blue line streams.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Sanitary Landfill</th>
<th>Slope</th>
<th>Site A Ongerarekieu</th>
<th>Site B Ngeruchael</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>Severe- seepage</td>
<td>6 to 12%</td>
<td>0</td>
<td>8,627</td>
</tr>
<tr>
<td>401</td>
<td>Severe seepages, slope</td>
<td>12 to 30%</td>
<td>12,532</td>
<td>63,282</td>
</tr>
<tr>
<td>402</td>
<td>Severe seepages, slope</td>
<td>30 to 50%</td>
<td>29,615</td>
<td>7,019</td>
</tr>
<tr>
<td>405</td>
<td>Severe seepages, slope</td>
<td>6 to 12%</td>
<td>12,455</td>
<td>708</td>
</tr>
<tr>
<td>406</td>
<td>Severe seepages, slope</td>
<td>12 to 30%</td>
<td>25,032</td>
<td></td>
</tr>
</tbody>
</table>

Soil Type 400 Aimeliik- Palau complex 6 to 12% slope has native vegetation and is mainly tropical forest. Cleared areas support savanna vegetation. The unit is 60% Aimeliik silt loam and 30% Palau silty clay loam. Included in this unit are small areas of Babeldaob soil on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained, and are in drainage ways and other concave area. Some areas have been deeply cut and underlying material is exposed. A few large boulders are on the surface of the soil or buried in the soil profile. The Aimeliik and Palau soil is very deep and well-drained and derived from volcanic rock. The soil permeability is moderately rapid. Effective rooting depth is 150 cm or more. If vegetation is removed, runoff is medium and the hazard of water erosion is moderate. Most of this area is watershed and can be used for pasture, crops and woodland. A few areas can be used for home site and garden crops. This soil is well suited for pasture, subsistence agriculture and forest crop production. This site is well suited for home site main limitation is slope and low soil strength. If buildings and roads are built, the low soil strength can be improved with adequate amounts crushed coral or basalt. Structures to divert runoff are needed. All soil materials need to dry sufficiently before filling and compacting areas of this unit. This unit can be used for septic systems. The soil type is unsuitable for a sanitary landfill.
Soil type was 401 Aimeliik–Palau Complex with a 12 to 30% slope has native vegetation that mainly tropical forest. Cleared areas support savanna vegetation. The unit is 60% Aimeliik silt loam and 30% Palau silty clay loam. Included in this unit are small areas of Babeldaob soil on ridges and small convex knolls in areas of grassland, Ngardok soils, and soils that are moderately well drained to somewhat poorly drained and in drainage ways and other concave area. Some areas have been deeply cut and underlying material is exposed. A few large boulders are on the surface of the soil or buried in the soil profile. The Aimeliik and Palau soil is very deep and well-drained and derived from volcanic rock. The soil permeability is moderately rapid. Effective rooting depth is 150 cm or more. If vegetation is removed, runoff is medium and the hazard of water erosion is moderate. Most of this area is watershed and can be used for pasture, crops, and woodland. A few areas can be used for home site and garden crops. This soil is well suited for pasture, subsistence agriculture and forest crop production. This site is poorly suited for home site development due to the slope and low soil strength. If buildings and roads are built, the low soil strength can be improved with adequate amounts crushed coral or basalt. Structures to divert runoff are needed. All soil materials need to dry sufficiently before filling and compacting areas of this unit. This unit is poorly suited to on-site waste disposal. The main limitations are slope and the hazard of lateral seepage. The soil type is well suited for a sanitary landfill.

402 Aimeliik-Palau Complex has a 30–50% slope with native vegetation that is mainly forest and cleared areas that support savanna vegetation. This unit includes small area of grasslands, Ngardok soils and somewhat poorly drained to moderately well-drained soils. The Aimeliik and Palau soil is very deep and well drained with moderately rapid permeability. Effective rooting is 150-cm. Runoff is rapid and the hazard of water erosion is high. Most of this area is watershed. Some areas are used for farmland and are moderately suited as pasture. The soil has low fertility and the erosion and soil degradation are hazards due to the slope. This area is poorly suited for home sites. Road requires the use of crushed basalt. Structures to divert runoff are needed. This unit is poorly suited for on-site waste disposal. Deep well-type leaching pits can be used where the depth to bedrock is greater than 6m.

The 405 Babelthuap-Ngarmau soil type has a 6 to 12% slope on ridges and upper side slopes and covers 5% of the pipe alignment. The vegetation is deteriorated savanna. The soil is very deep and well drained and derived from volcanic rock. The soil permeability is moderately rapid. Effective rooting depth is 150 cm or more. Removal of vegetation causes slow to medium runoff and a slight hazard to water erosion. This unit is mostly watershed and used for pasture and farmland and woodland if properly managed. This soil is well suited to woodland species tolerant to low soil fertility. Reforestation is needed. This unit is well suited to home site development. The main limitations are slope and low soil strength. Adequate amounts of crushed coral and basalt can strengthen the soil. Structures to divert runoff are needed. Allow the soil material to dry sufficiently before filling and compacting the areas. Septic tanks absorption fields need to be placed in the less sloping areas. Leach lines need to be placed along the contour. Avoid using pit leaching wherever possible.

