APPENDIX C
Aerial and Site Photos

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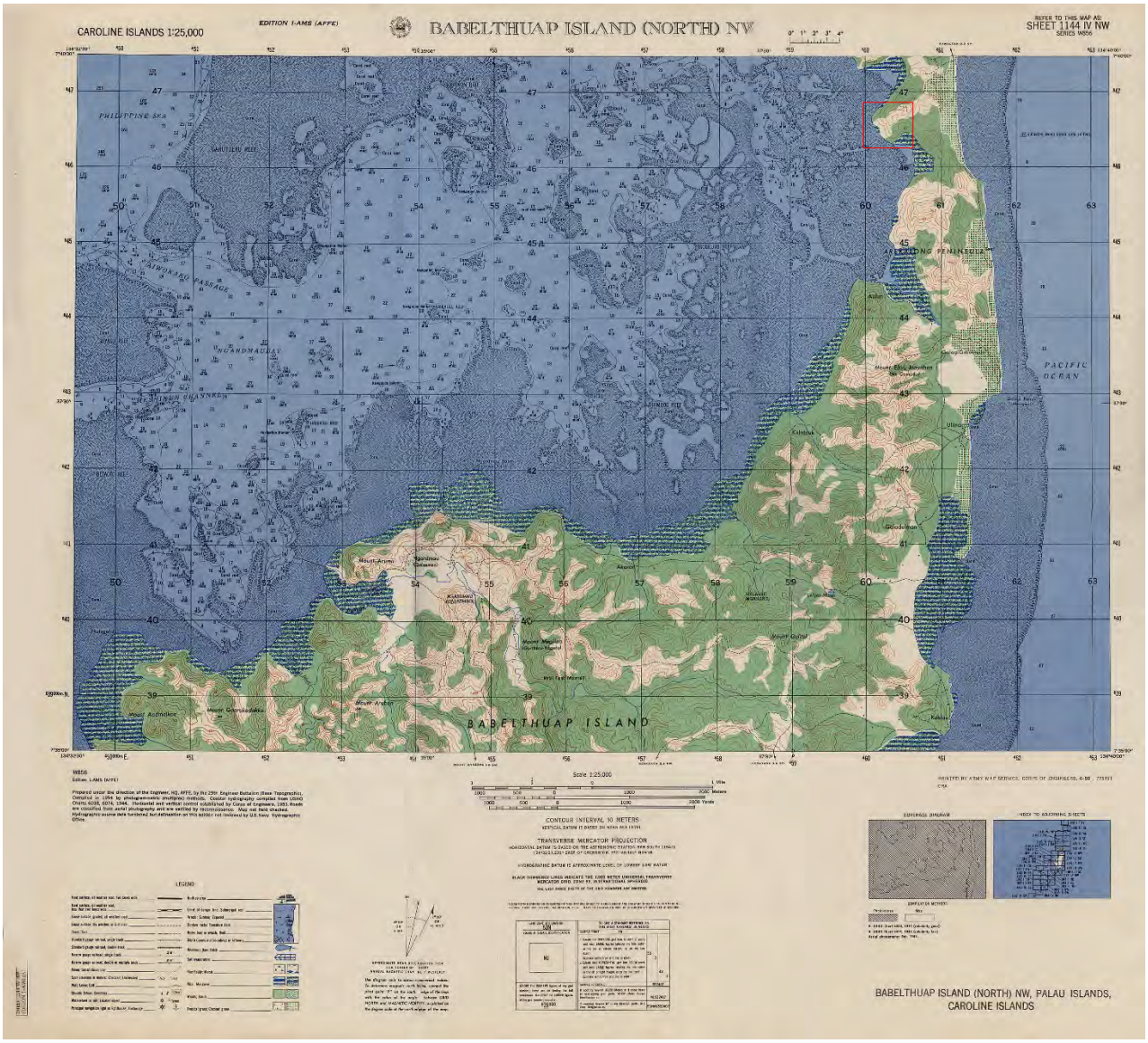

Photo No. 1 – 1954
U.S. Army Corps of Engineers topographic map of northern Babeldaob.

Photo No. 2 – 19 October 2004
Adjacent and east of the subject property showing the Compact Road. Photo compliments of Dr. Pat Colin. Ngaraard Tx Site.

Photo No. 3 – 31 January 2005
Subject property and surrounding properties. Photo from Google Earth. Ngaraard Tx Site.

Photo No. 4 – 10 June 2005
Adjacent and east of the subject property showing the Compact Road. Photo compliments of Dr. Pat Colin. Ngaraard Tx Site.

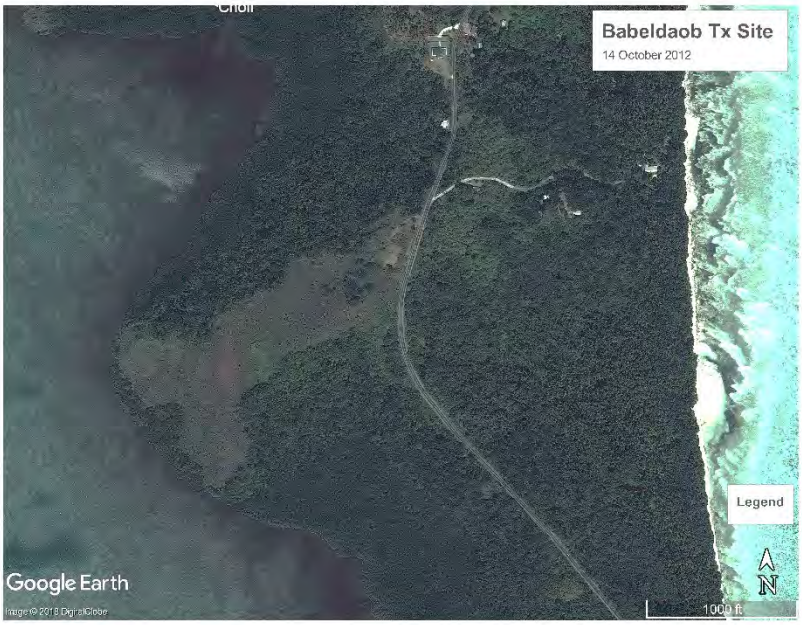

Photo No. 5 – 14 October 2012
Subject property and surrounding properties. Photo from Google Earth. Ngaraard Tx Site.

Photo No. 6 – 23 April 2014
Subject property and surrounding properties. Photo from Google Earth. Ngaraard Tx Site.

Photo No. 7 – 18 January 2017
Subject property and surrounding properties. Photo from Google Earth. Ngaraard Tx Site.

Photo No. 8 – 28 September 2018
Subject property and surrounding properties. Photo from ESRI. Ngaraard Tx Site.

Photo No. 9 – 1946
Map produced from 1944 aerial photographs for the U.S. Navy and War Department. Photo compliments of the University of Texas. Angaur Rx Site.

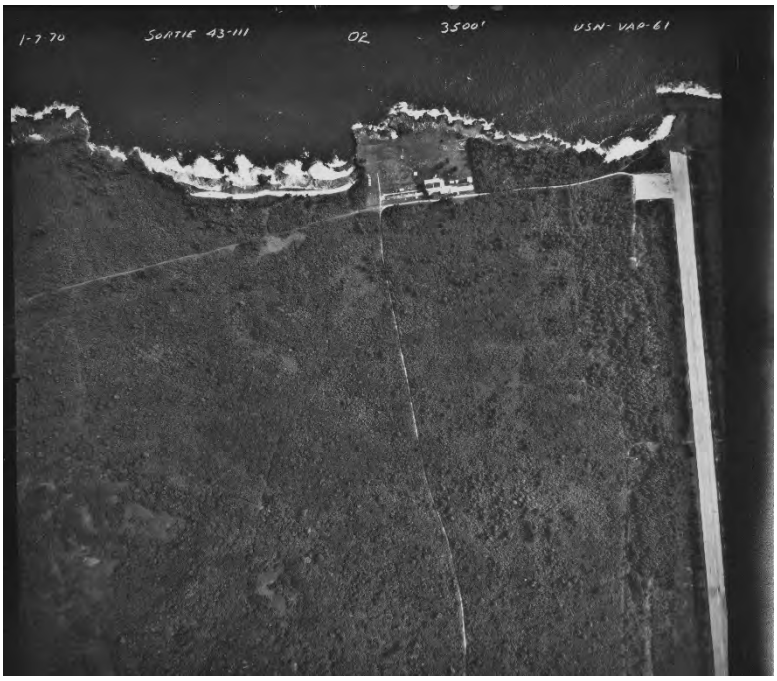

Photo No. 10 – 07 January 1970
Adjacent and west of the subject property. The Angaur airfield is on the right side of the photograph. U.S. Navy aerial photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 11 – 09 January 1976
Subject property and surrounding properties. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

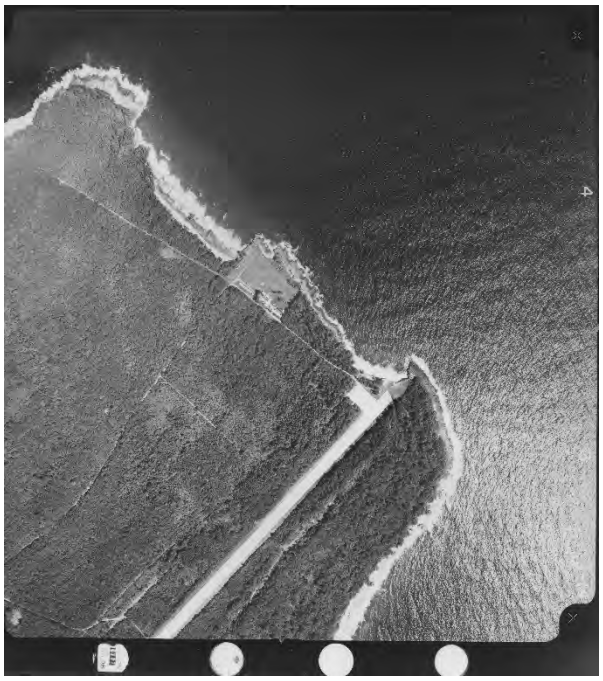

Photo No. 12 – 14 January 1976
Northern subject property and surrounding properties. Unknown source. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 13 – 1994
Aerial imagery of Angaur Island. Source unknown. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

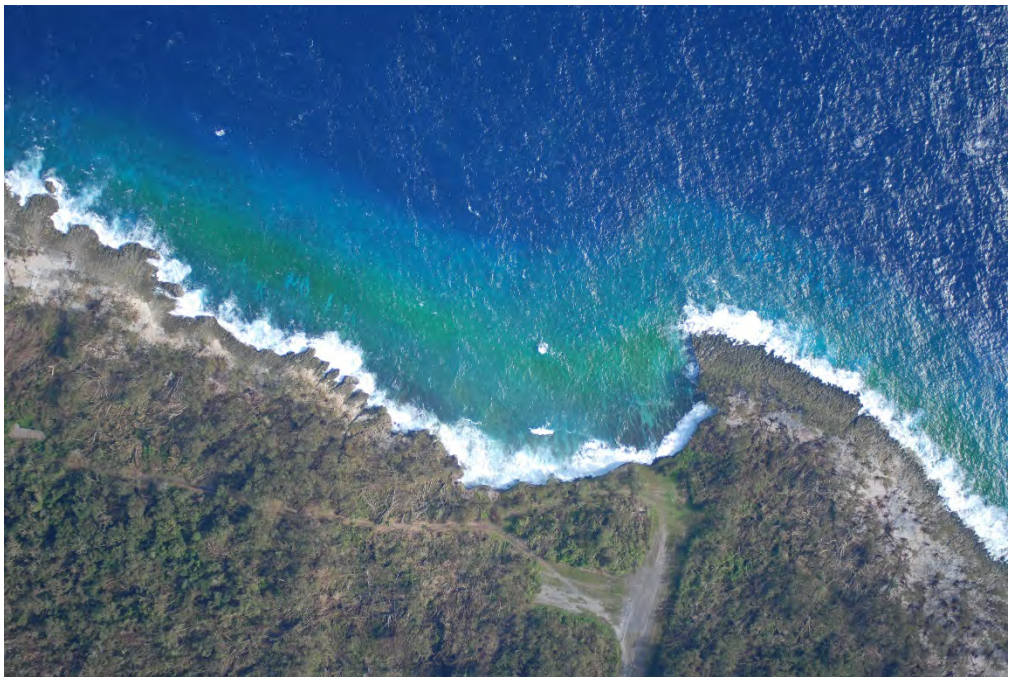

Photo No. 14 – 14 December 2012
Northern end of the Angaur runway. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 15 – 14 December 2012
Northern portion of the subject property. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 16 – 14 December 2012
North-central subject property. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 17 – 14 December 2012
South-central subject property. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 18 – 14 December 2012
Southern end of the subject property showing Rocky Point on the coast. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 19 – 14 December 2012
Northwest of subject property showing the local power generator building and former Loran Station. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 20 – 04 April 2013
Oblique aerial photograph showing the northern end of the subject property. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 21 – 04 April 2013
Oblique aerial photograph showing the southern portion of the subject property. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

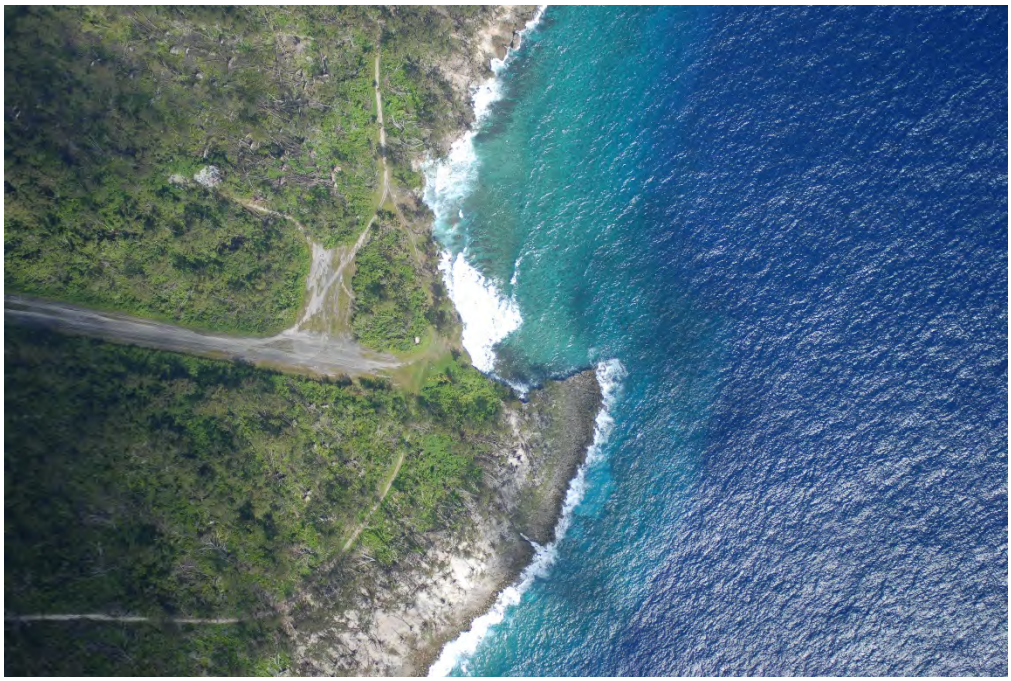

Photo No. 22 – 04 April 2013
Northern portion of the subject property and Angaur runway. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 23 – 04 April 2013
North-west of the subject property showing the former Loran station. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 24 – 04 April 2013
Northwest of the subject property showing the local power generator building and former Loran Station. Photo compliments of Dr. Pat Colin. Angaur Rx Site.

Photo No. 25 – 06 December 2014
Subject property and surrounding properties. Photo from Google Earth. Angaur Rx Site.

Photo No. 26 – 10 July 2018
Center of the Ngaraard Tx Site showing the eastern portion of the subject property and adjacent property east of the subject property in the distance. Looking northeast.

Photo No. 27 – 10 July 2018
Central portion of the Ngaraard Tx Site showing the edge of the dense vegetation located on the southern portion of the subject property. Looking south.

Photo No. 28 – 10 July 2018
Northern portion of the Ngaraard Tx Site showing the western bluff and ocean. Looking west.

Photo No. 29 – 10 July 2018
MEC avoidance along the northern tree line of the Ngaraard Tx Site. Looking north.

Photo No. 30 – 10 July 2018
Western bluff of the Ngaraard Tx Site subject showing mangrove adjacent to the beach. Looking west and down from the bluff.

Photo No. 31 – 11 July 2018
Collecting soil sample 18PA-BAB-004 from the Ngaraard Tx Site.

Photo No. 32 – 10 July 2018
New construction on the subject property at the Ngaraard Tx Site. Looking northeast.

Photo No. 33 – 10 July 2018
Shed located on the subject property between the residential buildings at the Ngaraard Tx Site. Looking south.

Photo No. 34 – 22 November July 2019
Completed construction of the new house on the subject property at the Ngaraard Tx Site. Looking north.

Photo No. 35 – 22 November 2019
Outhouse building located to the east of the southernmost residential building at the Ngaraard Tx Site. Looking west.

Photo No. 36 – 22 November 2019
Rain catchment and two buildings on the subject property at the Ngaraard Tx Site. Looking east.

Photo No. 37 – 22 November 2019
Archaeological data recovery to the south of the residential buildings at the Ngaraard Tx Site. Looking southeast.

Photo No. 38 – 22 November 2019
Archaeological data recovery to the south of the residential buildings at the Ngaraard Tx Site. Looking east.

Photo No. 39 – 22 November 2019
Collecting Sample 19PA-BAB-001 from downhill of the archaeological site at the Ngaraard Tx Site. Looking southeast.

Photo No. 40 – 22 November 2019
Vacant land on the subject property at the Ngaraard Tx Site. Looking west.

Photo No. 41 – 22 November 2019
Vacant land on the subject property at the Ngaraard Tx Site. Looking south.

Photo No. 42 – 12 July 2018
Angaur Rx Site subject property and Angaur runway. Looking west.

Photo No. 43 – 12 July 2018
Main access road showing thick vegetation at the Angaur Rx Site. Looking north.

Photo No. 44 – 13 July 2018
Airplane wing in the jungle adjacent to sample location 18PA-ANG-009 at the Angaur Rx Site. Looking west.

Photo No. 45 – 12 July 2018
Location of sample 18PA-ANG-010 and -011 adjacent to a deteriorated tar drum and spilled bitumen at the Angaur Rx Site. Looking south.

Photo No. 46 – 12 July 2018
Cut bank in limestone from the geotechnical investigation. These paths were used for the VSI at the Angaur Rx Site. Looking northwest.

Photo No. 47 – 12 July 2018
Regrowth over cleared trails generated during the geotechnical investigation at the Angaur Rx Site. Looking west.

Photo No. 48 – 12 July 2018
Large piece of frag identified during MEC avoidance activities at the Angaur Rx Site.

Photo No. 49 – 12 July 2018
Abandoned mining equipment adjacent to soil sample 18PA-ANG-004 at the Angaur Rx Site.

Photo No. 50 – 12 July 2018
Vertical sidewall from former phosphate mining on the subject property at the Angaur Rx Site.

Photo No. 51 – 13 July 2018
Lone deteriorated drum adjacent to soil sample 18PA-ANG-020 at the Angaur Rx Site.

Photo No. 52 – 12 July 2018
Weather station on the northern end of the subject property at the Angaur Rx Site. Looking east.

Photo No. 53 – 14 July 2018
Northern portion of the drum dump along a topographic survey trail at the Angaur Rx Site. Looking west.

Photo No. 54 – 14 July 2018
Collecting GPS coordinates from the northern portion of the drum dump at the Angaur Rx Site. Looking east.

Photo No. 55 – 14 July 2018
Deteriorated drums in the drum dump at the Angaur Rx Site.

Photo No. 56 – 14 July 2018
Additional deteriorated drums in the drum dump at the Angaur Rx Site. Looking southeast.

Photo No. 57 – 14 July 2018
Additional deteriorated drums in the drum dump at the Angaur Rx Site. Looking north.

Photo No. 58 – 17 November 2019
Collecting a survey check sho at the Angaur Rx Site t. Looking northeast.

Photo No. 59 – 17 November 2019
Demarcating step-out samples with survey tape and measuring tape from 2018 sample locations at the Angaur Rx Site. Looking east.

Photo No. 60 – 17 November 2019
Collecting a survey point from sample location 19PA-ANG005-20E at the Angaur Rx Site. Looking northwest.

Photo No. 61 – 17 November 2019
VSI of the northern extended footprint at the Angaur Rx Site. Looking southeast.

Photo No. 62 – 19 November 2019
Digging a hole to locate a suitable water source for sampling at the Angaur Rx Site. Looking north.

Photo No. 63 – 20 November 2019
Collecting soil sample and GPS point of 19PA-ANG-002 at the Angaur Rx Site. Looking northeast.

Photo No. 64 – 20 November 2019
Collecting water sample 19PA-SW-02 adjacent to the landfill on Angaur Island. Looking southwest.

Photo No. 65 – 20 November 2019
Sample point 19PA-SW-02 looking southeast to the landfill on Angaur Island. Looking southeast.

Photo No. 66 – 20 November 2019
WWII era well used to supply Angaur with running water. Sample location 19PA-GW-01. Looking southeast.

Photo No. 67 – 21 November 2019
U.S. Coast Guard well adjacent and west of the Angaur landing strip approximately 65 feet from the Angaur Rx Site. Collecting sample 19PA-GW-02. Looking west.

APPENDIX D
References

REFERENCES

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APPENDIX E
Interviews

EBS Interview Questionnaire

Interview Details

Name: Mark Vereen Date: July 19, 2018 Time: 12:00

Affiliation:
☐ Government Employee ☐ Adjacent Property Owner
☐ Owner of the subject property ☐ Nearby Resident
☒ Other (describe): former US Coast Guard assigned to the Angaur LORAN station, as safety officer and equipment operator

Email address (optional): Phone Number (optional):

Site Location ☐ Babeldaob (Ngaraard) ☒ Angaur (Ngeaur)

Interview Questions

1 - How long have you been a resident of the Republic of Palau?

☐0-5 years ☐10-20 years
☐5-10 years ☒20+ years
☐I am not a resident:

2 - Are there any local landfills on or near the subject property?

☐No
☒Yes (list address or general location):

150m NW of property USCG use of community land fill was limited and maybe some auto batteries were disposed there. No other concernes

3 - Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☒No
☐Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☐ No
☒ Yes (list approximate date, type of spill, and general location and distance from the subject property)

A diesel fuel storage tank was overfilled in mid-1975 and a sizeable "pond" of fuel resulted off the generator building on what was the camp baseball field at the time.

4 - Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?

☒ No
☐ Yes (list quarry or borrow pit if known):

5 - Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subject property?

☒ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

☐ No
☒ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

Four 10,000 gallon fuel storage tanks were part of the LORAN facility

6 - Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?

☒ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

the camp did have a below ground water cistern for storing rainwater catchment

Are you aware of any USTs currently or formerly located on adjacent properties?

☒ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 - Are you aware of any illegal dumping having occurred on or adjacent to the subject property?

☒ No
☐ Yes (list general location where illegal dumping occurred for all properties):

8 - Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?

☐ No
☐ Yes (list building type and general location):

9 - Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?

☒ No
☐ Yes (list substances stored on the property):

10 - Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?

☒ No
☐ Yes (list all known uses for each property):

11 - Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?

☒ No
☐ Yes (Note the known locations)

12 - Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to name a few.

☒ No
☐ Yes (please provide details below)

13 - Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?

☒ No
☐ Yes (list type of oil if known)

14 - Were pesticides or herbicides ever sprayed on the subject property?

☒ No
☐ Yes

15 - Were drums ever stored or buried on the subject property?

☐ No
☒ Yes (note the contents of the drum and location if known)

mostly drums of bitumen

16 - Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?

☐ No
☒ Yes (list all that apply)

the hardstand area at the north end of the runway was used for off loading fuel

17 - Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?

☒ No
☐ Yes (list all that apply)

18 - Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?

☒ No
☐ Yes (list all that apply)

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

EBS Interview Questionnaire

Interview Details

Name: CLEOPHAS N. ROBERT Date: July 18, 18 Time: 9:30 AM

Affiliation:
- ☐ Government Employee
- ☐ Adjacent Property Owner
- ☑ Owner of the subject property
- ☐ Nearby Resident
- ☐ Other (describe):

Email address (optional):

Phone Number (optional): 488-8498

Site Location
- ☑ Babeldaob (Ngaraard)
- ☐ Angaur (Ngeaur)

Interview Questions

1 - How long have you been a resident of the Republic of Palau?

- ☐ 0-5 years
- ☐ 5-10 years
- ☐ I am not a resident:
- ☐ 10-20 years
- ☑ 20+ years

2 - Are there any local landfills on or near the subject property?

- ☑ No
- ☐ Yes (list address or general location):

3 - Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

- ☑ No
- ☐ Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☑No
☐Yes (list approximate date, type of spill, and general location and distance from the subject property)

4 - **Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?**

☐No
☐Yes (list quarry or borrow pit if known):

MASON ROCKS QUARRY: BASECOURSE ON DRIVEWAY ENTRANCE

5 - **Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subject property?**

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and approximate distance from the subject property)

6 - **Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?**

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any USTs currently or formerly located on adjacent properties?

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 - **Are you aware of any illegal dumping having occurred on or adjacent to the subject property?**

☑No
☐Yes (list general location where illegal dumping occurred for all properties):

8 - **Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?**

☐No
☐Yes (list building type and general location):
1ST HOUSE: CONCRETE/HOLLOW BLOCKS W/ TIN ROOF
2ND HOUSE: CONCRETE/HOLLOW BLOCKS BUT EVENTUALLY BE A 3 STORY BLDG.

9 - **Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?**

☑No
☐Yes (list substances stored on the property):

10 - **Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?**

☑ No
☐ Yes (list all known uses for each property):

11 - **Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?**

☐ No
☐ Yes (Note the known locations)

2 SEPERATED SEPTIC TANKS FOR THE TWO BUILDINGS ON THE PREMISES.

12 - **Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to name a few.**

☑ No
☐ Yes (please provide details below)

13 - **Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?**

☑No
☐Yes (list type of oil if known)

14 - **Were pesticides or herbicides ever sprayed on the subject property?**

☑No
☐Yes

15 - **Were drums ever stored or buried on the subject property?**

☑No
☐Yes (note the contents of the drum and location if known)

16 - **Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?**

☑No
☐Yes (list all that apply)

17 - **Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?**

☑No
☐Yes (list all that apply)

18 - **Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?**

☑ No
☐ Yes (list all that apply)

OLD PALLETS AND DEBRIS SUCH AS LEAVES BUT NOTHING HAZARDOUS.

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

MR. ROBERT IS SURE AND INSISTED TO THE BEST OF HIS KNOWLEDGE THAT THIS SITE HAS NOT BEEN EXPOSED TO ANY HAZARDOUS CHEMICALS OR SUCH THAT MAY HARM THE ENVIRONMENT; NATURE HIS AWARE OF THE SITE & ADJACENT PROPERTIES HAS NOT BEEN TOUCHED TO ATS AND UST OR WAR REMAINS THAT ~~HAS~~ MAY HAVE ENVIRONMENTAL IMPACT.

EBS Interview Questionnaire

Interview Details

Name: Steven Kanai Date: 7/24/18 Time: 11:00 Am

Affiliation:
- [x] Government Employee
- [ ] Owner of the subject property
- [ ] Other (describe):
- [ ] Adjacent Property Owner
- [x] Nearby Resident

Email address (optional): steven.kanai@gmail.com Phone Number (optional):

Site Location
- [x] Babeldaob (Ngaraard)
- [ ] Angaur (Ngeaur)

Interview Questions

1 - How long have you been a resident of the Republic of Palau?

- [ ] 0-5 years
- [ ] 5-10 years
- [ ] I am not a resident:
- [ ] 10-20 years
- [x] 20+ years

2 - Are there any local landfills on or near the subject property?

- [x] No
- [ ] Yes (list address or general location):

3 - Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

- [x] No
- [ ] Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☑No
☐Yes (list approximate date, type of spill, and general location and distance from the subject property)

4 - **Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?**

☑No
☐Yes (list quarry or borrow pit if known):

5 - **Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subject property?**

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

☒No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and approximate distance from the subject property)

6 - **Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?**

☒No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any USTs currently or formerly located on adjacent properties?

☒No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 - **Are you aware of any illegal dumping having occurred on or adjacent to the subject property?**

☒No
☐Yes (list general location where illegal dumping occurred for all properties):

8 - **Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?**

☒No
☐Yes (list building type and general location):

9 - **Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?**

☒No
☐Yes (list substances stored on the property):

10 - **Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?**

☒No
☐Yes (list all known uses for each property):

11 - **Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?**

☒No
☐Yes (Note the known locations)

12 - **Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to name a few.**

☒No
☐Yes (please provide details below)

13 - **Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?**

☒ No
☐ Yes (list type of oil if known)

14 - **Were pesticides or herbicides ever sprayed on the subject property?**

☒ No
☐ Yes

15 - **Were drums ever stored or buried on the subject property?**

☒ No
☐ Yes (note the contents of the drum and location if known)

16 - **Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?**

☒ No
☐ Yes (list all that apply)

17 - **Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?**

☒ No
☐ Yes (list all that apply)

18 - **Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?**

☒No
☐Yes (list all that apply)

8/2/18

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

SEBS Interview Questionnaire

Interview Details

Name: KENNOSUKE A. SUZUKY Date: 12-16-19 Time: 9:00 AM

Affiliation:
- ☑ Government Employee
- ☐ Adjacent Property Owner
- ☐ Owner of the subject property
- ☐ Nearby Resident
- ☐ Other (describe):

Email address (optional): Phone Number (optional): (680) 775-3887

Site Location ☐ Babeldaob (Chol, Ngaraard) ☑ Angaur (Ngeaur)

Interview Questions

1 Did you complete an interview questionnaire in 2018 as part of the initial EBS?

☑ No
☐ Yes

If you answered "No" proceed to question number 2. If you answered "Yes", to your knowledge, have any activities or events occurred at the subject property or adjacent properties since completing that interview that could cause any adverse impacts to the environment? For example, illegal dumping or burying trash, oil or gasoline spills, pesticide or herbicide application, discovery of old drums or dump sites, or similar. Please list all items below to complete and conclude this SEBS questionnaire

2 How long have you been a resident of the Republic of Palau?

☐ 0-5 years
☐ 5-10 years
☐ I am not a resident:
☐ 10-20 years
☑ 20+ years

3 **Are there any local landfills on or near the subject property?**

☐No
☑Yes (list address or general location):
facing north at the end of the runway, its on the left side.

4 **Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.**

☑No
☐Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☑No
☐Yes (list approximate date, type of spill, and general location and distance from the subject property)

5 **Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?**

☑No
☐Yes (list quarry or borrow pit if known):

6 **Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subject property?**

☑No
☐Yes - Formerly
☐Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

☑ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 **Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?**

☑ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any USTs currently or formerly located on adjacent properties?

☑ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

★ 8 **Are you aware of any illegal dumping having occurred on or adjacent to the subject property?**

☐ No
☑ Yes (list general location where illegal dumping occurred for all properties):

9 **Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?**

☑ No
☐ Yes (list building type and general location):

10 **Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?**

☑ No
☐ Yes (list substances stored on the property):

11 **Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?**

☑ No
☐ Yes (list all known uses for each property):

12 **Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?**

☑ No
☐ Yes (Note the known locations):

13 **Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to name a few.**

☐ No
☑ Yes (please provide details below):

The site is full of WWII relics,

14 **Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?**

☑ No
☐ Yes (list type of oil if known)

15 **Were pesticides or herbicides ever sprayed on the subject property?**

☑No
☐Yes

16 **Were drums ever stored or buried on the subject property?**

☑No
☐Yes (note the contents of the drum and location if known)

17 **Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?**

☑No
☐Yes (list all that apply)

18 **Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?**

☑No
☐Yes (list all that apply)

19 **Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?**

☑No
☐Yes (list all that apply)

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

EBS Interview Questionnaire

Interview Details

Name: Roxanne Y. Blesam Date: 07/24/18 Time:

Affiliation:
☐ Government Employee ☐ Adjacent Property Owner
☐ Owner of the subject property ☐ Nearby Resident
☐ Other (describe): EQPB EO

Email address (optional): eqpb@palaunet.com Phone Number (optional):

Site Location: Babeldaob (Ngaraard) X Angaur (Ngeaur)

Interview Questions

1 - How long have you been a resident of the Republic of Palau?

☐ 0-5 years
☐ 5-10 years
☐ I am not a resident:
☐ 10-20 years
X 20+ years

2 - Are there any local landfills on or near the subject property?

X No
☐ Yes (list address or general location):

3 - Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

☐ No
☐ Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

X No
☐ Yes (list approximate date, type of spill, and general location and distance from the subject property)

4 - Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?

X No
☐ Yes (list quarry or borrow pit if known):

5 - Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subjectproperty?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

We are not aware

6 - Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?

☐ No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

We are not aware

Are you aware of any USTs currently or formerly located on adjacent properties?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 - Are you aware of any illegal dumping having occurred on or adjacent to the subject property?

☐ No
☐ Yes (list general location where illegal dumping occurred for all properties):

We are not aware

8 - Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?

X No
☐ Yes (list building type and general location):

9 - Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?

☐ No
☐ Yes (list substances stored on the property):

10 - Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?

X No
☐ Yes (list all known uses for each property):

11 - Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?

X No
☐ Yes (Note the known locations)

12 - Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to nameafew.

X No
☐ Yes (please provide details below)

We are not aware

13 - Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?

☐ No
☐ Yes (list type of oil if known)

We are not aware

14 - Were pesticides or herbicides ever sprayed on the subject property?

☐ No
☐ Yes
We are not aware

15 - Were drums ever stored or buried on the subject property?

☐ No
☐ Yes (note the contents of the drum and location if known)

We are not aware

16 - Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?

☒ No
☐ Yes (list all that apply)

17 - Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?

☐ No
☐ Yes (list all that apply)

We are not aware

18 - Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?

X No

☐ Yes (list all that apply)

We are not aware

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

EBS Interview Questionnaire

Interview Details

Name: Roxanne Y. Blesam Date: 07/24/18 Time:

Affiliation:
☐ Government Employee ☐ Adjacent Property Owner
☐ Owner of the subject property ☐ Nearby Resident
☐ Other (describe): EQPB EO

Email address (optional): eqpb@palaunet.com Phone Number (optional):

Site Location X Babeldaob (Ngaraard) ☐ Angaur (Ngeaur)

Interview Questions

1 - How long have you been a resident of the Republic of Palau?

☐ 0-5 years
☐ 5-10 years
☐ 10-20 years
X 20+ years
☐ I am not a resident:

2 - Are there any local landfills on or near the subject property?

X No
☐ Yes (list address or general location):

3 - Are you aware of any spills or releases to the environment having occurred on the subject property? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

X No
☐ Yes (list approximate date, type of spill, and general location)

Are you aware of any spills or releases to the environment having occurred on adjacent properties? For example, oil or gasoline spills, overfilling automobiles or storage tanks, tank or drum leaks, paint spills and similar.

X No
☐ Yes (list approximate date, type of spill, and general location and distance from the subject property)

4 - Are you aware of any offsite gravel, topsoil, or backfill being brought onsite from an offsite source?

X No
☐ Yes (list quarry or borrow pit if known):

5 - Are you aware of any aboveground storage tanks (AST) currently or formerly located on the subjectproperty?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any ASTs located on adjacent properties?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

6 - Are you aware of any underground storage tanks (UST) currently or formerly located on the subject property?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and location on the subject property)

Are you aware of any USTs currently or formerly located on adjacent properties?

X No
☐ Yes - Formerly
☐ Yes - Currently
(list the contents if known, and approximate distance from the subject property)

7 - Are you aware of any illegal dumping having occurred on or adjacent to the subject property?

X No
☐ Yes (list general location where illegal dumping occurred for all properties):

8 - Are you aware of any permanent/temporary buildings being currently or formerly located on the subject property?

☐ No
x Yes (list building type and general location): There are two residences located on the property

9 - Are you aware of any hazardous substances such as oil, gasoline, solvents, coolant, paint or similar products ever being stored on the subject property?

X No
☐ Yes (list substances stored on the property):

10 - Has the subject property or adjacent properties ever been utilized for commercial (business/services) or industrial use?

X No
☐ Yes (list all known uses for each property):

11 - Are you aware of any injection wells (including floor drains and septic tanks) on or adjacent to the subject property that were used to dispose of wastewater directly to the subsurface?

X No
☐ Yes (Note the known locations)

12 - Have you ever witnessed any action or event on or adjacent to the subject property that might be considered hazardous to the environment? For example, an overturned car or ATV, a vehicle catching fire, target practice with a firearm, or burying metal debris to nameafew.

X No
☐ Yes (please provide details below)

13 - Was the subject property ever sprayed with oil (used or new petroleum products, cooking oil, mineral oil or transformer oil) for dust control?

X No
☐ Yes (list type of oil if known)

14 - Were pesticides or herbicides ever sprayed on the subject property?

X No
☐ Yes

15 - Were drums ever stored or buried on the subject property?

X No
☐ Yes (note the contents of the drum and location if known)

16 - Was the subject property ever used for refueling operations such as refueling boats, airplanes, automobiles or heavy equipment?

X No
☐ Yes (list all that apply)

17 - Aside from a few abandoned vehicles or appliances, was the subject property ever used as a junkyard or for salvage operations?

X No
☐ Yes (list all that apply)

18 - Was the subject property ever used for burning or incinerating garbage, building debris, or other materials?

X No
☐ Yes (list all that apply)

Additional Information

Please provide additional information that you deem important and is not otherwise listed above. This may include contact information for other knowledgeable individuals, sketches, maps, as-built drawings, details or firsthand accounts of encountering hazards (munitions or hazardous substances) on the property, or seeing sheens or other staining while on the property.

Interview of 2 Former USCG Employees about Angaur

From: STOWERS, JOHN E CTR USAF AFMC AFIMSC Det 2/CEB <john.stowers.ctr@us.af.mil>
Sent: Monday, August 13, 2018 12:08 PM
To: McClure, Andrew (Drew); Neptun, Kristina
Cc: Stowers.John@live.com; FARRIS, JAMES R GS-13 USAF AFMC PACAF/AFIMSC Det 2/CEB
Subject: [EXTERNAL] FW: Interview of 2 Former USCG Employees about Angaur
Attachments: 3450901-LORSTA Angaur PDS.2012_09_10.docx

Kristi, Drew,
Just received the below email. Have you seen this? Any problem with included in the EBS?

Thanks,
John Stowers
AFIMSC Det 2/CEB
Contractor (Cherokee Nation Businesses)
DSN 448-2543 work (at Hickam AFB)
210-325-7778 cell (in Hawaii)

From: INGOGLIA, J M GS-14 USAF PACAF/AFCEC/CFPE
Sent: Monday, August 13, 2018 8:26 AM
To: STOWERS, JOHN E CTR USAF AFMC AFIMSC Det 2/CEB <john.stowers.ctr@us.af.mil>
Cc: GRANNIS, WILLIAM E GS-13 USAF PACAF/AFCEC/CFPE <william.grannis@us.af.mil>; HERBST, GEORGE A GS-13 USAF PACAF/AFCEC/CFPE <george.herbst@us.af.mil>; FRAZER, BRETON B GS-13 USAF PACAF/AFCEC/CFPE <breton.frazer.1@us.af.mil>; CIBOCH, BRENT M GS-13 USAF PACAF/AFCEC/CFPD <brent.ciboch@us.af.mil>
Subject: FW: Interview of 2 Former USCG Employees about Angaur

John,

This info should be included in the Palau EBS for the Angaur site as appropriate.

We queried two former USCG civilian environmental staff persons (Jay Silberman and Dennis Mead) about their recollections of the Ngaraard location where the EBS found the abandoned drums. The USCG previously had a LORAN station at this location. Following is an account in their words, dated 9 Aug 18:

Jay reported that " Me and Dennis [copied above] went out there in the mid-90s to take a look. We poked around the grounds and inside the main station building, and my recollection is that they just walked away from the station when they left. [e.g., all of the transformers and capacitors, of which there are ~200, were still in the transmitters]. The station was also using an unlined landfill along with the residents. And then there was the huge transformer [~65 gallon dielectric fluid capacity] we saw sitting on someone's porch. We…walked over there to check it out. Turns out they were using it for water catchment....
Over the course of the next few years, we negotiated the right with our lawyers and with USCG HQ to investigate/cleanup these remote stations. The ruling was basically that places like Palau had been

independent too long to provide any statutory authority for us to clean it up. [we were able to investigate/cleanup Yap, but that's a very long story]. Based on the other loran cleanups we've done, you can expect a big one. Attached and below is some additional info. " (I have an attachment that I will forward when I can retrieve it from my personal email)

http://www.loran-history.info/angaur_island/angaur_island.htm

"Any plot plans we might have had would have been trashed long ago by our office. The only thing I can offer you is a map found by a quick google search. The station is easily seen at the top of the map. " https://upload.wikimedia.org/wikipedia/commons/f/f6/Angaur_State_map-fr.svg

http://www.loran-history.info/angaur_island/angaur_island.htm

Dennis reported: "No site map but google maps can show the location of the northern site, no records of the older southern site. Locals complained of two invasive species brought by the CG, one is a nettle found in the antenna field and the other is a shrew species. We only walked around the northern site, visited the landfill and the launch point (near north end of the runway). Orengas Thomas was our guide, he claimed ownership of the land but I heard later his ownership was contested. His son (grandson?) was in the CG and stationed at MSO Honolulu when I retired. Nice guy but probably retired now. Because of the vegetation you could only see the water if you were near the ledge over by the diesel storage tanks."

Thanks, mi

United States Coast Guard
U.S. Department of Homeland Security

U.S. Coast Guard
Real Property Environmental Liability Project Documentation Sheet

A. PROJECT INFORMATION

A1. Project Data

RPUID: TBD	**Project Name:** Env Rest Former LORSTA Angaur	**Project No.:** 3450901
ATU: 33	**OPFAC:** 51292	**Servicing CEU:** Honolulu
Common Unit Name: CG CEU HONOLULU		**Common Location Name:** Former LORSTA Angaur (Palau)
Street Address: N/A	**Location City:** Angaur Island	**Location State/Terr.:** Republic of Palau
Project Manager: Dennis Mead **Phone No.:** (808) 535-3464 **Email:** dennis.j.mead@uscg.mil		**Managing Unit (CEU, HQ, etc.):** CEU Honolulu

Identification Method

☐ Due Care ☐ Construction/Demolition ☒ RP Transfer/Due Diligence
☐ Unit Field Report ☐ Inherited ☐ Other _____

Date Identified: June 2006	**Prioritization Risk Ranking Score:** 19.5	**ELE:** $110K

Source of Contamination:

Potentially contaminated soil and/or groundwater due to improper historic disposal practices.

A2. Project Description

Historic Asset Use:

The former LORAN Station Angaur was commissioned to the 14th District and began operation in June 1945 as a monitoring station only. The monitoring station operated until it was disestablished in November 1945. The station was rebuilt as a transmitting station between October 1965 and August 1966. The transmitting station operated until December 1977 and was disestablished in January 1978.

Current Asset Use:

The site is located on Angaur Island within the Republic of Palau. The USCG no longer conducts operations at this site. CEU Honolulu Environmental Branch personnel have not yet been to the site to confirm the current physical nature of the site. A more thorough site description will be gathered once the investigation is complete.

EL Description:

Potential improper waste disposal practices at this site represent an EL. In June 2006, the CEU Honolulu environmental office conducted a desktop review of the former LORAN Stations located within the D-14 AOR. During this review, former LORAN Station Angaur was identified. Due to its remote location and historical activities associated with LORAN station operations, it is likely that contaminated or PCB containing debris was improperly disposed at the Site. In addition many small capacitors are thought to still exist in the storeroom. An SI is needed to confirm these suspicions and identify further actions necessary.

A site investigation is planned that will include the collection of surface and sub-surface soil and groundwater samples from the site. Additionally, a magnetometer survey will be conducted to determine if there are any areas with large accumulations of iron buried in the vicinity that may represent a buried debris location. Additionally, the contractor will contact local inhabitants who may know of the disposition of scrap metal or other debris accumulated during the station operations.

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Real Property Environmental Liability Project Documentation Sheet

A3. Regulatory/Legal Driver(s)	
DoD Overseas Environmental Baseline Guidance Document, Compact of Free Association	
A4. References	
1.	CEUH General Scope Work
2.	www.loran-history.info
3.	

B. BASIS OF ESTIMATE (BOE)

B1. Liability Status Phase:

☒ Not Reasonably Estimable – Recognize cost to study
☐ Remediation Not Reasonably Estimable – Recognize cost to contain
☐ Reasonably Estimable – Recognize best estimate

B2. Cleanup Strategy:

The following investigation strategy is based on the CEU Honolulu experience at similar facilities.

- Contact former USCG personnel or local inhabitants that may have specific knowledge of where landfill or disposal areas are located.
- Take on site and near shore biota samples to test for PCB migration off site.
- Divide the area into 20 decision units (approximately 0.5-2 acres each) and conduct MI/DU sampling of the surface soil samples.
    - 20 MI/DU PCB surface soil samples
    - 20 MI/DU Metals surface soil samples
- Surface scan of the area with a magnetometer and sub-surface soil and water samples taken from four sites. Soil samples will be collected from four borings in 2-foot depth increments until water is reached or refusal is encountered using portable drilling equipment.
    - 20 PCB subsurface soil samples
    - 20 Metals subsurface soil samples
    - 4 PCB Groundwater samples
    - 4 Metals Groundwater samples
- A summary report will be prepared to present the findings of the SI and recommend any future investigation and/or remedial actions necessary.

B3. Key Assumptions :

Uncertainties:

- The presence of contaminated debris, soil, groundwater, or sediments has not been assessed at this point. Therefore, the need for further investigation or remediation beyond a Site Inspection is unknown cannot be classified as “probable”.

Assumptions:

- Assume groundwater is at 10 feet bgs.
- Assume that logistics challenges (such as travel to site and shipping of equipment) make the site a “Moderate” complexity in RACER.

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U.S. Department of Homeland Security

U.S. Coast Guard
Real Property Environmental Liability Project Documentation Sheet

Contingencies:

- A 10% contingency factor has been assumed across all future phases.

B4. Cost Estimate Source :

☒ RACER | ☐ Approved Remedy Selection Document (FS/RAP/ROD/PP/etc) | ☐ Historical |

☐ Contract | ☐ Other: _____

C. COST ESTIMATE SUMMARY

(See attached documentation for detailed estimate)

Fiscal Year Basis of Estimate: 2012

Future Phase #1:	Site Inspection	**Estimated Cost:**	$96K
Future Phase #2:		**Estimated Cost:**	
Future Phase #3:		**Estimated Cost:**	
		10% Contingency	$10K
		Total Environmental Liability (Rounded Up to the Nearest $5K):	**$110K**

D. SIGNATURE AND APPROVAL

Estimator

Name/Title (Print): Robert Singer, PE/Contractor	**Telephone:** 207-828-2643
Signature/Date:  09/11/2012	

Reviewer

The undersigned has reviewed this RP EL Project Documentation and associated EL estimate for accuracy, completeness, and compliance with the U.S. Coast Guard EL Policies and the U.S. Coast Guard EL Process Guide.

Name/Title (Print): Dennis Mead Environmental Protection Specialist	**Telephone:** 808-535-3464
Signature/Date:	

APPENDIX F
Field Logbooks

VISUAL SITE INSPECTIONS AND SOIL SAMPLING.

EBS - REPUBLIC OF PALAU

AUTHORS:
ANDREW McCLURG

Rite in the Rain®
ALL-WEATHER
FIELD
№ 353-MX

AF1-J07-5FGA6502-H04-0001

9 July 2018 PALAU EBS - PROJECT KICKOFF MEETING

0700 MET TENCAP + USAF CLIENT REPRESENTATIVES IN THE LOBBY CAFE AT PALAU CONTINENTAL HOTEL FOR BREAKFAST.

USAF COL. ERIC BROOK
USAF LT COL. DAVID "FLICK" ARMITAGE
USAF TENCAP CHRIS CORTOT
USAF TENCAP DALE McGHEE
USAF TENCAP LT. KRISTOV GEORGE
USAF PMR JIM FARRIS
ON ISLAND LIASON JON VOGT (NOT AT BREAKFAST - AT MORNING MEETING)

DREW MCCLURE
MIKE STUBING
PETE REDMOND
JACOBS (AUTHOR) ↓

0830 KICKOFF MEETING AT PALAU CONTINENTAL HOTEL - CONFERENCE ROOM.

- DISCUSSED PROJECT SITES AND PROJECT SCHEDULES
- EBS PROCESS, VSI AND SAMPLING
- UXO ~~SAFETY~~ TRAINING
- ENVIRONMENTAL OVERVIEW
- ARCHEOLOGY AVOIDANCE
- COMMUNICATION PLAN
- SAFETY BRIEF - GENERAL EVACUATION / EMERGENCY NUMBERS
- REFINED SCOPE

THROUGH DISCUSSIONS REGARDING THE EBS VSI PROCESS WE IDENTIFIED THE PROJECT SEARCH AREA (PRIMARY) AND SECONDARY AREAS OUTSIDE OF THE MAIN DISTURBANCE/CONSTRUCTION AREAS. THE PLAN IS TO INSPECT THE PERIMETER OF THE TX SITE AND DOCUMENT PROPERTY BOUNDARY AND ADJACENT PROTERIUS. NEXT COMPLETE A MORE DETAILED INSPECTION OF THE MAIN CONSTRUCTION AREA, SCREEN SOIL, & SAMPLE. FOR THE RX SITE ON ANGAUR WE WILL START WITH A PERIMETER SEARCH ON ESTABLISHED ROADS THAT SKIRT THE PROJECT AREA. WE THEN WILL WALK THE CLEARED AREAS (20-30 FOOT SWATHS CUT DURING THE GEOTECH INVESTIGATION) AND ASSESS THE CONSTRUCTION AREA. ADDITIONAL ENTRY ROUTES WILL BE CUT OR NAVIGATED TO ASSESS SECONDARY SEARCH AREAS.

1115 MEETING CONCLUDED
1125 TO MOL WITH JON VOGT TO GATHER COORDS W/ SAMPLING GEAR
1145 MET IN LOBBY TO GO TO LUNCH THEN OFF TO THE PROJECT SITE

9 JULY PALAU EBS - BABELDAOB TX SITE

1330 ONSITE AT TX SITE, PARKED AT CLEOPHUS (CHUCK SP) HOUSES TO THE NE OF SITE. A NEW HOUSE IS BEING CONSTRUCTED. SECOND STORY IS BEING BUILT W/ WORKERS ONSITE. REBAR / CINDER / CLAY BLOCK. SEPTIC TO THE WEST. JON VOGT NOTED - BARGE STYLE. NO LEACH FIELD PIPING NOTED.
BURN PIT TO WEST OF BUILDING APPROXIMATELY 20 FT FROM SW CORNER. METAL DEBRIS SIMILAR TO A CAN (SAME SIZE AS PAINT CONTAINERS)

SUBJECT PROPERTY TX SITE BABELDAOB

VANTAGE POINT FROM OOTE 10B EAST NORTHEAST BY INTERSECTION OF 007 E 11A.
- UNDEVELOPED LAND WITH SPORADIC TREE GROWTH AND GRASS / LOW LYING VEGETATION. TREES ARE DISTINCTLY SMALLER THAN ADJACENT VIRGIN AREAS. MOST OF THE PROPERTY WAS CLEARED, LIKELY THROUGH CONTROLLED BURN(S). SOIL IS RED SILTY SAND OR SILTY CLAY

- IN THE NEIGHBORING STATE OF Ngardmau, BAUXITE MINING TERRACES ARE PREVALENT WITH MINIMAL REGROWTH.
- LOTS OF PITCHER PLANTS ONSITE (SUBJECT PROPERTY) INDICATE POOR GROWING CONDITIONS / POOR QUALITY SOIL.

THE NORTHERN EDGE OF THE PROPERTY IS DOMINATED BY THICK VEGETATION AND STEEP TERRAIN. VEGETATION
(BM 9/9) ~~ALONG THE~~ WITHIN THIS AREA IS LARGER THAN THE CLEARED / BURNED AREA. THE THICK VEGETATION CAN BE SEEN ON AERIAL IMAGERY.

OVERALL THE AREA CLEARED/BURNED DOES NOT APPEAR TO CONTAIN ANY DISCARDED TRASH, ABANDONED ITEMS OR VEHICLES, AREAS OF STRESSED VEGETATION, OR DRUMS. WE PLAN TO RETURN TOMORROW TO COMPLETE A MORE INDEPTH VSI AND START SCREENING SOIL AND SAMPLING.

1523 TO CARS AND OFF SITE TO PALAU CONTINENTAL HOTEL

10 JULY 2018 PALAU EBS BABELDAOB TX SITE

0630 BREAKFAST W/ FIELD TEAM

PPE : MOD LEVEL D

PERSONNEL: DREW MCCLURE (JACOBS) (AUTHOR) JIM FARRIS AF IMSC
MIKE SOUBIE DELL MCGUIRE TONCAP
PETE REDMOND KRISTOV GEORGE

OBJECTIVE: • VSI AT BABELDAOB.
• SCREEN SOILS FOR SAMPLING AND COLLECT SOIL SAMPLES.
• LOGISTICS FOR ANGAUR SITE
• CONFIRM W/ JON VOGT REGARDING NEC PERMIT W/ PUBLIC WORKS

WEATHER: OVERCAST, 5-10 MPH WIND, 80% CHANCE OF RAIN (OUTER BANDS OF TYPHOON MARIA)

0740 PACKED CAR & PREPPED FOR FIELD WORK.
CONVERSED W/ JON VOGT AT PCH REGARDING RECORDS REVIEW AND LOGISTICS TO ANGAUR. WE SHOULD BE GETTING A PACKET OF PROPERTY INFO FROM THE VP. OFFICE TODAY OR TOMORROW.

0852 TO SITE

1025 CONTINUED ASSESSING PROPERTY BY INSPECTING PERIMETER IN COUNTER CLOCKWISE MOVEMENT FROM THE NE TO THE BLUFFS (W-SIDE). N SIDE OF PROPERTY DROPS OFF STEEPLY.

1100 NW SITE CONTAINS EITHER HAND DUG CIRCULAR PITS OR INTERMITTENT WASHING / EROSION.

1124 POTTERY SHARDS DISCOVERED ON N - NW SIDE OF SITE

1140 COLLECTED SCREENING SAMPLE SC-A RESULT = 0.6 ppm
- UNDISTURBED AREA W/IN "BURNED AREA" THAT WAS SPARSELY VEGETATED

1142 COLLECTED SCREENING SAMPLE SC-B RESULT = 0.4 ppm
- ~10 FEET EAST OF SC-A

1150 COLLECTED SCREENING SAMPLE SC-C RESULT = 1.6 ppm
- ~150-200 FEET S OF SC-A & SC-B - SIMILAR AREA

1153 COLLECTED SCREENING SAMPLE SC-D RESULT = 0.8 ppm
- SIMILAR AREA TO THESE OF SC-C

1225 HEAVY RAIN - MOBILIZE BACK TO CARS

1248 LUNCH

1417 TO SITE TO WRAP UP VSI.
THE EASTERN PORTION OF THE PROPERTY IS ADJACENT TO FOUR STRUCTURES. 2 OLDER HOUSES, 1 SHED/COVERED AREA, 1 NEW CONSTRUCTION HOME (2-STORY). SE SITE IS HEAVILY VEGETATED. SEVERAL CARES SHOULD BE TAKEN WHEN DIGGING TEST PITS OR GEOTECH BORINGS. THE VEGETATION IS MAINLY "VIRGIN" HARBOR GROWTH AND APPEARS HEALTHY.
THE CENTRAL - EAST/SOUTH CENTRAL PROPERTY IS ALSO

HEAVILY VEGETATED WITH MANGROVES LINING THE TIDAL ZONE BY THE BEACH. A MARSHY AREA EXISTS ADJACENT TO ONE OF THE CLEARED TEST PIT LOCATIONS. THIS WETLAND AREA IS SHOWN ON A GIS MAP LAYER YOU MAY HAVE ACCESS TO. FURTHER S OF THIS AREA IS A STEEP CUT BANK WITH RUNOFF TRICKLING DOWN THE SLOPE.

