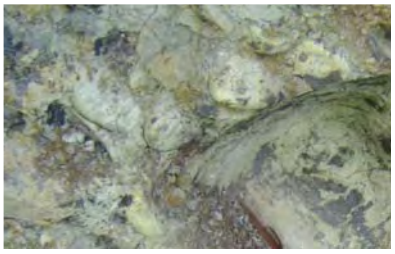
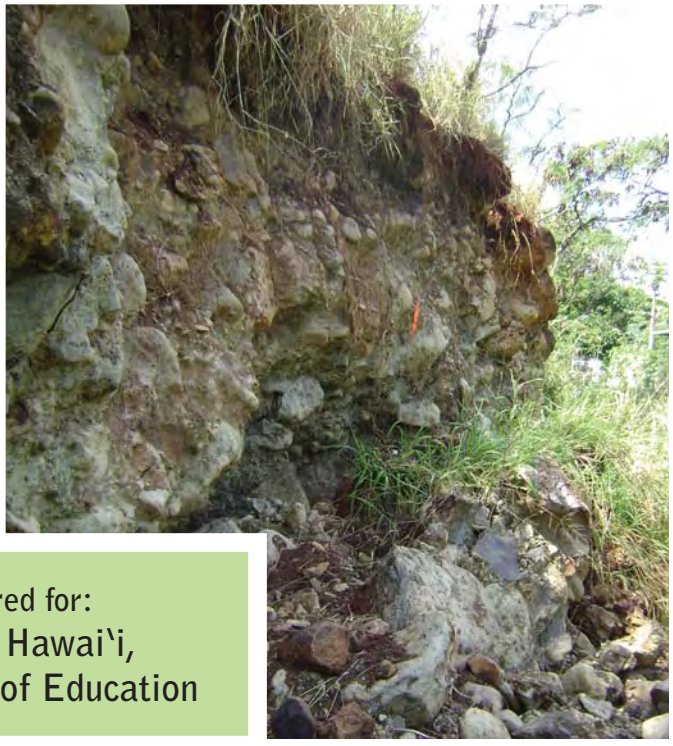
ʻAiea Intermediate School Erosion Control

Draft Environmental Assessment

Job No. Q71009-07

February
2010





Prepared for:
State of Hawaiʻi,
Department of Education

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ADA	Americans with Disabilities Act
BMP	Best Management Practices
BWS	Board of Water Supply
CIA	Cultural Impact Assessment
CZM	Coastal Zone Management
DLNR	Department of Land & Natural Resources
DOE	Department of Education
DOH	Department of Health
DP	Development Plan
DPP	Department of Planning and Permitting
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMS	Emergency Medical Services
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
HAR	Hawai‘i Administrative Rules
HECO	Hawaiian Electric Company
HPD	Honolulu Police Department
HRS	Hawai‘i Revised Statutes
LCA	Land Commission Award
Leq	Equivalent Sound Level
Ldn	Day-Night Equivalent Sound Level
LUO	Land Use Ordinance
mgd	million gallons per day
NAAQS	National Ambient Air Quality Standards
NPDES	National Pollutant Discharge Elimination System
OEQC	Office of Environmental Quality Control
OHA	Office of Hawaiian Affairs
OIBC	O‘ahu Island Burial Council
PUC	Primary Urban Center
ROH	revised ordinances of Honolulu
SHPD	State Historic Preservation Division
SMA	Special Management Area
TMK	tax map key

Project Summary

Item	Description
Project Name	‘Aiea Intermediate School Erosion Control, DOE Job No. Q71009-07
Proposing Agency	State of Hawai‘i, Department of Education (DOE)
Approving Agency	State of Hawai‘i, DOE
Anticipated Determination	Finding of No Significant Impact
Location	99-600 Kulawea Street, ‘Aiea, Hawai‘i ‘Aiea ahupua‘a, ‘Ewa District, O‘ahu
Tax Map Key	TMK [1] 9-9-005:001
Existing Uses	Intermediate school
Landowner	State of Hawai‘i
Need for Project	Severe erosion has occurred on the ‘Aiea Stream bank behind the school cafeteria. The erosion has caused the loss of several feet of land at the top of the bluff, and undermined an electrical box. As a result, electrical lines had to be rerouted to a new overhead line. The continuing erosion jeopardizes the stability of a campus roadway, which provides vehicular access to the cafeteria, classrooms and the school playing fields.
Project Description	Stabilize and protect a 150-foot segment of the eroding and distressed stream bank by backfilling, trimming or removing unstable outcrops and overhangs then applying wire-reinforced shotcrete. This will protect the stream bank slope from further scour, sloughing and retreat. The area at the toe of the stream bank slope will be excavated and backfilled to three feet below grade with reinforced shotcrete to protect the base of the slope from future scour and undermining by stream flows.
Flood Insurance Rate Map	Most of project area is within Zone AE-Floodway associated with ‘Aiea Stream.
State Land Use	Urban
Zoning	R-5 residential
Special Management Area (SMA)	Not within SMA

1 PROJECT DESCRIPTION

1.1 INTRODUCTION

The State of Hawai‘i Department of Education is proposing erosion control improvements along a section of ‘Aiea Stream adjacent to ‘Aiea Intermediate School, which is located at 99-600 Kulawea Street, ‘Aiea, O‘ahu, Hawai‘i. The project is located within TMK [1] 9-9-005:001 (Figures 1 and 2).

This Environmental Assessment (EA) has been prepared in accordance with Chapter 343, Hawai‘i Revised Statutes (HRS), Act 241, Session Laws of Hawai‘i (SLH) 1992, and Chapter 200 of Title 11, Department of Health (DOH) Administrative rules, “Environmental Impact Statement Rules.”

1.2 BACKGROUND AND NEED FOR PROJECT

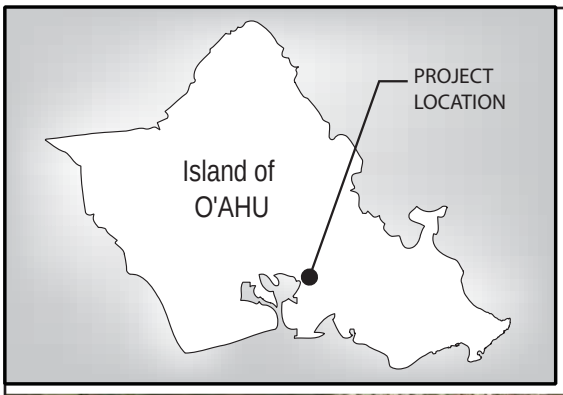
‘Aiea Stream runs along the northwestern perimeter of ‘Aiea Intermediate School. Over the years, severe erosion of the stream bank has caused the loss of several feet of land at the top of the stream bank bluff, running parallel to an on-campus roadway behind the school cafeteria. As the bluff has receded toward the school, the chain link fence has been moved back and is now right up against the roadway. The stream bank bluff adjacent to the roadway is near vertical with unstable overhangs and outcrops.

The erosion has already undermined an electrical box next to the roadway, which formerly housed the school’s main power supply. In 2008, the exposed electrical box was temporarily shored up to prevent it from collapsing into the stream. Last year, the primary power cables were rerouted to a new overhead line. The severe erosion continues to undermine the school roadway, which is used by cafeteria delivery trucks, and provides the only vehicular access to several buildings and playing fields. Parking along the roadway near the eroding stream bank has been restricted.

The current project is needed to repair and stabilize the distressed stream bank, to stop the eroding and retreating bluff, and to protect the adjacent roadway which is being undermined.

1.3 POSSIBLE ENVIRONMENTAL PERMITS AND APPROVALS

The following is a summary of environmental approvals and consultations that may be required for the proposed action. Chapter 4 includes a more detailed discussion of the project’s consistency with federal, State and local land use plans, policies and controls.