Soil type 406 Babeldaob-Ngarmau with a 12 to 30% slope covers about 100% of the proposed site. The vegetation is mainly savanna. The soil is very deep, well-drained and derived from volcanic rock. The soil permeability is moderately rapid. Effective rooting depth is 150 cm or more. If vegetation is removed, runoff is medium and the hazard of water erosion is moderate. Most of this area is watershed. This soil unit is poorly suited to pasture. The main limitations are very low soil fertility and large amount of gravel on and in the surface layer. This unit is productive if the gravel is cleared and organic matter is added. This unit is well suited to woodland species tolerant of very low soil fertility. Reforestation is needed. This unit is moderately suited to home site development. If buildings and roads are built, the low soil strength can be improved with adequate amounts crushed coral or basalt. Structures to divert runoff are needed. All soil materials need to dry sufficiently before filling and compacting areas of this unit. This unit is poorly suited to on-site waste disposal. Place leach lines on the contour and avoid using pit leaching. This soil type is unsuitable for a sanitary landfill.

6.2 Biological Environment
Site A Ongerarekieu The distances of three tributaries of the Tabechding River from proposed site are as follows: 244m to the NE tributary, 247m to NW tributary and 132m to the SE tributary. We propose shifting in the location of the solid waste disposal site towards the northwest to move it further from the SE tributary and forests and more within 405 type soils are less steep. These streams flow north 2.6 km into at mangrove channel or “taoch” that flows into the Ngaremeduu Bay. This site is not within the Ngaremeduu Conservation Area or the national land set aside for forestry and agriculture.

Site B Ngeruchael The proposed site includes the upper tributaries of two blue line streams that flow into the Tabechding River. The landfill will directly impact these two blue line streams.

Water quality

Site A Ongerarekieu During 2009, the water quality for the freshwater streams was measured at the northern tributary (Photoplate 3). The values in Table 1a show that the dissolved oxygen (mean of 6.09 mg/l), temperature (mean of 26.7°C) are at acceptable levels. The pH (mean of 6.4) may be slightly acidic tannic acids from leaves in the stream. The turbidity was relatively low (mean of 2.6 NTU). These values were normal for dry conditions in freshwater tropical streams. During September 10, 2009, we observed sediments flowing into the SE Forest along the main road and observed much clay sediment within the wetland area. The access road needs to be paved to prevent sedimentation into this tributary. During July 16, 2016 water quality was measured in similar location as 2009 and very high coliform counts were measured. Refer to Table 1b.

Site B Ngeruchael The water quality at Site B was tested for some of the same parameters using similar methods in 2017 as Site A during 2016. Site B Ngeruchael had less E.coli than one station at Site A but more than two other stations at Site A. The turbidity was and higher at Site B however the total dissolved solids were similar between the two sites. Site B did not meet EQPB standards for drinking water.

Figure 11 Site Map for Alternative Site A indicated by a yellow star and B indicated by a Red Star
Table 1a Water Quality measurements taken Sept 1, 2009 at Site A, Ongerarekieu

<table>
<thead>
<tr>
<th>Sample</th>
<th>Location</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Temperature °C</th>
<th>pH</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>07° 26.140, 134° 31.403</td>
<td>5.74</td>
<td>26.8</td>
<td>6.5</td>
<td>2.24</td>
</tr>
<tr>
<td>W1</td>
<td></td>
<td>5.79</td>
<td></td>
<td>6.4</td>
<td>2.38</td>
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Table 1b Water quality testing during July 16, 2016 at Site A, Ongerarekieu The location L1 N 07.43628 E134.52391, sample L2 was N 07.43558 E134.52328 L3 was approximately 7 meters southeast of L2.
Palau EQPB Water Quality Laboratory Test Results

TEI Testing - Aimeliik

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>Time</th>
<th>Sample ID</th>
<th>Total Coliform Bacteria</th>
<th>E. coli</th>
<th>Turbidity</th>
<th>Temperature</th>
<th>Salinity</th>
<th>TDS</th>
<th>Conductivity</th>
<th>Sample Type</th>
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<td>13</td>
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<td>26.3</td>
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Analysis No. | Parameter          | Method          | Equipment
1             | Total coliform    | IDEXX Colilert Method | Incubator 35.0 +/- 0.5°Celsius
2             | E. coli           | IDEXX Colilert Method | Incubator 35.0 +/- 0.5°Celsius
3             | Turbidity         | EPA Method 180.1     | 2100P Turbidimeter Hash
4             | Temperature       | Meter, in situ      | Orion 142
5             | Salthinity        | Meter, in situ      | Orion 142
6             | Total Dissolved Solids | Meter, in situ | Orion 142
7             | Conductivity      | Meter, in situ      | Orion 142

Released by: M. K. Ngirohechel
Date: 7/18/2018
Table 1c Water quality testing during July 16, 2016 at Site B Ongerarekieu The location L1 N 07.44220 E134.52199, sample L2 was N 07.442110 E134.52122.