THE SOUTHERN BOUNDARY DROPS STEEPLY TO THE WATER AND CONTAINS VERY THICK VEGETATION. SEVERAL HAND CUT SWATHS AND PROBES FROM GEOTECH INVESTIGATION. NO VISUAL EVIDENCE WAS IDENTIFIED THAT WOULD CONSTITUTE A RECOGNIZED ENVI COND.

NO OLFACTORY INDICATION OF CONT WAS IDED

NO GARBAGE, DRUMS, TANKS OR FOUNDATIONS WERE OBSERVED AND APPEARS TO HAVE PREVIOUSLY ~~HAS~~ BEEN USED FOR ~~BY~~ A HOMESITE, AND WAS AT ONE TIME CLEARED OR BURNED TO REMOVE ~~OF~~ VEGETATION.

DM 7/10

1530 OFF-SITE - DRIVE BACK TO PCH FOR END OF DAY DEPARTURE AND PROP FOR SAMPLE COLLECTION.

7.10.2018

11 JULY 2018 PALAU EBS BABELDAOB TX SITE

WEATHER: BROKEN SKIES, 80s, HUMID
PPE: MOD LEVEL D
PERSONNEL: DREW MCCLURG JACOBS (AUTHOR) JIM FARRIS AF IMSC
MIKE STUBING DALE MCGEHEE TONCAP
PETE REDMOND COL ERIC BROOKS USAF
KRISTOV GEORGE TONCAP

0630 BREAKFAST WITH CREW

OBJECTIVES:
- COLLECT SCREENING SAMPLES FROM TX SITE
- MEET WITH RECORDS OFFICE AT 0900 FOR LAND'S RECORDS
- COLLECT ANALYTICAL SAMPLES
- SAMPLE MANAGEMENT

0750 PETE, MIKE AND DALE TO TX SITE TO COLLECT SCREENING SAMPLES AND ORS LOCATIONS

0850 TO BUREA OF LANDS AND SURVEYS FOR 0900 MEETING W/ DIRECTOR

ATTENDEES: STERLINA GABRIEL (DIRECTOR) DREW MCCLURG
COL ERIC BROOKS JIM FARRIS
CHRIS CORTEZ KRISTOV GEORGE

QUESTIONS FOR (PM 7/11) STERLINA:

AWARE OF TX & RA SITES. LAND BOUNDARIES.

Ngaard - PART PRIVATE AND PART STATE OWNED
→ REFER TO BUREAU OF ARTS AND CULTURE. (SUNNY MORSE)
→ SOILS MAP IS AVAILABLE (2012)
- NRCS FOR REPORT (W/IN US EMBASSY)

Angaur: PART IS PRIVATE OWNED & PART IS UNDER
- NATIONAL CLAIM FOR USE.
- PROSPECT AREA
- BUREAU OF A&C FOR MORE INFO

1987 RETURNED TO PALAU
- Ngaard WAS SURVEYED FOR RESIDENTIAL DEVELOPMENT
- MANGROVE AROUND PERIPHERAL OF SITE
- NO COMMERCIAL/INDUSTRIAL USE TO MY KNOWLEDGE
- Ngaard STATE WOULD HAVE MORE INFORMATION.

0945 BACK AT PCH TO GET GEAR (DREW & JIM FARRIS)

1120 ONSITE - PETE, MIKE, & DALE ONSITE. DREW & JIM PETE & MIKE COLLECTED RID SCREENING SAMPLES. (COMPOSITE PAGE)

11 JULY 2018 PALAU BBS BABELDAOB TX

PID SCREENING SAMPLES

SAMPLE ID	PID (ppm)	SAMPLE ID 7/10	PID
SC-E	0.8	SC-A	0.6
SC-F	1.2	SC-B	0.4
SC-G	0.2	SC C	1.6
SC-H	0.6	SC-D	0.8
SC-I	1.0	SAMPLES ABOVE COLLECTED	
SC-J	1.8	ON JULY 10	
SC-K*	0.0		
BAG BLANK	0.0		

pm 7/11

* = COLLECTED ~ 10 inches bgs in fire pit area to the ~~south~~ west (pm 7/11) of the new building (SSW corner of bldg)

1207 SCREENING COMPLETED. SAMPLES TO BE COLLECTED FOR ANALYTICAL ~~ADDITIONS~~ (pm 7/11) WILL BE TAKEN FROM AREAS W/IN THICK "VIRGIN" VEGETATION, W/IN THE AREA PREVIOUSLY CLEARED/BURNED, AREAS W/IN THE CLEARED/BURNED AREA WHERE REGROWTH IS STUNTED. SAMPLES ARE INTENDED TO PROVIDE A BASELINE FOR NATURAL OCCURING ANALYTES AND ANY PRESENCE/ABSENCE OF CONTAMINANTS AT TARGET LOCALS

TIME	SAMPLE ID #		QUANTITY GLASS	QC SAMPLE INFO	NOTES
1230	18PA-BAB-001	→	2 9oz	NO	THICK VEG/E SIDE/HIGH IMPACT AREA
1249	18PA-BAB-002*	→	4 9oz	DUP	SC-J SCREEN/↓ SAME
1315	18PA-BAB-003	→	2 9oz	NO	SPARSE VEG/GOOD OF BURN CLEARED
1327	18PA-BAB-004	→	2 9oz	NO	↓ W-SIDE W/IN C/B
1338	18PA-BAB-005	→	2 9oz	NO	GOOD REGROWTH C/B AREA
1345	18PA-BAB-006	→	4 9oz	MS/MSD	↓ ↓ C/B ↓
1355	18PA-BAB-007	→	2 9oz	NO	THICK VEG, N BOUND.

* = DUPLICATE COLLECTED AND LABELED 18PA-BABX-002

NOTE: ALL SAMPLES COLLECTED WITH ZERO HEADSPACE FOR THE FOLLOWING ANALYSIS: FUELS (GRO, DRO, RRO) by SW8015, VOCs by SW8260, SVOCs by SW8270, Metals and Mercury by SW6020/SW7471, Explosives by SW8330, PCBs by SW8082, Pesticides by SW8081.

1412 LOADED UP AND ~~OFFSITE~~. DRIVING TO PCIT FOR SAMPLE MANIFESTING
1638 ALL SAMPLES LABELED & COC/SAMPLE SUMMARY UPDATED.
1730 MEETING W/TEAM & JON VOGT

ATTENDEES: JON VOGT, PETE REDMOND, DREW MCCLURE, COL ERIC BROOKS, JIM FARRIS, KRISTEN GEORGE, DALE MCGOHOT, CHRIS CORTEZ

Rite in the Rain

11 JULY — PALAU CBS — BABELDAOB Tx SITE

CON'T — BRIEF OVERVIEW -

DREW MCCLURE - DISCUSSED SAMPLING AND STATUS OF VSI AT Tx SITE.

PETE REDMOND - SUMMARY ON MUNITIONS DEBRIS (MD) & ARCHEOLOGY

CHRIS CORTEZ - SUMMARY OF MEETING W/ NAVD & SURVEY.

DREW MCCLURE - QUESTIONAIRRE & INTERVIEW QUESTIONS REQUESTED ALL DOCUMENTS FOR REVIEW & RESEARCH. - SOILS SURVEY - CONTRACT ROAD DATA - ANY ADDITIONAL INFO. JON VOGT WILL FORWARD ALONG. INTERVIEWS TO BE COMPLETED BY JUNE 20th AND SENT TO JIM FARRIS & JACOBS FOR REVIEW.

CHRIS CORTEZ - TRAVEL TO ANGAUR. CREW TO FLY IN CESSNAS TO ANGAUR. FLIGHT IS AT 9 a.m. RETURN FLIGHT IS SATURDAY AFTERNOON WITH GOVERNMENT PROVIDED TRANSPORTATION. TWO FLIGHTS TO ACCOMODATE GEAR.

1810 — MEETINGS ADJOURNED

END OF DAY SUMMARY

- COLLECTED 7 SCREENING SAMPLES
- COLLECTED 7 PRIMARY, 1 DUPLICATE, 1 MS/MSD SAMPLE FOR LAB ANALYSIS
- MET WITH MS. GABRIEL AT BUREAU OF LAND & SURVEY
- SAMPLE MANAGEMENT

7/11/18

12 JULY PALAU EBS TRAVEL TO ANGAUR RX SITE

0600 BREAKFAST W/ MIKE & PETE.

PERSONNEL: BREW MCCLURE JACOBS (AUTHOR) JIM FARRIS (AFIMSC)
MIKE STUBING
PETE REDMOND

WEATHER: SCATTERED RAIN, BDs, 5-10 MPH WIND

PPE: MOD LEVEL D

OBJECTIVES:
- TRAVEL TO ANGAUR
- BEGIN VSI AT RX SITE AND COLLECT SCREENING SAMPLES

0740 MET IN LOBBY TO LOAD VEHICLES
0800 TO AIRPORT - PMA
0945 ARRIVED IN ANGAUR - PMA CHARTER FLIGHT
1000 AT HOUSE BY STORE - UNLOADED GEAR AND PREPARED FOR SITE WORK
1157 TO ANGAUR RX SITE
1206 AT SITE. NORTH SIDE ALONG ACCESS ROAD
1253 CAMS COLLIER AND DALE NEGAHOD TOOK MAIN ROAD WITH ERIC BROOKS AND KRISTOY GEORGE TO AIRFIELD

VSI OF THE RX SITE ON ANGAUR

TWO LOCAL GUIDES ONSITE (BOAS AND STACY) TO HELP W/ ACCESS AND VSI. WE STARTED THE VSI BY WALKING THE "ACCESS" ROAD THAT TRANSECTS THE SITE ROUGHLY PARALLEL TO THE RUNWAY FROM NE TO SW ALL THE WAY TO ROCKY POINT. OVERALL THE EASTERN PORTION OF THE SITE IS THICKLY VEGETATED WITH VERY FEW NATURAL BREAKS ~~AND~~ ADJACENT TO THE ROADWAY. WE ASSESSED THE PRIMARY SEARCH AREA BY NAVIGATING ALL OF THE CLEARED SWATHS (20-30 FT WIDE) THAT WERE CUT DURING THE GEOTECH INVESTIGATION. DURING THE VSI WE USED THE SUI BORING MAP FROM THE GTI W/ ACCESS ROUTES FOR REFERENCE. WE COLLECTED SOIL SCREENING SAMPLES (SEE NEXT PAGE) FROM AREAS WHERE ANTHROPOGENIC INFLUENCE WAS DOCUMENTED, OR VEGETATION WAS ABSENT / APPEARED DIFFERENT FROM SURROUNDING VEGETATION.

AREAS OF CONCERN NOTED:
- OLD PHOSPHATE MINING PITS (VERY LARGE - SEE TOPO MAP) WITH LOTS OF RUSTED METAL DEBRIS. LARGE AREAS OF DEBRIS INDICATE POTENTIAL ENVI IMPACT - HEAVY METALS - POL - NUCLEOTIDES & PHOSPHATE MINING TAILINGS
- ASPHALT DRUMS (2 OBSERVED AND ONE DETERIORATED). STACY MENTIONED THAT ASPHALT WAS USED TO REPAIR THE RUNWAY AND PASS POST WAR.

1423 COMPLETED A VSI OF CLEARED TRAILS AND THE "ACCESS" ROAD ON THE EAST PROPERTY & BOUNDARY TO THE SE AND NE. BACK TO HOUSE FOR END OF DAY DOCUMENTATION.

12 JULY 2018 | PALAU GBS | Rx SITE ON ANGAUR

SCREENING SAMPLE ID#	PID READING	NOTES	TIME
SC-AA	0.6 ppm	Adjacent to old Jeep tire	1330
SC-AB	0.7	old metal equipment by cleared path	1337
SC-AC	0.8	Cleared vegetation w/ standing water	1345
SC-AD	0.9	old metal equipment by cleared path II	1351
SC-AE	0.6	Depression where mining likely occured	1410
SC-AF	0.9	Depression where mining likely occured	1412
SC-AG	1.2	Adjacent to old rusted metal equipment	1419
SC-AH	0.8	off cleared path by ET boring 23	1431
SC-AI	0.7	Asphalt drum adjacent to cleared path	1454
SC-AJ	0.9	Asphalt drum adjacent to cleared path 2nd	1455
SC-AK	0.9	II Asphalt drum between B-7 & B-5	1511
SC-AL	0.7	Asphalt on top of limestone	1527

SAME AREA

SAME AREA

ALL LOCATIONS MARKED W/GPS - SEE OTHER LOG BOOK

END OF DAY

- MOBILIZED TO ANGAUR Rx SITE
- COLLECTED 12 SCREENING SAMPLES
- CONDUCTED VSI OF EAST PROPERTY & SE & NE BOUNDARY

12 JULY 2018

13 JULY 18 PALAU EBS ANGAUR Rx SITE

0710 BRKFAST W/ POTE ROSMOND & MIKE STUBING - DISCUSSED PLAN FOR TODAY'S VSI & SAMPLING

PERSONNEL ONSITE: DREW MCELROY (AUTHOR) JACOBS JIM FARRIS AMJUSC
MIKE STUBING JON KLEIN NAVFORCE
POTE ROSMOND GUIDES: BOAS BELIBEI
STACY ANGESTINE

PPE: MOD LEVEL D

WEATHER: RAIN WITH HIGH WINDS, HEAVY AT TIMES.

OBJECTIVES:
- COLLECT SOIL SAMPLES FROM SCREENING LOCATIONS COLLECTED 12 JULY 18
- ASSESS SECONDARY SEARCH AREA ALONG W-SIDE OF SITE BY RUNWAY.

0840 MORNING SAFETY MEETING

0925 MET WITH GOVERNOR OF ANGAUR - KEN UYEHARA FOR AN INTERVIEW. MR. UYEHARA NOTED THE FOLLOWING
- THE RUNWAY USED TO BE SHORTER. USCG LENGTHENED THE RUNWAY AND PAVED/ASPHALTED IT. EXTRA DRUMS WERE DEF OVER IN TOWN MOST GOT DUMPED W/IN PROJECT AREA.
- OLD MILITARY ARMS & ~~AMMUNITION~~ DEBRIS WERE POSSIBLY DUMPED IN THE SW PORTION OF SITE. DAVE MOSES (KEN'S COUSIN) SAID THEY WERE STOCKPILED AT THE END OF THE RUNWAY AND PUSHED INTO THE OCEAN. DM 7/13
- THE LANDFILLS TO THE WEST OF THE RUNWAY ARE NO LONGER USED.
- HE WILL DISTRIBUTE QUESTIONAIRE TO ELDERS ON WEDNESDAY
- CONFIRMED PHOSPHATE MINING OCCURRED W/IN PROJECT AREA.

0955 ONSITE AT Rx SITE TO SAMPLE

1005 COLLECTED 1st SAMPLE - SEE ~~ABOVE~~ PAGE FOR DETAILS

1245 FINISHED MORNING SAMPLING AND HOOFED TO HOUSE FOR LUNCH. SAMPLES COLLECTED FROM AREAS ASSESSED DURING YESTERDAY'S (12 JULY) VSI/SCREENING LOCATIONS.

1345 BACK TO SITE TO ASSESS PROPERTY FROM THE RUNWAY SIDE. THE PROPERTY APPEARS SIMILAR W/ THICK VEGETATION ABUTTING THE RUNWAY. COLLECTED SAMPLES FROM A VARIETY OF AREAS. THE AREA FAR NORTH ONSITE WAS ABOUT OF DEBRIS. SAMPLES WERE COLLECTED FROM NATURAL VEG. AREAS FOR BACKGROUND PURPOSES. SEVERAL DETERIORATED DRUMS WERE NOTED DOWN SURVEY TRANSECTS FROM THE AIRPORT TO THE CLEARED PATHS VISUALLY SURVEYED YESTERDAY. ALL LOCATIONS MARKED W/ GPS. OVERALL THE PROPERTY REMAINS SIMILAR THROUGHOUT W/ INTERMITTENT METAL DEBRIS (equipment, drums, frag, MEC).

Rite in the Rain 19

13 July 18 PAPA 385 ANGAUR RM 5106

TIME	SAMPLE IDENTIFICATION	QC	GLASSWARE	NOTES
1005	18PA-ANG-001	DUP/MSD	16 x 9oz	FROM INNER TIRE SC-AA
1106	18PA-ANG-002	—	4 x 9oz	FROM SC-AB
1116	-003	—	↓	FROM SC-AC
1127	-004	—		FROM SC-AD
1155	-005	—		FROM SC-AE
1145	-006	—		FROM SC-AG
1203	-007	—		ADJACENT TO PIT BY SC-AG → likely no mining/transfer activity
1220	-008*	—		GOOD VEGETATION SW OF WING (no AIRPLANES)
1235	-009	—		BY B52 WING
1210	-010	—	↓	BENEATH ASPHALT DRUM SC-AJ
1135	-011	—	2 x 9oz	"STEP OUT" FROM SC-AJ
1145	-012	—	4 x 9oz	BENEATH ASPHALT DRUM SC-AK
1200	-013	—	2 x 9oz	"STEP OUT" FROM SC-AK
1210	-014	—	4 x 9oz	FROM SC-AL
1420	-015*	—	↓	NATIVE VEG - SAMPLE SC-AM
1435	-016 *(1)	—		BY B-11 NAT. VEG SC-AN
1457	-017	—	↓	BETWEEN B-11 & B-10 NAT VEG SC-AO
1600	-018	—	4 x 9oz	RUSTED DRUM TRANSECT TO B-5
1610	-019	—	2 x 9oz	"STEP OUT" FROM 018
1625	-020	DUP	4 x 9oz	RUSTED DRUM TRANSECT TO B-3 NO RADIO NUCLEOTIDES

SCREENING SAMPLES LISTED BELOW

TIME	ID #	PID	NOTES
1415	SC-AM	1.7 ppm	NATIVE VEGETATION - SAMPLE # 18PA-ANG-015
1435	SC-AN	1.6	BY B-11 - NATIVE VEG - SAMPLE # 18PA-ANG-016
	SC-AO	1.3	BETWEEN B-11 & B-10 SAMPLE # 18PA-ANG-017
1545	SC-AP	2.8	TRANSECT TO B-5 DRUM - # 18PA-ANG-018
1600	SC-AQ	1.7	TRANSECT TO B-5 DRUM - # 18PA-ANG-019 + 019 (pm'd)
1625	SC-AR	0.6	TRANSECT TO B-3 DRUM - # 18PA-ANG-020 + DUP

* = SAMPLE COLLECTED FROM AREAS FREE OF DEBRIS WITH HEALTHY VEGETATION FOR BACKGROUND REASONING

NOTE = SAMPLES W/ 2 OR 9oz COLLECTED FOR ALL ANALYSES EXCEPT RADIONUCLEOTIDES. SEE THE METHODS LISTED ON PAGE 6.

SAMPLES W/ ADDITIONAL QUANTITY WILL BE ANALYZED FOR RADIONUCLEOTIDES (ALPHA, BETA, GAMMA) BY SW 9310

(1) = COLLECTED EXTRA QUANTITY - NO RADIONUCLEOTIDE ANALYSIS

1640 OFFSITE - BACK TO HOUSE FOR SAMPLE MANAGEMENT

END OF DAY 7/13/18

(TP)

14 JULY 2018 PALAU EBS ANGAUR RX SITE

WEATHER: HEAVY RAIN, 5-15 MPH WIND (GREATER THAN YESTERDAY), 80s
PPE: MOD LEVEL D
PERSONNEL: DREW MCCLURE (AUTHOR) JACOBS — JIM FARRIS (AFA FMSC)
MIKE STERLING — JON VOGT (MOLOKAU)
PETE REDMOND — BOAS BULIBET (GUIDES)
STACY AUGUSTINE
OBJECTIVES: COLLECTED FINAL SAMPLES
- 1 PRIME + DUP FROM MINING AREA
- 4 PRIME FROM:
  - Adjacent to Runway
  - Drums found during geotech
  - NE side of site by B-18/B-19 (geotech borings)

0715 SAFETY MEETING AT OUR RENTAL HOUSE
0840 TO SITE TO COLLECT SAMPLES (SEE NEXT PAGE)
NOTE: NO SCREENING SAMPLES WERE COLLECTED FOR THE PRIMARY AND DUPLICATE SAMPLES THAT WERE COLLECTED TODAY. THE PID SHOWS "LAMP" ERROR, LIKELY FROM HUMIDITY/MOISTURE GETTING PAST THE FILTER.

VSI OVERVIEW AND SURROUNDING PROPERTIES

OVERALL THE PROPERTY IS THICKLY VEGETATED, WHICH MAKES A COMPREHENSIVE SEARCH VERY DIFFICULT. TALL AUSTRALIAN PINES AND BANYAN TREES TOWER ABOVE LOWER GROWING FRUIT AND NON-FRUIT BEARING TREES THAT GIVE WAY TO A DENSE UNDERSTORY THAT COVERS A SILTY SAND / CORALLINE LIMESTONE. DRAINAGE IS ROUGHLY NORTH TO SOUTH VIA OVERLAND FLOW. SHALLOW GW AT THE SITE CAN RISE W/ TIDES AND APPEAR IN SOME OF THE BOOMER PITS OR NATURAL CUTS THAT ARE PRESENT IN THE SOUTH OF THE SITE. PHOSPHATE MINING OCCURRED IN THE SOUTHERN PORTION OF THE SITE WEST OF THE ACCESS ROAD. STEEP WALLS ARE CUT INTO THE CORAL/LIMESTONE, AND RUSTED MINING EQUIPMENT IS PREVALENT ATOP THE GROUND. THE MINING AREAS APPEAR ON THE TOPO SURVEY MAP AS TWO SEPARATE AREAS; ONE OBLONG DEPRESSION NEAR GEOTECH BORINGS B-24, B-25, B-29, AND ONE IRREGULAR DEPRESSION JUST SW OF THE OTHER MINE NEAR GEOTECH BORINGS B-26, B-27, B-1, AND B-3. THE RUNWAY IS PAVED ASPHALT. ACCORDING TO THE GOVERNOR OF ANGAUR, THE USCG PAVED (DMPA) AND EXTENDED THE RUNWAY. ASPHALT LEFT OVER FROM THE PAVING WAS USED TO PATCH THE RUNWAY AND ROADS, BUT WAS LATER DUMPED ON THE SUBJECT PROPERTY AT THE DIRECTION OF THE LOCAL AUTHORITIES. RUSTED DRUMS, SOME CONTAINING TAR, WERE FOUND THROUGHOUT THE CENTER AND WEST PORTIONS OF THE SITE. ALL THAT WERE FOUND WERE MARKED W/ GPS. A WING FROM A B-32 WAS ALSO FOUND ADJACENT TO OTHER

14 JULY 18 PALAU EBS ANGAUR RD. SITE

EXIT - METAL DOBRIS. SOME LARGE PIECES OF FRAG WERE FOUND ALONG W/ A SPENT 0.50 CAL CARTRIDGE (SEE OTHER LOGBOOK). SUBSURFACE ANOMALIES WERE DETECTED, BUT NOT INVESTIGATED (OUT OF SCOPE). THE CLIENT MENTIONED A BAI ONSITE, WHICH WAS ~~ERRONEOUSLY~~ MISTAKENLY STATED. NO BAI EXISTS. A WEATHER STATION W/SOLAR WAS PRESENT ~~ONSITE~~ SITE

SURROUNDING PROPERTIES

THE SUBJECT PROPERTY IS SURROUNDED BY THE OCEAN TO THE NORTH AND EAST, UNDEVELOPED LAND TO THE SOUTH AND THE AIRPORT TO THE WEST. FURTHER WEST OF THE RUNWAY ARE OLD LIMESTONE BORROW PITS THAT WERE USED AS A LANDFILL UNTIL A NEW LANDFILL WAS OPENED ~~ON~~ ON THE NW SIDE OF THE ISLAND. THE USCG LORAN STATION WAS LOCATED FURTHER NW OF THE RUNWAY. BASED ON THE INTERVIEW WITH THE GOVERNOR AND HIS COUSIN, THE LEFT OVER GUNS/ARMS WERE STOCKPILED AT THE N END OF THE RUNWAY AND PUSHED INTO THE OCEAN. SEVERAL AIRPLANES (B-25 & FM-1 CORSAIR) ~~WRECKED~~ CRASHED BETWEEN THE LORAN AND RUNWAY.

0937 THE "DRUM" DEMOLITION FOR OUR SITE FIGURE IS MORE EXTENSIVE THAN ANTICIPATED. THIS AREA CONSISTS OF LIKELY 100+ DRUMS WITH AROUND 40-60 DRUMS ON THE SURFACE. A GPS 'LINE' WAS TAKEN TO MEASURE THE LENGTH IMPACTED. THE 'LINE' WAS STARTED ~10 feet Shy OF THE NORTHERN EXTENT. COLLECTING SAMPLES FROM VARIOUS AREAS BY THE DRUMS. ~~MOST~~ DRUMS APPEAR TO PREVIOUSLY CONTAIN TAR/ASPHALT. THIS IS LIKELY THE DRUM DUMP THAT THE GOVERNOR ALLUDED TO. SOME DRUMS WERE EMPTY W/NO TAR. WE DID NOT FIND ANY DRUMS THAT LOOKED SOUND ENOUGH TO CONTAIN CONTENTS. METAL PUNCHED LETTERING ON ONE DRUM READ "RHEEM-R-18-55" NO OTHER LETTERING WAS LEGIBLE. A SAMPLE OF THE TAR WAS ALSO COLLECTED IN CASE SPECIATION IS NEEDED FOR FUTURE DISPOSAL.

TIME	SAMPLE ID #	QC	GLASSWARE	NOTES
0905	18PA-ANG-021	DUP "X"	8 x 9oz	OLD MINING PIT BY EQUIPMENT
0830	18PA-ANG-022	—	2 x 9oz	BY WEATHER STATION
0845	18PA-ANG-023	—	2 x 9oz	Adjacent to Runway N
0900	18PA-ANG-024	—	2 x 9oz	" " " S
1005	18PA-ANG-025	—	2 x 9oz	N-RUSTED TAR DRUMS
1020	18PA-ANG-026	—	2 x 9oz	FURTHER N = 5 FOOT RUSTED DRUMS
1015	18PA-ANG-027	—	2 x 9oz	END-OF DRUMS - TAR
1030	18PA-ANG-028	—	2 x 9oz	S EXTENT OF DRUMS
(13) 1035	18PA-ANG-029	—	BAG	TAR SAMPLE

14 JULY 18 — PALAU EBS — ANGAUR RX SITES

1040	TO LORAN STATION – ABS TANK BY GENERATOR, TRANSFORMERS BY BUILDING.
1049	PHOTOGRAPHED AIRPLANE WRECKAGE ADJACENT TO LORAN STATION – MULTIPLE AIRPLANES AND DEBRIS NOTED
1109	LANDFILL – OLD DUMPSITE IN PITS TO THE WNW OF THE NORTH SIDE OF THE RUNWAY (GPS TAKEN). LOTS OF PLASTIC DEBRIS, DRUMS, AUTOMOBILES AND PARTS, CYLINDERS, AND GENERAL HOUSEHOLD DEBRIS. THIS SUMP SITE IS REPORTEDLY NO LONGER USED.
1114	TO HOUSE TO GATHER SAMPLES & LUGGAGE
1236	TO AIRPORT
1320	TAKE OFF FOR KOROR
1400	HEAD BACK TO PALAU CENTRAL HOTEL FOR SAMPLE MANIPULATION AND DEBRIEF.
1445	SAMPLES ON ICE (NOW ICE ADDED).

END OF DAY

- COLLECTED 8 PRIMARY SAMPLES, 1 DUPLICATE, 1 TAR SAMPLE – 1 PRIME / 1 DUP FOR RADIONUCLIDES IN ADDITION TO ALL OTHER ANALYTES
- COMPLETED VSI ON ANGAUR RX SITE
- DEPARTED ANGAUR.

7-14-18

Rite in the Rain

15 JULY 18 PALAU EBS IN KOROR - PREP FOR SHIPPING SAMPLES

WEATHER: SCATTERED HEAVY RAIN, 80s, VARIABLE WIND TO 20 MPH

PPE: MOD LEVEL D FOR SITE WORK

PERSONNEL: DREW MCCLURG (AUTHOR) JACOBS JIM FARRIS (AP MNSC)
POTE REDMOND
MIKE STUBING

OBJECTIVES:
- COLLECT 2 ADDITIONAL JARS FROM TX SITE FOR MS/MSD QUANTITIES — SAMPLE - 18PA-BAB-006
- DOWNLOAD AND BACKUP DATA (GPS & PHOTOS)
- MEET W/ CTSI AT 1500 TO COORDINATE SAMPLE SHIPMENTS

0630 BREAKFAST AND TAKEOUT - JACOBS ONLY

0730 MET JIM FARRIS & KRISTEN GEORGE (GENEAP) IN LOBBY TO DISCUSS DAILY WORK.

~~0800~~ TO NAARARD TX SITE TO COLLECT ADDITIONAL MS/MSD QUANTITIES

0950 ONSITE TO COLLECT 2 - 9oz JARS FOR MS/MSD
- 18PA-BAB-006 - ADDITIONAL QUANTITY COLLECTED FROM SAME LOCATION.

1150 BACK ~~AT~~ PALAU CONTRAL HOTEL FOR SAMPLE MANAGEMENT

1500 MEETING WITH JOHN DIAZ AT CTSI - SAMPLE SHIPMENT - 3RD PARTY FEDEX.
COMPLETED PAPERWORK AND AUTHORIZATION LETTER.
- FOLLOW UP TOMORROW W/ BIOSECURITY PAPERWORK TO FINALIZE SHIPMENT.

1600 BACK TO PCH TO FINISH SAMPLE MANAGEMENT

END OF ~~DAY~~

7.15.18

16 JULY 18 PALAU EBS SHIP SAMPLES & DEBRIEF

0830 DEBRIEF MEETING IN THE CONFERENCE ROOM AT PCM.
ATTENDEES: DREW MCCLURE (ACOMS)
PETE REDMOND
MIKE STUBING
JIM FARRIS (AFIMSC)
JON VOET (MUELLER)
CHRIS CORTES (TETRA TECH)
KRISTEN GEORGES
DAVE MCGEHEE

- CHRIS CORTES - KICKOFF AND OVERVIEW
- DREW MCCLURE PROJECT DEBRIEF
  - TX SITE MOSTLY BOMBING. PROPERTY TO THE NORTH IS ONLY POTENTIAL CONCERN. WE NEED AUXIALS AND HISTORY / DOCUMENTS FOR ALL SITES TO PIECE TOGETHER HISTORY.
  - RX SITE - LOTS OF DRUMS (TAR), MINING EQUIPMENT, MORTAR DEBRIS, AIRPLANE PARTS. PROPERTY WAS ASSESSED BY SAMPLING AROUND DEBRIS, DRUMS, AND NATURAL VEGETATION. SURROUNDING PROP. - USCG LORAN STATION TO N/W LIKELY IMPACTED. TRANSFORMER AND AST REMAIN ONSITE.
  LAND FILL IN OLD LIMESTONE BORROW PIT W/ VARIOUS HOUSEHOLD TRASH, DRUMS, - EMPTY, & FEW CYLINDERS, ELECTRONICS. BASED ON DISTANCE AND LIKELY HYDROLOGY, NOT LIKELY AN ENVI CONDITION FOR OUR PROPERTY.

PETE REDMOND - ONLY MD OBSERVED ON TX SITE - EXPENDED 0.50 CAL CARTRIDGES. NOT A REAL CONCERN
- RX SITE - FOUND 0.50 CAL EXPENDED CARTRIDGE AND FRAG. HIGH LIKELIHOOD FOR UXO TO BE FOUND THROUGHOUT.

MIKE STUBING - A DRAFT WRITEUP OF FINDINGS HAS BEEN COMPILED. A FEW SHOTS WERE FOUND ON TX & RX SITE. MINING EQUIPMENT LOCATED ON RX SITE.

JIM FARRIS - RECAP - YOS WE ACHIEVED OUR GOALS - THERE MIGHT BE A BIT OF "MOP UP" WORK. FOOD CROPS ARE BEING CULTIVATED TO THE SOUTH.
POTENTIAL FOR PHASE II ACTIVITIES.

16 July 18 PALAU GBS - SHIP SAMPLES

cont' Jon Vogt - Review of historic documents. He will provide us an of those via thumb drive for review.

0955 Meeting Concluded

1048 at Palau Department of Agriculture / Biosecurity office to obtain Certificate of Origin paperwork.

1137 Back at CTSI to finalize paperwork
- Shippers account number - letter from CTSI to FedEx in Guam for approval
- International Air Waybill - 1 for shipment
- Commercial Invoice - 1 for shipmon copied for ea. cooler
- Cert of Origin - 1 for ea. cooler
- Permittee Name (Lab)
- Label # for ea. cooler
- Permit #
- Proper labeling

1230 Back to PCH -
- Sit rep and PowerPoint slides for Chris Cortez
- Overview of project areas - sample locations - VSI coverage and archaeology / MEC notes

1545 Prepare samples for shipment to lab

1620 Dropped off coolers at CTSI for shipment

1700 Met project team for dinner & project wrap-up

2355 At airport to depart to Guam → Honolulu → onward. Pete Redmond & Drew McClure departed. Mike Sowing is on TDY/PTO until 21 July, then will return to Arizona.

End of Day

7.16.18

USACE PALAU SOBS & PHASE II 15 NOV 2019

WEATHER: 80-90°F, MOSTLY SUNNY, LIGHT BREEZE

PERSONNEL: DREW MCCLURE (JACOBS - TECH LEAD)
PETE REDMOND (JACOBS - SUPOS & SM)
MATT STEINKAMP (JACOBS - ARCHAEOLOGIST)

PPE: CIVILIAN CLOTHES & WOOD COVERED

OBJECTIVES:
- MEET WITH JON VOGT TO DISCUSS LOGISTICS & SCHEDULING
- INVENTORY GLASSWARE
- MEET WITH JOHN DIAZ TO DISCUSS SAMPLE SHIPMENT
- PREPARE TO TRAVEL TO ANGAUR

0630 SAFETY TAILGATE AT PCH. DISCUSSED AHAs, SPAs, SCHEDULE
0815 COMPLETED SPAS AND BEGAN UXO BRIEFING
1000 MET W/ JON VOGT AT PCH. DISCUSSED TRAVEL TO ANGAUR & LAB GLASSWARE LOGISTICS, CONTACT INFO FOR ON ISLAND RESOURCES.
1130 TO HARDWARE STORE TO PICK UP ADDITIONAL SUPPLIES
1215 TO CTSI TO MEET W/ JOHN DIAZ. HE INFORMED US THAT FED EX IS NOT AN EFFICIENT SHIPPING METHOD FROM PALAU AND SAMPLES WOULD GET ROUTED THROUGH TOKYO. WE WILL USED CTSI AIR FREIGHT THAT UTILIZES UNITED AIRLINES CARGO.
1247 STOPPED BY PALAU SHIPPING. THEY DO NOT HAVE OUR CUSTOMS YET AND ASKED THAT WE STOP BACK BY LATER IN THE AFTERNOON
1500 MET WITH JON VOGT & GEORGE HERBST (LAF - ARCHAEOLOGIST) TO DISCUSS ANGAUR SITE WORK. JON INFORMED THE TEAM THAT OUR LAB GLASSWARE IS HELD UP AT CUSTOMS AND WILL NOT BE AVAILABLE UNTIL MONDAY. NOW PLAN IS TO GO TO ANGAUR TOMORROW, AS SCHEDULED, TO COMPLETE THE VSI. ALL LOAD SAMPLES WILL BE COLLECTED INTO PLASTIC BAGS, SEALED AND PLACED IN COLD STORAGE UNTIL GLASSWARE ARRIVES. GW & DW SAMPLES WILL BE COLLECTED TUE & WED WHEN THE COOLERS ARRIVE. THE FIELD TEAM WILL DEMOBILIZE THUR & FRIDAY.
1610 TO HARDWARE STORES TO PURCHASE ADDITIONAL SUPPLIES.
1700 END OF DAY REPORTING

15 NOV 19

Rite in the Rain

16 Nov 19 — PALAU SOBS & PHASE II — VSALCO

WEATHER: OVERCAST TO MOSTLY SUNNY, 80-90, LIGHT WIND

PERSONNEL: D. McCLURE, R. REDMOND, M. STEINKAMP - JACOBS

PPE: CIVILIAN CLOTHES & MOD D

OBJECTIVES:
- MOBILIZE TO ANGAUR
- BEGIN VSI AT RX SITE
- COLLECT PHASE II SAMPLES

0630 SAFETY — SAFETY TAILGATE AT PCH.

0800 — MET CAPTAIN SIMON AT DOCK TO GO TO ANGAUR.

0920 — ARRIVED IN ANGAUR.

0945 — CHECKED INTO ACCOMMODATIONS. UNLOADED GEAR AND PREPARED FOR SITE WORK ON ANGAUR.

1045 — GEORGE HURBST OFFSITE W/ SIMON BACK TO KOROR.

1245 — TO SITE W/ LOCAL GUIDE FRANK SUMANG.

1310 — USING TRIMBLE TX TO LOCATE 18PA-ANG-002 FROM 2018. THIS SAMPLE HAD HIGHEST LEAD CONCENTRATION

1330 — COLLECTED TCLP SAMPLE INTO A PLASTIC BAG.
ID# 19PA-ANG-002-TCLP

1335 — CONTINUED STAKING OUT SAMPLE LOCATIONS FOR LEAD/PAINT DELINEATION SAMPLING. SEE ID#S AND TIMES BELOW

TIME	SAMPLE ID #		LOCATION	
1330	19PA-ANG-002-TCLP		18PA-ANG-002	TCLP METALS & LEAD/PAINT SW6020+SW8270
1350		-020S	20-FT S	
1355		-050S	50-ft S	
~~1400~~ 1400		-020E	20-ft E	
~~1403~~ 1403		-050E	50-ft E	
~~1406~~ 1406		-020W	20-ft W	
~~1409~~ 1409		-050W	50-ft W	
~~1410~~ 1410		-020N	20-ft N	
~~1415~~ 1415	19PA-ANG002-LEAD01		By ANG002 (2018)	LEAD PAINT CAP
~~1535~~ 1435	19PA-ANG-LEAD02		By ANG006 (2018)	↓
1445	19PA-ANG004-020W		20 ft W.	METALS SW8260
1448		-050W	50ft W	
1510		-020E	20ft E	
1513		-050E	50ft E	
1522		-020N	20ft N	
1525		-050N	50ft N	

1650 — LOCATED 18PA-ANG-006 AND -005. WE WILL RETURN TOMORROW TO SAMPLE THOSE LOCATIONS.

1615 — BACK TO HOUSE FOR SAMPLE MANAGEMENT & REPORTING

PALAU SOBS & PHASE II 17 NOV 19

WEATHER: OVERCAST, 80s°F, LIGHT WIND
PERSONNEL: DREW McCLURE, M. STEINKAMP, P. REDMOND (JACOBS)
PPE: MOD LEVEL D
OBJECTIVES: • FINISH LOAD DELINEATION SAMPLING
• VSI OF NEW PROPERTIES
• COLLECT SCREENING SAMPLES

0715 SAFETY MEETING AT BEACH HOUSE. DISCUSSED TRIP HAZARDS AND NAVIGATING UNEVEN TERRAIN, HYDRATION, AVOIDING METAL MINING DEBRIS.
0730 FRANK S. DROPPED VEHICLE OFF FOR SITE WORK
0830 CHECK SHOT (GNSS) AT ANG A-1 ON AIRFIELD
0835 ARRIVING IBPA-ANG-005 & 006 FOR LOAD DELINEATION
SAMPLING TIMES & ID #S BELOW

TIME	SAMPLE ID #	LOCATION	ANALYTICAL SUITE
0920	IBPA-ANG006 - 20S	(IBPA-ANG-006) +20ft S	LOAD SW6020
0925	- 50S	+ 50ft S	
0930	- 20W	+ 20ft W	
0936	- 50W	+ 50ft W	
0940	- 20N	+ 20 ft N	
0950	- 50N	+ 50 ft N	
1000	- 20E	+ 20 ft E	
1010	IBPA-ANG005 - 20N	(IBPA-ANG-005) +20 ft N	
1020	- 50N	+50 ft N	
1026	- 20 S	+ 20 ft S	
1028	- 50 S	+ 50 ft S	
1035	- 20E	+ 20 ft E	
1040	- 50E	+ 50 ft E	

1115 OUT OF JUNGLE. TO BEACH HOUSE TO PUT SAMPLES IN FREEZER.
1240 BACK TO SITE. STARTED VSI OF NORTH EXPANDED PROPERTY
1400 COMPLETED TRANSECTS FROM ROAD TO THE OCEAN @ APPROX 100 FT.
1410 BEGAN TRANSECTS FROM AIRSTRIP SOUTH EAST THROUGH JUNGLE TO ACCESS ROAD.
1430 COLLECTED SCREENING SAMPLE SCREEN-1 PID = 0.0 ppm
1440 " " " SCREEN-2 PID = 0.0 ppm
1450 " " " SCREEN-3 PID = 0.0 ppm
1523 COMPLETED TRANSECTS OF NORTH EXTENDED PROPERTY BOUNDARY. NOTHING THAT WOULD CONSTITUTE AN ENVIRONMENTAL CONDITION WAS IDENTIFIED
1542 DRIVE TO LANDFILL NW OF THE RUNWAY. MORE VEHICLES AND TRASH IS PRESENT THAN WHAT WAS NOTED IN 2018

Rite in the Rain

17 NOV 2019 PALAU DEBS PHASE II USACE

1542 CONT' AN ABANDONED US COAST GUARD DOZER WAS OBSERVED IN THE JUNGLE BETWEEN THE LANDFILL AND OCEAN (NW) OF LANDFILL ALONG W/ VARIOUS METAL DEBRIS.

1600 ASSESSED ACCESS ROUTE DOWN TO THE OVERBURDEN BORROW PIT TO THE W OF THE LANDFILL.

1635 TO BEACH HOUSE FOR SAMPLE MANAGEMENT & END OF DAY REPORTING.

17 NOV 19

USACE PERAU SDBS PHASE II 18 NOV 19

WEATHER: OVERCAST, 80s°F, LIGHT WIND
PERSONNEL: D. MCCLURE, P. REDMOND, M. STEINKAMP (JACOBS)
PPE: MOD LEVEL D
OBJECTIVES:
- VSI OF SOUTHERN EXPANDED PROPERTY
- ASSESS METHOD TO COLLECT WATER SAMPLES
- COMPLETE VSI OF INITIAL PROPERTY BOUNDARY.

0715 SAFETY TAILGATE, RAIN APPROACHING FROM THE W. FOOTING & VISIBILITY WILL BE HAMPERED.

0820 TO SITE TO COMPLETE VSI OF SOUTHERN PROPERTY BOUNDARY. COMPLETED THE VSI BY WALKING TRANSECTS EVERY 100 METERS (APPROXIMATELY) AT A E TO SE ORIENTATION.

0910 COLLECTED PID SCREENING SAMPLES APPROXIMATELY EVERY 150 Ft (~50 METERS).

TIME	SCREENING SAMPLE ID	PID READING	LOCATION
0910	SCREEN-04	3.5 ppm	TRANSECT #1 SOUTHERN MOST
0920	-05	0.0 ppm	#2 SOUTH MIDDLE
0930	-06	0.5 ppm	#2 ↓
0940	-07	0.0 ppm	#3 NORTH MIDDLE
0945	-08	0.0 ppm	#3 ↓
0950	-09	0.0 ppm	#3
1000	-10	0.0 ppm	#4 NORTHERN MOST
1005	-11	0.0 ppm	#4 ↓
1010	-12	0.0 ppm	#4
1015	-13	0.0 ppm	#4
1103	BAG BLANK	0.0 ppm	BLANK OF ZIPLOCK BAG

1130 LUNCH -

NOTES FROM VSI OF NOW PROPERTIES:
- NO ADDITIONAL FEATURES OR AREAS THAT WOULD CONSTITUTE AN ENVIRONMENTAL CONDITION WERE IDENTIFIED ON THE SUBJECT PROPERTY. THE AREAS APPEAR LUSH & OVERGROWN W/ DENSE VEGETATION. NO AREAS APPEARED STUNTED OR DEVOID OF NATIVE VEGETATION.

1300 RECON TO IDENTIFY SW & GW SAMPLE LOCATIONS.
1423 IDENTIFIED SW ADJACENT & SSE OF LOAD (2018) CONTAMINATED
1510 FOUND THE "COAST GUARD WELL" W OF THE AIRSTRIP. THERE IS A FAUCET FOR SAMPLE COLLECTION!
1630 STILL UNABLE TO LOCATE SW BY LANDFILL. WILL ATTEMPT TO FIND SW TOMORROW.

END OF DAY 18 NOV 19

Rite in the Rain

19 NOV 19 PALAU SERS & PHASE II USACE

WEATHER - MOSTLY SUNNY, 80°F, LIGHT BREEZE

PERSONNEL - D. MCCLURG, P. REDMOND, M. STOTNKAMP (JACOBS)

PPE: MOD LEVEL D

OBJECTIVES: • IDENTIFY LANDFILL WATER SAMPLE AREA.
• RECEIVE COOLER SHIPMENT (SAMPLE EQUIPMENT) AT DOCK
• FINISH VSI
• COLLECT SOIL & WATER SAMPLES

0730 SAFETY MEETING AT HOUSE

0815 TO SITE TO LOCATE SURFACE WATER BY LAND FILL.

0850 ABLE TO DIG w 2-3 FOOT HOLE IN LOW LYING AREA TO ACCESS GROUNDWATER. WILL RETURN 20 NOV 19 WHEN GLASSWARE ARRIVES TO SAMPLE WELL.

0910 INSPECTED LANDFILL FROM W/IN BORROW PIT. DRUMS, PAINT BUCKETS, A BATTERY, CYLINDERS, AND HOUSEHOLD TRASH NOTED. WILL CONTACT PMS TO DISCUSS COLLECTING A SAMPLE FROM THIS AREA FOR ADDITIONAL INFORMATION ON SURROUNDING PROPERTIES.

1000 TO BOAT DOCK TO LOAD/RECEIVE COOLER SHIPMENT.

1030 BOAT ARRIVED W/ 9 COOLERS OF SAMPLING GLASSWARE

1100 BEGAN TRANSFERRING BAGGED SOIL TO JARS

1400 FINISHED SAMPLE MANAGEMENT. BEGAN PRE-LABELING GROUNDWATER JARS.

1630 FINISHED SAMPLE MANAGEMENT & PREP WORK. CONTACTED EPHRAIM TO SET UP SAMPLING TIMES FOR 1500 TOMORROW TO SAMPLE LOCAL DRINKING WATER SOURCE.

1645 SAMPLE MANAGEMENT AND END OF DAY REPORTING

19 Nov 19

WAG6 PALAU SGBS PHASE II 20 NOV 19

WEATHER: MOSTLY SUNNY, 80sF, LIGHT BREEZE
PERSONNEL: D. MCCLURG, P. REDMOND, M. STEINKAMP (WAGBS)
PPE: MOD LEVEL D
OBJECTIVES:
- COLLECT TWO SURFACE WATER SAMPLES
- COLLECT REMAINING SOIL SAMPLES (AKA SAMPLES OF OPPORTUNITY) FOR BASELINE CONDITIONS
- COLLECT GNSS OF 1940s ERA COKE BOTTLE
- COLLECT DRINKING WATER SAMPLE & RECON OTHER DW SAMPLE LOCATION ("COAST GUARD WELL")

0715 SAFETY MEETING AT HOUSE. DREW & MATT CAUGHT A FLU LIKE BUG THIS WEEK. DREW IS ~95% BUT MATT FEELS ILL AGAIN TODAY ~85%. MATT TO STAY BACK THIS MORNING & WORK ON ARCH REPORT & SAMPLE MANAGEMENT
0810 TO SITE TO COLLECT SW SAMPLE
0845 19PA-SW-01 - SURFACE WATER COLLECTED FOR FULL SUITE ANALYSIS. SAMPLE LOCATION IS S TO SE OF LEAD CONTAMINATED 18PA-ANG-002, WHICH IS HIGHEST 2018 LEAD LEVEL, MATT AND PETE RECONNED THIS AREA ON 18 NOV FOR UXO & ARCH FEATURES. ASIDE FROM COKE BOTTLE, NONE NOTED.
0940 COLLECTED SOIL SAMPLE FROM SCREEN-4 LOCATION. ID# 19PA-ANG-001 AND DUPLICATE 19PA-ANGX-001 + MS/MSD. ALL 4OZ JARS COLLECTED TO ZERO HEADSPACE (ZHS)
1000 COLLECTED SCREENING SAMPLE: SCREEN-14 PID = 0.0 ppm
1007 (DM 11/22) → ALSO COLLECTED 19PA-ANG-002 FROM SCREEN-14 LOCATION. TO HOUSE TO PLACE SAMPLES IN FRIDGE.
1040 SAMPLE MANAGEMENT
1115 CONTACTED JOHN DIAZ W/ CTSI LOGISTICS REGARDING SAMPLE SHIPMENT. ALL CONFIRMED FOR SUNDAY (EARLY MON MORNING) ON UNITED TO HONOLULU VIA GUAM.
1245 TO LANDFILL TO COLLECT AN ADDITIONAL SOIL SAMPLE AND SECOND SURFACE WATER SAMPLE.
1310 SOIL SAMPLE COLLECTED - 19PA-ANG-003 ADJACENT TO DRUMS IN LANDFILL FOR FULL SUITE. SAMPLE IS OUT OF SCOPE. NEEDS PM APPROVAL
1330 DUG DOWN TO GW ~40-50 ft WEST OF LANDFILL. COLLECTED SURFACE WATER SAMPLE 19PA-SW-02 - FULL SUITE ANALYSIS
1460 AT HOUSE TO TRANSFER SAMPLES TO ~~FRIDGE~~ REFRIGERATOR. (DM 11/20)
1510 TO SCHOOL TO MEET LOPHRENN AND SAMPLE LOCAL WATER
1530 COLLECTED 19PA-DW-01 FROM RAIN DRINKING WATER AROUND THE CORNER FROM THE SCHOOL. TWO WELLS ARE CIRCA WWII. TWO CONNECTED WELLS ARE PRESENT NAMED WELL A AND WELL B. WE COLLECTED TWO SAMPLES FROM WELL.

Rite in the Rain.

20 Nov 19 PALAU SOBS I PHASE II VSATS

1530 CONT' THE "COAST GUARD WELL" IS A GW ~~THAT~~ USES A SUMP TO PULL GW FROM THE WELL TO A HOLDING TANK (CONCRETE). THE SUMP APPEARS TO USE SOLAR POWER TO OPERATE.

1620 TO HOUSE TO REPRESENTATIVE SAMPLES & COMPLETE END OF DAY REPORTING.

20 Nov 19

USACE PALAU SOBS ; PHASE II 21 NOV 19

WEATHER:
PERSONNEL: D. MCCLURE, P. REDMOND, M. STEINKAMP (JACOBS)
PPE: MOD LEVEL D ; CIVILIAN CLOTHES
OBJECTIVES:
- COLLECT DW SAMPLES FROM "COAST GUARD WORK"
- RETURN TO KOROR
- DROP SAMPLES IN COLD STORAGE AT CTSI
- CHECK BACK INTO PCH
- DEBRIEF W/ GEORGE HERBST

0545 SAFETY MEETING AT HOUSE.
0630 COLLECTED SAMPLE FROM "COAST GUARD WORK" BY AIRSTRIP 19PA-DW-02 + MS/MSD + DUPLICATE 19PA-DWY-02
0715 TO AIRPLANE GRAVEYARD TO MEASURE PROPELLER FOR GEORGE.
0945 SAMPLE MANAGEMENT
1030 BOAT ARRIVED. LOADED COOLERS TO TRANSPORT BACK TO KOROR.
1500 ARRIVED ; LOADED COOLERS TO TRANSPORT TO CTSI COLD STORAGE.
1510 DROPPED OFF COOLERS AT CTSI.
1535 CHECKED BACK IN TO PCH.
1600 END OF DAY REPORTING

21 Nov 19

Rite in the Rain.

22 NOV 19 PALAU SOBS PHASE II USACE

WEATHER: OVERCAST, 80s°F, 5-10 mph WIND

PERSONNEL: D. McCLURE, P. REDMOND, M. STEINKAMP

PPE: MOD LEVEL D

OBJECTIVES:
- COORDINATE W/ CTSI FOR SHIPMENT OF SAMPLES
- GO TO Tx SITE AND COMPLETE VSI
- COLLECT 2 SOIL SAMPLES FROM Tx SITE
- COORDINATE PAYMENT W/ ANGAUR STATE OFFICE.

0700 SAFETY MEETING AT PCH. COMPLETED CoCs AND GOT IN TOUCH WITH LEON (ANGAUR BOATH HOUSE) AND JAMES (CUSTOMS BROKER) TO COORDINATE PAYMENT

1030 HEADING FROM PCH TO Tx SITE

1142 MET GEORGE HERBST (AF) & JON VOGT (PROJECT LIAISON) AT Tx SITE.

1245 COLLECTED SOIL SAMPLE 19PA-BAB-001 FROM DOWNHILL OF TERRACE COMPLEX. THIS AREA HAS BEEN CLEARED AS PART OF THE ARCHAEOLOGICAL INVESTIGATION.

1310 THE 2018 VSI AREA APPEARS SIMILIAR TO WHAT WAS OBSERVED DURING THE INITIAL VSI. NO NEW DISTURBED AREAS, DUMP SITES, ETC. WAS NOTED. THE RESIDENTIAL PROPERTY APPEARED SIMILAR TO 2018. THE NEW CONSTRUCTION FROM 2018 HAD BEEN COMPLETED TO A TWO STORY RESIDENTIAL UNIT W/ STAIRS TO THE ROOF. THREE OTHER BUILDINGS WERE NOTED ON THE PROPERTY. SIMILAR TO 2018. NO AREAS WERE IDENTIFIED THAT WOULD CONSTITUTE A RECOGNIZED ENVIRONMENTAL CONDITION.

1340 SOIL SAMPLE 19PA-BAB-002 COLLECTED ~ 20 FT OFF OF ROADWAY DOWN GRADIENT OF THE RESIDENTIAL PROPERTY.

1400 DRIVING TO KOROR TO MEET ADMIN AT ANGAUR STATE OFFICE.

1530 PAID ANGAUR STATE DEPARTMENT FOR RENTAL CAR & SITE WORKER.

1600 TO PCH FOR SAMPLE MANAGEMENT & END OF DAY REPORTING

22 Nov 19

USACE PALAU SOBS & PHASE II 23 Nov 19

WEATHER: P/C, 80°F, 5-10 mph winds

PERSONNEL: D. McCLURG, P. RODMOND, M. STOLNKAMP (JACOBS)

PPE: CIV CLOTHES

OBJECTIVES:
- FINALIZE PAPERWORK W/ CTSI
- SEND PAPERWORK TO HAWAII APPL INC. EMPLOYEE WHO WILL ICE SAMPLES IN HNL
- SEND APPL ALL CoCs FOR SHIPMENT

0700 SAFETY MEETING AT PCH.

0815 MEET JOHN DIAZ AT CTSI TO FINALIZE SHIPMENT WILL MEET RONNIE AT CTSI ON 24 NOV TO ICE SAMPLES AND PACKAGE FOR FINAL TRANSPORT

ARCHAEOLOGY, UXO, AND SURVEY

EB 5 - REPUBLIC OF PALAU

AUTHORS:

MIKE STUBING

AFI-J07-5FGA6502-H04-0002

CONTENTS

PAGE	REFERENCE	DATE

Location Babeldaob Date 7/9/18

Project / Client Palau EBS

Tx Site GPS Log (Rover)

GPS Points

File 18 PA-BAB

Rover GPS

Pt. No.

