Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watersheds in Southern Guam

NOAA/ National Marine Fisheries Service Pacific Islands Regional Office, Habitat Conservation Division

Prepared for:

National Oceanic and Atmospheric Administration,
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Coral Reef Conservation Program

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ACRONYMS AND ABBREVIATIONS

CLTC	Chamorro Land Trust Commission
CZMA	Coastal Zone Management Act
EA	EA Engineering, Science, and Technology, Inc.
ft	feet
m	meter
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
PIRO	Pacific Islands Regional Office
POC	Point of Contact
SHPO	State Historic Preservation Office

1.0 EXECUTIVE SUMMARY

Upland erosion and sedimentation is one of the primary factors impacting coastal habitats and coral reef health. In order to implement upland stabilization, a site assessment and survey of the streams and riparian zones of the Manell and Geus watersheds were performed to select sites from which to gauge the effectiveness of erosion control measures. During the field survey activities, areas indicating significant erosion were identified and prioritized for applicability as watershed restoration demonstration sites.

Based upon the cause of erosion observed near the riparian zones of first to third order streams in both watersheds, we designed two erosion control projects to reduce sediment loads, and are described as follows:

1. Streambank stabilization using native vegetation to include native trees, shrubs, and grasses;

2. Riparian buffer (filter) strips using vegetation and log check dams.

Implementation of demonstration projects was initially scheduled to begin on August 19, 2013, with the plant material procured and maintained in the source nursery several months prior to implementation. However, coordination with the Guam State Historic Preservation Office was protracted and actual project implementation was delayed until December 11, 2014. As a result of delays, plant mortality occurred and surviving plants matured over the period of time. As conditions in the field varied from the initial field assessment, it was necessary to implement minor modifications to planting methods presented in the original project work plan.

Several native and one non-native plant species were selected for their ability to stabilize soils, through quick growth and extensive root systems. These species, with the exception of vetiver grass (*Chrysopogon zizanioides*), a non-native rhizomatous grass species, are also present in reference areas identified during the initial assessment. The removal of some undesired invasive bamboo (*Bambusa vulgaris)* was required during planting activities at the Geus demonstration site.

Based on the initial site selection assessment, three test plot sites were identified in the Manell watershed and two test plot sites were identified in the Geus watershed.

Manell Sites 1, 2, and 3 include the following actual dimensions and implemented practices:

- Site 1: A 14 feet (ft) x 33 ft, riparian planting and staking restoration areas adjacent to a first order drainage plot.
- Site 2: A 32 ft x 28 ft, hillside slump planting site in an adjacent soil type plot.
- Site 3: An additional 20 ft x 20 ft, tree and shrub planting adjacent to a hillside slump and

head cut plot. A deep gully was planted with vegetative barriers and a log check dam.

Geus Sites 1 and 2 include the following actual dimensions and implemented practices:

- Site 1: A 75 ft x 36 ft, reforestation and invasive species control plot, a planting of a series of vetiver grass filter strips and installation of log check dams within the gullies.
- Site 2: A 10 ft x10 ft, understory enhancement plot and planting of a series of vetiver grass filter strips.

Implementation of best management practices at Manell Sites 1, 2, and 3; and Geus Sites 1 and 2 will help to reduce stream water velocity and the amount of sediment entering the adjacent coastal waters. The goal of this project was to test two low cost, low maintenance options that can be implemented in other similar watershed conditions in Southern Guam to mitigate erosion and sedimentation that is impacting coastal habitats and coral reef health.

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2.0 INTRODUCTION

2.1 Purpose and Objective

The primary objective of this project was to assess the Manell and Geus Watersheds and design demonstration projects to stabilize stream bank and create riparian buffers in the Manell and Geus Watersheds in Southern Guam. The project objective was to demonstrate practices that improve stream stability and reduce the amount of sediment entering the downstream coastal waters, thereby reducing impacts to coastal benthic habitats and increasing coral reef health. The streams and riparian zones were initially assessed for feasibility of erosion control. As a result of the assessment, two types of erosion control best management practices were designed to reduce sediment loads in the Manell and Geus Watersheds:

1.) Vegetative methods were used to stabilize the nearby stream banks;

2.) Installation of riparian buffer strips using vegetative methods and other natural materials were used to test lower cost, low maintenance options that can be used in other locations as funding becomes available.

Based on the initial survey and assessment, the project was designed and included installation and maintenance tasks that could be completed by community volunteers.

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3.0 BACKGROUND INFORMATION

The following section presents background information including a site description and physical setting.

3.1 Watershed Description

3.1.1 Manell Watershed

The Manell watershed is located in southern Guam within the Village of Merizo (Figure 1). The headwaters of the watershed are located on Government of Guam property owned by the Chamorro Land Trust Commission (CLTC), while most areas transitioning into the coastal plain are privately owned. The watershed has a drainage area of 4.55 square miles. The rivers in the watershed are the Ajayan, Nelansa, Laolao, Fintasa, and Liyog Rivers, and Asgalao Creek, each with approximate lengths of 2.91 miles, 2.01 miles, 0.98 mile, 0.77 mile, 0.72 mile and 0.5 mile, respectively. The total river length for the watershed is 7.89 miles. The Ajayan River discharges to Ajayan Bay in the Pacific Ocean, and other rivers discharge directly to the Pacific Ocean. The highest elevation is about 1,122 feet (ft) [342 meters (m)] in the north area of the watershed. The watershed is comprised of mostly savannah areas, a few developed areas, and forested areas, which are limited to the surrounding ravines.

3.1.2 Geus Watershed

The Geus watershed is located in southern Guam within the Village of Merizo (Figure 1). The headwaters of the watershed are located on Government of Guam property owned by the CLTC, while most areas transitioning into the coastal plain are privately owned. The watershed has a drainage area of 1.73 square miles. The Geus River has an approximate length of 2.71 miles and discharges to the Philippine Sea. The highest elevation is about 833 ft (254 m) in the northeast of the watershed. The watershed land cover is comprised of forest and developed areas, in the ravines and lower reaches, respectively, and the upper portions of the watershed are grassland savannah with steep slopes.

3.2 Project Area Descriptions

The Manell subject sites are located in the eastern portion of the watersheds project boundary line (Figure 3 and Figure 5). The subject sites combined area consists of approximately 0.04 acres of undeveloped and unoccupied land with minimal vegetation and grass savannas surrounding the immediate areas. There are no existing structures or utilities on the property. Appendix A depicts photographs of the watershed, study sites, existing conditions, and implementation activities.

The Geus sites are located on the lower portion of the watershed project boundary (Figure 2 and Figure 4). The combined area of the site consists of approximately 0.06 acres of undeveloped and unoccupied land with minimal vegetation, a few tall trees, and some invasive plant species that surround the immediate areas. Appendix A depicts photographs of the watershed, demonstration sites, existing conditions, and implementation activities.

3.3 Land Use

There are no records that the Manell or Geus sites are being used for residential, industrial, or commercial land uses. The upper Manell watershed sites are land locked by a series of private land owners that are off the main access road. Access onto the Manell sites to perform the survey and implementation activities was granted by a private landowner. The upper Geus watershed sites were only accessed by foot along the river bed and adjacent bank edges.

4.0 LANDSCAPE DYNAMICS

In order to interpret the diverse factors that affect the coastal marine environment, understanding of landscape ecology principles of the onshore contributing drainage basin and their relation to the receiving waters (coastal marine environment) is helpful. Landscape ecology is the study of interactions between organisms and the environment in land areas where local ecosystems and land uses are repeated in similar form. Landscape ecology relates to causes and consequences of the spatial composition and configuration of landscape mosaics within the components of a landscape; plant communities, land use (human uses), and hydrologic patterns (rivers, streams, and channels). These principles and components have a direct correlation upon the amount and types of pollutants that affect the coral communities in the near-shore receiving waters.

The extent of the area being studied, commonly referred to as scale, is an important concept in landscape ecology. The processes that create and maintain the complex landscape features within one scale will be different from those at another scale. For purposes of our study, our scale is limited to watershed or drainage basin boundaries. The watershed or drainage basin boundary is the topographic feature in the landscape that drains to a river system. Condition of the watershed is important because it influences the quality, abundance, and stability of downstream resources and habitats by controlling production of sediments and nutrients, influencing streamflow, and modifying the distribution of nutrients into the receiving waters. To better understand the dynamics of the landscape as it relates to watersheds, our discussion is divided into three distinct features within the watershed: riparian; river, streams, and channels; and depositional environments.

Two main sediment sources are encountered in the watershed:

- Overland sediment (colluvial) sources. These are a major contributor to the sediment load at the tidal outlet of the rivers located in the Manell watershed and the Geus River. This includes colluvial sources of sediment that enter through landslides, and overland sediment sources that include erosion from the ground surface and suspension in sheet flow runoff. The lack of vegetation and presence of shallow saprolite are factors that enhance runoff and reduce potential for groundwater recharge. This enhances concentration of flow, and overall increases the likelihood of erosion through overland flows.

- In-channel sediment (alluvial) sources. Although portions of these watersheds have bedrock channel bed and banks, most of the rivers located in the Manell watershed and Geus River banks have either sand or silty clay banks, with lenses of gravel or cobble. Tall, vertical banks of fine erodible sediments with poor vegetation cover are exposed in these reaches. Incision of the channel bed in upper reaches of the watershed at the site of head cuts is considered a significant source of erosion.

4.1 Riparian Dynamics

The riparian zone is the land that adjoins, directly influences, or is influenced by a body of water. Although typically associated with the land immediately adjacent to water and floodplain, given the steep slopes and the number and location of first-order ephemeral streams in the Manell and Geus watersheds, the riparian zone is that area from the edge of the river upslope to the edge of the watershed boundary. Healthy riparian areas help stabilize stream channels, provide storage for sediment, serve as a nutrient sink for the watershed, and help to improve quality of water leaving the watershed. The riparian zone adjacent to existing water courses and drainages, if un-vegetated, is a contributor of fine sediments through overland flows and failures of the bank and riparian area. These large failures are often referred to as mass wasting, and involve the undercutting of a stream bank, and resulting failure of that bank into the channel.

