WETLANDS OF MARINE CORPS BASE HAWAII ISLAND OF OAHU, HAWAII

U.S. Army Corps of Engineers
Honolulu District

FINAL
July 2009

EXECUTIVE SUMMARY

In 2002, Marine Corps Base (MCB) Hawaii and the U.S. Army Corps of Engineers performed a wetland survey at its properties in Kane'ohe Bay, Waimanalo, Camp Smith, and Waikane Valley, all on the island of Oahu. As part of the update to MCB Hawaii's Integrated Resources Management Plan, the Environmental Compliance and Protection Department (here after referred to as the "Environmental Department"), of MCB Hawaii has tasked the U.S. Army Corps of Engineers (COE) Honolulu District to revisit some of these wetlands and to delineate other areas on MCB Hawaii, Kaneohe Bay, and Marine Corps Training Area Bellows (MCTAB). The delineations were performed in accordance with the COE 1987 Wetland Delineation Manual. This report is a supplement to the 2002 survey and contains the documentation which went into the delineation process.

During this study, several wetland boundaries have changed since the 2002 delineation. For example, a wetland improvement project was undertaken at the percolation ditch which more than doubled the wetland footprint. The following table summarizes the wetland changes from the 2002 delineation.

Wetland	**2002 Area (sf)**	**2009 Area (sf)**
Hale Koa	52,741	86,631
Sag Harbor	32,109	30,545
Percolation Ditch	41,266	93,018
Lower Waimanalo Stream (New)	N/A	53,754
Total	126,116	263,948

In 2002, wetland located on Bellows Air Force Station (AFS) was mistakenly delineated and referred to as the lower Waimanalo Stream Wetland. This wetland has been renamed the Bellows AFS wetland. In 2009, a new wetland was delineated between the Upper Waimanalo Stream and the Bellows AFS wetlands. This new wetland is referred to as the Lower Waimanalo Stream Wetland. Both the Upper and Lower Waimanalo Stream Wetlands are contained wholly within Marine Corps property on Marine Corps Training Area Bellows

Wetlands are dynamic in nature and their characteristics and size vary with changes in land use, hydrology patterns and other natural and human actions. This report and its contents are a snapshot of the wetlands that will surely change over time. It is intended that the research, mapping, and database that has been accomplished for this effort be put in a format that can be used for future updates or for individual wetlands. Geographic Information Systems (GIS) and Global Positioning System (GPS) techniques were used

to provide layers of information of present wetland conditions and form a basis for collecting comparative data in the future.

The regulatory statutes and guidance of the COE change through the years. As an example, certain types of wetlands have alternated between being regulated and not regulated. Even the wetland delineation manual has been through several changes. For these reasons, the Regulatory Branch of the COE should be contacted at (808) 438-9258 to verify whether proposed projects will affect waters of the U.S., including wetlands, and whether Department of the Army permits are required.

For further information on this report, please contact Benton Ching at (808) 438-1157 or through email at Benton.Y.Ching@usace.army.mil.

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Chapter 1 - Introduction

The purpose of this study was to update the MCB Hawaii wetland inventory and perform new wetland delineations for specific wetlands at MCB Hawaii, Kaneohe Bay, and Marine Corps Training Area Bellows (MCTAB). In June 2007, Mr. Lance Bookless of MCB Hawaii's Environmental Department and Mr. Benton Ching of the COE met several times to discuss the scope of work and visited MCB Hawaii properties at Kane'ohe Bay and Waimanalo. Based on the meetings and field visit, it was determined that the objectives of the project were to: (1) provide certified delineations of selected MCB Hawaii wetlands; and (2) provide a digital map and populate the wetland layer for MCB Hawaii's GIS.

A GIS layer of MCB Hawaii's wetlands has been prepared using ESRI GIS software to complement existing digital data. This layer builds upon the data created in 2002 and new delineations replaces old wetland delineations as applicable. The digital maps are compliant with Spatial Data Standards format which will allow it to be integrated into MCB Hawaii's existing GIS. In addition to the GIS files, other digital information such as data sheets, photographs, and other reference material are included in the project disk.

Chapter 2 - Wetland Mapping Process

2.1 Field Procedures

The wetland delineations were performed in accordance with the COE 1987 Wetland Delineation Manual (WDM). The WDM requires the presence of hydrophytic vegetation, hydrology and hydric soils and are documented in data sheets which are found in Appendix A. The wetland delineations were field verified by the Corps Regulatory Branch to confirm presence of the three requisite parameters. The verification letter can be found in Appendix B. For questions related jurisdictional determinations or the COE permit program, the Regulatory Branch should be contacted at (808) 438-9258. Field photographs are included in Appendix C.

2.2 Geographic Information Systems (GIS)

There have been a number of changes since the original wetland surveys were completed in 2002. One of the biggest changes is the development of the GEOFidelis program. This program is a Marine Corps wide enterprise GIS implementation. GEOFidelis sets the geospatial standards for the Marine Corps on a national level. MCB Hawaii has consolidated their GIS data between the different offices and programs to provide a common operating picture for MCB Hawaii installations.

During the prior survey, Environmental Department's GIS data was on a different horizontal projection and datum than MCB Hawaii Facilities Engineering's data. All MCB Hawaii GIS data is now on Hawaii State Plane Coordinate System, zone 3, NAD83 HARN (1993), meters. Base layers are housed in a relational geodatabase using the Spatial Data Standards (SDS; formerly called the Tri-Service Spatial Data Standards or TSSDS). Mr. Ron Salz is a USMC contractor and a Senior Consultant for GeoFidelis. Mr. Salz provided a document entitled "USMC MCBH Digital Data Specifications version 1.1" which was referred to in the preparation of GIS and other digital data used in this report.

Imagery for the entire island of Oahu has been updated by the 2005 Earthdata collect for the National Geospatial Agency and made publicly available. This dataset improves the publicly available island wide imagery from one meter to approximately one foot.

Also different in this supplement is a series of aerial photographs from 1927 through 1978 that fill in gaps from the previous report. They help to better understand the history of the wetlands on the western side of the base. Note that control points to roughly georeference these photographs were taken in the west and central portions of the base. The georeferencing works fine for these areas but the photographs become more distorted

as one moves away from the control points. All of the aerial imagery used in this report can be found in the project disk.

All vector data created in this report complies with the SDS standards and includes metadata.

Maps in this report are provided both in the print ready report and in a separate folder as GeoPDF files. The GeoPDF format allows layers to be turned off and on, coordinates to be displayed, and to allow users to measure areas and length all within Adobe Acrobat software. The extension for reading GeoPDF is free and included in the project disk in the tools folder. This extension must be loaded along with a current version of Adobe Acrobat. If this extension is not loaded, the maps can still be read in Adobe Acrobat but will not have the GIS-like functionality.

The project disk is arranged by folders as follows:

ArcGISMaps – MXD files to recreate the maps
Documentation – Copy of this report and GeoPDF maps
Geodatabases – GIS data gathered or developed for this report
Raster – Individual raster layers including basemaps and aerial imagery
References – Documents and guidance used for this report
Tables – Spreadsheets, databases used in this report
Tools – GeoPDF extension for Adobe Acrobat

Chapter 3 - Wetland Descriptions

3.1 Overview

MCB Hawaii maintains properties at Kane'ohe Bay, Waimanalo, Camp Smith, Puuloa, Manana, and Waikane Valley as shown in Figure 1. Selected sites were targeted for wetland delineation as shown in section 2. A descriptive overview of the wetlands on these installations is provided in this chapter.

The following areas were selected for evaluation and delineation:

- Hale Koa
- Sag Harbor
- Salvage Yard turn around area
- Temporary Lodging Facility
- Percolation Ditch
- MCTAB California grass community adjacent to the lower reach of Waimanalo Stream

3.2 MCB Hawaii, Kaneohe Bay

3.2.1 General

In 2002, 13 wetland sites were identified making Kaneohe Bay the MCB Hawaii installation with the most wetlands (figure 2). Portions of the five selected sites were previously surveyed.

The motor pool wetland, Nu'upia Ponds, Klipper Golf Course ponds, and the upper Waimanalo Stream wetland are not likely to be developed any time soon and boundaries do not appear to have changed. There are no plans for major development at Puuloa, Camp Smith and Waikane Valley Impact Area and Environmental Department is not aware of any new wetlands on these installations.

3.2.2 Hale Koa Wetland

Hale Koa Recreational Area is located on the Northwest corner of MCB Hawaii, Kaneohe Bay in the shoreline area between the north end of Runway 18-38 (the westernmost runway) and the Sag Harbor facilities as shown in Figure 3. The Sag Harbor facilities fence and runway form a triangular area with a wetland at its interior. The third side of the triangle is formed by Hale Koa Outdoor Recreation Area's campgrounds and parking lot on the west side of runway 18-38. Situated along the sandy shoreline, the Hale Koa Recreation Area provides camping areas, picnic pavilions,

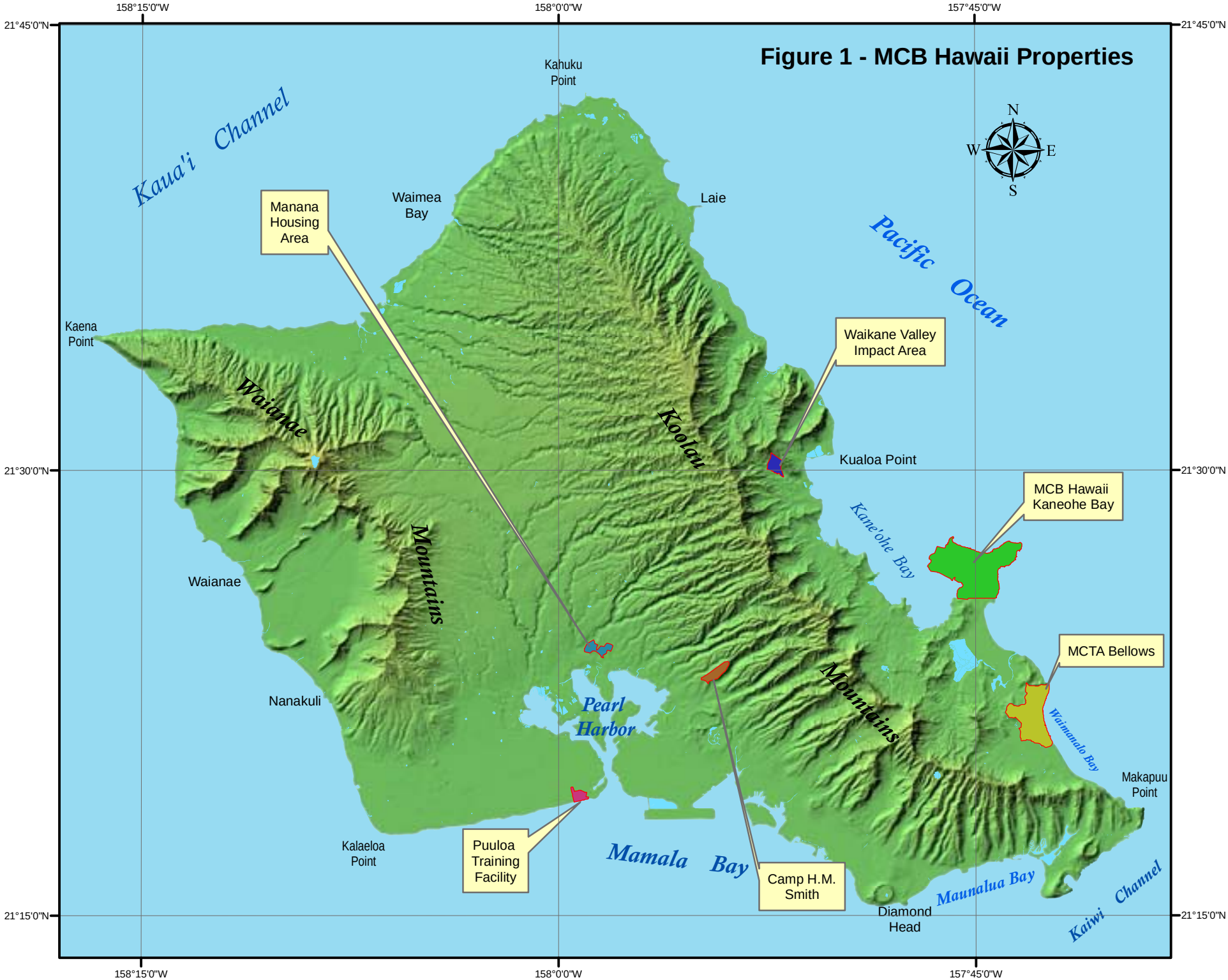
Figure 1 - MCB Hawaii Properties
158°15'0"W
158°0'0"W
157°45'0"W
21°45'0"N
21°30'0"N
21°15'0"N
N
S
E
W
Kahuku Point
Kaua'i Channel
Waimea Bay
Laie
Pacific Ocean
Manana Housing Area
Waikane Valley Impact Area
Kaena Point
Waianae
Koolau
Kualoa Point
MCB Hawaii Kaneohe Bay
Kane'ohe Bay
Mountains
Waianae
MCTA Bellows
Nanakuli
Pearl Harbor
Mountains
Waimanalo Bay
Makapuu Point
Kalaeloa Point
Puuloa Training Facility
Mamala Bay
Camp H.M. Smith
Maunalua Bay
Diamond Head
Kaiwi Channel

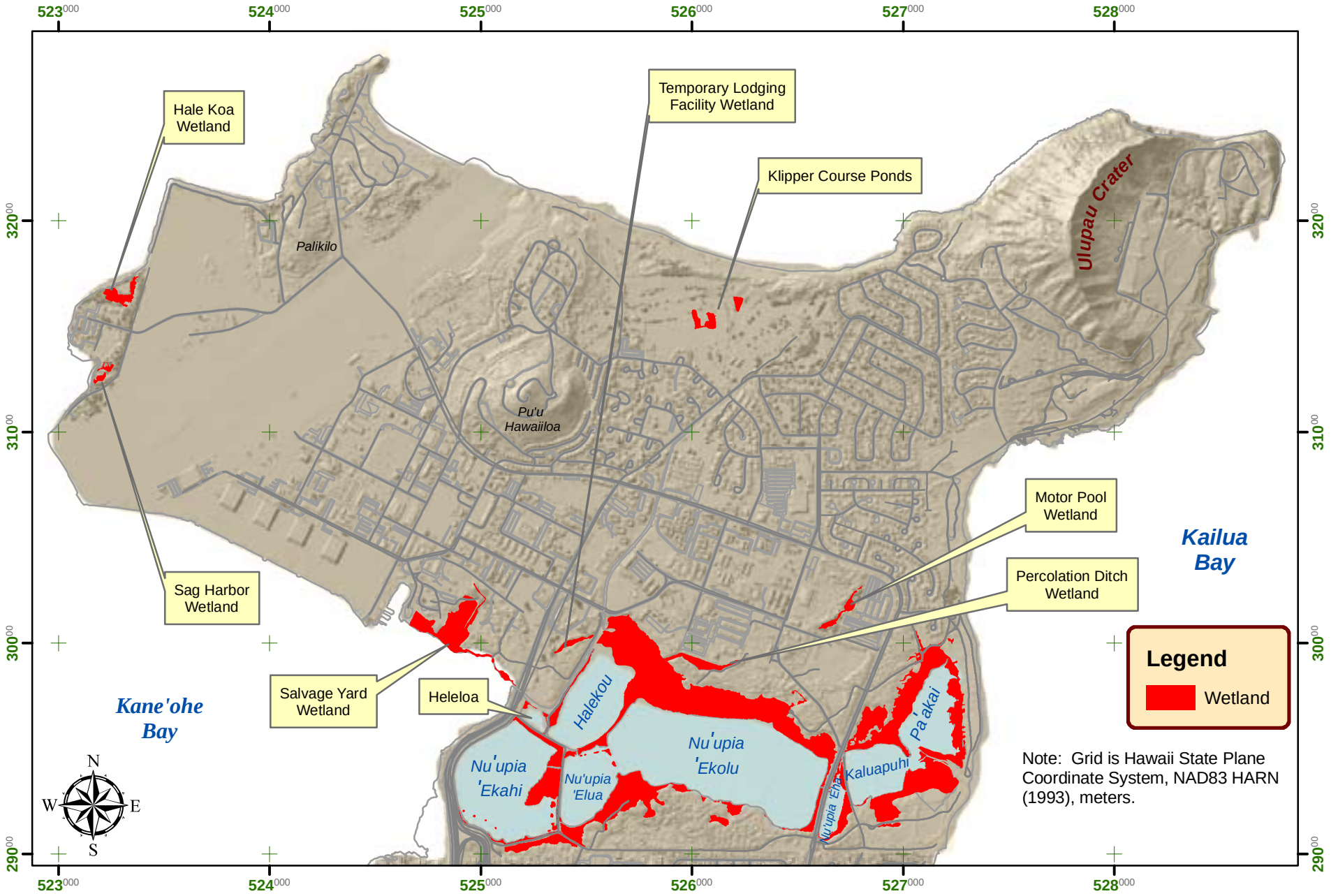

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Figure 2 - Wetlands at MCB Hawaii, Kaneohe Bay