1 - TP 2, previously mapped

2 - TP 3, and ceramics cluster

7/10/18

3 - Sta. B-1, check, begin day

4 - Proposed BS 1

5 - Proposed BS 2

6 - Archae[redacted] IO 1

7 - Soil Collection (SC) B

8 - SC A

9 - SC C

10 - SC D

11 - Void, do not use delete point

12 - MD[redacted] 001, 50 cal. shell

13 - Sta. B-1, check, end of day

MS 7/10/18

Location Babeldaob Date 7/11/18

Project / Client Palau EBS

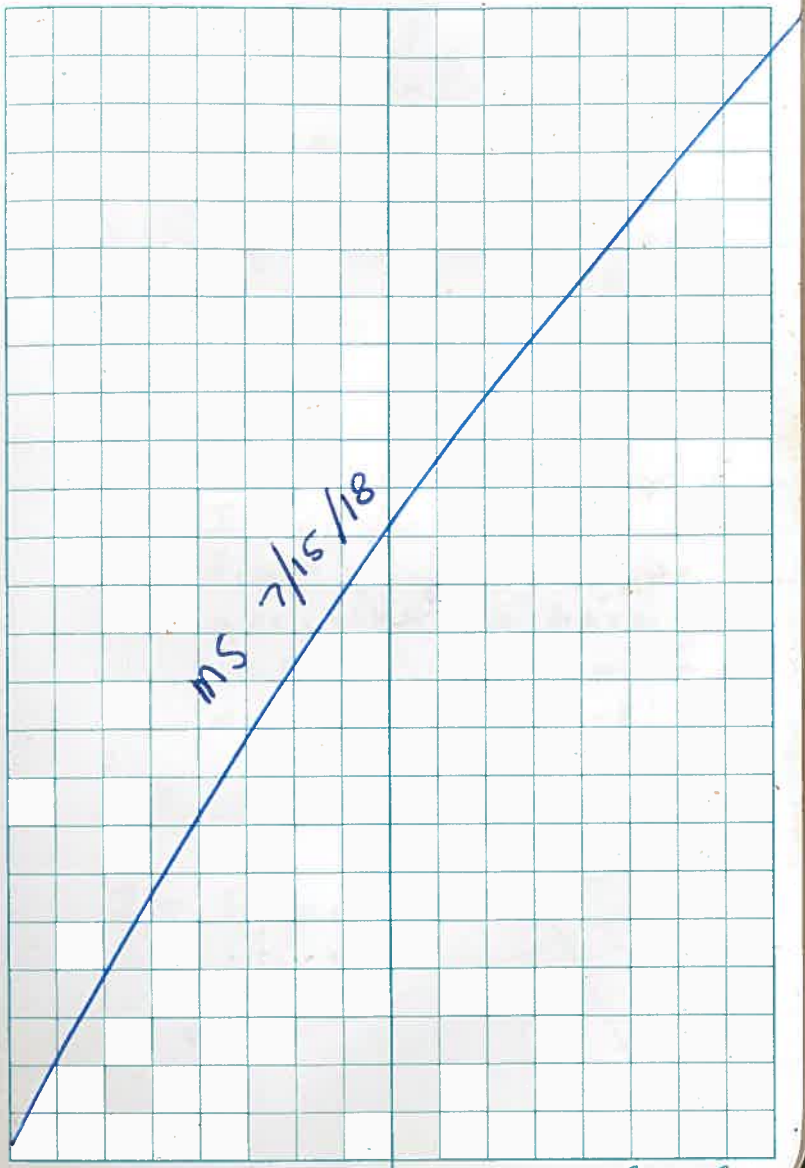
TX Site GPS Log (Rover)

GPS Points
File 18 PA-BAB
Rover GPS
7/11/18

Pt. No. 14 - Sta. B-1, check at start of day
15 - Soil Collection (SC) E
16 - SC F
17 - SC G
18 - SC H
19 - SC I
20 - SC J
21 - SC K
22 - 001, soil sample
23 - 002, same as pt. 20/SC J
24 - MD 002, 1943 0.50 cal, expended cartridge
25 - 003, same as pt. 16/SC F
26 - 004, same as pt. 9/SC C
27 - 005,
28 - 006
29 - 007

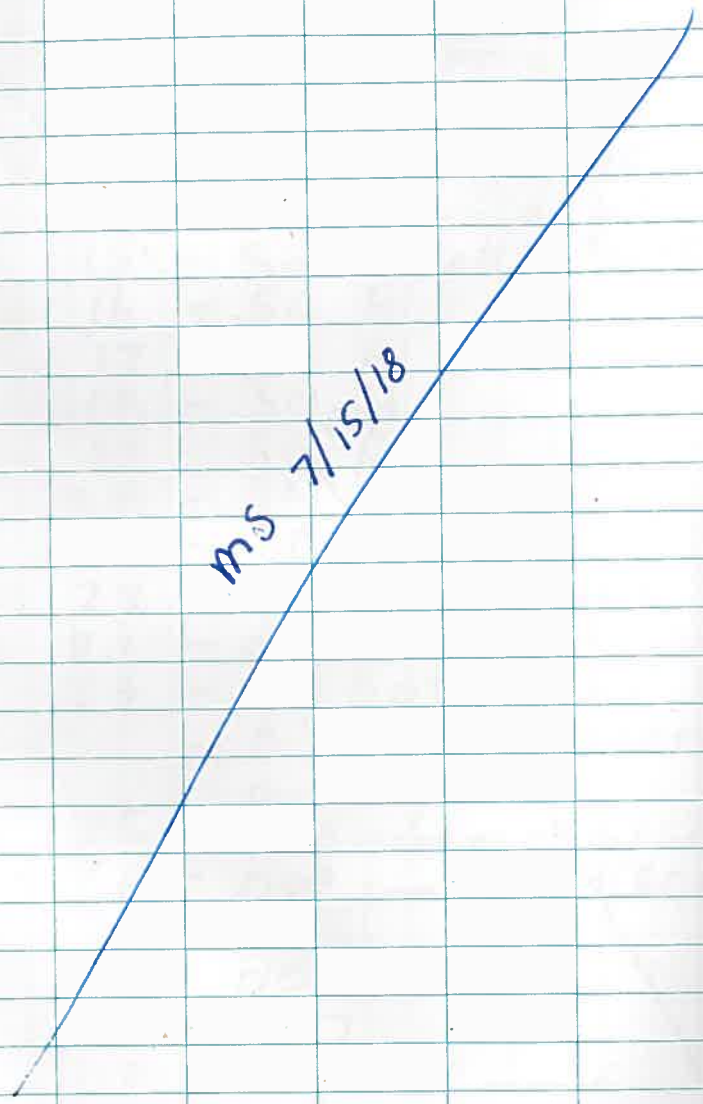
Location Date

Project / Client



Location _____ Date _____

Project / Client _____



Location Babeldaob Date 7/10-11/18

Project / Client Palau EBS

TX Site GPS Log (Base)

GPS Points
File 18PA-BAB
Base GPS

P

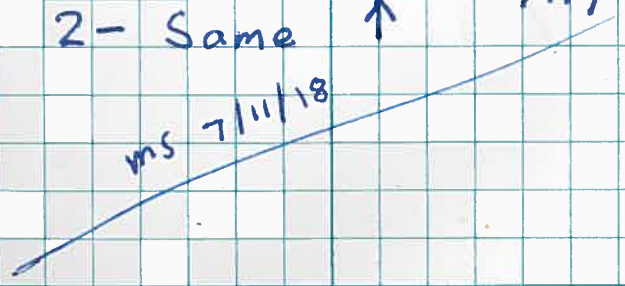
Pt. No. 7/10/11

1 - Proposed BS-1. Point was established prior to fieldwork as an offset base station. It was staked in the field using the rover gps, then the base gps unit was left in place during fieldwork.

~~Same~~

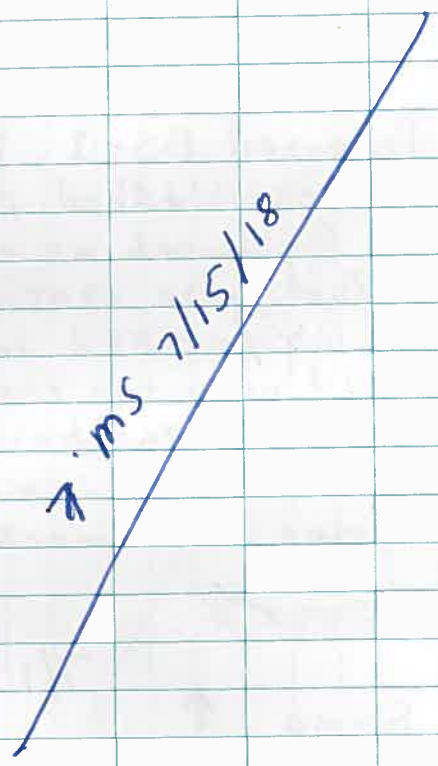
7/11/18

2 - Same



Location _____ Date _____

Project / Client _____



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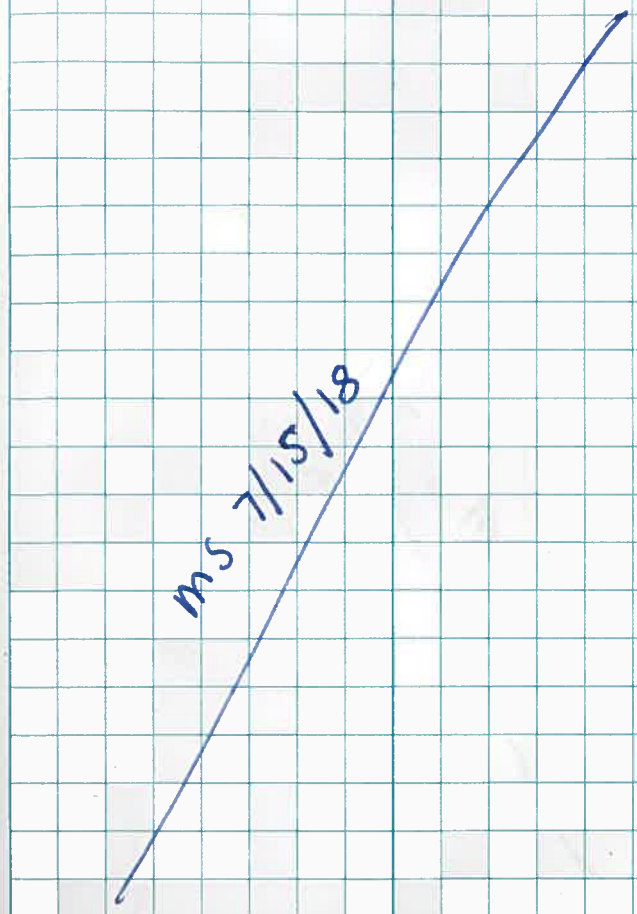
Project / Client _____



Location _____ Date _____

Project / Client _____

_____

Location _____ Date _____

Project / Client _____

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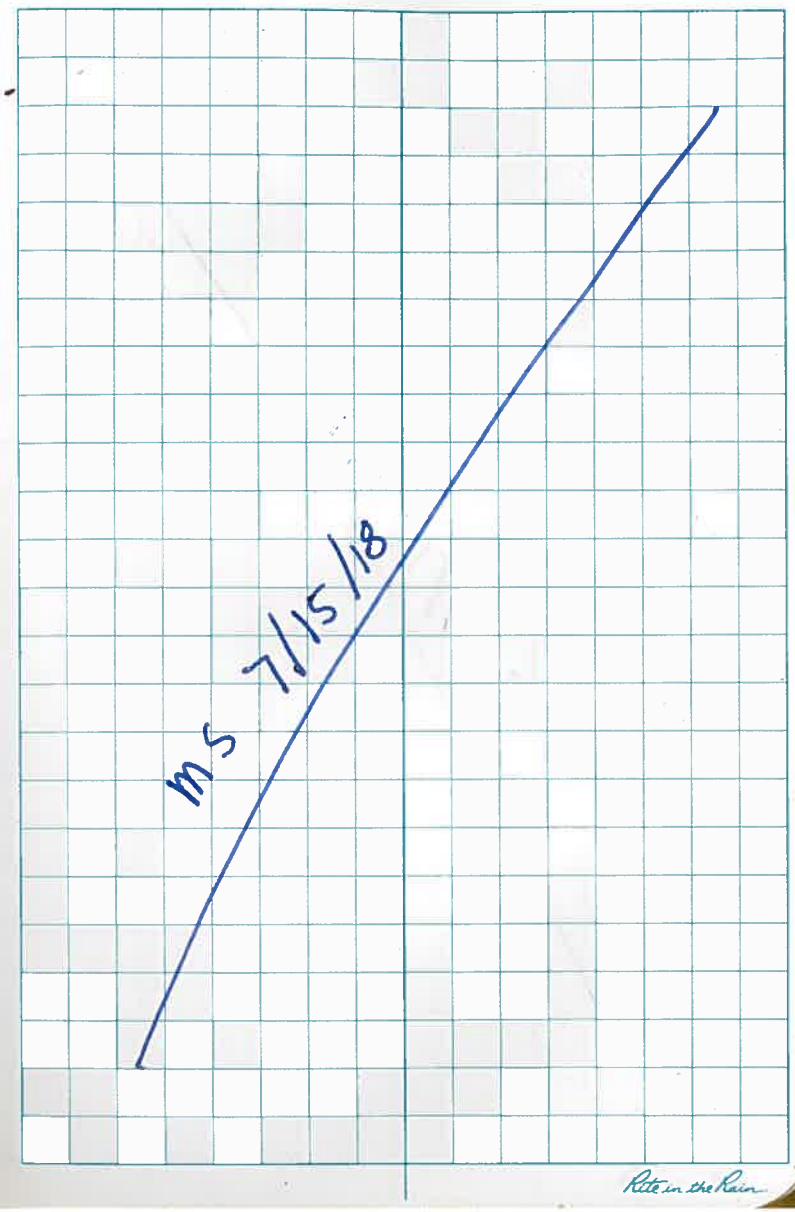

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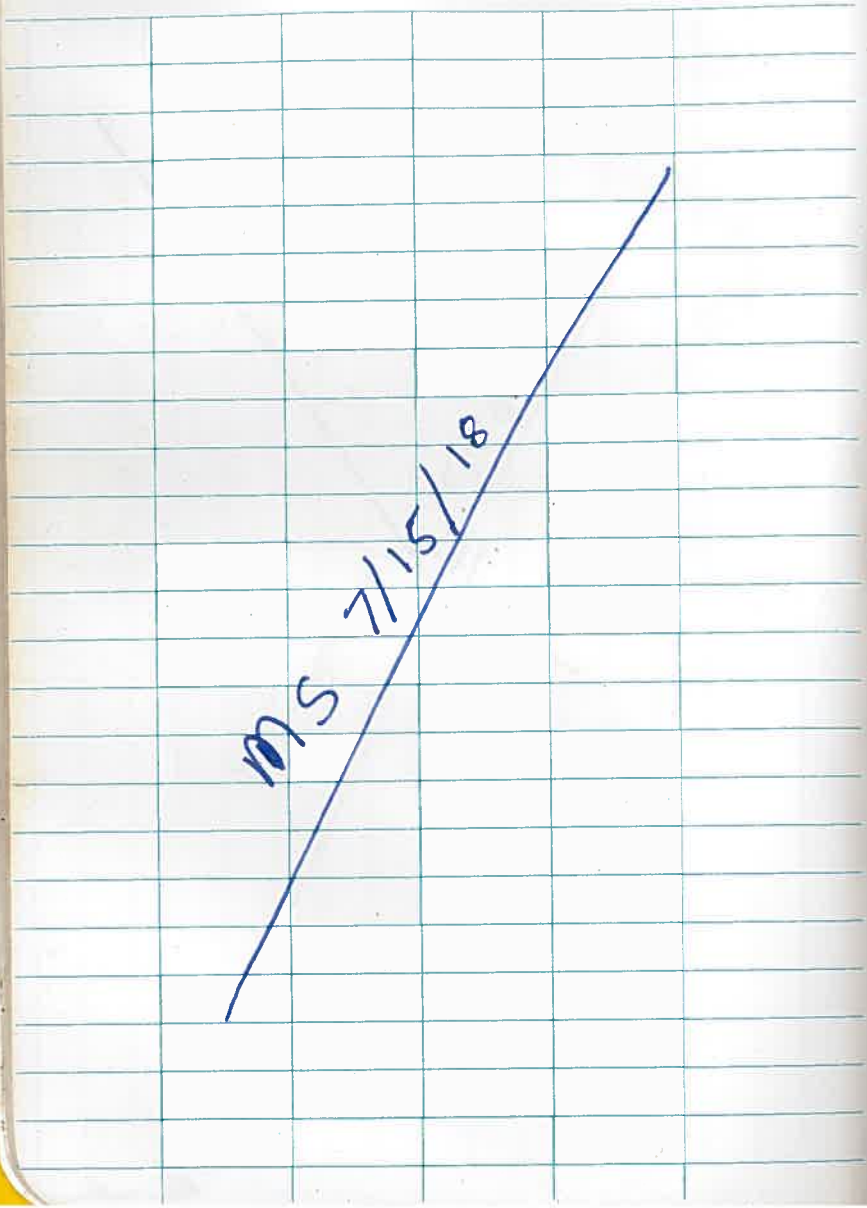
Project / Client _____



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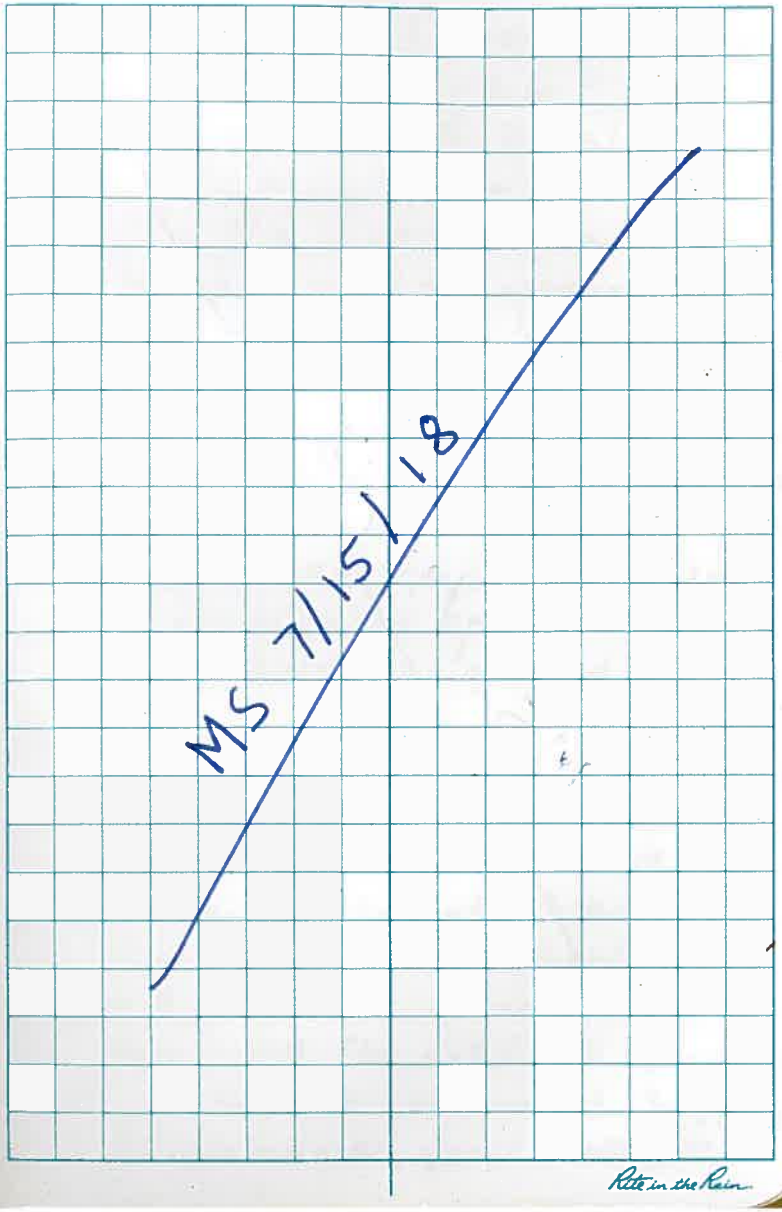
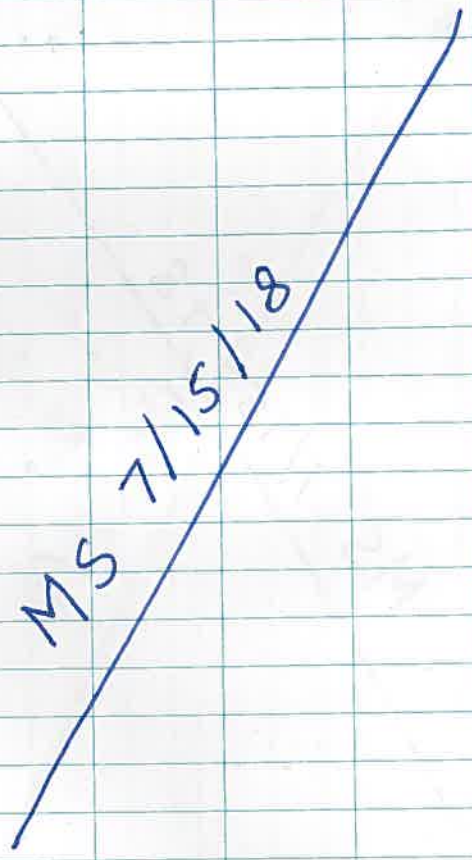
Project / Client _____



Location _____ Date _____

Project / Client _____



Location Babeldaob Date 7/10/18

Project / Client Palau EBS

Archaeology Notes

Arch Note 7/10/18

Arch Pt 1/GPS Pt. 6 - Estimated 15-20 sherds, including 2 rims, in a 3 x 3 m area, appears to be an isolated occurrence but surrounding area was not completely investigated. All plainwares, appeared to be gravel-tempered, some fine-blackened.

TP 3 - ceramic scatter in a previously excavated bore hole designated TP 3. The excavation was done during previous work on-site, and the artifacts were recorded at that time. At time of observation consisted of 15-30 sherds in a ~ 4 x 3 m area of soil from the bore hole. The artifacts apparently came from the excavated soil. All plainwares, grave-tempered, some fine-clouded

Location _____ Date _____

Project / Client _____

MS 7/15/18

Location _____ Date _____

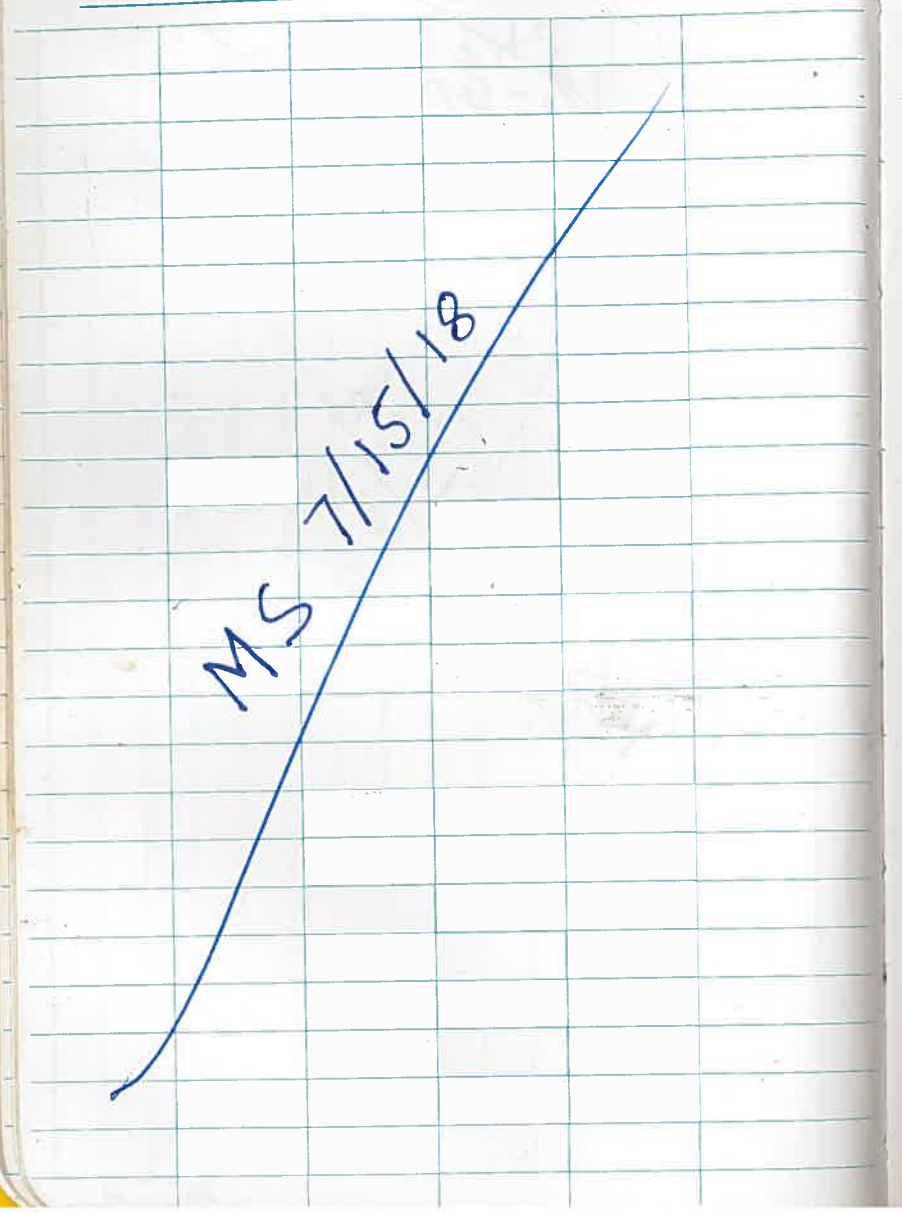
Project / Client _____

~~Photo Log~~
~~18-PA-BAB~~

MS 7/15/18

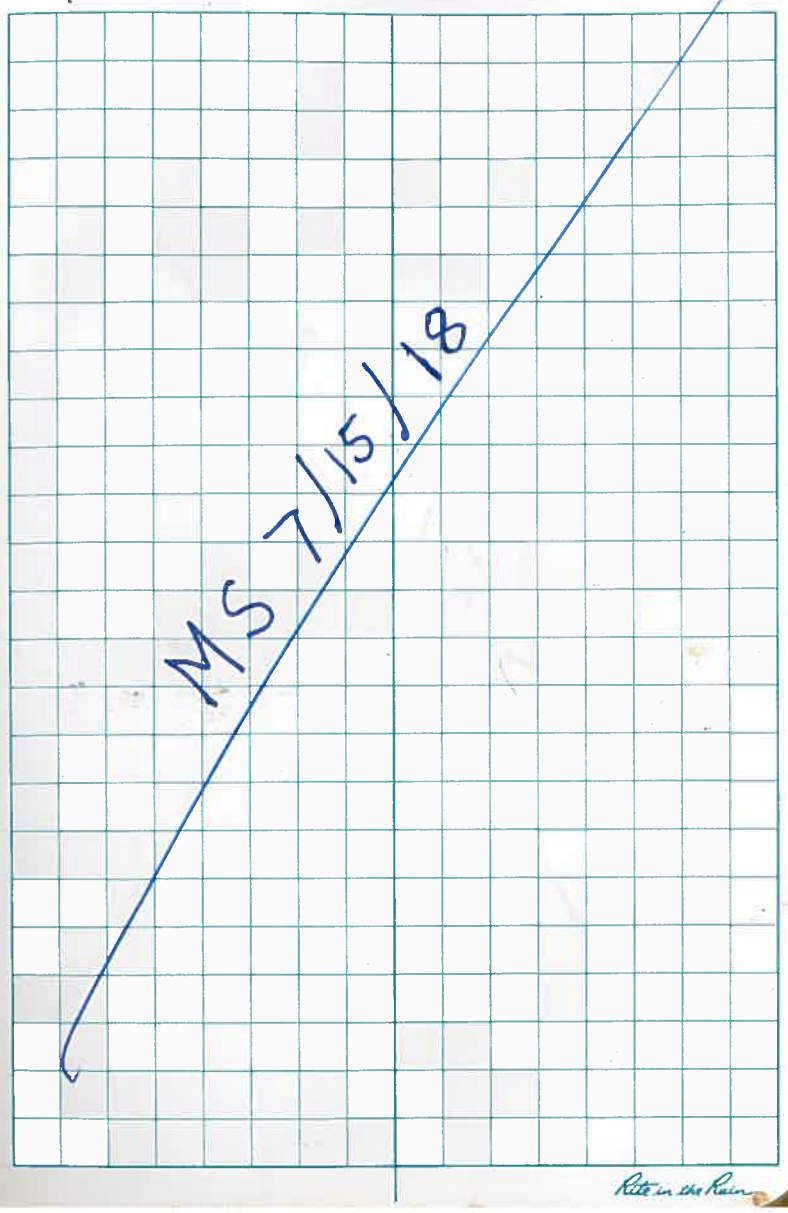
Location _____ Date _____

Project / Client _____



Location _____ Date _____

Project / Client _____



Location _____ Date _____

Project / Client _____

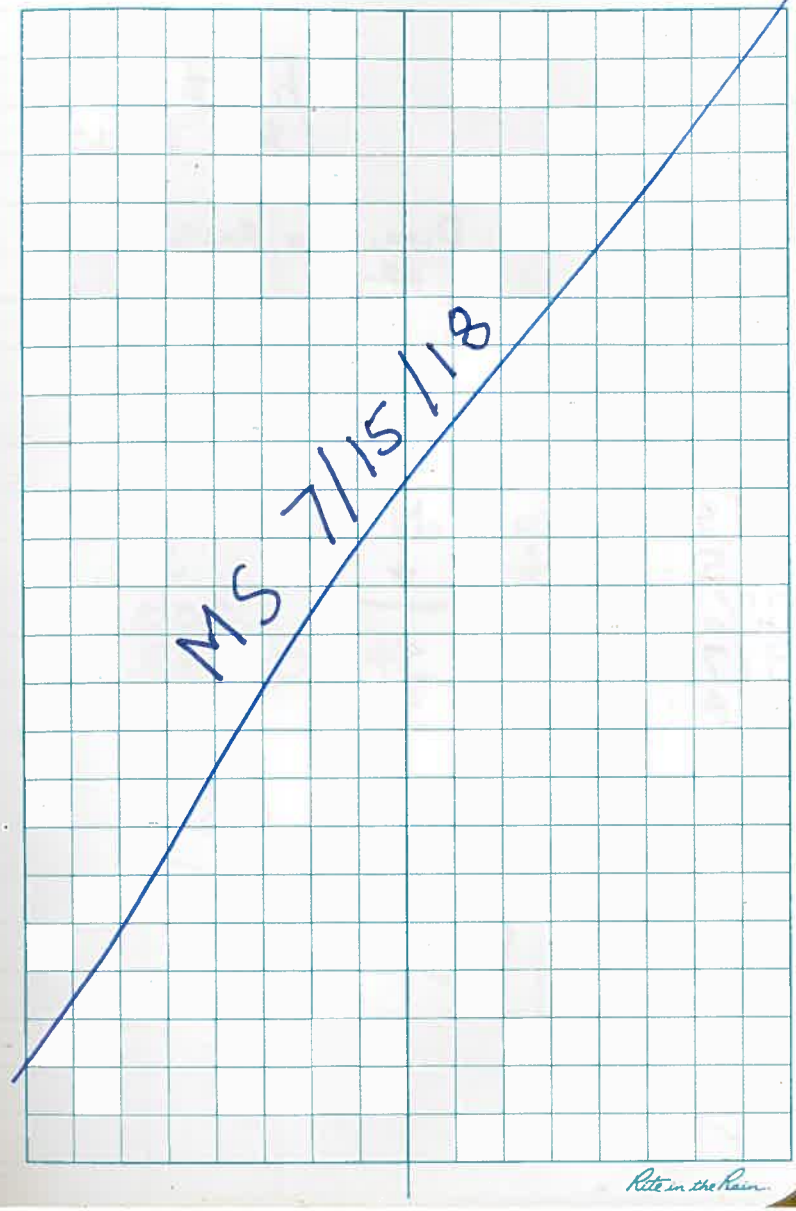
_____

MS 7/15/18

Location _____ Date _____

Project / Client _____

_____



Location Babeldaob Date 7/10-11/18

Project / Client Palau EBS

TX Site Photo Log

Photo 18 PA-

Photo No.	Direction Facing
895	—
896	N
897	↘
898	↓
899	N
914	↓
915	—
916	S
917	S
918	

MS 7/15/18

Location Babeldaob Date 7/10-11/18

Project / Client Palau EBS

TX Site Photo Log

Log BAB

Subject

Arch Pt. 1/GPS pt. 6

Ceramic close-up

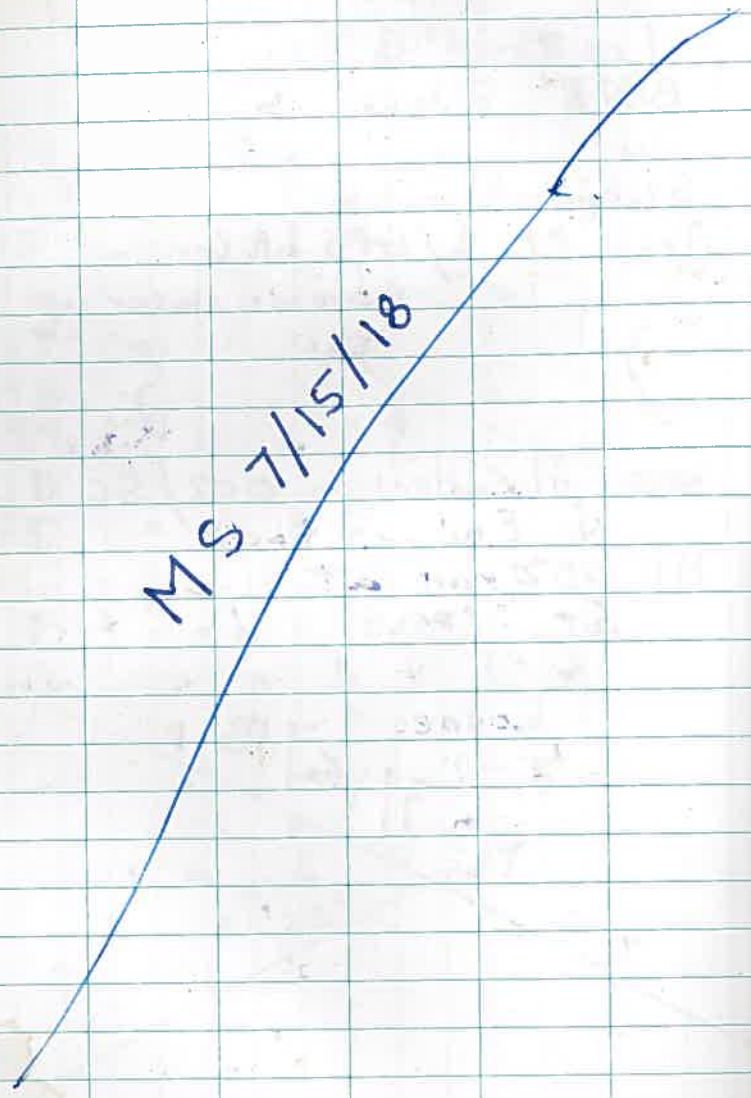
Soil Collection 002/SC J

MD 002, SC 004

MS 7/15/18

Location _____ Date _____

Project / Client _____



Location Angaur Date 7/12/18

Project / Client Palau EBS

RX Site GPS Log (Rover)

GPS Points
File 18 PA-ANG
Rover GPS
7/12/18

Pt. No.

1 - GPS A - 1 Mon, at ne end of runway, check shot at start of day. Point is a flagged nail in the runway.

2 - End of Rocky Pt. trail at coast

3 - Opposite end of Rocky Pt. trail on main road, connects with pt. 2

Note - Two sightings of a megapod were made along the Rocky Pt. trail

4 - Soil Collection (SC) AA

5 - SC AB - also large metal frags

6 - Arch ~~Pt~~ IO 1

7 - SC AC MS 7/12/18

8 - SC AD - also large metal frags

Location Angaur Date 7/12/18

Project / Client Palau EBS

RX Site GPS Log (Rover)

GPS Points, cont.

Pt. No	IO
9 - Arch	[redacted] ms 7/12/18 2 - 5 - 10 sherds in a 5x5 m area.
10 - SC AE	in the greater vicinity of these points is a significant concentration of metal and concrete. Very overgrown, probably from historic mining
11 - SC AF	
12 - SC AG	
13 - SC AH	
14 - SC AI	
15 - SC AJ	
16 - SC AK	ms 7/12/18 [redacted] at metal drum
17 - metal shrapnel fragment	
18 - "	"
19 - SC AL, in asphalt deposit	
20 - GPS A-1, check at end of day	

ms 7/12/18

Location Angaur Date 7/13/18

Project / Client Palau EBS

RX Site GPS Log (Rover)

GPS Points

Pt. No.	7/13/18
21 - GPS A-1, check at start of day	ms 7/13/18
~~22 - 001, soil sample~~	Void, delete, do not use point
23 - 001, soil sample	
24 - 010, same as gps 14/SC AI	
25 - 011, same as gps 15/SC AJ	
26 - 012, same as gps 16/SC AK	
27 - 013	
28 - 014, near gps 19/SC AL	
29 - 007	
30 - 008	
31 - 009	
32 - MD 003	
33 - SC AM/015, both samples from the same location	
34 - SC AN/016	
35 - SC AO/017	
36 - Void, delete, do not use point	
37 - Partially buried metal plate	

Location Angaur Date 7/13/18

Project / Client Palau EBS

RX Site GPS Log (Rover)

GPS Points, cont.

7/13/18

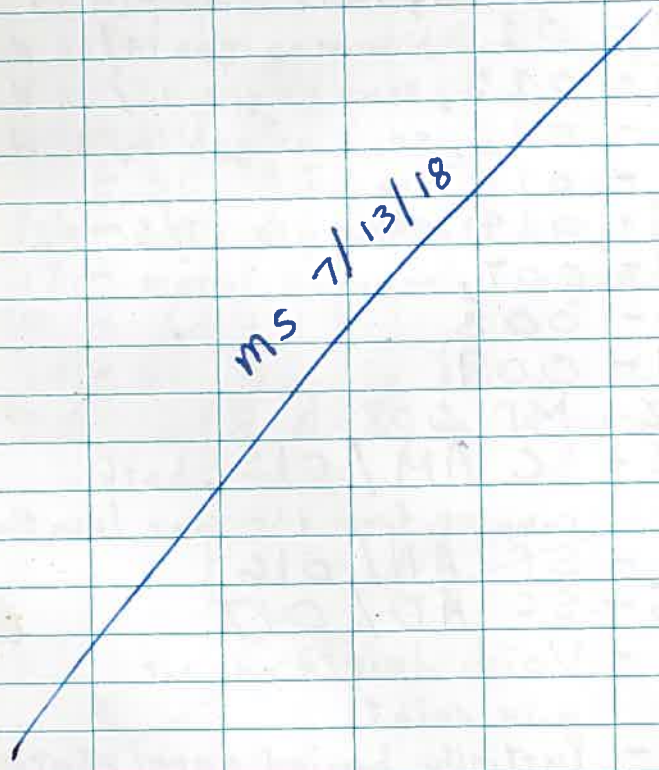
Pt No.

38 - SCAP/018

39 - SC AQ/019

40 - GPS A-1, check at end ✓ of day

41 - SC AR/020



Location Angaur Date 7/14/18

Project / Client Palau EBS

RX Site GPS Log (Rover)

GPS Points

Pt No. 7/14/18

42 - GPS A-1, check at start of day ms 7/14/18

43 - Sample 022

44 - 023

45 - 024

46 - Line, around perimeter of metal drums

47 - 025

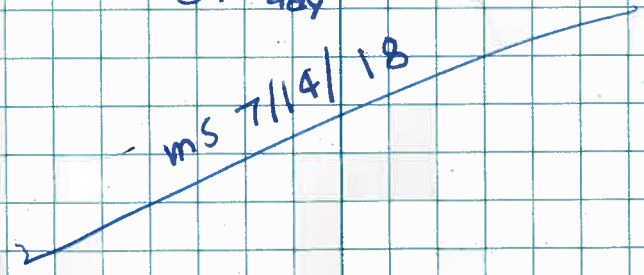
48 - 026

49 - 027

50 - 028

51 - local landfill, ~ center point, area is at least 75 m n-s x 30 m e-w

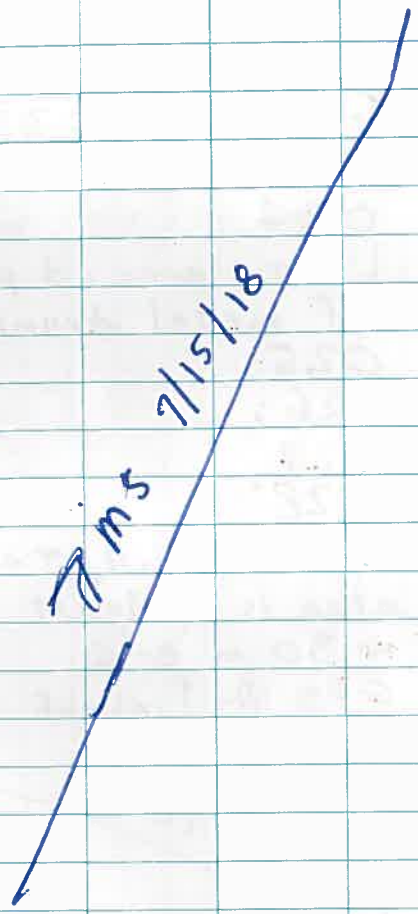
52 - GPS A-1, check at end of day



Location _____ Date _____

Project / Client _____

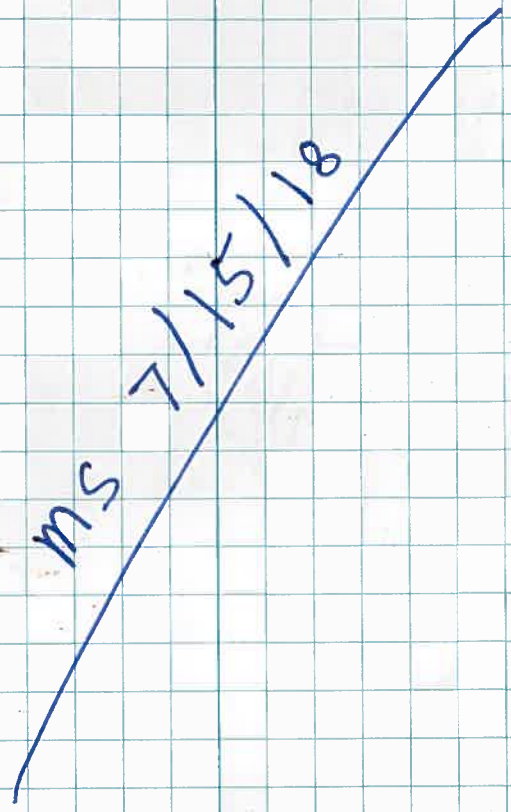
_____



Location _____ Date _____

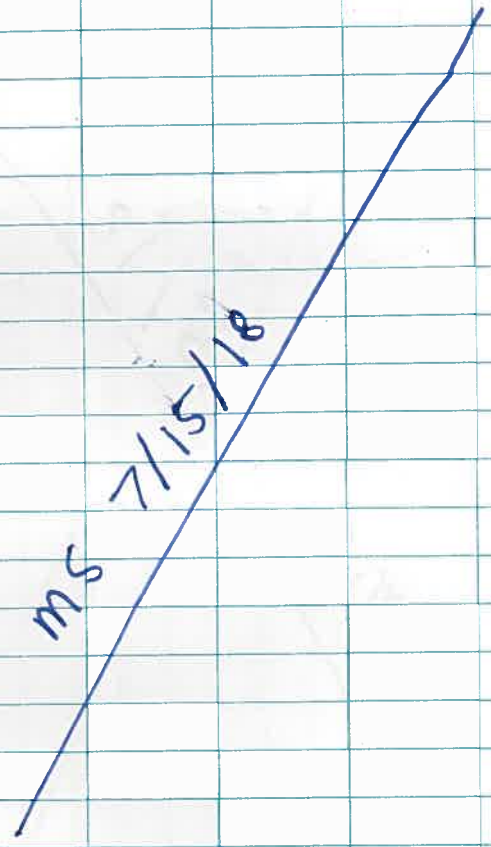
Project / Client _____

_____



Location _____ Date _____

Project / Client _____



Location Angaur Date 7/12-14/18

Project / Client Palau EBS

RX Site GPS Log (Base)

GPS Points
File 18 PA-ANG
Base GPS

Pt. No. 7/12/18

1 - GPS A-1 Mon, at ne end of runway, ms 7/15/18 ~~station~~ unit left at point during work. Point is a flagged nail in the runway.

ms 7/15/18

2 - Same 7/13/18

3 - Same 7/14/18

4 - Void, delete, do not use line

ms 7/15/18

Location _____ Date _____

Project / Client _____

ms 7/16/18

Location Babeldaob Date 7/16/18

Project / Client Palau EBS

TX Site GPS Log (Rover)

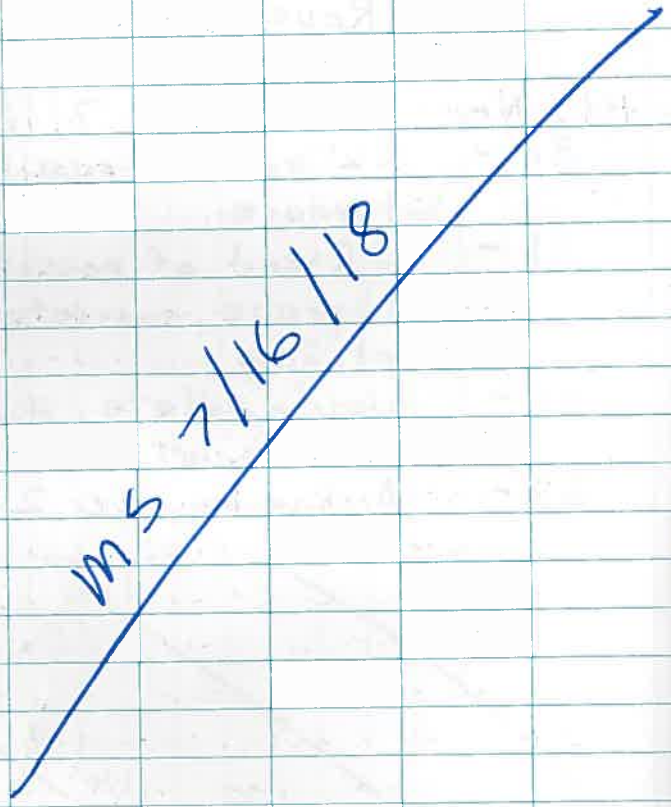
GPS Points
File 18 PA-BAB
Rover GPS

Pt. No.	7/16/18
30 -	NW end of possible terrace
31 -	SE end of possible terrace, connects to pt. 30
32 -	Void, delete, do not use point
33 -	Archaeology IO 2

ms 7/16/18

Location _____ Date _____

Project / Client _____



Location Babeldaob Date 7/16/18

Project / Client Palau EBS

TX Site Archaeology Note

Archaeology Notes

Visited a potential terrace in the vicinity of TP 14. The ms 7/16/18 ~~terrace~~ feature was found by a previous archaeologist, and designated as a possible terrace. It consists of a raised area, somewhat rectangular in shape, oriented nw-se. The feature appears to be made of soil and rocks, and is somewhat level on the top surface. It is ~~t~~ ms 7/16/18 mostly covered by vegetation, and actual dimensions could not be obtained. The feature could be either natural or cultural, due to the plant cover it could not be determined which ~~of the~~ ms 7/16/18 it is.

IO 2 - Two plainware sherds ~ 2 m nw-se from each other.

Location ANGAUR PALAU Date 11/16/2019

Project / Client

MATT STEINKAMP

7:30 AM - CREW DEPARTED HOTEL AFTER LOADING EQUIPMENT AND HEADED TO DOCKS TO BOARD BOAT TO ANGAUR. MET WITH BOAT CAPTAIN AND GEORGE OF AIRFORCE, LOADED BOAT AND HEADED SOUTH TO ANGAUR FROM KOROR. MILD SEAS, ARRIVED @ 9:10 AM AND UNLOADED BOAT AND MET FRANK (LOCAL) WHO IS OUR DRIVER, LOADED TRUCK AND HEADED TO BEACH HOUSE WHERE WE ORGANIZED OUR FIELD GEAR FOR THE DAY, THEN HEADED OUT TO LOCATIONS OF 18 PA ANG SAMPLE AREAS.

MILD WEATHER, YET HOT + HUMID. WE WERE ABLE TO PENETRATE JUNGLE WITHOUT CUTTING, THUS BYPASSING RECENTLY CUT AREAS.

JUNGLE IS HUMMOCKY WITH CORAL LIME STONE OUTCROPS AND BOULDERS, CORAL LIMESTONE FRAGMENTS AND THICK, LOW VISIBILITY VEGETATION. HUMAN DEBRIS CONSISTS OF LOTS OF RUSTED AND PLATY STEEL (OXIDIZED) MINOR STRUCTURAL DEBRIS. NO HISTORIC OR PRE-CONTACT ARTIFACTS OBSERVED, THOUGH VISIBILITY WAS LOW THERE ARE PATCHES OF GRASS (@ 50%) WAS ALSO OBSERVED.

- METHODS CONSISTED OF PETE LEADING CREW INTO JUNGLE FOR MEC AVOIDANCE WHILE AREA, MYSELF AND FRANK FOLLOWED TO EACH SAMPLE LOCATION. NO MEC WERE ENCOUNTERED

Location ANGAUR Date 11/16, 11/17/19

Project / Client

SAMPLE TASK:

DATE	Sample #	GPS RECORD TIME
11/16/19	19-PA-ANG002-20W	2:07
	19PA-ANG002-20W	2:12
	19PA-ANG002-50W	2:17
	19PA-ANG002-20S	2:22
	19PA-ANG002-50S	2:25
	19PA-ANG002-20E	2:27
	19PA-ANG002-50E	2:30
	19PA-ANG004-20W	2:57
	19PA-ANG004-50W	3:10
	19PA-ANG004-20E	3:11
	19PA-ANG004-50E	3:15
	19PA-ANG004-20N	3:20
	19PA-ANG004-50N	3:24
11/17/19	19PA-ANG006-20E	09:10
	19PA-ANG006-20S	0920
	19PA-ANG006-50S	0925
	19PA ANG006-20W	0930
	19PA ANG006-50 W	0936
	19PA ANG006-20N	0940
	19PA-ANG006-50N	0950

40

Location ANGAUR Date 11/17/19

Project / Client

7:30 AM Crew departed for site, Filling water jugs at school on the way. Mild, humid morning and mildly wet conditions from overnight rain. Completed less GPS sampling Area 19PA-ANG005 then conducted visual survey of additional area at North end of runway. Area was moderately thick in vegetation with some very good visibility areas. Ground surface was fairly uniform, with occassional micropore mounds, large trees and jagged limestone along coast. Soils were thin and appears to be stony loams of limestone fragments. In area Area 19PA-ANG005 the vegetation was very thick and steel structural debris was every where. The area/landscape of this sample location was below a limestone cliff and appears to be a quarry area that is now overgrown with a great deal of remnant steel debris.

No historic or precontact artifacts observed, though dense vegetation severely limites the ability to locate features.

Crew today is Drew, Pete, myself (no local help due to Survey).

Location ANGAUR Date 11/17-11/18/19

Project / Client

Date	Sample ID	Time
11/17/19	19PA-ANG005-20N	1010
	19PA-ANG005-50N	1020
	19PA-ANG005-20S	1025
	19PA-ANG005-50S	1035
	19PA-ANG005-20E	1035
	19PA-ANG005-50E	1040
	Screen 1	1430
	Screen 2	1440
	Screen 3	1450
11/18/19	Screen 4	0910
	Screen 5	0920
	Screen 6	0930
	Screen 7	0940
	Screen 8	0945
	Screen 9	0950
	Screen 10	1000
	Screen 11	1005
	Screen 12	1010
	Screen 13	1015

Departed to sample locations after morning Rain. Drew, Pete & myself (No local help today Due to Angaur Holiday). Very humid and wet after rain. We conducted sampling transects in single file line with Pete leading For UXO clearance/avoidance.
Break For Lunch - No cultural resources observed yet today.
- After lunch the crew collected Screen samples 4-13 (1-3 collected 11/17), which consisted of 0.5 gal soil sample into plastic bag after Pete UXO cleared screen location - typical mining debris observed, though fairly light near runway. No cultural resources observed.

11/19 (Tuesday)
Crew departs out about 7:30, weather is dry, calm and Hot (No Breeze). Crew heads out to locate water sample locations around landfill and lead sample locations, basically to sample behind landfill and near lead sample locations.
While searching for surface water to sample near lead sample locations ANG02 + ANG04 we recorded and collected a single historical isolated Artifact. "19PA-ANG-Coke Bottle" Point Generic

Isolate 01 is a clear COCA COLA Bottle measuring 7 3/4" tall x 2 1/4" diameter with diagnostic patent of PAT. D-105529 which dates to 1938-1951. No Bottling plant identification on this hip skirt Bottle. The Bottle was collected and the location recorded as 405927.91E/763395.85N ±3.88m the isolate was recorded in disturbed secondary context and is not directly associated with any Feature or other artifacts. And is in area of historic mining debris (pre-war).

11/20 (Wednesday)
Crew departs @ 7:30 to Field. clear, dry, calm, Hot day. Crew heads to water sample locations near lead sampling ANG02 and ANG04, We also tried to relocate "pottery sherds" that were recorded last year yet were not relocated. In the afternoon the crew collected water samples Below landfill and additional soil samples (surface water sample obtained = SW02) No cultural resources observed. Crew then obtained Drinking water samples at Coast Guard well.

Location ANGAUR + Koror + Babeldaop Date 11/21 - 11/22

Project / Client

11/21 (Thursday) - partly cloudy, warm, light breeze
Crew Heads out in Morning to sample water From CUTST Guess well, which was not conducted yesterday. Access to the well was very Good And sampling was completed. NO cultural resources encountered.
- Crew Heads back to house to Finalize samples For moving to Koror by Boat tomorrow And pack up For Boat ride From ANGAUR to Koror. Upon Reaching Koror the numerous (7) coolers were Hauled to CTSI For cold storage until shipping. Crew then checked into hotel After long Day.