Research has shown that a grass-shrub buffer of a little more than 10m wide next to the water's edge can reduce approximately 99% of total suspended solids (Mankin et. al. 2007). Grass filter strips of approximately 3m wide can reduce approximately 60% of total suspended solids before entering the watercourse (Daniels & Gilliam 1996). Furthermore, headwater streams (first-order perennial streams) that include flow from smaller ephemeral first-order streams, such as those common in the upper elevations of the Manell and Geus watersheds, are important elements of stream and river networks, in terms of influencing water quality in fourth- and higher-order rivers. Approximately 70% of the mean-annual water volume and 65% of the nitrogen flux in second-order streams are contributed by headwater streams, and their contribution to mean water volume and nitrogen flux decline only marginally to about 55% and 40%, respectively, in fourth- and higher-order rivers (Alexander et. al. 2007).

4.1.1 Fires

The periodic, human-caused fires are the primary maintaining factor for the savanna highlands in southern Guam. These fires are often caused by arson; ignited solely for the purpose of encouraging fresh grassland as grazing habitat for the non-native feral pig and Philippine deer. While these practices encourage grassland, they do not foster the growth of native tree and shrub vegetation which has superior erosion control abilities in comparison with the grassland. Grassland, while on the outward appearance appears dense, is shallow rooted, and relative sparse compared with the potential jungle habitats which could be in the riparian zone. Although wind forces also aid in maintaining the absence of forested areas, the near complete absence of tree and shrub species is attributed to fire (Fosberg 1960).

Additionally, during rainfall events, the loss of forest cover and lack of trees and shrubs increases the amount of storm runoff and reduces the amount of groundwater recharge and the rate of evapotranspiration. This causes increases in stream flood magnitude and stream energy and velocity, and contributes towards increasing erosion rates from stream banks. This increased bank erosion is in addition to increased introduction of suspended solids through sheet flows and eroding soil from fire-cleared destabilized riparian areas.

4.1.2 Soil Types

The soil type is the Akina-Agfayan series for both the Manell and Geus watershed areas. The soil ranges from very shallow to very deep, well drained, moderately steep to extremely steep soils; on strongly dissected mountains and plateaus remnants and jagged mountains.

Akina soils are primarily found on side slopes and ridgetops in these watersheds. These soils are very deep and well drained. The soils are red, acidic silty clay and clay and are underlain by saprolitic tuff at a depth of 20 to 40 inches.

Agfayan soils are primarily found on side slopes and ridgetops in these watersheds. These soils are very shallow and are well drained. The soils are slightly acid to neutral clay and are underlain by weathered bedrock at a depth of 4 to 15 inches.

4.1.3 Saprolite

Saprolite, or weathered bedrock, is present in close proximity to the soil surface in the riparian areas. Many first-order stream tributaries are incised through topsoil layers and are footed upon saprolite. Many of the exposed, un-vegetated areas of the southern Guam savanna are exposed saprolite.

Lacking organic matter, and being tough, dense, and retaining little moisture, saprolite is difficult to vegetate, but fortunately does not contribute significant sediment through rainfall events and resulting runoff. It does, however, contribute towards the increased watershed runoff observed through fire, as compared with a vegetated condition. Additionally, it prevents the vertical incision of stream channels in the upper watershed by providing a significant resistance to high energy stream flows.

4.1.4 Plant Density

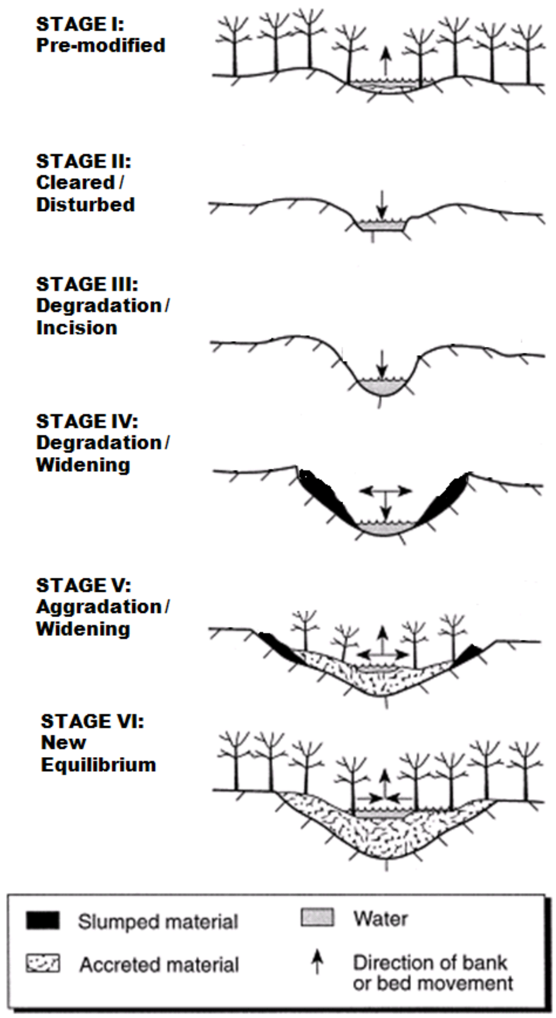
Plant density impacts watershed and riparian dynamics significantly. Increased plant root density holds soil and prevents erosion and mass wasting. Increased surface cover and canopy deflects rainwater and reduces soil detachment from the ground surface. A denser plant community also increases evapotranspiration, reduces rainwater runoff, and encourages groundwater recharge.

4.2 Stream Dynamics and Channel Evolution

Where bank armoring, boulders and bedrock are not present, the stream channels in these watersheds are subject to change and able to evolve channel features based upon the deformation of their bank and bed. This occurs through sediment transport processes. This dynamic process is referred to as channel evolution, shown in Figure 6 at right, and it describes the morphological changes which occur through time as a stream channel reaches a state of dynamic equilibrium.

When a stream reach attains a sediment transport state in which the amount of sediment delivered to it is equal to the amount of sediment it can transmit downstream, it is said to be in dynamic equilibrium. It is important to note that stable streams in dynamic equilibrium adjust their bed and banks through time, and need not be static in their plan form. In order to attain this state, different phases of channel degradation (channel erosion) and channel aggradation (channel building / deposition) may occur through the channel evolution process.

Figure 6. Channel Evolution Sequence



Source: Rosgen 1996

4.2.1 Rosgen Stream Classification

Each of the phases of channel evolution is characterized by the succession of "stream type" as defined in *Applied River Morphology* (Rosgen 1996). Stream type is a means of comparing similar streams based upon their connectivity to their floodplain, their bedload sediment (those sediment materials which are transported commonly in the channel), placement in the native geology (or valley type), their average slope, and their channel plan form sinuosity (a ratio of the length of stream channel to the length of the floodplain valley they occupy).

Valley type characterizes the geologic formation of a valley and plays an important role in determining channel classification and channel evolution. Just as narrow rift valleys, glacial valleys, or alluvial floodplain valleys differ in their physical constraints and relative dimensions, the streams which occupy those valleys differ in slopes, plan form, sediment transport properties, or other morphological properties. In order to make those types of stream comparable between watersheds, only streams in similar valley types are compared as shown in Figure 7.

Figure 7. Rosgen Valley Types

Valley Types	Summary Description of Valley Types	Stream Types
I	Steep, confined, V-notched canyons, rejuvenated side-slopes	Aa+, A, G
II	Moderately steep, gentle-sloping side-slopes often in colluvial valleys	B, G
III	Alluvial fans and debris cones	A, B, F, G, D
IV	Canyons, gorges and confined alluvial and bedrock-controlled valleys with gentle valley slopes	C, F
V	Moderately steep, U-shaped glacial-trough valleys	C, D, F, G
VI	Moderately steep, fault- , joint- or bedrock-controlled valleys	Aa+, A, B, C, F, G
VII	Steep, fluvial dissected, high-drainage density alluvial slopes	Aa+, A, G
VIII	Alluvial valley fills either narrow or wide with moderate to gentle valley slope with well-developed floodplain adjacent to river, and river terraces, glacial terraces or colluvial slopes adjacent to the alluvial valley	C, D, E, F, G
IX	Broad, moderate to gentle slopes, associated with glacial outwash or eolian sand dunes	C, D, F
X	Very broad and gentle valley slopes associated with glacio- and nonglacio-lacustrine deposits	C, DA, D, E, F, G
XI	Deltas	C, D, DA, E