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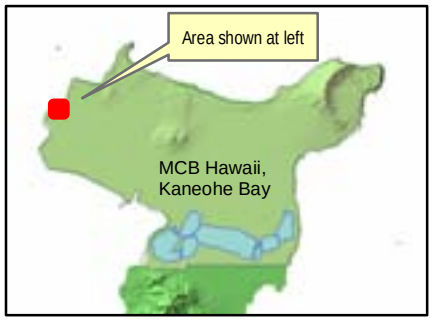

Legend

- Pavilion
- Camping area
- Datasheet (2009)
- Datasheet (2002)
- Wetland (2009)
- Wetland (2002)

Notes:
1. Imagery from 2005 EarthData collect.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

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25 0 25 Meters
100 0 100 Feet

N W E S

Figure 3 - Hale Koa Wetland

\\e0029\arcgismaps\Fig03_HaleKoa.mxd

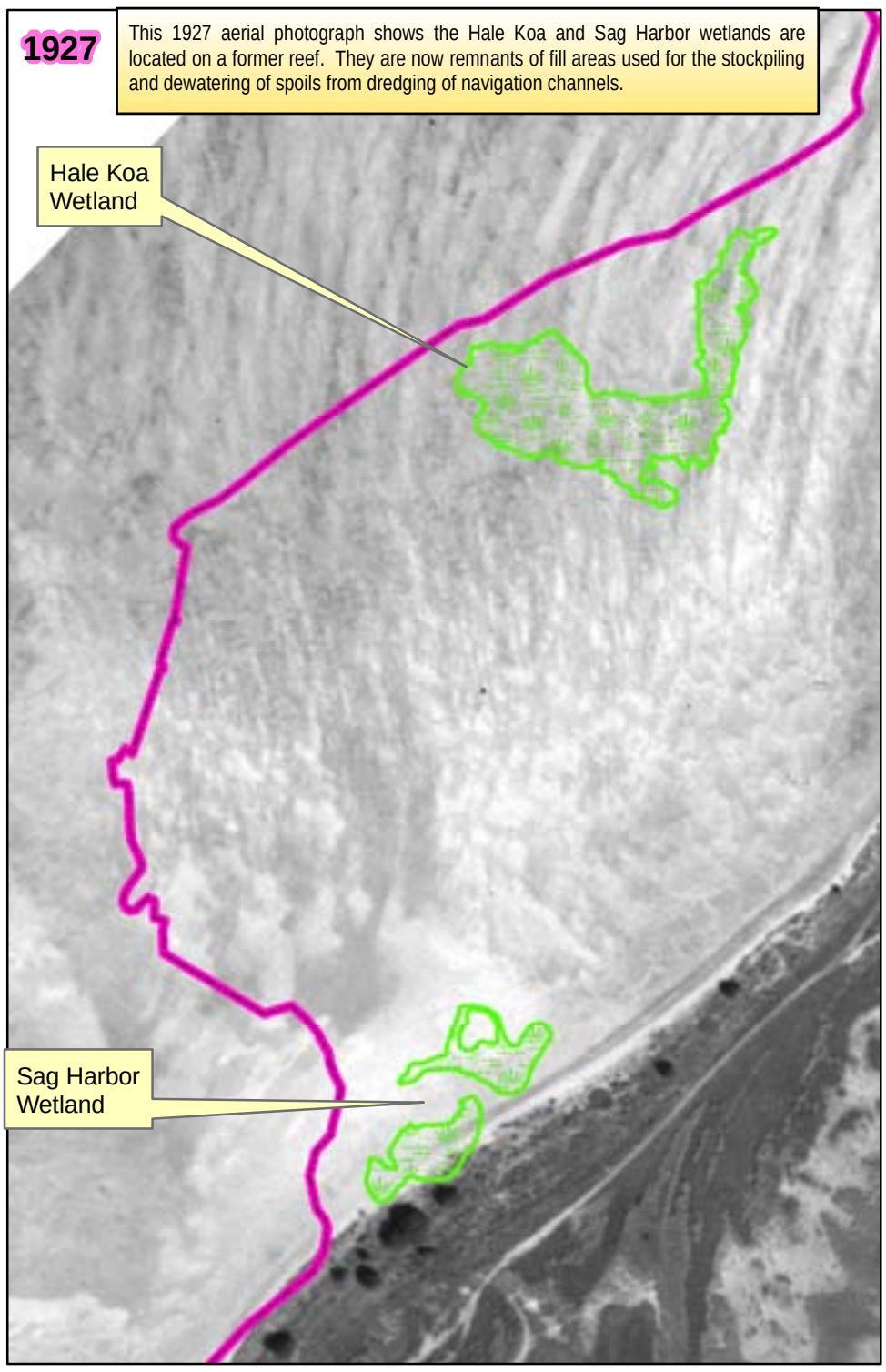
showers, and portable toilets. A sparse number of mature ironwood trees (*Casuarina equisetifolia*) grow along the shoreline and coral paved parking lot. The south boundary is marked by a perimeter fence which extends into the water. An access road has been cleared and maintained along the fence.

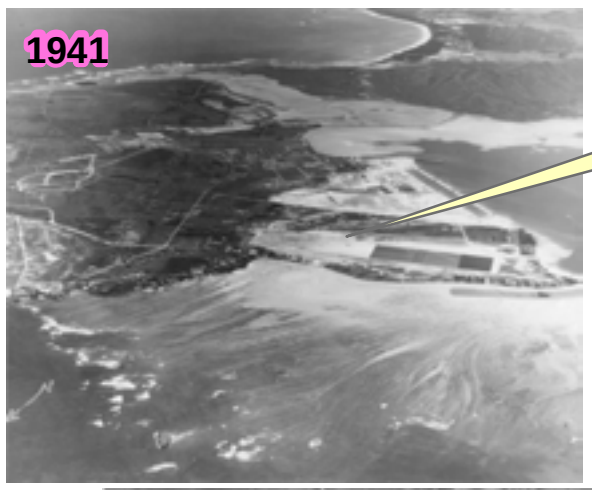
During the December 7, 1941 attack on Pearl Harbor, airplanes and related facilities at MCB Hawaii, Kaneohe Bay and Bellows Field at Waimanalo were also preemptively attacked. Following the attack, the west end of the Mokapu Peninsula was heavily modified with the expansion of the runways and construction of seaplane facilities. Historical aerial photographs and maps document the changes. Figures 4-8 compares historical photographs and maps of the Sag Harbor and Hale Koa wetlands. The 1927 photograph (Figure 4) are overlaid by the present coastline and the wetland boundaries. Dredging and filling operations had not yet commenced and the area where the wetlands occur was a reef flat. The 1941-1943 oblique aerial photographs show the seaplane runway being dredged near the south end of the runway. In the January 1945 photos, land reclamation is still occurring on the west and south sides of the runway. About a dozen seaplanes can be seen in Kane‘ohe Bay south of the hangars. Seaplanes are no longer seen in subsequent photographs. The 1951 oblique aerial photograph shows a dredge in the turning basin area. Mokapu Peninsula’s southern shoreline has not yet been fully straightened.

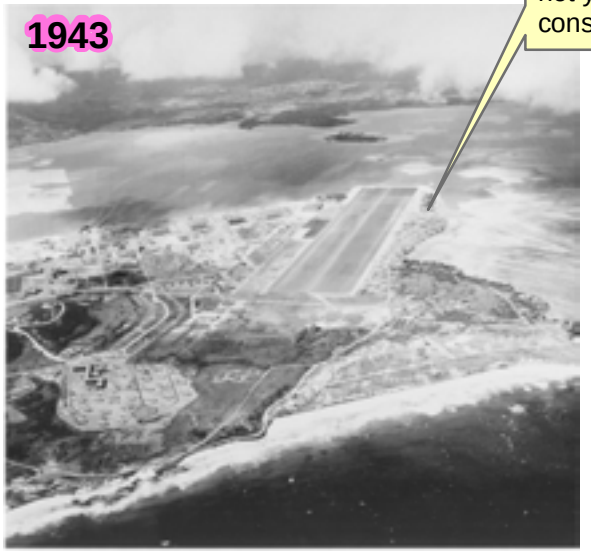
Aerial photographs from 1959 to the present show that there have not been any dredging changes. Between 1959 and 1965, upland vegetation has rapidly colonized the edges including the ironwood along the shoreline. The 1968 photo shows that the wetland area could have been a lot larger. However, development of the Sag Harbor facilities and construction of roads, parking lots, and other facilities have altered the wetland to its present configuration. Aerial photographs were taken following the December 1-2 and 4, 1969 storms when waves up to 50 feet high slammed the north shores of the main Hawaiian Islands (U.S. Army Corps of Engineers, 1970). In the photos between 1968 and 1969, there has been a lot of sand deposited in the present wetland area and the vegetation at the shoreline has been thinned out. Dredging of Sag Harbor was underway in 1972 and had been completed before the 1975 photo was taken.

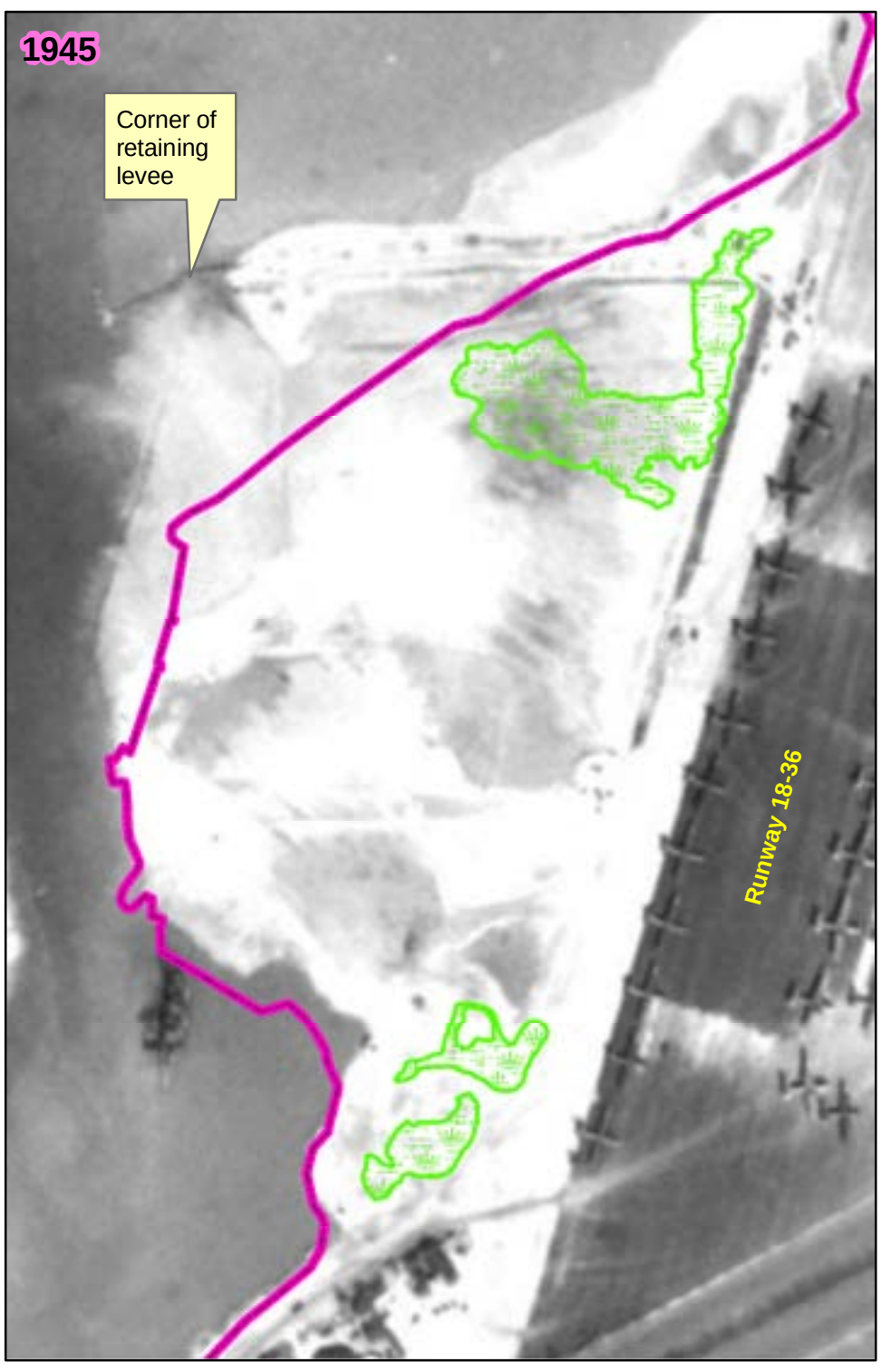
The 1993 photo shows that earthmoving has taken place to construct the parking lot for the Hale Koa Recreational Area. During the 2002 wetland survey, the sides of an unauthorized imu dug in the Hale Koa Recreation Area parking lot, showed stratified layers of gleyed sand and fill. It is surmised that the unfilled portions of the wetland reflect the conditions that would exist had the west end of Mokapu Peninsula not been filled.

The Hale Koa wetland was visited on 14 Nov 2007, 10 and 12 Dec 2007, and 8 January 2008. The area was inundated during all of the 2007 and 2008 visits. Almost all of the *Batis maritima* covered areas were inundated and the ponded water extended into *Pluchea* dominated scrub brush plant communities.









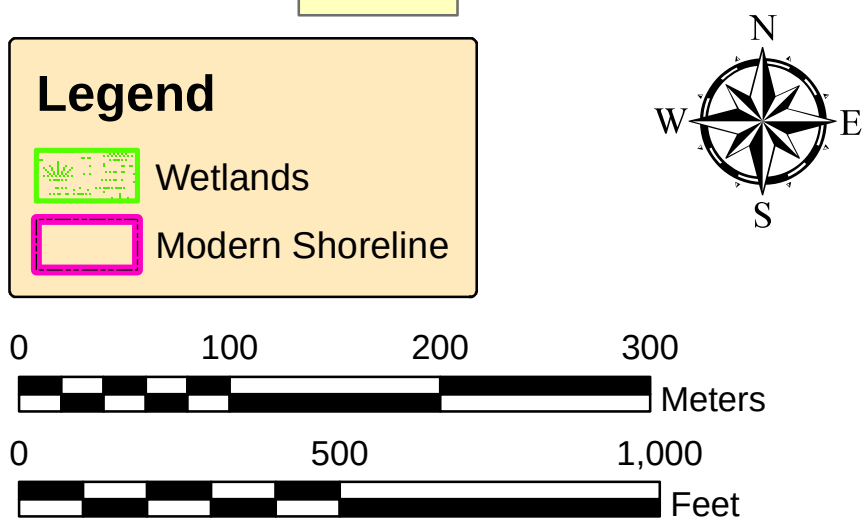


Figure 4 - Hale Koa and Sag Harbor Wetlands Aerial Photographs, 1927 to 1951

\\e0029\arcgismaps\Fig04_HKSag_1927_to_1951.mxd

1959

From 1959 to the present, there has not been any major dredging or manmade alterations to the shoreline although the shoreline at Hale Koa Beach has experienced erosion.

darkened area is the inundated south cell of Sag Harbor Wetland

1965

Shoreline vegetation growth including ironwood (*Casuarina equisetifolia*)

3 original buildings

Sumner Road

accumulation of soil and vegetation

Runway 18-36

1968

Prior to the construction of the Hale Koa roads, parking lot, and picnic areas, it appears that a larger area was low lying similar to the present wetland conditions.