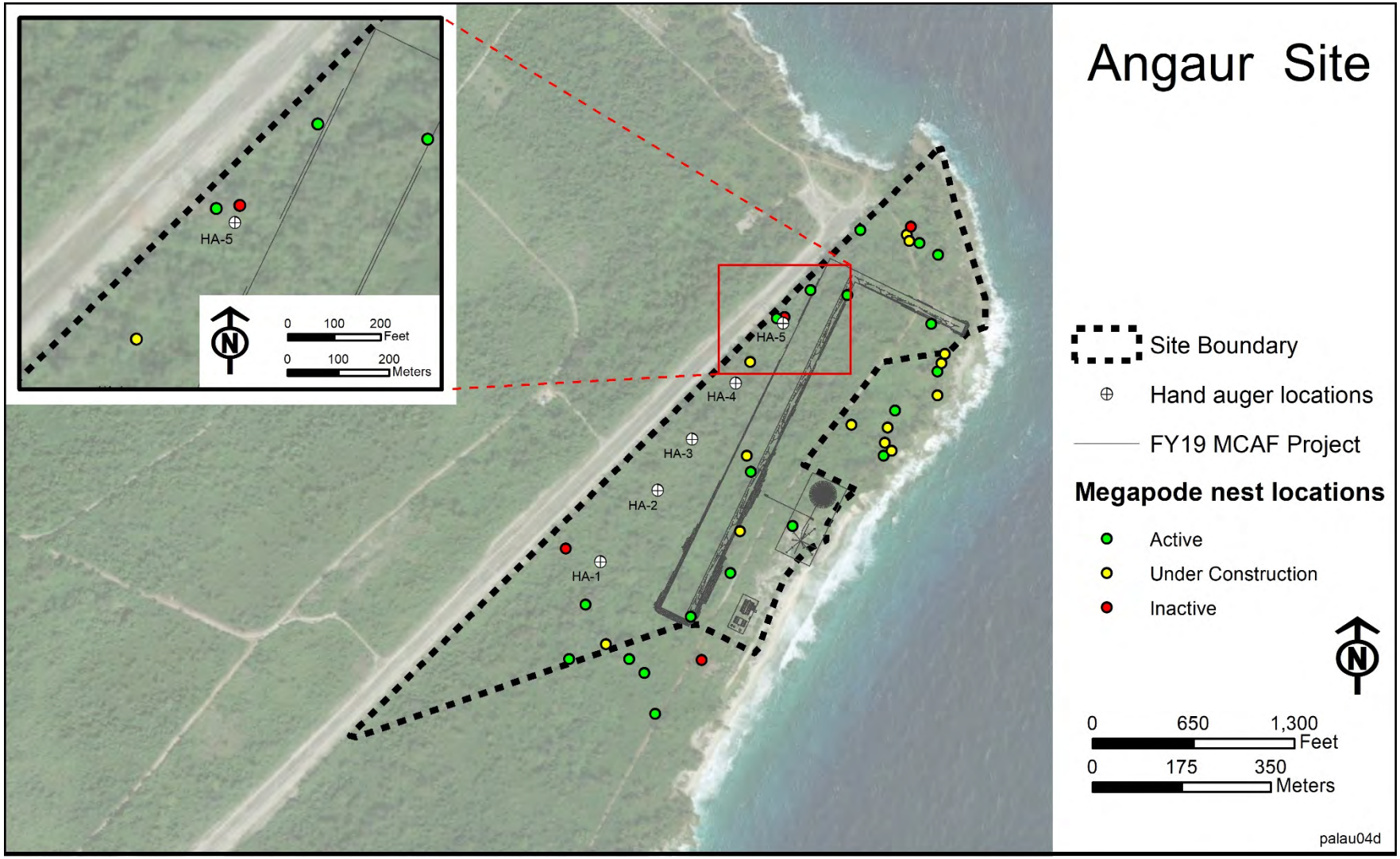
11/22 (FRIDAY)
Crew Departed to TX SITE And Met with George Herbst And JON VOGT on site.
Crew visually inspected Area and collected 2 soil samples. George gave tour of Archaeological site. After Fieldwork, Crew (DREW, MATT, PETE) drove to various Agencies to pay bills For service, then picked up coolers of icepacks to prepare For Sunday shipping. MATT Hauled Core Bottle Found on ANGAUR TO George to Deliver To SHPO.

Location Koror Date 11/23

Project / Client

11/23 (Saturday)
Crew Finalized Fedex paperwork and customs shipping Forms and paperwork For shipping coolers of samples and artifacts to shipping services To Add paperwork to shipping items, labels etc.

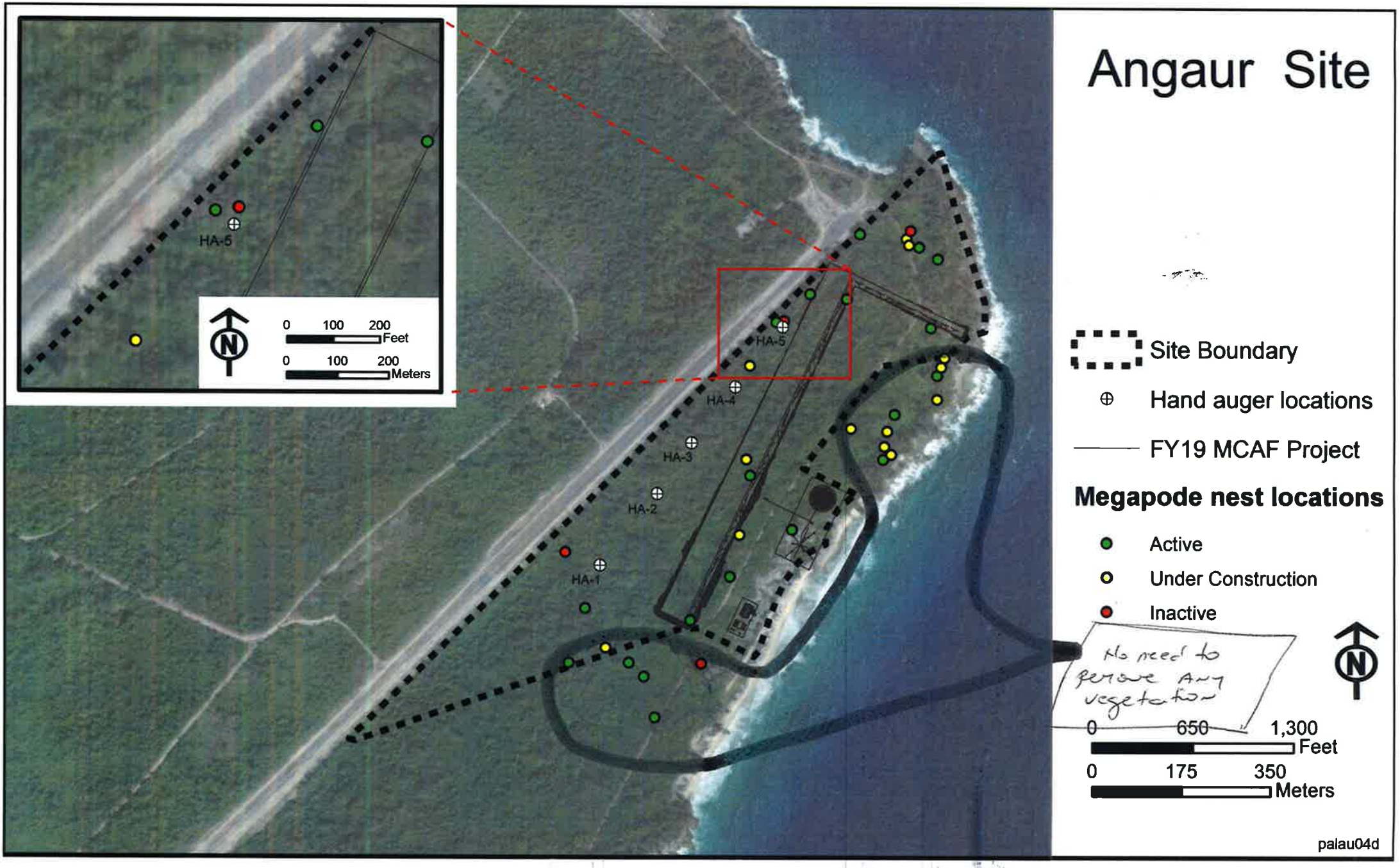
11/24 (Sunday)
Crew prepped And shipped coolers of Samples.


Angaur Site
HA-5
HA-4
HA-3
HA-2
HA-1
0 100 200 Feet
0 100 200 Meters
Site Boundary
Hand auger locations
FY19 MCAF Project
Megapode nest locations
Active
Under Construction
Inactive
N
0 650 1,300 Feet
0 175 350 Meters
palau04d

Megapode Nest Locations Angaur Island, Palau, Jan 22-26, 2019

ID	Status	N	E
N001	A	N6.91245	E134.15162
N002	A	N6.91130	E134.15139
N003	A	N6.91139	E134.15074
N004	I	N6.91091	E134.15028
N005	C	N6.91012	E134.14967
N006	C	N6.90846	E134.14961
N007	A	N6.90818	E134.14968
N008	A	N6.90639	E134.14932
N009	A	N6.90562	E134.14862
N010	A	N6.90462	E134.14780
N011	A	N6.90487	E134.14753
N012	A	N6.90583	E134.14676
N013	C	N6.90713	E134.14949
N014	C	N6.91237	E134.15244
N015	I	N6.91251	E134.15251
N016	C	N6.91226	E134.15248
N017	A	N6.91222	E134.15266
N018	A	N6.91201	E134.15299
N019	A	N6.91089	E134.15014
N020	I	N6.90485	E134.14881
N021	A	N6.90722	E134.15042
N022	A	N6.90846	E134.15203
N023	C	N6.90855	E134.15217
N024	C	N6.90901	E134.15146
N025	C	N6.90869	E134.15205
N026	C	N6.90896	E134.15210
N027	A	N6.90926	E134.15223
N028	C	N6.90953	E134.15298
N029	A	N6.90995	E134.15298
N030	C	N6.91010	E134.15305
N031	C	N6.91026	E134.15311
N032	A	N6.90487	E134.14647
N033	C	N6.90513	E134.14712
N034	A	N6.91079	E134.15287
N035	I	N6.90682	E134.14641
ON001	A	N6.89445	E134.13800
ON002	A	N6.89267	E134.13646
ON003	A	N6.88911	E134.12969
ON004	A	N6.88919	E134.12882
ON005	A	N6.88913	E134.12846
ON006	A	N6.88884	E134.12865
ON007	A	N6.89061	E134.12320
ON008	A	N6.89028	E134.12260
ON009	A	N6.89015	E134.12274
ON010	A	N6.89624	E134.12954
ON011	A	N6.89175	E134.12754
ON012	A	N6.89071	E134.12530
ON013	A	N6.89620	E134.12755
ON014	C	N6.89573	E134.12797
ON015	A	N6.89644	E134.12835
ON016	A	N6.89645	E134.12838
ON017	A	N6.89630	E134.12873
ON018	I	N6.90067	E134.14611
ON019	A	N6.90390	E134.14799

IDs starting with "N" are onsite nests, those starting with "ON" are offsite nests
Status: A=active, I=inactive, C=under construction
All nests were flagged in the field with yellow tape flagging and labelled with nest ID


Angaur Site
HA-5
0 100 200 Feet
0 100 200 Meters
HA-5
HA-4
HA-3
HA-2
HA-1
Site Boundary
Hand auger locations
FY19 MCAF Project
Megapode nest locations
Active
Under Construction
Inactive
No need to remove any vegetation
0 650 1,300 Feet
0 175 350 Meters
palau04d

Natural and Cultural Resource Investigations to Support Construction of Air Domain Awareness Radar Facilities in the Republic of Palau

Natural Resource Surveys

Final Survey Report

Prepared by:

Argonne National Laboratory
Environmental Science Division
9700 South Cass Avenue
Lemont, IL 60439

and

Belau National Museum
Koror, Republic of Palau

Submitted to:

Breton Frazer
Environmental Program Manager, Pacific Division

June 2020

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CONTENTS

FIGURES

FIGURES (CONT.)

TABLES

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EXECUTIVE SUMMARY

Natural resource surveys were conducted at the proposed locations of two Tactical Multi-Purpose-Over-the-Horizon Radar (TACMOR) facilities, one on Babeldaob Island in the state of Ngaraard (the Ngaraard transmitter [Tx] site) and one on Angaur Island (the Angaur receiver [Rx] site) in the state of Angaur. Natural resource surveys were conducted January 14–18, 2019, at the Ngaraard site and January 22–26, 2019, at the Angaur site. Survey staff from Argonne National Laboratory and from the Belau National Museum surveyed both sites in order to characterize the plant and animal communities prior to any future project construction. Particular focus was on determining whether rare or protected species occur at the sites and the locations of sensitive resources (e.g., bird nest sites, rare or endemic plants) that should be protected or avoided. Of concern was the potential occurrence of 14 rare or protected plants, 28 rare or protected animals, and the Micronesian Megapode, an endangered bird known to nest on Angaur Island. Standardized survey protocols were used at both the Ngaraard Tx and Angaur Rx sites.

TABLE ES-1 Rare or Protected Species Observed at the Ngaraard Tx and Angaur Rx Sites, January 2019

Common Name	Scientific Name	International Union for Conservation of nature (IUCN) Red List[b, c]	Palau Proposed List[b]	U.S. Endangered Species Act (ESA)[b]	Ngaraard Tx Site	Angaur Rx Site
Plants						
Indian Mangrove	*Ceriops tagal*	NL	T	NL	X	
Mesecheues	*Aglaia mariannensis* (*palauensis*)	VU	T	NL	X	
Birds						
Micronesian Megapode (Bekai)	*Megapodius laperouse*	EN	E	E		X
Palau Fruit-Dove (Biib)[a]	*Ptilinopus pelewensis*	LC	T	NL	X	X
Palau Nightjar (Chebacheb)	*Caprimulgus phalaena*	NT	T	NL	X	
Palau Owl (Chesuch)[a]	*Pyrroglaux podargina*	LC	T	NL	X	
Palau Kingfisher (Cherosech)	*Todiramphus pelewensis*	NT	NL	NL	X	
Morningbird (Tutau)	*Pachycephala tenebrosa*	LC	T	NL	X	
Palau Fantail (Melimdelebteb)[a]	*Rhipidura lepida*	LC	T	NL	X	
Palau Flycatcher[a] (Charmelachull)	*Myiagra erythrops*	LC	T	NL	X	
Palau Bush Warbler (Wuul)[a]	*Horornis annae*	LC	T	NL	X	
Mammals						
Pacific Sheath-tailed Bat (Chesisualik)	*Emballonura semicaudata*	E	NL	NL	X	X
Palau Fruit Bat (Olik)[a]	*Pteropus pelewensis*	NT	T	NL	X	X

[a] Endemic species; occurs only in the Republic of Palau.

[b] NL = not listed; NT = near threatened; VU = vulnerable; LC = least concern; T = threatened; E = endangered.

[c] The IUCN listings apply to a species throughout its range, including any occurrence in the Republic of Palau.

The Ngaraard Tx site has a rolling terrain and includes savanna/grassland and a variety of forest habitats. None of the habitats that occur on the site are unique or uncommon, and all may be found in other areas of Babeldaob Island. The expansive, centrally located savanna/grassland is ecologically affected as a result of forest clearing from traditional Palauan terracing activities of the area that occurred prior to Western contact. More than 198 plant species were found among these habitats with at least 159 species being native to Palau and 21 of these endemic, occurring only in Palau. Two of the species are proposed by Palau for designation as threatened, and one of these is designated as vulnerable on the IUCN Red List of Threatened Species. A total of 28 bird species were either observed or heard during the avian surveys at the site. Nine of these species have an IUCN Red List and/or proposed Palau designation. None of these species requires a unique habitat, and with the exception of the Palau Nightjar, these species were regularly seen or heard throughout the survey period. Likely nesting areas for the Black Noddy and White Tern were identified in the north and southwest forest. Both species of bat (Pacific Sheath-tailed Bat and Paulau Fruit Bat) were reported from the site, and a roost for the Palau Fruit Bat was found in the northern forest at the site. Survey efforts for the Pandanus Skink (IUCN Red List designation of near threatened) failed to find any individuals.

The Angaur Rx site is quite different from the Ngaraard site. Angaur Island is a relatively flat, raised, limestone plateau. The site of the proposed Rx facility was the location of a major World War II (WWII) battle and before that had phosphate mining, both of which had an impact on the ecology of the island. Supertyphoon Bopha also had an impact on the island in December 2012. All these have resulted in the area being quite disturbed, especially compared to the Ngaraard site. Surveys of the Rx site found more than 148 plant species, 92 of which are native and 8 of which are endemic to Palau. No plants with IUCN Red List, Palau, or ESA designations were found during the survey. Two culturally important plant species, one a critical component of Angaur's first birth ceremony and the other associated with childbirth, were found within the Rx facility footprint. A total of 18 bird species were documented during the surveys, 3 of which have an IUCN Red List or Palau-proposed designation. The Palau Fruit-dove is proposed for listing by Palau as threatened, while the Palau Kingfisher is IUCN Red List designated as near threatened. Neither of these species has habitat requirements unique to the Rx site.

The third rare or protected species found at the Angaur Rx site was the Micronesian Megapode. The species is designated as endangered on the IUCN Red List and under the ESA; it is proposed for listing as endangered by Palau. The megapode was the second most observed or heard bird species during the avian surveys at Angaur. It was reported during all survey activities and each day of the surveys. More importantly, 32 active megapode nests were documented within the Rx site footprint. An additional 19 nests were found south of the site and outside of the project footprint. The density of nests within the site falls within the upper range of nest densities previously reported across the rest of Palau. It is clear that the Rx project area provides quality nesting habitat for this endangered species.

On the basis of the survey results, a number of potential mitigation measures are identified (but are not limited to): collecting fruit, seed, cuttings, and entire specimens of endemic, rare, and protected species (if small) for propagation and transplant in areas with active nesting; delaying project activities until fledging has occurred; minimizing vegetation clearing to the extent practicable; implementing project activities in a manner that provides continual escape

routes for adult and juvenile megapodes to unaffected habitat; collecting megapode eggs for artificial incubation and subsequent use in reintroductions elsewhere on Palau; and capturing adult megapodes for reintroduction elsewhere on Palau.

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1 INTRODUCTION

The U.S. Air Force has proposed construction of two Tactical Multi-Purpose Over-the-Horizon Radar (TACMOR) facilities (one transmitter [Tx] facility and one receiver [Rx] facility) in the Republic of Palau for air domain awareness. The agency is evaluating the potential adverse impacts of that construction on natural and cultural resources within the project footprints and adjacent areas. The Tx facility site is located on the northern end of Babeldaob Island, within the state of Ngaraard (Figure 1). The Rx facility site is located on Angaur Island, at the southern end of the archipelago in the state of Angaur (Figure 1). Facilities to be constructed include electrical utilities, reinforced concrete pads and foundations, tiedowns for equipment, water and wastewater facilities, access roads, paved parking and turnaround areas, and two levels of security fencing to support the installation of TACMOR equipment. Construction of these facilities will require extensive site work.

To assist the U.S. Air Force in identifying potential environmental impacts and mitigation options, environmental surveys were conducted at each of the two proposed facility sites. Surveys were conducted at each site to provide baseline information regarding the nature and condition of natural resources at each location. The surveys characterized the plant and animal communities at each site, including their distribution, relative abundance and occurrence, and status under the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2018) and the Republic of Palau's threatened and endangered species list. This report presents the results of these surveys, as well as mitigation options to be considered for addressing impacts on the natural resources that may be incurred with project development at each site.

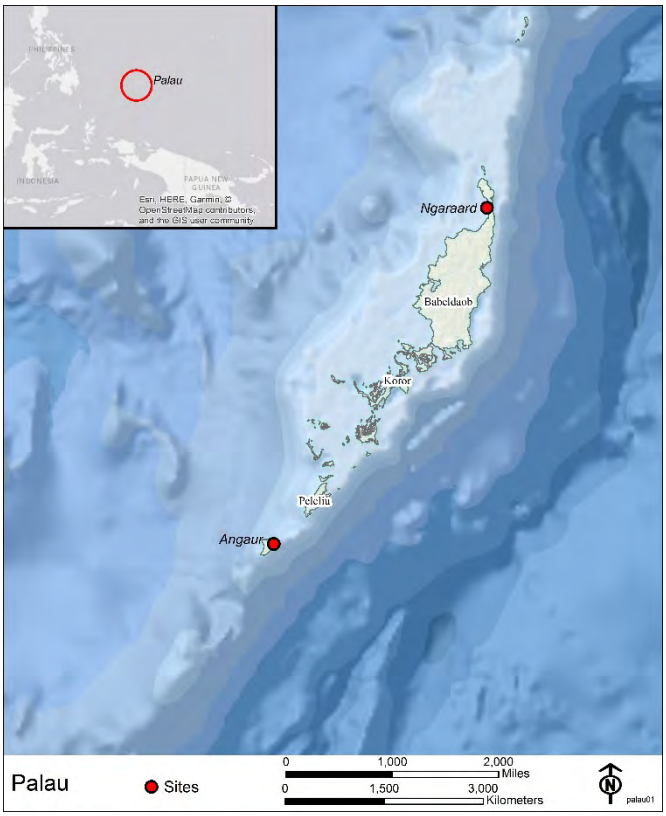

FIGURE 1 Project Locations for TACMOR Facilities on Babeldaob and Angaur Islands, Republic of Palau.

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2 SITE DESCRIPTIONS

2.1 NGARAARD SITE

The Ngaraard site is located on the top and slopes of a hill adjacent to the ocean on the northern end and western side of Babeldaob Island (Figure 2). Compared to the Angaur site, which was the location of a major World War II (WWII) battlefield as well as of phosphate mining that began in the late 1800s, the Ngaraad site shows limited evidence of recent human disturbance. Currently there is a small dryland taro (*Colocasia esculenta*) field in the easternmost portion of the site, adjacent to the Compact Road. Immediately to the west of this field are several outbuildings and a homestead. Besides a gravel drive from the Compact Road to the homestead, there is no evidence of any further recent human disturbance at the site.

FIGURE 2 Proposed Tx Facility Location, Ngaraard, Babeldaob Island. (The proposed Tx facility may occur within the site boundary as shown).

The site exhibits considerable topographic relief within the project area. The highest elevation (50 meters [m]) occurs on the east side of the site. The site gradually slopes westward to about 40 m in elevation before steeply decreasing to near sea level to the north, west, and south; about one quarter of the site is occupied by the hilltop. Most of the hilltop and westward slope is open savannah dominated by grasses, ferns, scattered shrubs, and small trees. An

emergent marsh, approximately 1,500 square meters (m^2) in area, is located on the south-central portion of the hilltop. A small seep emanates from the downslope portion of the wetland and flows to the south. Areas of bare clay soil and of exposed volcanic bedrock are scattered across the hilltop.

A narrow strip of tropical hardwood forest and a small patch of mangroves at the coastline are just outside the western edge of the project area. To the immediate north and within the project area is a very steep slope (approximately 45%) of unbroken dense tropical hardwood forest. A steep slope also occurs at the southern edge of the project area, but this slope is less steep and more irregular in topography and includes a small stream formed by the wetland seep on the hilltop. Tropical hardwood forest with a dense understory of shrubs, small trees, and vines dominates the south slope. An extensive mangrove forest is just outside of the project area at the bottom of the south slope of the hill.

2.2 ANGAUR SITE

Angaur Island is a relatively flat, raised, limestone plateau with minimal soil overlying fractured limestone. The proposed facility would be located in the northeast portion of the island, between the island's airplane runway and the coast; a semipaved road runs through the site paralleling the coast (Figure 3).

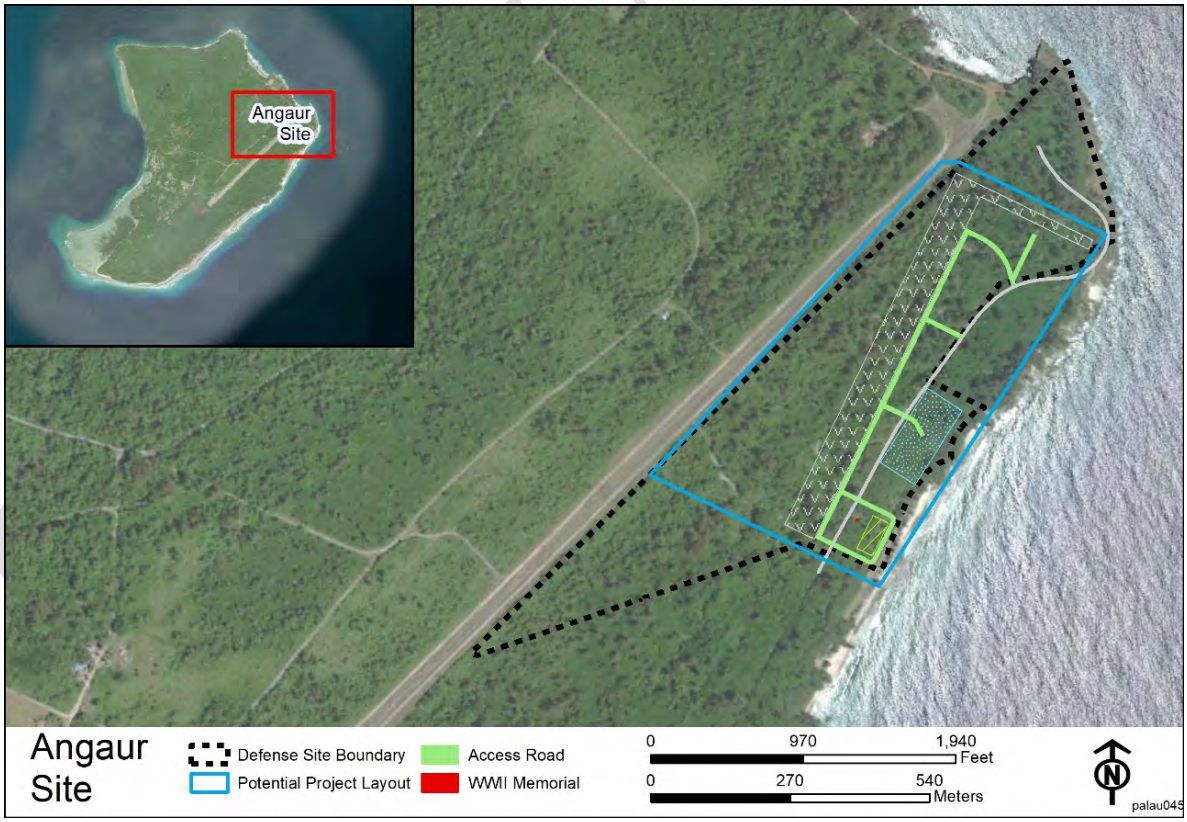

FIGURE 3 Proposed Rx Facility Location, Angaur Island.

The Angaur site is located on a major WWII battlefield (September 17–October 22, 1944), and portions of the site were subject to phosphate mining beginning in the late 1800s. As a result, the site is much more disturbed than the Ngaraard site. More recently, in December 2012 Supertyphoon Bopha struck Palau as a Category 4 storm, with its eye passing 35 miles south of Angaur Island. Along the eastern facing coast of the island (which includes the Rx site), the storm surge caused extensive damage, pushing several hundred feet inland in some areas and resulting in considerable damage to coastal habitats. Evidence of this damage is readily evident from the coast road south of the Rx site.

As a result of the past phosphate mining, the WWII battle, and most recently Supertyphoon Bopha, the site and surrounding areas have been extensively disturbed and now support dense secondary vegetation growth. This secondary vegetation is a mix of tropical hardwood trees and shrubs, with grasses and forbs in the understory and open areas. Numerous large trees emerge from the surrounding lower canopy within the project footprint. The adjacent coastline is rocky and does not support mangrove.

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3 METHODS

3.1 LITERATURE REVIEW

Prior to the surveys, Argonne performed a thorough literature review of the ecosystems of Palau, with a focus on Babeldaob and Angaur Islands and the species of concern that could be found in the habitats at the Ngaraard and Angaur sites and their immediate surroundings. The species of concern are those identified on the IUCN Red List of Threatened Species; those identified by the Palau government as threatened, endangered, or rare; and those listed under the ESA. The literature evaluated during this review included scientific journals, federal agency reports, reports from the Belau National Museum, and scholarly books, as well information from local natural resource experts.

The review resulted in a list of rare, threatened, and endangered species that occur in Palau and that could occur in areas affected by the two proposed facilities (Table 1). To develop this list, we reviewed (1) the IUCN Red List of Threatened Species (IUCN 2018); (2) a list of species being considered for listing as threatened and endangered by the government of Palau (provided to the U.S. Air Force Civil Engineer Center [AFCEC] by the Palau Environmental Quality Protection Board [EQPB]; and (3) the ESA list, which includes a number of foreign species, several of which occur on Palau.

TABLE 1 Rare, Threatened, and Endangered Species That Could Occur in Potentially Affected Habitats in the Ngaraard and Angaur Project Areas.

Common Name[a]	Scientific Name	IUCN Red List[b]	Palau Proposed List[c]	ESA List[d]	Habitat
Plants					
Caroline Cinnamon tree (Ochod)	*Cinnamomum carolinense*	NL	T	NL	Forest; reported to occur on Babeldaob Island
Cinnamon Tree (Ochod)	*Cinnamomum pedatinervium*	NL	T	NL	Forest
Palau Palm (Esbuuch)	*Ponapea* (*Ptychosperma*) *palauensis*	NL	E	NL	Forest
Rock Island Palm (Bochelauchererak)	*Hydriastele* (*Gulubia*) *palauensis*	NL	E	NL	Forest
Xylocarpus (Meduulokebong)	*Xylocarpus moluccensis*	LC	T	NL	Mangrove swamp; reported to occur on Babeldaob Island; mangrove swamp is adjacent to Ngaraard project area.
Tilol	*Garcinia matsudai* (*matudae*)	NL	T	NL	Forest; reported to occur on Babeldaob Island
Esemiich	*Terminalia samoensis*	NL	T		Forest; reported to occur on Babeldaob Island
Esemiich	*Terminalia crassipes*	NL	T	NL	Forest; reported to occur on Babeldaob Island
Rhizophora hybrid	*Rhizophora* x *lamarckii*	NL	T	NL	Mangrove swamp; mangrove swamp is adjacent to Ngaraard project area.

TABLE 1 (Cont.)

Common Name[a]	Scientific Name	IUCN Red List[b]	Palau Proposed List[c]	ESA List[d]	Habitat
Indian Mangrove	*Ceriops tagal*	NL	T	NL	Mangrove swamp; reported to occur on Babeldaob Island; mangrove swamp is adjacent to Ngaraard project area.
Mesecheues	*Aglaia mariannensis* (*palauensis*)	VU	T	NL	Understory, thickets, and secondary forest; reported to occur on Babeldaob Island
Fadang	*Cycas micronesica*	EN	NL	NL	Closed canopy forest; reported to occur on Babeldaob Island
Nandu Wood (Amansis)	*Pericopsis mooniana*	VU	NL	NL	Coastal forest; reported to occur on Babeldaob Island
Parkia (Kmekumer)	*Parkia parvifoliola*	VU	E	NL	Forest canopy; reported to occur on Babeldaob Island
Invertebrates					
Trumpet Shell (Debusech)	*Charonia tritonis*	NL	E	NL	Marine
Helmet of Conch Shell (Omuu)	*Cassis cornuta*	NL	E	NL	Marine
Giant Clam (Keratel, Otkand)	*Tridacna gigas*	VU	T	NL	Marine
Giant Clam	*Tridacna derasa*	VU	T	NL	Marine
Giant Clam (Ribkungel)	*Tridacna squamosa*	NL	T	NL	Marine
Giant Clam (Kim)	*Hippopus hippopus*	NL	T	NL	Marine
Reptiles					
Green Sea Turtle (Melob)	*Chelonia mydas*	EN	T	E[e]	Marine
Hawksbill Sea Turtle (Uel)	*Eretmochelys imbricata*	CE	T	E	Marine
Olive Ridley Sea Turtle	*Lepidochelys olivacea*	VU	E	T	Marine
Loggerhead Sea Turtle	*Caretta caretta*	NT	E	E[f]	Marine
Leatherback Sea Turtle (Bekuu)	*Dermochelys coriacea*	VU	E	E	Marine
Pandanus Skink	*Lipinia leptosoma*	NT	NL	NL	Pandanus trees; reported to occur on Babeldaob and Angaur Islands; pandanus trees were observed in Ngaraard project area during site visit.
Birds					
Palau Gray Duck (Debar)	*Anas superciliosa pelewensis*	NL	E	NL	Fresh and salt water wetlands
Micronesian Megapode (Bekai)	*Megapodius laperouse*	EN	E	E	Limestone and beach strand forest; observed in Angaur project area during site visit
Palau Ground-dove (Omekrengukl)	*Gallicolumba canifrons*	NT	E	NL	Forest
Nicobar Pigeon (Laib)	*Caloenas nicobarica*	EN	E	NL	Forest
Palau Fruit-Dove (Biib)	*Ptilinopus pelewensis*	LC	T	NL	Forest; heard in Ngaraard project area during site visit
Micronesian Imperial-Pigeon (Belochel)	*Ducula oceanica*	NT	T	NL	Forest
Eurasian Moorhen (Debar)	*Gallinula chloropus*	LC	T	NL	Wetlands
Purple Swamphen (Uek)	*Porphyrio porphyrio*	LC	T	NL	Wetlands
Palau Nightjar (Chebacheb)	*Caprimulgus phalaena*	NT	T	NL	Forest

TABLE 1 (Cont.)

Common Name[a]	Scientific Name	IUCN Red List[b]	Palau Proposed List[c]	ESA List[d]	Habitat
Far Eastern Curlew (Delerrok)	*Numenius madagascariensis*	EN	NL	NL	Shore and near-shore
Bar-tailed Godwit	*Limosa lapponica*	NT	NL	NL	Shore and near-shore
Black-tailed Godwit	*Limosa limosa*	NT	NL	NL	Shore and near-shore
Great Knot	*Calidris tenuirostris*	EN	NL	NL	Shore
Curlew sandpiper	*Calidris ferruginea*	NT	NL	NL	Shore
Red-necked Stint	*Calidris ruficollis*	NT	NL	NL	Shore
Gray-tailed Tattler	*Tringa brevipes*	NT	NL	NL	Shore and near-shore
Japanese Night-heron	*Gorsachius goisagi*	EN	NL	NL	Wetlands (vagrant)
Palau Owl (Chesuch)	*Pyrroglaux podargina*	LC	T	NL	Forest
Palau Kingfisher (Cherosech)	*Todiramphus pelewensis*	NT	NL	NL	Wetlands, streams
White-breasted Woodswallow (Mengaluliu)	*Artamus leucorynchus*	LC	T	NL	Forest and adjacent openings
Morningbird (Tutau)	*Pachycephala tenebrosa*	LC	T	NL	Forest
Palau Fantail (Melimdelebteb)	*Rhipidura lepida*	LC	T	NL	Forest; observed in Ngaraard project area during site visit
Palau Flycatcher (Charmelachull)	*Myiagra erythrops*	LC	T	NL	Forest; observed in Ngaraard project area during site visit
Palau Bush Warbler (Wuul)	*Horornis annae*	LC	T	NL	Forest; observed in Ngaraard project area during site visit
Blue-faced Parrotfinch	*Erythrura trichroa*	LC	T	NL	Forest
Mammals					
Pacific Sheath-tailed Bat (Chesisualik)	*Emballonura semicaudata*	E	NL	NL	Forest
Palau Fruit Bat (Olik)	*Pteropus pelewensis*	NT	T	NL	Forest; observed in Ngaraard project area during site visit
Dugong (Mesekiu)	*Dugong dugon*	V	E	E	Near-shore

[a] Palau common names are in parentheses.

[b] IUCN Red List status: NL = not listed, LC = least concern, VU = vulnerable, NT = near threatened, EN = endangered, CE = critically endangered (IUCN 2018).

[c] Proposed for Palau's threatened and endangered species list: NL = not listed, T = threatened, E = endangered.

[d] Listed on the ESA list of threatened and endangered species: NL = not listed, T = threatened, E = endangered.

[e] Central West Pacific Distinct Population Segment (DPS).

[f] North Pacific Ocean DPS.

In addition to species listed in Table 1, there are numerous snail species that are listed as endangered and are limited in distribution to specific islands in Palau (Rundell 2005); further research will be needed to determine whether any could occur at either the Tx or Rx sites.

3.2 NATURAL RESOURCE SURVEYS

The possible occurrence of munitions and explosives of concern (MEC) on both sites was an important consideration, with greatest concern at the Angaur site. At both sites, MEC technicians from the Norwegian People's Aid (NPA) accompanied survey staff during each of the natural resource surveys, at times using magnetometers to detect the presence of MEC to ensure safety during surveys.

Natural resource surveys were conducted at each site by two survey crews comprising staff from Argonne and the Belau National Museum (BNM) working under contract with Argonne. The wildlife survey crew consisted of two Argonne wildlife ecologists and a BNM avian specialist. The vegetation survey crew consisted of an Argonne plant specialist and several BNM plant experts under the supervision and direction of Ann Kitalong, Acting Manager of the BNM Natural History Section.

3.2.1 Plant Survey Methods

The major plant communities at each site and their immediate surroundings were surveyed using a pedestrian survey protocol at the Ngaraard site, January 14–18, 2019, and at the Angaur site, January 22–26, 2019 (Figure 4).

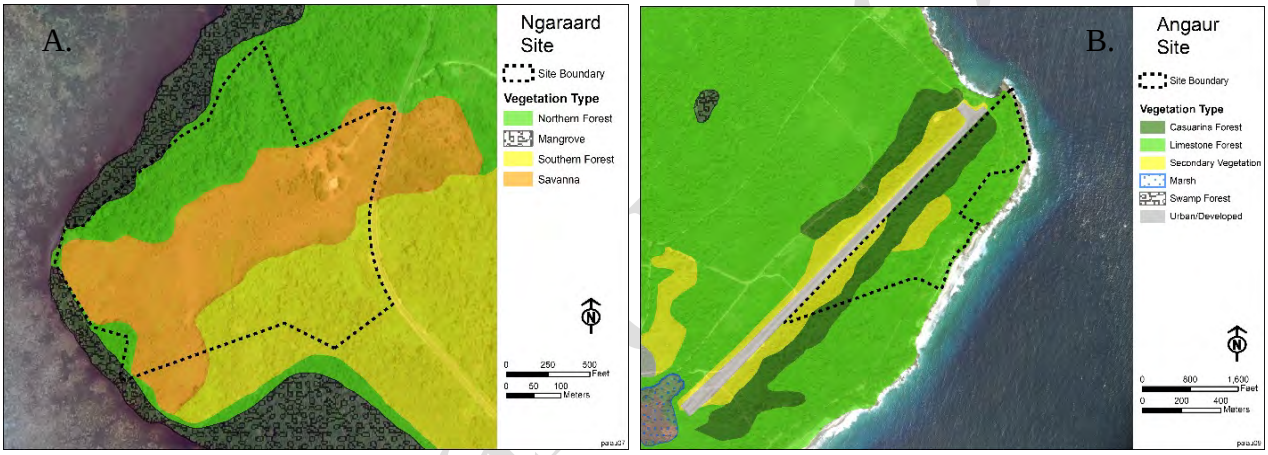

FIGURE 4 Major Plant Communities Surveyed at the Ngaraard Tx (A) and Angaur Rx (B) Sites.

Plant communities were identified and characterized based on dominant species in each height stratum and mapped on aerial imagery of the sites. Reference photographs of each community were taken to record species composition, structure, and density. All plant communities were surveyed, and plant species were recorded along with their relative abundance and status as endemic, rare, threatened, or endangered. All listed or endemic plants encountered were documented, and the plant communities of the site mapped. Listed or endemic plants suitable for salvage were marked for potential mitigation. The quality of each community was assessed based on the level of disturbance and on the presence of invasive and non-native species. Any individual protected or rare plants that could be candidates for removal and transport to another location were photographed and flagged, and Global Positioning System (GPS) coordinates of their locations obtained. Unidentified plants were similarly documented. The survey team also measured diameter at base height (DBh) and estimated heights of any large dominant trees in each habitat.

3.2.2 Wildlife Survey Methods

Each site was surveyed for terrestrial vertebrate animal species, with the primary focus on the rare, threatened, and endangered species listed in Table 1. Specifically, the surveys targeted birds, bats, megapode nests, and the Pandanus Skink. The survey approaches for each of these target biota are described in the following paragraphs. Weather conditions (air temperature, wind direction and strength, cloud cover, and precipitation) were recorded during each survey.

3.2.2.1 Avian Surveys

Two survey approaches were employed to assess the composition of avian communities at the two sites, daytime point-count surveys and traveling-count surveys. Evening traveling-count surveys were also conducted for owls (and other nighttime birds) and bats. Additional surveys were conducted for megapode nests on the Rx site, and for megapodes and their nests elsewhere on Angaur. The bat and owl survey and the megapode nest survey methods are described later in this section.

Avian Point-Count Surveys. Each site was surveyed daily using the EQPB point-count protocol for bird diversity surveys. This protocol calls for 15-minute surveys to be conducted at specific locations in the morning between 06:30 and 07:30 hours and under rainless conditions. At each point-count location, all birds directly observed or heard were documented during each 15-minute interval. Recordings were also collected during each point-count for later use to confirm the birds heard and to identify any birds not readily recognized in the field by their calls.

Ten point-count locations were identified at each site encompassing all habitat types present. At the Ngaraard Tx site, three point-count locations were established in the northern savanna (NG001–NG003), two in the southern savanna (NG004 and NG005), one in the northern forest (NG009), and four within the southern forest (NG006–NG008 and NG010) (Figure 5). Point count locations NG001–NG008 were surveyed daily, January 14–18. Point count NG009 was added on January 16 and NG010 on January 17. At the Angaur Rx site, five point-count locations were established within the forest along the runway (AN001–AN003, AN009, and AN010), two within the forest along the northeastern coast (AN005 and AN006), and three within the forest along the coast road (AN004, AN007, and AN008) (Figure 6). At both the Tx and Rx sites, the point-counts were surveyed in groups of 3–4 by individual survey staff, and the groupings were alternated daily among the staff to minimize surveyor bias.

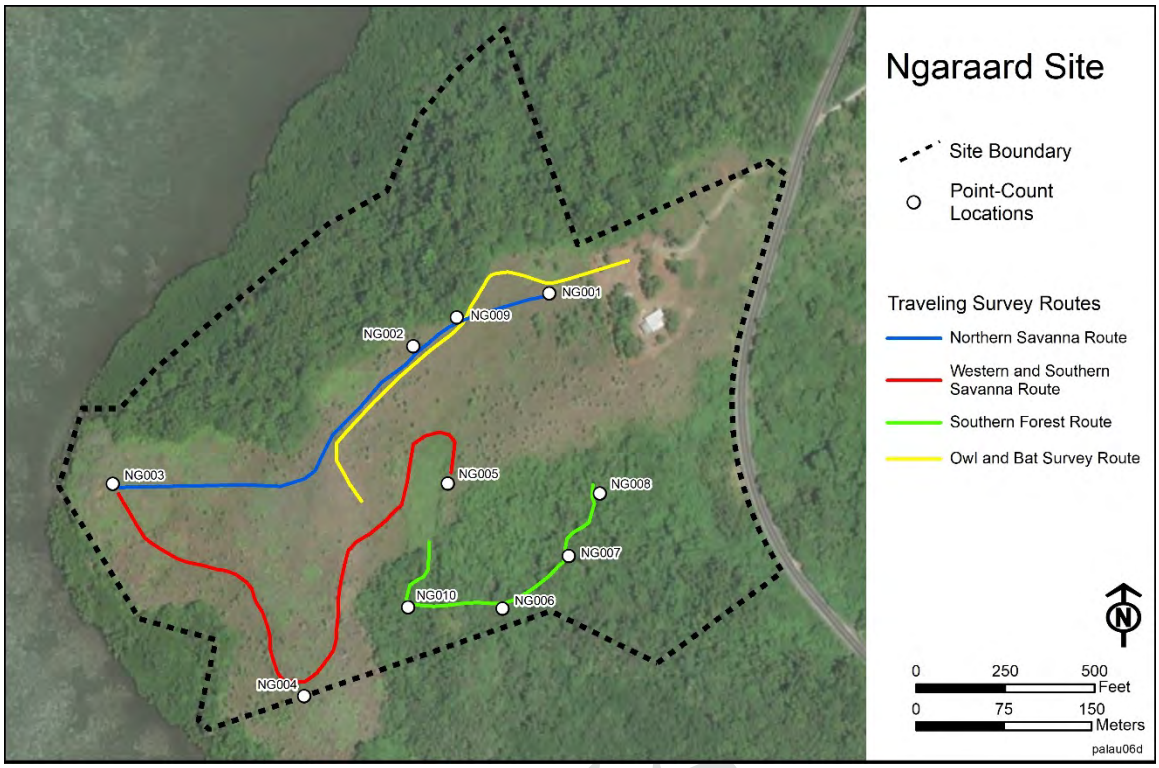

FIGURE 5 Avian Survey Point-Count Locations, Traveling-Count Routes, and Owl and Bat Night Surveys at the Ngaraard Tx Site.

Avian Traveling-Count Surveys. Each site was also surveyed daily using the eBird traveling count protocol (eBird 2018), which involves walking a predetermined route and documenting all species observed or heard along the route. At the Ngaraard Tx site, one route was through the northern portion of the savanna, one through the western and southern portion of the savanna (and including the wetland in the south-central savanna area), and one through the southern forest (Figure 5). At the Angaur Rx site, one route was along the western site boundary and the runway, and a second route passed through the northern and eastern forest following the coast road (Figure 6). At the Tx and Rx sites, the routes were walked daily following completion of the point-count surveys, each route by an individual survey staff, and the routes were alternated daily among staff to reduce surveyor bias.

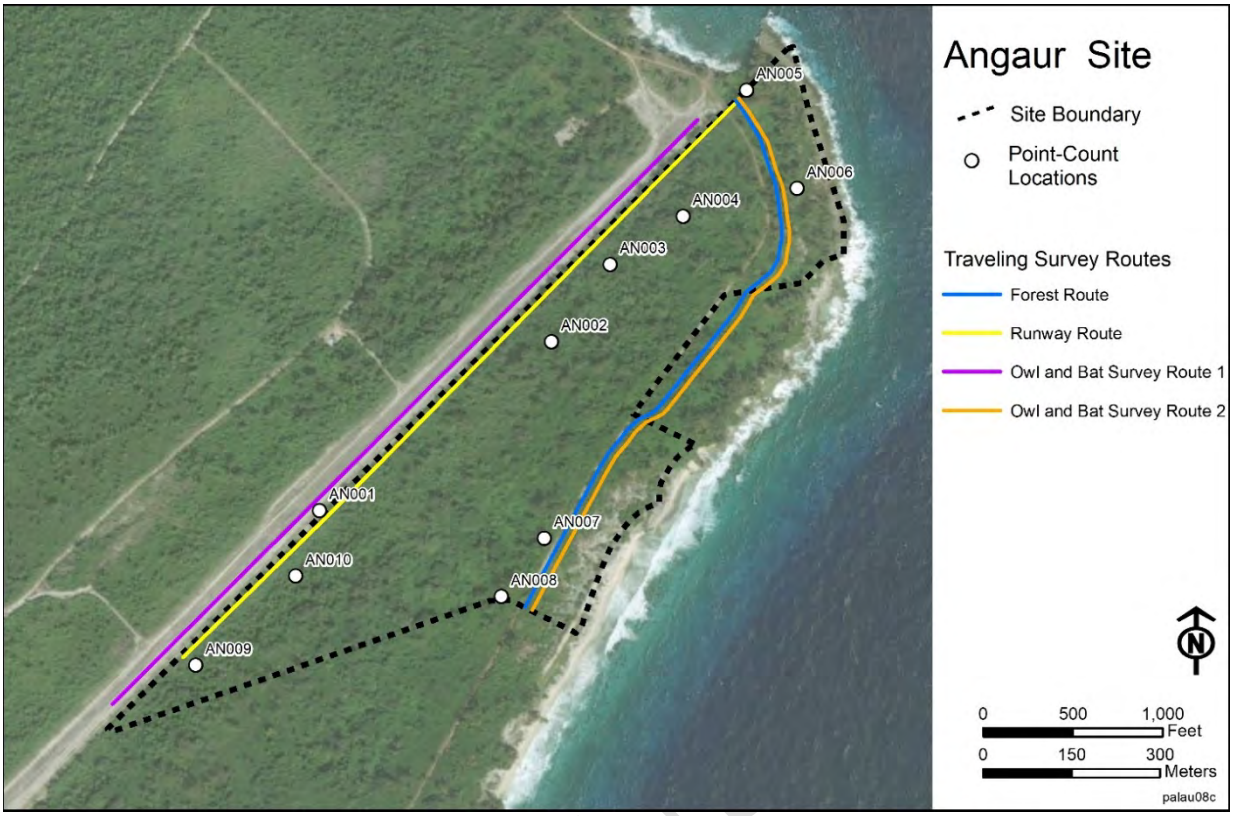

FIGURE 6 Avian Survey Point-Count Locations, Traveling-Count Routes, and Bat and Owl Night Survey Routes at the Angaur Rx Site.

3.2.2.2 Megapode Nest Survey

The Micronesian Megapode is listed as endangered on the IUCN Red List and the ESA (Table 1). This megapode is a pigeon-sized bird of the forest floor. The Micronesian Megapode is omnivorous, taking a variety of plant and animal foods available on the forest floor, including seeds, beetles, ants, other insects, and plant matter (USFWS 1998). During nesting, this species constructs nesting mounds of sand (in coastal areas) or leaf litter and other debris (in more inland areas) (USFWS 1998; Olsen et al. 2016).

Based on previous surveys conducted on Palau, it appears unlikely that megapodes occur on the Ngaraard site. Megapodes occasionally have been seen or heard on Babeldaob Island, but only one nesting mound (in the northern part of the island) has been reliably documented and described (Olsen et al. 2016). Olsen et al. (2016) documented nest mounds on islands adjacent to Babeldaob but not on the main island itself. They stated that megapodes observed on Babeldaob are likely commuting from nearby islands to forage on Babeldaob. The rugged terrain with high topographic relief and lack of flat, coastal strand habitat at the Ngaraard Tx site decreases the likelihood of megapodes on site.

In contrast, the Micronesian Megapode is known to occur on Angaur Island, and several individuals, as well as two nest mounds, were observed at the Angaur Rx site during a presurvey site visit in October 2018. In addition, one of the MEC technicians, who is a resident of Angaur, identified 13 nests within the project footprint prior to our surveys. For the megapode nest survey, all areas of the Angaur Rx site were intensively surveyed for nests by walking all portions of the site, documenting all nest mounds encountered (including those previously reported by the MEC technician) with regard to location (GPS), size, and status (active, under construction, inactive). In addition to the Rx footprint, a small forested area immediately adjacent to the Rx site along the northeast coast was similarly surveyed (Figure 7).

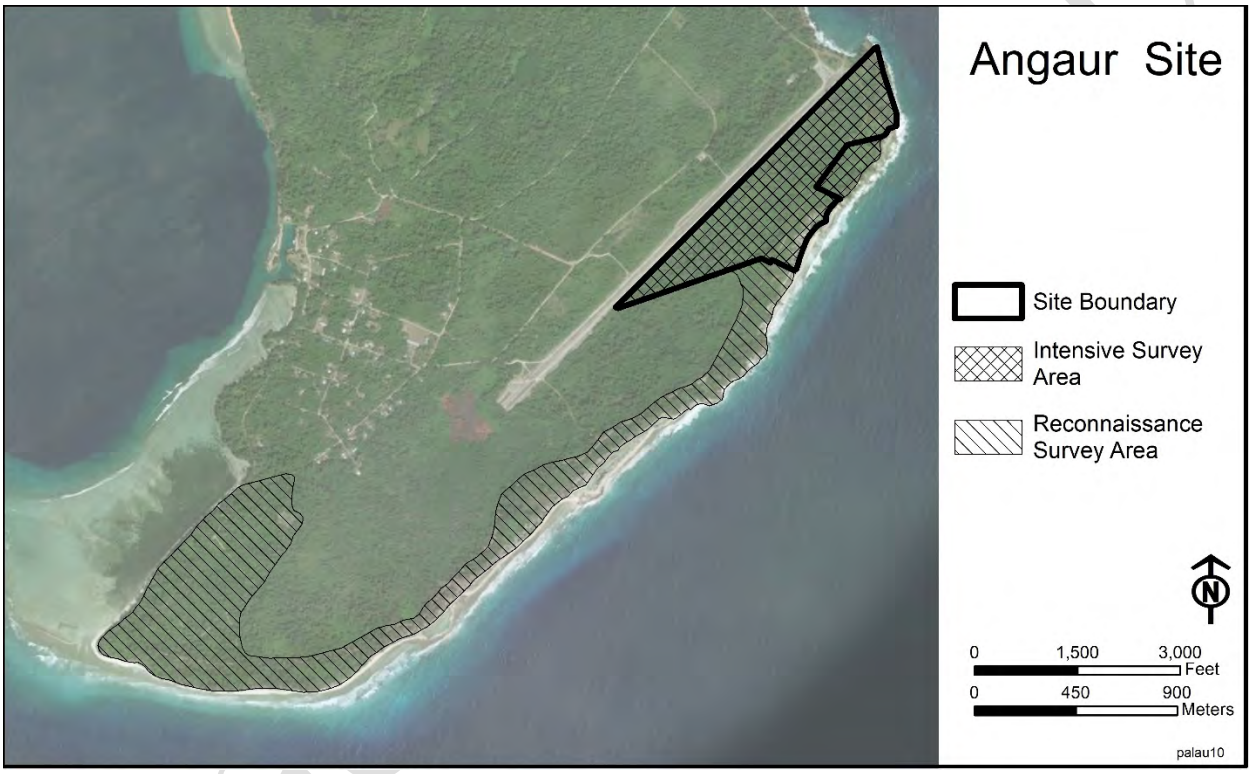

FIGURE 7 Megapode Nest Survey Areas at the Angaur Rx Site.

Besides the intensive walking nest surveys of the Rx site and adjacent eastern coastal forest area, we surveyed areas of Angaur south of the Rx site for both megapodes and their nests. Areas along the coastal road south of the site that appeared to be suitable for megapodes, or from which megapodes were heard calling, were briefly surveyed on January 26, 2019, for nest mounds. Observations from this area of adult megapodes and their nests, as well as the presence of actively calling adults, will provide insight into the status of megapodes and their habitats elsewhere along the southern portion of Angaur, outside the Rx footprint.

3.2.2.3 Owl and Bat Night Surveys

Two bat species occur on Palau, the Pacific Sheath-tailed Bat (chesisualik) (*Emballonura semicaudata*) and the Palau Fruit Bat (olik) (*Pteropus pelewensis*). Both species are on the IUCN Red List: the Pacific Sheath-tailed Bat is designated as endangered and the Palau Fruit Bat as near threatened (Table 1). The Palau Fruit Bat is also proposed for listing as threatened on Palau's threatened and endangered species list. The Palau Owl (chesuch) (*Pyrroglaux podargina*) is listed as least concern on the IUCN Red List but has been proposed for listing as threatened on Palau's threatened and endangered species list (Table 1).

Surveys for the Palau Owl and the two bat species were conducted at the Tx and Rx sites. At each, the survey staff walked a route beginning at approximately 18:00 hours (about 30 minutes before sunset) for a period of 45–50 minutes, until complete darkness, counting all bats observed along the route. The staff also played recordings of the Palau Owl at various locations along the route and listened for individuals to answer the recorded call. Because of the nature and setting of each site, a single route was followed at the Ngaraard Tx site and two routes at the Angaur Rx site (Figures 5 and 6, respectively). At the Angaur site, only one route was surveyed each evening, alternating the routes each day. While both the Palau Owl and the Pacific Sheath-tailed Bat are nocturnal species, the Palau Fruit Bat is a daytime species. Thus, observations of this species were also recorded during the avian point-counts and traveling-count surveys.