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### Terrestrial Site A Ongerarekieu

There were two major ecosystems at the site: grassland and lowland forest at Site A Ongerarekieu (Table 2-4, Photoplates1-7). The grasslands were dominated by the fern, *Dicranopteris linearis* var. *ferruginea* (itouch) and *Lycopodiella cernua* (olochouila beab) and the shrub, *Eurya japonica* var. *nitida* (cheskiik). The riparian areas near the streams adjacent to the site included palm *Pinanga insignis* (chebouch) and fern tree *Sphaeropteris nigricans*. The largest trees were *Campanosperma brevipetiolata* (kelelacharm), *Maranthes corymbosa* (bkau), *Manilkara udoido* (udeuid), *Ormosa calavensis* (chedebungelked), *Semecarpus venenosa* (tonget), *Elaeocarpus joga* (dekmerek) and *Horsfieldia palauensis* (chersachel). The smaller *Pandanus aimiriikensis* and *Osmoxylon pachyphyllum* (kesiamel) and *Ixora casei* were found as well. Immediately surrounding the forest is secondary vegetation including *Macaranga carolinensis* (bedel), *Cerbera manghas* (chemeridech) and *Rhus taitensis* (eues). Disturbed areas of the old access road were characterized by secondary vegetation including ferns, grasses and sedges.

The adjacent forest included large endemic trees of fruiting *Garcinia matsudai* (tilol), *Calophyllum pelewense* (chesemolech), *Fagraea ksid* (ksid), and *Manilkara udoido* (udeuid) and *Gmelina palawensis* (blacheos). The smaller endemic *Osmoxylon pachyphyllum* (kesiamel) and fern trees *Sphaeropteris nigricans* (chelu) and *Pinanga insignis* (chebouch) were common understory trees. Ferns and saplings dominated the ground cover. Ferns, orchids and vines were the dominate epiphytes (Photoplate 3). We made frequent observation of large fallen trees with large root systems. These large endemic trees had several tree growing from each fallen trunks. Showing that fallen tree trunk open space and enable new trees to grow from them rather than sprouting from seeds. This natural process of regeneration is important to consider when planning harvestable sizes and number of trees to harvest from a given forest.

During 2016, the TEI team also observed *Finschia chloroxantha*, the only plant in the Proteaceae Family, within the savanna area. The native *Spathoglottis carolinensis* was also observed. Refer to Photoplate 6. During, 2016, the TEI team also observed several invasive species along the access road including *Timonius timon*, and *Leucaena leucocephala*. In the forest area we observed the invasive plant *Clidemia hirta*. Refer to Photoplate 7.
Sensitive habitats and wildlife corridors

Terrestrial

Site A Ongerarekieu

In 2016, at least 6,500m² of forest and 9,000m² of savanna will be impacted for the initial phase of the proposed landfill. This is an estimated total area of 15,500m². As other infrastructure is incorporated in later phases of the proposed landfill, more of the 80,000 m² habitat will be directly impacted. Mangroves are 2.6km to the north within the Tabechding Watershed that drain into the Ngermeduu Bay. This is a sensitive habitat and serves as a wildlife corridor. Mangroves are 1.8 km east of the site which drains into the Ngertachebeab Bay through the Kekerel Debochel which is part of the Ngerderar River Watershed and Conservation area.

Sensitive habitats are found adjacent to Site A proposed for the national landfill. Most of the proposed site is within a savanna. The proposed alternate configuration would move it further from the forest and tributaries and more centrally located on the savanna areas. The savanna habitat provides many medicinal plants for the customary first bath ceremony. Most of these plants are shrubs and ferns. The forest has a more diverse assemblage of is part of the Tabechding Watershed with several important freshwater tributaries and is considered more sensitive with birds and other animals using these streams as corridors. The fruit dove biib are known to build their nest along streams. Large endemic trees were found in the forests.

Site B Ngeruchael

In 2017, at least 15,500 m² of forest will be impacted by the initial phase of a proposed landfill or the enter area. As other infrastructure is incorporated in later phase of the proposed landfill more than 80,000 m² of habitat will be directly impacted. Site B is also within the Tabechding Watershed that drains into the Ngermeduu Bay. This is sensitive habitat and serves as a corridor for wildlife. Most of this site is sensitive lowland forest including two blue line streams.

Terrestrial Wildlife Corridors

Wildlife corridors refer to habitats or linked habitats that animals move within to feed, mate or otherwise use in their life cycle. If any of these linkages are disturbed or movement is blocked, the animals are considered threatened. The bird community was an important forest community at the site. The native riverine forest provides a diversity of fruits and seeds. Birds move to and from nesting sites to prepare their nests or feed their young. We observed many endemic birds and plans and native snakes and skinks. For the first time in the field, we observed the native frog in the nearby forests at Site A. The freshwater streams served as a corridor for freshwater fish and snails. Freshwater fish, snails and bird species are good indicators of the health of an ecosystem as they depend upon the resources within the system to survive. Monitoring the presence of indicator snails, fish and birds is a cost effective way to know if there is a change in the overall health of a system over long periods of time. Palau needs to conduct further research to determine threshold stream velocities for its freshwater ecosystems.