Sumner Road

Runway 18-36

1968

Sumner Road

southern cell of Sag Harbor wetland

Legend

Wetlands

Modern Shoreline

N

W E

S

0 100 200 300

Meters

0 500 1,000

Feet

Figure 5 - Hale Koa and Sag Harbor Wetlands Aerial Photographs - 1959 to 1968

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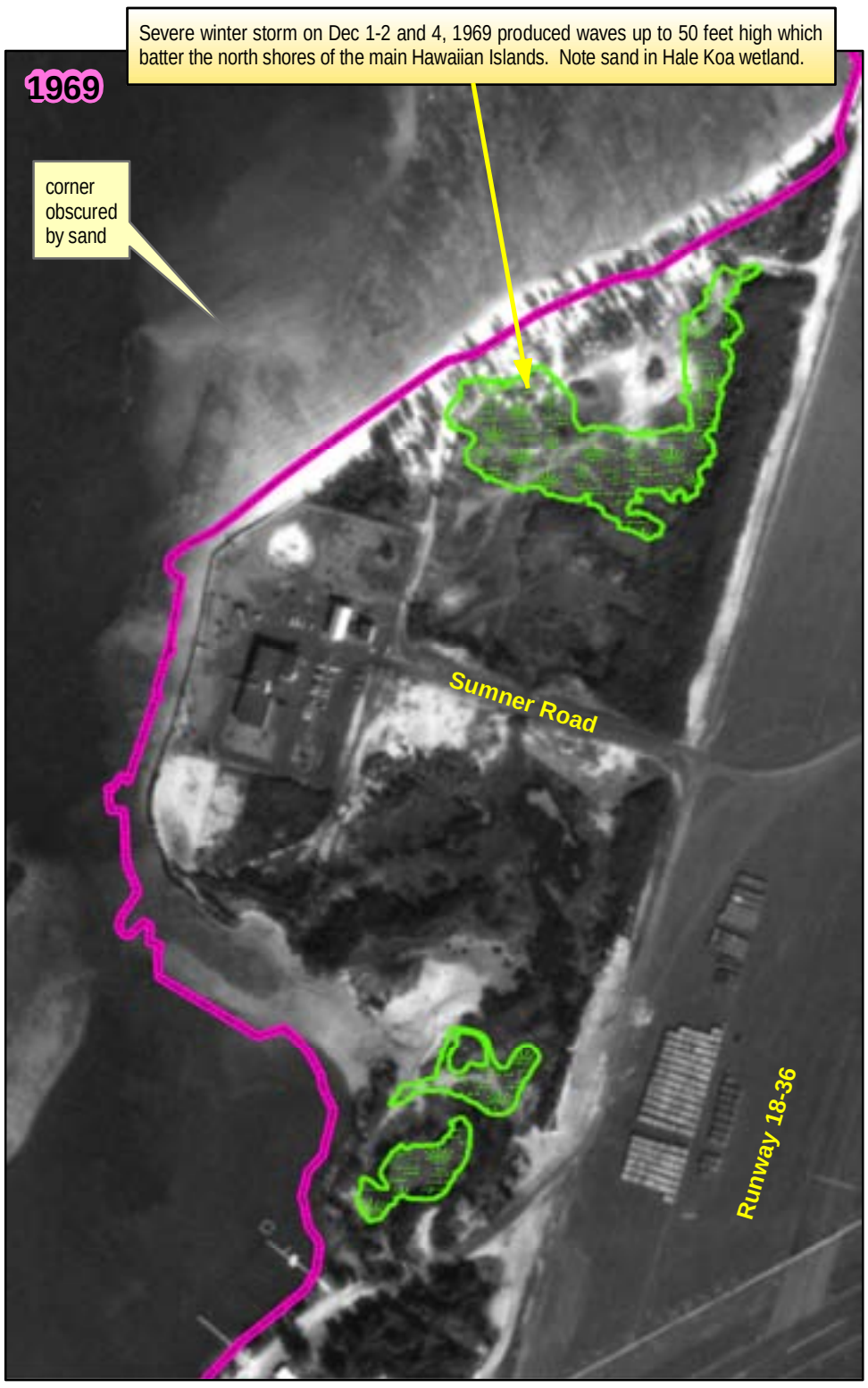

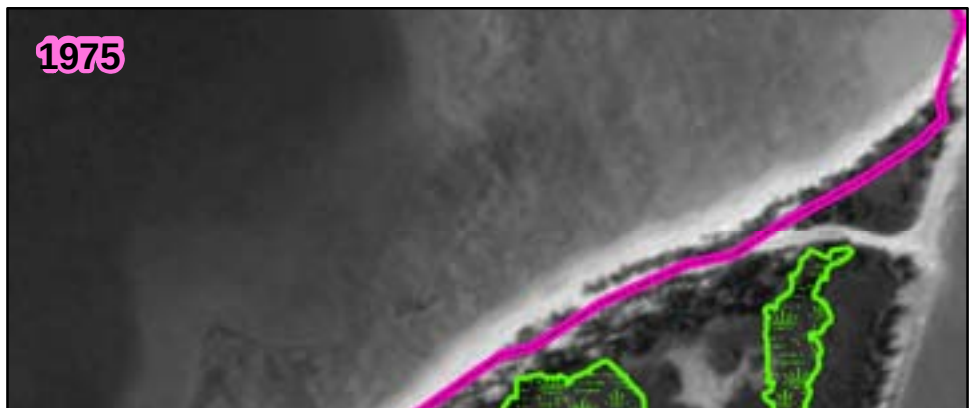

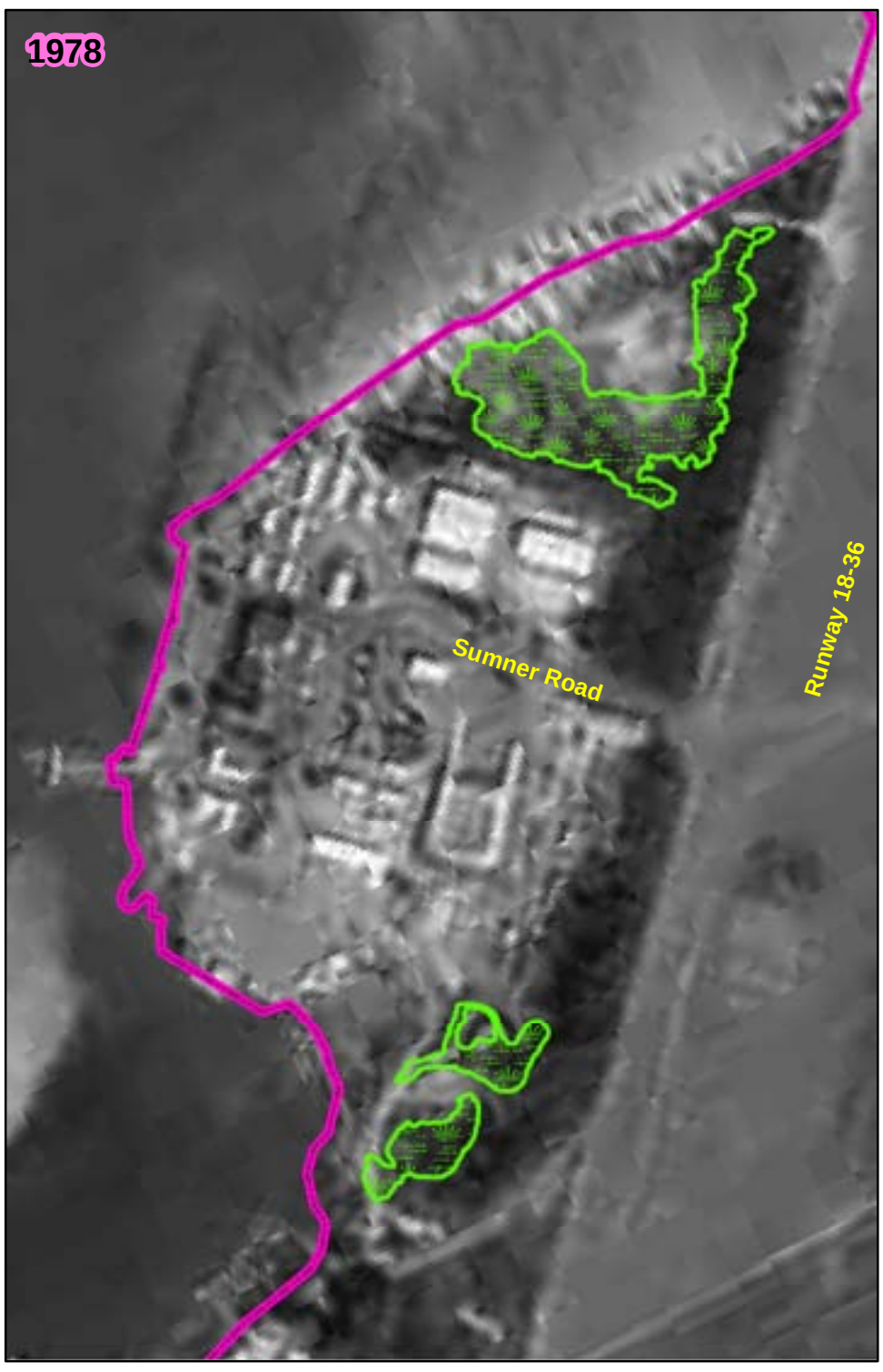

The two cells are clearly separated indicating that the fill between them was likely placed during the construction of pens at Sag Harbor.

Legend

Wetlands

Modern Shoreline

N W E S

0 100 200 300 Meters

0 500 1,000 Feet

Figure 6 - Hale Koa and Sag Harbor Wetlands Aerial Photographs - 1969 to 1978

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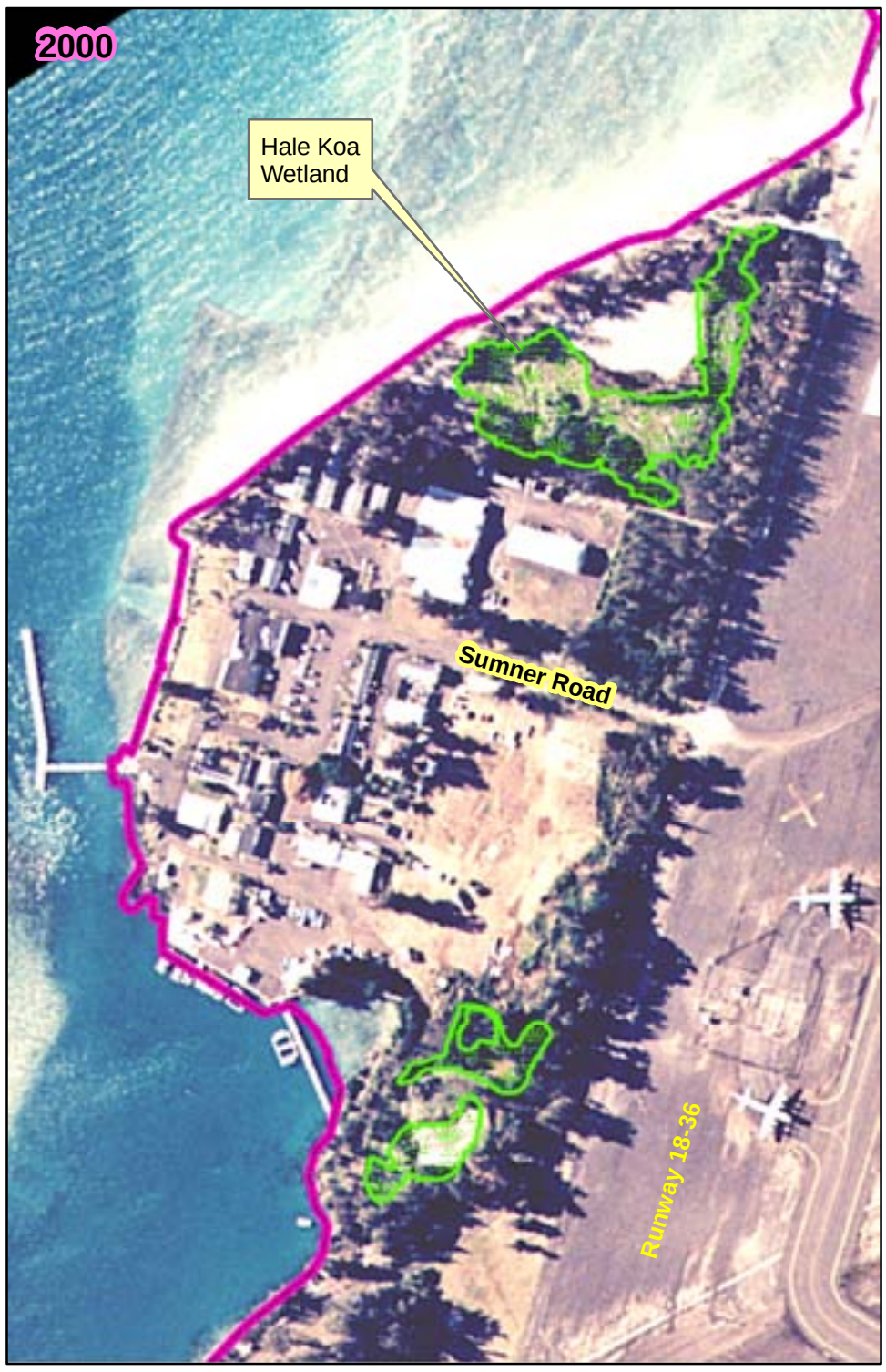

Legend

- Wetlands
- Modern Shoreline

N
W E
S

0 100 200 300
Meters

0 500 1,000
Feet

Figure 7 - Hale Koa and Sag Harbor Wetlands Aerial Photographs - 1993 to 2005

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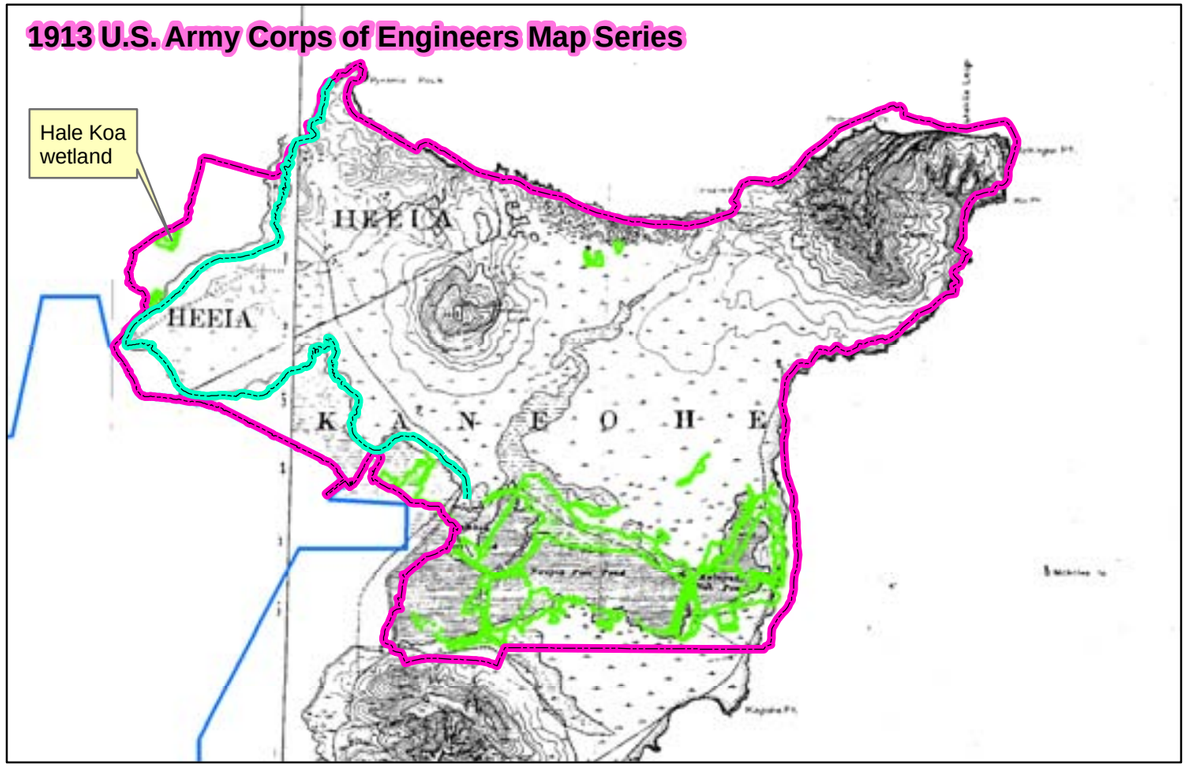