Source: Rosgen 1996

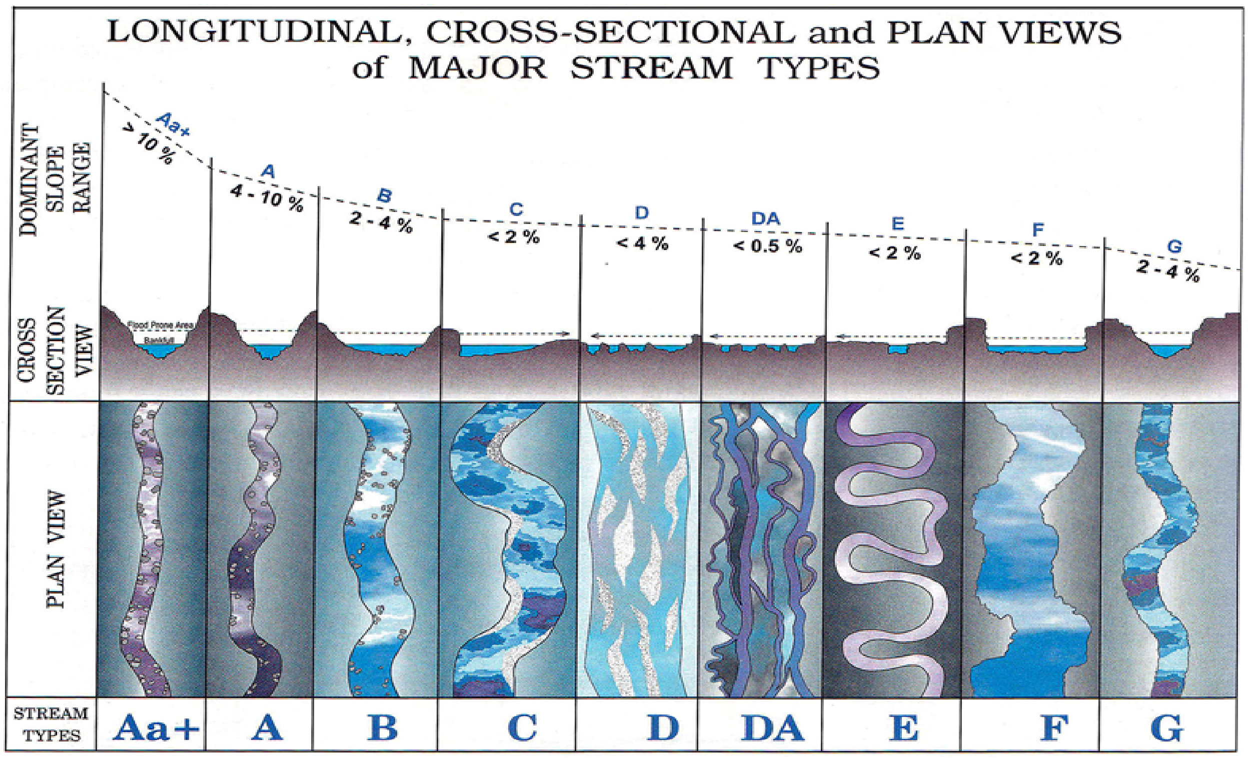
The Manell and Geus stream and river systems transition through three different valley types and several stream types as described by the Rosgen 1996 classification scheme:

- Upper elevations and the first-order stream contained within are valley type VII, characterized by steep, highly dissected fluvial slopes that contain predominantly low-sinuosity A and G stream types. Figures 8 and 9 depict typical stream types and how they relate to slope and cross section.

- Lower reaches which approach the coastline and tidal influence are valley type III, alluvial fans and debris cone dominated systems. However, these sections have been highly altered by agriculture and residential development, as well as potential stream pattern modification to accommodate infrastructure. This valley type is predominated by G stream types and second- and third-order streams.

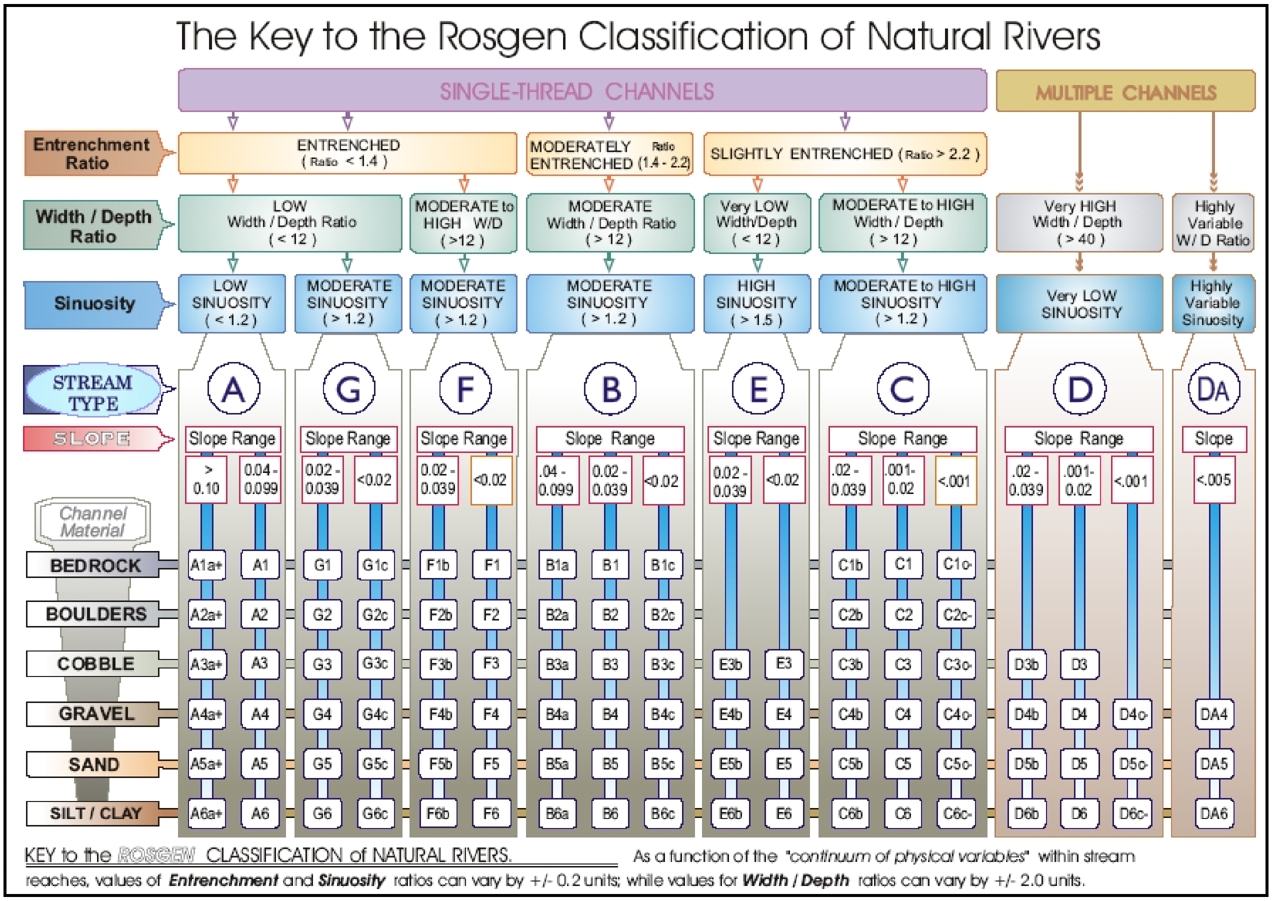
- At the coastal plain and tidal interface, the valley type transitions to type XI, which are deltaic landforms with wave and/or tidal influence. This area is also highly modified by infrastructure, agriculture and residential development. Although typical stream types for this valley type would include stream/wetland systems with braided depositional D stream types, the stream types found presently are entrenched G and F stream types and a single fourth- or higher-order stream.

Figure 8. Rosgen Stream Types



Source: Rosgen 1996

Figure 9. Rosgen Stream Types



Source: Rosgen 1996

4.2.2 In-Stream Sediment Transport

Stream reaches in the Manell and Geus watersheds with a defined channel have incised through the highly erodible and shallow topsoil and are generally footed upon bedrock or weathered saprolite materials. Bedrock vertical control dominates all reaches except for those upper reaches in valley type VII. Sediment bedload is characterized by finer particles in the first-order reaches, coarsening to gravels and small cobble through second and third order tributaries.

Stream channels in southern Guam are storm-dominated flow regime channels. Significant storm events provide sufficient runoff frequency and magnitude of discharge sufficient to transport sediment and form channel morphology. Sediment sources include overland flow, bank erosion, and colluvial sources such as landslides.

Suspended sediment is transported throughout all orders of stream reach. No stream reaches were observed with opportunity to significantly settle, accrete, or otherwise remove suspended sediments from the stream system. As such, suspended sediments are not deposited until they reach the coastal receiving waters.

4.3 Depositional Environments

As no significant coastal wetland zones or other connected floodplains exist where sediment can be deposited prior to the tidal coastal zone, a particle of sediment washed from the first-order tributaries in the upper watershed of Manell or Geus will ultimately reach the tidal zone. Aside from gravel bars, it can be assumed that any sediment which enters the stream systems, including suspended sediment, can be expected to ultimately be transported to the shallow marine zone of the island. Once it enters the shallow marine zone, it is subject to smothering coral, decreasing water quality, and being transported by long-shore sediment transport processes, increasing its range of impact on benthic communities and impacting aesthetics of the coastal waters.

5.0 ASSESSMENT, SITE SURVEY, AND IMPLEMENTATION OF FIELD ACTIVITIES

The purpose of this section is to describe the survey activities, observations for the field investigation, and implementation activities.

5.1 Existing Data or Data Limits

Multiple sources of existing data were used to assist in the field efforts. Aerial photography, soil maps, LIDAR topography, and existing parcel mapping data were utilized to conduct initial desktop reconnaissance and understand watershed traits, slopes, and runoff potential. These data were integral to determining landform cover types, presence of existing roads and access points, and determining which sites were viable for investigation.

5.2 Field Data Collected

Field data was collected for the study sites. This data included measurement of study site slope using an inclinometer, dimensions of study sites, proximity to drainages and streams, visual evaluation of canopy cover and root density or ground cover, and presence of topsoil. Notable geologic features, the composition of existing vegetation and the presence of invasive species were also recorded for the sites.

5.2.1 Site Reconnaissance

A site reconnaissance was conducted prior to survey field activities to identify access into the watershed areas. Several locations of potential priority sites were flagged prior to commencing survey field work. No Unexploded Ordinance was observed at the sites during the site reconnaissance.

5.2.2 Vegetation Clearing

Vegetation was cleared during the site reconnaissance activity. Minimum hand clearing was performed to cut foot trails through the thick vegetation to access the Geus watershed area and the demonstration sites. Vegetation clearing was not required at the Manell watershed area to access the demonstration sites. Natural re-vegetation occurs rapidly on Guam; therefore, no vegetation restoration was performed. Minimal disturbed areas were expected to re-vegetate naturally.

5.2.3 Screening Parameters for Site Selection

Utilizing the known sources of sediment and natural stream succession and recovery sequence, EA evaluated several key parameters in the selection of pilot project sites. These include:

- *Proximity to the Stream Channel*. Sites immediately adjacent to the stream channel were preferred over more isolated sites.