3.2.2.4 Pandanus Skink Survey

The Pandanus Skink is designated as near threatened on the IUCN Red List (Table 1). The preferred habitat for this species is in the axils of leaves of the Pandanus palm, and both the skink and the palm have been reported from Babeldaob and Angaur Islands. Numerous Pandanus palms occur in the savanna portion of the Ngaraard Tx site, and survey staff examined individual palms (Figure 8) for the occurrence of this skink. These surveys were conducted for 2–3 hours daily, January 14–17, 2019; no survey was conducted on January 18 because of heavy rains. No Pandanus palms occur on the Angaur Rx site, and thus no surveys were conducted for this skink at the Angaur site.

FIGURE 8 Pandanus Palms at the Ngaraard Tx Site.

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4 RESULTS

4.1 NGARAARD TX SITE

Between the two sites, the Ngaraard Tx site has a greater variety of habitat types and a more diverse flora and avifauna than the Angaur Rx site. Neither the plant communities nor the avifauna identified during the survey are unique to the site, and similar habitats, plant communities, and avifauna occur in other parts of Babeldaob Island. The following paragraphs discuss the distribution, condition, and status of the vegetation and wildlife observed during the surveys of this site.

4.1.1 Vegetation

At the Ngaraard Tx site, plant surveys were conducted daily from January 14 through January 18. Seven plant community types were identified through these surveys: volcanic forest, mangrove forest, riparian forest, agroforest, savannah and grassland, freshwater marsh, and freshwater swamp forest.

4.1.1.1 Terrestrial Plant Diversity

More than 198 species of plants were observed during the survey, at least 159 of which are native. Of these, 21 are endemic species, 4 are endemic varieties, and 2 are natives that can become invasive. Of the 198 species, 2 have IUCN or Palau designations. The mesecheues tree (*Aglaia mariannensis* [*palauensis*]) is listed as vulnerable on the IUCN Red List and, along with the Indian Mangrove (*Ceriops tagal*), is proposed for listing as threatened on Palau's Threatened and Endangered list (Table 1). One mesecheues tree was found in the northern forest, while the Indian mangrove was found in the mangrove forests in the northwest and southwest portions of the site. Two 20-foot (ft) -tall specimens of *Rauvolfia insularis* (omechidel), a small evergreen tree, were found within the northern forest. This species has been considered vulnerable because of its restricted range (Costion et al. 2009), although it is not listed as such on the IUCN Red List. Figure 9 shows some of the endemic orchid species found at the Ngaraard Tx site.

A total of 41 introduced species were found at the site; 2 have become naturalized and 7 are considered to be invasive. The northern forest had more plant species (80) compared to the southern forest (59). The northern forests had at least 18 endemic species, including 10 endemic species that were found only in the northern forest and 3 of which are endemic orchids. The southern forest had 8 endemics, but these were also found in the northern forest. The savanna had one endemic species, *Hedyotis tomentosa* (leblebul), and this species was found only in the savanna.

FIGURE 9 Native and Endemic Orchids Found from Forest and Savanna Habitats at the Ngaraard Tx Site (Source: Kitalong et al. 2019)

4.1.1.2 Plant Communities

Volcanic Forest. Volcanic forests occur on basalt soils; these lowland forests are dense, multilayered, and structurally complex encompassing distinct subtypes of forest in undisturbed ecosystems (Republic of Palau, 2010). The volcanic lowland forests are considered the most species rich in Micronesia and have the highest rate of endemism (Stemmermann 1981).

The northern and southern forests at the Tx site are largely volcanic forests. In these forests of the site, the largest trees (in both diameter and height) encountered during the surveys were *Campnosperma brevipetiolata* (kelelacharm), *Calophyllum inophyllum* (btaches), *Maranthes corymbosa* (bkau), and the endemic *Fagraea ksid* (ksid) and *Ficus microcarpa* (lulk). Other large trees included *Canarium hirstuum* (mesecheus), *Elaeocarpus joga* (dekemerir), *Ormosia calavensis* (chedebsungelked), *Pterocarpus indicus* (las), and *Rhus taitensis* (eues) (Figure 10). The uncommon endemic understory trees *Rauvolfia insularis* (omechidel) and the native threatened *Aglaia mariannenis* were also found. The palm *Heterspathe elata* (demailei) was common along steep rock slopes. Overall, the forests along the northern boundary were less disturbed from human activities and exhibited higher biodiversity than the southern volcanic forest.

Mangrove Forest. Mangrove forests are dense forests that grow in brackish to salty water along a narrow strip of the tidal zone near the shore. Mangrove forests are widespread around Babeldaob, found in the low-lying, coastal, muddy seashores, quiet bays, and estuaries (Republic of Palau 2010). Mangrove forests are also found in the Rock Islands, commonly along the edge of marine lakes. Mangroves are very important in buffering the effects of storms and waves along coastal areas. They also provide nursery habitat for marine life and filter runoff exiting terrestrial ecosystems; these actions help to sustain coral reef and fish habitat by reducing siltation. The species-rich mangrove forests of Palau include more than 24 different mangrove species and are the second largest forest type in Palau (Republic of Palau 2010).

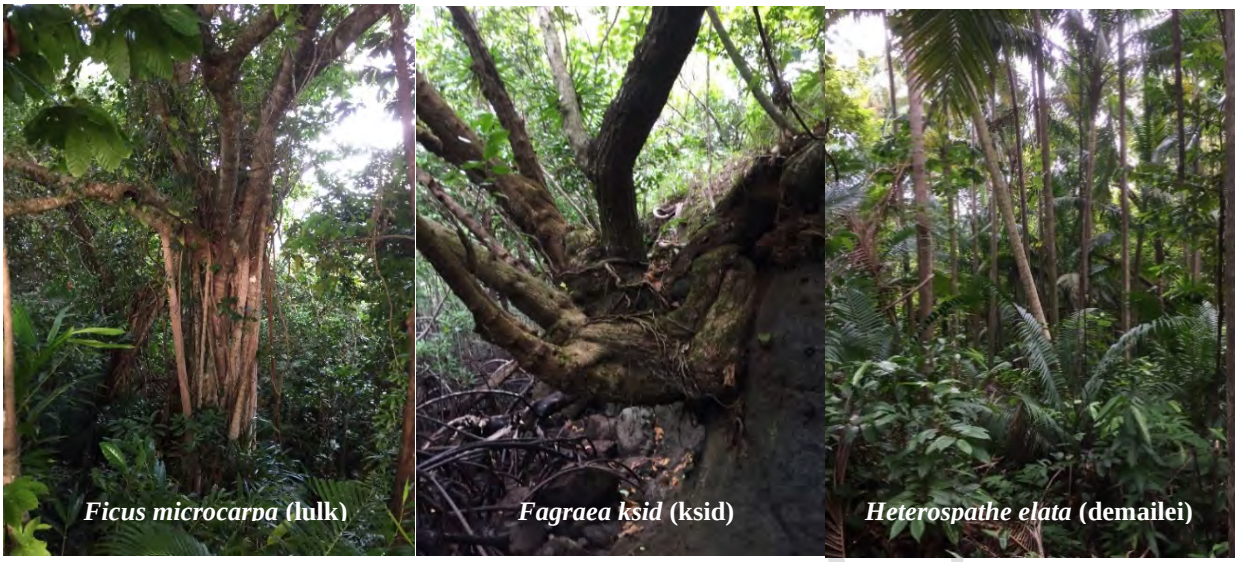

FIGURE 10 Large Trees of the Northern and Southern Forests at the Ngaraard Tx Site.

At the Tx site, the mangrove forests occur along the western boundary of the site (Figure 11). These forests are dominated by two mangrove species, *Sonneratia alba* (urur) and *Rhizophora mucronata* (tebechel), which occur along the outer margin of the forest. Inner mangrove forest trees include a number of mangrove species, including the threatened Indian mangrove, *Ceriops tagal* (biut), *Bruguiera gymnorrhiza* (kodenges), *Xylocarpus granatum* (medulokebong), and *Lumnitzera littorea* (mekekad).

FIGURE 11 Mangrove Forest at the Ngaraard Tx Site.

Riparian Forest. Riparian forests occur along forested streams, and two such forests were found in the northern and southern forests of the site. In the northern forest, a relatively steep sloped stream flows westward into the mangrove forest (Figure 12), while in the southern forest a stream flows westward through the southern portion of the Tx site. In contrast to the stream in the northern forest, this southern stream has less slope and a wider wet zone (with saturated soils) throughout its path through the southern forest. In both riparian forests, the dominant upper-story tree is *Colona scabra* (chuchab). The palm, *Heterospathe elata* (demailei), is also common. A variety of understory plants were found, including the wetland plant, *Donax canniformes* (terming).

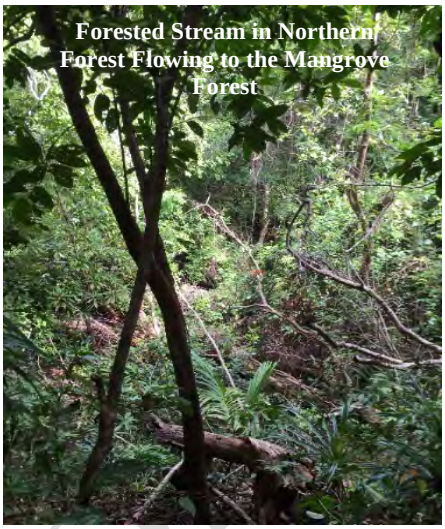

FIGURE 12 Riparian Forest at the Ngaraard Tx Site.

Agroforest. Agroforests are areas under cultivation for fruit and food crops and trees and wood products and, as a result, are often a mosaic of manmade landscapes that are integrated into the natural landscape (Republic of Palau 2010). At the Tx site, agroforest occurs in the eastern portion of the site, from just west of the homestead eastward to the Compact Road. Two areas are in active cultivation of dryland taro, *Colocasia esculenta* (kukau). Other plants under cultivation in this agroforest area include *Acacia auriculiformis*, coconut palm *Cocos nucifera* (lius), and some fruit trees (Figure 13).

FIGURE 13 Portions of the Agroforest Area in the Eastern Portion of the Ngaraard Tx Site.

Savanna Grasslands. Savanna grasslands are found where the forest has been removed, typically along the ridges. Savanna grasslands with associated trees occur on volcanic soil substrates where the primary forest has been removed. There are more than a dozen endemic savanna species on Palau, suggesting that there may have been some isolated pockets of native savanna in other parts of Palau (Republic of Palau 2010). At savanna grasslands, the loss of the native forest has resulted in soil erosion and degradation, which in turn decreases the probability of forest regeneration.

The northwestern portion of the savanna is dominated by the false staghorn fern *Dicranopteris linearis*, which is indicative of highly weathered and acidic soils that have low nutrient retention and are typically nutrient deficient (Deenik 2011). The savanna systems also persist in some areas because of repeated periodic fire caused by humans. Savanna habitat is found throughout the island of Babeldaob and in areas of Koror (Republic of Palau 2010). The vegetation typically consists of grass, sedges, ferns, shrubs, and some scattered trees.

FIGURE 14 Several Views of the Savanna at the Ngaraard Tx Site.

At the Tx site, the central portion of the site is savanna grassland, extending from the homestead in the eastern portion of the site westward across most of the site to the forest along the western coast (see Figure 4). A number of small tree and shrub species were found on the savanna grassland (Figure 14). These included the *Pandanus tectorius* (ongor), which occurs throughout the eastern and southeastern portions of the savanna, *Commersonia bartramia*, (bebechelut), *Melochia compacta* (chermallucheang), *Morinda citrifolia* (ngel), and *Symplocos racemosa* Roxb. var. *palauenses* (chebtui).

In general, these small trees and shrubs are more abundant in the western and southwestern portions of the savanna. The endemic shrub, *Hedyotis tomentosus* (leblebul), is common along the savanna boundary with the northeast forest. Grasses, sedges, and ferns are the dominant vegetation in the central and western portions of the savanna. Dominant grasses include *Eriachne pallescens* **(**in more eroded soil areas) and several species of *Ischaemum* and the fern *Nephrolepsis biserrata* in areas with less eroded soils. The presence of highly eroded soils and likely chronic fires in the past have prevented reforestation on this savanna grassland.

Freshwater Marsh. A small freshwater marsh occurs in the south-central portion of the savanna grassland and drains southwest to the southern forest. The freshwater marsh is dominated at its upper end by a dense stand of the large perennial grass *Phragmites karka* covering approximately a 200-m^2 area (Figure 15). A smaller area of approximately 25 m^2 in the lower end of the marsh is dominated by the herbaceous perennial *Hanguana malayana* (euais). Both species are native to Palau.

FIGURE 15 Phragmites Stand in the Savanna Marsh Wetland

Freshwater Swamp Forest. Freshwater swamp forests tend to occur slightly inland of mangrove forest in areas of fresh or slightly brackish water and in wet lowland areas or along the riparian zone. This sensitive forest habitat represents the least amount of area of all forest types on Palau (Republic of Palau 2010). The dominant canopy species in swamp forests are relative to their proximity to saltwater and other topographic considerations, such as riparian verses lowlands near the coast or inland. There is less variation in the other layers of this forest. Typically, the forest floor growth is predominantly the seedlings of the dominant trees.

At the Tx site, a swamp forest was found downslope in the western portion of the northern forest. This swamp forest is characterized by large trees of several species, such as the endemic *Calophyllum pelewense* (chesemolech) and the native *Campnosperma breviopeliolatum* (kelelcharm) and *Dolichandrone spathacea* (rriu) in the upper canopy (Figure 16). Medium-sized trees in this forest include *Cynometra ramiflora*, (ketenguit), *Quassia indica* (cheskeam), and

FIGURE 16 A Swamp Forest in the Northern Forest.

Barringtonia racemosa (koranges), which were found in the understory along with a variety of wetland sedges. The primary understory tree of the swamp forest is *Hibiscus tiliaceus* (chermall). Ground vegetation includes *Phragmites karka* (alkelsed), *Alocasia macrorrhiza*, the sedge *Scirpodendron ghaeri* (loloi), *Donax canneformis* (temring), and the vine, *Derris trifoliata* (kemokem).

4.1.2 Wildlife

4.1.2.1 Avifauna

At the Ngaraard Tx site, a total of 35 15-minute EQPB point-count surveys were conducted at 10 locations over a 5-day period (January 14–18, 2019). During this same period 9 eBird (2018) traveling-count surveys were carried out along 3 predetermined routes (covering about 14 person-miles). Night surveys were also conducted at the site over a four-day period (January 14–17, 2019). A total of 1,524 individuals from 28 species were counted during these avian surveys (Table 2); Figure 17 shows some of the species seen or heard at the Ngaraard Tx site.

FIGURE 17 Micronesian Myzomela (left), Palau Flycatcher (center), and Common Cicadabird (right)

Of the 28 species documented at the site, 9 have an IUCN Red List and/or Palau designation, and 2 are non-native species (Table 2). Among the nine designated species, two were only heard, and only once during the five days of surveys. The Palau Night Jar (Palau proposed threatened) was heard on one occasion during a night survey, calling from a distance beyond the northern forest and well outside the Tx project footprint. A single Imperial Dove (IUCN Red List and Palau proposed threatened) was heard but not observed in the southern woods, calling from a distance.

Several species were only observed as flybys or flyovers or only heard from well beyond the Tx site, and these species are not likely to regularly occur within the Tx footprint (Table 3). For example, the Rufous Night-heron and the Pacific Reef Heron were only observed flying along the western boundary of the Tx site, while a Great Crested Tern was observed on a single occasion flying offshore along the western boundary of the site.

TABLE 2 Species Observed or Heard during Point-Count, Traveling-Count, and Night Surveys at the Ngaraard Tx Site, January 14–18, 2019

Common Name	Status[a]	Point-Count[b] Survey (*n* = 35)		Traveling-Count[c] Survey (*n* = 9)		Night[d] Survey (*n* = 4)	
		Total Count	Mean Count	Total Count	Mean Count	Total Count	Mean Count
Red Junglefowl		1	0.0	0	0	0	0
Palau Fruit-Dove	P-T	121	2.5	85	7.1	1	0.25
Micronesian Imperial-Pigeon	IUCN-NT, P-T	1	0.0	0	0	0	0
Palau Nightjar	IUCN-NT, P-T	0	0	0	0	1	0.25
Palau Swiftlet		2	0.0	23	1.9	0	-
Buff-banded Rail		0	0	3	0.3	2	0.50
Pacific Golden-Plover		3	0.1	12	1.0	4	1.0
Swinhoe's Snipe		2	0.0	2	0.2	0	0
Brown Noddy		2	0.0	2	0.2	0	0
Black Noddy		45	0.9	24	2.0	1	0.25
White Tern		92	1.9	36	3.0	1	0.25
Great Crested Tern		0	0	1	0.1	0	0
Yellow Bittern		1	0.0	1	0.1	0	0
Pacific Reef-Heron		2	0.0	0	0	0	0
Rufous Night-Heron		6	0.1	1	0.1	1	0.25
Palau Owl	P-T	0	0	0	0	12	3.0
Palau Kingfisher	IUCN-NT	5	0.1	2	0.2	1	0.25
Collared Kingfisher		4	0.1	2	0.2	0	0
Micronesian Myzomela		57	1.2	34	2.8	1	0.25
Common Cicadabird		11	0.3	11	0.9	0	0
Morningbird	P-T	9	0.2	13	1.1	1	0.25
Palau Fantail	P-T	35	0.8	14	1.2	1	0.25
Palau Flycatcher	P-T	33	0.7	11	0.9	2	0.50
Palau Bush Warbler	P-T	105	2.3	48	4.0	0	0
Dusky White-eye		168	3.6	86	7.2	4	1.0
Micronesian Starling		193	4.2	122	10.2	14	3.5
Eurasian Tree Sparrow	Non-native	0	0	1	0.1	0	0
Chestnut Munia	Non-native	24	0.5	21	1.8	0	0
Total number of birds		922	26.3	555	61.7	47	11.7
Total number of species		23		23		15	

[a] IUCN Red List status: IUCN-NT = near threatened; Palau proposed listing: P-T = threatened.

[b] Daily point-count surveys at eight locations, January 14–18; one additional point-count location was added and surveyed January 16–18, and another point-count location added and surveyed January 17 and 18.

[c] Daily traveling-count surveys conducted January 15–18, 2019.

[d] No night survey conducted on January 18, 2019, because of inclement weather.

TABLE 3 Bird Species Observed Only as Flybys/Flyovers or Only Heard from Well Beyond the Ngaraard Tx Site Boundary.

Species	Nature of Occurrence
Red Junglefowl	Heard on one occasion calling from well beyond the northeast corner of the site.
Palau Nightjar	Heard on one occasion calling from well beyond the northeast corner of the site.
Great Crested Tern	Observed once flying offshore of the site.
Pacific Reef Heron	Two individuals observed, each flying along the western coast and past the site.
Rufous Night-Heron	Observed on several occasions, but in all instances flying along the coast and past the site.

Half of the 28 species reported from the site were observed and/or heard on at least 4 of the 5 survey dates, with 11 species encountered each day (Table 4). Of the 28 species reported from the Tx site, 23 were represented by 10 or fewer total individuals, with each of these species averaging fewer than 2 individuals per day. Seven of these species were represented by 2 or fewer than 4 total individuals (Table 4). The 5 most frequently reported species were, in order of total number encountered, the Micronesian Starling (329), the Dusky White Eye (258), Palau Fruit Dove (206), Palau Bush Warbler (153), and the White Tern (129).

TABLE 4 Bird Species Occurrence by Date at the Ngaraard Tx Site, January 14–19, 2019.[a]

Common Name	Jan. 14	Jan. 15	Jan. 16	Jan. 17	Jan. 18	Total	Daily Mean
Red Junglefowl	0	1	0	0	0	1	0.2
Palau Fruit-Dove	18	39	33	69	47	206	41.2
Micronesian Imperial-Pigeon	0	0	0	0	1	1	0.2
Palau Nightjar	0	0	1	0	0	1	0.2
Palau Swiftlet	0	0	0	25	0	25	5.0
Buff-banded Rail	0	1	0	2	2	5	1.0
Pacific Golden-Plover	0	4	2	7	6	19	3.8
Swinhoe's Snipe	0	0	0	0	4	4	0.8
Brown Noddy	0	0	2	1	1	4	0.8
Black Noddy	17	8	9	13	23	70	14.0
White Tern	31	34	21	33	10	129	25.8
Great Crested Tern	0	1	0	0	0	1	0.2
Yellow Bittern	0	0	0	0	2	2	0.4
Pacific Reef-Heron	0	0	0	0	2	2	0.4
Rufous Night-Heron	2	1	4	0	1	8	1.6
Palau Owl	0	2	5	5	0	12	2.4
Palau Kingfisher	0	4	2	1	1	8	1.6
Collared Kingfisher	0	0	3	3	0	6	1.2
Micronesian Myzomela	10	19	20	15	28	92	18.4
Common Cicadabird	0	0	3	8	11	22	4.4
Morningbird	1	4	5	8	4	22	4.4
Palau Fantail	7	5	9	18	11	50	10.0
Palau Flycatcher	8	6	8	17	7	46	9.2
Palau Bush Warbler	15	28	27	45	38	153	30.6
Dusky White-eye	39	53	56	55	55	258	51.6
Micronesian Starling	34	60	66	94	75	329	65.8
Eurasian Tree Sparrow	0	1	0	0	0	1	0.2
Chestnut Munia	2	13	10	16	4	45	9.0
Total number birds	184	284	286	435	333	1522	304.4
Total number of species	12	19	19	19	21	28	18

[a] Total number of birds observed or heard during the point count, traveling count, and night surveys.

Two species, the Black Noddy and the White Tern, were observed every day flying over portions of the site. A small flock of White Tern (6–10 birds) appeared to be roosting in the northern forest and likely within the northernmost forest area of the Tx footprint. Similarly, small numbers of Black Noddy (up to 4–6 individuals) regularly flew into and out of the forest along the western boundary of the Tx site, and smaller numbers appeared to use the same areas of the northern forest as the White Tern. These observations suggest that both the northern and

southwestern woods may be providing active nesting areas for the White Tern and Black Noddy (see Figure 18).

Both the point-count and traveling-count methods (see Section 3.2.2.1) include the reporting of any species heard from the survey location. As a consequence, some species may be heard from a completely different habitat type than that of the survey location. This in fact was the case for a number of species during the surveys at the Ngaraard Tx site. For example, the Palau Fruit Dove was regularly heard from all the savanna point-count and traveling-route locations as it called from the northern and southern forest habitats, but was never observed on or calling from savanna habitat. The Palau Bush Warbler was similarly heard from but also seen in the forest habitat along its boundary with the savanna. Both are forest species.

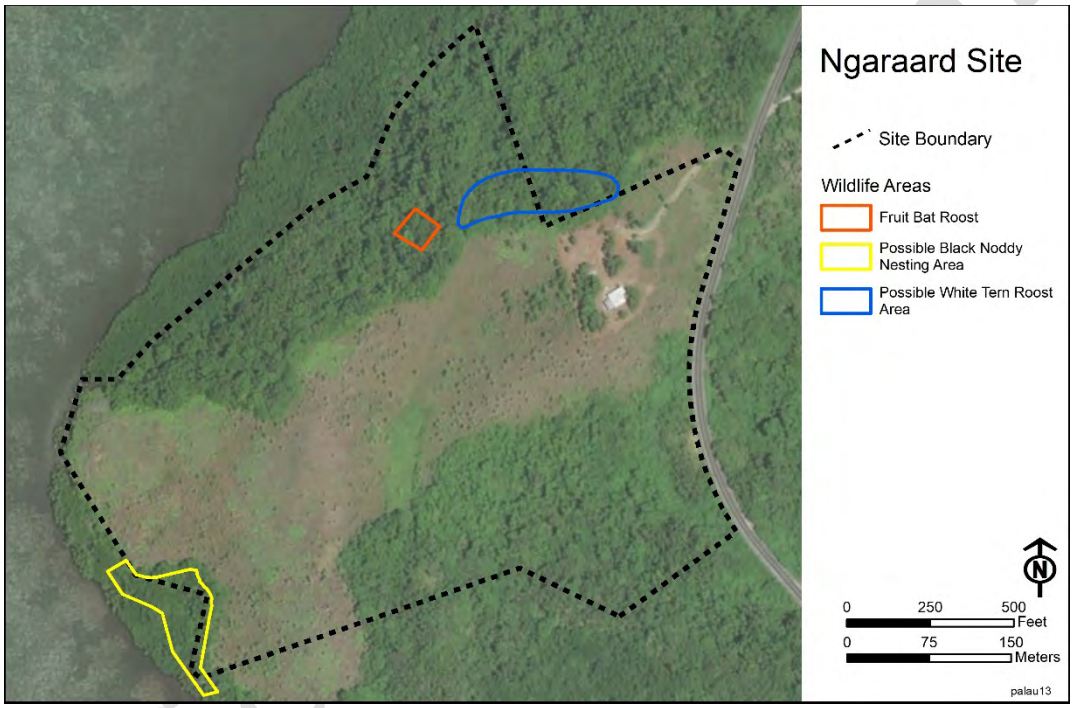

FIGURE 18 Location of Fruit Bat Roost and Areas of Potential Black Noddy and White Tern Roosting and Nesting Areas.

Similarly, both species of noddy as well as the White Tern were regularly seen from all savanna survey locations. None of these species is a savanna dweller and was only observed flying over the savanna to and from their preferred forest nesting and roosting areas. In contrast, the Micronesian Starling and the Dusky White-eye, two of the most frequently reported species at the Tx site, were regularly observed and/or heard from both the savanna and forest habitats of the site. Table 5 identifies the habitats best associated with the avian species encountered during the Tx site surveys, considering the known life histories of these birds.

TABLE 5 Habitats of Bird Species Reported from the Ngaraard Tx Site, January 14–19, 2019.[a]

Common Name	Scientific Name	Northern Savanna	Southern Savanna	Northern Forest	Southern Forest
Palau Fruit-Dove	*Ptilinopus pelewensis*			X	X
Micronesian Imperial-Pigeon	*Ducula oceanica*				X
Palau Swiftlet	*Aerodramus pelewensis*	X	X		
Buff-banded Rail	*Gallirallus philippensis*	X[b]	X[c]		
Pacific Golden-Plover	*Pluvialis fulva*	X	X		
Swinhoe's Snipe	*Gallinago megala*	X			
Brown Noddy	*Anous stolidus*			X	X
Black Noddy	*Anous minutus*			X	X
White Tern	*Gygis alba*			X	X
Yellow Bittern	*Ixobrychus sinensis*		X		
Palau Owl	*Pyrroglaux podargina*			X	X
Palau Kingfisher	*Todiramphus pelewensis*	X[d]		X	X
Collared Kingfisher	*Todiramphus chloris*				X
Micronesian Myzomela	*Myzomela rubratra*	X	X	X	X
Common Cicadabird	*Edolisoma tenuirostre*			X	X
Morningbird	*Pachycephala tenebrosa*			X	X
Palau Fantail	*Rhipidura lepida*	X	X	X	X
Palau Flycatcher	*Myiagra erythrops*	X[e]	X[e]	X	X
Palau Bush Warbler	*Horornis annae*			X	X
Dusky White-eye	*Zosterops finschii*	X	X	X	X
Micronesian Starling	*Aplonis opaca*	X	X	X	X
Eurasian Tree Sparrow	*Passer montanus*				X
Chestnut Munia	*Lonchura atricapilla*	X	X	X	

[a] Excludes species that were only heard from beyond the Tx site or only observed flying over and past but not actually visiting the site (see Table 3).
[b] Seen foraging in grassy areas along the northern forest edge, north of the homestead, and in grassy areas and the taro field along the entrance road to the site.
[c] Heard calling from along the southern forest and savanna border.
[d] A single individual was seen at the marsh located in the south central portion of the savanna.

4.1.2.2 Bats

Both bat species were observed at the Ngaraard Tx site (Table 6). A single Palau Sheath-tailed Bat was observed during the morning avian point-count survey in the south-central savanna from point-count location NG005. No individuals were observed during the night surveys, times during which one would have expected to see this species if present at the site. The absence of this small bat during the night surveys may have been due to relatively strong and at times very gusty winds that occurred during all the night surveys. During the night surveys, winds were estimated at 13–18 mph (Beaufort wind scale 4) on one night and at 25–31 mph (Beaufort wind scale 6) during the other three survey nights.

In contrast, the Palau Fruit Bat was observed during the avian point-count and traveling-route surveys and on three of the four surveys (Table 6). Individual fruit bats were often observed flying across the savanna to and from the northern and southern forests, and a roost was observed in the northern forest near point-count location NG009 (Figure 18). Figure 19 shows several fruit bats roosting at this location.

TABLE 6 Bat Survey Results, Ngaraard Tx Site, January 14–18, 2019.

Common Name	Scientific Name	Status[a]	Total Count		
			Point-Count[b] Survey	Traveling-Count Survey[c]	Night Survey[d]
Pacific Sheath-tailed Bat	*Emballonura semicaudata*	IUCN-E	1	0	
Palau Fruit Bat	*Pteropus pelewensis*	IUCN-VU, P-T	37	7	20

[a] IUCN Red List status: IUCN-E = endangered, IUCN-VU = vulnerable; Palau proposed listing: P-T = threatened.

[b] Daily point-count surveys at eight locations, January 14–18, 2019; additional point-count location added and surveyed January 16–18, 2019; another point-count location added and surveyed January 17 and 18, 2019.

[c] Daily traveling-count surveys conducted January 15–18, 2019.

[d] No night survey conducted on January 18, 2019 because of inclement weather.

FIGURE 19 Palau Fruit Bats Roosting in the Forest Immediately North of Point-Count Location NG009.

4.1.2.3 Pandanus Skink

While the Pandanus Skink has been reported from the southern portion of Babeldaob Island, the likelihood of finding this species on the Tx site may be quite low. The BNM indicates that the habitat for this species is shaded Pandanus palms, where it inhabits the axils of the leaves, often along streams and swamps. More than 100 Pandanus palms were examined at the Tx site for the presence of the Pandanus Skink. The survey covered about 75% of the savanna area, where the palms occur out in the open and in direct sun. While another skink species and a gecko were observed, no Pandanus Skinks were found during the surveys.

4.2 ANGAUR RX SITE

The Angaur Rx site has fewer habitat types, a less diverse plant fauna, and a less diverse avifauna than the Ngaraard Tx site. Neither the plant communities nor the avifauna identified during the surveys are unique to the site, and similar habitats, plant communities, and avifauna occur in other parts of Angaur Island. The site is notable in the presence of the Micronesian Megapode and its nest mounds, both of which are absent from the Ngaraard Tx site. The following paragraphs discuss the distribution, condition, and status of the vegetation and wildlife observed during surveys of this site.

4.2.1 Vegetation

4.2.1.1 Terrestrial Plant Diversity

Plant surveys were conducted daily at the Angaur Rx site from January 22 through January 26, 2019. More than 148 species of plants were observed during the survey of the Angaur Rx site, 92 of which were native species, including 8 endemics. None of the species recorded from the Rx site has any IUCN, Palau, or ESA designation. A total of 23 introduced species were also observed, 3 of which have become naturalized and 7 are now considered invasive. The distribution of native plants across the site did not show a significant difference from north to south or east to west. The coastal forest areas had plants restricted to those that tolerate exposure to open sea water spray. In contrast to the Ngaraard Tx site, no orchid species was found at the Angaur Rx site during the 5-day survey. Note that there were no herbarium specimens of orchids or records of orchids from Angaur Island at the Belau National Museum. It is unclear why the Family Orchidaceae is not represented.

4.2.1.2 Plant Community Types

Four plant community types were initially identified at the Angaur Rx site: *Casuarina* forest, limestone forest, secondary forest, and barren land (Figure 20). However, based upon the plant associations observed during the vegetation surveys, three other plant community types were found: coastal strand, agroforest, and wetland.

Coastal Strand. Coastal strand is a plant community of flowering plants that form along the shore in loose sand just above the high-tide line. This community typically has low species diversity, as so few plants can tolerate the harsh conditions of high winds, regular salt spray, and high summer temperatures. Plants must also be adapted to sandy saline soils with extremely low nutrient loads and low water-holding capacity. At the Angaur Rx site and surrounding areas, this community type occurs along the upper portion of the sandy or rocky beaches and is limited inland by the presence of coastal forest. This community is dominated by herbaceous creeping vines such as *Ipomoea litoralis*, grasses such as *Sporobolus spp.* and *Fimbristylis cymosa,* the salt-tolerant shrub *Pemphis acidula,* and several species of the herb *Portulaca* (Figure 21).

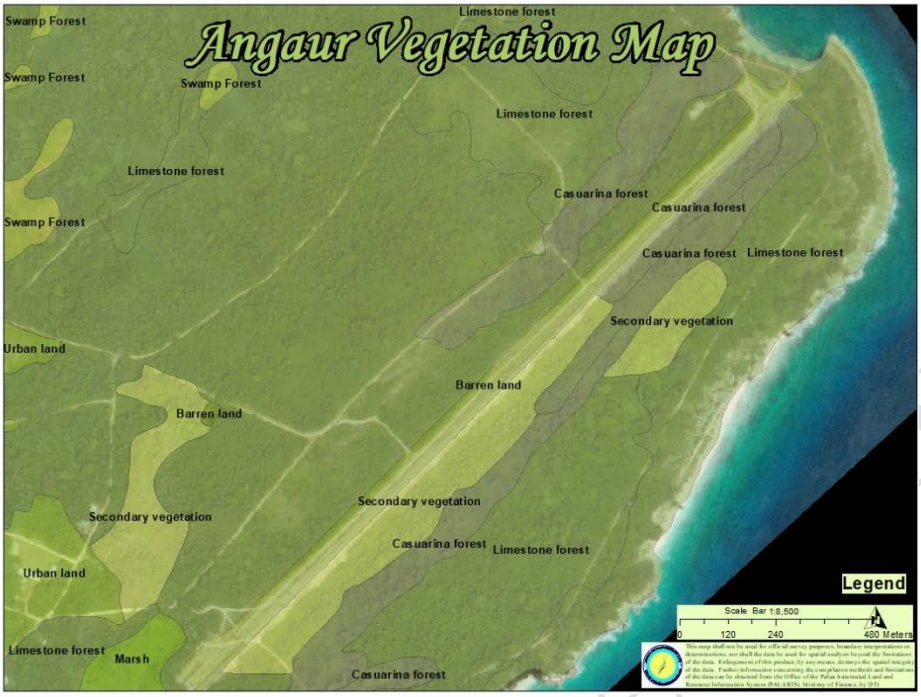

FIGURE 20 Major Plant Community Types at the Angaur Rx Site and Surrounding Areas (Source: Kitalong et al. 2019).

FIGURE 21 Common Vegetation on the Coastal Strand Habitat along the Angaur Rx Site.

Limestone Forest. In Palau, limestone forests are found on limestone islands and outcrops, mainly on Peleliu, Angaur, the Rock Islands, and Airai. In these areas, a limestone substrate of the coral rock is overlain by organic matter from the vegetation, which in places forms a thin layer of soil in which the vegetation grows (Republic of Palau 2010). Limestone forest is the major plant community type of the Angaur Rx site (Figure 17) and may be

subdivided into three forest types; coastal limestone forest, raised limestone platform forest, and *Casuarina* forest.

Coastal limestone forest occupies the easternmost half of the Rx site, primarily between the coast road and the coastal strand community along the coast (Figure 22). Large trees found in this coastal limestone forest included *Casuarina equisetifolia* (ngas), *Pisonia grandis* (mesbesibech), and *Barringtonia asiatica* (bdul). The understory included a number of smaller trees and shrubs, such as *Pemphis acidula* (ngis), *Heliotropium foertherianum* (rirs), *Pipturus micronesicus*, and *Hernandia nymphaeifolai* (doko). A *Cordia subcordata* (kelau), a culturally important tree species, was found in the northeastern portion of the coastal limestone forest.

FIGURE 22 Trees and Shrubs of the Coastal Limestone Forest at the Angaur Rx Site.

The remainder of the eastern portion as well as much of the central portion of the Rx site is raised limestone platform forest. This forest is dominated by the native tree *Casuarina equisetifolia* (ngas), which is widespread throughout this forest. A less abundant but no less obvious tree of this forest is the parasitic *Ficus microcarpa* (lulk), which is one of many *Ficus spp.*, often called "strangler figs" because of their growth pattern. The seeds of these species germinate in cracks in the tops of other trees, and as the roots grow downward toward the ground, they envelope the host tree. Several large *F. microcarpa* trees occur throughout the central portion of the Rx site, including some with root systems expanding more than 160 ft (50 m) and overtaking other large trees (Figure 23). Aerial views of the site show large areas of the upper canopy covered by this *Ficus* species.

Of note in the raised limestone platform forest is the presence of a large stand of the endemic *Buchanania palawensis* (omail), with trees reaching heights over 70 ft (22 m), in the northwest and southwest portions of the forest. This was the largest stand of *Buchanania palawensis* trees BNM staff members have ever seen in Palau. Other trees present in this forest include *Syzygium samaragense* (rebotel) (common within both the northeast coastal limestone and raised limestone platform forests), *Phyllanthus kanehirae* (kesengelngolm), *Planchonella*

obovata (chelangel), and *Premna serratifolia* (chosm). Small understory trees of the raised limestone platform forest include the native *Melicope trichantha* and *Allophylus timorensis* (chebludes) and the invasive *Timonis timon* (liberal).

FIGURE 23 Large Ficus microcarpa in the Central Forest at the Angaur Rx Site.

Casuarina forest occurs primarily in the west-central portion, and along the entire length, of the Rx site (Figure 16) and is so named because it is dominated by *Casuarina equisetifolia* (ngas). This a coastal tree common in sand and coral rubble and often near the high-water mark, but can also be found in both limestone and volcanic soils and as part of the coastal strand vegetation. The southern states of Angaur, Peleliu, and the Ngemelis Complex are dominated by large *Casuarina* trees (Republic of Palau 2010). At the Rx site, trees reached diameters of more than 6 ft (2 m), with extensive buttressed trunks (Figure 24). While the *Casuarina* tree may occur throughout the site, from the coast to the forest interior, it is the dominant species in both size and numbers within the main *Casuarina* forest in the central portion of the site.

Secondary Vegetation. Secondary vegetation is the result of disturbance of primary forest habitat. The past phosphate mining, the WWII battle, Supertyphoon Bopha, and newly cut survey roads have all resulted in an extensive secondary growth forest throughout much of the western portion of the Rx site. This community type includes broad leaf, smaller stemmed shrubs, and trees such as *Clerodendron speciosissimum, Melochia compacta* (chermalluchang), *Melanolepis multiglandulosa,* and the *Macaranga carolinensis* (bedel), which is a dominant member of the plant community. The invasive *Timonius timon* (liberal) is also present within this secondary vegetation habitat. Figure 25 shows some of the secondary vegetation at the Angaur Rx site.

FIGURE 24 Large, Buttressed Casuarina Trees in the Central Portion of the Angaur Rx Site.

FIGURE 25 Common Secondary Vegetation at the Angaur Rx Site.

Phosphate Quarry Vegetation. Phosphate mining occurred on Angaur from 1909 through the late 1950s while the island was under German, Japanese, and American administration (Arnow 1961). The vegetation within the quarry sites is a mix of limestone forest, *Casuarina* forest, secondary vegetation, and wetlands (Figure 26). However, the density and diversity of plant species were much less in this highly disturbed area than in the other plant communities of the Rx site.

Agroforest. There was very little agroforest on the Rx site. In the north central forest of the site (Figure 27), there was a small planted tree community containing a large mahogany, *Swietenia macrophylla* (mahogani); the betelnut, *Areca catechu* (buuch); and coconut, *Cocos nucifera* (lius).

Wetland. There was a small wetland with *Hibiscus tiliaceus* (chermall) and the fern *Acrostichium* (okkuam) and *Areca catechu* (buuch) in the west central portion of the site. The sister of the clan chief who owns this land used to farm in this area (Gabriel 2019).

FIGURE 26 Abandoned Pit with Scrap Metal from Past Phosphate Mining and Other Activities; Vegetation Incudes *Flacourtia rukam* in the Center and *Asplenium nidus* Ground Cover.

FIGURE 27 Agroforest with Coconut, *Cocos nucidfera* (lius) (left), and *Areca catechu* (buuch) (right) in the Northcentral Portion of the Angaur Rx Site.

4.2.1.3 Culturally Significant Plants

Two species of plants were found on the Rx site, which, although not listed by the IUCN, Palau, or ESA, are very culturally important. Flowers of *Cordia subcordata* (kelau) (Figure 28) are a critical component of Angaur's first birth ceremony (ngasech), which is a ceremony unique to the inhabitants of Angaur. No other state in Palau requires that this flower be used during the first birth ceremony. One rubak (i.e., an elder or chief) in Angaur is responsible for the blooming of this tree for a birth ceremony (Kitalong et al., 2019). One such tree was found in flower and fruit along the northeast coast of the site. Another plant was found on site, but without fruit or flowers, by the NPA team member, Pelagia Gabriel. Other kelau trees were located further south but offsite, and none and none were in bloom. The *Syzygium samarangense* (rebotel) is a significant plant in Palauan culture. The leaves are used during a woman's hot bath

after the birth of her first child. Several large rebotel trees were found along the northeast and central coast of the site.

FIGURE 28 The Culturally Important *Cordia subcordata* and *Syzygium samarangense*.

4.2.1.4 Vulnerable Species

Pisonia grandis (mesbesibech) is considered a vulnerable species on the IUCN Red List. The flowering tree *Pisonia grandis* was found along the northeast and southeast coasts of the Rx site. In Palau, there are only two other known populations of this species, on Kayangel and on the Southwest Island of Fanna. These two islands, together with Angaur, are highly vulnerable to climate change impacts. Kayangel's *Pisonia* population was greatly affected by Super Typhoon Haiyan in 2013.

4.2.2 Wildlife

4.2.2.1 Avifauna

At the Angaur Rx site, a total of 48 15-minute point-count surveys were conducted at 10 locations over a 5-day period (January 22–26, 2019). During this same period 10 traveling-count surveys were carried out along two predetermined routes, covering about 7.5 person-miles. Five nightly surveys were also conducted at the site (January 22–26, 2019). A total of 1,528 individuals from 19 species were counted during the avian surveys (Table 7) at the site. Only three of these species have an IUCN or Palau designation, while the Micronesian Scrubfowl

(Megapode) is also designated as endangered under the ESA. In contrast, there were nine IUCN and/or Palau designated species at the Ngaraard Tx site.

The bird community of the Rx site was dominated by three species, the Micronesian Starling (626 total records), the Micronesian Megapode (247), and the Collared Kingfisher (119) (Table 7 and Figure 29). These species were seen or heard daily from throughout the site proper (Table 8). The Micronesian Starling is the most common bird at the site; it was seen in flocks of as many as 10 or more individuals and was seen or heard from all areas of the site. Both the megapode and the Collared Kingfisher were also seen and heard from all portions of the site on all survey dates (Table 8).

TABLE 7 Species Observed or Heard during the Point-Count, Traveling-Count, and Night Surveys at the Angaur Rx Site, January 22–26, 2019.

Common Name	Status[a]	Point-Count[b] Survey (*n* = 48)		Traveling-Count[c] Survey (*n* = 10)		Night Survey[d] (*n* = 5)	
		Total Count	Mean Count	Total Count	Mean Count	Total Count	Mean Count
Micronesian Scrubfowl	IUCN-EN, P-E, USESA-E	102	2.1	113	10.89	32	6.4
Red Junglefowl		18	0.4	12	1.38	2	0.4
Palau Fruit-Dove	P-T	7	0.2	12	1.38	2	0.4
Buff-banded Rail		5	0.1	6	0.75	9	1.8
Slaty-legged Crake		15	0.3	1	0.13	25	5.0
Pacific Golden-Plover		10	0.2	39	4.0	16	3.2
Swinhoe's Snipe		0	0	0	0	9	1.8
Brown Noddy		2	0.0	0	0	0	0
Black Noddy		0	0.0	4	0.50	0	0
White Tern		27	0.6	52	4.63	0	0
Intermediate Egret		0	0.0	1	0.0	0	0
Cattle Egret		0	0.0	1	0.0	0	0
Rufous Night-heron		0	0	0	0	1	0.12
Palau Kingfisher	IUCN-NT	6	0.1	0	0.0	0	0
Collared Kingfisher		62	1.3	41	3.75	16	3.2
Micronesian Myzomela		5	0.1	5	0.50	0	0
Dusky White-eye		4	0.1	1	0.13	0	0
Micronesian Starling		259	5.4	250	25.4	117	23.4
Chestnut Munia	Non-native	75	1.7	149	14.9	15	3
Total number birds		597		687		244	
Total number of species		14		15		11	

[a] IUCN Red List status: IUCN-EN = endangered, IUCN-NT = near threatened; Palau proposed listing: P-E = endangered, P-T = threatened; ESA status: USESA-E = endangered.

[b] Daily point-count surveys at eight locations, January 14–18, 2019; another point-count location added and surveyed January 16–18, 2019, and another point-count location added and surveyed January 17 and 18, 2019.

[c] Daily raveling-count surveys conducted January 15–18, 2019.

[d] No night survey was conducted on January 18, 2019, because of inclement weather.

In contrast, while the Chestnut Munia and White Tern were two of the five species most often observed or heard during the surveys, their numbers included observations from areas outside the Rx footprint or as flyovers along the coast paralleling the eastern site boundary. For example, 140 of the 239 records of this species are of birds observed in large flocks foraging on the runway adjacent to the site.

FIGURE 29 Micronesian Starling (left), Micronesian Megapode (center), and Collared Kingfisher (right).

Of the 19 species reported from the Angaur Rx site, 11 were observed and/or heard on each of the 5 survey dates, and another species was observed and/or heard on 4 of the 5 dates (Table 8). In contrast, individuals of three species, the Rufous Night-heron, the Intermediate Egret, and the Cattle Egret, were observed only on a single survey date.

Six species were observed only as flybys or flyovers, were observed only in grassy areas along the runway, or were only heard from well beyond the Rx site, and these are not likely to occur within the Rx footprint (Table 9). For example, the Intermediate Egret, Cattle Egret, and Rufous Night-heron were only observed a single time, the former two along the runway and the latter as a flyover. Similarly, the Brown Noddy was only observed flying over the eastern boundary of the site along the coast.

TABLE 8 Bird Species Occurrence by Date at the Angaur Rx Site, January 22–26, 2019.

Common Name	Jan 22	Jan 23	Jan 24	Jan 25	Jan 26	Daily Mean
Micronesian Scrubfowl	36	50	53	45	63	49.5
Red Junglefowl	3	5	8	9	9	6.8
Palau Fruit-Dove	2	9	2	4	4	4.2
Buff-banded Rail	2	4	6	1	7	4.0
Slaty-legged Crake	5	5	7	12	12	8.2
Pacific Golden-plover	14	10	21	9	11	13.0
Swinhoe's Snipe	0	1	6	0	2	1.8
Brown Noddy	0	0	1	1	0	0.4
Black Noddy	0	4	0	0	0	0.8

TABLE 8 (cont).

Common Name	Jan 22	Jan 23	Jan 24	Jan 25	Jan 26	Daily Mean
White Tern	11	13	30	9	13	15.2
Rufous Night-heron	0	1	0	0	0	0.2
Intermediate Egret	0	0	1	0	0	0.2
Cattle Egret	1	0	0	0	0	0.2
Palau Kingfisher	0	0	0	3	3	1.2
Collared Kingfisher	21	23	31	20	24	23.8
Micronesian Myzomela	2	2	1	3	2	2.0
Dusky White-eye	1	1	0	0	0	0.4
Micronesian Starling	88	138	128	122	150	125.2
Chestnut Munia	5	85	48	37	34	41.8
Total number birds	191	351	343	275	334	298.8
Total number of species	13	15	14	13	13	13.6

TABLE 9 Bird Species Observed Only as Flybys/Flyovers or Only along the Runway.

Species	Nature of Occurrence
Swinhoe's Snipe	Observed only in grassy areas along the runway.
Pacific Golden Plover	Observed only in grassy areas along the runway.
Brown Noddy	Observed only flying along the coast adjacent to the site.
Rufous Night-Heron	Observed only once, flying over the runway.
Intermediate Egret	Observed only once, in grassy areas of the runway.
Cattle Egret	Observed only once, in grassy areas of the runway.

4.2.2.2 Micronesian Megapode

The Micronesian Scrubfowl (Megapode) (*Megapodius laperouse*) was a primary focus of the natural resource surveys on the Angaur Rx site. This species is listed as endangered on the IUCN Red List and on the ESA list (USFWS 1998, 2018), and is proposed as endangered for the Palau list of threatened and endangered species. The Palau population is currently recognized as a subspecies (*Megapodius laperouse senex*) but, on the basis of morphological, behavioral, and vocalization differences, may actually be a separate species (Olsen et al. 2016). The IUCN assessment of the megapode's status in Palau (subspecies *senex*) indicates that it is generally uncommon to rare and locally distributed (IUCN 2018). In 1991, the total population for Palau (excluding Kayangel Island) was estimated at 497 birds. In 2005, a repeat survey found stable numbers on Peleliu and Babeldaob, but evidence of declines in the Rock Islands and on Angaur Island (IUCN 2018).

Megapode Numbers. The Micronesian Megapode was heard and observed during all daytime point-count and traveling-count avian surveys and was heard during each of the owl and bat night surveys (Table 10; Figure 30). During each day of the surveys, an average of 2.1 megapodes was heard or observed from each point-count survey location, and an average of 10.8 megapodes was heard or observed along each traveling-count survey route. During the night surveys, an average of 6.4 megapodes was heard each evening. A number of individuals were also heard or observed during the megapode nest surveys (Table 10); the relatively small number of birds detected during the nest surveys is likely due in part to the presence of a greater number of survey staff (four staff) than during the daytime surveys (one staff per survey).

TABLE 10 Number of Micronesian Megapodes Observed or Heard by Survey Type and Date.

Survey Type[a]	Number Observed or Heard					Daily Mean
	Jan. 22	Jan. 23	`Jan. 24	Jan. 25	Jan. 26	
Point Count	10	21	23	22	26	20.4
Traveling Count, Runway Route	9	6	3	5	15	7.6
Traveling Count, Forest Route	13	11	23	11	17	15
Night Survey	4	12	4	7	5	6.4
Forest North of Runway	7	1	0	0	1	1.8
Nest Survey	3	0	6	8	0	3.4
Reconnaissance Area	na	na	na	na	23	na

[a] See Figure 6 for point-count locations and traveling-count routes, and Figure ZZZ for onsite and offsite nest survey areas.

In addition to the birds reported from the Rx site, an additional 23 birds were heard or observed during the reconnaissance area survey conducted on January 26, 2019, south of the Rx site (Figure 30). This was the second-highest number of all megapodes reported that day from the site (Table 10). As shown in Figure 30, megapodes were observed or heard each day from areas throughout the Rx site footprint, although more so in the northern portion of the site. This is likely due to the southern portion of site having a denser understory vegetation and less developed forest habitat. In the reconnaissance survey area, a number of birds were heard or observed from the far southern end of the survey area (Figure 30). The absence of birds along the southeastern coast is likely due, in part, to the disturbed nature of this area. Heavily affected in 2012 by Super Typhoon Bopha, considerable damage to coastal habitats in this area is still evident today.

Megapode Nest Sites. A total of 35 megapode nests were found within the Rx project footprint (Figure 31), 3 of which were determined to be inactive. An additional 19 nest mounds (all but 1 active) were found in the reconnaissance area outside of the Rx site. Regardless of their location, most of the nests were large. The five largest nests were 10–12 m in length, had widths ranging from 6 to 10 m and heights ranging from 0.8 to 1.6 m. Table 11 summarizes the characteristics of the nests found on the Rx site and in the reconnaissance area south of the site. The sizes of the nests found at the Rx site are comparable to the sizes of 24 nests measured on Palau by Wiles and Conroy (2001).

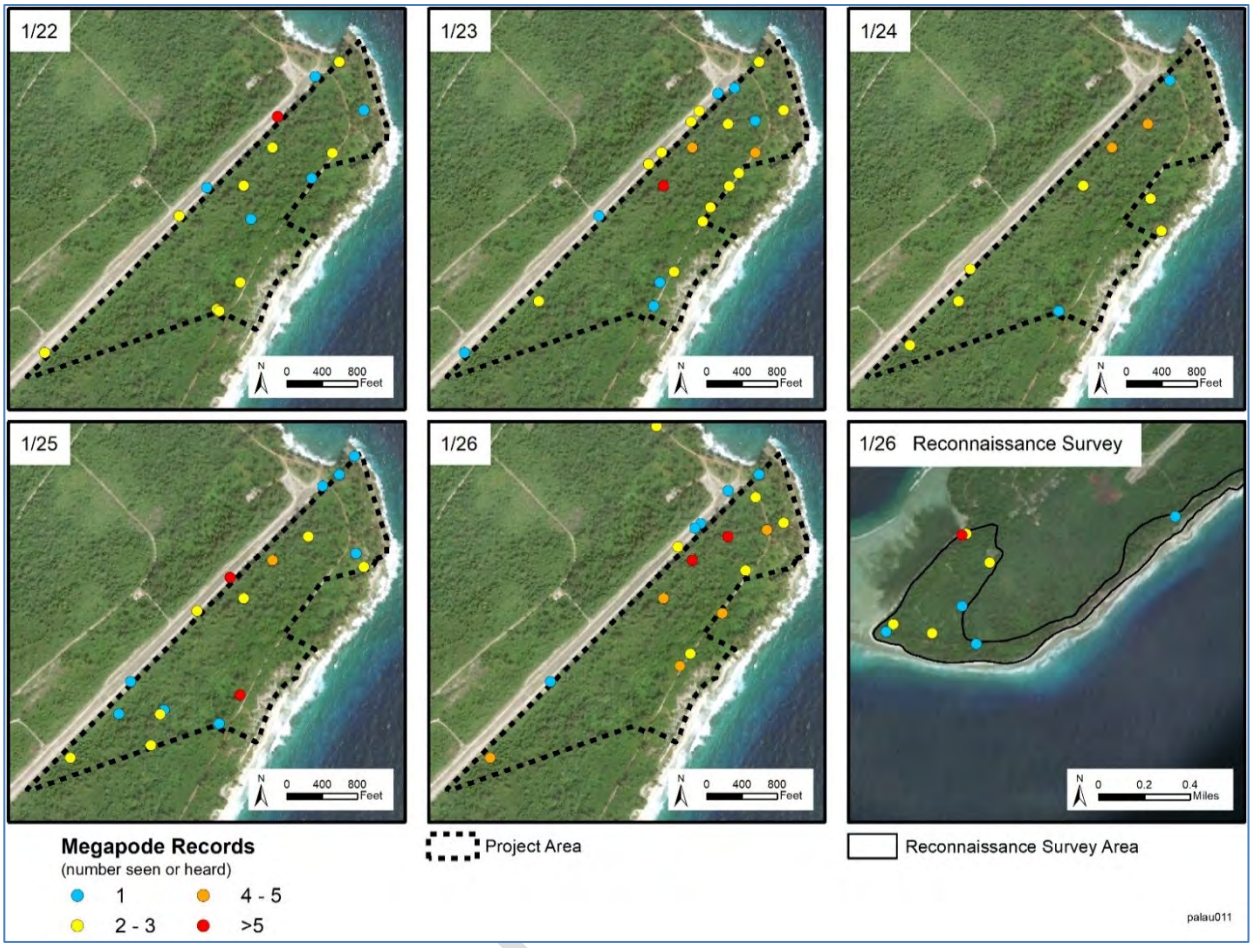

FIGURE 30 Locations of Daily Megapode Sightings and Vocalizations at the Rx Site, January 22–26, 2019 and in Reconnaissance Survey Area, January 26, 2019

TABLE 11 Nest Parameters of Megapode Nests found at the Rx Site and Reconnaissance Survey Area, Angaur Island.