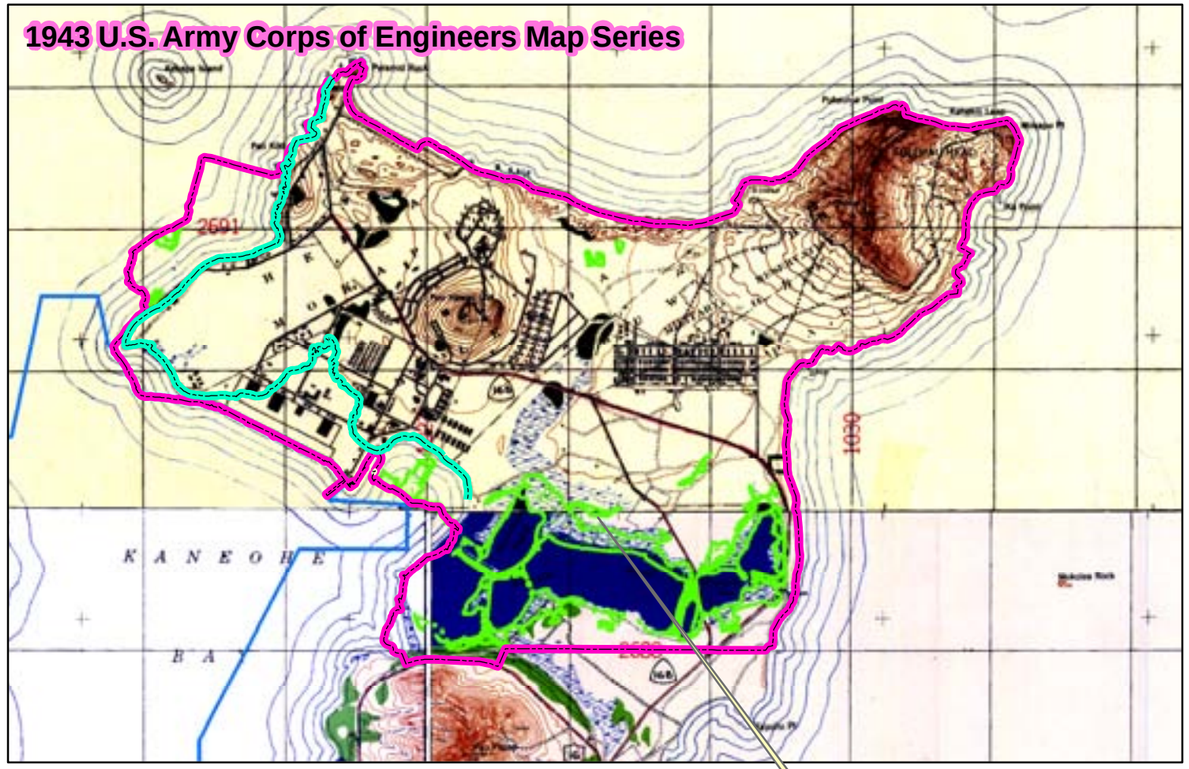

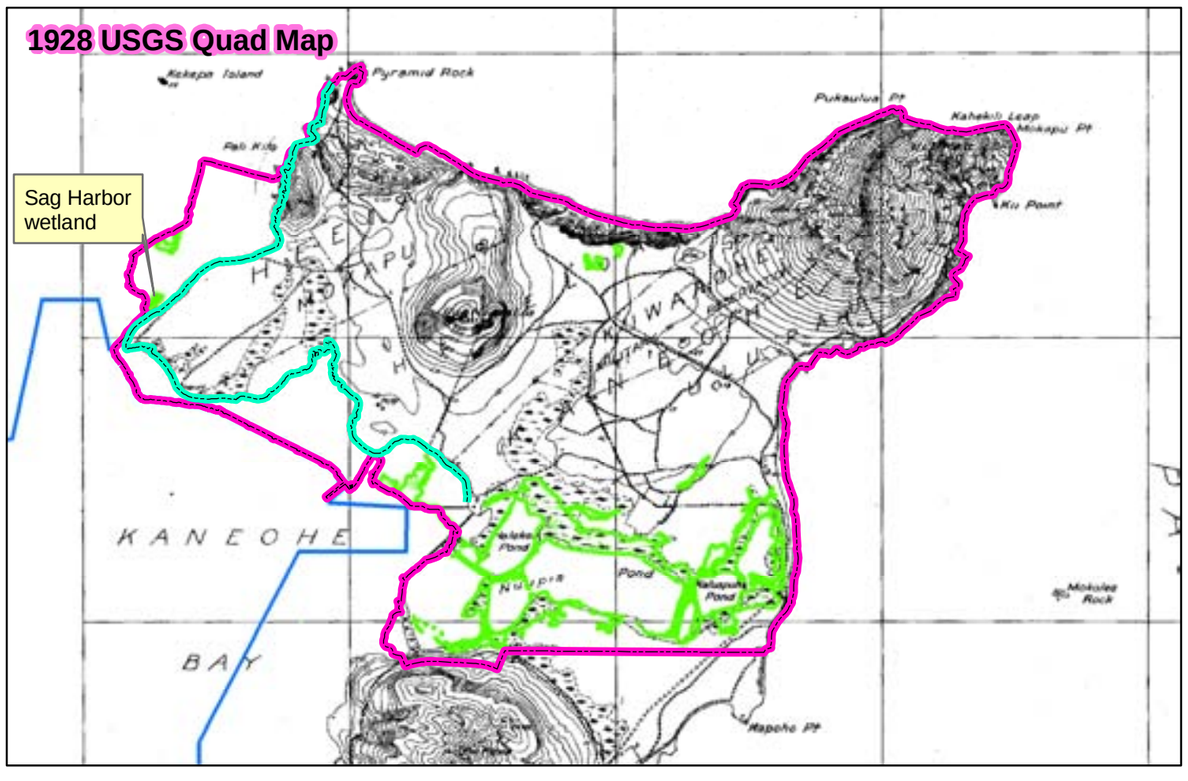

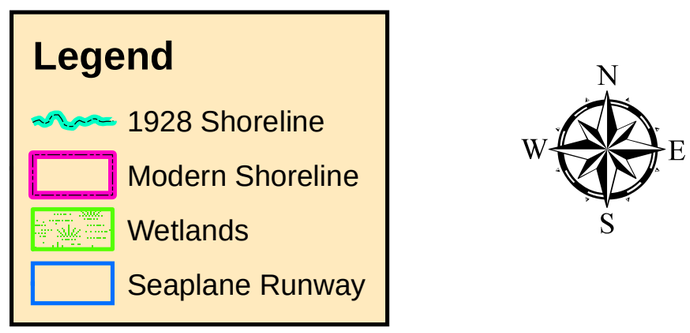

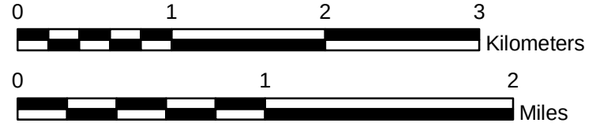

Figure 8 - Hale Koa and Sag Harbor Wetlands

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The water was deepest (estimated over 24 inches) on the south edge where a large mangrove (*Rhizophora mangle*) dominated the area and merged with a *milo (Thespesia populnea)* vegetative community. Many of the sedges were drowned. Marks on the vegetation indicated that the water levels were 2-3 inches higher than observed on the day that the observations were highest (8 Jan 2008).

Mats of algae were draped over the '*ākulikuli kai (Batis maritima)* and hanging in and out of the water (Figure 9). While there were plenty of insects, no fish were observed. During the spring and summer months, most of the standing water recedes.

Figure 9 – Dried algae mat overalying *akulikuli kai* after water recedes.

The area has been unchanged since the 2002 survey except that high water levels were observed in the wetlands which persisted for close to two months. While '*ākulikuli kai* dominates the interior of the wetland, mangrove, *milo*, sourbush (*Pluchea indica)* and *Pluchea x fosbergii* also dominated their sections along the edges of the wetland. Other wetland vegetation observed included California grass (*Brachiaria mutica*) and *kaluhā (Bolboschoenus maritimus).* Upland vegetation included ivy gourd (*Coccinia grandis*), *koa haole* (*Leucana leucocephala*), ironwood (*Casuarina equisetifolia),* and Chinese violet *(Asystasia gangetica).*

The shoreline also appears to encroach into the area and into some of the campsites. According to Mr. Lance Bookless (MCB Hawaii, Environmental Department), sand and material deposited on the road after high waves are typically pushed into camp site #7. The area was inundated in November through December 2007 (Figure 10). On both occasions, the sand patterns indicated the shoreline was overtopped. Camp site #6 is closer to the runway which also drains to this area and into camp site #7. These areas are dominated by *milo*.

Figure 10 - Flooding between camp sites 6 and 7.

The inundated areas were GPS'd on Dec 2007 and a wetland delineation map is shown on

figure 3. No new projects or changes in land use are anticipated.

The shoreline is undergoing erosion. Part of the problem is a declining number of mature ironwood trees growing along the shoreline. Ironwood trees produce needles which blanket the ground and block the sun which prevents other vegetation from establishing itself. Ironwood also have shallow root systems and do not tolerate ocean inundation well. These properties make ironwood dominated shorelines vulnerable to erosion. The aerial photos show that the ironwood have been dying and the shoreline have been moving inward. This is also evident when the stumps of old trees are seen 40-50 feet offshore of the remaining live trees. Where there were once several rows of ironwood trees, the Hale Koa shoreline now has a single row remaining and some of their roots are already exposed. Having seen similar shorelines with ironwood and erosion, it is very likely that the ironwood will eventually be undermined and fall into the sea.

Hardening of the shoreline often affects sediment transport patterns and structures such as seawalls reflect energy and causes sand to be pushed out to sea. A simpler and more environmentally friendly method would be to integrate vegetation that would help to stabilize the shoreline.

It is recommended that *naupaka (Scaevola sericea), ʻakiʻaki (Sporobolus virginicus),* and pickleweeds (*Sesuvium portulacastrum* and *Batis maritima*) be planted along the shoreline. With the exception of *Sesuvium portulacastrum*, these are all native plants which all grow well along the shoreline and allow them to absorb moderate wave energy and retain sand. Recommended shoreline trees are *hala (Pandanus tectorius)*, tree heliotrope *(Tournefortia argentea), naio (Myoporum sandwicense)*, or *kauila ʻānapanapa (Colubrina asiatica)* which are more appropriate than ironwood.

3.2.3 Sag Harbor Wetland

Sag Harbor is on the western edge of the Mokapu Peninsula near the western tip of the Mokapu Peninsula (figure 11). The northern area has been cleared of mangrove which made it more conducive for receiving GPS signals. MCB Hawaii is considering the construction of an opening between the south cell and Kaneʻohe Bay to restore tidal influence to the area.

Since the 2002 surveys, the Sag Harbor area has been fenced off and secured by Waterfront Operations. The area was also cleared of mangroves which made it possible to GPS the north side of the wetland. Juvenile mangroves were uprooted during the site visits and the area remains free of large mangrove trees.

There has been no physical change to the wetland boundaries from the 2002 study. However, a large part of the North cell's boundary was originally estimated from aerial photography due to the hampering of GPS signals which were obstructed by the mangrove forest. In 2007, the mangroves were almost completely removed and this section of the wetland was GPS'd. The results are shown on figure 11.

Notes:
1. Imagery from 2005 EarthData collect.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.
3. North cell wetland boundary adjusted in 2009 after mangrove clearing.

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Figure 11 - Sag Harbor Wetland

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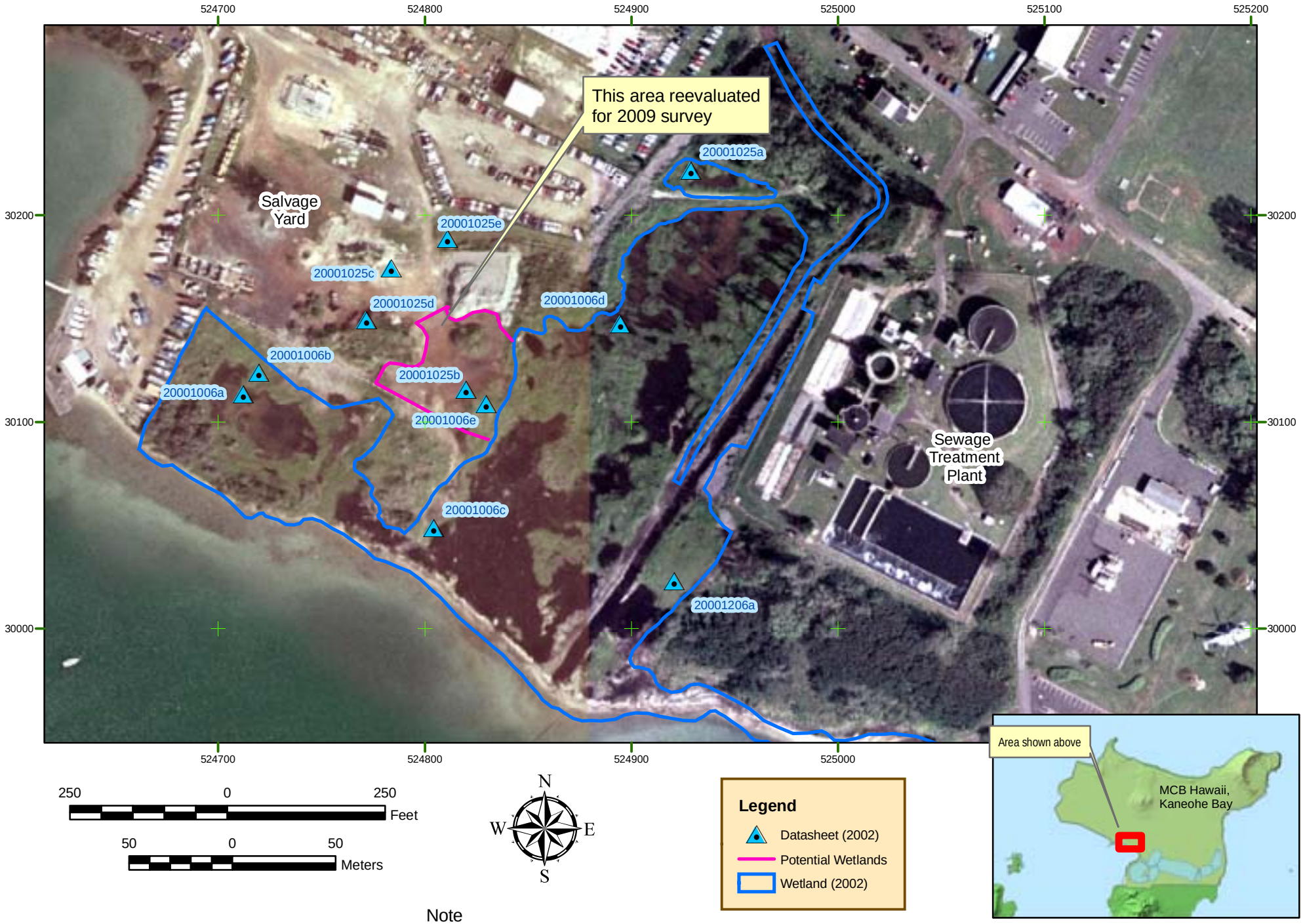
3.2.4 Salvage Yard Wetland

The salvage yard wetland is bounded by the wastewater treatment plant, automobile impoundment lot, salvage yard, marina and the shoreline (Figure 12). From the 1927 aerial photograph, it is clear that the entire wetland is located on a former reef. In the 1953 photograph (Figure 13), much of the area that is presently occupied by the automobile impoundment lot, salvage yard, and marina appears to be paved. The wetland delineation appears to follow the paved areas. In the 1959, 1965, 1968, and 1978 photos, many of the manmade features were removed.

During the 2002 survey, the main wetland was covered by thick mangrove forests. It is now clear of large adult mangrove trees but juveniles continue to emerge from the floating propogules. Also, some of the previously stockpiled material has been removed and area has been scarified by AAV's. The health of the wetland has been improved by these actions and are undoubtedly more appealing to the endangered Hawaiian Stilt.

Figure 14 – Turnaround area at salvage yard.

The wetland boundaries have remained the same as the 2002 report but there was a question on whether an area near the parking lot was a wetland or not (figure 14). It had a level hard pan surface with a very thin layer of soil over it. Using a sharpshooter



Note
1. Imagery from 2005 EarthData collect.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

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Figure 12 - Salvage Yard Site Plan

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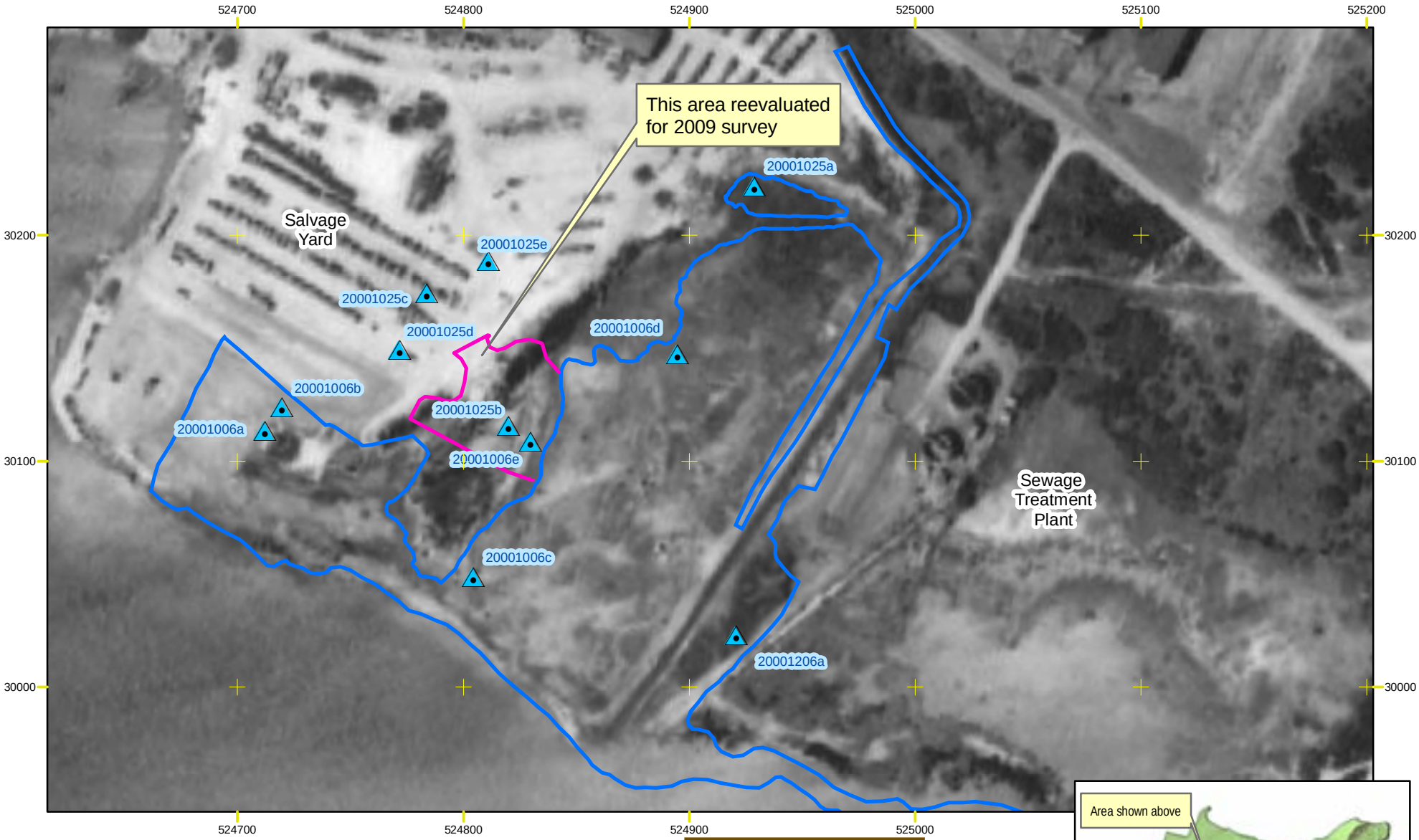


U.S. Army Corps of Engineers
Honolulu District

Notes:
1. Aerial photograph dated 29 Aug 1953 from U.S. Geological Survey.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

Figure 13 - Salvage Yard (1953 Photo)

\\e0029\arcgismaps\Fig13_SalvYard1953.mxd

shovel, the hard layer could not be penetrated more than a couple of inches. Looking back at the 1953 photograph, it is apparent that this area had been paved.