- *Site Slope.* Sites with steep slopes subject to colluvial forces or high velocity sheet flows were observed as higher risk and needing restoration more than sites with gentle slopes.

- *Density of Vegetation and Presence of Invasive Species.* EA's field observations indicated that site burning and invasive species both have similar effects in displacing native vegetation and creating sources of erosion. Additionally, absence of either canopy, understory, or both were seen as increasing priority of restoration over sites that contained vegetation. Canopy and understory provide valuable energy dissipation capacity of intense rainfall, and combined with root cover, reduce potential for erosion via sheet flow.

- *Presence of Topsoil.* Sites to be restored with vegetation must have existing topsoil to support those plants. Although many sites in the Manell watershed appear brown and un-vegetated, many of these sites are exposed saprolite and are not significant contributors of sedimentation.

- *Proximity to Hillside Slump, Head Cut, or Colluvial Features.* These locations are concentrations of fine sediments before they enter the stream channel. Stabilizing these sites with vegetation is seen as a priority approach to prevent sedimentation.

5.2.4 Manell Site Selection and Evaluation

Based on the site selection assessment, three demonstration sites were identified in the Manell watershed. The Manell test plots are located in the upland savannahs in close proximity to first order tributaries, head cuts, and colluvial features. Site disturbance in these areas is predominantly from periodic burning of the grassland. Despite the apparent grass cover, vegetative cover is quite poor and insufficient to prevent detachment of soil particles by rain and subsequent erosion during runoff events. Persistent trade winds, high elevations, and extreme winds from storm events and super typhoons also may limit vegetation in these portions of the watershed.

Site 1, 2, and 3 include the following dimensions and practices:

- Site 1: A 10 ft x40 ft, riparian planting and staking restoration area adjacent to a first order drainage plot.
- Site 2: A 15 ft x15 ft, hillside slump planting site in an adjacent soil type plot.
- Site 3: An additional 15 ft x15 ft, tree and shrub planting adjacent to a hillside slump and head cut plot.

Although other sites in the watershed were potential restoration areas, these demonstration sites represented the most accessible sites. Other BMP practices, such as utilizing biodegradable soil stabilization fabrics, may be utilized at these sites in the future if access and budget constraints allow. These materials may enhance the stability of the sites as vegetation becomes established.

5.2.5 Geus Site Selection and Evaluation

Based on the site selection assessment, two demonstration sites were identified in the Geus watershed. The Geus sites are in close proximity to each other. Located in existing forested conditions, the sites are on the edge of existing reference condition native forest and invasive-species (bamboo) dominated forest. The site is situated near a steep slope, and directly up-gradient of a large first order tributary drainage and associated head cut.

Site 1 and Site 2 include the following dimensions and practices:

- Site 1: A 35 ft x35 ft reforestation and invasive species control plot.
- Site 2: A 10 ft x10 ft understory enhancement plot.
- Site 1 and Site 2: A series of vetiver grass filter strips.

Although additional sites in the Geus watershed were evaluated, multiple sites with potential were ruled out due to the extreme inaccessibility, or constraints relating to property ownership or existing land uses. Additionally, particularly in the lower Geus watershed, work to effectively control erosion would entail bank grading, stone, or other treatments which would require earthwork in addition to planting.

5.2.6 Conclusions Regarding Channel Evolution and Potential for Self-Recovery

Due to frequent burning adversely affecting vegetation germination and recruitment, stream channel evolution remains stationary at a degrading/widening stage, with colluvial forces continuing to supply sediment even after incision is halted due to presence of bedrock. Fluvial erosion forces then transport this colluvium to reaches downstream and ultimately to coastal zones. Although variations to this successional channel evolution may occur, channel evolutionary stage is locked into a degradation stage, contributing fine sediment downstream with little hope of reaching dynamic equilibrium as watershed disturbance and lack of vegetation establishment continues.

5.3 Notifications and Permits

Prior to field activities all required permits were acquired. The following notifications and permits were acquired:

- Informal consultation under Section 7 of the Endangered Species Act of 1973
- Coastal Zone Management Act (CZMA) determination

- Formal consultation under Section 106

An informal consultation under Section 7 of the Endangered Species Act of 1973 was approved on October 18, 2013 stating that the project activities may affect, but are not likely to adversely affect the federally endangered Mariana swiftlet *(Aerodramus bartschi)* and the threatened Mariana fruit bat *(Pteropus mariannus mariannus).* The consultation letter is included in Appendix B.

The CZMA determination letter for this project was determined to be consistent with the objectives and policies of the Guam Coastal Management Program, in accordance with the Coastal Zone Management Act of 1972 (P.L92- 583), as amended (P.L94-370) on November 22, 2013. The determination letter is included in Appendix B.

Project personnel were briefed on recognition and reporting of archaeological features during a site visit and coordination with the Guam State Historic Preservation Office (SHPO) Archaeological Technician, Mr. Masga. Mr. Masga provided an in-field training exercise for all personnel performing field activities. During the site visit Mr. Masga made his observations along the foot trail leading into the Geus sites and at both Geus sites. Several plants were installed at both Geus sites to demonstrate the installation methods being used for the project. The formal Section 106 review approval was granted on December 1, 2014. The consultation letter is included in Appendix B.

5.4 Field Implementation

Implementation of demonstration projects was initially scheduled to begin on August 19, 2013, with the plant material procured and maintained in the source nursery several months prior to implementation. However, coordination with the Guam State Historic Preservation Office was protracted and actual project implementation was delayed until December 11, 2014. As a result of delays, plant mortality occurred and surviving plants matured over the period of time.

As conditions in the field varied from when the field assessment was initially made, it was necessary to implement minor modifications to planting methods presented in the work plan. These minor modifications were discussed and agreed upon by the NOAA Point of Contact (POC) prior to implementation activities.

A variety of native and one non-native species were selected for their ability to stabilize soils, through quick growth, and extensive root systems. These species, with the exception of vetiver grass (*Chrysopogon zizanioides*), a non-native rhizomatous grass species, are also present in reference areas identified during the initial assessment.

Table 1 shows the proposed plants scientific name, common or Chamorro name, area to plant, and total quantity of plants planned initially during the assessment.

Table 1. Proposed Plant Species List

Scientific Name	Common or Chamorro Name	Area to Plant	Total Plants at Manell	Total Plants at Geus
Woody shrubs				
Morinda citrifolia	Lada or Noni	Manell & Geus	0	35
Hibiscus tiliaceous	Pago (Installed as live stakes)	Manell & Geus	312	28
Neisosperma oppositifolia	Fagot	Geus only	0	8
Ferns				
Thelypteris opulenta	N/A	Geus only	0	85
Nephrolepis hirsutula	Sword Fern	Manell & Geus	0	85
Polypodium scolopendrium	Monarch Fern	Manell & Geus	0	85
Grass				
Chrysopogon zizanioides	Vetiver grass	Manell & Geus	1232	353
Trees				
Artocarpus mariannensis	Dukduk	Geus only	0	2
Artocarpus altilis	Lemai	Geus only	0	2
Pandanus tectorius	Kafu	Manell & Geus	12	8
Pandanus dubius	Pahong	Geus only	0	5
Cocos nucifera	Coconut (3 year)	Manell & Geus	12	4

Table 2 shows the plants that were installed at both the Geus and the Manell site locations. The table includes the scientific name, common or Chamorro name, area to plant, and total quantity of plants installed at Geus and Manell site locations.

Table 2. Installed Plant Species List

Scientific Name	Common or Chamorro Name	Area to Plant	Total Plants at Manell	Total Plants at Geus
Woody shrubs				
Morinda citrifolia	Lada or Noni	Manell & Geus	0	32
Hibiscus tiliaceous	Pago (Installed as live stakes)	Manell & Geus	64	12
Neisosperma oppositifolia	Fagot	Geus only	0	4
Ferns				
Polypodium scolopendrium	Monarch Fern	Manell & Geus	0	*275
Grass				
Chrysopogon zizanioides	Vetiver grass	Manell & Geus	*1250	*500
Trees				
Pandanus tectorius	Kafu	Manell & Geus	12	23
Cocos nucifera	Coconut (3 year)	Manell & Geus	13	7
* approximate totals				

Transport of project materials and equipment, and access into the sites were done by foot. Hand tools such as shovels, picks, spades, machetes, etc. were used during implementation. No heavy equipment was used during project activities. No Unexploded Ordinance was observed at the sites during the site implementation activities.

5.4.1 Invasive Species Treatment

The removal of some unwanted invasive bamboo (*Bambusa vulgaris)* was required during planting activities. Bamboo is taxonomically a grass, but its habit is tree-like. It forms dense stands of cylindrical, jointed woody stems that can grow up to 60 ft in height and 1.5 - 4 inches in diameter. Bamboo branches appear from the nodes and have narrow lanceolate leaves. The bamboo was sprayed and treated with the herbicide glyphosate using the recommended rates specified on the label. An approval was granted by the Guam Environmental Protection Agency for the use of glyphosate on bamboo at the Geus site. The bamboo was sprayed with one application at the bases of intact and the cut bamboo culms. The herbicide application was performed by a licensed pesticide applicator.

5.4.2 Planting Methods

The plant species mix represented a combination of woody, herbaceous, and understory canopy species. A hole was dug up to 40% wider than the container the plants were grown in. When root-bounded plants were encountered the root system was slit, flared out, and pruned over the planting hole before installation. When more than 20% of the vetiver grass root system was pruned, the leaf area was proportionately removed before plant installation. The plant root balls were installed just below the natural ground level and then the hole was backfilled with soil and packed well to remove air-pockets to provide the plants vertical stability.

Vetiver grass clumps were separated from the container into individual grass slips and the leaves were cut back leaving approximately six inches in length. A three inch hole was dug approximately every three to four inches and the vetiver grass slips were placed in the holes, then soil was backfilled and packed well to remove air-pockets.