	Range (m)			Mean (m)		
Nest Parameter	**Rx Site Nests**	**Reconnaissance Area Nests**	**Wiles and Conroy 2001**	**Rx Site Nests**	**Reconnaissance Area Nests**	**Wiles and Conroy 2001**
Width	0.3–10.0	1.0–10.0	5.2–7.6	4.4 ± 2.8	4.2 ± 2.4	6.2 ± 0.7
Length	1.6–12.0	2.0–10.0	6.1–9.1	5.8 ± 3.1	6.1 ± 2.6	7.3 ± 1.2
Height	0.1–1.6	0.3–1.3	0.8–1.5	0.7 ± 0.4	0.8 ± 0.3	1.1 ± 0.2

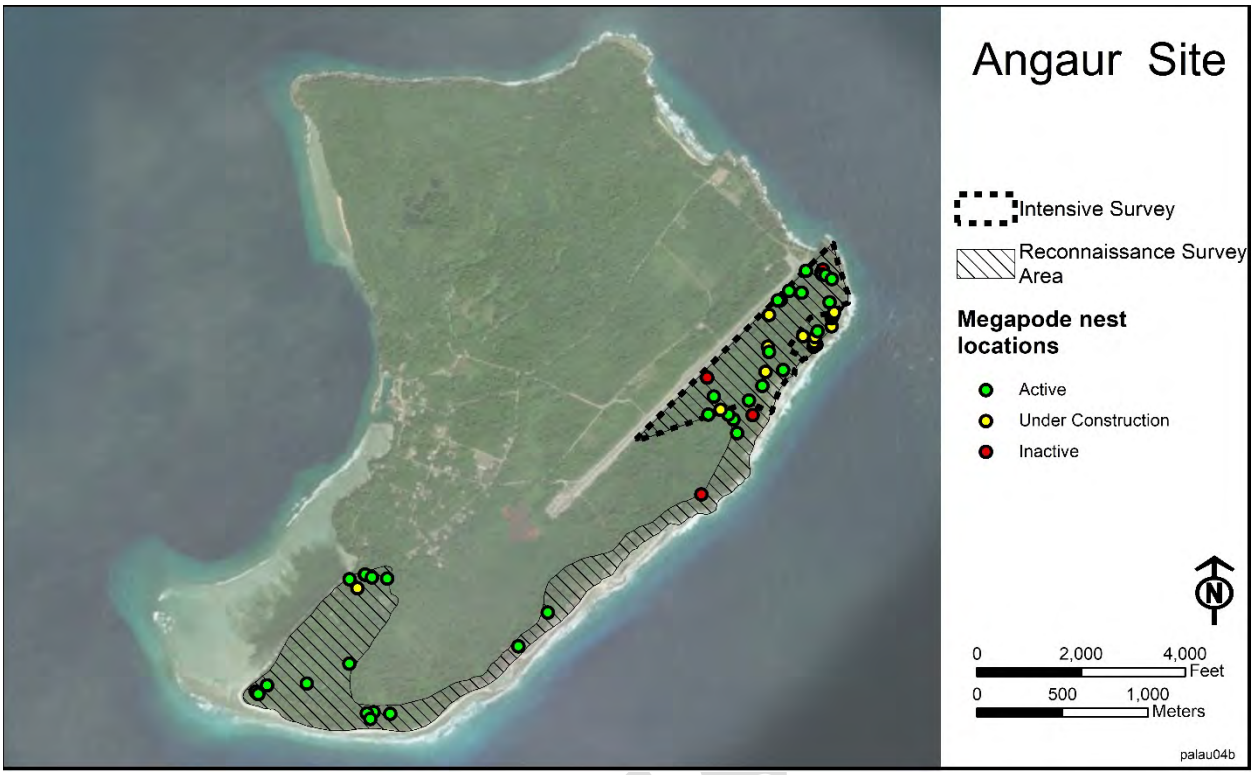

FIGURE 31 Locations of Megapode Nests Found on the Angaur Rx Site, January 22–26, 2019, and in the Nearby Offsite Reconnaissance Area, January 26, 2019

Within the Rx site, most nests (28) were found at the base of large *Casuarina* trees, with a small number against fallen logs and stumps (Figure 32). The majority of these nests were constructed of gravel and a mix of leaves, twigs, and other similar organic materials. In contrast, the majority (14 of 19) of the reconnaissance area nests were built of sand; four were built with gravel and one with a mix of sand and gravel (Figure 32).

Between 2011 and 2014, Olsen et al. (2016) conducted a field survey of megapode nests across much of Palau. They surveyed all islands inside the coral barrier reef that surrounds the Palau archipelago, as well as Kayangel Atoll, which occurs outside of the barrier reef. Their survey did not include Angaur but did include Peleliu Island and nearby islets. Among the islands surveyed, they identified approximately 800 hectares (ha) of level forested terrain they considered suitable nesting habitat for the megapode. Of this habitat, 450 ha were found to support active nest mounds. On the Rock Islands, they estimated the density of active nest mounds to range from 0.2 to 1.4 nests/ha, while at Kayangel Atoll densities ranged from 0.4 to 1.9/ha (Olsen et al. 2016). Lowest densities were estimated for Babeldaob and Peleliu Islands and their associated islets, where active nest densities were less than 0.2/ha. In comparison, the active nest density at the Rx site is estimated at 0.8/ha, which falls in the mid to upper end of the density range of Olsen et al. (2016) and well above the range estimated for Peleliu Island. The presence of 18 active nests in the southern portion of Angaur Island suggests that suitable megapode nesting habitat exists in other parts of the island.

FIGURE 32 Megapode Nests from the Rx site (A-D) and the Offsite Reconnaissance Area (E-H). Note the Gravel vs. Sand Nest Construction Between the Two Areas.

4.2.2.3 Bats

The Palau Fruit Bat and the Pacific Sheath-tailed Bat are present at the Rx site; both species were observed every evening and along both survey routes (Table 12). The Pacific Sheath-tailed Bat became active each evening shortly after sunset, actively foraging along the open canopy over the coast road on the east side of the site and along and over the runway to the west. During the surveys, Palau Fruit Bats were often observed prior to and shortly after sunset, flying from the Rx site to a potential roost site in the forest across the runway from the site. In addition, a fruit bat roost site was observed in the eastern portion of the Rx site, in the vicinity of point-count location AN009 (see Figure 6). This roost was in a large *Casuarina* tree; Figure 33 shows bats roosting at this location.

TABLE 12 Number of Bats Observed by Survey Date during Evening Surveys[a] at the Angaur Rx Site.

Common Name	Status[b]	Number Observed					Daily Mean
		Jan. 22	Jan. 23	Jan. 24	Jan. 25	Jan. 26	
Pacific Sheath-tailed Bat *Emballonura semicaudata*	IUCN-EN	7	15	33	21	7	16.6
Palau Fruit Bat *Pteropus pelewensis*	IUCN-VU, P-T	2	6	14	4	10	7.2

[a] See Figure 6 for bat and owl survey routes.

[b] IUCN Red List status: IUCN-EN = endangered, IUCN-VU = vulnerable (IUCN 2018); Palau proposed listing: P-T = threatened.

FIGURE 33 Roosting Fruit Bats, Angaur Rx Site, January 25, 2019.

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November 20, 2020

Mark Ingoglia and George Herbst
AFIMSC Det 2/CEV (Pacific Region)
25 E. St., Suite C-300
Joint Base Pearl Harbor-Hickam, Hawaii 96853

Dear Mr. Ingoglia and Mr. Herbst,

Argonne National Laboratory (Argonne) is providing support to the U.S. Air Force in its evaluation and mitigation of potential adverse impacts that could be incurred with the construction of two Tactical Multi-Mission Over-the-Horizon Radar (TACMOR) facilities in the Republic of Palau. One of the facilities (the transmitter [Tx] facility) is located on the northern end of Babeldaob Island, within the State of Ngaraard. The attached letter report presents the results of an assessment conducted of the cultural and natural resources at two sites (Soil Disposal 1 [SD 1] and Soil Disposal 2 [SD 2]) being considered to for use as soil disposal and/or equipment laydown areas in support of construction of the Tx facility.

The assessment of the two soil disposal sites was conducted between October 25 and November 4, 2020, by archaeologist Dr. Jolie Liston of Micronesian Heritage Consulting, LLC and the Environmental Division of the Belau National Museum led by Dr. Ann Kitalong, both under contract with Argonne National Laboratory, and the U.S. Air Force Talon TACMOR Palau Site Coordinator, Jon Vogt. The objectives of the surveys at SD 1 and SD 2 were to:

1) assess the potential for significant cultural and natural resources concerns should these areas be used for soil disposal;

2) provide preliminary documentation of said features for planning purposes; and

3) make recommendations on the suitability of each site for soil disposal and equipment laydown activities.

During these surveys, each site was assessed with a focus on identifying flora, fauna, habitats, and cultural properties of significance present or likely to occur at each site and their immediate surroundings, and which of these resources could be impacted if the site were to be selected to support Tx construction activities.

Based on the survey findings, the SD 1 site is preferred for use as a soil disposal and staging area for the Tx Site because of a combination of: 1) SD 1 being almost exclusively savanna rather than forest habitat; 2) the presence of a single, small surface archaeological site that can be mitigated without detrimental loss to Palau's cultural landscape; 3) the close proximity to the Tx Site; 4) ownership by Ngaraard State who have intimated they are amenable to a land lease agreement; and 5) a fairly level terrain. The primary issue

for use of SD 1 is the access route that would require removal of a small amount of forest habitat and passage across a small drainage area and three small streams.

The SD 2 site has a number of factors that suggest it could be suitable for use supporting Tx facility construction: 1) the south half of the site is already leveled and developed, 2) a relatively close proximity to the Tx Site; 3) a fairly level terrain across the entire site; 4) an existing, previously constructed, gravel road providing access to the site; and 5) largely savanna and previously disturbed secondary growth habitat across the site. However, there is a significant archaeological site (NA-2:22) at SD 2 which would require extensive mitigation, as site development would destroy a portion of the archeological site. There is also the likelihood that additional archeological artifacts and features may be discovered if SD 2 undergoes development. In addition, compared to SD 1 there are potential land ownership issues. Because of these latter factors, SD 2 is not recommended for use as a soil disposal and staging area for the Tx Site.

Please contact me with any questions or comments you have on the report and its conclusions and recommendation.

Sincerely,

Ihor Hlohowskyj
Principal Ecologist/Environmental Biologist
Argonne National Laboratory

SUBJECT: Letter Report: Cultural and Natural Resource Assessment of Proposed Soil Disposal Areas 1 and 2 for the Tactical Multi-Mission Over-the-Horizon Radar Facilities in Chol, Ngaraard, Republic of Palau

As requested by the U.S. Air Force Installation and Mission Support Center, Detachment 2 Civil Engineering Division (AFIMSC Det 2/CEV), this letter report presents an assessment of the cultural and natural resources at two potential soil disposal sites (Soil Disposal 1 [SD 1] and Soil Disposal 2 [SD 2]) that may support construction of the Tactical Multi-Mission Over-the-Horizon Radar (TACMOR) facility in Chol, Ngaraard, Republic of Palau (Ngaraard Tx site).

The assessment is based on limited reconnaissance surveys of the proposed SD 1 and SD 2 sites conducted between 25 October and 4 November 2020 by archaeologist Dr. Jolie Liston of Micronesian Heritage Consulting, LLC and the Environmental Division of the Belau National Museum led by Dr. Ann Kitalong, both under contract with Argonne National Laboratory, and the U.S. Air Force Talon TACMOR Palau Site Coordinator, Jon Vogt. The letter report incorporates the work of all three entities.

1. AREA OF POTENTIAL EFFECT

The areas of potential effect (APEs) include the two disposal sites as well as access routes to each from the Compact Road. The potential access routes considered a 15.2 m (50 ft) wide corridor.

The SD 1 site is a relatively flat, estimated 4-hectare (9.9-acre) parcel located 1.5 km (0.9 mi) south of the Ngaraard Tx site and approximately 300 m (0.2 mi) west of the Compact Road (Figures 1 and 2). This parcel is largely savanna and has not been historically disturbed. The landowner is Ngaraard State, with state public lands administered by the Ngaraard State Public Land Authority (Figure 2). The Ngaraard Governor stated he would be amenable to allowing the parcel to be used for a soil disposal site or as a staging area for Tx site construction. There is no existing vehicle access to the site, and construction of an approximately 300 m (0.2 mi) long access road from the Compact Road would be required. The proposed access road would stay within the boundaries of the Ngaraard State public land parcel.

The SD 2 site is a relatively flat, estimated 2-hectare (5-acre) parcel located 6 km (3.7 mi) south of the Tx Site, off the east side of the Compact Road (Figures 3 and 4). It is separated from the Compact Road by a low, elongated knoll. The SD 2 parcel is located to the north of the Ngaraard State landfill, which is currently in use. The site is within three privately owned cadastral lots (Figure 4). There are no state public lands in the SD 2 footprint. The northern half of the site is undisturbed savanna grasslands. The southern half of the site was leveled for use as a rock crusher plant and staging area in support of Compact Road construction in 2001 (Figure 5). Access roads paralleled the northern, western, and southern boundaries of the crusher plant. The southern unpaved access road remains in existence as it connects the Compact Road to the Ngaraard landfill and could be used for the proposed soil disposal.

Fill capacity in the soil disposal sites is dependent on the final disposal design and planned finished grades. The sites could be finished into flat buildable areas for landowners to utilize, or if the need for capacity drives the design, slopes could be built up, in a benched manner for stability, to higher elevations.

The coordinates of the corners of proposed soil disposals and the beginning and end of the proposed access roads are provided in Table 1.

Table 1. Coordinates of Soil Disposal 1 and 2 (UTM Zone 53N)

Location	Easting	Northing
Access road to SD 1	460108.623449	846053.28667
	460155.917815	846065.192944
	460199.574152	846070.153892
	460251.829465	846065.523674
	460316.652511	846050.971562
Five corners of SD 1	460137.0577	845965.9827
	459944.0836	845918
	459867.937	846027.5258
	459985.8077	846170.431
	460051.5232	846137.0517
Five corners of SD 2	459606.901492	841981.616068
	459685.565839	841972.589012
	459708.133479	841933.256839
	459594.650487	841834.60401
	459472.785228	841888.766347
Access road to SD 2	459434	841877

Figure 1. Proposed SD 1 in the savanna habitat 1.5 km south of the Ngaraard Tx site.

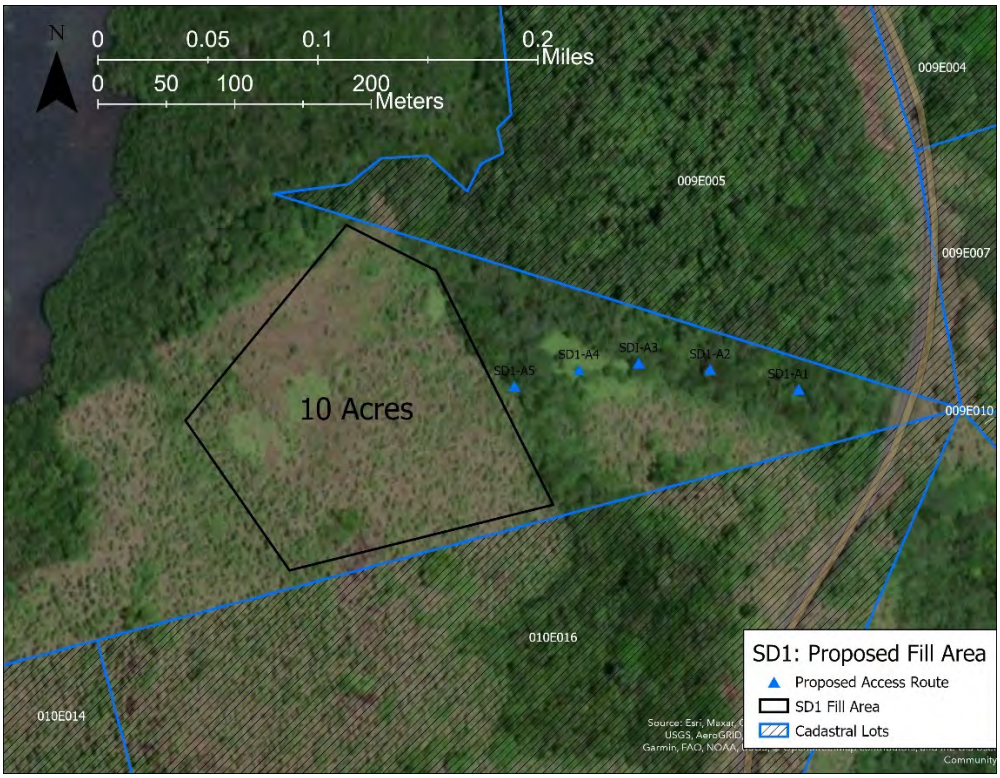

Figure 2. Proposed SD 1 and access route showing boundaries of cadastral lots.

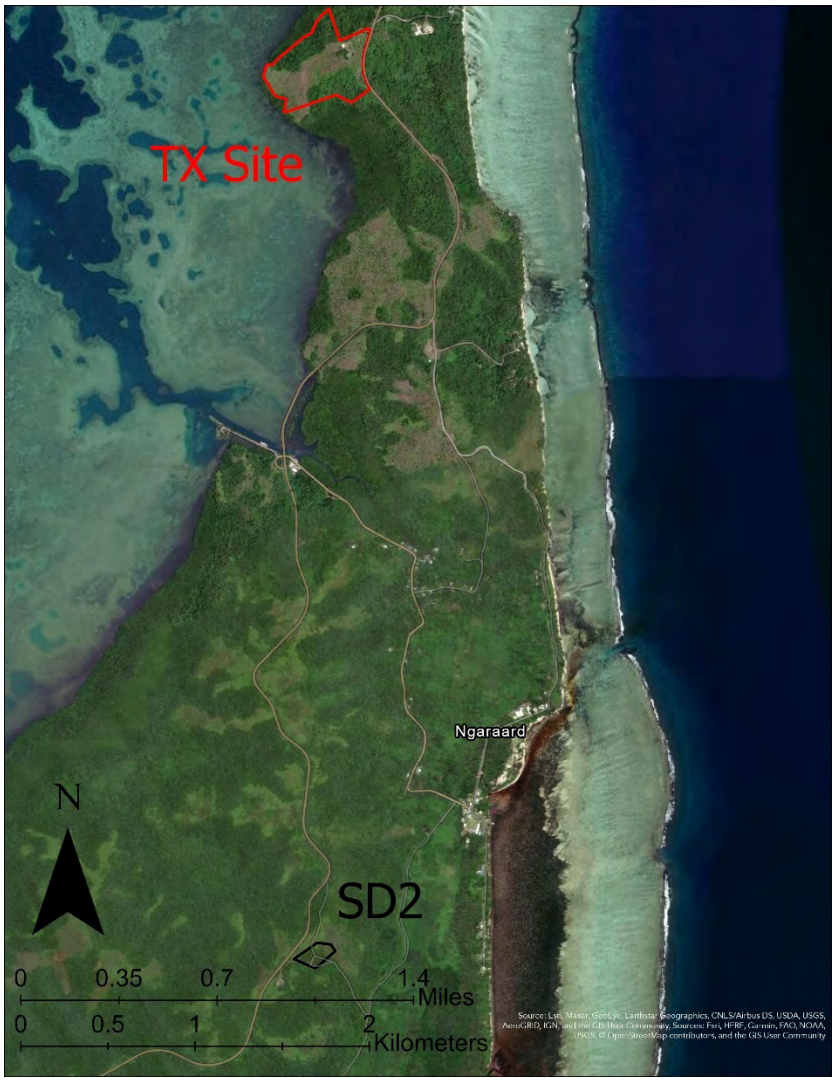

Figure 3. Proposed SD 2 in the savanna habitat 6 km south of the Ngaraard Tx site.

Figure 4. Proposed SD 2 and access route showing boundaries of cadastral lots.

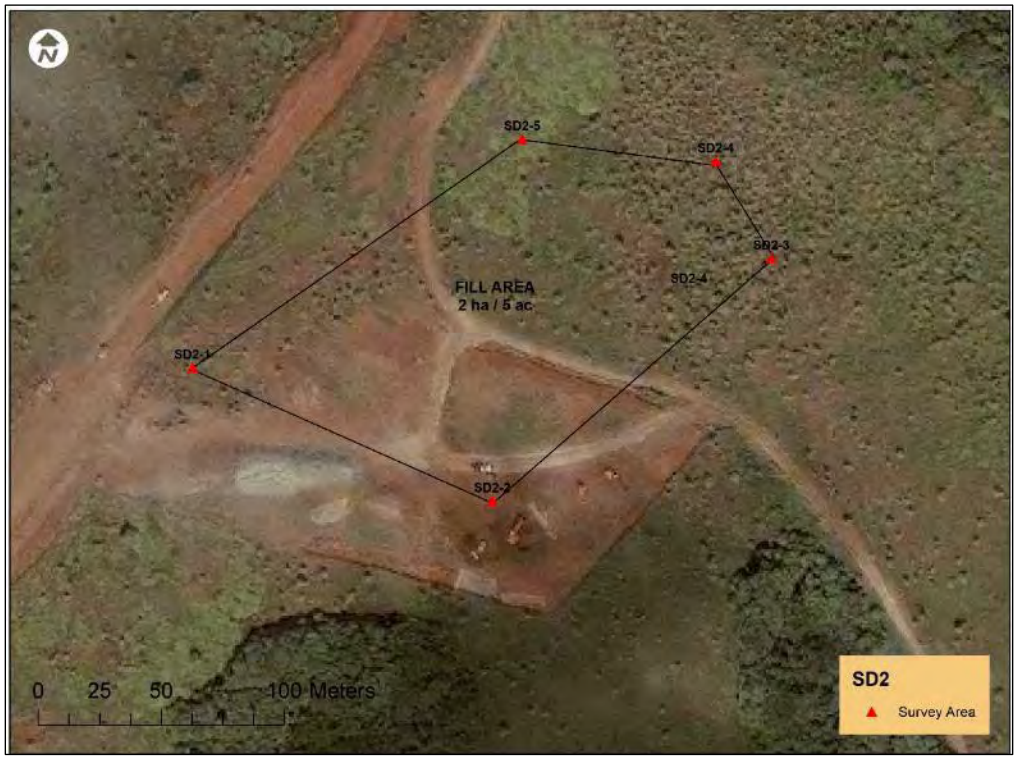

Figure 5. SD 2 on a 2001 aerial photograph showing area leveled for the crusher plant and adjacent access roads with the Compact Road under construction on the left.

2 OBJECTIVES

The objectives of the limited reconnaissance survey of SD 1 and SD 2 and their access routes are to:

1) assess the potential for significant cultural and natural resources concerns should these areas be used for soil disposal;

2) provide preliminary documentation of said features for planning purposes; and

3) make recommendations on the suitability of the sites for soil disposal and equipment laydown activities.

3 METHODS

The two potential disposal sites were chosen by the TACMOR Palau Site Coordinator based on numerous factors, including vegetation and distance from the Tx Site. During preparatory site visits Mr. Vogt acquired UTM locations of parcel corners and access routes that were migrated into an ArcMap environment. The waypoints were loaded into multiple Garmin GPSMAP 66 handheld global positioning systems (GPS) for use in field navigation.

Field work entailed limited reconnaissance pedestrian surveys of the proposed soil disposal areas and access routes by the archaeological, environmental, and TACMOR Palau Site Coordinator teams. When schedules permitted, the three teams conducted the surveys concurrently.

During these surveys, the teams assessed each site with a focus on identifying flora, fauna, and cultural properties of significance, habitat and bird diversity, and potential impacts of site use on wetlands and stream drainages. They recorded their observations about cultural and natural assets and the overall terrain in field books and took photographs of key points.

Presentation of the findings of the proposed SD 1 and SD 2 survey efforts are organized by individual disposal site number. Figures illustrating specific sites and features follow their respective sections.

4 FINDINGS

4.1 Proposed Soil Disposal 1

Overall, the proposed SD 1 site is in fairly level savanna with forested terrain just outside the boundaries on the west, north, and east (Figure 2; Table 2). Ngerbailiang ridgeline rises off of the south side of the parcel. The proposed east-west aligned access road is largely under forest canopy broken in the center by a narrow segment of savanna.

The east half of the proposed access road will dissect three small streams meandering through the forested, sloping terrain. Figure 6 marks the locations of these streams with labels PIC1, PIC2, and PIC3 and corresponding Figures 7-9. The streams flow south to north, are less than a meter wide, and are incised about a meter deep. The western extent of the proposed access road, under the riparian forest, crosses a wetland drainage (Figure 10).

The initial 100-m (328-ft) eastern extent of the proposed access road (closer to the Compact Road) slopes down at approximately 30 degrees to the west, with the slope gradually lessening to 12 degrees and then 6 degrees upon reaching the savanna (Figure 11).

On the west side of SD 1, outside of the proposed disposal boundary, upland forest covers a steep, approximately 10-m (33-ft) slope, which extends down to a stream with significant flow. Mangrove forest lines the opposing side of the stream.

A traditional pottery scatter initially documented during cultural resources work associated with the Compact Road (Wickler et al. 2005:369) and subsequently by the HPO (Olsudong et al. 2006:39) is located within the SD 1 parcel. The locations of geotagged pictures are indicated in Figure 6.

Table 2. Sections of Soil Disposal 1

Section	Terrain	Natural Resources	Cultural Resources
Access road	west sloping terrain (12- to 30-degree slopes)	forest; west end will dissect 3 small streams; east end transects wetland drainage	ephemeral landscape modification close to Compact Road
Soil disposal area	fairly level terrain	savanna grasslands	traditional pottery scatter (Site NA-3:15)

Vegetation

Savanna Grasslands

Savanna grasslands with associated scattered trees occur on volcanic soil substrates where the primary forest has been removed (Figures 12 and 13). The presence of highly eroded soils and likely chronic fires in the past have prevented reforestation on this savanna. Ground visibility in the savanna is about 20% with an approximately 40-m (131-ft) long section of dense, high *Dicranopteris linearis* (itouch) splitting the forest in the west half of the proposed access road, which reduces ground visibility to zero. There is a slight possibility cultural resources could lie beneath this thick itouch.

Small tree and shrub species occur on the savanna grassland. These plants are not threatened or endangered species. They include *Pandanus tectorius* (ongor), which occurs throughout the savanna, *Commersonia bartramia* (bebechelut), *Melochia compacta* (chermallucheang), *Morinda citrifolia* (ngel), and small trees of *Symplocos racemosa* Roxb. var. *palauenses* (chebtui) and *Alphitonia carolinensis*. The endemic *Timonius mollis* was found along the site's southeast drainage. The endemic shrub, *Hedyotis tomentosus* (leblebul), is found along the savanna boundary with the northeast forest. Grasses, sedges, and ferns are the dominant vegetation in the central and western portions of the savanna (Figure 14). Dominant grasses include *Eriachne pallescens* (in more eroded soil areas) and several species of *Ischaemum* and the fern *Nephrolepsis biserrata* in areas with less eroded soils. The ferns *Dicranopteris linearis* (itouch), *Lycopodiella cernua* (olecheiulabeab), *Lindsaea ensifolia*, *Blechnum orientales* (klorouikl), and *Selaginella pseudo volkensii* were found by the southeast drainage.

Forests and Wetlands

An approximately 50-m (164-ft) wide riparian forest runs north-south along the eastern survey area, bordering the east side of the soil disposal area (Figure 15). While the soil disposal footprint does not impact the riparian forest, the east-west aligned access road will transect it. The riparian

forest terrain drains to the north and northwest. The associated wetland was dominated by large *Campnosperma brevipetiolata* (kelelacharm) (Figure 16). The largest trees observed were the endemic *C. inophyllum* with an estimated diameter of 1 m (3.3 ft) just above the stream running along the northeast and eastern portion of the riparian forest and a *C. hirsutum* with an estimated diameter of 0.6 m (2 ft) along the northern forest.

The forests outside the SD1 boundary consists of an upper canopy of the endemic trees *Horsfieldia palauensis* (chersachel), *Syzygium mesekerrak* (mesekerrak), *Fagraea ksid* (ksid), and *Garcinia matsudai* (tilol). Native trees include the large *Cannarium hirsutum* (mesecheues), *Calophyllum inophyllum* (btaches), *Maranthes corymbosa* (bkau), *Elaeocarpus joga* (dekemerir), *Pterocarpus indicus* (las), *Ormosia calavensis* (chedebsungelked), *Planchonella obovata* (chelangel), *Semecarpus venenosa* (tonget), *Rhus taitensis* (eues), *Cerbera manghas* (chemeridech), *Alphitonia carolinensis* (chelebiob), and stands of the palms *Heterospathe elata* (demailei), *Pinanga insignis* (chebouch), and *Draceana multiflora* (orredakl).

The lower canopy trees include the endemic trees *Osmoxylon truncatum* (kesiamel), *Pandanus aimiriikensis* (chertochet), and *Timonius mollis*. Native trees in the lower canopy or understory include *Premna serratifolia (*chosm), *Eugenia reinwardtiana* (kesiil), *Phaleria nisidai* (ongael), *Cynometra racemosa* (ketenguit), *Ixora casei* (kerdeu), *Mussaenda philippica* (cherecheroi), and *Callicarpa elegans* (keruiau). The secondary forest includes *Macaranga carolinensis* (bedel) (Figure 17). The largest grass, *Bambusa vulgaris* (bamboo) and the herb *Alpinia publifora* (sui) and the saplings of these trees are present. Herbs include *Tacca palmata* and *Tacca leontopetaloides*. Orchids include the native *Nervilia platychila* and the endemic *Crepidium setipes*.

The mangroves outside of the soil disposal footprint to the west consist of *Bruguiera gymnorrhiza* (kodenges), *Rhizophora* spp. (tebechel), and *Sonneratia alba* (urur) (Figure 18).

Bird Diversity

Over 17 species of birds were either heard or seen at or near the proposed site, mainly in the offsite forest habitats around the site periphery. Species observed included the following species: a group of over 30 endemic Palau Swiftlets (*Aerodramus pelewensis*, chesisekiaid); the endemic subspecies of conservation concern, the Nicobar Pigeon (*Caloenas nicobarica pelewensis*, laib); the endemic Palau Fruit Dove (*Ptilinopus pelewensis*, biib); and the threatened endemic subspecies, the Micronesian Imperial Pigeon (*Ducula oceanica monachal*, belochel). Other endemic forest birds heard or seen on site include the Bush Warbler (*Cettia annae*, wuul); the Dusky White-eye (*Zosterops finshchii*, chetitalial); the Palau Flycatcher (*Myiagra erythrops*, charmelachull) with a juvenile; the Micronesian Myzomela (*Myzomela rubrata kobaysahii*, chesisebangiau); the Micronesian Starling (*Aplonis opaca orii*, kiuid), the Collared Kingfisher *(Todiramphus chloris teraokai*, tengadidik), and the Palau Fantail (*Rhipidura lepida*, melimdelebteb).

Two endemic Palau Owls (*Pyrroglaux podargina*, chesiuch), were heard on the morning of 29 October 2020, which is unusual, as the owl is usually active and vocal at night. The native Black Noddy (*Anous minutus*, bedaoch), the winter migrant Whiskered Tern (*Chlidonias hybrida)*, the native White-tailed Tropicbird (*Phaethon lepturus*), and the native White Tern (*Gygis alba candida*, sechosech) were observed flying over the site crossing the forest and savanna. An unidentified hawk or osprey was observed circling the site. Several bats, *Pteropus pelewensis* (olik), were observed flying over the site.

Archaeological Site

The SD 1 site contains one previously documented archaeological site, Site NA-3:15 (Olsudong et al. 2006:39; Wickler et al. 2005:369). Site NA-3:15 is a light traditional pottery scatter extending over 20 m^2 (215 ft^2) of the savanna. The scatter is centered at 7°39'12.553" north, 134°38'13.006" east, some 40 m (131 ft) west of the location documented on the Palau Bureau of Cultural and Historical Preservation (BCHP) site map (Figure 7).[1] The approximately 10 mm (0.4 in) thick sherds were fired in a reduced atmosphere and display flanged and thickened rims suggesting they date to later in Palau's cultural sequence (Figure 19). Trowel probes suggest the scatter is not associated with a cultural deposit and may result from use of the area for collecting and gathering activities or may be a product of erosion from Ngerbailiang hill to the south.

The terrain at the northeastern extent of the proposed access road, where it joins with the Compact Road, may be artificially leveled (7°39'14.051" N, 134°38'26.128" E). Landscape modification is minimal. A potential flattened ridge and step-terrace is located adjacent to a stream just outside the parcel and to the north of the proposed access road, indicating the presence of landscape modification in the vicinity. The morphology and extent of modifications does not resemble traditional earthworks, and the presence of coconut trees in the forest suggest terrain modifications may be associated with German Era coconut plantations. Regardless, the modification to the terrain is so ephemeral and limited in scope that it cannot be recorded as an archaeological site.

[1] Original site documentation, in the 1997 Compact Road investigations, occurred before accurate GPS locational devices were useable on Palau. The BCHP used the site location map provided by the Compact Road investigations in their national site map. The use of a GPS device during the current work identified the precise site location.

Reference Images: Proposed Soil Disposal 1

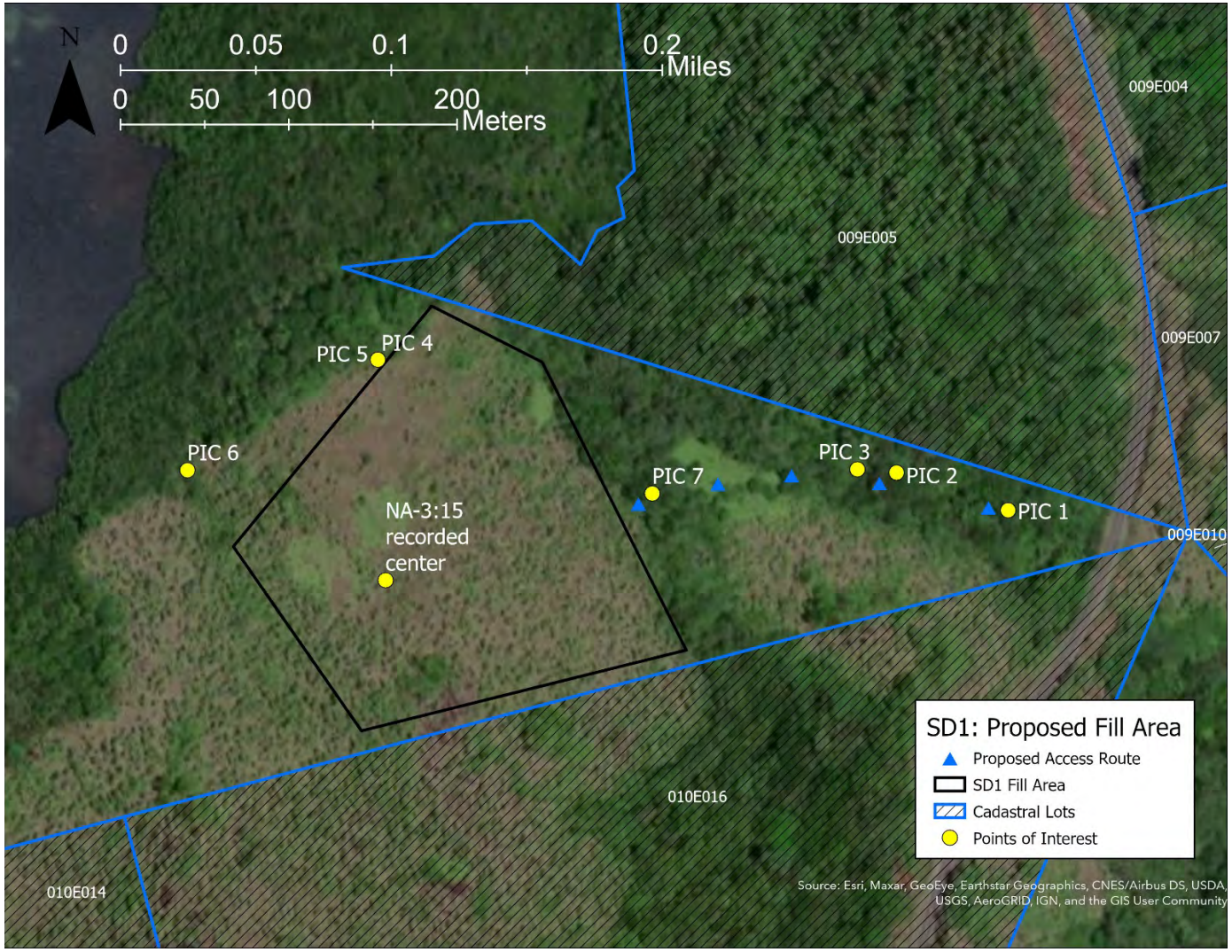

Figure 6. Reference image showing locations of following geotagged photographs labelled as PIC and center point of Site NA-3:15 recorded during the reconnaissance survey.

Figure 7. Stream in area of access road. Image taken at PIC 1 to west-northwest. See Figure 6 for location.

Figure 8. Stream in area of access road. Image taken at PIC 2. See Figure 6 for location.

Figure 9. Stream in area of access road. Image taken at PIC 3. See Figure 6 for location.

Figure 10. Wetland drainage in riparian forest bordering east side of SD 1. Image taken at PIC 7 with view to 110°. See Figure 6 for location.

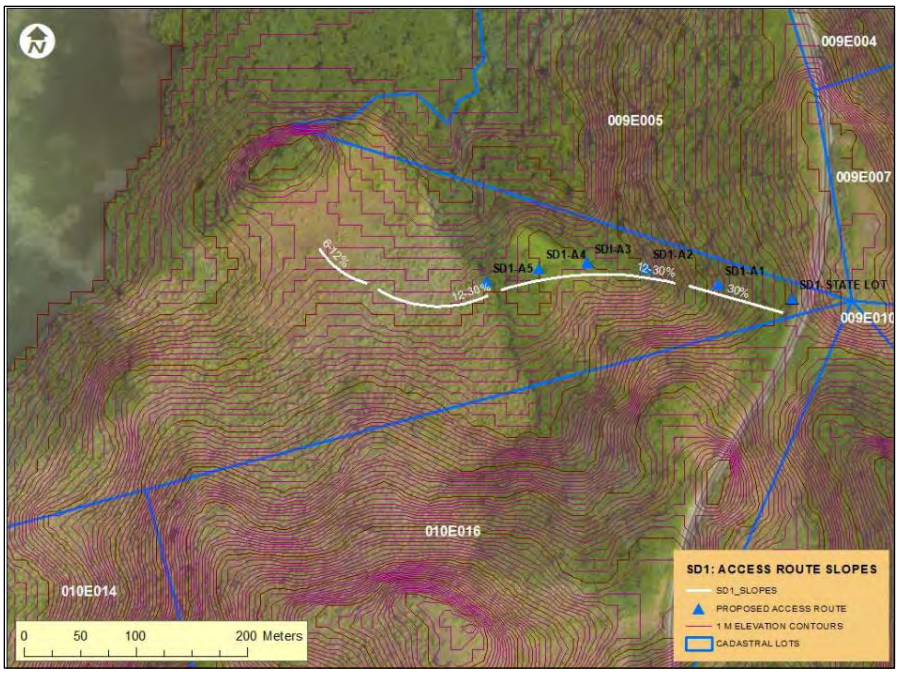

Figure 11. Slope of access route to proposed SD 1. One-meter contours are extrapolated from the 1980 USGS topographic map and are not precise.

Figure 12. Overlooking proposed SD 1 site. Image taken at PIC 4 with view to southeast. See Figure 7 for location.

Figure 13. Overlooking proposed SD 1 site. Image taken at PIC 5 with view to south. Ngerbailiang ridgeline in background. See Figure 7 for location.

Figure 14. Central section of savanna showing ferns *Dicranopteris linearis*, *Pandanus tectorius*, *Melastoma* and sedges. Left view to north, center view to northwest, and right view to west.

Figure 15. Left: Riparian forest wetlands in east flowing northeast from smaller flow at southeast. Center: Growing to northeast into large flow and pool. Right: Extending into a larger stream right that flows into the mangroves along the steep slope on the northern boundary. All outside of the soil disposal footprint.

Figure 16. Left: *Symplocus* (left) *Cannarium* (right) in the northwest forest outside of the project area footprint. Right: *Campnosperma brevipetiolata* in the eastern riparian forest that is crossed by the access road.

Figure 17. Left: Northwest corner of forest with *Symplocos* and *Macaranga*. Right: Drop to incised stream in mangroves on west edge of savanna.

Figure 18. Left: Northwest forest with *Planchonella, Campnosperma, and Sonneratia.* Center: Northern forest showing *Cannarium, Planchonella,* and *Macaranga.* Right: Steep slope to mangroves on west edge of savanna.

Figure 19. Traditional pottery sherds from the Site NA-3:15 pottery scatter in the savanna under SD 1.

4.2 Proposed Soil Disposal 2

The south half of SD 2 is on the now abandoned Compact Road crusher plant and staging area parcel (Figure 4, Lot 105E002; Figure 5), with the north half remaining in native savanna grasslands (Table 3). The SD 2 parcel is separated from the Compact Road to the west by a low, elongated knoll. The proposed access road is on the current gravel road extending onto the crusher plant parcel (Figure 20). There are no wetlands on site.

Table 3. Sections of Soil Disposal 2.

Section	Terrain	Natural Resources	Cultural Resources
Access road	previously disturbed roadbed	previously disturbed roadbed	none
Soil disposal area	south half – abandoned, levelled pad for Compact Road infrastructure north half – gentle slope to south progressively steeper to north	south half – secondary growth on Compact Road infrastructure north half – savanna grasslands	Imengel (NA-2:22); traditional meeting place; first occupied c. 800–400 BCE

The approximately one-hectare (2.5-acre) south half of SD 2 is on land that was graded level for the crusher plant. Recently someone has begun construction on a house in the middle of this area, although it looks as though construction is currently halted (Figure 21). The Ngaraard Governor states that those who began the construction are not the rightful owners, so the home frame may not stand for long.

The savanna-covered terrain in the north half of SD 2 bears a 30- to 12-degree southeast facing downward slope. The archaeological site of Imengel (Site NA-2:22) was previously documented as on the slightly elevated terrain between SD 2 and the Compact Road and under the abandoned crusher plant. Current reconnaissance survey indicates the site extends beyond the documented boundary to the north and east across the proposed soil disposal parcel (Figures 22 and 23).

Vegetation

Young trees and saplings are re-establishing in the crusher plant parcel. The disturbed area along the southern access road contains introduced and invasive weeds including C*hromolaena odorata* (ngesngesil) and *Leucaena leucocephala* (telengtungd) (Figures 24 and 25).

A linear patch of forest lines the north side of the current gravel access road, in SD 2. The forest consists of an upper canopy of the endemic trees *Horsfieldia palauensis* (chersachel) and *Garcinia matsudai* (tilol). Native trees include *Calophyllum inophyllum* (btaches), *Maranthes corymbosa* (bkau), *Elaeocarpus joga (dekemerir)*, *Ormosia calavensis* (chedebsungelked), *Planchonella obovata* (chelangel), *Rhus taitensis* (eues), *Cerbera manghas* (chemeridech), *Alphitonia carolinensis* (chelebiob), the palm *Pinanga insignis* (chebouch), and *Draceana multiflora* (orredakl). The lower canopy trees include the endemic trees *Osmoxylon truncatum* (kesiamel), *Pandanus aimiriikensis* (chertochet), and *Timonius mollis*. Native trees in the lower canopy or understory include *Premna serratifolia (*chosm), *Ixora casei* (kerdeu), *Mussaenda philippica* (cherecheroi), and *Callicarpa elegans* (keruiau). The secondary forest includes *Macaranga carolinensis* (bedel) along the forest edge where it meets the savanna, which defines the north half of SD 2. Herbs include *Tacca leontopetaloides*.

Savanna grasslands dominate the north half of the SD 2 site (Figure 25). Grasses, sedges, and ferns are the dominant vegetation. Dominant grasses include *Eriachne pallescens* in more eroded soil areas with several species of *Ischaemum* and the fern *Nephrolepsis biserrata* in areas with less eroded soils. The presence of highly eroded soils and likely chronic fires in the past have prevented reforestation on this savanna grassland.

The small tree and shrub species found in the savanna include *Pandanus tectorius* (ongor), which occurs throughout the savanna, *Commersonia bartramia* (bebechelut), *Melochia compacta* (chermallucheang), *Morinda citrifolia* (ngel), and small trees of *Symplocos racemosa* Roxb. var. *palauenses* (chebtui) and *Alphitonia carolinensis*. The endemic shrub *Hedyotis tomentosus* (leblebul) is common on the site. The tree *Cerbera manghas* (chemeridech) was found in large numbers.

Although no wetlands or running streams were observed in SD 2, there is evidence of drainage along the central portion of the savanna portion of the site heading southeast (Figure 25). The ferns *Dicranopteris linearis* (itouch), *Lycopodiella cernua* (olecheiulabeab), *Lindsaea ensifolia*, *Blechnum orientales* (klorouikl), and *Selaginella pseudo volkensii* were found by the southeast drainage area (Figure 26).

Bird Diversity

More than eight species of birds were either heard or seen at or near the proposed SD 2. The birds were mainly found in the surrounding off-site forest and included the endemic and species-of-conservation-concern Nicobar Pigeon (*Caloenas nicobarica pelewensis*, laib). Also seen were three endemic Palau Fruit Doves (*Ptilinopus pelewensis*, biib); the threatened endemic Micronesian Imperial Pigeon (*Ducula oceanica monachal*, belochel); several endemic Dusky White-eye (*Zosterops finshchii*, chetitalial); several endemic Palau Flycatcher (*Myiagra erythrops*, charmelachull); and several endemic Micronesian Starling (*Aplonis opaca orii*, kiuid). The native Black Noddy (*Anous minutus*, bedaoch) and native White Tern (*Gygis alba candida*, sechosech) were observed flying over the site.

Archaeological Site

The SD 2 site is immediately to the east of the documented archaeological site of Imengel (NA-2:22). The current recorded extent of the Imengel site is based on material evidence identified during the cultural resource investigations for the Compact Road and associated nearby crusher plant. Imengel consists of a series of earth platforms, leveled areas, and associated stonework (Liston et al. 2007:149–172; Liston and Rieth 2011:258–268; Wickler et al. 2005:362). Intact cultural deposits in the site have been radiocarbon dated to as early as c. 800–400 BCE. Imengel is interpreted as a resting place due to its location on a natural low, elongated knoll surrounded by earthwork complexes, by oral history, and by subsurface evidence.

Reconnaissance survey for SD 2 shows that the Imengel site extends to the east and north to include the extent of the SD 2 parcel. Although ground visibility in the savanna is only about 30%, exposed soil areas contain traditional pottery sherds and at least two stone alignments are present (Figures 27 and 28). Some of the pottery observed is very thin (approximately 4 mm [0.16 in]) with no surface modifications, indicating it likely dates prior to 1 CE.

Reference Images: Proposed Soil Disposal 2

Figure 20. Current access road on south side of SD 2. Photograph taken at 459,572-841,832 UTM, heading 135°.

Figure 21. Framed structure being built on old crusher plant area in the south-central half of SD 2. Image taken on current access road facing north-northeast. See Figure 23 for location of structure.

Figure 22. View of SD 2 from slightly elevated terrain between the Compact Road and the soil disposal parcel. View to south-southeast.

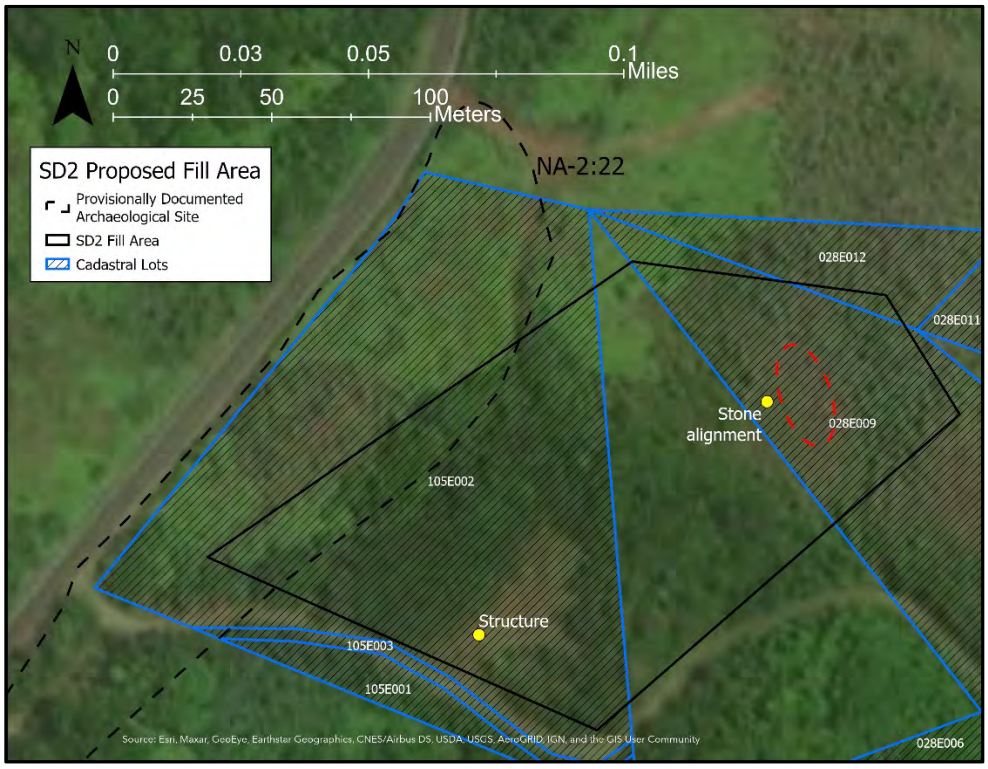

Figure 23. Location of SD 2 relative to previously documented extent of archaeological site NA-2:22 and newly documented stone alignment. Red oval indicates area of dry freshwater drainage channel, pictured in Figure 25.

Figure 24. Invasive and introduced weeds on old crusher plant parcel, southern boundary of SD 2.

Figure 25. Left: View of north-central portion of SD 2 with *Pandanus tectorius* the dominant tree in the savanna. Center: *Cerbera manghas (*chemeridech) saplings expanding into the area disturbed by the old crusher plant. Right: Evidence of freshwater drainage through savanna in central area of SD 2 but no flowing water (area indicated by red oval in Figure 23).

Figure 26. Left: View of northwest area of SD 2 dominated by the fern *Dicranopteris linearis* (itouch) with forest in background. Center: View eastward over SD 2 from low hill immediately to the east of the Compact Road. Right: Highly eroded old access road outside of northwest corner of SD 2; view to west.

Figure 27. Stone alignment, an undocumented feature of Site NA-2:22, in the savanna of SD 2 (location pictured in Figure 23). View to west.

Figure 28. Dense pottery scatter, an undocumented component of Site NA-2:22, in the savanna of SD 2. The sherd scatters occur throughout the exposed soil in the savanna.

5 RECOMMENDATIONS AND MITIGATION

Of the two soil disposal sites surveyed, SD 1 is recommended over SD 2 for use in supporting Tx Site construction. The recommendations and mitigation measures should the two areas be used as soil disposal and staging areas are provided in the following section.

5.1 Soil Disposal 1

Between the two sites, the SD 1 parcel is preferred for use as a soil disposal and staging area for the Tx Site because of a combination of: 1) SD 1 being almost exclusively savanna rather than forest habitat; 2) the presence of a single, small surface archaeological site that can be mitigated without detrimental loss to Palau's cultural landscape; 3) the close proximity to the Tx Site; 4) ownership by Ngaraard State who have intimated they are amenable to a land lease agreement; and 5) fairly level terrain. The primary issue for use of SD 1 is the access route that would require removal of a small amount of forest habitat and passage across a small drainage area and three small streams.

The following natural and cultural resource mitigation measures are recommended to accompany SD 1. Mitigation measures take into consideration primary construction impacts and secondary impacts around the disposal due to potential long-term erosion. These mitigation measures address the majority of the required Palau Environmental Quality Protection Board Earthmoving Permit which includes a permit from the Bureau of Cultural and Historical Preservation.

- Development: Consideration of regulations mandated by Palau's Environmental Quality Protection Board for streams and swamp forests, which include a 60-ft (18.3-m) buffer around these wetlands (EQPB, Chapter 2401).
- Development: An erosion control plan that takes into consideration the run-off effects and altered drainages in the riparian forest bordering the east side of SD 1 and the mangrove habitats off the west side of the SD 1 site. Establishment of substantial barriers between the forest edge and the soil disposal. These barriers are critical so that the forests can continue to serve as buffers for wetland and streams.
- Design: Design of the access road needs to consider the steep (c. 30%) westerly slope coming off the first 100 m (328 ft) west of the Compact Road.
- Design: Placement of culverts on the SD 1 access road to pass water flow of three small streams under the roadway.
- Pre-Construction: Removal of important plants in the construction zone for re-planting by the naturalist team.
- Pre-Construction: Archaeological collection of a sample of surface artifacts and placement of a minimum of five shovel tests to determine if intact cultural deposits are present at Site NA-3:15. Should intact cultural deposits be encountered, a 1 × 2 m controlled test unit should be excavated. The purpose of the archaeological work is to determine the presence and nature of subsurface deposits and the function and age of the site.
- Construction: Archaeological spot monitoring during grading and construction to identify and document any surface artifact scatters not identified under the thick vegetation cover and determine if cultural deposits are present.
- Construction: Presence of an environmental scientist accompanying the surveyors setting the access road alignment to suggest slight adjustments to the alignment to ensure

significant old trees are avoided.

5.2 Soil Disposal 2

The SD 2 parcel has a number of factors that suggest it could be suitable for use as a soil disposal site. These factors include 1) the south half of the SD 2 parcel being already leveled and developed, 2) a relatively close proximity to the Tx Site; 3) a fairly level terrain across the entire parcel; 4) an existing, previously constructed, gravel road providing access to the site; and 5) largely savanna and previously disturbed secondary growth habitat across the site. However, there is a significant archaeological site at SD 2 which would require extensive mitigation, as site development would destroy a portion of the archeological site. There is also the likelihood that additional archeological artifacts and features may be discovered if SD 2 undergoes development. In addition, compared to SD 1 there are potential land ownership issues. Because of these latter factors, SD 2 is not recommended for use as a soil disposal and staging area for the Tx Site.

The SD 2 parcel is on an archaeological site (Site NA-2:22) that has produced one of the oldest cultural dates on Babeldaob, and its preservation is recommended. If the Palau Bureau of Cultural and Historical Preservation allowed earthmoving on the property, a substantial amount of archaeological mitigation, as described below, would be required. The SD 2 parcel is within three cadastral lots under separate land ownership. A structure is currently being constructed in the south half of the parcel suggesting there would be concerns with acquiring land use. There appears to already be a land ownership dispute concerning placement of the structure. There could be significant issues with resolving land ownership of the three lots through the court system before negotiations for lease agreements could commence.

Should SD 2 be selected for supporting the Tx Site project, the following natural and cultural resource mitigation measures are recommended. Mitigation measures take into consideration primary construction impacts and secondary impacts around the disposal due to potential long-term erosion. These mitigation measures address the majority of the points raised in the required Palau Environmental Quality Protection Board Earthmoving Permit which includes a permit from the Bureau of Cultural and Historical Preservation.