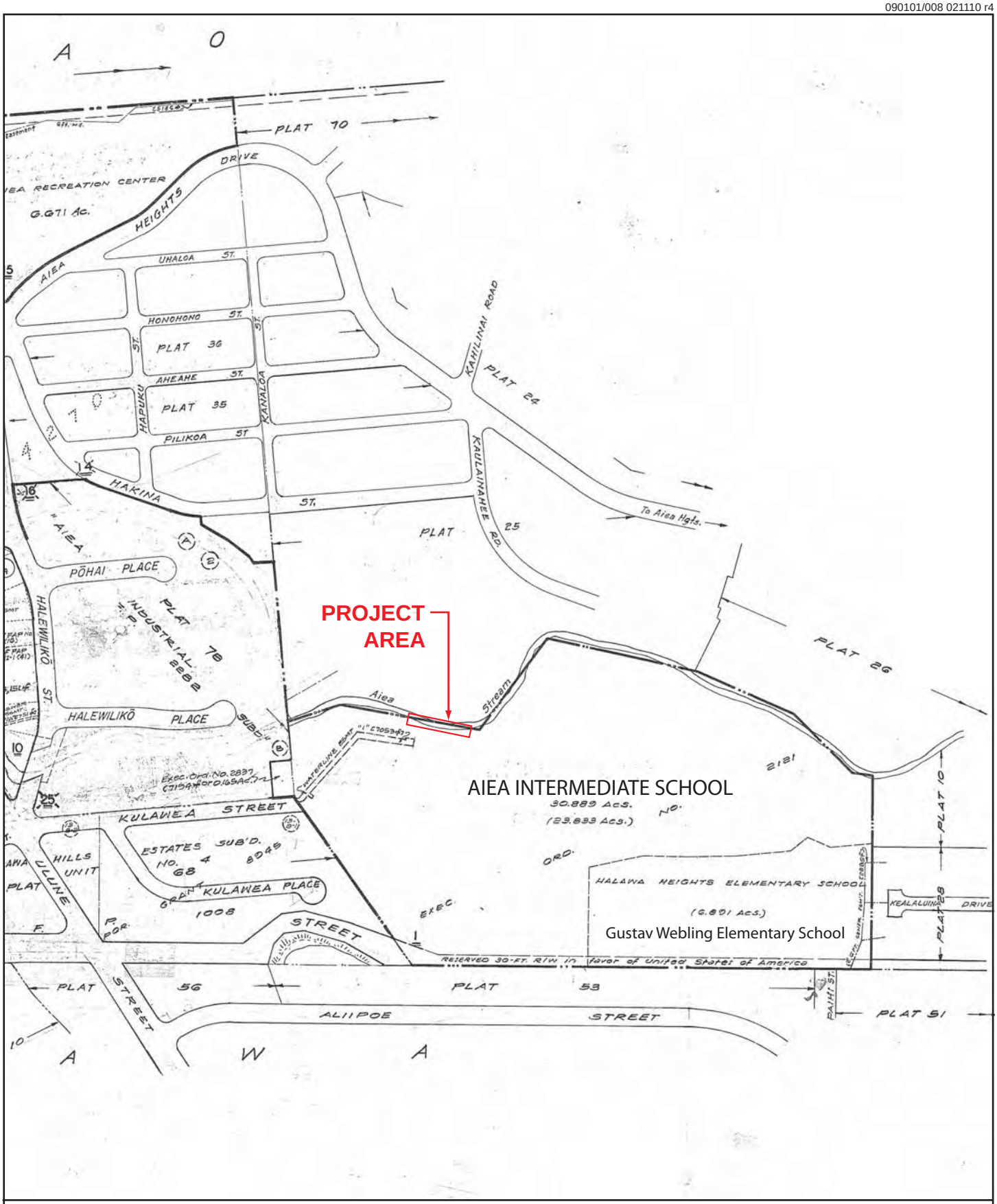


NORTH

Figure 1

LOCATION MAP

'Aiea Intermediate School Erosion Control EA



North

0 200 400

Scale in Feet

Figure 2

TAX MAP KEY

'Aiea Intermediate School Erosion Control EA

Table 1-1: Possible Environmental Permits and Approvals

Approval/Consultation	Agency
Federal	
Department of the Army, Section 404 permit	U.S. Army Engineer District, Regulatory Branch
State of Hawaiʻi	
Chapter 343 Hawaiʻi Revised Statutes (*Environmental Assessment)*	Office of Environmental Quality Control
HRS Chapter 6E review (*Historic*)	Department of Land and Natural Resources, State Historic Preservation Division
Coastal Zone Management Consistency Review	Office of Planning, Coastal Zone Management Office
Section 401 Water Quality Certification (WQC)	Department of Health, Clean Water Branch
Community noise permit and noise variance	Department of Health
Construction plan approval	Department of Health
Use and Occupancy Agreement	Department of Transportation
Construction plans approval	Disability Communication Access Board
City and County of Honolulu	
Construction, grading, and trenching permits	Department of Planning & Permitting
Construction plan approval	Department of Planning & Permitting Department of Design and Construction Department of Environmental Services

*Note: Consultation with the State of Hawaiʻi Department of Land & Natural Resources, Commission on Water Resource Management confirmed that a Stream Channel Alteration Permit (SCAP) is not required for the project.

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 NO-ACTION ALTERNATIVE

The No-Action alternative would do nothing to address the ongoing erosion at the stream bank at 'Aiea Intermediate School. Left untreated, the bank would continue to erode and the bluff on the school property would continue to retreat closer to the roadway and into the campus. The stream bank erosion has already undermined an existing electrical box, requiring relocation of the school's electrical lines and abandonment of the electrical box. Unstable portions of the roadway alongside the stream are unusable for parking. Without further action, the retreating stream bank will damage the access road, jeopardize vehicle deliveries to the cafeteria and classrooms, and could damage water lines providing potable water and fire protection to the school. The chain link fence at the top of the slope could collapse, resulting in a student safety concern. The erosion problems have required ongoing significant maintenance over the years, and the no-action alternative would lead to continued repair expenditures.

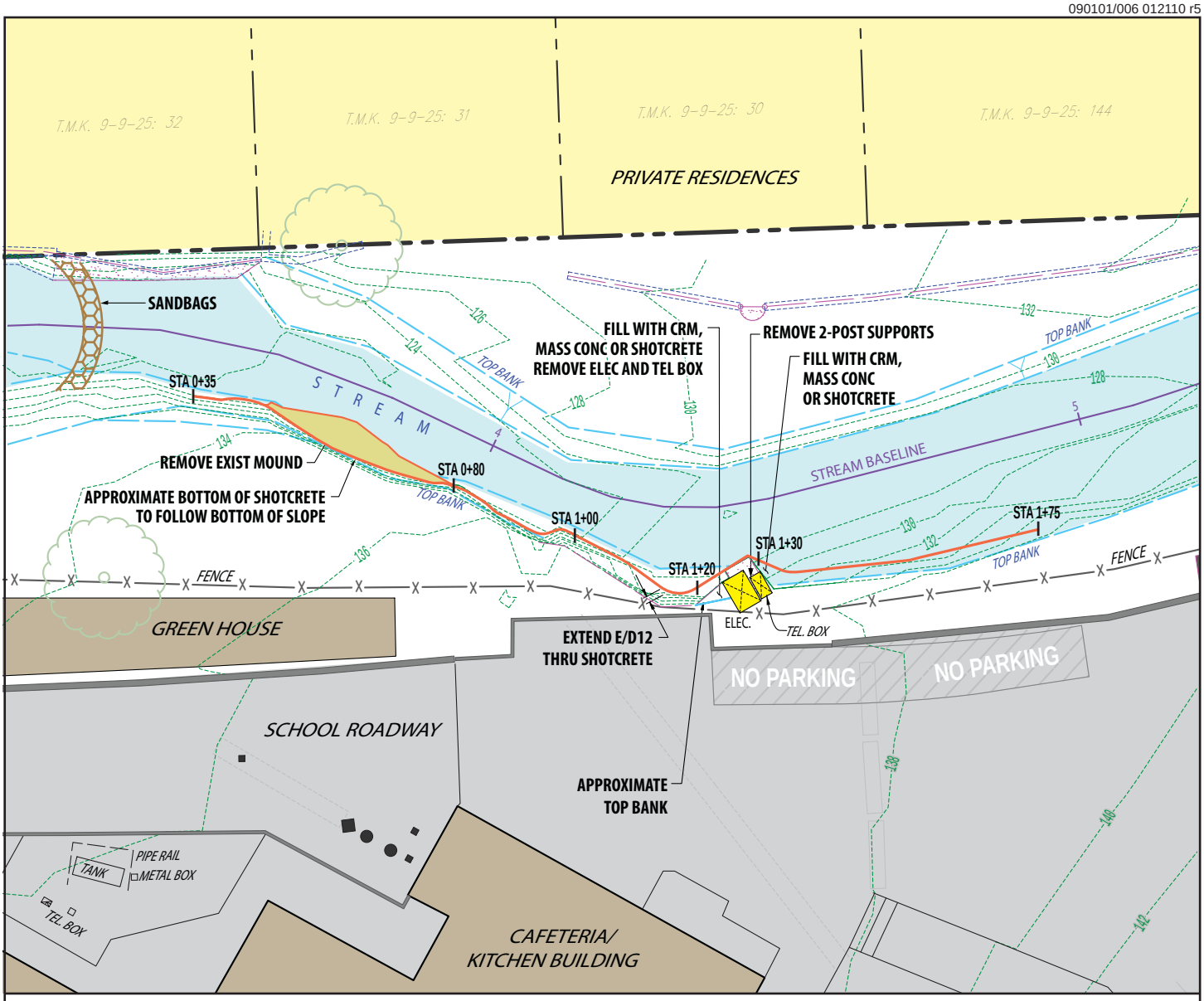
The ongoing scour and erosion of the stream bank would also cause large quantities of debris and sediment to collapse into the stream channel, particularly during periods of high rainfall. This would have an adverse effect on both stream and near shore water quality in Pearl Harbor. The no action alternative was determined to be unacceptable and was eliminated.

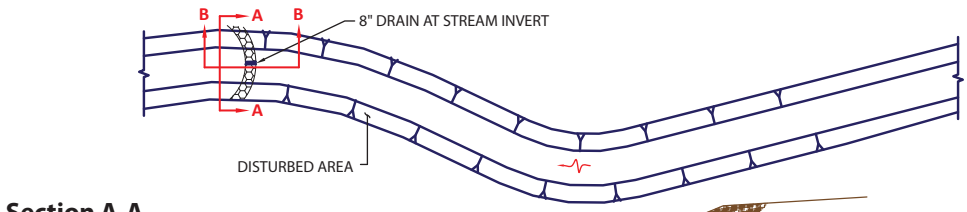
2.2 PROPOSED ACTION

The proposed project will protect and stabilize a 150-foot segment of the eroding stream bank in this area, as shown in Figures 3 and 4. Sections of the stream bank which have already been undermined will be supported with grouted rip rap or mass concrete and unstable outcrops and overhangs will be trimmed or removed. Wire reinforced shotcrete will then be applied over the entire eroding and distressed stream bank to prevent further sloughing and retreat of the stream bank caused by stream scour and erosion. Shotcrete is a concrete mixture which is sprayed at high velocity through a hose and nozzle. This application process allows the concrete mixture to be placed on steep slopes. Prior to the application of the shotcrete, the bank surface will be prepared by the removing loose debris and vegetation and placing geocomposite sub-drainage strips on the slope.

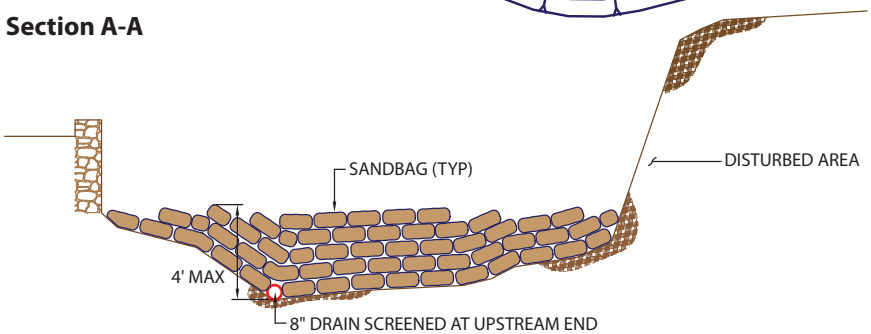
At the toe of the slope near the stream, the bottom three (3) feet below grade will also be excavated, reinforced with reinforcing steel, and backfilled with shotcrete. This will protect against scour caused by the stream flow.

A sub-drain system in the shotcreted area of the stream bank will prevent infiltrated surface water from building up behind the slope face protection. Water will be released through weep holes or small pipes at the bottom of the slope.