Live stakes consisted of freshly cut pago (*Hibiscus tiliaceous*) branches typically between a quarter and three quarters of an inch in diameter and 1.5 ft long. They were installed with the bud end up, and bottom cut at an angle to facilitate driving them into the ground. Pago is a species which is relatively easy to grow by cuttings and directly placing into the soil.

5.4.3 Manell Site Field Implementation

Manell test plots were located in the upland savannahs in close proximity to first order tributaries, head cuts, and colluvial features. Site disturbance in these areas is predominantly from periodic burning of the grassland. Despite the apparent grass cover, vegetative cover is quite poor and insufficient to prevent detachment of soil particles by rain and subsequent erosion during runoff events. Persistent trade winds, high elevations, and extreme winds from storm events and super typhoons also may limit vegetation in these portions of the watershed.

Site 1, 2, and 3 include the following actual dimensions and implemented practices:

- Site 1: A 14 ft x 33 ft, riparian planting and staking restoration areas adjacent to a first order drainage plot.
- Site 2: A 32 ft x 28 ft, hillside slump planting site in an adjacent soil type plot.
- Site 3: An additional 20 ft x 20 ft, tree and shrub planting adjacent to a hillside slump and head cut plot. A deep gully was planted with vegetative barriers and a log check dam.

A photograph log of field implementation activities is included in Appendix A. Detailed descriptions of activities in each site are provided below.

Site 1

Site 1 is 14 ft x 33 ft in dimension. Within the plot one row of vetiver grass, six coconuts (*Cocos nucifera)*, and 31 pago live stakes were planted. One row with 22 linear feet of vetiver grass was planted at approximately 4 slips per foot. One row with six coconuts was planted approximately eight feet apart and pago live stakes were planted midway between the coconuts. All other pago live stakes rows were secured in the ground approximately four feet apart. All rows run perpendicular to the slope (parallel with the contours).

Site 2

Site 2 is 32 ft x 28 ft in dimension. Two rows of vetiver grass, seven coconuts, six pandanus (*Pandanus tectorius)*, and 21 pago live stakes were planted in the plot. Two alternating rows with 15 linear feet of vetiver grass were planted at approximately four slips per foot. Each row was planted parallel from each other at one foot apart. Seven coconuts were planted approximately eight feet apart and pago live stakes were planted midway between the coconuts. Two rows of pandanus were planted approximately eight feet apart and pago live stakes were planted midway between the pandanus. All other pago live stakes rows were secured in the ground approximately every four feet. All rows run perpendicular to the slope (parallel with the contours).

Site 3

Site 3 is 20 ft x 20 ft in dimension. One row of vetiver grass, six pandanus, 12 pago live stakes were planted in the plot. One row with 20 linear feet of vetiver grass was planted at approximately four slips per foot. Two rows of pandanus were planted approximately eight feet apart and pago live stakes were planted midway between the pandanus. All rows of live stakes were planted perpendicular to the slope (parallel with the contours). All other pago live stakes was used to build and secure the log check dams.

One log check dam was installed within Site 3. A log check dam’s main purpose is to hold fine and coarse material carried by flowing water in the gully and to stabilize gully heads by slowing down the velocity of water. This enables the water to percolate into the ground, through the small void spaces between the logs and at the top of the spillway. The log check dams and posts were made of pago live stakes and were placed across (perpendicular) the gully and keyed into the sides of the gully wall for dam stability. The posts were used to secure the logs in place. The maximum height of the log check dams is approximately nine inches from the ground level. The check dams are approximately two feet in length. Both its downstream and upstream face inclination are approximately 20 percent backwards. Vetiver grass was planted within the gully, both in front and behind the log check dams. Further down the gully, three pandanus were also planted approximately six feet apart, running parallel with the slope.

5.4.4 Geus Site Field Implementation

The Geus demonstration sites are in close proximity to each other. Located in existing forested conditions, the site is on the edge of existing reference condition native forest and invasive-species (bamboo) dominated forest. The site is situated near a steep slope, and directly up-gradient of a large first order tributary drainage and associated head cut.

Site 1 and Site 2 include the following actual dimensions and implemented practices:

- Site 1: A 75 ft x 36 ft, reforestation and invasive species control plot, a planting of a series of vetiver grass filter strips and installation of log check dams within the gullies.
- Site 2: A 10 ft x10 ft, understory enhancement plot and planting of a series of vetiver grass filter strips.

A photograph log of field implementation activities is included in Appendix A. Detailed descriptions of activities in each site are provided below.

Site 1

Site 1 encompasses a 75 ft x 36 ft area. Within the plot a 45 ft x 36 ft area was planted with five rows of vetiver grass, 30 lada (*Morinda citrifolia)*, four fagot (*Neisosperma oppositifolia*), 275 monarch ferns (*Polypodium scolopendrium*), 23 pandanus, seven coconuts, and five pago. Pandanus were planted approximately eight feet apart and lada, coconut, pago, and fagot were planted interspersed midway between the pandanus. The monarch ferns were planted interspersed midway between the lada, coconut, pago, and fagot. Five rows with 2.5 linear feet of vetiver grass were planted in a small gully at approximately four slips per foot. All rows run perpendicular to the slope (parallel with the contours).

Within the plot a 16 ft x 15 ft area was planted with four rows of vetiver grass and two lada. Five pago live stakes and dead bamboo stems were used to build and secure two log check dams.

The first log check dam and posts was made from dead bamboo stems and five pago live stakes. The pago live stakes were used as posts to secure the logs in place. The length of the log check dam is approximately four feet and one foot in height from the ground level. Two alternating rows of vetiver grass were planted in front of the log check dam. The vetiver grass rows are approximately 7.5 ft in length and were planted perpendicular to the slope.

The second log check dam and posts was made from dead bamboo stems. The posts were used to secure the logs in place. The length of the log check dam is approximately 11 feet and the height from ground level is eight inches. Two alternating rows of vetiver grass were planted in front of the log check dam. The vetiver grass rows are approximately 15 ft in length and were planted perpendicular to the slope.

Both log check dams were placed across (perpendicular) the wide gully and keyed into the side of the gully wall for dam stability. The downstream and upstream face inclinations of the dams are approximately 10 to 15 percent backwards.

Within the plot, three bamboo clumps were sprayed and treated with the herbicide glyphosate using the recommended rates specified on the label. The bamboo was sprayed with one application at the bases of intact and the cut bamboo culms.

Site 2

Site 1 is 10 ft x 10 ft in dimension. Within the plot, three alternating rows of vetiver grass and four pago live stakes were planted. Three one foot spaced alternating rows with ten linear feet of vetiver grass were planted at approximately four slips per foot. Four pago live stakes were planted within the plot with random spacing.

5.5 Demobilization

After completing the field activities, all equipment and supplies used were demobilized from the project sites. All trash was cleaned up prior to demobilization from the sites.

6.0 RECOMMENDATIONS

6.1 Vegetation Control

EA selected best management practices to address potential erosion sources and mechanisms. Additionally, the selected practices recognize constraints of the sites, such as accessibility, and local availability of materials. Planting and seeding are recognized as the most cost effective and implementable means of achieving erosion control for the study sites. Planting is recommended adjacent to drainages and streams; however it is not recommended within the channels itself. Planting inside of the stream banks is likely to be unsuccessful due to washout from large stream flows. EA identified several primary practices:

- *Containerized Stock Planting.* The installation of larger containerized stock plants is essential to establishing tree canopy and understory shrubs at the restoration sites. The highest cost alternative, containerized plants, also has the greatest survivability compared to other practices.

- *Live Stake Planting.* Live stakes of pago is a cost effective means of introducing vigorous riparian vegetation to the sites. Rapid growing and tolerant of wet or dry conditions, pago live stakes can aid in the restoration of native vegetation to these sites.

- *Bare Root Planting.* Bare root specimens of vetiver grass at four stems per linear foot were selected to hold deep loose soil such as in colluvial deposits, as well as create vegetative filter strips near channels and head cuts to limit the surface transport of sediment into stream channels. Vetiver is a non-native species from Southeast Asia, however it does not produce seed and spreads through rhizomatous action. It is seen as a local control for erosion with low risk of spreading to pristine habitats as an invasive species. Coupled with tree and shrub plantings, it is likely to be eventually shaded and replaced by native species, once canopy is established.

- *Herbaceous Plantings.* Native herbaceous ferns is an essential part of the native forest community. Establishing groundcover in planting areas will reduce erosive potential through sheet flow and runoff.

These practices were implemented using the plant species found in Table 2.

6.2 Invasive Plant Species Control

The control of invasive species is essential to reducing erosion. Invasive species in the forested areas of the study watersheds displace native vegetation and are observed to reduce vegetative cover, particularly groundcover. At the very least, the initial control of invasive species is recommended as part of the maintenance of the demonstration plots.

6.3 In-Stream Control

In-stream restoration measures must be able to aid in the natural recovery of streams, and if implemented, would also require the establishment of riparian vegetation. If a natural system is to replace the impaired stream systems, vegetation must be present to stabilize bare soil, slow runoff, and support stream banks.

In-stream restoration and stabilization measures generally involve the placement of stone, logs, or various products to resist shear stress, protect banks, and foster recovery of the stream bed and banks to a dynamic equilibrium. This involves grading, excavation, and the alternation of stream base level to connect the existing channel with a floodplain. Several practices could be implemented:

- Log revetment/rootwads could be installed to form stable sills and deflect energy from banks. This approach could be instituted in areas of moderate impairment with some stable floodplain benches.

- Stone bank protection could be installed in areas where extensive grading and floodplain restoration could not be instituted. These approaches are particularly useful for protecting roads, existing trees and infrastructure.

- In-channel stone vanes and step pools could be installed to reduce flow energy and uplift stream channels.

In-stream controls require engineering study, design, and hydraulic analysis. While potentially viable in some instances in the studied watersheds, their viability at the study sites was limited.