Section E. Species Diversity

Terrestrial biodiversity

Site A Ongerarekieu

During 2009, the team observed over 121 species including 102 terrestrial plants, 16 species of birds and wildlife were observed or heard on or adjacent at proposed Site A at Ongerarekieu. During 2009 and 2016, over 129 species including 106 terrestrial plants, 16 species of birds and at least 7 species of other wildlife were observed or heard on or adjacent to this proposed site. The 106 species of plants, representing 59 families were found on or near the site. Twenty three plant species are endemic and nowhere else in the world, 74 plants are native to Palau but are found elsewhere and 6 introduced species and three that are probably native but identified to Genus. Refer to Tables 2-5. The 102 species of plants, representing 58 families were found on or near the site. Twenty two plant species are endemic and nowhere else in the world, 77 plants are native to Palau but are found elsewhere and 3 introduced species. This proposed site and adjacent forest have at least 14.5% of Palau’s endemic plants. Sensitive species included the endemic and indigenous trees and rare larger trees. A total of 12 small trees and shrubs (Dbh >2cm) were identified, measured (Dbh) and heights estimated (Table 4). These trees and shrubs found included Trichospermum
ledermannii (chelsau), Phyllanthus palauensis, Timonius subauritus and the shrubs Hedyotis korrorensis (chemudelach) and Eurya japonica var. nitida (chesiik). The density of small trees and shrubs along the surveyed savanna area was 12 trees/120m² = 0.10/m². A total tree and shrub volume of 6.8cm³ was calculated. Table 4 showed that 5 species of trees represented 100% of the volume.

Site B Ngeruchael
During 2017, alternate Site B at Ngeruchael over 105 species including 84 terrestrial plants, 15 species of birds and at least 6 species of other wildlife were observed or heard on or adjacent Site B at Ngeruchael. The 106 species of plants, representing 51 families were found on or near the site. A total of 78 native plants were recorded including 26 plant endemic species at least 4 introduced species of which three are invasive ant other species identified to Genus. This proposed Site A and adjacent forest have at least 19% of Palau’s endemic plants. Water quality had relatively high E.coli bacteria (210-370 MPN) and was turbid (NTU33-36) on February 14, 2017 a day after heavy rain. The streams did not meet EQPB clean water standards for bacteria and turbidity. A total of 129 trees represent 18 species of plants were measured along the transect lines covering 365.76 m². The estimated density of small trees and shrubs was 0.35/m². A total tree and shrub estimated volume of 0.26m³/m². This swamp forest included large Campnosperma brevipetiolata; the ten trees represented 38% of the total tree volume measured. The palm, Pinanga insignis (chebouch) was the common understory tree, the 69 trees measured represented 29% of the total volume. Large less common trees were bkau (Maranthes corymbosa), chersachel (Horsfieldia palauensis), chemeridech (Cerbera floribunda), the tree fern cheluu (Sphaeropteris nigricans), tonget (Semecarpus venenosa), ngmu (Stemonurus ammui), and dekemerir (Elaeocarpus joga). Endemic trees and shrubs included tilol (Garcinia matsudai) chesemolech (Calophyllum pelewense) chelilai (Fagraea heteroana var. galilai), udeuid (Manilkara udoido), blacheos (Gmelina palauensis), mesekiu (Astronidium palauense) and kesiamel (Osmoxylon pachyphyllum and Osmoxylon truncatum). We observed large tree ferns Sphaeropteris nigricans up to 10 m high and 0.7 m in diameter. Site B was a typical swamp forest association with similar species as Site A.

Ground cover
Site A Ongerarekieu-During 2009 and 2016 over 14 species of plants were found as ground cover including 5 species of tree and shrubs (>1cm diameter). The dominant cover was the ferns Dicranopteris linearis var. ferruginea (72.9%) and Lycopodiella cernua (olcheiulbeab). Refer to Table 3.

Site B Ngeruchael- During 2017, ground cover was dominated by seedlings of chersachel (H. palauensis), chebouch (P. insignis) and the highly invasive Heterotis rotundifolia and Clidemia hirta. The small grassy open area leading into Site B and before the forest and near the road was dominated by grass, Ischaemum ciliare, and the ferns Dicranopteris and Nephrolepis biserrata.

Epiphytes
Site A Ongerarekieu-The epiphytic Cassytha filiformis was found on some of the small trees and bushes of the savanna at Site A Ongerarekieu. Within the adjacent forests s or plants attached to trees were common in the forests. A total of 78 vines, ferns and other plants were found. The climbing Pandanus, Freycinetia villalobosi (iul) and the ferns, Asplenium nidus and, Microsorum scolopendria were found. Epiphytic orchids included Bulbophyllum and Dendrobium orchids were found. The most abundant epiphytic vines included Ficus sagittata and Epipremnum carolinense (toilalech). In general, more epiphytes were found on the larger and more common trees of the forests compared to only one vine in the savanna. The presence of epiphytes on these trees indicates a healthy community of associated plants.