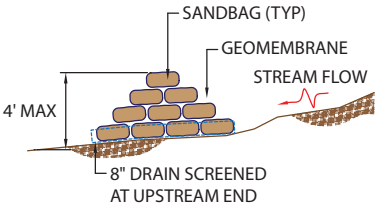




Section A-A



Section B-B

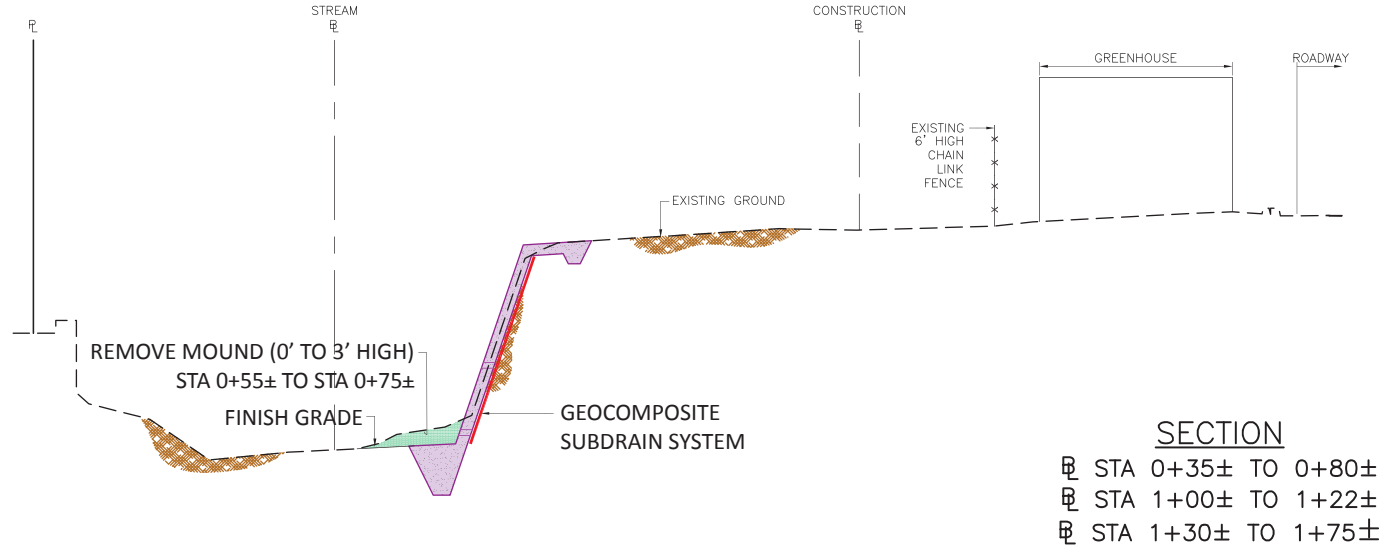


EROSION CONTROL DETAILS

Figure 3

SITE PLAN

'Aiea Intermediate School Erosion Control EA

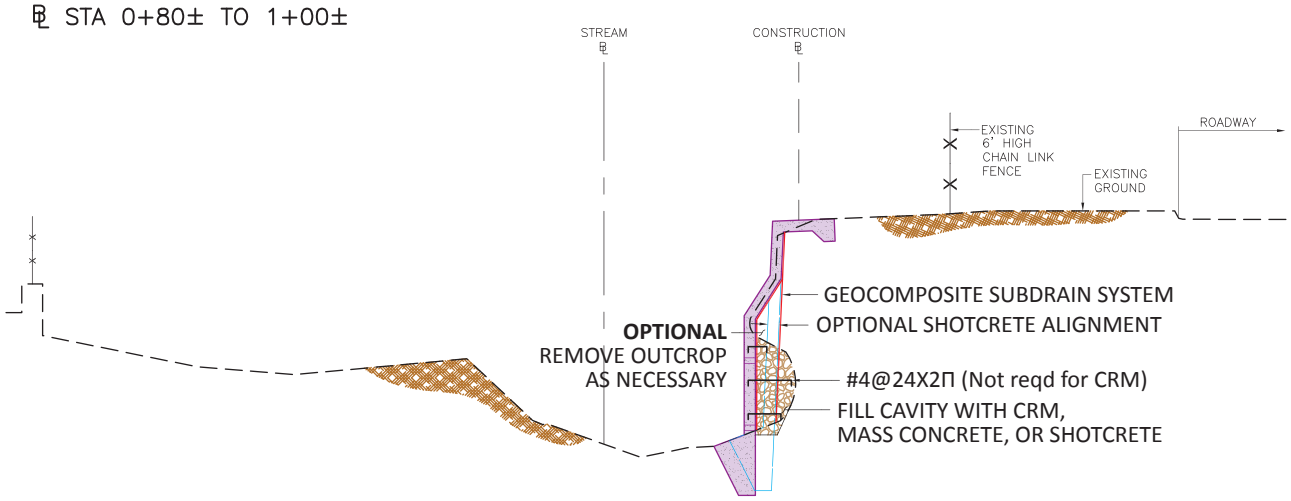


SECTION

℄ STA 0+35± TO 0+80±
℄ STA 1+00± TO 1+22±
℄ STA 1+30± TO 1+75±

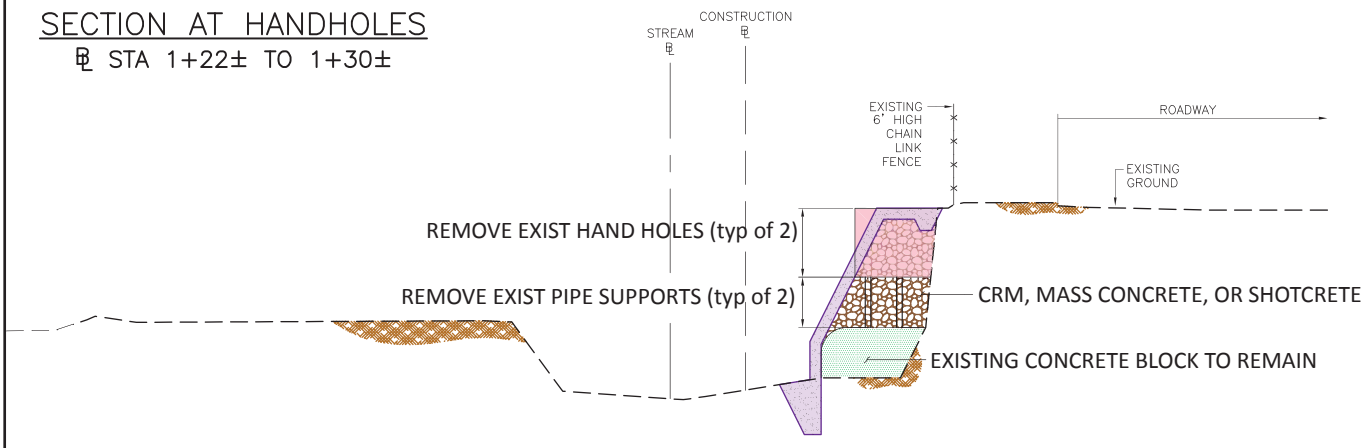
SECTION

℄ STA 0+80± TO 1+00±



SECTION AT HANDHOLES

℄ STA 1+22± TO 1+30±



Source: Sato & Associates, 2009

Figure 4

TYPICAL SECTIONS

'Aiea Intermediate School Erosion Control EA

The wire-reinforced shotcrete will partially cover the surface at the top of the stream bank on the school property, where it will be keyed into the flat surface at the top of the stream bank.

Construction is expected to take approximately three months, and is planned during the summer when school is not in session. The stream is expected to be mostly dry during the summer months, so stream diversion will not be required. However, best management practices are proposed to ensure that debris does not affect water quality. Prior to construction, sandbags will be placed across the width of the stream downstream of the work area. An 8-inch diameter screened drain will be inserted at the stream invert, to allow backed-up stream waters to continue to be released, while preventing rocks and sediment in the work area from entering the stream. The sandbags will remain in place throughout the construction period and removed when work is completed.

2.3 ALTERNATIVE REPAIR METHODS AND MATERIALS

Other techniques and materials are available to control stream bank erosion. Selection of the most appropriate approach is based on the project objectives, habitat issues, site conditions, and budgetary constraints.

Biological shore protection techniques utilize vegetation and natural materials for bank stabilization and protection. This alternative is not appropriate for a number of reasons. Biological or vegetative methods of erosion control are best suited for areas with a maximum slope of 2:1 (horizontal to vertical). The stream bank in the project area is steeper, at 1:1 slope, and already heavily damaged. The geotechnical consultant also reported that future vegetation growth could dislodge unstable boulders and cobbles protruding from the eroded bank.

A hydrologic analysis of the stream flows indicate that erosion forces at the toe of the stream bank are high, and that vegetation would not provide adequate erosion protection. The geotechnical engineers determined that a more resilient form of protection, such as shotcrete, was required. Finally, biological shore protection would do nothing to correct the severe structural damage to the stream bank that has already occurred.

Other alternatives to the proposed action involve various types of rocks, boulders or rip rap that could be used to armor the bank or redirect stream flows. The project considered repair materials such as grouted rip rap (GRP) and reinforced concrete to stabilize the bank. While these materials are readily available in Hawai‘i, it was determined that backfilling the steep, irregular-shaped areas could be best accomplished with shotcrete, given its ease and speed of application.

2.4 COMPARISON OF ALTERNATIVES

A Geotechnical Exploration and Evaluation Report (Yogi Kwong Engineers, 2009) was conducted to evaluate project site conditions, assess the stability of the stream bank and roadway, and provide recommendations for remediation. The study, which is included as Appendix A, evaluated the composition of soils and subsurface conditions, and conducted a slope stability

analysis. A number of alternatives, including those discussed above, were considered. The proposed action was recommended in the geotechnical report, based on the study findings and the consultant’s experience in similar geologic settings. The proposed erosion control improvements meet the project objectives to repair existing damage and provide future protection and erosion control. It is appropriate for the site conditions and an economically feasible solution.

3 AFFECTED ENVIRONMENT, IMPACTS AND MITIGATION

3.1 INTRODUCTION

This chapter describes the existing environment, potential project impacts and proposed mitigation. This chapter is organized by resource area, and is generally divided into: 1) physical environment, 2) biological environment, 3) socio-economic environment, 4) utilities and infrastructure, 5) traffic, and 6) public services and facilities.