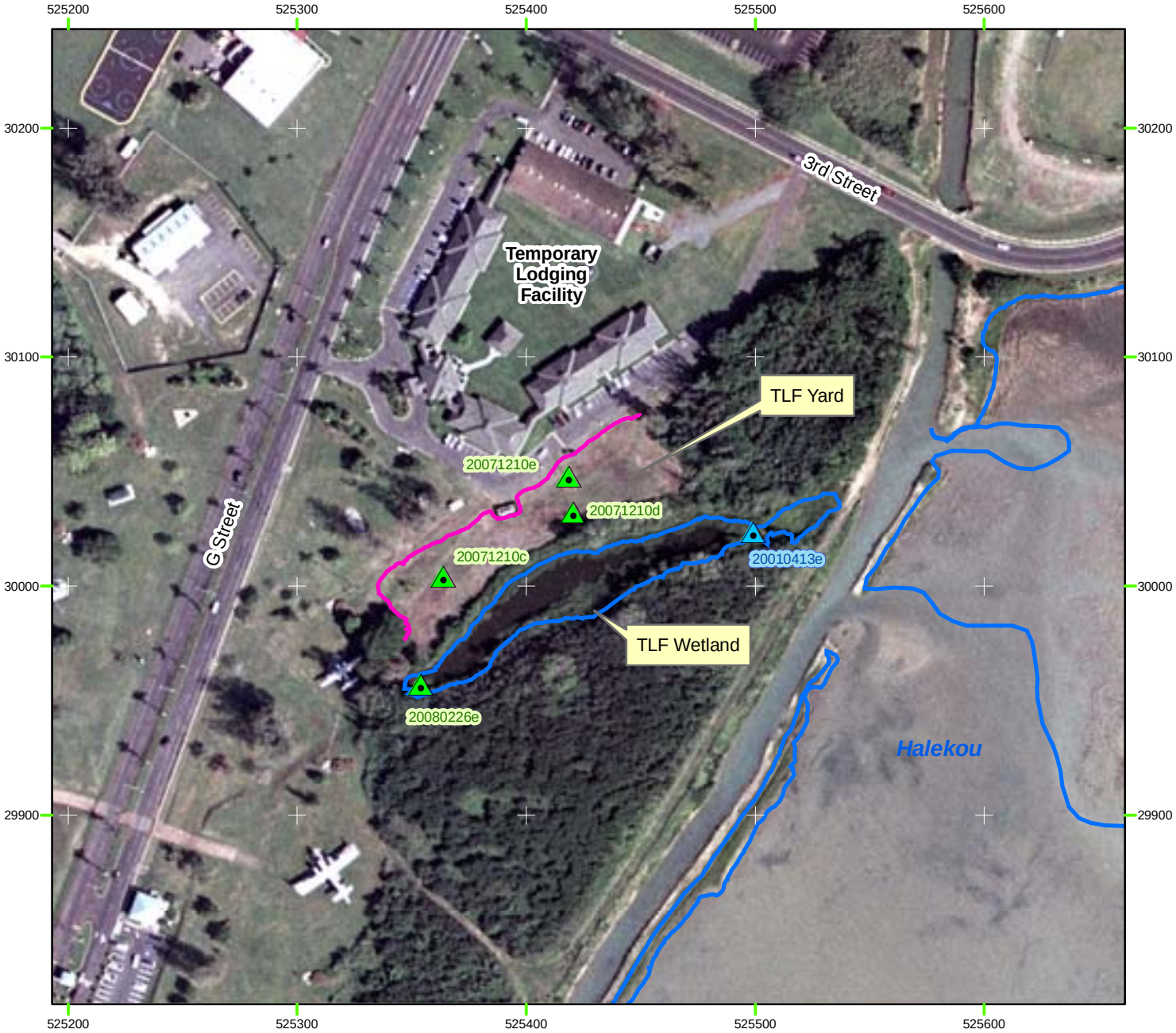
This area has been visited by the COE on numerous occasions since the 2002 delineation. Although the soils are sometimes saturated and a salt crust is evident, there has never been any vegetation. The previous paving and lack of soils and vegetation prevents this area from being called a wetland.

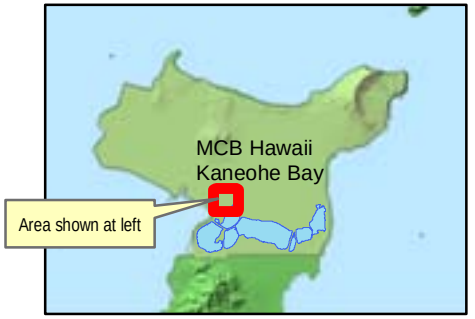
3.2.5 Temporary Lodging Facility (TLF)

The TLF is located just inside of the H-3 gate at the intersection of G Street and 3rd Street as shown in figure 15. Environmental Department noticed wetland vegetation growing in the lawn area (Figure 16) between the TLF buildings and the wetland delineated in 2002 and requested that this area be checked for wetlands.

Figure 16 – Lawn area of TLF. TLF wetland delineated in 2002 is to the left of the trees and shrubs.

The grassed area between the berms and the TLF had a dark saturated clay loam layer atop a sandy coral rubble layer. Since the area is disturbed, it may have been soil from the wetland or imported soil used to level the area. Emergent wetland species including water hyssop *(Bacopa monnieri), ʻākulikuli (Sesuvium portulacastrum), Eleocharis sp., kaluhā (Bolboschoenus maritimus),* can be found in the grassed area along with Bermuda





Legend

- Potential Wetland
- Datasheet (2009)
- Datasheet (2002)
- Wetland (2002)

Notes:
1. Imagery from 2005 EarthData collect.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

U.S. Army Corps of Engineers
Honolulu District

250 0 250 Feet
50 0 50 100 Meters

N W E S

Figure 15 - Temporary Lodging Facility

\\e0029\arcgismaps\Fig15_TLF.mxd

grass (*Cynodon dactylon*) and upland species such as false daisy (*Eclipta alba*), sleeping grass (*Mimosa pudica*), beggar's tick (*Bidens pilosa*) and *Kyllinga nemoralis*. Sample points were taken in 3 locations. The dark saturated mud was a 3 to 10 inch thick layer of clay loam overlaying a sandy clay layer. Although the clay layer was saturated and retains moisture, the lower layer was well drained.

Mr. Bookless indicated that the area was cleared and grassed when the TLF was renovated in 2002-2003. Irrigation sprinklers were not installed and the Bermuda grass had a hard time establishing itself.

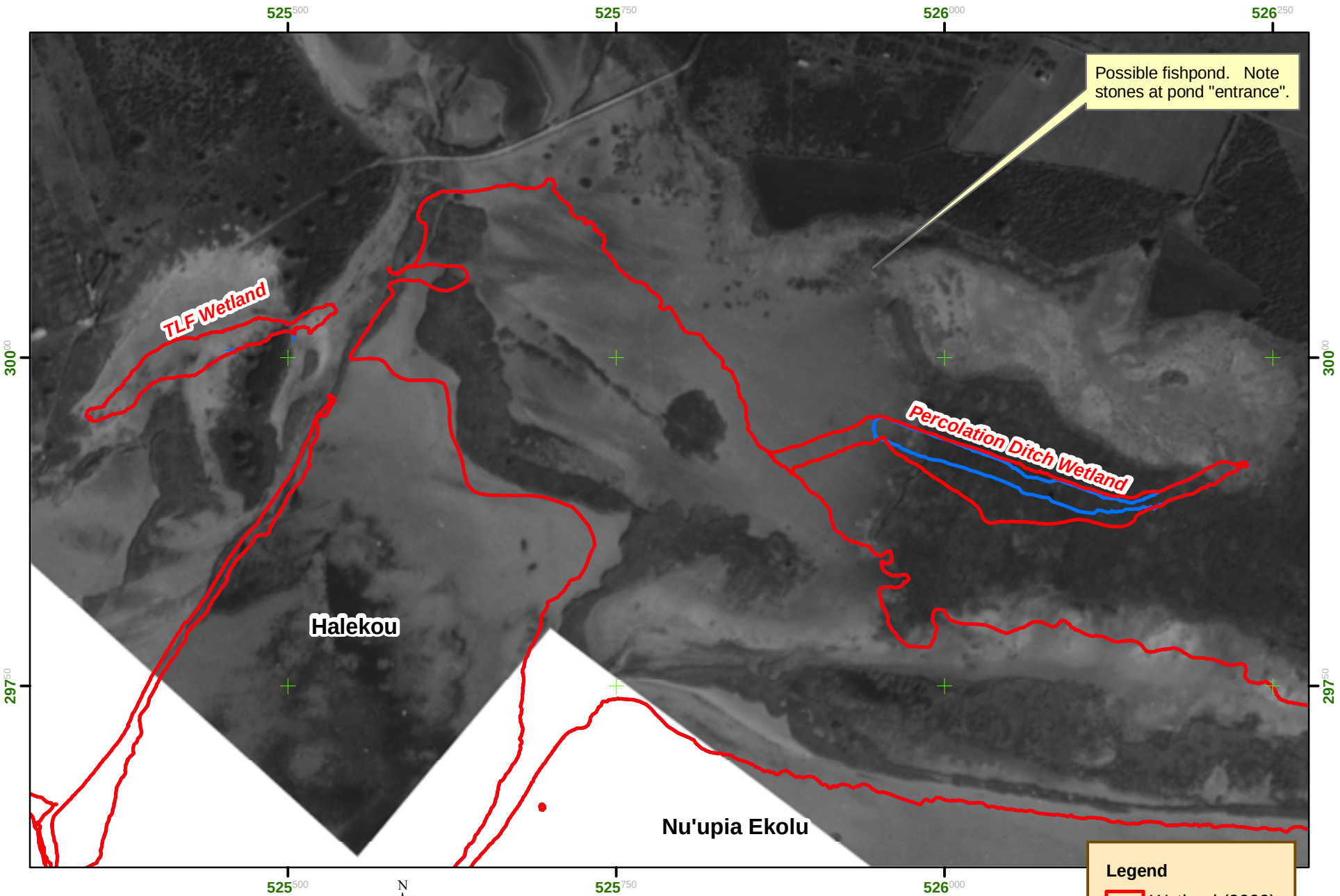
The 2002 TLF wetland was contained by the TLF yard on one side and a berm on the Nu'upia pond side. This wetland is a remnant of the Nu'upia pond system. It was revisited on 10 Dec 2007 and was found to be deep and overgrown. 3rd Combat Service Company's Amphibious Assault Vehicles (AAVs) annually conduct Mud Ops, wherein the 26 ton vehicles break up invading *Batis maritima*. Mud Ops at the TLF wetland targets California grass (Brachiaria mutica) which is the primary vegetation that fills the open water of the TLF wetland.

The TLF area has undergone many changes throughout the years. In the 1927 aerial photograph (figure 17), there is no development or buildings within the modern TLF footprint. The land area between the TLF and Main Gate Pass house was a former landfill that operated from the 1940's until 1976. This site is part of the Installation Restoration Program (IRP) for hazardous and toxic materials storage and disposal activities at military installations. The photo shows that the TLF area may have received runoff from the drainage system running along the west side of Halekou Pond. The 1945 aerial photograph (figure 18) shows the most development with several buildings constructed near the present wetland. In the 1953 photograph, buildings closest to today's TLF wetland and the existing drainage ditch were removed and have not returned. The 1959 aerial photograph shows the remainder of the buildings in the area covered by the modern TLF footprint have been removed. In the 1965 aerial photograph (figure 19), the wetland area remains disconnected from Halekou Pond and appears to be fastland. The tree line is consistent with the existing condition today and the grassed lawn was undeveloped at the time.

Although there is wetland vegetation, the soils drain well and have not developed hydric conditions. Under the present conditions, the TLF yard is not a wetland.

3.2.6 Percolation Ditch

The percolation ditch is located north of Nu'upia 'Ekolu pond and is shown in Figure 20. When this wetland was visited in 2000, the ditch was heavily overgrown with California grass and water was confined to a narrow strip closest to the motor pool parking lot. By the end of the project, AAV's had trampled and scarified the area. The AAV track marks can be seen in the aerial photo.



N
W E
S

250 0 250 Feet

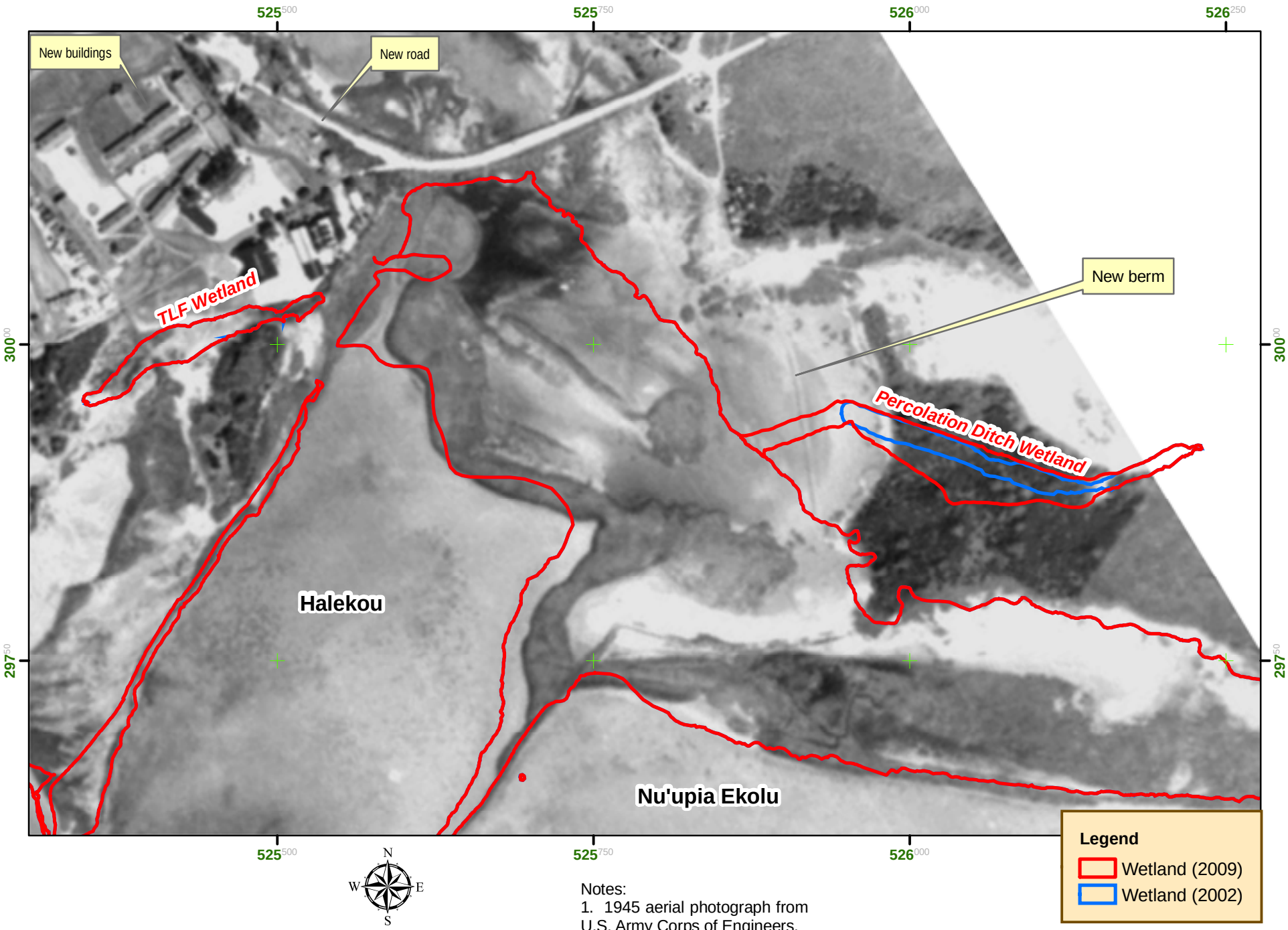
100 0 100 Meters

Notes:
1. 1927 aerial photographs from U.S. Geological Survey.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