Site B Ngeruchael-The most common epiphytes were iul, the climbing Pandanus, (Freycinetia villalobosi), the liana, toilalech (Epipremnum carolinense) the filmy ferns, Cephalomanes genus and the fern Antrophyum

Birds and Wildlife
Site A Ongerarekieu- During 2009, the TEI team observed or heard at least 12 species of birds in the forest that included 5 endemic bird species and 4 endemic subspecies at Site A. During 2016, the TEI Team observed 14 species of birds including 5 endemic and 5 endemic subspecies. The number of bird
species is considered a critical number based upon the National Bird Protocol (Table 5). We observed the blue snake *Dendrelaphis lineolatus* (nguis) and the native frog *Platymantis pelewensis* at the forest edge for the first time during an environmental assessment (Photoplate 3). Most wildlife was seen in the forests rather than the savanna.

**Site B Ngeruchael**—During 2017, the TEI team observed or heard at least 15 species of birds in the forest that included 7 endemic bird species and 4 endemic subspecies at Site B. The number of bird species is considered a critical number based upon the National Bird Protocol. Native skinks and the native boa snake, *Candoia carinata* and olik, the native fruit bat *Pteropus pelewensis*

**Species and Habitats considered rare, endangered threatened, sensitive or otherwise unique.**

All endemic plants and animals are considered sensitive. At Site A, Ongerarekieu, we found over 23 endemic plants listed in Table 2. We saw or heard 6 endemic and 5 endemic subspecies of birds, an endemic frog and an endemic. At Site B Ngeruchael, we recorded over 26 endemic plants and saw seven endemic and 4 endemic subspecies of birds. These savanna and forests are sensitive ecosystems in Aimeliik. The habitat map shows how the forests are commonly found near the rivers and streams (Figure 3). The savanna and forests are critical habitats to buffer the rivers and help filter runoff, they provide vital habitat for wildlife.

6.3. Socio-cultural, economic and political environment

This project is expected to have social-cultural, economic and political impacts. During 2009, the community members were in favor of a State solid waste disposal site at Site A, Ongerarekieu, because the existing solid waste site was overflowing into the streets and polluting the nearby lagoon. We interviewed the former governor who resided in Imul. During interviews in 2009, community members were concerned that the existing site was a health hazard as there had been no covering or bulldozing of the solid waste on a regular basis. The former governor also stated that the proposed site was near streams that may have an impact as well. Another woman living adjacent to the existing site said the existing waste disposal site needed to be shut down and relocated. During the 2016 survey—survey questions attached, as Appendix 4—regarding a proposed landfill the community was supportive of a landfill. Refer to Appendix 5.

In 2009, a clear benefit for the communities was that they will have a new and better managed solid waste disposal site. They could close the existing site, which was a health safety hazard to the people of Imul. The potential economic benefit for the National, State and private solid waste collectors and to all the community members will be the funds they redeemed from recycled aluminum and plastic containers and other items. There was an opportunity for the Imul residents to partner with the State to initiate a recycling center. It was recommended that Aimeliik State develop a land use plan for this area. The relative peace and tranquility at the proposed national landfill will be decreased by sound of vehicles transporting solid wastes to the site. However there are no homes in this area. Potential negative impacts are as follows: increased pollution from leachate into the upper watershed of the Tabechding River and another potential unmanaged and unsafe solid waste site. In 2009, it was recommended that the Governor work closely with the National Public Works National Landfill and Solid Waste Management programs to implement an integrated solid waste program for the Aimeliik Community immediately. It was further recommended that adequate funding be secured to design a modern small-scale sanitary landfill with a proper leachate recirculation system that meets the needs of Aimeliik State for at least the next 25 years of projected growth (Winzler and Kelly 2004).

During a community meeting and a statewide survey in 2016, there were mixed responses to the landfill, but overall support, based on surveys. Some community members only wanted a state landfill and no National Landfill. Others supported the National under the condition that it is built with minimal environmental impacts with financial support and employment priority to Aimeliik State. Refer to Appendices 1, 2 & 3 for participants list and two sets of scribes’ minutes for the November 15, 2016 own hall meetings. Furthermore, 50 households were surveyed at random and recorded.

Demographics are as follows for total surveys were as follows:
The results from the survey on the impact of moving the landfill showed either support or do not see any changes or harm from the new landfill. The main concerns are cost for transport from Koror of trash and whether the cost would be translated to additional expense for them. For most Koror residents they do not think of the trash collection because it is already being collected, whereas most people from Aimeliik’s concern is pests and general cleanliness in the community. Full results are shown in Tables 6-8, and appendixes 5.

A final community meeting was held on July 4, 2017, where design components and results of Environmental and Socio-Economic Assessment were presented. An open discussion with all invited (announced via newspaper and radio and flyers throughout Aimeliik) revealed some concerns on cleanliness and access to landfill site were brought up and addressed directly by public works director and design team. An additional concern was on land disputes in the area, which were directly addressed by representatives of the President’s office. Minutes and attendance list are provided in the appendix 6.
7. Impact Assessment

General biological resource impacts were the following:

1) Removal of vegetation to construct the proposed solid waste disposal site and access road.

2) Long term impacts to water quality in the nearby Watershed

3) Health and sanitation issues include pests and insect that can transmit diseases to people.

4) Solid waste and sewage pollution during construction of this project.

5) Introduced species

Impact 1. Direct impacts (removal) of sensitive habitats, sensitive species and their habitats, and the movement corridors of sensitive species and indirect impacts (disturbance by construction or operation activities).