The discussion of environmental impacts includes both direct and indirect impacts. Direct impacts are those caused by the action and occur at the same place and time. Indirect effects may occur later in time or farther in distance, but are still reasonably foreseeable. The analysis in this chapter also identifies possible cumulative environmental impacts. Cumulative impacts are defined as the results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

3.2 PHYSICAL ENVIRONMENT

3.2.1 Location and Site Conditions

‘Aiea Intermediate School is located at 99-600 Kulawea Street in ‘Aiea, O‘ahu, Hawai‘i. The school was established in 1963 and the entire property encompasses 23.8 acres. The southeast corner of the school property is occupied by Gus Webling Elementary School. The surrounding neighborhood is a single-family residential area developed between 1949 and 1969, with most of the homes in the immediate vicinity built in the 1970s.

‘Aiea Stream meanders for approximately 2,500 feet along the northwest boundary of ‘Aiea Intermediate School. The project area is a severely eroded, 150-foot long segment along the stream bank, parallel to an internal road and behind the cafeteria and kitchen building. The paved road is the school’s only vehicular and fire access to the back side of the campus, and is also used by delivery trucks to the cafeteria.

The stream corridor in this area is overgrown with tall Guinea grasses, shrubs and trees all the way down the bank. In the immediate project area, the stream bank is less vegetated, and severely eroded and scoured at the toe of the slope. The erosion has resulted in overhanging outcrops with protruding boulders and cobbles on the stream bank.

At the top of the embankment on the school property, the land has receded into the campus toward the roadway. Where there was formerly a wide buffer between the roadway and the edge of the stream bluff, the bluff is now right up against the roadway. Parking has been banned along the stream side of the road because of the unstable bluff. At the top of the stream bank within the school property, there are overhead electrical, telephone, and cable TV lines, and underground water and sewer lines.

Exposed electrical box undermined by the receding stream bank. Electrical lines were relocated in 2009. (photos courtesy of YKE)

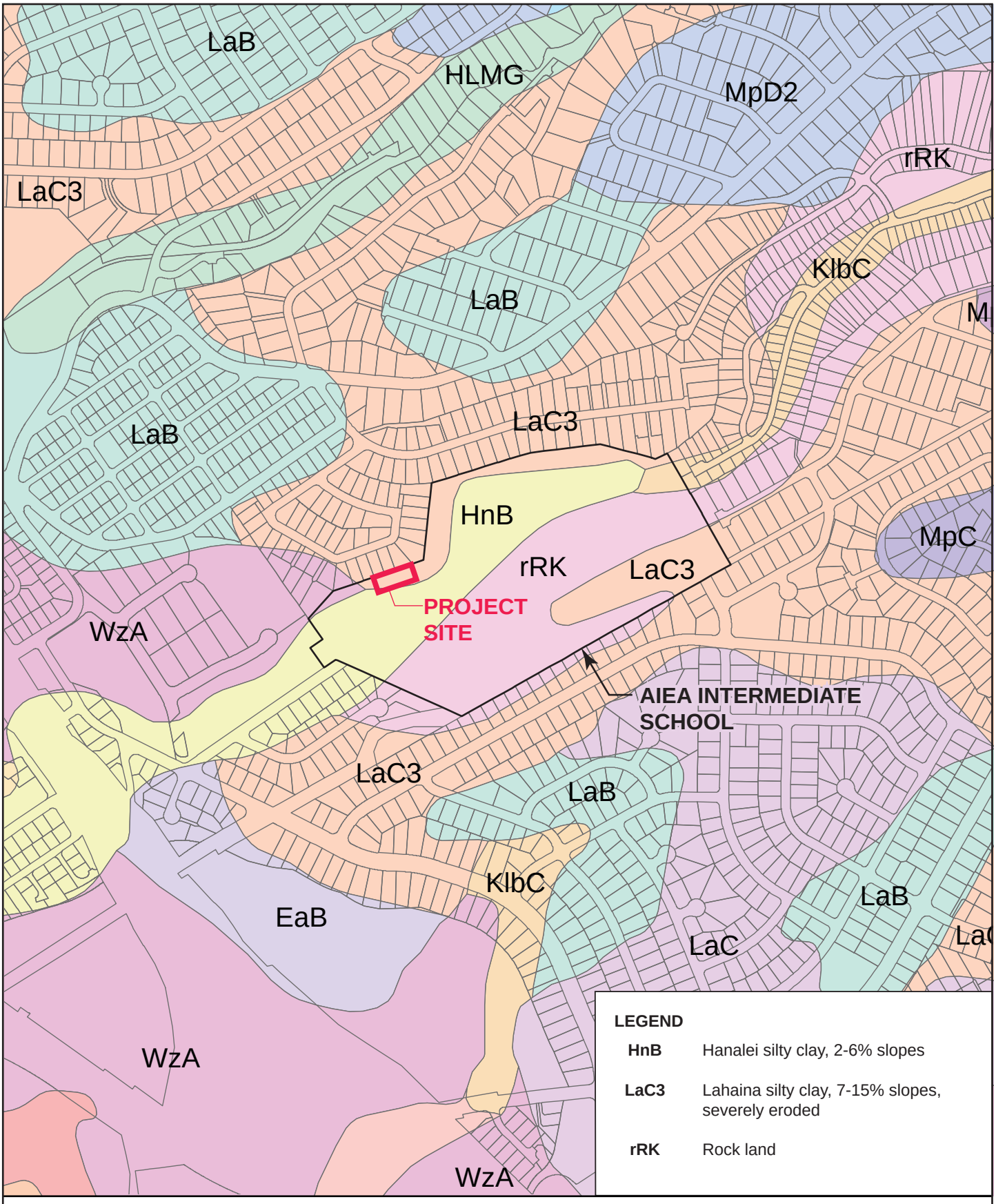
The erosion has already undercut an electrical and telephone hand hole box, leaving an exposed area beneath the box. In 2008, a concrete block was poured and steel posts were placed to support the underside of the box, in an attempt to prevent it from collapsing into the stream. In 2009, the electrical lines were relocated to an overhead line.

3.2.2 Topography and Soils

Existing Conditions

Elevations at the stream bed are 127 feet above mean sea level, and about 140 feet at the top of the bank near the school roadway. Topography at the school property is fairly level.

The southern half of the school property is characterized by Rock Land (rRK), and the northern half closest to 'Aiea Stream is Hanalei silty clay with 2 to 6 percent slopes (Figure 5). Other soils in the vicinity are Lahaina series silty clay with 7 to 15 percent slopes (LaC3), and Waipahu silty clay with 0 to 2 percent slopes (WzA). Lahaina silty clay is of good quality for producing pineapple and sugarcane, while Waipahu silty clay is of good quality sugarcane and house lots.



North

0 200 400 600

Scale in Feet

Figure 5
SOILS MAP
'Aiea Intermediate School Erosion Control EA

Soils in the project area consist of a top layer of sandy reddish-brown alluvial sediment overlying a thick layer of dark brown sandy clay. Alluvial sand and sediment is mixed with the bottom layer of large boulders and cobbles which protrude from the stream bank slope.

Impacts and Mitigation

The recommended erosion control improvements involve preparing the slope by removal of vegetation, trimming and/or supporting unstable and undermined outcrops and overhangs on the bluff, and then application of wire reinforced shotcrete. These improvements will protect the stream bank from future scour erosion and stream bank retreat, and will alter the topography of the existing slope which is uneven and badly eroded.

Construction activities will employ best management practices to prevent soil loss and erosion. Any impact of construction activities on soils will be mitigated by measures outlined in the following regulations:

- Chapter 14, Articles 13-16 as related to Grading, Soil Erosion and Sediment Control, of the Revised Ordinance of Honolulu, 1990, as amended.
- Department of Planning and Permitting, Rules relating to Soil Erosion Standards and Guidelines, (1999);
- USDA Soil Conservation Services Erosion and Sediment Control Guide for Hawai'i, (1968).

A grading permit is not expected to be required. Typically, a permit is required for grading which:

1. changes the drainage pattern with respect to abutting properties
2. exceeds 50 cubic yards of cut or fill
3. exceeds 3 feet in vertical height at its deepest point

The proposed project will entail structural excavation which is required to provide a smooth surface, and to key the shotcrete at the toe of the stream bank, preventing it from being undermined by the stream. The project will not change the drainage pattern. Proposed excavation will not exceed 50 cubic yards of cut, and will not exceed three feet in vertical height at its deepest point.

3.2.3 Geology and Geotechnical

A Geotechnical Exploration and Evaluation Report (Yogi Kwong Engineers, LLC, 2009) was completed for the project. The purpose of the study was to 1) explore the stream bank conditions in the vicinity of the undermined electrical manhole and the subsurface conditions below the adjacent roadway; 2) assess the stability of the existing adjacent stream bank and adjacent roadway; and 3) develop geotechnical recommendations for remediation measures. The

geotechnical engineers also performed a “walk through” of the stream to identify additional areas of distress along the stream bank near the northwest school boundary.

This section summarizes the findings of the Geotechnical Exploration and Evaluation Report, which is included as Appendix A.

Existing Conditions

The Geotechnical Exploration and Evaluation Report found the stream bank bluff is severely scoured and undermined at the toe of the slope near the stream. This has resulted in overhanging outcrops and exposed boulders and cobles. Vertical tension cracks were observed on the bank adjacent to the overhanging outcrops. The scour and erosion have also undermined an electrical hand hole box leaving a large cavity beneath the box. The electrical lines were relocated in 2009.

The opposite bank across ‘Aiea Stream is adjacent to single family residences on Uwau Drive. The bank in this area is also overgrown with vegetation. Many homeowners have constructed retaining walls of various heights on their property bordering the stream. The geotechnical consultant also observed scour and sloughing of the stream banks upstream of the project area.

Eroded stream bank and residence on the other side of the stream. (photo courtesy of YKE)

Impacts and Mitigation

The geotechnical consultant noted that the very steep stream bank bluff in the project area is vulnerable to further erosion and progressive sloughing or spall due to surface runoff and stream scour. They also note that future vegetative growth on the bank could dislodge unstable cobbles and boulders.

Based on their evaluation, the geotechnical team provided specific recommendations for remediation which have been incorporated into the project plans. The geotechnical report recommended grouted rip rap or mass concrete be used to backfill and support the undermined stream bank outcrops and overhangs. Alternatively, it recommended that undermined outcrops be trimmed or removed. Grouted rip rap or mass concrete backfill was also recommended for the cavity below the undermined electrical hand hole box.