U.S. Army Corps of Engineers
Honolulu District

Figure 17 - Temporary Lodging Facility and Percolation Ditch (1927 Photograph)

\\le0029\arcgismaps\Fig17_PercDitch1927.mxd

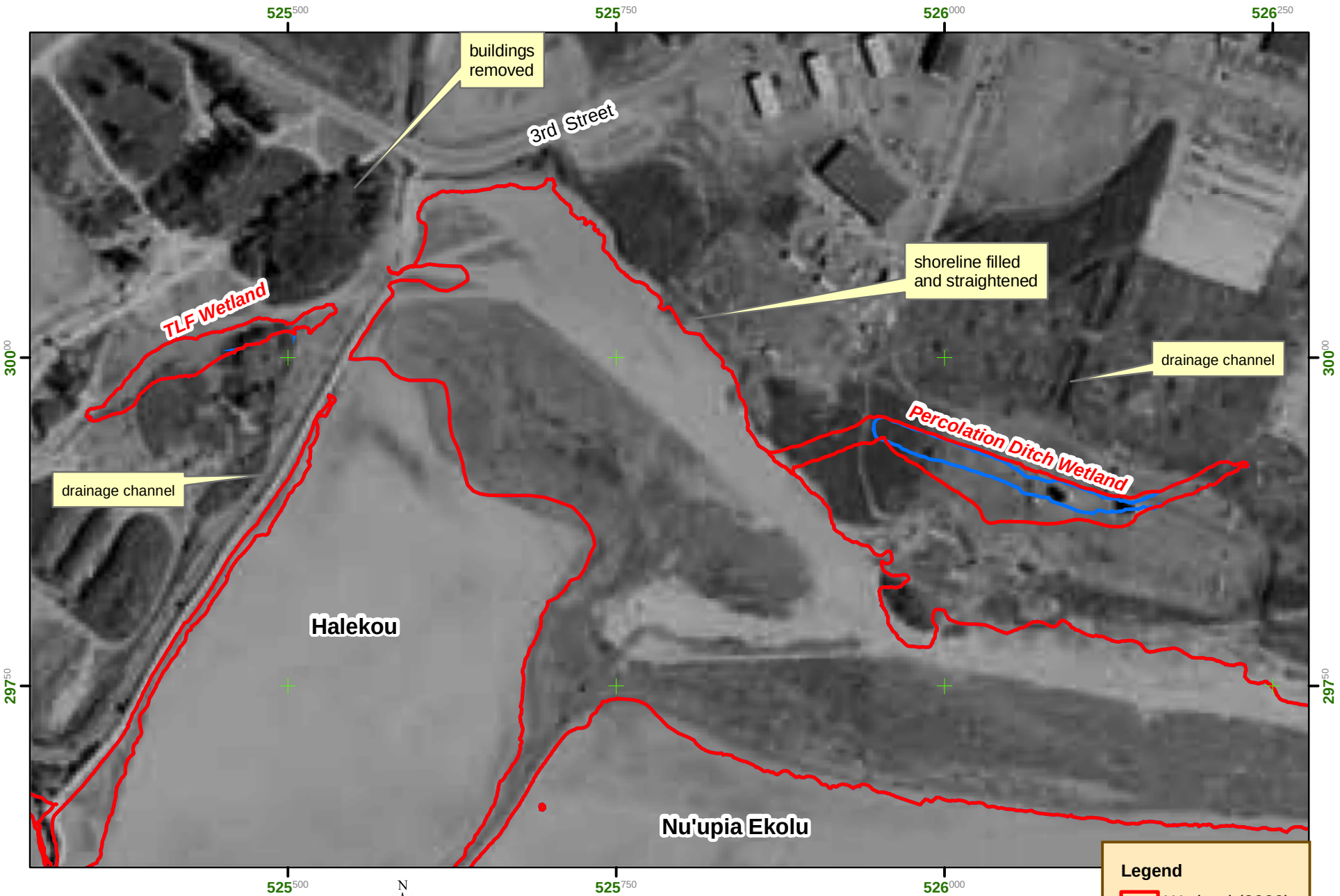


Notes:
1. 1945 aerial photograph from U.S. Army Corps of Engineers.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

U.S. Army Corps of Engineers
Honolulu District

Figure 18 - Temporary Lodging Facility and Percolation Ditch (1945 Photograph)

\\e0029\arcgismaps\Fig18_TLF_PercDitch1945.mxd

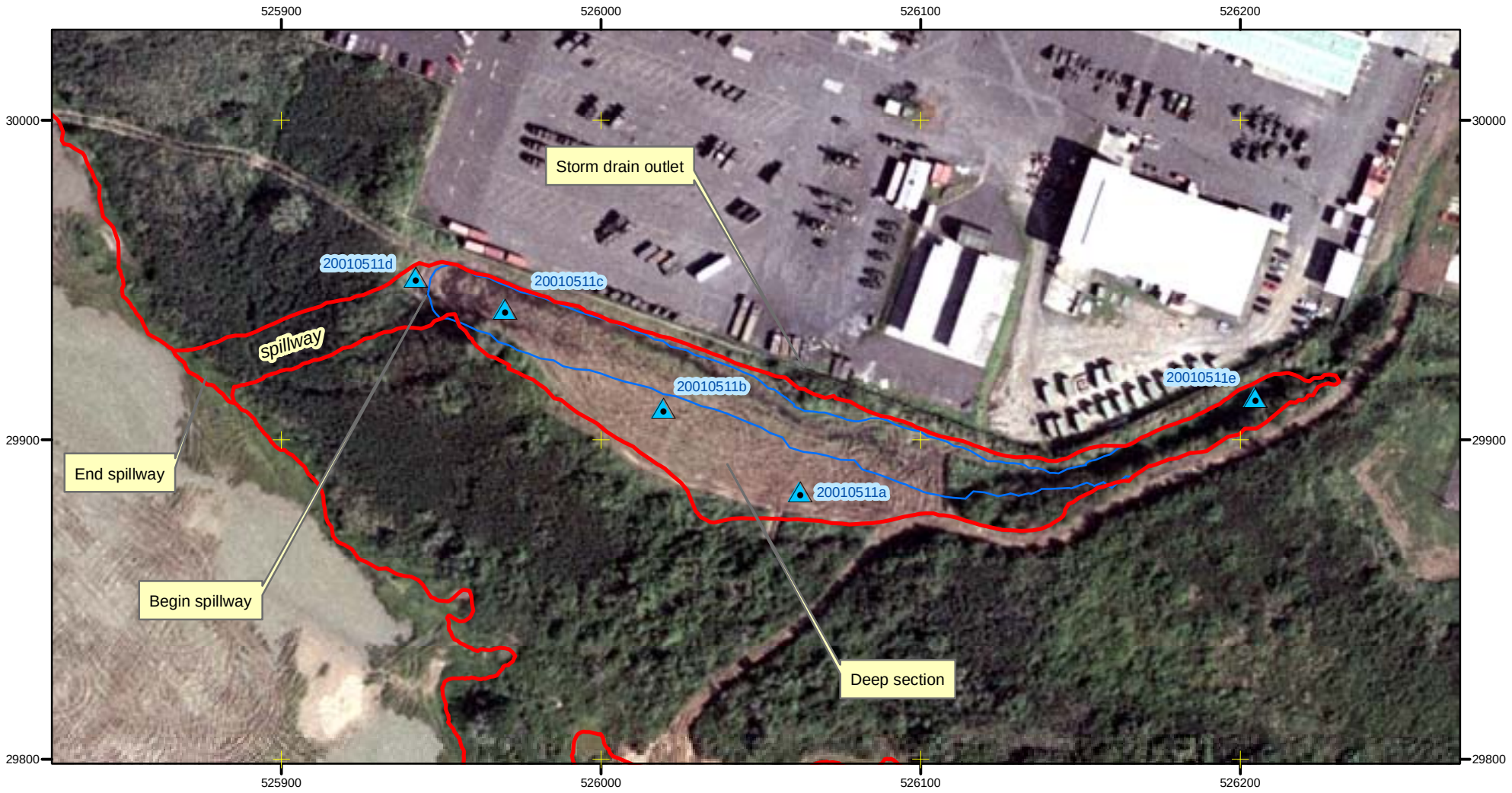


U.S. Army Corps of Engineers
Honolulu District

Notes:
1. 1965 aerial photograph from U.S. Department of Agriculture.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.

Figure 19 - Temporary Lodging Facility and Percolation Ditch (1965 Photograph)

\\e0029\arcgismaps\Fig19_TLF_PercDitch1965.mxd



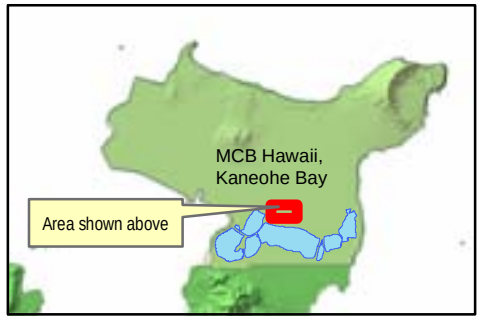
100 0 100 200 Feet

25 0 25 50 Meters

N W E S

Legend

- Datasheet (2009)
- Datasheet (2002)
- Wetland (2009)
- Wetland (2002)



U.S. Army Corps of Engineers
Honolulu District

Notes:
1. Imagery from 2005 EarthData collect.
2. Grid is Hawaii State Plane Coordinate System, Zone 3, NAD83 HARN (1993), meters.
3. Area was excavated and planted in 2006.

Figure 20 - Percolation Ditch Site Map

\\e0029\arcgismaps\Fig20_percditch.mxd

In the 1927 aerial photograph (figure 17), the present main body of the percolation ditch appears to be in a vegetated fastland area. North of the ditch, the area was inundated and may have been used as a fishpond. In 1945 (figure 18), the shoreline is being straightened and extended. The 1953 photo shows that the shoreline has been extended compared to the 1945 photograph. In subsequent photos, a road ran parallel and north of the percolation ditch. By 1959, filling along the shoreline was completed and the area was vegetated.

During the 2002 survey, this area was a drainage ditch for the adjacent AAV Platoon/Engineer Platoon Combat Support Company. The area was overgrown by California grass and wetland conditions occurred in a narrow strip. In 2006, a wetland restoration project was conducted at this site by MCB Hawaii, Environmental Department. The area was regraded to deepen the interior, expand the footprint, replant with native vegetation, and establish a hydraulic connection to Nu‘upia Ponds. The areas on the slopes and above the banks surrounding the wetland were planted with *hala* (*Pandanus tectorius*), *milo* (*Thespesia populnea*), and *naupaka*, (*Scaevola sericea*). Wetland vegetation was planted along the edges of the wetland and included *‘ahu‘awa* (*Cyperus givanicus*), *‘aka ‘akai* (*Schoenoplectus lacustris*), *Cyperus polystachyos*, *kaluhā* (*Bolboschoenus maritimus*), water hyssop (*Bacopa monnieri*), *‘ākulikuli* (*Sesuvium portulacastrum*), and seashore paspalum (*Paspalum vaginatum*). The wetland restoration project followed the U.S. Environmental Protection Agency’s best management practices for storm water management.

The results have been good. Two types of wetlands were created. The deeper portion (Figure 21) provides year round open water which has attracted a family of endangered *‘alae ke‘oke‘o* or Hawaiian coot (*Fulica alai*). The spillway section (Figure 22) provides flat shallow wetland conditions and contains rushes, sedges and depths of a foot or less. The endangered *ae‘o* or Hawaiian stilt (*Himantopus mexicanus knudseni*), egrets and other waterbirds use the spillway and do not use the deeper portions of the wetland. According to Diane Drigot (personal communication), Senior Natural Resources Management Specialist at Environmental Department, the

Figure 21 – Upstream end of the deep section of the percolation ditch. An endangered *‘alae ke‘oke‘o* or Hawaiian coot is in the center of the photo.

elevation at the top of the spillway is designed to retain flood runoff up to the 10-year storm. Overflow through the spillway is directed to Nu‘upia Ponds.

In 2002, the wetland covered approximately 3,834 square meters. In 2006 the wetland was expanded to 8,642 square meters which is a 225% increase in area. The area has been remapped as shown in figure 12 and the GIS wetland layer has been updated.

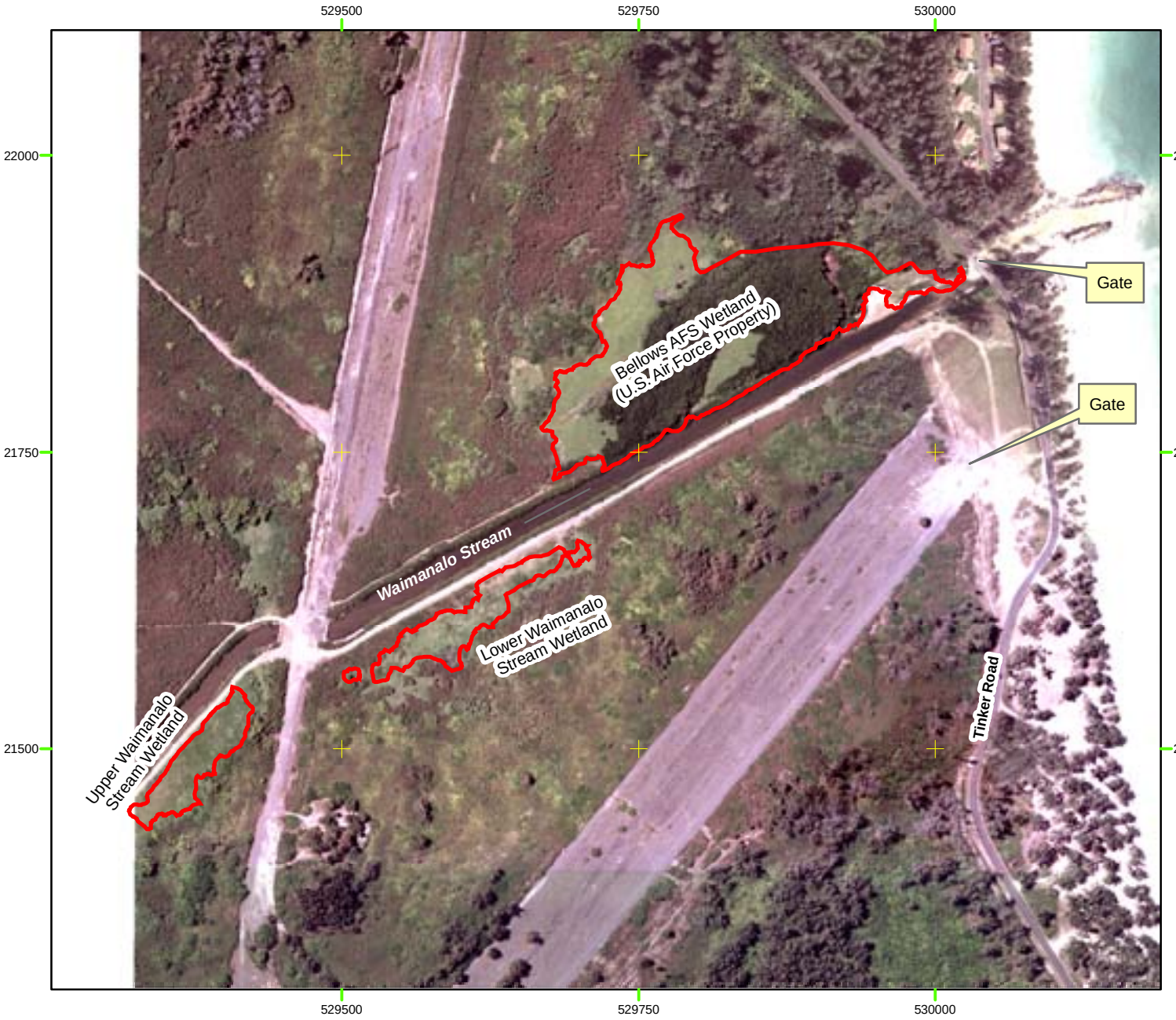
Previously, California grass covered the entire area. MCB Hawaii uses internal staff and volunteers to control the comeback of this invasive species. However, this is an ongoing battle that must be fought to prevent aggressive nonnative species from reclaiming their former dominance. Fauna species such as *auku‘u* or black-crowned night heron (*Nycticorax nycticorax hoactli*), *ae‘o,* fish, tadpoles, and dragonflies are other fauna are regularly observed in the wetland.

Figure 22 – The percolation ditch spillway is very flat and well suited for wading birds such as the endangered *ae‘o* or Hawaiian Stilt

3.3 Marine Corps Training Area Bellows (MCTAB)

3.3.1 Lower Waimanalo Stream Wetland

In 2002, the Bellows Air Force Station (AFS) wetland was mistakenly delineated. It was not located on Marine Corps property but is kept in this report for reference purposes only. In the 2002 report, the Bellows AFS wetland was called the lower Waimanalo Stream Wetland. For clarification purposes, The wetland located on the Bellows AFS has been renamed the Bellows AFS wetland. Both the Bellows AFS and upper Waimanalo Stream wetlands are shown in Figure 23. The newly delineated wetland will be called “Lower Waimanalo Stream Wetland”. The Upper and Lower Waimanalo Stream Wetlands are contained wholly within Marine Corps property on Marine Corps Training Area Bellows.