- Development: An erosion control plan that takes into consideration the run-off effects and altered drainages.
- Pre-Construction: Removal of important plants in the construction zone for re-planting by the naturalist team.
- Pre-Construction: Archaeological mitigation estimated at two to three weeks of fieldwork in the north half and west edge of the parcel to hand clear the thick vegetation, identify and document the features and artifacts encountered, and to hand-dig trenches for data recovery. Although the number of data recovery trenches cannot be ascertained without first identifying the features present, it would likely be at least four trenches. Fieldwork would be followed by laboratory analysis (e.g., wood identification, radiocarbon dating, and pottery analysis), research and writing, and report production. The purpose of the data recovery is to obtain information about the significant site before it is destroyed.
- Construction: Archaeological spot monitoring during grading and construction to identify and document any cultural features or deposits not identified during data recovery.

6 SUMMARY

The 4-hectare (9.9-acre) SD 1 parcel is preferred for use during Tx Site construction with measures implemented to mitigate the loss of forest and an archaeological site and to minimize impacts on water quality and soil erosion. The 2-hectare (5-acre) SD 2 parcel is not recommended for use as a Tx Site disposal area due to the extensive archaeological mitigation that would be needed at the significant archaeological site (Site NA-2:22) in the parcel, and land leasing concerns stemming from three separate land owners of the site.

The primary impacts on the natural and cultural assets by the proposed SD 1 could include: 1) creation of an approximately 300 m (0.2 mi) long clear-cut corridor through forest that transects three small streams, with erosion and runoff concerns and the likely loss of some endemic and native forest and wetland plant species and 2) destruction of a traditional artifact scatter. Construction and use of the soil disposal has the potential to introduce invasive species during heavy equipment traffic and localized, temporary disturbance of bird and wildlife populations.

The SD 1 parcel is on fairly level savanna with upland forest outside all but the southern perimeter and along the access route. The 300 m (0.2 mi) long access route from the Compact Road to the disposal area is almost entirely in the forest. These forests comprise a rich diversity of endemic and native trees and provide many ecosystem services including a source of food, timber, wildlife habitat, medicine, a filtering system for water, and a buffer from storms. The trees present include many species contributing to Palau's rich biodiversity. Under the IUCN criteria, all native species on Babeldaob may be considered at risk due to land use changes over time, with endemic and native wetland species also at risk due to the relatively limited wetland forests in Palau.

Three small north-south trending streams transect the east half of the east-west aligned access road while a wetland drainage dissects the west end of the access road. With proper design and implementation of erosion and runoff controls such as culverts, water flow along the access road will not be impacted and water quality impacts will be minimized. These same measures should ensure that erosion and runoff associated with the soil disposal area does not impact the forest habitats to the north and west. Archaeological fieldwork is needed to mitigate destruction of the traditional pottery scatter in the proposed SD 1 parcel.

The natural and cultural resources specialists recommend the use of the proposed SD 1 site but not use of the proposed SD 2 site. Measures to mitigate the impacts of soil disposal construction and use on the resources are provided in this report.

7 REFERENCES

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NGARAARD STATE

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MEMORANDUM OF UNDERSTANDING
BETWEEN NGARAARD STATE GOVERNOR BENJAMIN ISKAWA
AND THE NGARAARD STATE PUBLIC LAND AUTHORITY

1. General

a. This memorandum of understanding is entered into by Governor Benjamin Iskawa located at PO Box 6026, Ngaraard State, Palau 96940, and Chairman Robert Tutii of the Ngaraard State Public Land Authority located at PO Box 6026, Ngaraard State, Palau 96940.

b. The purpose of this Agreement, hereinafter referred to as the MOU, is to approve the request made by the US Air Force, in their December 7, 2020 letter to Governor Iskawa (Attachment 1) for consideration of the referenced public land parcel, in Elab Hamlet, identified as Soil Disposal Area 1 (SD1) for potential use by the TACMOR Project Construction Contractor, during the Transmit (TX) Site project construction (Attachment 2: SD1 Location Map).

2. Background

a. During the design of the TACMOR Project, the requirement for off-site soil disposal areas, resulting from TX site excavation of a substantial amount of soil, was identified.

b. The TACMOR project team, working with the Ngaraard State Governor, nominated several areas of Ngaraard State public land for consideration as potential soil disposal sites. Criteria for the nomination of sites included 1) proximity to the TX project site, 2) land topography, 3) ease of access, and 4) existing environmental resources. (Attachment 3: Letter Report on Ngaraard State Lands)

c. The site identified as "SD1" was considered most favorable given it met the aforementioned criteria areas. In addition, site "SD1" has other favorable conditions including 1) level elevations and 2) absence of significant environmental and cultural resources.

3. Agreement

a. It is agreed by the parties to give favorable consideration for the use of state public land, identified as SD1, located in Elab Hamlet, for the disposal of excess soil from the TACMOR Project TX Site.

b. It is understood use of the site will be available to the construction contractor as an option and at their discretion. Use of the site would be pending an agreement between the contractor and Ngaraard State Government.

c. It is understood certain improvements to the land area will include construction of an access roadway, for ingress and egress to the disposal site, from the Palau Compact Road highway. All activities will be conducted by the construction contractor and subject to the laws and regulations of the Republic of Palau.

4. Agreement Termination

Termination of this agreement may be effected by either party to the MOU upon 30 day written notice to the other party.

Both parties have read and agree to comply with all terms and provisions of this MOU.

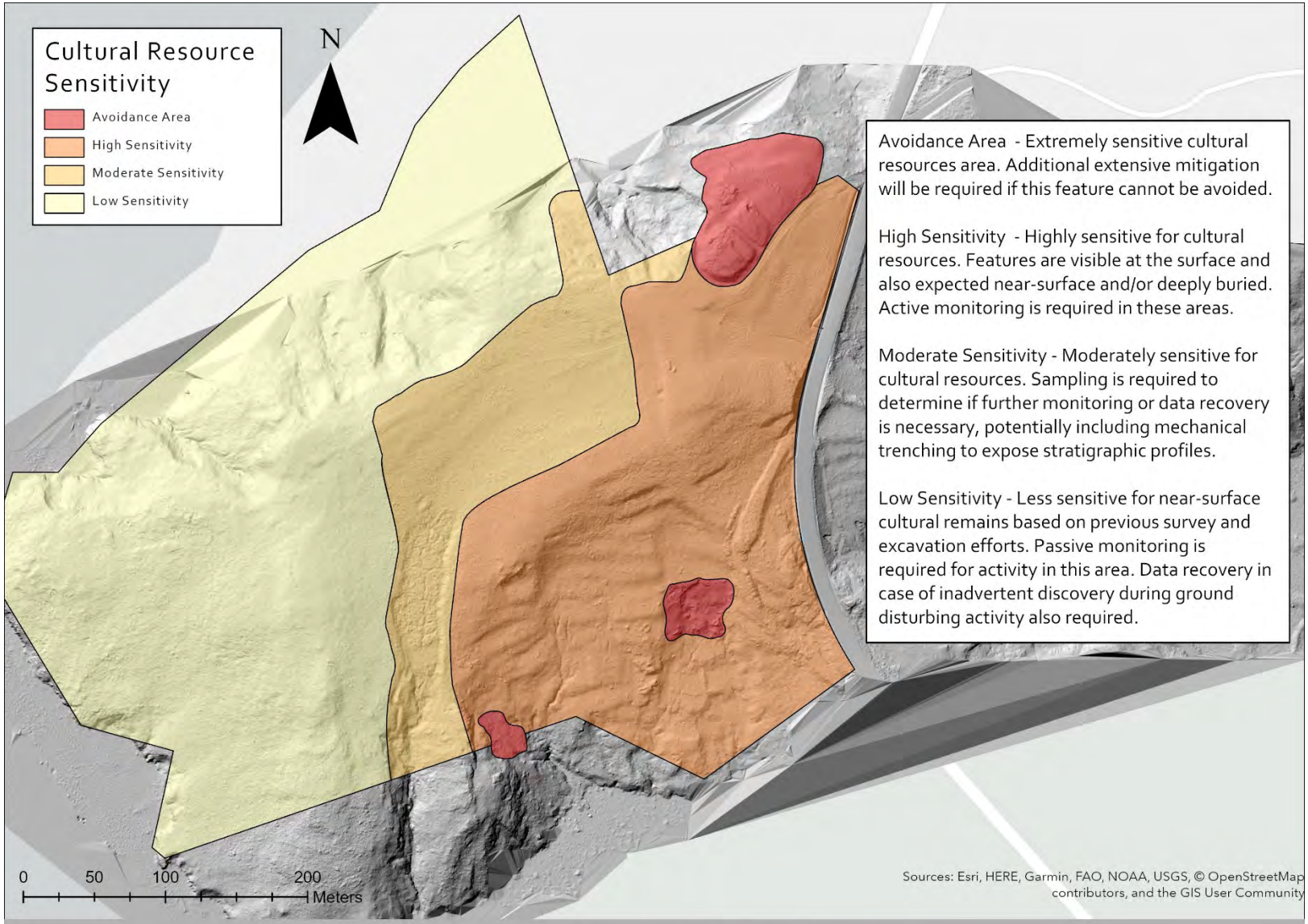
Governor Benjamin Iskawa — Date: 3/25/21

Chairman Robert Tutii, NSPLA — Date: 3/29/21

Attachment 1: US Air Force letter of request to Governor Iskawa

Attachment 2: SD1 Location Map

Attachment 3: Letter Report on Ngaraard State Lands



Cultural Resource Sensitivity Areas

BIOMASS MANAGEMENT

In preparation of project development, both the Tx and Rx sites will undergo extensive vegetation clearance. This clearance will include at both sites the sitewide removal of green and woody vegetation, some of which may be harvestable for human use, as well as some limited vegetation pruning in areas near the Anguar Rx site. Project development at both sites must consider not only how vegetation will be cleared at each site (in order to minimize impacts to soil, water quality, and ecological resources), but also how to harvest, process, and distribute any such materials for use on Anguar, Babeldaob, or other Palauan Islands. The following sections identify biomass management measures for consideration during project designs of the Tx and Rx sites. Table 4 presents some of the planning considerations for these biomass management measures.

Table 1 Biomass Management Activities and Planning Considerations.

Biomass Management Activity	Planning Considerations	Estimated Cost[a]
Harvest of useful timber from each project footprint.	Prior to vegetation clearing, survey and mark all trees for lumber, firewood, or other uses.	$15K
	Bring in portable sawmill and necessary staff for timber processing.	TBD
	Location of timber processing and storage areas.	TBD
	Final disposition of processed lumber and firewood. Identify transportation needs and scheduling off-site/off-island transport.	TBD
Generation of usable compost for local community use from green waste generated at each site.	Location of compost processing and storage areas.	TBD
	Bring in mobile chipper or tub grinder and necessary staff.	TBD
	Processing of green waste, including management of compost windrows in manner that limits propagation of invasive coconut rhinoceros beetle.	TBD
	Final disposition of compost. Identify transportation needs and scheduling off-site/off-island transport.	TBD

[a] BNM identified an estimated cost for both timber harvest and composting at $150K (BNM 2019).

4.1 Harvestable Woody Vegetation

Vegetation clearing at the two sites will result in the removable of all trees within the site footprints. Some of the trees are of sufficient size to be harvested for use as lumber or firewood.

4.1.1 Lumber

The amount of useable lumber that could be generated from cleared trees was estimated as the number of board-feet of lumber that could be produced. A board-foot is a common measure of lumber volume, defined as a piece of wood with a volume of 144 in^3 (e.g., a board that is 12 in. wide x 12 in. long x 1 in. thick). A number of methods (called 'rules') have been developed for estimating board-foot tree volumes (Cassens 2001; OSU 2016). To estimate the amount of lumber that could be produced from the Tx and Rx sites, the International 1/4-inch rule for standard board-foot volumes was used. This rule is widely used by state agencies in the U.S., as well by the U.S. Forest Service, and is generally considered the best estimate of the amount of lumber that can be sawn from a tree or log. This rule estimates the board-foot content of a tree based on the tree diameter 4 ½ feet above ground (the diameter at breast-height, *dbh*) and the tree height. Grosenbaugh (1952) published a formula for this rule, and this formula was used to estimate board-foot volumes from each site.

At the Tx site, 18 species of trees were identified as potentially harvestable for lumber production, while at the Rx site 11 species were similarly identified. For project planning considerations, two approaches were used to provide an estimate of board-feet of lumber that could be produced at each site. In one approach, an estimate of harvestable lumber was generated using the total tree heights of only trees that were identified during the surveys for lumber production. This approach assumes the entire length of the tree trunk is merchantable, which is not likely. A more realistic estimate was calculated for the same trees but assuming that the merchantable height of each tree was limited to 75% of the total tree height. The number of board-feet of lumber that could be generated at each site was similarly estimated (full and 75% height) for all trees, regardless of whether the tree was identified for lumber production or not. It is important to note that the surveys were able to characterize each tree at the two sites,

At the Tx site, the amount of lumber that could be produced from trees only identified for lumber harvest ranged from approximately 14,540 to 20,984 board-feet, and for all on-site trees from 81,250 to 115,223 board-feet (Table 5). The volume of this produced lumber ranges from with an estimated volume ranging from 45 to 65 yd^3 for trees marked for lumber harvest, and from 91-120 yd^3 for all trees.

Table 2 Potential Lumber Produced during Vegetation Clearing at the Tx and Rx Sites.[a]

	75% Height		Full Height	
	Board-Foot	**Cubic Yards**	**Board-Foot**	**Cubic Yards**
Only Trees Identified for Lumber Harvest				
Tx Site	14,540	45	20,984	65
Rx Site	28,577	88	39,270	121
All Trees				
Tx Site	81,250	251	115,223	356
Rx Site	330,582	1,020	460,801	1,422

[a] Estimated following International ¼-inch rule for tree volume estimation.

At the Rx site, the estimated number of board-feet that could be produced from trees marked for timber harvest ranged from 28,577 to 39,270 board-feet, and from 330,582 to 460,801 board-feet for all trees (Table 5). The volumes of lumber produced from trees marked for lumber harvest ranges from 88 to 121 yd^3, and from 1,020 to 1,422 yd^3 for all trees.

There are a number of uncertainties that need to be kept in mind regarding the uncertainties. First, the International ¼-inch rule is based on a dbh measured internal to the bark of a tree, so a true dbh cannot be obtained until a tree is cut down. The dbh values used for the Tx and Rx estimates were measured on the outside of the bark of each tree, so the final estimates will be overestimated to some degree. Second, the trees identified by the BNM for harvest did not include a number of trees that that are, or could be used for lumber production. Thus, the board-foot estimates for each site based on BNM designation likely underestimate the actual lumber volumes that could be generated. Conversely, not all tree species reported from each site are suitable for lumber production, and thus the estimates derived using all trees overestimates the actual level of lumber that could be produced.

4.1.2 Firewood

In contrast to the relatively small number of trees identified at the Tx and Rx sites as harvestable for lumber production, many more were identified for harvest for firewood. A firewood cord estimator was used that derives the number of cords per tree as a function of the dbh of the tree (UNH 2005). To estimate the potential amount of firewood that could be produced at the Tx site, the calculator was applied to all trees with a dbh of 5 inches or more, excluding those identified by BNM staff for lumber production. At the Rx site, BNM staff identified trees for lumber production and for firewood production. For this site, the amount of firewood that could be produced was estimated for the trees with a dbh of 5 inches or more and identified by the BNM staff for firewood production but excluding those also identified for timber production. In addition, firewood production was also estimated for all trees at the site, excluding those identified for lumber production.

At the Tx site, 63 trees from three species were identified as potentially suitable for firewood production. These trees are estimated to produce as much as 50 cords of firewood, with an estimated volume of 238 yd^3. At the Anguar Rx site, 62 trees from three species were identified as suitable for firewood production, although 44 of these trees were also marked for timber harvest. Excluding those identified for timber, the firewood-designated trees are estimated to produce 55 cords of firewood, with an estimated volume of about 260 yd^3. Considering all trees at the site with a dbh of 5 in. or more not identified for timber production, as much as 103 cords of firewood, with an estimated volume of 288 yd^3 could be produced at the Rx site. At the Anguar site, one tree in particular, *Casuarina equisetifolia,* is an especially useful firewood, having been described as the ‘best firewood in the world’ (Tropical Plants Database 2019). This tree was identified for both timber and firewood production by the BNM staff.

4.2 Green and Brown Waste Volume and Management

The clearing of vegetation from the Tx and Rx sites will include not only removal or harvestable timber, but also the clearing of smaller non-harvestable trees, shrubs, and all non-woody vegetation. These activities will generate both 'green' waste (any green plant material such as leaves) and 'brown' waste (twigs, branches, root stumps) at each site, and project development will need to manage each these waste materials (i.e., on-site storage, reuse, and disposal).

4.2.1 Waste Volume

Waste generated during timber harvest will include leaves, branches, and the non-harvestable portions of each trunk. Estimates of the volume of these wastes are difficult to determine. For example, published estimates include 7% of harvestable volume per tree for eastern Amazonia (Gerwing et al., 1996), to 30% of harvestable volume for the U.S. (ORNL 2011). Harvesting a 40 ft tall mango tree may produce as much as 12 yd^3 of waste (Hulbert 2019). These waste estimates are for aboveground residues. Belowground stumps have been estimated to add (in the U.S.) as much as 14% to the residue volume for softwoods, and up to 24% for hardwoods (McKeever 2004).

In addition to the biomass associated with the harvestable trees at each site, other sources of green and brown waste that will have to be addressed include the understory vegetation, belowground materials comprising roots the forest floor litter (e.g., dead leaves twigs, fruits, etc.), and lying and standing dead trees. Estimates of the percent of each of the total aboveground biomass of mature forests vary widely. Table 6 presents estimates of understory vegetation, forest floor litter, belowground, and dead wood biomass, as a percentage of the aboveground biomass of mature forest habitat, at each site.

Table 3 Biomass Estimates of other Forest Components Expressed as a Percent of the Aboveground Biomass in Trees, and Corresponding Biomass Estimates for the Tx and Rx Sites.

Non-harvestable Forest Component	Percent of the Aboveground Forest Biomass[a]	Tx Site[b] (yd^3)	Rx Site[c] (yd^3)
Understory Vegetation	≤ 3%	16 – 18[d]	47 – 51[d]
Belowground (stumps and roots)	4 – 230%	53 – 59[e]	156 – 171[e]
Forest Floor Litter	≤ 5%	23 – 30[f]	78 – 85[f]
Dead Wood	5 – 40%	132 – 148[g]	390 – 427[g]
Estimated total biomass of forest components:		224 - 255	671 - 734

[a] Source: Brown 1997.
[b] Based on aboveground biomass of 529-594 yd^3 of lumber and firewood production estimated for the Tx site.
[c] Based on above ground biomass of 1,561 – 1,710 yd^3 of lumber and firewood production estimated for the Rx site.
[d] Estimate based on assumed 3% understory biomass.
[e] Estimate based on assumed 10% root biomass as the shallow soils would preclude large root masses.
[f] Estimate based on assumed 5% forest litter biomass.
[g] Estimate based on assumed 25% dead wood biomass.

To estimate the total amount of waste materials that may be generated at each site, biomass estimates of non-harvestable components of forests were applied to the volumes

harvestable timber (lumber and firewood) from all trees at each site (see Table 5). For estimation purposes, the harvestable timber volume is assumed to equal the total aboveground biomass at each site.

Table 4 Estimates of Waste that could be Generated at the Tx and Rx Sites.

Forest Component	Percent of Aboveground Biomass	Tx Site (yd^3)	Rx Site (yd^3)
Harvestable Timber[a]	-	594	1,710
Green and Brown Waste Source			
Harvest Waste (leaves, branches, twigs)	7-30%[b]	25 - 107	99 - 427
Understory Vegetation	3%[c]	16 - 18	47 - 51
Belowground (Stumps and Roots)	10%[c]	53 - 59	156 - 171
Forest Floor Litter	5%[c]	23 - 30	78 - 85
Dead Wood	25%[c]	132 - 148	390 - 427
Total Green and Brown Waste Biomass		263 - 362	770 – 1,161

[a] From Table 5 and Section 4.1.2.
[b] Gerwing et al., 1996; ORNL 2011.
[c] From Table 6.

4.2.2 Management

Given the volumes of waste materials that may generated, development of a green and brown waste disposal plan will be necessary to effectively manage these wastes. The plan should address green and brown waste use, pre- and post-processing requirements, composting requirements, and invasive species concerns.

Green and Brown Waste Use. The brown and green waste generated at both sites may be used for a variety of purposes (Table 8), a both sits as well as elsewhere on Babeldaob and Anguar Islands.

Table 5 Use Options for Green and Brown Waste from the Tx and Rx Sites.

Potential Use	Green Waste	Brown Waste
Project Uses		
Erosion Control	X	X
Sedimentation Control	X	X
Work Surface Stabilization		X
Offsite Uses		
Wood Chips for Mulch		X
Fuel		X
Landfill Cap		X
Sewage Sludge Composting	X	X
Compost for Soil Amendments	X	

Chipped brown waste can be used to produce mulch and fuel, as well as providing a carbon source for sludge composting. Green waste can be composted and used to amend soil health and improve productivity (e.g., added to gardens and agricultural fields). It may also be mixed with sewage waste and composted together to produce soil additives while reducing sewage disposal a treatment plants. Green and brown waste may also be used to provide a cover on landfills. Both green and brown wastes can also be used during development of the Tx ad Rx site. These materials can be used to cover exposed for exposed soils, thus reducing soil erosion. These wastes may also be used along drainage ways to reduce sedimentation risks to drainageways, mangrove swamps, and coastlines. Brown wastes (e.g., wood chips) may also be used on laydown and equipment parking areas, stabilizing exposed soils and providing initial capture of small accidental spills and leaks of fuels and other project related fluids (e.g. lubricants, paint).

Waste Processing. The processing of green and brown wastes generated during timber harvest and vegetation clearing at each site will likely be of two types: chipping of brown waste and composting of green waste, each with different implementation requirements. As shown in Table 7, as much as 360 yd^3 or more green and brown waste may be generated at the Tx site during timber harvest and site clearing, and as much as 1,160 yd^3 at the Rx site. The generation of these waste volumes will occur over some period of time, and will require some amount of short-term stockpiling, depending on how quickly these materials can be processed (e.g., chipped, shredded composted). Post-processed wastes will similarly need to be stockpiled.

Location of Green and Brown Waste Stockpiles Awaiting Processing. If processing occurs concurrently with or shortly following timber harvest and site clearing, the pre-processed waste materials can most likely be stockpiled within cleared areas of each project footprint. However, construction schedules will need to be taken into account so onsite stockpiles will not interfere with project development. If such conflicts are considered likely, then offsite stockpiling will need to be considered, as will the transport of the wastes from the project site to the offsite stockpile location. Siting of stockpiles (both onsite and offsite) should also take into account precipitation and runoff, and implement measures to avoid impacting any nearby freshwater and marine environments.

Chipping Requirements. The chipping of brown wastes (e.g., twigs, branches, and stumps) will require the use of a grinder or a chipper (Figure 1). As with the stockpiling of green and brown wastes, chipping may occur within the project footprint concurrent with timber harvest and vegetation clearing, or at the offsite stockpile locations. Chipping considerations should include considerations of fuel requirement, storage and accidental spills, air emissions, and noise. Management of wood chips will need to consider handling and short-term storage as the chips are generated. Long-term storage may result in decomposition, reducing the usefulness of the chips. If offsite storage is needed, siting of the offsite stockpiles should take into account precipitation and runoff, and implement measures to avoid impacting any nearby freshwater and marine environments.

Figure 1 Examples of portable grinding and chipping equipment for processing green wastes.

Composting Requirements. Green waste composting involves placing the waste in piles or linear windrows in which microorganisms decompose the waste materials and convert it to compost. Given the amount of green waste that may be generated at the Tx and Rx sites (125 and 478 yd^3, respectively), onsite composting may not be an option, and offsite composting may be necessary. Assuming a windrow with a 5 ft height and 10 ft width (Richard 1992), a single windrow for composting the wastes for each site (Table 7) would be 138 ft in length for the Tx site and 511 ft in length for the Rx site.

Windrows composting also requires turning of the windrow to ensure internal temperatures remain optimal for decomposition (e.g., must not exceed 140°F [60°C]). Turning, typically involves flipping the original windrow and to a new windrow such that composting materials at the top of the initial windrow are placed in the bottom of the new windrow. Thus, the composting site will need to provide space for two identical side-by-side windrows for each individual windrow, as well area between the two windrows for the turning equipment (e.g., a front-end loader) to operate. Using the windrow widths and lengths identified above, together with an equipment operational width of 20 ft between the windrows, composting (whether on- or offsite may require about 0.13 acres for the Tx site and 0.5 acres for the Rx site.

Invasive Species Concerns. A number of invasive plant species were identified during the natural resource surveys of each project site. The production of lumber and firewood should not result in the accidental transport of any of the invasive species to other location. However, the use of mulch (from brown waste chipping) and compost produced at the two sites has the potential for spreading some of these species to other locations. While the use of mulch is unlikely to result in the introduction of any of the invasive plants to other areas, should the mulching have included branches with seedpods, it is possible that some seeds may have survived processing and thus be transported along with the mulch. Green waste collected or composting may also include seeds from some of the invasive species. While heat generated during composting kill seeds, seed mortality can vary greatly depending on species, compost temperature, and duration of thermal exposure (Dahlquist et al., 2007). Seed survival may be increased with incorrect or incomplete composting management. While examination of processed mulch or compost for seeds of invasive plants is not possible, identification during timber harvest and vegetation clearing of invasive plant species may greatly reduce the potential of their inadvertent introduction elsewhere on Palau.

Of critical concern on Palau is the coconut rhinoceros beetle (*Oryctes rhinoceros*), which has decimated the coconut palms on Palau, and can damage numerous other plants, including betelnut, pineapple, and sugarcane. Adult beetles lay their eggs in decaying organic matter including compost piles. To minimize the transport of this beetle in compost originating from either of the project sites, the compost piles and windrows should be maintained properly. Because it may take as much as 137 to 282 days between eggs being deposited in a compost pile to when the adults first emerge, a properly maintained compost should not serve as a source of this beetle (American Samoa Community College 2005). In addition, when turning compost piles, any rhinoceros beetles found should destroyed.

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STORMWATER PROTECTION REPORT

FINAL DESIGN SUBMITTAL

2 July 2021

Submitted By

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In Association with

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I. INTRODUCTION

A. Purpose:

This report is conducted to:

- Calculate the change in stormwater runoff from pre-construction to post-construction.
- Design drainage facilities to retain the increase in stormwater runoff and, to the extent possible, release the retained storm water in a manner that restores flow distribution to pre-construction conditions.
- Preserve water quality by implementing best management practices and stormwater management features to filter and treat water quality volume flow.

B. Project Location

The Transmit project site is located on the largest and northernmost island of Babeldaob, Republic of Palau.

The Receive project site is located on the island of Angaur, Republic of Palau.

Complying with UFC 3-210-01 Low Impact Development is not a project requirement because the project sites are located outside of the United States.

C. Proposed Action

The purpose of this project is to grade and prepare the site for the construction of the necessary infrastructure and utilities to install the Tactical Multi-Mission Over-the-Horizon Radar (TACMOR) system as described in the infrastructure control document (ICD) for the TACMOR system, Revision 6 (Draft).

The Transmit Site will include clearing and grubbing, earthmoving activities, and the installation of Mechanically Stabilized Earth (MSE) walls, foundations for the main TACMOR system features, fencing, and an access road from the existing Compact Road. The Defense Site area is 204,524 m^2 and the area that will be disturbed is 104,301 m^2.

The Receive Site will include clearing and grubbing, earthmoving activities, and the installation of foundations for the main TACMOR system features, fencing, and access roads from the existing coastal road. The Defense Site area is 396,238 m^2 and the area that is disturbed is the same, 404,671 m^2.

D. Existing Topography

The Transmit project site is located on a hillside with an open grass plateau surrounded by steep and heavily forested cliffs. The site is bordered by steep forested cliffs to the north, the Compact Road to the east, steep forested cliffs and a mangrove to the south, and steep cliffs and Pacific Ocean to the west. Near the center of the site, the topography of the plateau creates a valley

leading to the south. In the middle of the valley is a marsh area with an intermittent brook flowing down the southern cliffs to the mangrove. Elevations in the project vicinity range from 56m at the top of the hill in the north to less than 1m at the coast in the south.

The Receive project site is located on an area on the eastern edge of the island. The site is bordered on the east by a rocky coastline leading to the Pacific Ocean and an existing airstrip runway to the west. The area is heavily forested and mostly level, aside from existing borrow and mining pits. Elevations in the project vicinity range from about 7m at the airstrip to about 1m at the coastline.

E. Soils and Vegetation

The soils at the Transmit Site are generally fine-grained and cohesive silt with a slow infiltration rate. The soils are potentially expansive, which may impact the volume when it gets wet. Additionally, according to the NRCS (Natural Resources Conservation Service) Web Soil Survey, the soils on the plateau area have a Hydrologic Soil Group (HSG) rating of C and the forested cliffs have a HSG rating of D, which maintains the findings of the geotechnical report.

The current vegetation at the Babeldaob site consists of grass savannah on the plateau and tropical rainforest on the surrounding cliffs.

On the other hand, the soils at the Receive Site on Angaur are very different from the Transmit Site on Babeldaob. The soils at Angaur are medium dense, silty sandy limestone gravel, which are overlaying native coralline limestone. The NRCS's Web Soil Survey shows that majority of the site has a HSG rating of A.

The current vegetation at the Angaur site consists of thick forest with dense underbrush.

See Figure 1.**1** for map showing the overall soil type of the country, as well as the project locations for both the Transmit Site and the Receive Site.

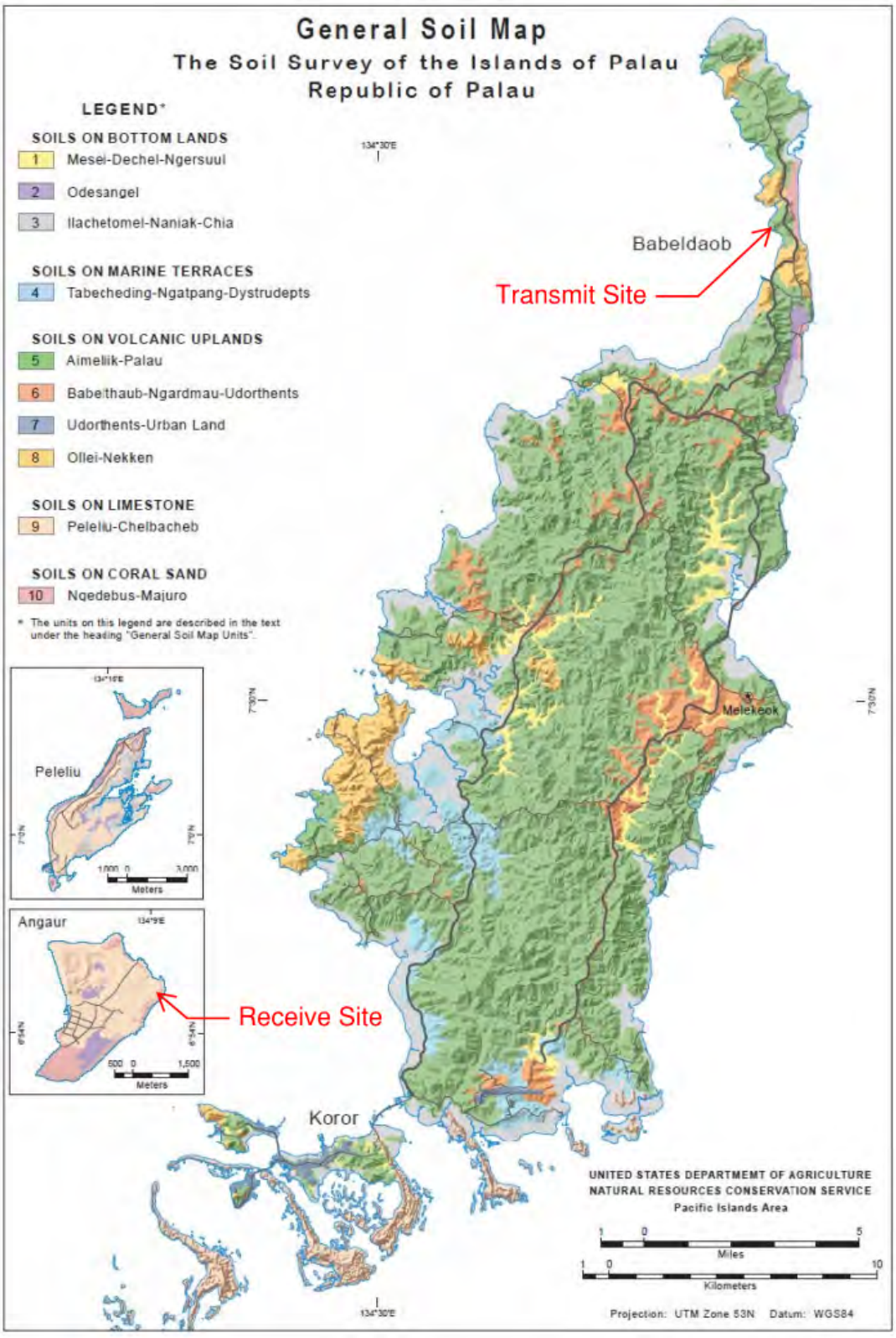

Figure 1.1: General Soil Map of Palau (NRCS 2008)

II. HYDROLOGY ANALYSIS

A. Design Criteria

The drainage facilities were designed in accordance with the Palau Stormwater Management Manual, which takes into account four different criterions: recharge volume (Re_V), water quality volume (WQ_V), channel protection volume (CP_V), and overbank flood control volume ($Q_{p\text{-}25}$). The Palau Stormwater Management Manual provides equations for recharge rate and water quality, and uses Technical Release No. 55 "Urban Unit Hydrology for Small Watersheds" (TR-55) for determining the required volumes for channel protection and overbank flood control. However, the equations in TR-55 use imperial units; since this project uses metric units, the final calculations will convert from imperial to metric.

B. Recharge Criteria (Re_v)

For the recharge volume, the Palau Stormwater Management Manual has two different equations, depending on the geology of the site. As shown in Figure 2.3, the country is separated into two different categories: the limestone-dominated regions (Peleliu, Angaur, the Rock Islands, and outer atolls) and the volcanic-dominated regions (Babeldaob and Koror).

The equation for the recharge volume in limestone-dominated regions is as follows:

$$Re_V = (P)(A)(I)/12 \quad (1)$$

Where: Re_V = Recharge volume (acre-ft)

P = Precipitation (1.2 inches)

A = Site area (acres)

I = Site imperviousness (as a decimal)

12 = Conversion from inches to feet.

The Receive Site on Angaur falls into the limestone-dominated region category. For this equation, P is constant as 1.2 inches. The calculations for the Receive Site can be found in Appendix A-6.

On the other hand, natural recharge is more restricted in the volcanic-dominated regions because only a small amount of rainfall infiltrates into the soil. The Palau Stormwater Management Manual has a different, yet similar, equation for these regions. The equation for volcanic-dominated regions is as follows:

$$Re_V = (F)(A)(I)/12 \quad (2)$$

Where: Re_V = Recharge volume (acre-ft)

F = Recharge factor (inches)

A = Site area (acres)

I = Site imperviousness (as a decimal)

12 = Conversion from inches to feet.

The recharge factor F is based on the Hydrologic Soil Group (A, B, C, or D), and the values of F are also provided by the Palau Stormwater Management Manual:

Hydrologic Soil Group	Recharge Factor (F)
A	0.46
B	0.27
C	0.13
D	0.06

The Transmit Site on Babeldaob falls into the volcanic-dominated region category. At the project site, the majority of the proposed building area is on areas that have a hydrologic soil group rating of C; therefore, the recharge factor of 0.13 inches was used in the calculations, which can be found in Appendix A-3.

C. Water Quality Criteria (WQ_v)

The water quality volume criterion improves the water quality by capturing and treating annual storm events. The Palau Stormwater Management Manual provides the equation for water quality volume:

$$WQ_V = (P)(A)(I)/12 \quad (3)$$

Where: WQ_V = Water quality volume (acre-ft)

P = Precipitation (inches)

A = Site area (acres)

I = Site imperviousness (as a decimal)

12 = Conversion from inches to feet.

The value of precipitation used in this equation, P, is determined by the quality of water resource that the stormwater is draining into. The Palau Stormwater Management Manual categorizes water quality into two types: “moderate quality” and “high quality.” If the water resource is of “moderate quality,” then the value of P is 0.7 inches; otherwise, the water resource is of “high quality” and the value of P is 1.2 inches. The project site can only be specified as an area of “moderate quality” if the area is either indicated on the maps in Figure 2.4 and Figure 2.5, or listed in the tables shown in Figure 2.6. Otherwise, the water quality of the area is considered as “high quality.” Even if the project site is located in one of the areas specified by the maps or tables, the Palau Environmental Quality Protection Board should

always be consulted before designating a site as “moderate quality” because if the project site drains into a “high quality” water resource, it should be designated as “high quality” instead.

The water resource for both the Transmit Site and the Receive Site are “high quality” and therefore the value of P for both sites is 1.2 inches. The calculations for the water quality volumes can be found in Appendix A-3 and A-6, for Transmit and Receive Sites respectively.

D. Channel Protection Criteria (CP_V)

The Palau Stormwater Management Manual uses the method from the Maryland Stormwater Design Manual to design for channel protection volume, which estimates the outflow/inflow ratio based on the unit peak flow for a 1-year, 24-hour storm event. This outflow/inflow ratio is then used in the graph provided by TR-55 to determine the corresponding storage/runoff volume ratio. Finally, the channel protection volume is calculated by multiplying the runoff volume by the storage/runoff volume ratio.

E. Overbank Flood Control Volume ($Q_{p\text{-}25}$)

The Palau Stormwater Management Manual uses the 25-year, 24-hour storm event to design for overbank flood control. The average precipitation of a 25-year, 24-hour storm is 12.4 inches/24 hours. The Overbank Flood Control Volume is calculated by using the ratio of the existing peak flow over the proposed peak flow to determine the corresponding storage/runoff volume ratio, then multiplying that ratio by the 25-year storm runoff volume.

F. Retention Basin Volume Design

According to the Palau Stormwater Management Manual, retention areas should be designed using a two-year, 24-hour storm event and hold at least 75% of the Water Quality Volume. The average precipitation of a two-year, 24-hour storm is 7.2 inches/24 hours. The peak flow and runoff volume can be calculated with guidance from TR-55. The design volume of the retention basin is calculated by multiplying the storage/runoff volume ratio by the 2-year storm runoff volume.

G. TR-55 Method

TR-55 Method for calculating the hydrology has four main steps: determining the amount of rainfall, calculating the Curve Number, measuring the time of concentration, and computing the peak flow. TR-55 also provides steps to design storage volume based on ratios of peak flows.

All of the calculations using TR-55, which include calculating the CN, time of concentration, and volume, for both the EG and FG of the Transmit Site can be found in Appendices A-1 and A-2, respectively. Similarly, the Receive Site EG and FG can be found in Appendices A-5 and A-6, respectively.

1. Rainfall

According to the Palau Stormwater Management Manual, rainfall is typically uniform across the entire country and it is type IA rainfall distribution. In order to design for channel protection, overbank flood control, and for guidelines listed for retention basins, TR-55 will be repeated three times for 1-year, 2-year, and 25-year storm events. The average rainfall for Palau is listed in Table 2-1.

Table 2-1: Average Rainfall in Palau (in inches)

Recurrence Interval (yr)	Frequency (%)	Average Rainfall, P (in)
1	100	5.8
2	50	7.2
10	10	10.5
25	4	12.4
50	2	13.8
100	1	15.2

Therefore, according to Table 2-1, the value of P is 5.8, 7.2, and 12.4 inches, for the 1-year, 2-year, and 25-year storm, respectively.

2. Curve Number

In using TR-55, one of the most important factors in determining both peak flow and runoff volume is the Curve Number (CN). The Curve Number is essentially a measure of how much water can infiltrate the ground: the number ranges from 0 to 100, with 0 being the most pervious and 100 being completely impervious. The major factors affecting the CN are the hydrologic soil group (HSG) rating, ground cover type, hydrologic condition, and antecedent runoff condition (ARC).

After the Curve Number is determined, the height of the runoff can be calculated with the Soil Conservation Service's (SCS) runoff equation:

$$Q = \frac{(P-I_a)^2}{(P-I_a)+S} \quad (4)$$

Where: Q = Runoff (inches)

P = Average precipitation (inches)

S = Potential maximum retention after runoff begins (inches)

I_a = Initial abstraction (inches).

TR-55 makes the assumption that initial abstraction, $I_a = 0.2S$, and that the potential maximum retention is calculated by a simple equation, $S = \frac{1000}{CN} - 10$. Therefore, if the P (rainfall) and CN are known, then the height of the runoff, or the left over water that could not infiltrate the ground, can be calculated. Furthermore, by multiplying the height of the runoff by the area of the watershed, the total runoff volume can be calculated:

$$V_r = 53.33Q(A_m) \quad (5)$$

In which: V_r = Runoff Volume (acre-ft)

Q = Runoff (inches)

A_m = Drainage Area (mi^2)

53.33 = Conversion Factor from in-mi^2 to acre-ft.

As such, just by determining the amount of rainfall and the Curve Number, one can calculate the height and volume of runoff, which in turn will be used to calculate the peak flow and storage volume. Therefore, it is imperative to choose an appropriate Curve Number for any given watershed.

3. Time of Concentration

Another important factor in TR-55 is the Time of Concentration (T_C). The Time of Concentration is defined as the "time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed," which, in other words, the longest time it would take a drop of water to travel across a watershed. Time of Concentration is calculated by a summation of all of the Time of Travel (T_T), as shown:

$$T_C = \sum T_{T_1} + T_{T_2} + \cdots T_{T_m} \quad (6)$$

Where: T_C = Time of Concentration (hr)

m = Number of Flow segments

The Time of Travel is affected by the length of flow and the velocity, but TR-55 adds more complexity to the time of concentrating by categorizing three different types of flow: sheet flow, shallow concentrated flow, and channel flow. First, TR-55 categorizes sheet flow as "flow over plane surfaces" that "usually occurs in the headwater of streams." However, TR-55 also states that "after a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow," which implies that sheet flow only occurs is specific areas and only for certain lengths at a time. In other words, even if stormwater is flowing over a plane surface, due to characteristics of water and the roughness of the surface, water usually ends up collecting into shallow concentrated flows past 300 feet. For sheet flow, TR-55 provides Manning's kinematic solution:

$$T_T = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5}s^{0.4}} \quad (7)$$

Where: T_T = Time of Travel (hr)

n = Manning's roughness coefficient

L = Length of Flow (ft)

P_2 = 2-year, 24-hour rainfall (in)

s = Slope of hydraulic grade line (ft/ft).

While sheet flow depends more on the type of surface, shallow concentrated flow and open channel flow depend more on the slope and velocity. The Time of Travel is derived from the length divided by the velocity, as shown in equation (8) below:

$$T_T = \frac{L}{3600V} \quad (8)$$

Where: T_T = Time of Travel (hr)

L = Length of Flow (ft)

V = Average Velocity (ft/s)

3600 = Conversion Factor from second to hour.

Velocity for shallow concentrated flow is given by Figure 2.1 given the watercourse slope. On the other hand, velocity for an open channel is given by Manning's channel velocity equation:

$$V = \frac{1.49r^{2/3}s^{1/2}}{n} \quad (9)$$

Where: V = Average Velocity (ft/s)

n = Manning's roughness coefficient for open channels

r = Hydraulic radius (ft) = area/wetted perimeter

s = Slope of hydraulic grade line (ft/ft).

The difference between a shallow concentrated flow and an open channel lies in the definition of an open channel. According to TR-55, open channels are officially designated as such by the United States Geological Survey (USGS); in other words, channels will be shown as blue lines on a map and can be viewed by aerial photographs. Usually, a watershed will have a combination of these three types of flows, and the Time of Concentration is a summation of all the Time of Travel. For calculation purposes, the minimum Time of Concentration is 0.1 hours.

For this project, there are no existing open channels, and because both project sites are largely undeveloped, there are not many instances of natural sheet flow either. However, large flat areas will be graded for the post-construction condition, which generate sheet flow. Since the flat areas will not be impervious surfaces, the Time of Concentration will increase for those watersheds, which in turn will decrease the flow rate.

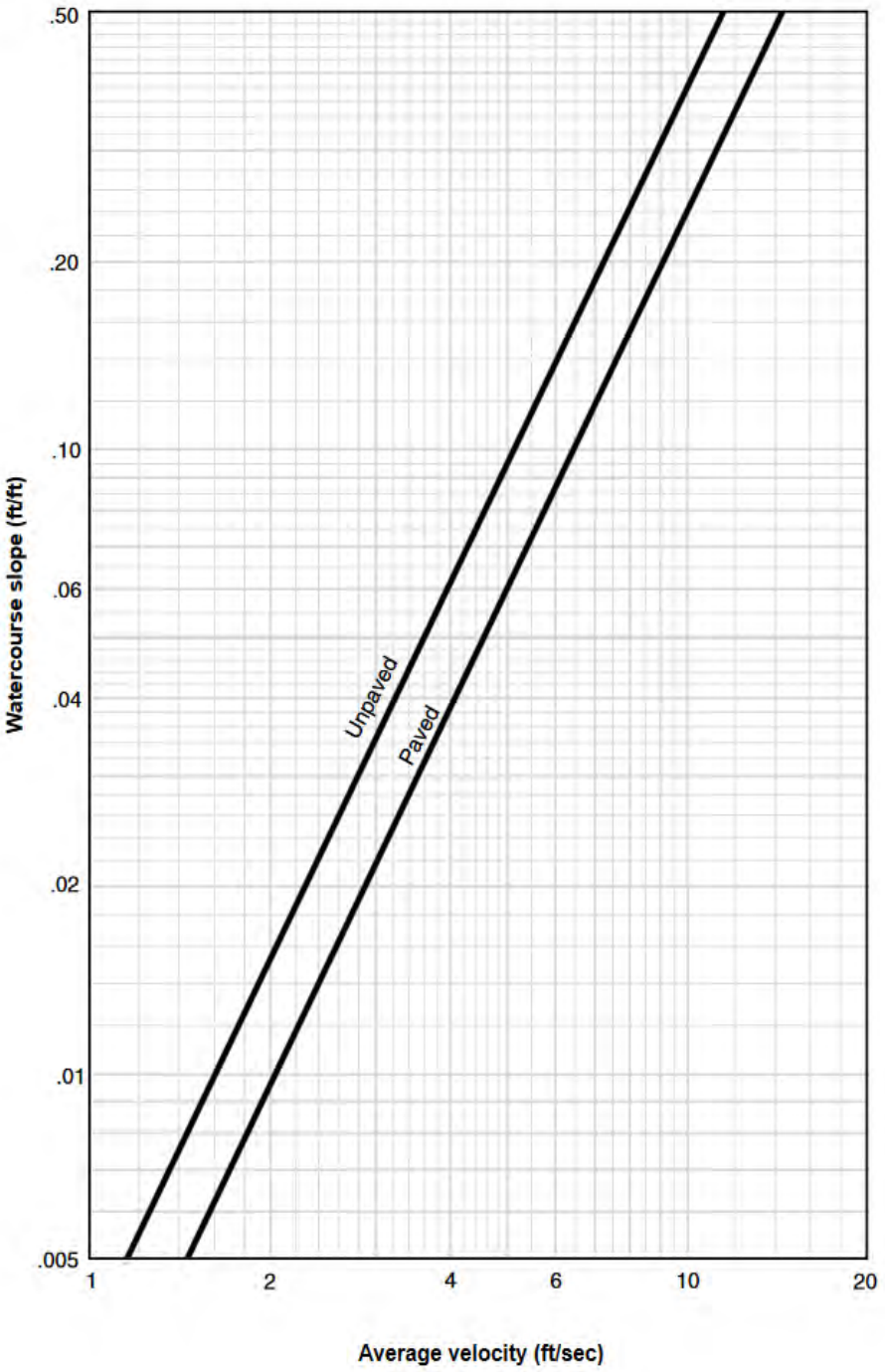

Figure 2.1: Average velocities for estimating travel time for shallow concentrated flow

4. Peak Flow

Calculating the peak flow can be done by either one of two methods: the graphical peak discharge method, or the tabular hydrograph method. The graphical peak discharge method is less complex, but it is limited in scope because it assumes the watershed is hydraulically homogeneous (described by one CN), has no subdivisions, and there is only one main stream and thus only one time of concentration. If the graphical peak discharge can be applied, then the equation is as follows:

$$q_p = q_u A_m Q F_p \quad (10)$$

Where: q_p = Peak discharge (cubic feet per second [cfs])

q_u = Unit peak discharge (cfs per square mile per inch [csm/in])

A_m = Drainage area (square miles)

Q = Runoff (inches)

F_p = Pond and swamp adjustment factor (coefficient)

The unit peak discharge is determined by the type of rainfall distribution, the time of concentration, and the ratio I_a/P. The pond and swamp adjustment factor are based on the percentage of pond and swamp areas, and TR-55 provides a table with those factors. As mentioned before, the graphical peak discharge method is faster than the tabular hydrograph method, but the information it provides is too limited, especially for a more complex watershed.

The concept of the tabular hydrograph is similar to that of the graphical peak discharge: multiply the drainage area, A_m, and the runoff, Q, by a unit hydrograph value to obtain the discharge value. However, instead of just the peak value of the unit hydrograph, multiple coordinates along the unit hydrograph are selected and then scaled by the product of A_m and Q to find multiple coordinates of the final hydrograph. In this way, the final hydrograph can be plotted on a graph and the area under the curve, or the runoff volume, can be calculated. TR-55 provides those coordinates of the unit hydrograph, which depend on the type of rainfall distribution, time of concentration, the I_a/P ratio, and also the total time of travel from the end of the subarea to the outlet. The tabular hydrograph method provides more information, such as the time of peak flow, and it allows greater accuracy when measuring more complex watersheds. However, it is more complex than the graphical peak discharge method and the level of accuracy is not always useful for designers, especially when designing conservatively.

5. Volume

Determining the storage volume is based on a chosen ratio of peak outflow discharge versus peak inflow discharge: $^{q_o}/_{q_i}$. Usually, the peak outflow discharge is equal to the existing conditions and the peak inflow discharge is the proposed conditions, but the designer can choose a different ratio to meet another requirement. TR-55 provides a figure, shown below, that relates the outflow/inflow ratio to storage/runoff volume ratio, $^{V_s}/_{V_r}$.

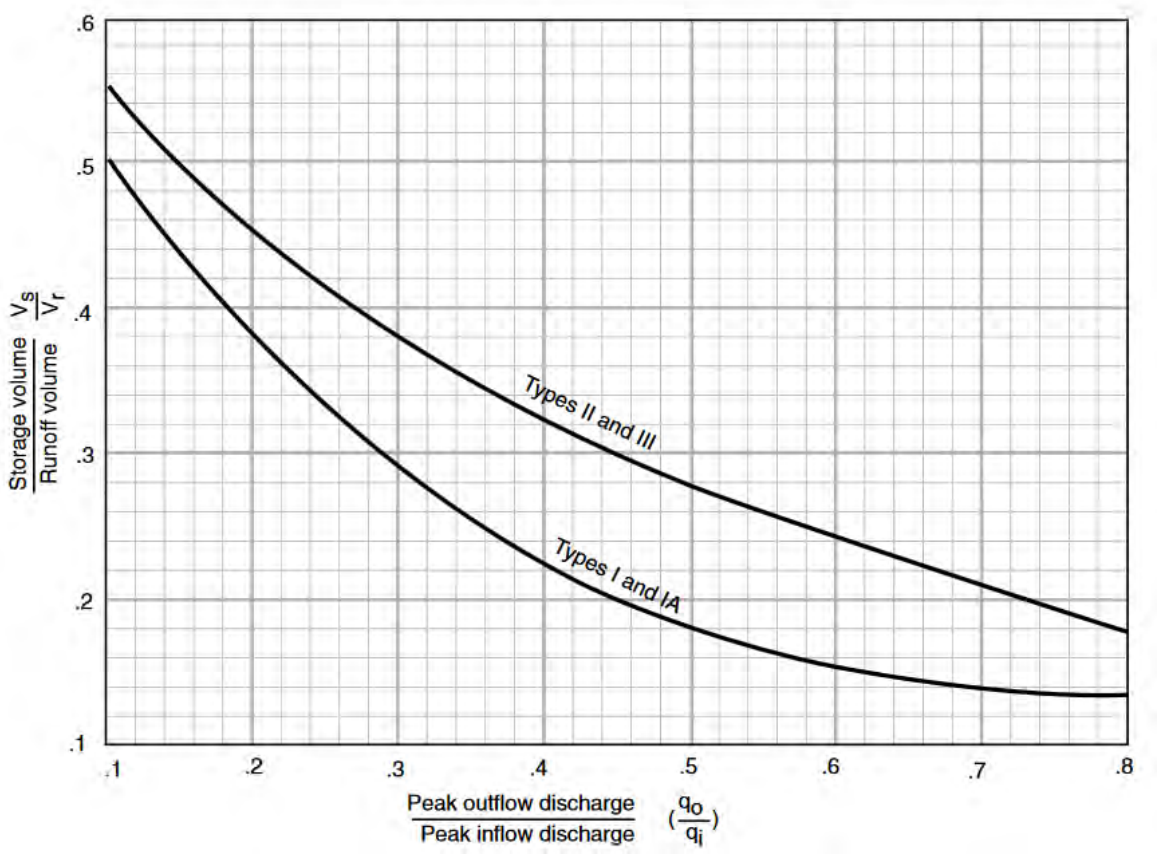

Figure 2.2: Approximate detention basin routing for rainfall types I, IA, II, and III

After the storage/runoff volume ratio is determined by Figure 2.2, the storage volume is simply the ratio multiplied by the runoff volume. The runoff volume is equal to the height of the runoff, Q, multiplied by the area, Am:

$$V_r = 53.33Q(A_m) \quad (11)$$

Where: V_r = Runoff Volume (acre-ft)

Q = Runoff (inches)

A_m = Drainage area (square miles)

53.33 = Conversion factor from in-mi^2 to acre-ft.

By completing these steps, the storage volume for any storm event can be calculated.