After clearing the vegetation on the stream bank and supporting or trimming the outcrops and overhangs, it was recommended that wire-reinforced shotcrete be applied to the surface of the stream bank bluff. This serves to protect the slope from future scour, progressive sloughing and stream bank retreat that will eventually undermine and destabilize the adjacent roadway and utilities. A cobble rubble masonry (CRM) or gabion wall was recommended to be constructed at the toe to provide additional scour protection at the stream bed level. However, reinforced structural shotcrete has been incorporated to provide additional scour protection at the toe of the stream bank bluff, in-lieu of a CRM or gabion wall.

During construction and excavation in the area, the construction contractor will closely monitor the stability of the site to ensure safety and avoid collapse of the eroded stream bank. The geotechnical study notes that the condition behind the bank area which is covered by overgrown vegetation is unknown. Therefore, it is recommended that the construction contractor exercise caution when removing vegetation and loose material to avoid destabilizing the bank. It is recommended that the use of heavy construction equipment be prohibited, to avoid creating strong ground vibrations near the stream bank or along the adjacent roadway. The study cautions that vibrations from construction equipment, particularly during rainy periods, could result in cave-ins. Construction during the dry summer months would also help mitigate this risk.

3.2.4 Climate and Air Quality

Existing Conditions

Climate

Climate on the Island of O‘ahu is influenced by its subtropical location, topography, and the surrounding Pacific Ocean. Temperatures in ‘Aiea range from an average high of 89 degrees Fahrenheit in August, to an average minimum of 65 degrees Fahrenheit in February. Day and night temperature variations tend to be fairly limited during both summer and winter, with an average difference of 14 to 15 degrees. The annual average precipitation in ‘Aiea is 58.74 inches, with rainfall fairly evenly distributed through the year. The wettest month is December, with an average rainfall of 6.72 inches.

Air Quality

National Ambient Air Quality Standards (NAAQS) have been established for seven major air pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), particulate matter smaller than 10 microns (PM_{10}), particulate matter smaller than 2.5 microns ($PM_{2.5}$), sulfur oxides (SO_x), and lead. Air pollutant levels are monitored by the State Department of Health (DOH) at a network of sampling stations statewide, although there are no sampling stations in windward O‘ahu. Based on ambient air monitoring data, the U.S. Environmental Protection Agency has classified the island of O‘ahu and the entire State of Hawai‘i as being in attainment of the federal standards.

Air quality within the project area is good, as the surrounding general area is primarily residential in nature and its location near the ocean results in continuous on-shore breezes. There are no major sources of air pollution in the area.

Impacts and Mitigation

Construction and demolition activities will generate some dust in the immediate area which has the potential to impact the school cafeteria, kitchen, and nearby classrooms. The project area is less than 50 feet from the cafeteria building and about 200 feet from the nearest classroom buildings. Homeowners across ‘Aiea Stream are less likely to be affected by dust, as they are upwind of the prevailing northeast trades. In order to mitigate impacts to the school, construction will be scheduled during the summer months to the extent possible, to minimize impacts to the school.

The construction contractor will employ fugitive dust emission control measures in compliance with provisions of the State DOH Rules and Regulations (Chapter 43, Section 10) and Hawai‘i Administrative Rules (HAR) Chapter 11-60.1, “Air Pollution Control,” Section 11-60.1-33 on Fugitive Dust.

During construction, the contractor will spray water, as necessary to control dust. In addition, the following measures will be implemented to minimize dust and air quality impacts:

- Provide an adequate water source at the site prior to start-up of construction activities;
- Pave or revegetate work areas cleared of vegetation as soon as possible to reduce dust;
- Provide adequate dust control measures during weekends, after hours, and prior to daily start-up of construction activities;
- Control dust from debris being hauled away from the project site;
- Move construction equipment to and from the work sites during non-peak traffic periods, to the extent possible, in order to minimize disruption to area traffic.

Overall, air quality impacts during construction will be temporary in duration.

Long-Term Impacts

The project will not have a long-term adverse affect on air quality.

3.2.5 Natural Hazards

Existing Conditions

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), the area surrounding ‘Aiea Stream is within Zone AE-Floodway (Figure 6). The AE-Floodway represents the **“***water course or portion of the floodplain which must be reserved in order to carry or discharge the regulatory flood without cumulatively increasing the flood elevation of the floodplain more than a foot at any point.”*

According to the City and County’s Land Use Ordinance (LUO) (Sec. 21-9.10-5, Floodway district), the floodway is *“the watercourse reserved to discharge the regulatory flood.…The floodway is an extremely hazardous area due to the velocity of floodwaters which could carry debris, and erosion potential…”*. As such, uses in the floodway are limited to those with low flood damage potential and those that would not obstruct the regulatory flood, affect the capacity of the floodway, or cause any increase in regulatory flood elevations.

The National Flood Insurance Program (NFIP) regulates developments within Zone AE. The project must comply with the rules and regulations of the NFIP presented in Title 44 of the Code of Federal Regulations (44CFR) whenever development within a Special Flood Hazard area is undertaken. The project engineers will coordinate with the County NFIP coordinators at the City and County Department of Planning and Permitting and will verify that the project improvements do not obstruct the regulatory flood, affect the capacity of the floodway, or increase the flood elevation.

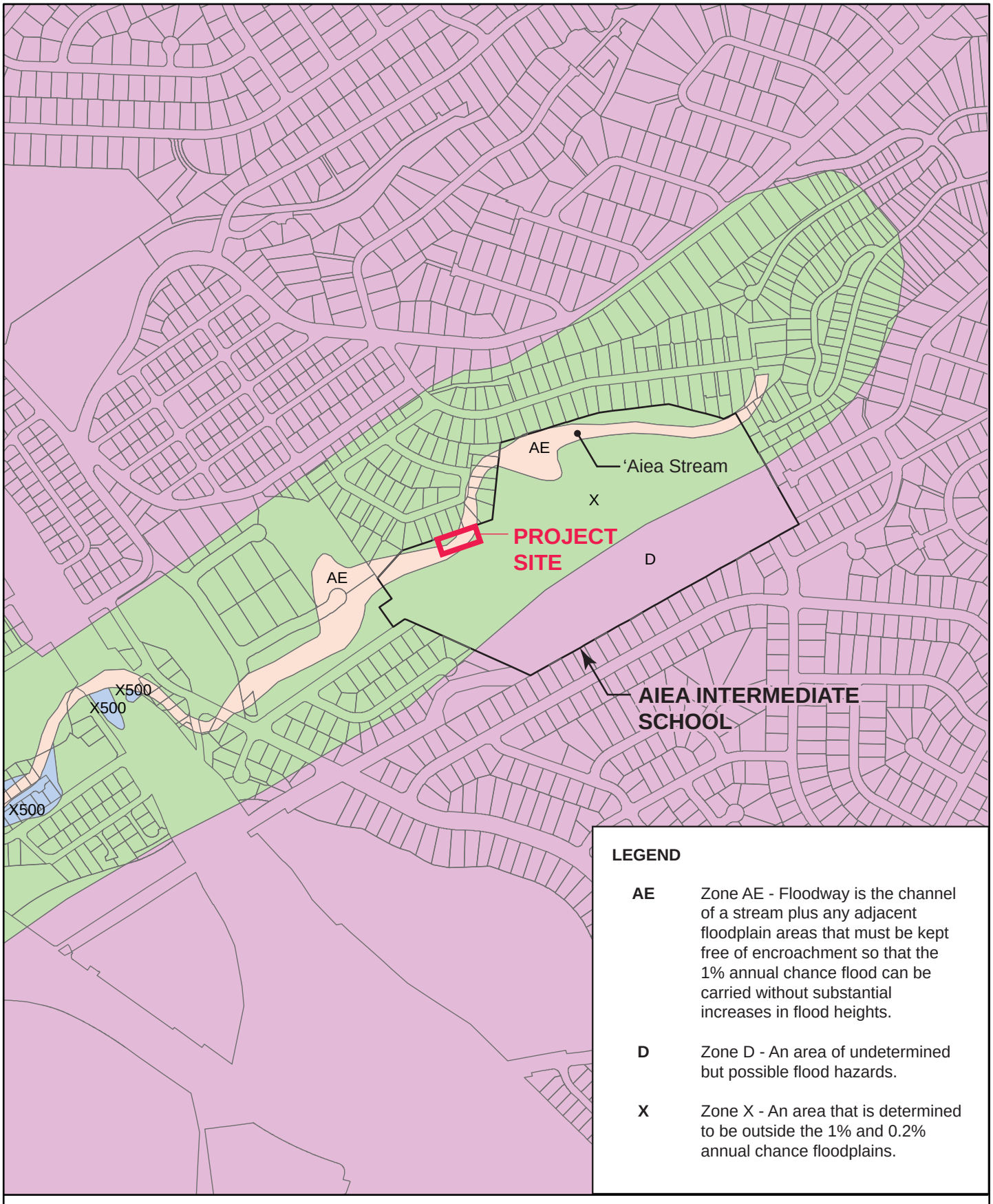
The surrounding area, including most of the school campus, is within Zone X, areas outside the 0.2% annual chance floodplain, or 500 year flood.

The project site is not vulnerable to tsunami or great seismic hazard. Based on evacuation maps prepared for the O‘ahu Civil Defense Agency, the project site is outside the tsunami evacuation area. The Island of O‘ahu is in the Uniform Building Code (UBC, 1997) Earthquake Zone 2A. The UBC contain six seismic zones, ranging from 0 (no chance of severe ground shaking) to 4 (10% chance of severe shaking in a 50-year interval).

Impacts and Mitigation

By protecting a severely eroded stream bank against stream scour and progressive retreat, the project will reduce runoff, sedimentation and minimize the risk of extensive property damage at the school.

The repair of the stream bank will not alter the capacity of the stream floodway, and will not increase the risk of stream overflow or flooding downstream. A hydraulic analysis concluded that the water surface elevation and stream velocity should be relatively unchanged after project completion. Project engineers will verify the “no rise” flood condition.



LEGEND

AE	Zone AE - Floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.
D	Zone D - An area of undetermined but possible flood hazards.
X	Zone X - An area that is determined to be outside the 1% and 0.2% annual chance floodplains.