Notes:
1. Imagery from 2005 Earthdata collect.
2. Grid is Hawaii State Plane Coordinate System, zone 3, NAD83 HARN (1993), meters.

Legend

Wetland (2009)

U.S. Army Corps of Engineers
Honolulu District

N
W E
S

250 0 250 500 Feet

100 0 100 Meters

Figure 23 - Waimanalo Stream Wetlands, MCTAB

\\le0029\arcgismaps\Fig23_Waimanalo_Stream.mxd

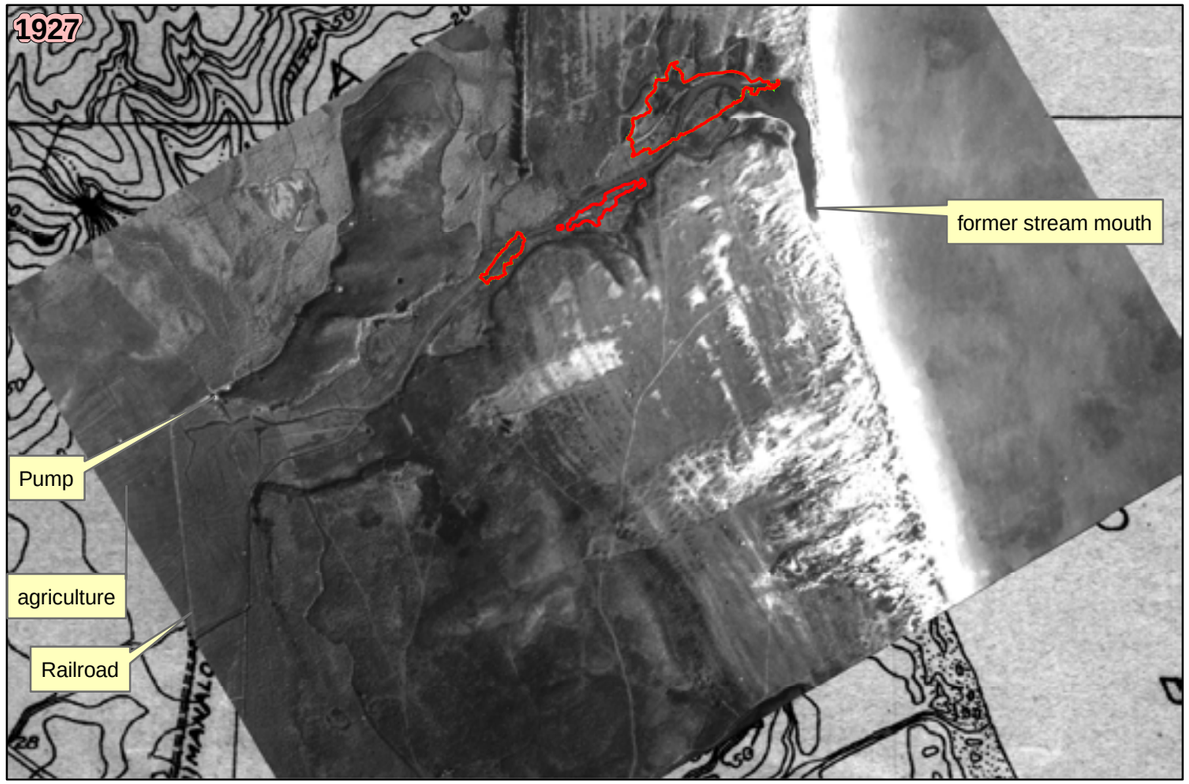
The Lower Waimanalo site was also visited in 2002 but the conditions were very dry during the summer and the soils were hard and dry. At the time of the 2002 survey, the hydric parameters were not prominent and this area was not considered a wetland. However, standing water had persisted between site visits in December 2007, January 2008, and April 2009 and the drift marks indicated that the water existed prior to the initial site visit.

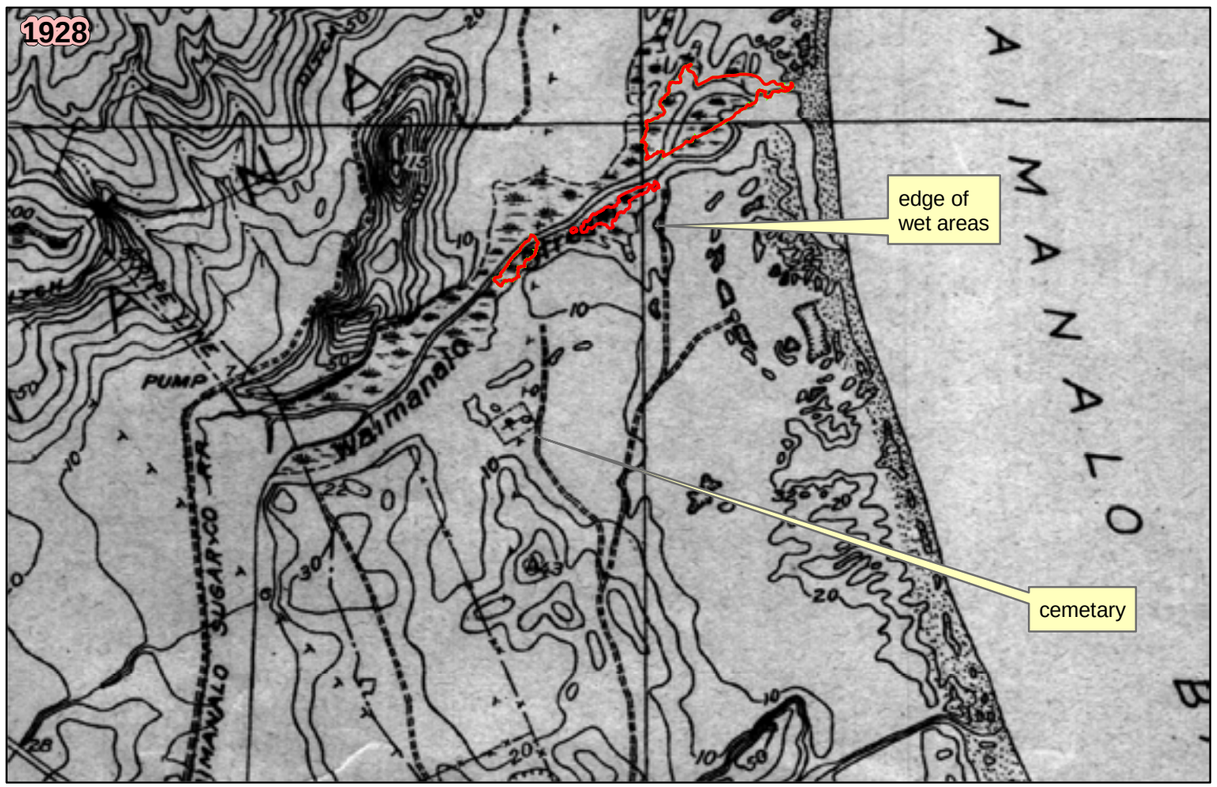
Historically, Waimanalo Stream has meandered through MCTAB but appears to have been confined to a floodplain shown on both the 1927 aerial photograph (figure 24a) and the 1928 USGS topographic map (figure 24b). These two figures show the agricultural features that existed prior to the construction of the runways which were completed in January 1933 (ref. DOT Airports Division). The 1943 COE topo map (figure 24c) shows that the runways have been built and crosses over Waimanalo Stream. Downstream of the runway crossing, the stream has not been straightened. In the 1948 photograph (figure 25a), Waimanalo Stream has been straightened to a layout close to what exists today. The 1962 aerial photograph (figure 25b) shows open water in the Lower Waimanalo Stream wetland.

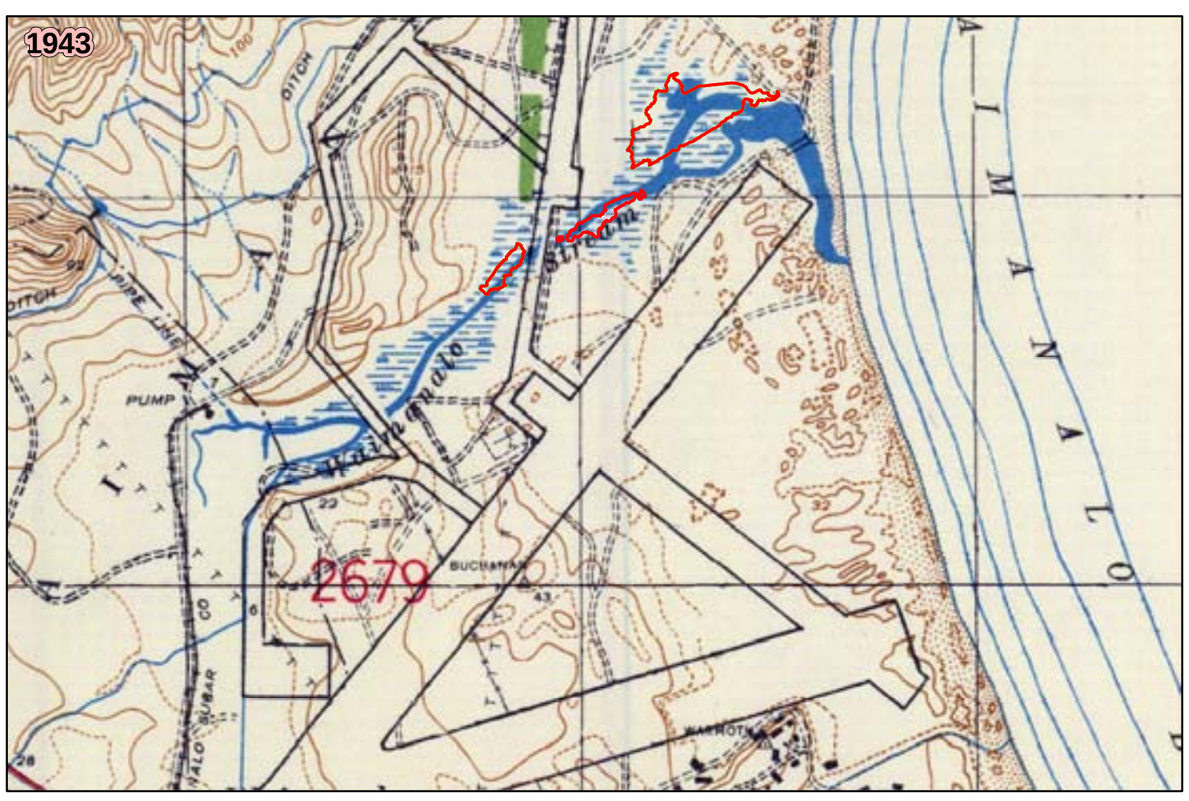
Based on earlier visits in 2001 and 2007, the area is seasonally flooded and the site meets the hydrology requirements of the 1987 Wetland Delineation Manual. Standing water was found in the lower to middle portions of the wetland (Figure 26). The upper portions of the wetland periodically contained standing water but also had a high water table.

Figure 26 – Lower section of the wetland looking upstream. Waimanalo Stream is on the right hand side behind the access road.

California grass (*Brachiaria mutica*) was the primary vegetation over most of the wetland. Outside of the wetland, areas were dominated by Christmas berry *(Schinus terebinthifolius)*, Java plum (*Syzygium cumini)*, *koa haole* (*Leucaena leucocephala*), ivy gourd *(Coccinia grandis)*, and Chinese violet *(Asystasia gangetica).* In the fringes of the open water area, Kaluhā (*Bolboschoenus maritimus*) was observed. The slopes confine the water much like the earlier maps and photographs show.







Legend

- Wetland (2009)
- Wetland (2002)

N
W E
S

500 0 500 Meters

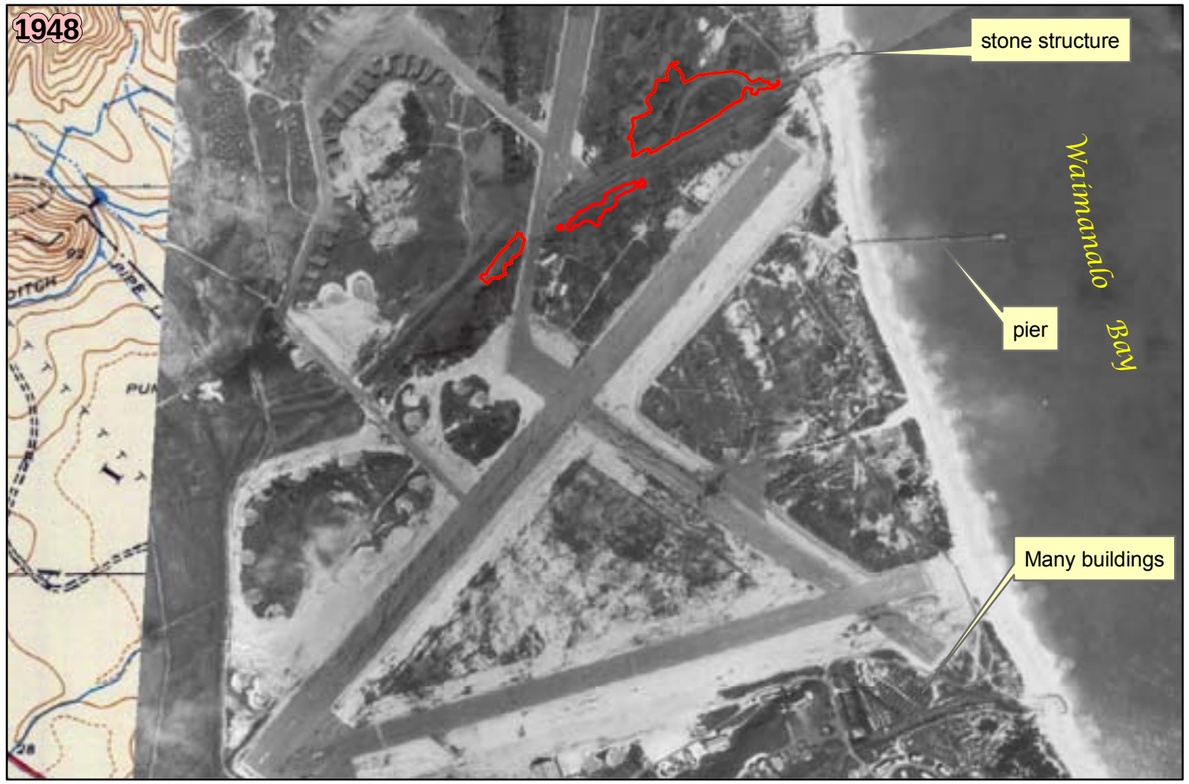
1,000 0 1,000 2,000 Feet

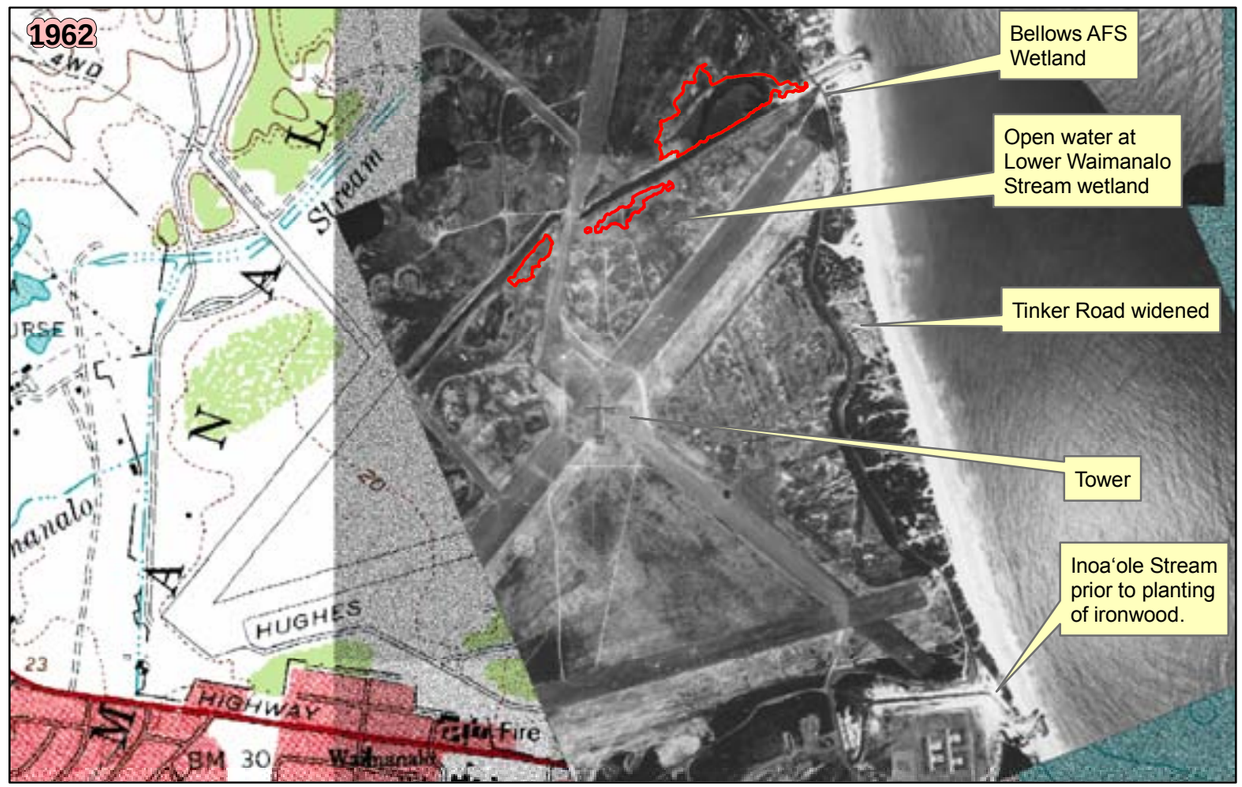
Notes:

1. Upper left (figure 24a) is a 1927 aerial photograph which show conditions before air field was constructed.
2. Upper right (figure 24b) is a 1928 USGS topographic map. All wetlands near Waimanalo Stream are within floodway. Note agricultural railroad, pipes, and ditches.
3. Lower left (figure 24c) is a 1943 USACOE topo map. Runways are in, stream has not been straightened.
4. All maps are the same scale (1:14000).