6.3.1 Protection of Installed Vegetation

Planting immature seedlings should be protected from weeds and animals (ungulates) or other organisms as necessary to ensure suitable plant establishment. Applying organic mulch around trees or shrubs will help to conserve moisture and control weeds. Individual tree protection or fencing of the entire test plot can be utilized as determined in the field to best protect the plantings. This may vary based on individual site conditions and size of test plots.

6.4 Monitoring and Maintenance

Following successful installation of plantings, within the first month, the plantings should be inspected and monitored for proper establishment. Any damage, distress, or infestations or diseased plants should be recorded. Plants that are found dead within the first few months should be replaced.

The ultimate survivability of the test plots should be measured one year following installation. This should be measured as a count of living stock compared to as-built recorded installation counts.

Periodic maintenance of new plantings should occur. Continue to remove bamboo and other unwanted vegetation and debris which can inhibit growth. When new bamboo growth near the plots is observed, immediately cut and/or spray glyphosate herbicide over the entire clump. Several treatments must be done to effectively kill the bamboo. Watering should occur if unexpected dry weather occurs; otherwise, the rainy season should be sufficient for watering the plant stock. If reduced plant growth is observed, a periodic application of complete fertilizer (nitrogen, phosphorus, potassium) may be warranted to expedite plant establishment.

During maintenance activities, disturbed areas and sediment controls, including the log check dams and filter strips, should be inspected to ensure the controls are in place and adequately functioning. If sediment inspections indicate that a control is not functioning properly, the control should be replaced or modified.

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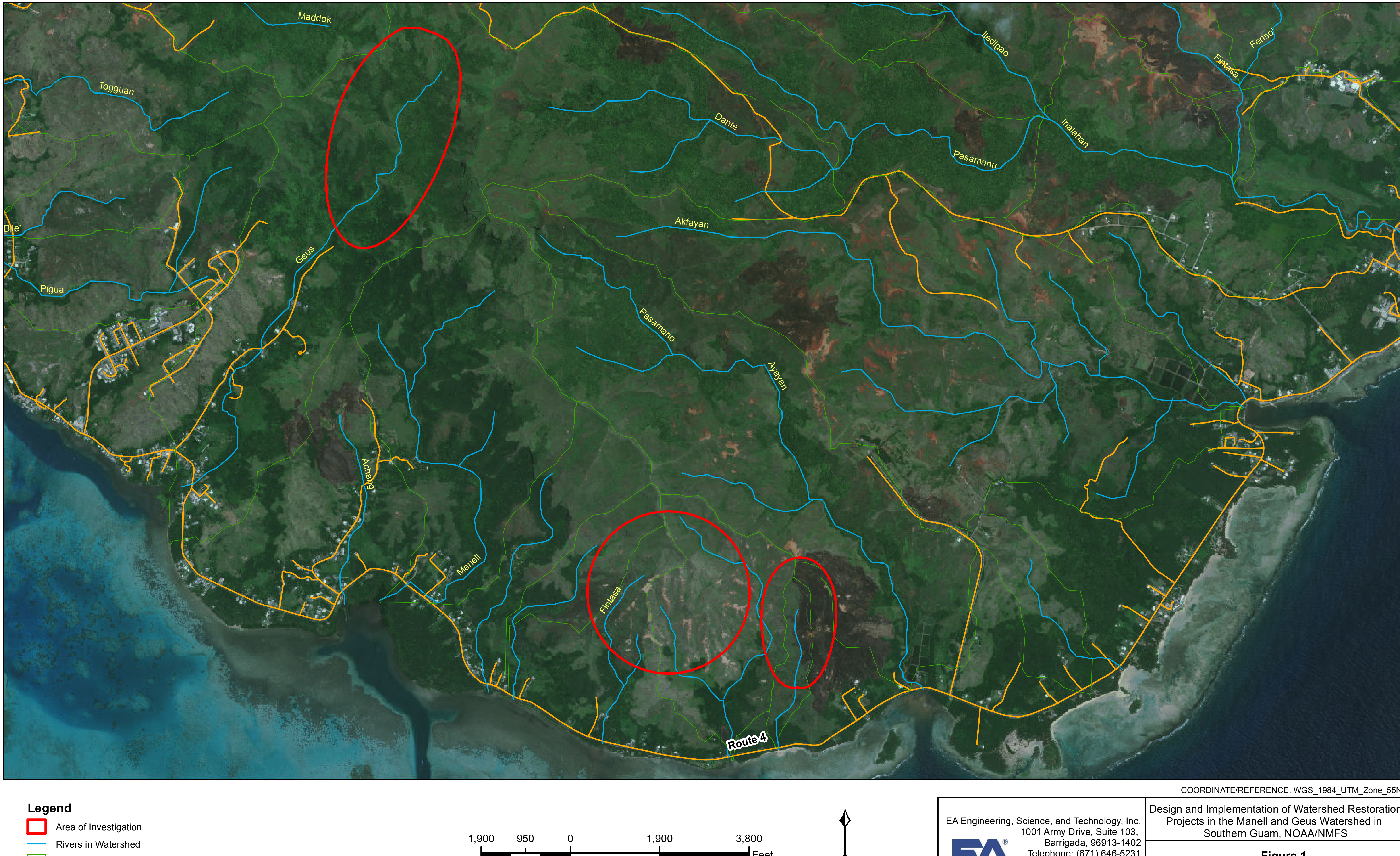
Figures



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Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watershed in Southern Guam, NOAA/NMFS

Figure 1
Vicinity Map

Drawing No. NOAA_Manell and Geus Watersheds_Fig 1_Vicinity Map	Date: 02/18/13	Drawn By: JSoriano	EA Project No.6266201

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COORDINATE/REFERENCE: WGS_1984_UTM_Zone_55N

Legend

- Site 1: 35 FT X 35 FT
- Site 2: 10 FT X 10 FT
- River in Watershed

60 30 0 60 120 Feet

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Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watersheds in Southern Guam, NOAA/NMFS

Figure 2
Geus Watershed Site Location

Drawing No. NOAA_Manell and Geus Watersheds_Fig 2 Geus Watershed	Date: 05/20/13	Drawn By: JSoriano	EA Project No.6266201

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Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watersheds in Southern Guam, NOAA/NMFS

Figure 3
Manell Watershed Site Location

Drawing No. NOAA_Manell and Geus Watersheds_Fig 3 Manell Watershed	Date: 05/20/13	Drawn By: JSoriano	EA Project No.6266201

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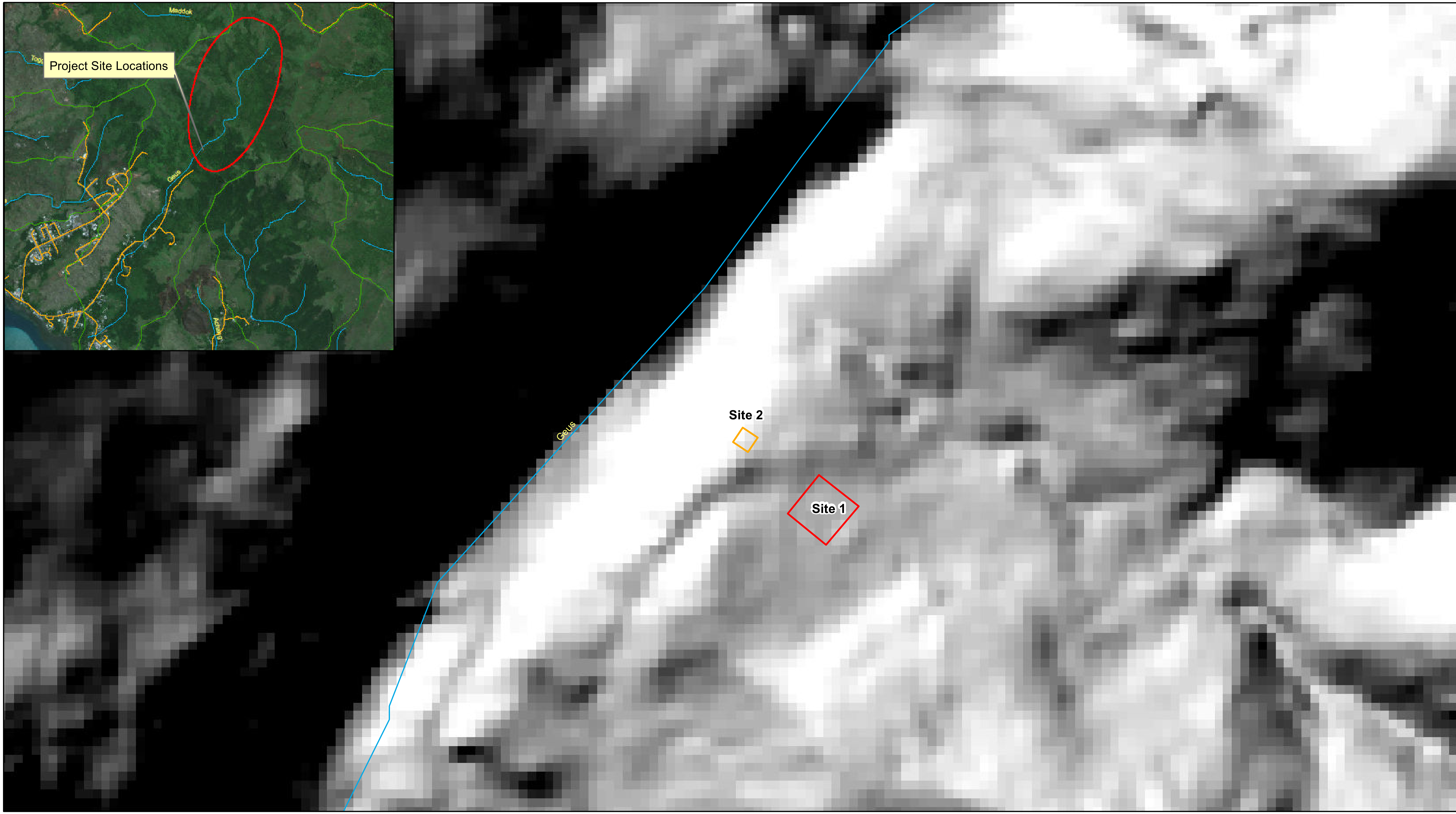