The removal of vegetation especially upstream from the nearby tributaries of the Tabechding, which drains into the mangroves, can potentially cause pollution and sediment accumulation in these waterways. It is important to remove only what is necessary to construct the access road and solid waste disposal site and leave a vegetative buffer of at least 20m of savanna around the entire proposed site. In addition there should be a closed drainage system to keep leachate within the site. Native trees can be planted along the boundary of the site where there is now savanna to further buffer and reduce impacts to this watershed. The 401 soil type is poorly suited for home site development due to the slope and low soil strength. If buildings and roads are built, the low soil strength can be improved with adequate amounts crushed coral or basalt. Structures to divert runoff are needed. All soil materials need to dry sufficiently before filling and compacting areas of this unit. This unit is poorly suited to on-site waste disposal. The main limitations are slope and the hazard of lateral seepage. The soil type is unsuitable for a sanitary landfill. Alternative Site A will require the removal of less forest than Site B. Most savanna in Palau is disturbed forest area from previous land use activities. Alternative Site B will require the removal of more forested area than Site A.

Impact 2. Short and long term impacts to water quality in the Tabechding River and Watershed from leachates, pollutants, silt, and sediment runoff.

The proposed design calls for drop inlets, cross drains, riprap linings to direct the run-off to natural waterways. This is not recommended for this site as it is the upper watershed of the Ngeremeduu Watershed and could potentially impact water quality downstream and prevent use of these water for future development in these areas. All run off should be contained on site.

A major concern for this project is freshwater quality. Both sites A and B did not meet EQPB water standards based upon high bacteria and turbidity. A major issue for Site B is that it includes two blue line streams that are part of the upper tributary of the Tabechding River and the source of drinking water for Ngatpang. This is the key reason that Site B is considered less suitable as a National landfill site. Siltation and sediment runoff and other pollutants create poor water quality that causes all organisms to be negatively impacted. Heavy sediments cover habitats within the streams and smother the aerial root systems of obligate wetland plants. Pollutants cause the normal oxygen levels to, temperatures to rise, and nutrient levels to increase and be hazardous to all living organisms. A specific range of these parameters is vital for survival of organisms in these wetland environments. It is critical that proper erosion controls are set especially surrounding the location near the dam and pump station and along all boundaries of the site adjacent to ravine forests to the east and north. A zone of native grass should be left intact along the southern boundary of Site A to act as a natural filter of sediments.
A monitoring program for water quality is needed to address long-term impacts to this watershed. It is recommended that a monitoring program of the forest health and adjacent tributaries be established for the duration of this project in partnership with the EQPB, Forestry and Aimeliik State. If a landfill is placed at either site, it is not recommended that drinking water be pumped downstream from these sites. It is critical that downstream of either Site A or Site B is closely monitored for the freshwater organisms within this watershed. There should be regular water monitoring streams adjacent to the proposed site for fecal coliforms, turbidity, dissolved oxygen, pH, and temperature and other harmful leachate chemicals as determined by EQPB. The greatest potential source of runoff of sediments will occur during the cut and fill and grading to prepare the site. It is important that all soil erosion mitigation infrastructures (i.e., silt screens, sediment traps on site now) are in place before any further coring of soil, clearcutting or grading continues. Throughout the duration of the project, strict erosion control practices must be implemented to protect the streams from an overload of sediments.

Pesticides, Insecticides and Herbicides are poisons used to kill unwanted plants and animals. Fertilizers are used to grow wanted plants, however can change the chemistry of soils and waters to prevent to growth of other species. So, some of these products kill native plants and animals as well. A real danger is the potential risk of these poisons or fertilizers entering any source of drinking water on-site and offsite. The other danger is if these poisons accumulate in plants and agricultural crops that are eaten by local animals including people. It is important that a well-regulated hazardous waste storage facility be built and managed onsite for any hazardous or potentially hazardous wastes. These substances must also be identified and properly stored and disposed of during construction and operations of the landfill.

There is a list of restricted use pesticides, insecticides and herbicides and fertilizers that can only be used under certain conditions. All pesticides and herbicides need to be cleared through EQPB and the Department of Agriculture in Palau and the Agricultural Department at Palau Community College. Biodegradable products are now on the market that have been tested and are safe to use. We strongly recommend that only biodegradable products be used during site preparation and soil stabilization.
Impact 3. Health and Sanitation Issues

The existing solid waste disposal site is in a wetland draining directly into the lagoon and should be closed immediately in Aimeliik State and other unpermitted solid waste disposal sites in Palau. The proposed National Landfill requires a financially sustainable and well-managed solid waste program. The potential health and sanitation issues that the Imul community was facing need to be addressed. The future impacts need to be avoided with a proper leachate management system and a reduction of waste through recycling, reuse, and reduction.

Impact 4. Sewage and Solid Waste

We recommend that portable toilets be used during construction. These toilets need to be properly maintained and all wastes properly disposed. Potential negative impacts include health problems from enteric bacteria entering the nearby water. It is crucial that the solid waste management plan be implemented even during construction. Recycling of aluminum cans and plastics will be practiced. Solid waste should be removed from the site on a regular basis until it is finally approved as an operational landfill. Storage areas for solid wastes must follow all the sanitation guidelines stated in EQPB regulations.