North

0 200 400 600

Scale in Feet

Figure 6
FIRM MAP
'Aiea Intermediate School Erosion Control EA

3.2.6 Surface and Groundwater

Existing Conditions

The project site is situated within the ‘Aiea watershed, located on the lower leeward slopes of the Ko‘olau mountains. The basin-like landform is defined by ‘Aiea Heights on its west side and the ridgeline of Halawa Heights on its east side. The watershed is approximately four miles long and two-thirds mile wide, with a maximum elevation of 1,560 feet. The total watershed area is approximately 1,300 acres (2.0 square miles).

‘Aiea Stream arises from three branches originating at elevations of 1,460 feet, 1,200 feet, and 980 feet, southwest of Pu‘u Ua‘u on the western slopes of the Ko‘olau Mountain. The total stream length is 6.8 miles, with the main branch flowing from the Keaiwa Heiau State Park and Recreation Area, southwest between ‘Aiea Heights and Camp Smith, and alongside ‘Aiea Intermediate School, before beside discharging at ‘Aiea Bay, in the east loch of Pearl Harbor. At the point where it passes the ‘Aiea Intermediate School campus, the stream ranges in elevation from 175 feet to 110 feet with an average slope of three percent. The stream banks are heavily vegetated, and the stream bed is unlined and very irregular, consisting of basalt bedrock and boulders in this area. A lower section of the stream between Kamehameha Highway and Moanalua Road (downstream of the school) was channelized and lined with concrete in the 1970’s. This was done to alleviate flood problems in this lower-lying reach of the stream.

‘Aiea Stream is classified as a perennial stream by the State of Hawai‘i Division of Aquatic Resources, and assigned a stream code of 3-4-003. Stream waters are classified as Class 2 inland waters. The State of Hawai‘i Department of Health (DOH) identified ‘Aiea Stream as an impaired water body in its “Final 2004 List of Impaired Waters of Hawai‘i.” The DOH has identified Water Quality Limited Segments (WQLS) around the State, which are water bodies which cannot reasonably be expected to attain or maintain State water quality standards without additional action to control non-point source pollution. Pollutants of concern are identified for each impaired water body, and include nutrients, suspended solids and sediment, turbidity, polychlorinated biphenyls (PCBs), bacteria, and phosphorus.

The DOH identified the primary pollutants of concern for ‘Aiea Stream as turbidity and trash. As part of its compliance with the federal Clean Water Act, the DOH’s Total Maximum Daily Load (TMDL) process will identify activities that may help reduce pollutant loads and improve water quality. Currently, the DOH is preparing TMDL recommendations for ‘Aiea Stream.

Stream water was sampled by AECOS, Inc. in January 2010 from three stations near the project site (see Appendix D). The samples showed elevated conductivity and depressed Dissolved Oxygen (DO) relative to State of Hawai‘i water quality criteria for streams. Turbidity, nitrate-nitrite, total nitrogen, and total phosphorus concentrations were particularly elevated at a station upstream of the project site. It was noted, however, that a single sampling event does not imply impairment for these parameters, and at least three sampling events would be required to make a comparison with state water quality standards (AECOS, Inc. 2010).

The ‘Aiea area overlies the Pearl Harbor aquifer, the largest supplier of groundwater on ‘Oahu. The project will have no impact on groundwater resources. The geotechnical field exploration (YKE, 2009) did not encounter groundwater during two exploratory borings. The study notes, however, that perched groundwater may develop in the stream bank bluff during and after significant and prolonged rainfall events and/or high flood stages. For this reason, the stream bank improvements have been designed to provide adequate drainage, to avoid the build up of water pressure behind the shotcrete slope facing.

Impacts and Mitigation

The proposed construction activities have the potential to create runoff and debris that could enter the stream, affecting water quality. The construction contractor will implement best management practices during construction. Prior to construction, sandbags will be placed across the entire width of the stream downstream of the work area. Although this section of the stream is expected to be dry during the summer months when construction is planned, an 8-inch screened drainage pipe will be placed at the stream invert within the sandbagged area. This will allow any stream water to flow through the area. The sandbags will remain in place throughout the construction period and will be removed when work is completed. The construction contractor will curtail work and take action as necessary to protect the work site and adjacent property and stored materials from storm damage and erosion.

The project will require a Department of Army Section 404 permit for the discharge of dredged and/or fill material into waters of the U.S. The placement of reinforcing fill at the toe of the slope near the stream, below the mean high water mark, is considered fill. A Section 401 Water Quality Certification (WQC) from the State Department of Health Clean Water Branch will also be obtained. The contractor will comply with all conditions of these approvals, including implementation of a site specific best management practices plan and water quality monitoring during construction.

In the long term, the project will have an overall positive impact on the water quality of ‘Aiea Stream by correcting a severe scour and erosion problem that is continually contributing sediment and debris into the stream, in addition to larger rocks and boulders during heavy rains.

3.2.7 Noise

Existing Conditions

Noise levels in the vicinity of the project site are relatively low, consistent with the character of the school and surrounding residential uses. The primary source of noise at the project site is associated with school activities, use of the adjacent cafeteria, and truck traffic on the internal road.

Noise is regulated by the DOH under HAR Chapter 11-42, “Vehicular Noise Control for O‘ahu,” and Chapter 46, “Community Noise Control.” The current allowable noise limits for residential, apartment, and community business properties on O‘ahu are as follows:

Zoning	Daytime 7:00 AM to 10:00 PM	Nighttime 10:00 PM to 7:00 AM
Residential	55 dBA	45 dBA
Apartment	60 dBA	50 dBA
Community Business	60 dBA	50 dBA

Impacts and Mitigation

Short-Term Construction Impacts

Construction activities will generate temporary noise that could have short-term impact on some school activities and adjacent land uses. To the extent possible, construction will be scheduled during the summer months to minimize impact on students. As construction is expected to take approximately three months, some work will occur when school is in session.

All construction activities will comply with the DOH Administrative Rules Chapter 11-46 on Community Noise Control. In cases where construction noise exceeds, or is expected to exceed the DOH's "maximum permissible" noise levels at the school property line, a permit will be obtained from the DOH to operate vehicles, construction equipment, power tools, etc. that emit noise levels in excess of "maximum permissible" levels. To reduce the noise impact of construction activities, the contractor will try to limit high noise level work to before and after school hours.

The State Department of Health (DOH) currently regulates construction noise under a permit system. Under current procedures, noisy construction activities are restricted to hours between 7:00 AM and 6:00 PM, Monday through Friday, excluding certain holidays, and 9:00 AM and 6:00 PM on Saturdays. Construction is not permitted on Sundays. The majority of construction work will be performed during the day to ensure minimal nighttime noise impacts on nearby residences.

Operational Noise

Once the project is completed, there will not be any long-term increase in noise.

3.3 BIOLOGICAL ENVIRONMENT

3.3.1 Botanical Resources

'Aiea Intermediate School is a highly altered urban environment. Most of the vegetation within the school campus and around the cafeteria consists of landscaping or introduced, non-native species. The stream bank areas are vegetated with non-native riparian grasses and weeds. Other vegetation in the area includes plumeria, cactus, kiawe, and koa haole. There are no native flora or threatened or endangered species present in the project area. The project will not have an adverse effect on botanical resources.

3.3.2 Terrestrial Fauna and Avifauna

The project improvements will take place within a developed area of the school campus, and within the riparian area of an altered urban stream. There are no known threatened or endangered species or their habitats in the areas where improvements are proposed.

Fauna that would likely be found within the project area include mammals that typically inhabit urban areas including feral cats (*Felis catus*) rats (Rattus sp), house mouse (Mus musculus) and Indian mongoose (*Herpestes a. auropunctatus*).

Avifauna found on the project site would include alien species common to urban environments, such as the Common Mynah (*Acridotheres tristis*), Red crested Cardinal (*Paroaria coronata*), Northern Cardinal (*Cardinalis cardinalis*), House Finch (*Carpodacus mexicanus*), Java Sparrow (*Padda oryzivora*), Rock Pigeon (*Columba livia*), Spotted Dove (*Streptopelia chenensis*), Zebra Dove (*Geopelia striata*), Red-vented Bulbuls (*Pycnonotus cafer*), and Japanese White-eye (*Zosterops japonicus*).

The project will not have an adverse effect on terrestrial fauna or avifauna.

3.3.3 Stream Biota

Stream biological and water quality surveys (AECOS, 2010) conducted for the project identified only non-native aquatic species in ‘Aiea Stream near the project site. None of the aquatic species observed is listed as threatened or endangered (Appendix D).

The findings are consistent with an earlier flora and fauna study for lower ‘Aiea Stream was conducted in 1997 by Eric B. Guinther of AECOS, Inc. as part of an Environmental Impact Statement for the ‘Aiea Sugar Mill property. The 1997 study included a reconnaissance survey of ‘Aiea Stream, and assessed the natural resource value of the stream segment between ‘Aiea Intermediate School and Ulune Street, immediately south of the project area. It concluded that ‘Aiea Stream has minimal aquatic resource value. Only exotic (introduced) species of fish and macro invertebrates were noted. These included species such as guppies, crayfish, and pond snails. Plants observed close to the riparian zone were dominated by introduced species. Many were ruderal weeds, that is, plants characteristic of disturbed areas. The 1997 study determined that the area investigated in lower ‘Aiea Stream was of low environmental and biological value (AECOS, Inc., 1997).

Overall, the erosion control improvements will not have an adverse effect on stream biota. During construction, best management practices will be employed to minimize environmental impacts to water quality in the vicinity of and downstream of the site. Preliminary BMP plans call for sandbags to be placed across the stream bed, with water allowed to flow through a screened, 8-inch pipe. Although these BMPs have the potential to adversely affect diadromous populations, i.e., native invertebrates that migrate between the ocean and fresh water during their life cycle, no diadromous species were observed in ‘Aiea Stream during the 2010 or 1997 reconnaissance surveys, and it is unlikely that any are present.

3.4 SOCIO-ECONOMIC ENVIRONMENT

3.4.1 Demographic Characteristics

Existing Conditions

According to the 2000 U.S. Census, resident population in ‘Aiea was 9,019, a 1.3% increase over the 1990 resident population of 8,906 persons. This represented a slower growth rate than the rest of ‘Oahu for the same period. During this period, the population of the entire City and County of Honolulu increased by 4.8%.

Impacts and Mitigation

The proposed project will not affect area population or demographics. The improvements are limited to erosion control at a segment of ‘Aiea Stream adjacent to the school. The project will not affect school enrollment or school capacity. The project will not significantly affect the local economy, other than some minor short-term economic benefits resulting from public construction activity.