COORDINATE/REFERENCE: WGS_1984_UTM_Zone_55N

Legend

- Site 1: 35 FT X 35 FT
- Site 2: 10 FT X 10 FT
- River in Watershed

bareearth2m

Value

High : 254

Low : 0

70 35 0 70 140 Feet

EA Engineering, Science, and Technology, Inc. 1001 Army Drive, Suite 103, Barrigada, 96913-1402 Telephone: (671) 646-5231 Facsimile: (671) 646-5230	Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watersheds in Southern Guam, NOAA/NMFS **Figure 4** **Geus Watershed - Lidar Map**

Drawing No. NOAA_Manell and Geus Watersheds_Fig 4 Geus Watershed -Lidar	Date: 05/20/13	Drawn By: JSoriano	EA Project No.6266201

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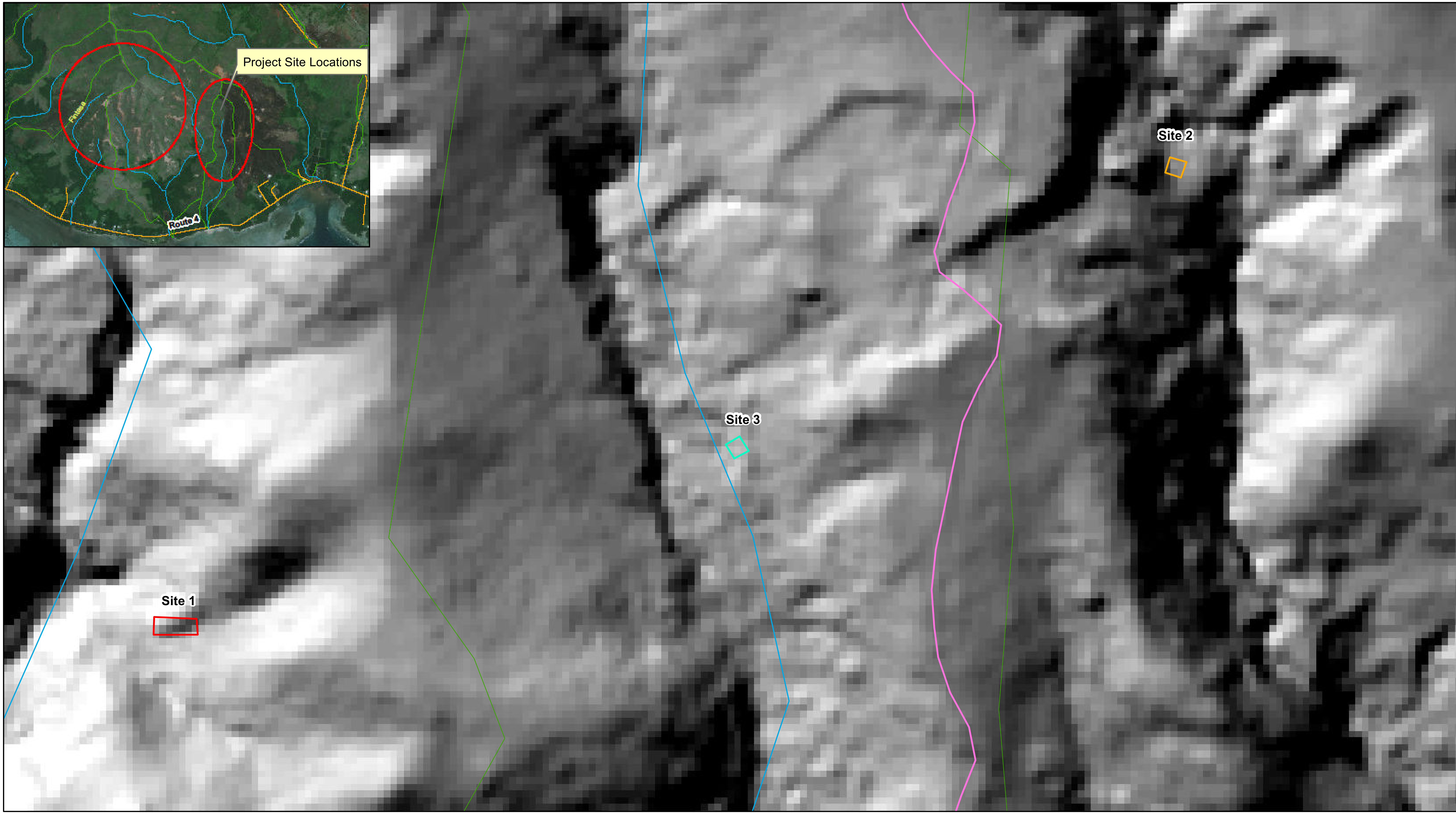

COORDINATE/REFERENCE: WGS_1984_UTM_Zone_55N

Legend

- Site 1: 10 FT X 40 FT
- Site 2:15 FT X 15 FT
- Site 3: 15 FT X 15 FT
- Access Route
- River in Watershed
- River in Sub watershed

bareearth2m

Value

High : 254

Low : 0

90 45 0 90 180 Feet

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Design and Implementation of Watershed Restoration Projects in the Manell and Geus Watersheds in Southern Guam, NOAA/NMFS

Figure 5
Manell Watershed - Lidar map

Drawing No. NOAA_Manell and Geus Watersheds_Fig 5 Manell Watershed Lidar	Date: 05/20/13	Drawn By: JSoriano	EA Project No.6266201

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Appendix A

Photograph Log

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PHOTOGRAPH LOG

Geus Watershed, Site 1

Geus Site 1

Geus Site 1, East End of Site

Geus Site 1, with Flagging

Geus Site 1, Downward Slope

Geus Watershed, Site 2

Geus Site 2

Geus Site 2, Overlooking Cliff

Geus Site 2, with Flagging

Geus Site 2, View Facing East

Manell Watershed, Site 1

Manell Site 1, View Facing Northeast Toward River

Manell Site 1, View Facing North

Manell Site 1, Beginning of Ravine

Manell Site 1, Soil Texture

Manell Watershed, Site 2

Manell Site 2, View Facing Northeast

Manell Site 2, View Facing East

Manell Site 2, View Overlooking Cliff

Manell Site 2, Sparse Vegetation Cover

Manell Watershed, Site 3

Manell Site 3

Manell Site 3, Collecting GPS Location Point

Manell Site 3, View Facing North

Manell Site 3, Bare Patch of Soil from Erosion

Geus Watershed, Site 1 Implementation

Geus Site 1, Plant Installation Completed

Geus Site 1, Installing plants

Geus Site 1, Preparing Vetiver Slips for Planting

Geus Site 1, Plant Installation Completed

Geus Watershed, Site 1 Implementation

Geus Site 1, Installed 1st Log Check Dam and Filter Strips

Geus Site 1, Completed Log Check Dams and Filter Strips

Geus Site 1, Installed 2nd Log Check Dam and Filter Strips

Geus Site 1, 2nd Log Check Dam and Filter Strips

Geus Watershed, Site 1 & Site 2 Implementation

Geus Site 1, Installation of Filter Strips in a Small Gully

Geus Site 1, Spraying Bamboo with Herbicide

Geus Site 2, Completed Installation of Filter Strips

Geus Site 2, Completed Installation of Filter Strips

Manell Watershed, Site 1 Implementation

Manell Site 1, Installation of Filter Strips

Manell Site 1, Installation of Filter Strips and Plants

Manell Site 1, Completed Installation of Pago Live Stakes

Manell Site 1, Installation Completed

Manell Watershed, Site 2 Implementation

Manell Site 2, Installing plants

Manell Site 2, Installation of Filter Strips and Plants

Manell Site 2, Installation Completed

Manell Site 2, Installation Completed

Manell Watershed, Site 3 Implementation

Manell Site 3, Installation Completed

Manell Site 3, Installation of Filter Strips and Plants

Manell Site 3, Installation of Filter Strips and Log Check Dam

Manell Site 3, Installation Completed

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Appendix B

Agency Correspondence

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
2013-I-0446

OCT 18 2013

Ms. Valerie A. Brown
National Marine Fisheries Service
Pacific Islands Regional Office
1601 Kapiolani Boulevard, Suite 110
Honolulu, Hawaii 96814

Subject: Informal Section 7 Consultation on the Manell-Geus Watershed Restoration Project, Guam

Dear Ms. Brown:

The U.S. Fish and Wildlife Service (Service) received your letter on September 9, 2013, requesting our concurrence that the proposed Manell-Geus Watershed Restoration Project may affect, but is not likely to adversely affect the federally endangered Mariana swiftlet (*Aerodramus bartschi*) and the threatened Mariana fruit bat (*Pteropus mariannus mariannus*). Our analysis and finding in this consultation are based on your letter dated September 4, 2013; emails between the Service and the National Marine Fisheries Service (NMFS); and other information available to us. This response is in accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 *et seq.*). A complete administrative record is on file in our office. Our response to this correspondence was delayed due to the recent lapse in federal appropriations and subsequent shutdown of our office.

Project Area

The Manell-Gues watershed is located in the southwest of Guam. Most of the watershed is located in Merizo Village. In the Manell Watershed, the restoration sites are located in the sub-watersheds of the Liyog River and Asgadao Creek. There is no development in this area; however most of the vegetated areas are highly degraded due to frequent wildfires. In the Gues Watershed, the restoration sites are located along the Gues River. Forest is present along the river, but there has been an increase in the non-native bamboo (*Bambusa vulgaris*). The project area includes approximately 0.07 acres.