Impact 5. Introduced Species

During 2009, the invasive toad, *Bufo marinus* was found at Site A on two occasions. During 2016 three additional invasive plants were found, two along the access road and one in the forest at Site A. Refer to Photoplate 7. The invasive toad and two highly invasive plant species were found at Site B in 2017. The prevention of introduction from equipment or containers is critical and most cost effective. It is important to eradicate invasive species as quickly and effectively as possible. All solid waste and soil brought to the proposed National Landfill site should be inspected by the Bureau of Agriculture for invasive species. If invasive species are found at or near the site this should be reported to the Bureau of Agriculture Invasive Species Program.

Prevention is the most cost effective way to deal with invasive species. All equipment needs to be cleaned and if any invasive weeds or animals like toads and African snails or brown tree snakes are found, they need to be destroyed immediately. Posters and awareness pamphlets about these organisms should be available for the staff. It is imperative that this project does not result in the introduction of any other invasive species from elsewhere in Palau through disposal of unwanted weeds during the life time of the landfill or from heavy equipment contaminated with seedlings. A potential threat is the brown tree snake, *Boiga irregularis*. The brown tree snake in Guam has almost wiped out the native bird populations.

Biological impacts considered significant

Biological impacts considered most significant are listed in order of importance below:

1) Removal of vegetation can cause potential soil erosion and sediment overload into nearby watersheds and will disrupt life cycles of organisms such as freshwater fish and snails. Loss of plants can result in loss of topsoil and create and already infertile unproductive land.

2) Potential short and long term change in water quality. Water is essential for all living organisms to survive. It the water is polluted all organisms are in jeopardy within all habitats. Potential pollutants from terrestrial runoff, chemical pollutants like pesticides and fertilizers and sewage waste and leachate can harm all living things in the fresh water and terrestrial environments.

3) Health and sanitation conditions that can potentially cause illness within the community such as rodents and pests attracted to the site and mosquitoes carrying disease.
4) Solid waste and sewage disposal during the project implementation will have a negative impact on this watershed if not implemented properly.

5) Introduced species can potentially create havoc on natural plant and animal communities as have been described in earlier section. The greatest threat to the bird community is the potential introduction of the brown tree snake of Guam.

6) Secondary impacts of increased land activities. The presence of endangered or endemic species at or near the site warrants concern over increased land activities. Much is still unknown about the migratory patterns of these species.

8. Mitigation Measures for the Project


1) Implement a basic policy to avoid any obstruction of the natural drainage at the site. Implement a basic policy to maintain a 60-ft buffer zone or more along the forested areas and steep sloped grasslands on the eastern and northern side. The buffer zone should consist of existing undisturbed vegetation and forests wherever possible. Place 2 to 3 rows of silt fences, 2 to 3 rows of plant native shrubs and 2 to 3 trenches down slope to help retard or reduce any flow of leachate off site. Make sure the leachate recirculation system is operating properly.

2) Do not stockpile soil or wastes near the river tributaries. Any stockpiles should be located at least 100m away from the three tributary drainage systems on site.

3) Replant the exposed areas with similar native vegetation and trees as was present before the removal as soon as possible or cover this area.

4) Utilize common native species, preferably endemic, indigenous or rare plants for landscaping.

5) In advance of the implementation of earth work and facility construction, available native trees, shrubs, and other plants should be transplanted to a temporary nursery near the implementation area. After construction, these plants can be transplanted back for site rehabilitation.

6) Utilize local nurseries whenever possible and develop a nursery on site using a variety of endemic and indigenous plants already found on site and listed in Table 1.

7) Surface erosion control should involve planting ground cover plants immediately after earthwork is done.

8) Local non-invasive or local lawn grass type species should be used to the landscape areas facing the access road and the slopes of the berm for the disposal area.

9) Mitigation measures should include a silt fence along the entire down slope forested area and along the stream banks on either side. Good erosion control management practices and monitoring should be applied for the duration of this proposed project.

Impact 2. Long term impacts to water quality

1) Set up an effective closed system for leachate for this proposed disposal site that does not drain into the nearby water systems.

2) Install an impermeable liner in the land fill to avoid seepage into the soils that all have severe limitations for landfill construction and operations.
3) Implement a site erosion control plan needs to include an inventory of material on site and implementation of erosion control infrastructure is needed. For example, silt screens and sediment traps should be constructed and set in place before construction begins. This includes screens that line the forest edge and also diversion or traps before water enters the watershed area.

4) Monitor and maintain the screens and traps and other erosion control measures throughout the duration of the project. Test the leachate recirculation system to ensure that it is functioning properly. Also have regular water quality testing at original water quality test sites/stations done for this assessment.

5). We recommend that less than an acre of land (an acre is 4047m²) be exposed at any given time. All recently graded areas greater than one acre should be covered with industrial plastic cover or locally produced equivalent to prevent runoff. Soil erosion on more than an acre of bare soil is almost impossible to manage during a heavy rain. Appropriate materials should be available on site to cover bare areas during of heavy rains. Materials could include gravel, woven coconut fronds, bundles of tied grass and industrial erosion control matting.