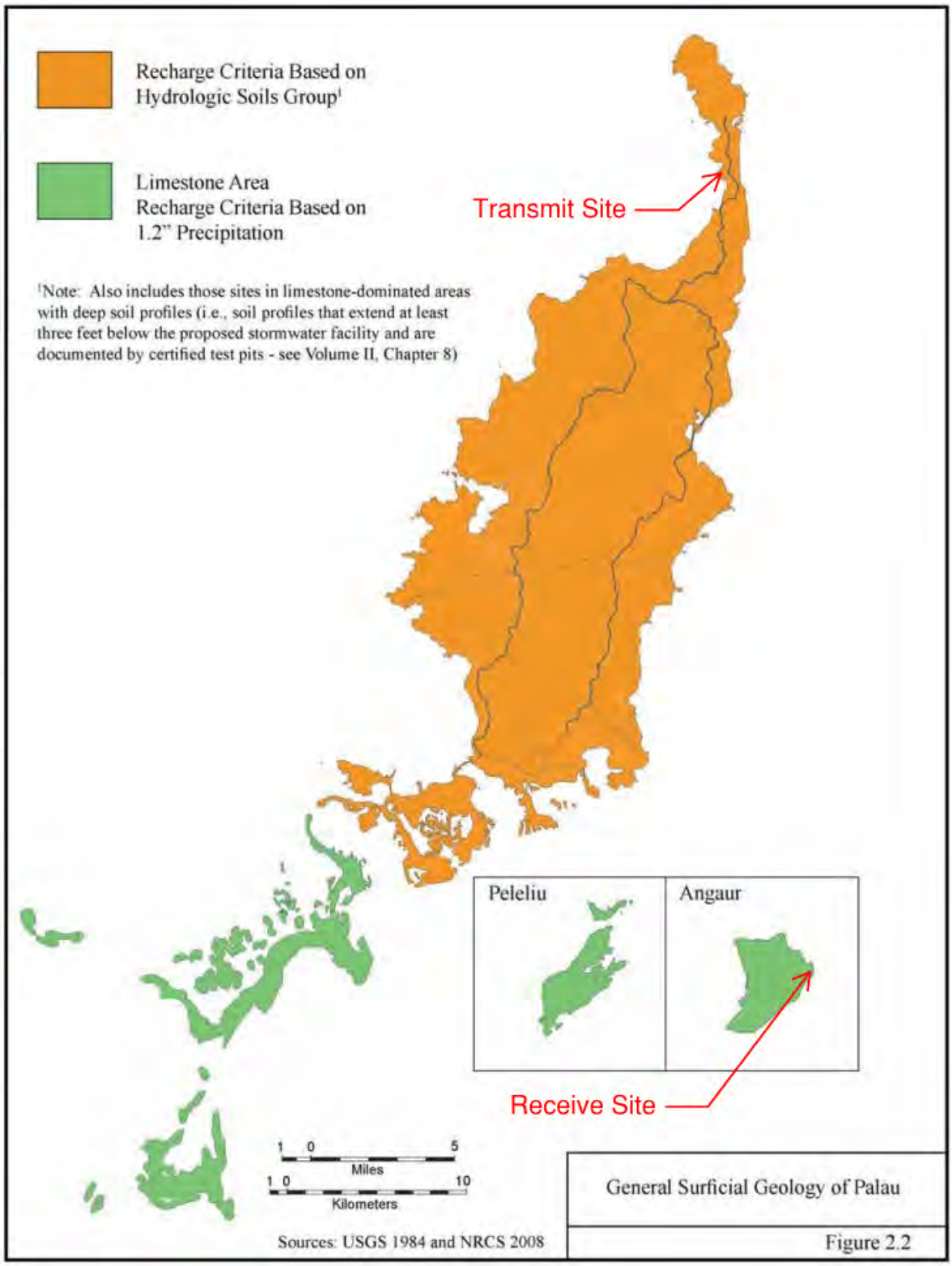

Figure 2.3: General Surficial Geology of Palau

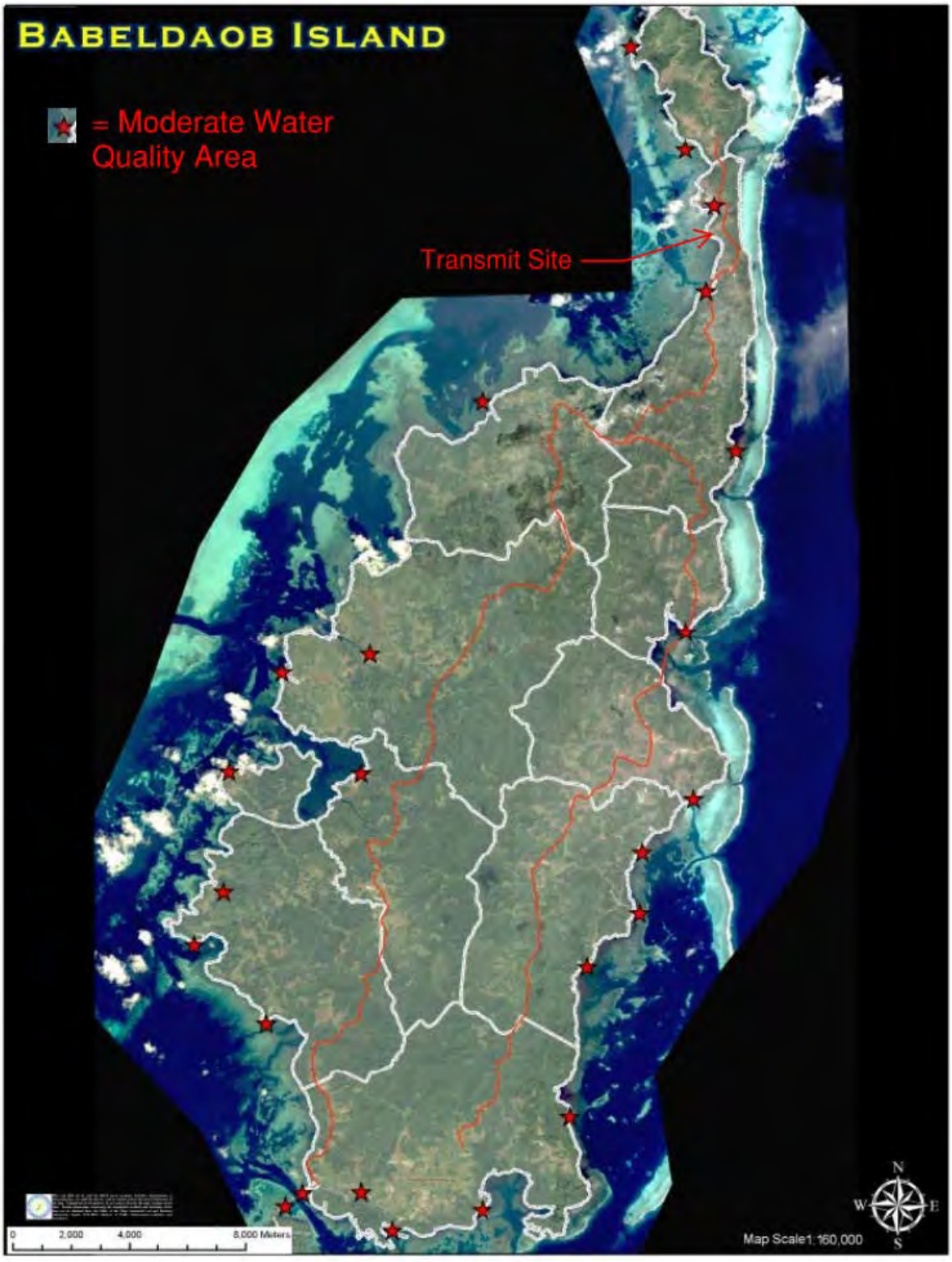

Figure 2.4: Location of Moderate Water Quality Areas on Babeldaob

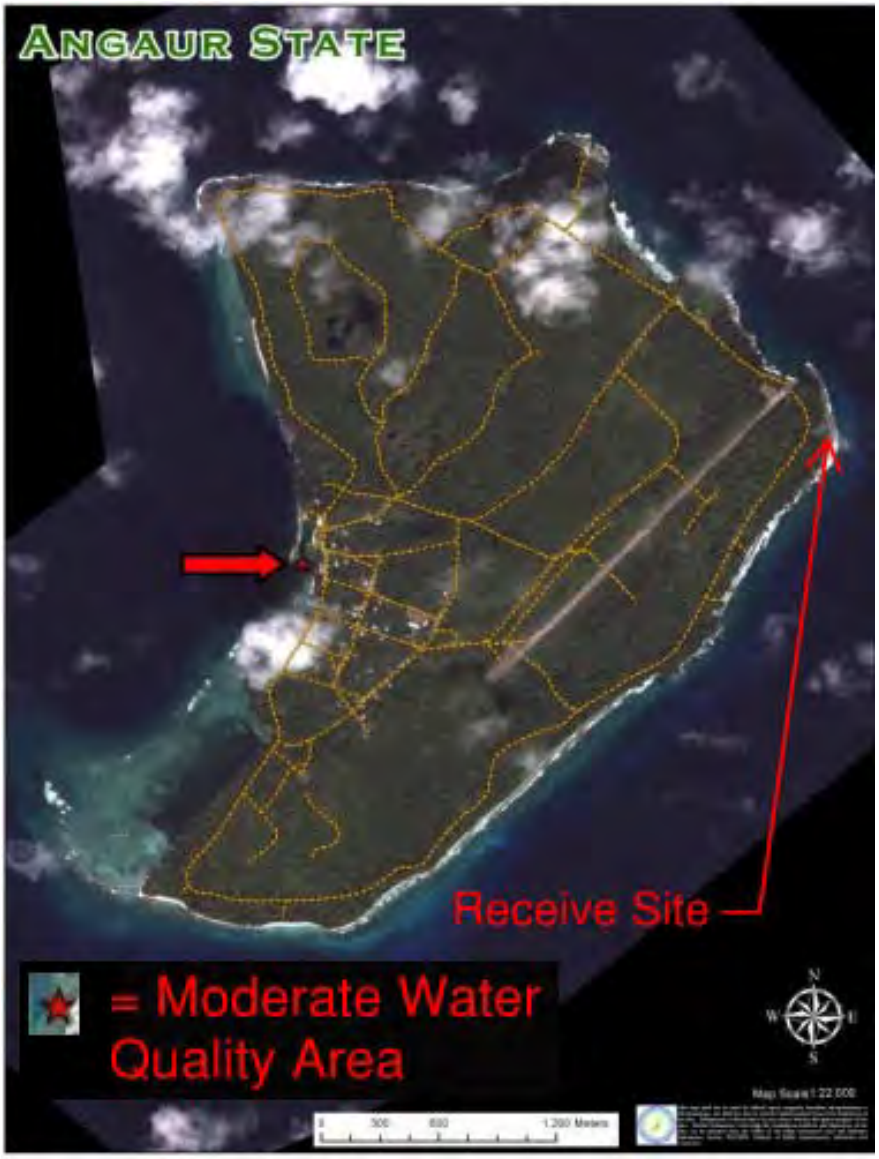

Figure 2.5 Locations of Moderate Water Quality Areas on Angaur

Water Quality Volume (WQ_v) Requirement as a Function of Land Use and Resource Quality

Land Use Classification	Resource Quality Designation[1]	
	High	**Moderate**
All Conventional Land Uses	1.2 in (90% Rule)	0.7 in (80% Rule)
Hotspots	1.2 in (90% Rule)	1.2 in (90% Rule)

1. Resource quality is defined as both freshwater resources and coastal resources. In Palau, coastal waters are designated as AA, A (high quality) and B, BB (moderate quality). All fresh surface waters in Palau have been designated as Class 1 (high quality). Refer to **Section 1.5.1** for more specific information regarding resource classification.

Locations of "Moderate Quality" (Class B) Surface Water Resources; all other marine waters are "High Quality" (Class AA, A) except for designated sandmining areas (Class BB) which are also "Moderate Quality" (See Figures 2.3, 2.4, and 2.5) (EQPB, 1996 - Marine and Fresh Water Quality Standards) (Class B designation applies only within 1000 feet of designated docks – see EQPB for individual project determinations)

Island	Class B Surface Waters
Babeldaob	Village docks
Koror	Malakal (Ngemelachel) Harbor
	M-Dock (Singhatoba) including S.E. of Ngerbeched Shore
	Kemangel Toachel, excluding T-Dock (Ngerkemais)
	Metukerademul to E. side of old Japanese Dock (Derromel)
	Ngereksong
	Nikko (Iwayama) Bay from the Nikko pier to a shoreline boundary approximately 1200 feet N.W. of the Nikko pier and an additional 300 feet of offshore reef flat to the N.W. of the shoreline boundary.
	Waters extending 200 meters from the shoreline of Ngerur Island.
Peleliu	Akalakul (Elochel) Dock
Angaur	Angaur (Ngeaur) Harbor

Figure 2.6 Tables of Moderate Quality Surface Water Resources

III. TRANSMIT SITE DRAINAGE CONDITIONS

A. Existing Conditions

The existing transmit site is heavily forested with steep cliffs. Figure 3.1 below illustrates the different existing watersheds, numbered E1, E2, and E3.

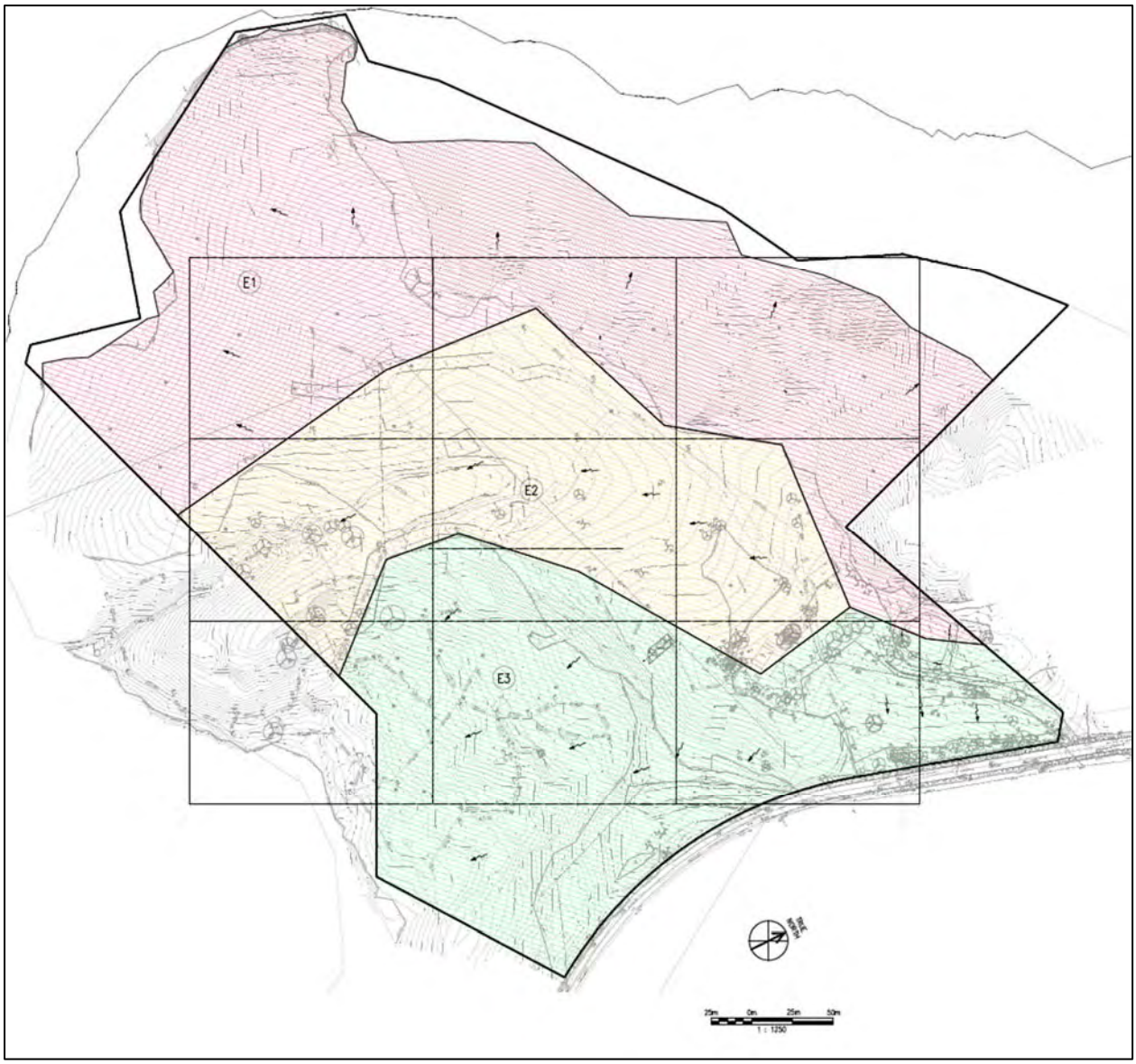

Figure 3.1: Transmit Site Existing Drainage Conditions

The existing site is largely undeveloped with isolated pockets of development including a residential complex, archaeological features, and concrete swales with a drain inlet at the Compact Road. According to the Geotechnical Investigation Report, the percolation for the site ranges from 0.03 cm to 0.09 cm, which means that runoff will percolate very slowly. Therefore, stormwater runoff will follow the contours of the natural topography. As such, the existing site is divided by natural topography into three watersheds, named E1, E2, and E3 on Figure 3.1.

The description of the drainage flow of each area is as follows:

- Area E1 is comprised of northern and western cliffs in the project site. The stormwater in this area would flow down the steep cliffs into the ocean.

- Area E2 is the central valley leading to the marsh. The marsh serves as a temporary storage for stormwater runoff before releasing it into the forested area, which in turn leads to the mangrove.

- Area E3 the southern forested area in which stormwater runoff drains to the south towards the existing mangrove. This area receives runoff from the marsh in area E2.

To directly compare the existing condition with the proposed condition, each area was analyzed separately using the TR-55 graphical peak discharge method using the 1-year, 10-year, and 25-year storm event. The results of the calculations are summarized in Table 3-1 below.

Table 3-1: Transmit Site Existing Drainage Summary

Watershed	E1	E2	E3	Summary
Area (m2)	81,427	47,477	60,606	189,510
CN	77	82	82	N/A
TC (hr)	0.1	0.1	0.1	0.1
Q [1-yr] (mm)	77	90	90	N/A
Q [10-yr] (mm)	172	188	188	N/A
Q [25-yr] (mm)	217	235	235	N/A
V [1-yr] (m3)	6,328	4,291	5,464	16,082
V [10-yr] (m3)	14,041	8,970	11,433	34,444
V [25-yr] (m3)	17,776	11,198	14,277	43,251
qp [1-yr] (m3/s)	0.404	0.274	0.374	1.052
qp [10-yr] (m3/s)	0.896	0.572	0.783	2.251
qp [25-yr] (m3/s)	1.134	0.715	0.978	2.827

Each area was analyzed separately for Q, the height of runoff, V, volume of runoff, and qp, peak runoff discharge for each storm event. Then, the total volumes and peak flow rates were added in the Summary column of Table 3-1. The complete calculation can be found in the Appendix.

Temporary Conditions:

During construction, erosion control BMPs will be installed to manage sediment runoff. BMPs include geotextile matting, diversion dikes and swales, check dams, sediment traps, and filter socks.

During mass grading, the contractor will leave berms along the edges of grading, with a dual row of filter sock, trapping runoff with the graded area and preventing any design storm flow to reach downstream waters. As grading advances, the berm and filter sock row will continue to move down slope with construction.

In addition, on open cleared areas, diversion dikes and swales, along with sediment traps and check dams will control flow and reduce downstream velocities. Narrow cleared areas will be covered with erosion control matting and pined to prevent erosion from wind and rain. Diversion dikes along the southern cliffs will also route stormwater runoff the sediment traps before overflowing the downstream mangrove areas.

B. Proposed Conditions

The proposed changes will cut the existing steep cliffs to provide flat areas for the installation of radar antennas and supporting facilities. As a result, the drainage pattern of the site will change. The proposed transmit site has been separated into three watersheds, P1, P2, and P3, to compare to the existing conditions. However, watersheds P1 and P3 were further divided into subareas to study the proposed drainage features, as shown below in Figure 3.2.

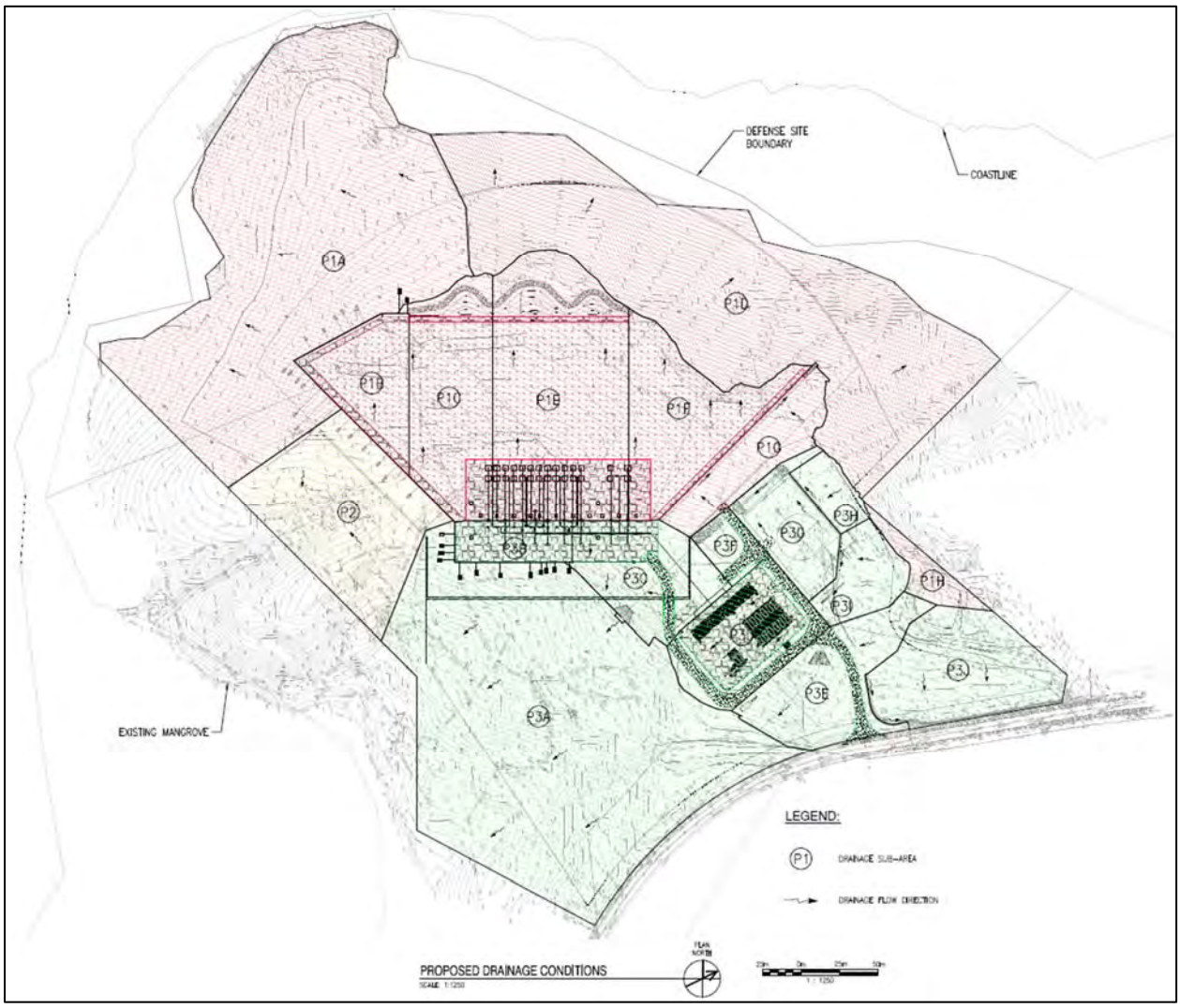

Figure 3.2: Transmit Site Proposed Drainage Conditions

As mentioned previously, the drainage pattern of the proposed condition will be different from the existing condition. Specifically, majority of the area from existing watershed E2 will instead become part of proposed watershed P1, which drains towards the west instead of south. To help balance the amount of drainage, features such as swales and culvert pipes were added to redirect some drainage to flow south in watershed P3.

The description of each area is as follows:

- Area P1 is the watershed in which stormwater runoff flows from the western and northern cliffs to the ocean. For drainage calculations, P1 is split into eight subareas to calculate drainage for new features.
    - There will be an unquantifiable amount of stormwater runoff that either infiltrates or seeps directly into the MSE wall backfill. To protect its structural integrity, the design of the MSE wall contains underdrains that connect to outlets with riprap that leads downstream to the mangrove.
- P2 has no proposed facilities, except to install security fencing along existing grades, therefore the drainage pattern will remain same as existing condition, stormwater will still flow to the existing mangrove to the south.
- P3 is divided into ten subareas which consist of part of the existing land, proposed Secure Compound, QVIS Antenna, Access Roads, and the backside of the Antenna Array. The grading in this area was designed to convey storm runoff generated from new impervious areas towards to the mangrove in the south. To accomplish this, grassed swales and a road culverts were designed to guide stormwater from the QVIS area flowing into a retention basin. Additionally, grated drain inlets that connected to drainpipes would direct stormwater from the access roads to large swale-like areas that lead excess stormwater to the south mangrove.

Each area was analyzed using the TR-55 graphical peak discharge method with the 1-year, 10-year, and 25-year storm events. The results of the calculations are summarized in Table 3-2 below.

Table 3-2: Transmit Site Proposed Drainage Summary

Watershed	P1	P2	P3	Summary
Area (m2)	106,968	10,236	72,306	189,510
CN	78	82	82	N/A
TC (hr)	0.1	0.1	0.1	0.1
Q [1-yr] (mm)	81	90	89	N/A
Q [10-yr] (mm)	176	188	186	N/A
Q [25-yr] (mm)	222	234	233	N/A
V [1-yr] (m3)	8,617	917	6,405	15,939
V [10-yr] (m3)	18,814	1,920	13,469	34,203
V [25-yr] (m3)	23,729	2,398	16,838	42,965
qp [1-yr] (m3/s)	0.549	0.062	0.447	1.058
qp [10-yr] (m3/s)	1.312	0.134	0.939	2.385
qp [25-yr] (m3/s)	1.655	0.167	1.174	2.996

Each area was analyzed separately for Q, the height of runoff, V, volume of runoff, and qp, peak runoff discharge for each storm event. Then, the total volumes and peak flow rates were added in the Summary column of Table 3-2. The complete calculations can be found in the Appendix.

C. Pipe Hydraulics

As mentioned in the previous section, proposed area P3 includes several pipe culverts under the access roads. Each culvert is referred to by its outlet and each was assigned a number:

- Outlet 1 is the culvert pipe nearest the existing Compact Road. It pipes runoff from the grated drain inlet under the access road to the swale-like area that eventually leads to the south mangrove.

- Outlet 2 is the culvert pipe under the access road leading to the Main Antenna Array. It takes stormwater that exceeds the freeboard elevation of the retention basin and pipes it under the access road to another swale-like area that also leads to the south mangrove.

- Outlet 3 is the culvert pipe under the access road next to the QVIS Antenna Area. It takes runoff from the swale and pipes it underneath the access road to the retention basin and connects with the Outlet 2 system.

Calculations using the proposed hydrology were done to verify that the pipe culverts would be able to handle the 10-year and 25-year storm events. The pipes will be Corrugated Metal Pipe (CMP) and have a diameter of 0.6096m (2 feet). The calculations used Manning's Formula to solve for the normal depth and pipe velocity. The pipe would be considered adequate as long as the normal depth was not larger than the diameter of 0.6096m and the pipe velocity was not extraordinarily high, such as 3 m/s. The following tables 3-3 and 3-4 summarize the results of the calculations.

Table 3-3: Transmit Site Culvert Normal Depth

Pipe	Normal Depth (m)	
	10 YR	25 YR
Outlet 1	0.117	0.132
Outlet 2	0.090	0.100
Outlet 3	0.126	0.141

Table 3-4: Transmit Site Culvert Pipe Velocity

Pipe	Pipe Velocity (m/s)	
	10YR	25 YR
Outlet 1	0.110	0.139
Outlet 2	0.063	0.078
Outlet 3	0.210	0.263

From the results of the calculations in Table 3-3 and Table 3-4, all three culverts would be able to handle the 10-year, and 25-year storm events.

D. TX Conclusions

After analyzing the hydrology of the site in both the existing and proposed conditions, the differences in the total site were compared in the following table.

Table 3-5: Transmit Site Comparison

	Pre Development	Post Developent	Difference
Area (m2)	189,510	189,510	0
Impervious %	0.29%	8.85%	8.56%
TC (hr)	0.100	0.100	0
V [1-yr] (m3)	16,082	14,367	(-)1,715
V [10-yr] (m3)	34,444	32,087	(-)2,357
V [25-yr] (m3)	43,251	40,693	(-)2,558
qp [1-yr] (m3/s)	1.052	0.955	(-)0.097
qp [10-yr] (m3/s)	2.251	2.238	(-)0.013
qp [25-yr] (m3/s)	2.827	2.838	(-)0.011

Because the drainage pattern is different between the existing and proposed conditions, the site is compared as a whole. As shown in Table 3-5, even though the impervious area will increase by 8.56%, the overall runoff volume and flow will decrease slightly because the grading in the proposed condition is flatter. As such, there is no required storage as a result of changes in the proposed condition. However, the Palau Stormwater Management Manual also requires runoff storage according to four criterions: recharge volume, water quality volume, stream protection, and overbank control. These volumes are listed in the following table.

Table 3-6: Transmit Site Required Storage Volumes

Watershed	Channel Protection (1-Year) [m3]	Overbank Flood Control (25-Year) [m3]	Water Quality Volume [m3]	Recharge Volume [m3]	Required Volume [m3]	Provided Volume [m3]
P1	1,073	3,128	262	262	262	303
P2	79	251	0	0	0	0
P3	853	2,134	153	153	153	185
Total	1,152	5,513	414	414	414	488

In the proposed condition, there will be sediment traps for watershed 1, which has a volume of 330 cubic meters, and a retention basin for watershed 3, which has a volume of 185 cubic meters. According to the Palau Stormwater Management Manual, stream protection and overbank control shall be waived if a project has "direct discharges (after water quality treatment) to a stream or river with contributory drainage area greater than 5-square miles, large lakes or reservoirs, or any coastal waters subject to tidal action." Since the project discharges to coastal waters and it can store the water quality volume for treatment, those two criterions do not apply. Therefore, the required storage volume will only be the water quality volume and recharge volume.

IV. TRANSMIT SITE PERMANENT BMPS

A. BMP Selection

For the Transmit Site, storing stormwater for extended periods of time is undesirable because the underlying soil at the site is ill-suited for percolation. On the other hand, slowing down flow and short-term storage of stormwater is important for collecting sediment and preserving water quality. Grass swales, check dams, retention basins, and sediment traps will be used to temporarily store stormwater and to control outflow. Additionally, this site contains a large amount of earthwork; specifically, majority of the earthwork will result in cut slopes. To reduce erosion caused by stormwater, slopes will be protected with riprap, grouted rubble paving, and mulching/hydro-seeding.

1. Sediment Traps

There will be one permanent sediment trap at the site for watershed P1: it is located at the edge of the Earth Mat. The sediment trap is a series of three small ponds, and each of the ponds have two steps. The purpose of this sediment trap is to slow down runoff and to capture some sediment before it overflows and disperses offsite. The volume of the sediment trap is 303 cubic meters with 0.305m (1 foot) free board.

2. Retention Basin

At the Transmit Site, there will be one designed retention basin for Watershed P3 located between the Secure Compound and the Public Restriction Fence. It is connected to the sediment trap that is for the QVIS Antenna Area via an underground culvert underneath the Access Road. It has an outlet pipe that is underneath the road leading to the Main Antenna Array. The volume of the basin is 185 cubic meters with 0.305-meter (1 foot) freeboard.

3. Grass Swales

There are six major grass swales in the site: (1) at the foot of the cut slope bordering the QVIS Antenna Area, (2) at the west edge of the QVIS Antenna Area that leads to the retention basin via underground culvert, (3) at the foot of the cut slope bordering the north edge of the Earth Mat, (4) at the edge of the MSE retaining wall at the west edge of the Earth Mat and leading to the 2-step sediment trap, (5) at the area behind the Main Antenna Array which is connected to the retention basin via culvert pipe, and (6) in the area between the Compact Road and the Secure Compound, and is also connected with a culvert pipe to an inlet near the QVIS Antenna Area. The purpose of the grass swales is to redirect runoff to a different direction, either towards another stormwater drainage feature or offsite.

4. Check Dams

Check dams will be installed within the grass swales to moderate velocity of the stormwater, which helps prevent erosion, and to filter out trash and debris.

5. Grouted Rubble Paving (GRP)

There will be Grouted Rubble Paving (GRP) installed along slopes adjacent to culvert headwalls for slope stabilization.

6. Riprap Slope Protection

There will be riprap (un-grouted rock rubble) placed at the end of swales, along slopes adjacent to culvert headwalls, along sediment trap spillways and at MSE wall outlets. The purpose of riprap is to spread the flow and reduce stormwater velocity, preventing erosion of slopes and downstream areas.

7. Mulching/Hydro-seeding

Cut slopes and any disturbed area will be mulched/hydro-seeded to promote slope stabilization and reduce erosion.

B. Maintenance Requirements

Proper maintenance of each permanent BMP should be practiced at least bimonthly, and after heavy rainfall to assure proper facilitation of the stormwater runoff and stormwater management. Maintenance should include the following:

- trimming grassed areas,
- removing sediments and debris collected within the swales and in the sediment traps, check dams, and basins,
- inspection of grouted rubble paving and riprap lining,
- and cleaning out the culvert pipes to mitigate clogging.

V. RECEIVE SITE DRAINAGE CONDITIONS

A. Existing Conditions

The existing condition is separated into four watersheds, labeled E1 to E4, shown in Figure 5.1 below.

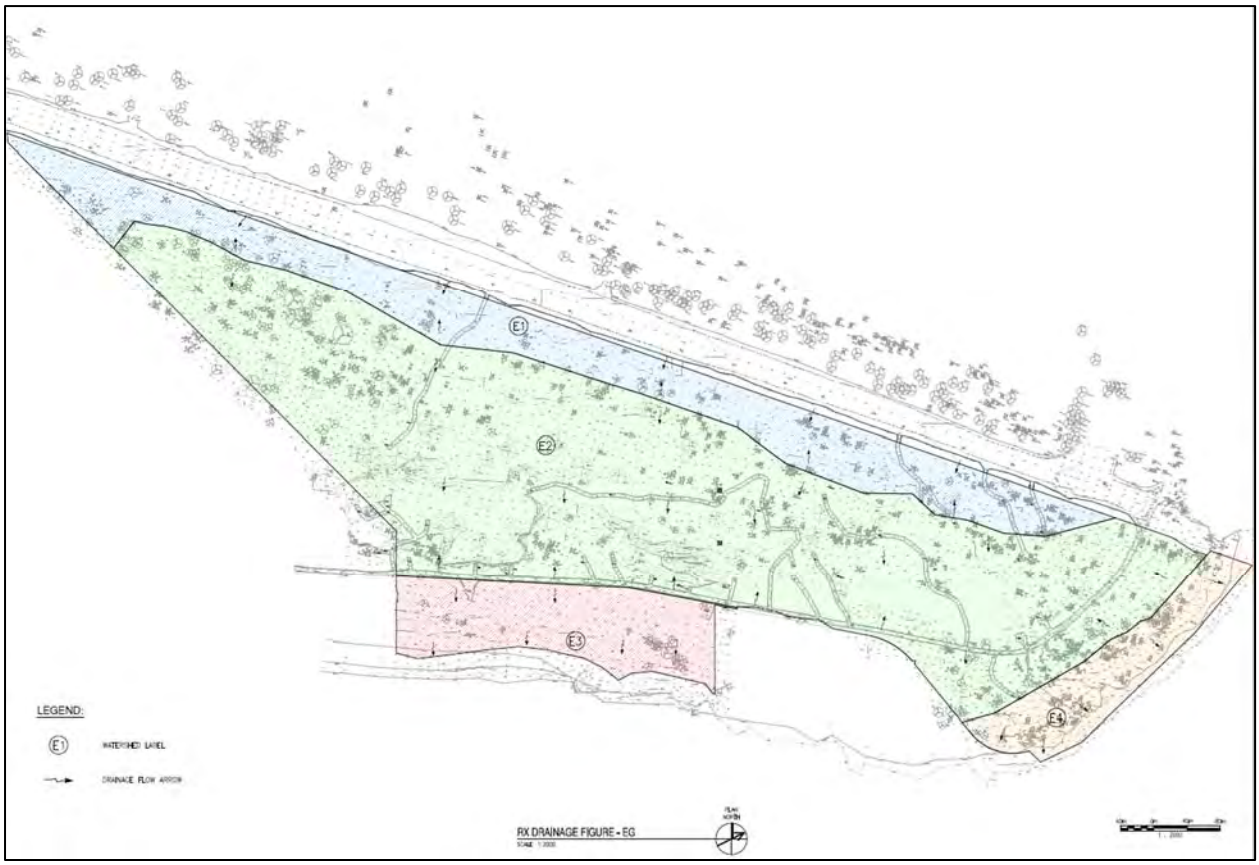

Figure 5.1: Receive Site Existing Drainage Conditions

The existing receive site is flat, undeveloped forest with only a dirt coastal road running along the perimeter. The site was previously developed and used as an airfield during WWII and is currently heavily overgrown. According to the Geotechnical Investigation Report, the percolation rates for this site range from 0.185 cm to 5.08 cm, which indicates that stormwater is more likely to percolate into the ground rather than flow offsite. As such, most of the site acts like a large basin. However, there is a small ridge encircling the project site that separates the different drainage areas. This ridge runs along the east edge of the airstrip and runs to the east of the borrow pits.

The description of each area is as follows:

- Area E1 is the area between the existing airstrip and the aforementioned ridge. In this area, stormwater collects in this valley-like area and it percolates into the ground.

- Area E2 is the central area to the east of E1. There are two large borrow pits located in this area. Because the ground is flat in this area, water tends to percolate into the ground rather than flow towards a basin or offsite. There is an existing coastal road that runs along the small ridge, which effectively makes a border for area E2.

- Area E3 is the eastern rectangular area on the side of the existing coastal road. Water tends to flow east towards the ocean, but there is a small depression along the east edge that will collect stormwater.

- Area E4 is the northern area past the existing coastal road. The area is relatively steep, and water will flow north to the ocean.

The graphical peak discharge method from TR-55 was repeated three times for three different storm events: 1-year, 10-year, and 25-year storms. Table 5-1 summarizes the results from using TR-55. The complete calculations can be found in the Appendix.

Table 5-1: Receive Site Existing Drainage Summary

Watershed	E1	E2	E3	E4	Summary
Area (m2)	75,590	259,786	35,973	24,037	395,387
CN	58	44	43	43	N/A
TC (hr)	0.1	0.1	0.1	0.1	0.1
Q [1-yr] (m)	0.037	0.014	0.013	0.013	N/A
Q [10-yr] (m)	0.110	0.064	0.061	0.061	N/A
Q [25-yr] (m)	0.148	0.094	0.090	0.090	N/A
V [1-yr] (m3)	2,803	4,168	462	309	7,742
V [10-yr] (m3)	8,324	17,776	2,193	1,465	29,761
V [25-yr] (m3)	11,266	25,869	3,251	2,172	42,557
qp [1-yr] (m3/s)	0.137	0.108	0.011	0.008	0.263
qp [10-yr] (m3/s)	0.570	0.822	0.096	0.064	1.553
qp [25-yr] (m3/s)	0.796	1.496	0.181	0.130	2.603

Each area was analyzed separately for Q, the height of runoff, V, volume of runoff, and qp, peak runoff discharge for each storm event. Then, the total volumes and peak flow rates were added in the Summary column of Table 5-1. The complete calculations can be found in the Appendix.

B. Temporary Conditions

During construction, erosion control BMPs will be installed to manage sediment runoff, as shown in Figure 5.2 below.

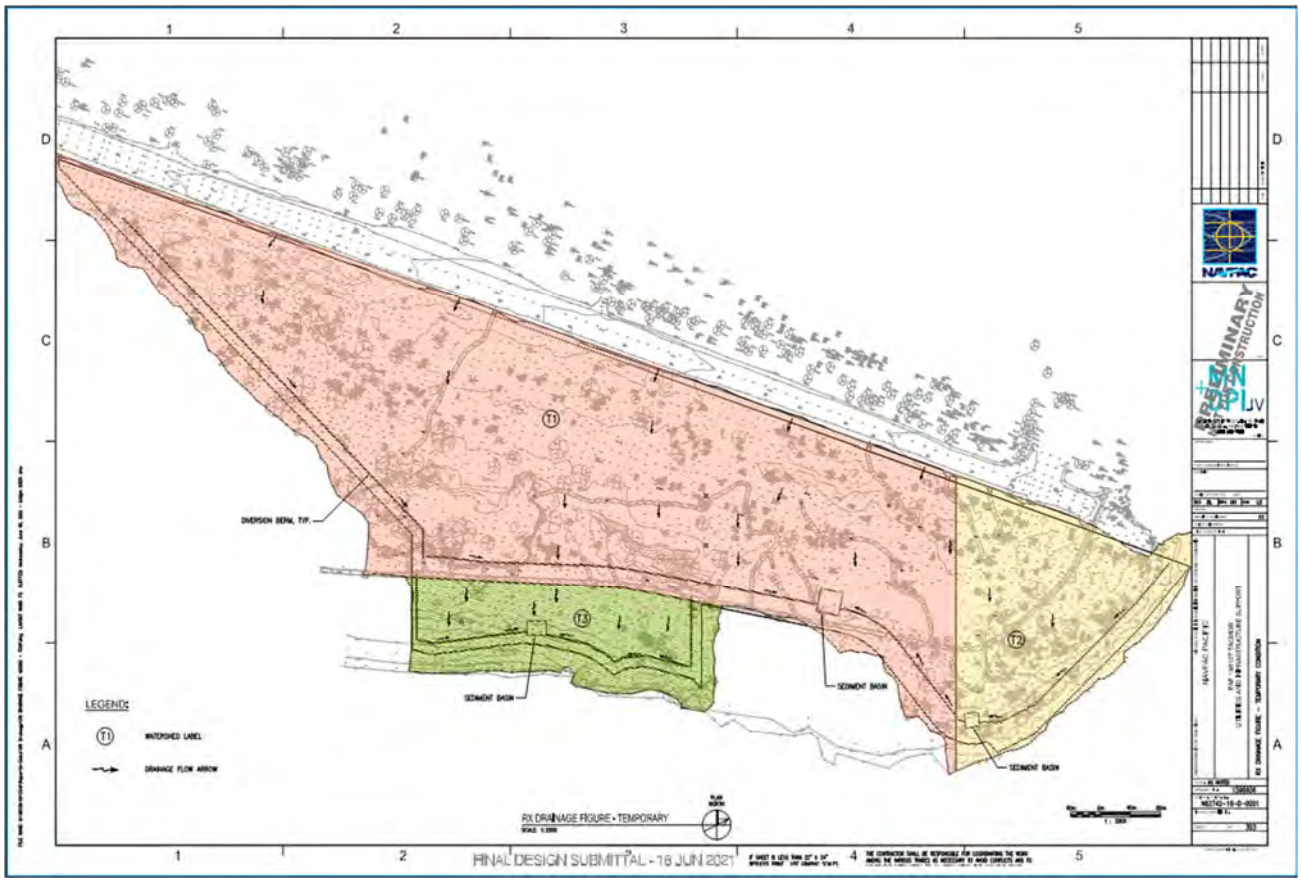

Figure 5.2: Receive Site Temporary Drainage Conditions

According to the Palau Stormwater Management Manual, a 1.5-inch storm event is used as a basis for sizing temporary sediment traps. Therefore, a storm event with precipitation of 1.5 inches was applied using TR-55 methodology to estimate the runoff storage volume required.

As shown in Figure 3.3 above, there will be 3 temporary sediment basins installed and earth dikes will be installed to convey runoff to these temporary sediment basins. Area T1 represents the area for the west temporary sediment basin, T2 is for the middle temporary sediment basin, and T3 is for the east temporary sediment basin. Table 3-5 below summarizes the data.

Table 3-2: Temporary Drainage Summary

Drainage Area	Area (ac^2)	Peak Flow (ft^3/s)	Runoff Volume (m^3)	Provided Volume (m^3)
T1 (1.5”)	80.5	1.07	1565.019	1800.000
T2 (1.5”)	18.0	0.24	349.2326	361.000
T3 (1.5”)	12.5	0.17	243.4809	468.000
Summary (1.5”)	111	1.48	2157.732	2629.000

Each area was analyzed using TR-55 methodology and each sediment basin was sized to sufficiently store the runoff volume from a 1.5-inch storm. Due to the excellent on-site percolation and infiltration rate, most surface runoff is expected to percolate prior to flowing into the sediment traps.

Additional measures include a dust screen along the airstrip and dual row of filter socks along all downstream areas and along the coast line.

C. Proposed Conditions

The proposed condition is separated into four watersheds, labeled P1 to P4, shown below in Figure 5.3 below.

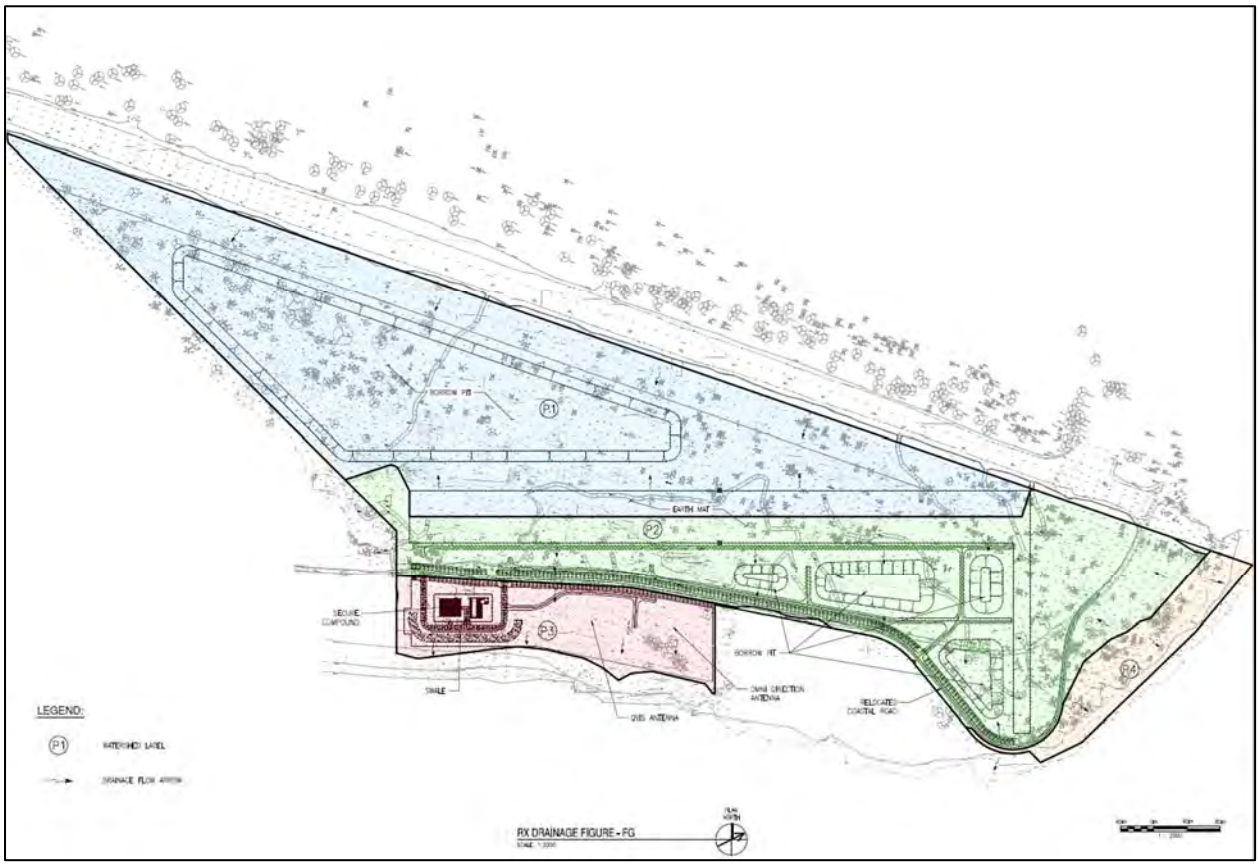

Figure 5.3: Receive Site Proposed Drainage Conditions

In the proposed condition, a completely level Antenna Area and Earth Mat will be installed at elevation 7m in the area where the existing borrow pits are located. A retention basin will be designed adjacent to the Earth Mat. East of the Earth Mat, a Secure Compound, QVIS Antenna, and OMNI Antenna will be constructed with access roads from the existing coastal road.

The description of each area is as follows:

- Area P1 is the area in between the airstrip and the proposed Earth Mat. The area is larger than area E1 because it includes the large borrow pit which also collects and disposes of stormwater runoff.

- Area P2 consists of the previous area E2 that will not travel to the proposed storage basin. Generally, water will just percolate to the ground, just as it does in existing conditions. Additionally, there will be multiple borrow pits that will also collect and dispose of stormwater runoff.

- Area P3 is the same as area E3, but it w2oads. There will also be another borrow pit added to this area, which will collect and dispose of stormwater runoff. The overall drainage pattern is still the same for this area.

- Area P4 is like area E4, with the same drainage pattern. The only difference is that because of the new access road looping around the Earth Mat, there is less area for the watershed.

The graphical peak discharge method from TR-55 was repeated three times for three different storm events: 1-year, 2-year, and 25-year storms. Table 5-2 summarizes the results from using TR-55.

Table 5-3: Transmit Site Proposed Drainage Summary

Watershed	P1	P2	P3	P4	Summary
Area (m2)	205,085	136,387	35,973	17,942	395,387
CN	53	54	46	43	N/A
TC (hr)	0.3	0.15	0.1	0.1	0.3
Q [1-yr] (m)	0.032	0.034	0.02	0.02	N/A
Q [2-yr] (m)	0.052	0.055	0.04	0.03	N/A
Q [25-yr] (m)	0.147	0.151	0.12	0.10	N/A
V [1-yr] (m3)	9,458	5,766	1,016	231	16,470
V [2-yr] (m3)	25,744	16,245	3,375	1,094	46,458
V [25-yr] (m3)	34,173	21,733	4,679	1,621	62,206
qp [1-yr] (m3/s)	0.462	0.149	0.025	0.006	0.641
qp [2-yr] (m3/s)	1.764	0.751	0.147	0.048	2.711
qp [25-yr] (m3/s)	2.415	1.257	0.260	0.097	4.029

Each area was analyzed separately for Q, the height of runoff, V, volume of runoff, and qp, peak runoff discharge for each storm event. Then, the total volumes and peak flow rates were added in the Summary column of Table 5-2.

D. RX Conclusions

After analyzing the hydrology of the site in both the existing and proposed conditions, the following table summarizes the results of the calculations.

Table 5-4: Receive Site Comparison

	Pre-Development	Post-Development	Difference
Area (m2)	482,376	482,376	0
Impervious %	8.33%	9.78%	1.44%
TC (hr)	0.625	0.300	-0.325
V [1-yr] (m3)	11,064	14,645	3,580
V [2-yr] (m3)	19,200	24,189	4,989
V [25-yr] (m3)	59,577	69,011	9,434
qp [1-yr] (m3/s)	0.248	0.341	0.093
qp [2-yr] (m3/s)	0.452	0.758	0.306
qp [25-yr] (m3/s)	2.402	3.021	0.619

For the Receive Site, the overall drainage pattern does not change; the main difference is in the amount of impervious area, which increases the amount of stormwater runoff, as shown in Table 5-3. The Palau Stormwater Management Manual requires storage volume to retain the increase in stormwater runoff, which are shown below in Table 5-4.

Table 5-5: Receive Site Required Storage Volumes

Symbol	Category	1	2	3	4
Rev	Recharge Volume	1,007	339	91	0
WQV	Water Quality Volume	1,007	339	91	0
Cpv	Stream Protection	1,082	640	131	51
Qp-25	Overbank Control	7,286	3,635	776	347

According to Table 5-4, the required storage volumes are based on the Overbank Control criteria because the volumes produced by the 25-year storm are the highest among the four criteria for all watersheds. However, because the site is flat and the percolation rates are so high, the entire watersheds themselves act as a percolation basin. Therefore, although there are no designed retention basins, there are borrow pits on the site that will collect, store, and dispose of stormwater runoff by percolation. The large borrow pit located in area P1 has a storage volume of 95,514 cubic meters with 0.3048m (1 foot) freeboard. The smaller borrow pits in area P2 have a collective storage volume of 27,635 cubic meters. Finally, the swale in P3 can hold 607 cubic meters.

In the event of a 25-year storm, the borrow pits in P1 and P2 are capable of storing the runoff. The swale on P3 would be able to account for the recharge, water quality, and stream protection volumes, but it cannot hold overbank control volume. However, according to the Palau Stormwater Management Manual, “direct discharges (after water quality treatment) to a stream or river with contributory drainage area greater than 5-square miles, large lakes or reservoirs, or any coastal waters subject to tidal action.” Since P3 discharges to coastal waters, the stream protection and overbank control volumes are waived. Similarly, for area P4, because there is no increase to stormwater runoff due to increased impervious surfaces, and because runoff discharges to coastal waters, stream protection and overbank control is also waived.

In conclusion, the Receive Site comply with the Palau Stormwater Management Manual requirements because while the high percolation rates allow most of the stormwater runoff to percolate, there are additional borrow pits that can also store the required volumes for water quality.

VI. RECEIVE SITE PERMANENT BMPS

A. BMP Selection

For the Receive Site, the existing area is generally flat, and the percolation rate is high; essentially the entire site is a natural retention basin. With the proposed Antenna Array Area, the ground will be raised to an elevation of 7 meters and flat. However, the finish ground will be gravel, which means it will remain pervious from existing conditions. Therefore, the addition of the Antenna Array will not alter the existing drainage pattern. Grass swales and check dams will be installed to redirect stormwater away from proposed features. Additionally, disturbed areas will be mulched/hydro-seeded to reduce erosion.

1. Grass Swales

Grass swales were designed to protect the new features in the proposed condition. The swales are designed to be trapezoidal swales, with a total width of about 3 meters and a maximum of 2H:1V side slopes. The swales will be placed to direct flows around the compounds to protect them from stormwater runoff.

2. Check Dams

Check dams were designed to moderate stormwater velocity and prevent erosion. It serves the purpose of trapping part of the sediment and helping filter out the trash and debris. They will be installed in grass swales throughout the project.

3. Slope Protection

There will be riprap and Grouted Rubble Paving (GRP) installed where necessary to slow down the flow of stormwater prior to downstream areas.

4. Mulching/Hydro-seeding

Any other disturbed area will be mulched or hydro-seeded to protect against erosion and provide slope stabilization.

B. Maintenance Requirements

Proper maintenance of each permanent BMP should be practiced at least bimonthly, and after heavy rainfall to assure proper facilitation of the stormwater runoff and stormwater management. Maintenance should include the following:

- trimming grassed areas,
- removing sediments and debris collected within the swales and check dams,
- and inspection of grouted rubble paving and riprap lining.

VII. CONCLUSION

The installation of the Tactical Multi-Mission Over-the-Horizon Radar (TACMOR) equipment will affect the existing drainage conditions at both the Transmit Site on Babeldaob and the Receive Site on Angaur.

The earthwork will especially affect stormwater at the Transmit Site because the steep hills and valleys will be flattened, which affects the overall drainage pattern of the site. Since the drainage pattern was changed, the hydrology of the entire site was analyzed as a whole. From the results of the calculations, both the runoff volume and flow do not increase, so no additional storage is required. However, sediment traps and a retention basin were still designed to store some runoff temporarily for preserving water quality.

On the other hand, for the Receive Site, the high percolation rate of the existing soil means the site acts like a retention basin. Therefore, while the proposed condition increases the stormwater runoff because the overall drainage pattern does not change, the natural retention basin will store the increase in stormwater runoff. The natural basin stores the required volumes for recharge, water quality, stream protection, and overbank control. Additionally, there are borrow pits that also collect, store, and dispose of stormwater by percolation.

In conclusion, stormwater drainage for both the Transmit Site and the Receive Site meets the requirements for the Palau Stormwater Management Manual and the Overseas Environmental Baseline Guidance Document (OEBGD).

VIII. REFERENCES

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A. APPENDIX

Transmit Site Existing Condition Calculations