3.4.2 Archaeological, Historic, and Cultural Resources

A literature review and field inspection report for the project was prepared by Cultural Surveys Hawai‘i (August 2009) (Appendix C). The project area was defined as the entire school property, and the “area of potential effect” (APE) was defined as the 150-foot portion of the stream corridor that will be repaired. The purpose of the report was to determine if there are any archaeological resources within the APE.

Existing Conditions

Historic Background

The project area lies within the plateau portion of the ‘Aiea *ahupua‘a*, in the traditional ‘Ewa District (‘*Ewa Moku*). Background research by Cultural Surveys Hawai‘i found few historic references to ‘Aiea itself, and information regarding traditional Hawaiian lifestyle and land use patterns in the area is based mostly on the surrounding *ahupua‘a*, and the larger *‘Ewa moku*, which includes the project area. Most early historic references to *‘Ewa* noted the fishponds at Pu‘uloa (now Pearl Harbor), and coastal areas that were rich in ocean resources.

By the mid-1930’s, the Honolulu Plantation Company had more than 23,000 acres leased in and around ‘Aiea, as well as several plantation camps. Over the years, the lower portions of ‘Aiea developed around the H-1 and H-3 Freeway interchange, and the Pearl Harbor Naval base. The lower portions of ‘Aiea were rezoned for residential and industrial use in the 1960’s, and these land uses dominate the existing development pattern today.

Historical research indicated that there is little possibility that the project area contains subsurface cultural material related to pre-contact agricultural practices or plantation-era agricultural and ranching activities. This was confirmed during the field survey by Cultural Surveys Hawai‘i. No archaeological resources or historic properties were observed within the APE.

Impacts and Mitigation

The proposed erosion control improvements will not impact historic or cultural resources, and no further archaeological work was recommended. However, in the unlikely event that previously unidentified subsurface historic properties are encountered during construction, work in the vicinity should stop immediately and the State Historic Preservation Division (SHPD)’s O‘ahu office contacted.

The Literature Review and Field Inspection report was sent to the SHPD for review in accordance under HRS Chapter 6E-8 and HAR Chapter 13-275.

Cultural Impact Assessment

A Cultural Impact Assessment (CIA) was prepared (Cultural Surveys Hawai‘i, January 2010), in compliance with HRS Chapter 343 which requires consideration of a proposed project’s effect on cultural practices and resources. The CIA was prepared in accordance with the Office of Environmental Quality Control (OEQC) Guidelines for Assessing Cultural Impacts, and is included in Appendix C.

As part of the CIA, Cultural Surveys Hawai‘i contacted Hawaiian organizations, agencies and community members in order to identify individuals with cultural expertise and/or knowledge about the project area and vicinity. The organizations consulted included the SHPD, the Office of Hawaiian Affairs (OHA), the O‘ahu Island Burial Council (OIBC), Hui Mālama I Nā Kūpuna ‘O Hawai‘i Nei, the Pearl Harbor Hawaiian Civic Club, the ‘Aiea Neighborhood Board, community and cultural organizations in ‘Aiea, and community members. Formal interviews were held with three individuals.

Background research and community consultation did not find evidence of any cultural properties within the project area. However, a previous oral history conducted in 1994, noted that *“a small heiau called Kaonohiokala is located behind the ‘Aiea Intermediate School in the bushes.”* The CIA notes that no burials have been documented near or within the project area, though it states that it is possible that undocumented burials exist within or near the project area.

Community Concerns

The individuals consulted during the CIA identified five potentially adverse project impacts. These five concerns are listed below, with an *italicized* response.

1. Erosion—one community member recommended consulting with an engineer to assess the reason for the ongoing erosion. She observed that the erosion has been influenced by

rainwater runoff from the mauka subdivisions. She speculated that the problem may be due to include inadequate drainage systems upstream, excess mangrove growth at the mouth of the river near Pearl Harbor, and excessive dumping of trash.

Response: *Erosion will occur in any unlined stream. The severity depends on the type of soil, the type and amount of vegetation, and the velocity of the water flowing through the stream. Developments mauka of the school will increase storm water flow through the site due to increase of impermeable surfaces (roadway, buildings, etc). Obstructions, including mangroves, at the mouth of the river will not affect the hydraulics of the stream at the site. Large bulky items will create turbulence and increase erosion in the immediate vicinity.*

2. Flooding—another individual expressed concern that flooding during heavy rains could lead to additional erosion downstream of the project area.

   Response: *The proposed improvements will be designed to minimize changes of the stream hydraulics thereby not affecting the hydraulics downstream.*

3. Pollution—One individual contends that toxins and pollutants from the former 'Aiea Sugar Mill are still contaminating the stream, and that protection and precautions should be taken.

   Response: *The scope of this project does not include containment/ abatement of toxins and pollutants from the old Aiea Sugar Mill.*

4. Freshwater Resources—One individual recommended planting native plans along the banks of 'Aiea Stream next to the project site after the stream sides have been stabilized in order to minimize future erosion and promote native plants.

   Response: *Planting of native plants is not within the scope of this project. The existing vegetation should aid in minimizing erosion and is maintenance free.*

5. Timing—One individual recommended only commencing with the project when there is little or no flow in 'Aiea Stream.

   Response: *Construction work will be done during dry weather. The construction contractor will be required to develop best management practices to minimize erosion and storm water runoff during construction.*

CIA Recommendations

Cultural Surveys Hawai'i included the following recommendations in the CIA to mitigate potentially adverse effects on cultural, historic and natural resources, practices and beliefs:

1. Cultural monitoring should be included in the project. According to a previous oral testimony, a *heiau* named Kaonohiokala is located directly east of the project area. As the exact location of the *heiau* is unknown, project personnel should be informed of the possibility of finding this *heiau.* In addition, land disturbing activities may uncover

burials or other cultural resources. Should cultural or burial sites be identified during ground disturbance, all work should immediately cease and the appropriate agencies notified pursuant to applicable law.

2. Community members should be further consulted throughout the planning process, including the design and implementation of the proposed development. Addressing their concerns will minimize the impact of the project on the cultural practices and traditions of the *kama’aina* of ‘Aiea and allow them to continue their stewardship of ‘Aiea Stream and other natural resources, the Pōhaku o Ki‘i, Keaīwa Heiau, and other historic and cultural properties.

According to the archaeological consultant, the recommendation for cultural monitoring was included because the location of the Kaonohiokala *heiau*, in particular its rock walls, could not be determined from archival documents, and it is possible that the *heiau* lies very close to the project area.

Unlike archaeological monitoring, which is governed by a clear set of laws and guidelines and occurs under the auspices of the State Historic Preservation Division, “cultural monitoring” is less well defined. There are no laws or regulations which provide guidance on the scope of work, responsibilities or qualifications of a cultural monitor in Hawai‘i. According to the archaeological consultant, appropriate cultural monitoring for this project might involve a knowledgeable community representative (individual or organization), preferably with Hawaiian ties to the area, spending time on site or in consultation with the project personnel. The cultural monitor could also serve as a liaison to interested Hawaiian groups in the event that any cultural items (bones, heiau, sacred rocks, medicinal plants, etc.) are inadvertently discovered.

The Department of Education will provide appropriate cultural monitoring as recommended by the Cultural Impact Assessment. In order to meet the recommendation for community consultation, the ‘Aiea Neighborhood Board and ‘Aiea Intermediate School will be kept informed of the project status as it proceeds through the design and construction phases. The public review of the Draft Environmental Assessment also provides another opportunity for the community, including native Hawaiian organizations, to obtain information and express concerns.

3.5 UTILITIES AND INFRASTRUCTURE

3.5.1 Existing Conditions

Water service to ‘Aiea Intermediate School is provided by the City and County of Honolulu’s Board of Water Supply (BWS). Sewer service to the school is provided through the City and County of Honolulu. Electrical service is provided by Hawaiian Electric Company (HECO) and telephone service is by Hawaiian Telcom. Water and sewer lines connect to the City’s system at the entrance to the school. Major utility lines are located within the school’s access roadway between the stream and the cafeteria building. The school has a propane gas tank used by the cafeteria for cooking.

The retreat of the stream bank has undermined an electrical hand hole box at the top of the bank, which until recently served the school’s primary power equipment. In 2008, temporary shoring repairs were made to stabilize the box and prevent it from sliding down the stream bank. However, due to the continuing erosion problem, the electrical lines were relocated to a nearby overhead pole in 2009. This power pole is also vulnerable to undermining if the stream bank continues to retreat toward the road.

As the stream bank has retreated toward the school, the school fence has been threatened and is now right at the edge of the roadway. The school has prohibited parking along a section of the roadway due to safety concerns and to prevent unnecessary pressure on the over steep bank slope.

3.5.2 Impacts and Mitigation

The project will have a positive impact on the school utility system by correcting an ongoing erosion problem that has already undermined an electrical hand hole box, and continues to threaten the roadway, power poles, and utility lines within the road.

Construction drawings will be submitted to the BWS, HECO, Hawaiian Telcom and Oceanic Time Warner for review and comment and to insure that there will be no adverse impact to utility infrastructure or service. The construction contractor will coordinate with these agencies during the construction period and service will not be interrupted.

3.5.3 Drainage

Existing Conditions

The majority of storm water runoff generated within the ‘Aiea Intermediate School campus sheet flows toward the stream. The balance of runoff is collected by inlets and conveyed by the school’s drainage system which outfall into the stream. The proposed project will not change the drainage pattern for the school site.

Storm drain discharge downstream of electrical box.

Available topographic plans show a 12-inch storm drain pipe discharging through the stream bank bluff just a few feet downstream of the electrical box, daylighting at mid-face of the stream bank bluff. The geotechnical engineers observed a long segment of pipe of similar material and size in the stream bed just downstream from where the storm drain daylights. This appears to confirm that the stream bank, with the embedded storm drain pipe, at one time extended significantly further into the stream bed. Apparently, after the bank eroded, a large section of the drain pipe was left exposed and subsequently broke off. The existing drain pipe will be extended to outside of the shotcrete lining.

Impacts and Mitigation

The proposed erosion control project will not affect drainage patterns at the school, and will have no impact on runoff from the site.

The shotcrete facing that will be applied onto the stream bank will be designed to include a sub-drain system of weep holes installed in a grid pattern. This will allow any ground seepage or perched groundwater to drain, rather than buildup behind the shotcrete facing.