6) Any pesticides, herbicides and insecticides and fertilizers proposed for the project need to be listed and approved by the Department of Agriculture and EQPB. Application methods must be clearly stated. Storage of these chemicals must be in designated areas with proper containment and disposal clearly stated. We recommend that the applicant consult with the Division of Agriculture, the Palau Community College and the EQPB regarding safe biodegradable pesticides and application.

7). Retain a biologist and engineer and public health expert throughout the duration of the landfill construction and operation to ensure proper construction and implementation of the landfill waste management plan and closure of unpermitted dump sites and development of transfer stations. Their scope of work would include monitoring and maintaining structures or activities developed for mitigation. Implement a monitoring program for water quality and erosion control.

8) Develop standard operations and procedures for all phases of construction and operations for the landfill.

9) Develop emergency mitigation action plans for unpredicted heavy rains and unforeseen limitations of final mitigation measures. Once the landfill is complete the implementation of the maintenance and management plan will be the responsibility of this professional team.

**Impact 3 Health and Sanitation Issues**

1) Upon completion of the landfill, close and cap the existing solid waste disposal sites throughout Palau immediately and set up transfer systems for all states in Babeldaob and especially Koror and the outer lying States. Many of the current state landfills are located near mangroves as well as close to the community and are not properly maintained, resulting in large pest populations that may result in chronic disease and contamination of neighboring ecosystems, e.g. mangroves, oceans, forest and savannah areas.

2) Secure funds for an intensive recycling program and hazardous waste removal program to serve projected population growth for the next 50 years.

**Impact 4 Sewage and Discharge**

1) Use portable toilets that located on flat and least sloped areas that meet specifications approved by EQPB.

**Impact 5 Introduced species.**

1). Control and if possible eradicate any invasive alien species. Consult the Division of Agriculture regarding invasive or potentially invasive plants and animals associated with plants.
2) It is ecologically sounder to work with your endemic and indigenous species and avoid any potential problems with introduced species. Whenever possible use local non-invasive seeds and plants to hydro seed the slopes and re-vegetate the site. It is important that all plants imported be screened and approved by the Division of Agriculture.

3) All equipment and materials shipped or flown in for this project needs to be screened for introduced plants or animals. Any introduced plants and animals found should be destroyed immediately. The quarantine and customs agents need to be consulted to determine the best way to screen for unwanted introduced pests. A mechanism needs to be in place to monitor for and eradicate any accidental introductions.

Impact 6 Water and Energy Usage
1) Practice best water and energy conservation methods. Design and construct rain catchment tanks with capacities to hold water for periods of drought and dust control if needed. Use alternative energy such as solar for the site. Use renewable energy options such as solar energy when possible for the site.

Conclusion:
Based upon a comparative analysis of both Site A at Ongerarekieu and Site B at Ngeruchael, it is recommended to use Site A at Ongerarekieu. The top justification is that fact that Site B includes two blue line streams on site compared to Site A that has no blue line streams on site. Other factors include the lower percentage of forest directly impacted at Site A and closer proximity to the national highway.

Implementing an effective and successful recycling program through an integrated national solid waste plan will reduce the volume of solid waste that enters the proposed National Landfill and provide a healthier and cleaner environment to the community. The goal should be zero waste, as all natural and man-made materials we use and produce can be reused in Palau or elsewhere in the world. The establishment of a new and well-managed National Landfill in Aimeliik will serve as an incentive for the communities to aim towards zero waste. Through a conscientious effort of each resident, much waste can be recycled- if not all. Hazardous waste, scrape metal from appliances, old tires, plastics, aluminum, glass, and tree cuttings can be recycled by the national recycling center in Koror and private companies. Organic wastes can be used for compost for home gardens. Trips to the proposed national landfill should be infrequent and for many unnecessary if people are committed to implement the three R’s-reduce, reuse and recycle. Each State can be a leader and role model in the reduction of waste in Palau. Each State can ban non-recyclable materials in their communities. The existing non-permitted solid waste disposal sites, as well as states sites, should be closed immediately with proper capping and physical removal of any wastes that can be recycled while implementing all safety precautions. An alternative configuration of the proposed location of the National Landfill will place the landfill further from the adjacent forest and stream where the 405 type soil is more suitable. Implementation of the mitigation measures recommended in this EIS will help ensure that the project will have minimal impacts to the Tabechding watershed. This site is near the main road and compact road so transfer stations can be established for Babeldaob and Koror.
8.2 Summary Matrix of predicted environmental issues/impacts and proposed mitigation/enhancement measures and responsibilities
See Attachment

8.3 Environmental Management and Monitoring Plan

The proposed National Landfill and adjacent streams will be monitored regularly at the same stations to serve as a baseline for a monthly monitoring program for the duration of the project. Regular inspections by Environmental Sanitation will ensure that there are no areas on site that serve as breeding grounds for mosquitoes or rodents. Agriculture will make regular inspections for invasive species. Erosion and sediment control infrastructure will 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 at aforementioned test sites. 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 all parties responsible. In addition, leachate should be treated and tested if released at slow rates and in conjunction with storm runoff to allow for higher volume mixing.
9. References


The Environment, Inc. 2000-2001. Environmental Assessments for the Compact Road Submitted to DAEWOO.