Figure 24 - MCTAB Waimanalo Stream (1928-1943)

\\poh-fs-s02\gis\Environmental\E0029\arcgismaps\Fig24_MCTAB_1927_to_ 1943





Legend

- Wetland (2009)
- Wetland (2002)

N W E S

500 0 500 Meters

1,000 0 1,000 2,000 Feet

Notes:

1. Upper left (figure 25a) is a 1948 aerial photograph which shows that Waimanalo Stream has been straightened.
2. Upper right (figure 25b) are 1962 aerial photographs. The Central Waimanalo Stream wetland shows open water in an area that presently is hard to see due to the dominance of *Brachiaria mutica*. Upstream of the runway crossing over Waimanalo Stream, the area is at least 50% covered by floating vegetation.
3. Lower left (figure 25c) is 2005 EarthData imagery. *Rhizophora mangle* dominates the oxbow at Lower Waimanalo Stream wetland. *Brachiaria mutica* dominates the Upper and Central Waimanalo Stream wetlands.
4. All maps are the same scale (1:14000).

Figure 25 - MCTAB Waimanalo Stream (1948-2005)

\\e0029\arcgismaps\Fig25_MCTAB_1948to2005.mxd

The soils are typically a 4-12 inch thick clay loam layer over fine coralline sand. The area is mapped as Jaucas sand which matches the sandy ground seen in the1928 aerial photos. The darker top layer is likely material from the floodplain but also from the California grass which dominates the area. Figure 27 shows the delineation map for the Lower Waimanalo Stream Wetland.

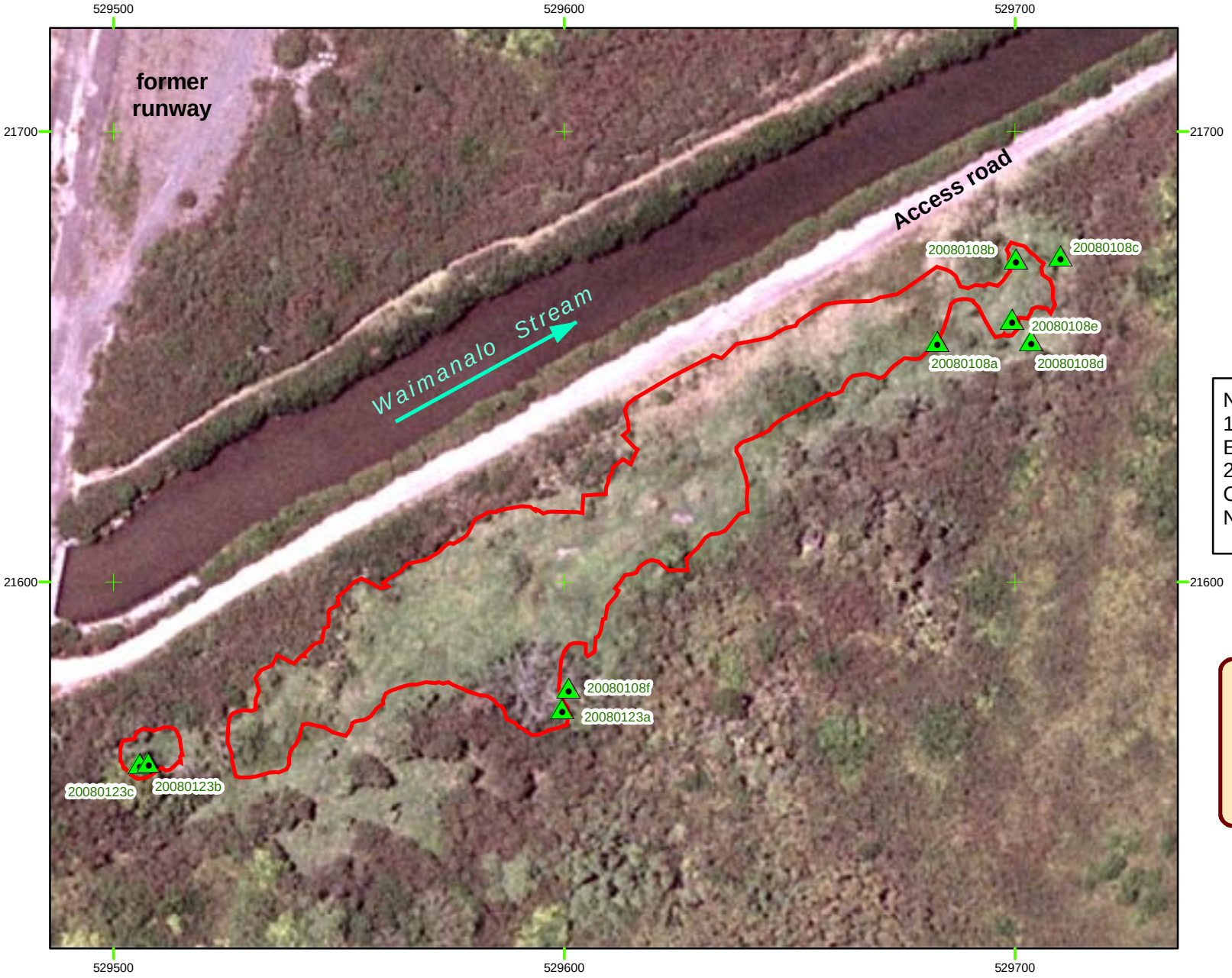
Ducks were seen in the open water area on almost every visit. Wild pigs were seen in 2001 and 2007. The road side near the lower end of the wetland was used for chipping mangroves but this is done as necessary and not on a regular basis.

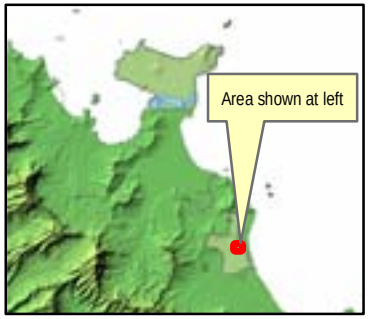
3.3.2– Runway 18-36 North Wetland

In January 2008, a visit was made to a field located north of LZ Gull, east of the point where the two northern most runways, 21R/03L and 18/36, intersect in Training Area 3 (TA-3) on MCTAB. This area is shown on Figure 28 and was dominated by California grass. The edges of the meadow contained kiawe, koa haole, Java plum, and christmasberry. The area had a drainageway and was very hummocky.

The area contained gley soils which is usually a sign of prolonged soil inundation somewhere in its history. The site was visited during the wet season and there were pockets of wet areas and other areas where water could not be found.

Mr. Gordon Olayvar (personal communication) indicated that this was a former training area for the Motor Vehicle Operator's School. The uneven terrain had many high and low spots which made it difficult to make a quick delineation. This area was not identified during the initial scope of work and there was not sufficient field time to include this in the present survey unless the vegetation could be cleared.





Notes:
1. Imagery from 2005 Earthdata collect.
2. Grid is Hawaii State Plane Coordinate System, zone 3, NAD83 HARN (1993), meters.

Legend

- Datasheet (2009)
- Wetland (2009)

U.S. Army Corps of Engineers
Honolulu District

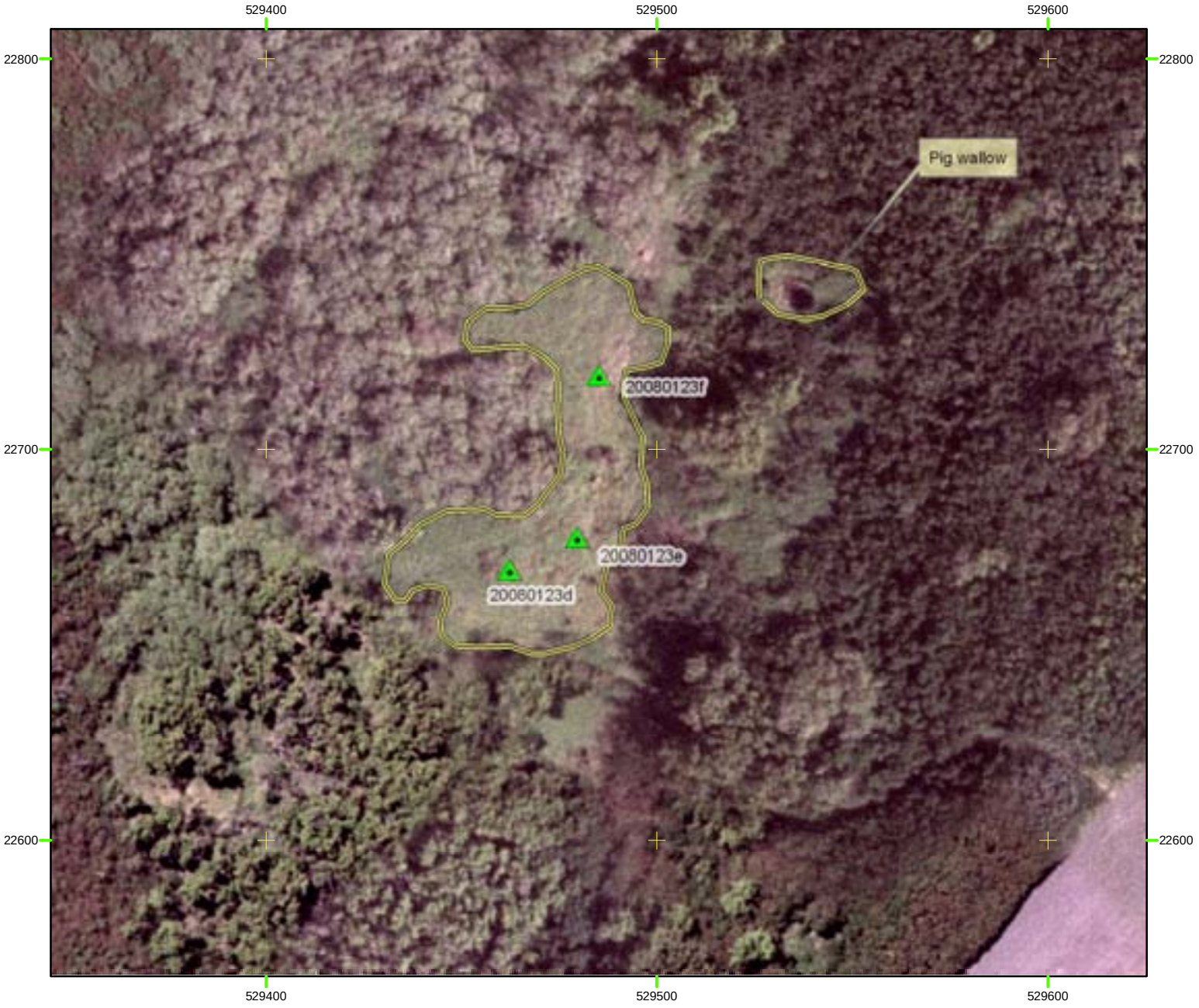
N W E S

100 0 100 Feet

25 0 25 Meters

Figure 27 - Lower Waimanalo Stream Wetland, MCTAB

\\e0029\arcgismaps\Fig27_MCTAB_Lower_Waimanalo.mxd



Notes:
1. Imagery from 2005 Earthdata collect.
2. Grid is Hawaii State Plane Coordinate System, zone 3, NAD83 HARN (1993), meters.

Legend

- Potential Wetland
- Datasheet (2009)

U.S. Army Corps of Engineers
Honolulu District

N
W E
S

100 0 100 200 Feet

50 0 50 Meters

Figure 28 - Runway 18-36 North Wetland MCTAB

\\e0029\arcgismaps\Fig28_MCTAB_Runway.mxd

Chapter 4 - Summary and Conclusions

This report was intended to supplement the 2002 report and not to replace it. Table 1 summarizes the changes to the wetland inventory.

Table 1 – 2009 Changes to MCB Hawaii Wetland Inventory

Site	Notes	Wetland?	2009 Area (sf)	Change (sf)
Hale Koa Recreation Area	Boundary revised	Yes	86,631	33,890
Sag Harbor wetland	Boundary revised	Yes	30,545	-1,564
Salvage Yard Turnaround	New area not a wetland	No	0	0
Temporary Lodging Facility Yard	New area not a wetland	No	0	0
Percolation Ditch	Boundary revised	Yes	93,018	51,752
Lower Waimanalo Stream	New wetland	Yes	53,754	53,754

Of all the Department of Defense services in Hawaii, MCB Hawaii is the most active in managing its wetlands. MCB Hawaii recognizes the value and importance of this resource which impacts the health of the entire watershed's environment. A good example is the enlargement of the percolation ditch wetlands by planting and grading in 2006. This effort more than doubled the area of the wetland which quickly became the home of a family of endangered Hawaiian coots. The site has also been designed to filter and retain sediments and pollutants which prevent them from entering Nu'upia Ponds and Kane'ohe Bay. Environmental Department staff work with schools and volunteers to control invasive vegetation along the shoreline of this wetland.

The continual removal of invasive vegetation is a never ending battle among wetlands throughout the world. MCB Hawaii's use of AAV's is a unique and invaluable tool in this effort. Without this support, it would likely be economically unfeasible to keep the vegetation from choking the wetlands and the shorelines of Nu'upia Ponds and Kane'ohe Bay. The salvage yard and Sag Harbor wetlands have been cleared of mangrove forests which dominated the wetlands in 2002. Although there are juveniles returning, it is much more manageable. The AAV's were used at the salvage yard and there is more open water which makes it attractive for nesting and foraging by the endangered Hawaiian stilt. Mangroves were introduced to Hawaii in the 1920's so its removal brings this area of MCB Hawaii back to a more original natural state before the Mokapu Peninsula was used for military purposes.

The area of focus for the delineation at the salvage yard was a small turn around area. Similar to 2002, there was no vegetation and this area remains a non wetland. The boundaries of the salvage yard wetland did not change.

On the other hand, the removal of the mangroves made it possible to GPS the back edge of the Sag Harbor wetlands. The delineation line for this wetland was adjusted. Stilt and ducks use this wetland.

The grass yard in the Temporary Lodging Facility contained wetland vegetation. However, the soil and hydrology parameters were not met and this area is presently a nonwetland.

The Hale Koa wetlands were expanded quite a bit. During the 2002 survey, the hydrological conditions were not as apparent as they were during the current survey. Continued inundation made it clear that the eastern lobe of this was a wetland.

The Lower Waimanalo Stream wetland at MCTAB is also newly delineated. During the summer months, this wetland is very dry unlike the permanent or near permanent inundation in portions of the lower and upper Waimanalo Stream wetlands. This area is heavily vegetated by aggressive species such as California grass and Christmas berry. All of the Waimanalo Stream wetlands could use some vegetative clearing to stem the natural senescence to upland areas.

Table 2 – Wetland Areas

Wetland Name	**Area (square meters)**	**Area (acres)**
MCB Hawaii, Kaneohe Bay	528,996	130.71
Hale Koa	8,048	1.99
Sag Harbor	2,838	0.70
Salvage Yard	38,927	9.62
Nu‘upia Ponds	454,033	112.19
Percolation Ditch	8,642	2.14
3rd Marine Motor Pool	5,212	1.29
Kaneohe Klipper Golf Course	7,895	1.95
Temporary Lodging Facility	3,402	0.84
MCTA Bellows	8,838	2.18
Upper Waimanalo Stream	3,937	0.97
Lower Waimanalo Stream	4,901	1.21
Bellows Air Force Station (AFS) Wetland*	31,748	7.85

* The Bellows AFS wetland is not part of MCTAB. This wetland had accidentally been delineated in 2002 and is indicated in this report for reference purposes only.

MCB Hawaii wetlands filter sediments and pollutants, reduce erosion, and provide home to flora and fauna. These functions play an important role in the health of the overall environment including the ocean. MCB Hawaii wetlands have increased and improved since the 2002 survey and it is hoped that the upward trend will continue into the future. Stewardship of the environment and our natural resources benefits everyone.