Project Description

The NMFS proposes to stabilize stream banks and create riparian buffers in the Manell-Gues watershed. The project would include planting mostly native plants using hand tools, securing natural fiber mats with biodegradable stakes to the ground surface, and using rocks in the surrounding area in conjunction with vegetation. Native plantings would include *Morinda citrifolia*, *Hibiscus tiliaceous*, *Neisosperma oppositifolia*, *Thelypteris opulenta*, *Nephrolepis hirsutula*, and *Polypodium scolopendrium*. The non-native and non-invasive grasses *Cynodon dactylon* and *Chrysopogon zizanioides* would be used to enhance sediment retention and rapidly establish ground cover in the project sites.

The NMFS also proposes to manually cut and treat with herbicide a small stand of non-native bamboo within an approximate 35-foot by 35-foot area. The herbicides, Roundup or Rodeo (20 percent solution with the active agreement of glyphosate), would be applied to bamboo using the cut-stump method. Up to three applications of herbicide would be used on the bamboo.

The project plantings would be completed within 1 month, and restoration sites would be monitored for 6 months after plantings. Newly planted individuals that are not thriving would be replaced, as needed.

Conservation Measures

The following measures identified in your September 4, 2013, letter and September 12, 2013, email will be implemented at the project site to avoid and minimize project impacts to Mariana swiftlets and Mariana fruit bats. These conservation measures are considered part of the project description. Any changes to, modifications of, or failure to implement these conservation measures may result in the need to reinitiate this consultation.

1. Access into the watersheds will be on foot, with manual cutting of vegetation to create walking trails up along the rivers, when necessary.
2. No heavy equipment will be used during the project.
3. Project activities would be limited to restoration sites, and no project activities would be conducted in areas designated as wetlands. Personnel may transit through or near wetlands to get to sites, but will not implement any plantings or erosion control within wetlands.
4. If Mariana fruit bats or Mariana swiftlets are observed within the project area during project activities, work will stop until the bat or swiftlet leaves on its own.
5. All work activities will begin after sunrise and will conclude prior to sunset, between the hours of 7:30 am and 5:00 pm. No activities will occur at night.

Species Description

<u>Mariana swiftlet</u>

The Mariana swiftlet is endemic to the southern islands of the Mariana archipelago, and currently occurs on the islands of Guam, Aguiguan, and Saipan. Rota and Tinian once supported swiftlets, but the species has been extirpated from these islands. Saipan supports the largest number of swiftlets with estimates exceeding 5,000 individuals. Guam supports the second highest number of swiftlets with 1,150 individuals on Guam (Grimm 2008). Swiftlets have been introduced on Oahu, Hawaii; the most recent population estimate is 66 individuals (Cruz et al. 2008; Grimm 2008; Wile and Woodside 1999).

On Guam, the three caves known to have nesting and roosting swiftlets are located on Naval Base Guam in the north-eastern corner of the Naval Munitions Site. Observations at Mahlac cave indicated the majority, over 90 percent, of swiftlets occur outside of the cave between 0800 and 1500 hours. Most birds leave their cave at dawn to forage and return at sunset, though some return from foraging to roost in cave during the day. Although there are no observations of swiftlets within the project area, swiftlets forage in other watersheds, such as the Talofofo and Fena Valley watersheds.

<u>Mariana fruit bat</u>

The Mariana fruit bat (bat or fanihi) is endemic throughout the Mariana Islands. Although fanihi occur throughout the Marianas archipelago, healthy populations in the four southern islands are considered essential for recovery (USFWS 2009). In addition, planned training on northern islands such as Pagan (DON 2013) may negatively impact the status of the species as a whole since Pagan harbors the highest number of fanihi of the northern islands (USGS 2011). Of the southern islands, Guam and Rota have the highest numbers of fanihi in recent history, and have the largest areas of available suitable habitat for the species (USFWS 2009).

Fanihi rely on forest habitat that contains a diversity of food resources available throughout the year (USFWS 2009). They use both primary and secondary limestone forest habitat for foraging and roosting, and have been observed foraging in non-native forests (USFWS 2009). Major threats in Guam include hunting by humans, predation on young by brown treesnakes (*Boiga irregularis*), and habitat loss and degradation (USFWS 2009).

Population numbers of fanihi in Guam have declined throughout the past century, and current numbers are less than 30 bats (NAVFAC 2013). The most recent colony to exist on Guam was at Pati Point, at the northern end of the flight line on Andersen Air Force Base (AAFB). Counts within the past two years have indicated that this colony has been abandoned, but fanihi have been observed in 2012 in areas of AAFB. Fanihi also have been observed in low numbers at the Naval Base Guam during surveys in 2008. Fanihi have not been observed using the project area, but the area is within its historic range.

Effects of the Action

Potential effects to Mariana swiftlets and Mariana fruit bats from implementation of the proposed action are disturbance from noise or movement of personnel or equipment used for restoration activities. Disturbance would result in the displacement of swiftlets or bats that forage or roost (for bats) within the project area. However, based on the low likelihood of swiftlets or bats being present within the project area, we consider effects to both species to be discountable or unlikely to occur. In the unlikely event that a swiftlet or bat is present within the project area, the NMFS has proposed that all project activities would stop until the swiftlet or bat has left on its own. Displacement as a result of project activities would only occur if project personnel did not observe a swiftlet or bat in time to cease activities before disturbance to these species occurred. However, we consider effects to these species from displacement to be insignificant as it is expected that swiftlets and bats would be able to readily use adjacent habitat and resume their normal behavior.

In addition, the manual application of the herbicides, Rodeo or Roundup, to bamboo is expected to have insignificant effects to Mariana swiftlets and Mariana fruit bats. These two herbicides contain the active ingredient glyphosate which have been extensively investigated for their potential adverse effects in non-target organisms. The glyphosate formulations have been determined to be of minimal risk to the environment (USEPA 1993, WHO 1994). Furthermore, the herbicides would be manually applied over a small area and per the labels' instructions to avoid drift and run-off.

Conclusion

The NMFS will ensure the implementation of conservation measures to avoid and minimize the above potential effects to Mariana swiftlets and Mariana fruit bats. Therefore, we concur that the proposed project may affect, but is not likely to adversely affect, swiftlets and bats. Unless the project description changes, or new information reveals that the proposed project may affect listed species in a manner or to an extent not considered, or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to section 7 of the ESA is necessary.

If you have any questions regarding this consultation, please contact Leilani Takano, Fish and Wildlife Biologist, (phone: 671-355-5096, email: leilani_takano@fws.gov).

Sincerely,

for Loyal Mehrhoff
Field Supervisor

Literature Cited

Cruz, J.B., S.R. Kremer, G. Martin, L.L. Williams, and V.A. Camacho. 2008. Relative abundance and distribution of Mariana swiftlets (Aves: Apodidae) in the Northern Mariana Islands. Pacific Science 62: 233-246.

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Eddie Baza Calvo
Governor of Guam

Ray Tenorio
Lieutenant Governor

BUREAU OF STATISTICS & PLANS

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Lorilee T. Crisostomo
Director

NOV 22 2013

Ms. Valerie A. Brown
Fishery Biologist, NMFS Pacific Islands Regional Office
Habitat Conservation Division
Guam Field Office
P.O. Box 315488
Tamuning, GU 96931

Hafa Adai Ms. Brown:

The Bureau's Guam Coastal Management Program (GCMP) has completed the review of the Federal Consistency Determination that you have submitted for the proposed project to "Implement Watershed Restoration Projects in the Manell-Geus Watershed" in Merizo, funded by the NOAA's Coral Reef Conservation Program, Fisheries Pacific Islands Regional Office (PIRO).

The restoration project will stabilize the stream banks of Manell-Geus river and create riparian buffers to reduce stream velocity and the amount of sediment entering the downstream coastal waters, following the two types of erosion controls designed by the contractor, EA Engineering, Science, and Technology, Inc. namely: 1) Stream bank stabilization using vegetative material to include native plants and grasses; and 2) Riparian buffer strips using vegetative methods and/or natural fibers and/or other appropriate methods. The work will involve planting typical containerized trees and vegetations using hand tools, securing natural fiber mats with biodegradable stakes and used rocks in the surrounding area or shrub of varying sizes and natural fibers; and installation of riparian buffer strip using vegetation and/or natural fibers or other appropriate methods, as fully described in the submitted drawing plans. Implementation of best management practices within each area will help assess the low cost, low maintenance options that can be implemented on similar watershed conditions in Guam.

Based on the description of the proposed activity and indicated close coordination with us and other Federal and local agencies including US Fish and Wildlife Service, National Marine Fisheries, US Army Corps of Engineers, Guam Environmental Protection Agency, Guam Department of Agriculture, the State Historic Preservation Office, the National Resource Conservation Service and the Merizo Mayor's Office, the Bureau concurs that this proposed project is consistent with the objectives and policies of the Guam Coastal Management Program, in accordance with the Coastal Zone Management Act of 1972 (P.L92-583), as amended (P.L94-370). This Federal Consistency statement, however, does not preclude the need to obtain other Federal and local Government of Guam approvals, clearances and/or waivers.

Si Yu'os Ma'ase,

LORILEE T. CRISOSTOMO
Director

cc: GEPA
DPR
DLM
ACOE
NOAA/A. Loerzel

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Eddie Baza Calvo
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Ray Tenorio
Lt. Governor

Raymond F.Y. Blas
Director

In reply refer to:
RC 2014-0209

December 1, 2014

Valerie A. Brown
Fishery Biologist
USDC, NOAA
National Marine Fisheries Service
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg. 176
Honolulu, Hawaii 96818

Subject: Section 106 Review
Undertaking: Manell-Geus Watershed Restoration Pilot Project

Dear Ms. Brown:

Thank you for consulting with us and coordinating with Mr. Masga, historic preservation program Archaeological Technician, to provide an in-field training exercise for your personnel at the Geus location. Based on his field observations, a review of the Manell project locations and a discussion with Jaquay Soriano concerning field procedures, we concur with your findings of "no historic properties affected". We hope that the project yields its desired results.

If you have any questions or need further assistance from our office, please do not hesitate to contact us.

Sincerely,

Raymond F. Y. Blas
Director

Lynda Bordallo Aguon
State Historic Preservation Officer

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