During construction, appropriate measures will be implemented to prevent pollutants and runoff from entering ‘Aiea Stream and the storm drain system. Sandbags will be placed across the stream downstream of the work area, to prevent debris, sediment or pollutants from entering the stream.

The project is not expected to require a National Pollutant Discharge Elimination System (NPDES) permit for storm water discharge associated with construction, as the project area is less than one acre in size.

3.5.4 Solid and Hazardous Wastes

The City and County of Honolulu’s Department of Environmental Service is responsible for refuse pick up, hauling and disposal from the surrounding residential areas. The school, as well as commercial establishments and multi-family residential developments contract with private haulers. Refuse is disposed at the City’s H-POWER refuse to energy plant located at Campbell Industrial Park and the Waimanalo Gulch Landfill in leeward O‘ahu.

The project will not have short or long-term impacts due to hazardous materials, waste or petroleum products. All construction materials will be properly used, transported, stored and disposed. Any soil, rocks, vegetation or debris removed from the site will be properly disposed at DOH-approved City and County disposal or recycling facilities, and in accordance with applicable City, State, and Federal requirements. No construction waste materials will be buried or disposed on site.

3.6 TRAFFIC

3.6.1 Existing Conditions

The main entry to the school is at the terminus of Kulawea Street, a local residential street, accessed off Ulune Street, one of the primary east-west routes through ‘Aiea. Traffic on Kulawea Street is limited to the school and the residents living on the street. There is no through traffic. The ‘Aiea Intermediate School campus has one main roadway, connecting the main parking lot at the entrance to the school to the cafeteria area, classrooms and playing fields at the back of the campus. The roadway runs in a northerly direction along the western boundary of the school property, generally following ‘Aiea Stream. The stream is at a lower elevation than the school property.

3.6.2 Impacts and Mitigation

The stream bank repair will occur alongside portions of the main school roadway, and will have short-term impacts on access and circulation within the campus. The stream bank has retreated up to the roadway, and therefore construction work along and near the roadway cannot be avoided. The school roadway will be used for construction equipment staging and access and may be partially obstructed. Delivery trucks to the kitchen and cafeteria will need to coordinate delivery times to minimize conflicts with construction equipment and activities. Because there are no other vehicle routes through the campus or to the cafeteria, vehicular access through the area must be maintained, but will likely be down to one lane.

The school has identified the large playing field at the back of the school as the main equipment and supply staging area. However, because of the proximity of the work area to the main roadway, adverse impacts to circulation and access cannot be avoided. Fire access will be maintained at all times.

The project improvements will be constructed during the summer, when there will be fewer students and staff, and no regular cafeteria deliveries. However, given the three-month construction period, some work will be ongoing when school is back in session. During this time, construction will not be allowed during peak school traffic periods. Vehicular access through the area will be maintained, and construction personnel will be available to direct traffic through the area. The work area will be coned and fenced off for safety. The contractor will coordinate activities with the school to ensure that large delivery trucks will be able to access the cafeteria and other areas of the school as needed.

Outside the school campus, there will be no adverse traffic impacts on surrounding streets and roads. Construction equipment will be mobilized to and from the school during non-peak traffic hours. There will be no equipment or material staging off-campus.

3.7 PUBLIC SERVICES AND FACILITIES

3.7.1 Police, Fire and Emergency Services

Existing Conditions

Police, fire and emergency services are provided through the City and County of Honolulu. The project area is serviced by the Honolulu Police Department’s Pearl City Station on Waimano Home Road. An early consultation letter from the Honolulu Police Department indicated that the department had no comments.

The project area is served by the Honolulu Fire Department’s ‘Aiea Fire Station on ‘Ulune Street and Waiau Fire Station on Komo Mai Drive in Pearl City. Ladder service is available from the Waiau Station. The City and County of Honolulu provides emergency medical services.

Parks and recreation centers located within the vicinity include Keaiwa Heiau State Recreation Area, Halawa District Park, ‘Aiea Recreation Center, and Napuanani Park. The ‘Aiea Public Library is also located near the project site.

Medical service is available at Pali Momi Medical Center on Moanalua Road.

Impacts and Mitigation

The project will not have an impact on the need for fire, police or emergency services, on facilities or operations. An early consultation letter from the Honolulu Police Department is included in Chapter 7.

3.7.2 Schools

Existing Conditions

Current enrollment at ‘Aiea Intermediate School is approximately 653 students in grades 7 and 8. The school is part of the Department of Education’s (DOE) ‘Aiea Complex, which also includes ‘Aiea High School and five elementary schools--‘Aiea Elementary, Pearl Ridge Elementary, Alvah Scott Elementary, Waimalu Elementary, and Webling Elementary.

Impacts and Mitigation

The project will repair an eroding area at the stream area adjacent to ‘Aiea Intermediate School. The project will have a positive impact on the school by repairing a long-time, severe erosion problem that has caused the stream bluff to retreat into the school property. The erosion continues to undermine utilities and a school access road, and poses a physical danger to students. The project will have no impact on school enrollment or activities. During construction, there will be noise and dust. Work will be scheduled during the summer months to minimize impact to students, although there may be some overlap with the school year. The work area will be secured, and portions of the adjacent roadway may be closed, but vehicular and fire access will remain available throughout the construction period. A construction staging area approximately 5,000 square feet in size will be required for materials and equipment. The school has indicated that this can be accommodated at the playing fields at the back of the school. The construction contractor will notify the school administration of the anticipated work schedule and maintain communication with school personnel during construction to make sure school operations are not adversely impacted.

4 CONSISTENCY WITH EXISTING PLANS, POLICIES AND CONTROLS

4.1 STATE OF HAWAI‘I

4.1.1 Hawai‘i State Plan

The 1996 Hawai‘i State Plan (Chapter 226, HRS) is the umbrella document in the statewide planning system. It serves as a written guide for the future long-range development of the state by describing a desired future for the residents of Hawai‘i and providing a set of goals, objectives, and policies that are intended to shape the general direction of public and private development.

By correcting a severe, ongoing erosion problem along the banks of ‘‘Aiea Stream at the ‘Aiea Intermediate School, the project is consistent with the State Plan objectives and policies for the **physical environment—land, air and water quality**:

> “(b) To achieve the land, air and water quality objectives, it shall be the policy of the State to…(5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.” (Section 226-13, HRS)

The project is also consistent with the objectives and policies for **socio-cultural advancement—education:**

> “(b) To achieve the educational objective, it shall be the policy of this State to:…(2) Ensure that the provision of adequate and accessible educational services and facilities that are designed to meet individual and community needs…” (Section 226-21, HRS).

4.1.2 State Land Use Classification

The State Land Use Commission, pursuant to Chapter 205 and 205A, HRS and Chapter 15-15, Hawai‘i Administrative rules, is empowered to classify all lands in the State into one of four land use districts: urban, rural, agricultural and conservation. All of ‘Aiea Intermediate School is located within the Urban district. Activities or uses within the Urban district are regulated by the City and County of Honolulu.

4.1.3 Coastal Zone Management

Coastal Zone Management (“CZM”) objectives and policies (Section 205A-2, HRS) and the Special Management Area (“SMA”) guidelines (Section 25-3.2 ROH) have been developed to preserve, protect, and where possible, to restore the natural resources of the coastal zone of Hawai‘i. All lands in the State of Hawai‘i and the area extending seaward from the shoreline are classified as valuable coastal resources within the State’s CZM area.

Part II of Chapter 205A, HRS contains the general objectives and policies upon which all counties have established Special Management Areas (SMA). The project site outside the City and County of Honolulu's SMA, and a SMA use permit is not required.

The proposed erosion control measures are directly in support of the following CZM objectives:

Coastal Hazards
CZM Objective: *Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.*

> **Discussion:** The Project will address a severe erosion problem within a segment of the 'Aiea Stream bank, adjacent to 'Aiea Intermediate School. Without the project, erosion of the bank will continue, adversely affecting stream water quality and threatening school property, including a roadway and the main electrical lines servicing the school. The receding land at the top of the bank is adjacent to the school cafeteria, creating a hazardous situation for students and staff.

Marine Resources
CZM Objective: *Promote the protection, use, and development of marine and coastal resources to assure their sustainability.*

> **Discussion:** 'Aiea Stream empties into 'Aiea Bay, in the east loch of Pearl Harbor. Siltation and debris from eroding areas along the stream will ultimately enter the waters of Pearl Harbor. The proposed erosion control measures will correct this situation, and have a positive effect on marine and coastal resources downstream.

4.2 CITY AND COUNTY OF HONOLULU

4.2.1 County General Plan

General Plan Objectives and Policies

The project is in conformance with the following policies and guidelines of the City and County of Honolulu's *1992 General Plan Objectives and Policies.*

Chapter III. Natural Environment

Objective A: To protect and preserve the natural environment.
Policy 2: Seek the restoration of environmentally damaged areas and natural resources.
Policy 6: Design surface drainage and flood-control systems in a manner which will help preserve their natural settings.

Chapter V. Transportation and Utilities

Objective C: To maintain a high level of service for all utilities.
Policy 1: Maintain existing utility systems in order to avoid major breakdowns.

4.2.2 Primary Urban Center (PUC) Development Plan

The City and County of Honolulu’s Development Plan (DP) program provides a relatively detailed framework for implementing General Plan objectives and policies for the growth and development of O‘ahu at a regional level.

The project site is located within the Primary Urban Center (PUC) DP area, which extends from downtown Honolulu to Pearl City in the west to Waialae-Kahala in the east. The PUC is home to almost half of O‘ahu’s population and three-quarters of all jobs. The City and County’s Primary Urban Center Development Plan (June 2004) provides a vision for the PUC in the areas of land use, transportation, infrastructure, and public facilities. It also provides policies and guidelines for achieving that vision.

Chapter 4 of the PUC DP addresses Infrastructure and Public Facilities. Two sections of this chapter are directly applicable to the proposed erosion control project—Section 4.6, Infrastructure and Public Facilities, and Section 4.7, School and Library Facilities.

Figure 7 illustrates the PUC DP Land Use Plan. ‘‘Aiea Intermediate School is designated as an “Institutional” land use.

Section 4.6, Stormwater System

Section 4.6, Stormwater Systems, is concerned with controlling polluted storm water runoff. The DP notes that in the western end of the PUC, major drainage ways flow into the east loch of Pearl Harbor. DP policies that are directly applicable to the proposed project include managing storm water flows though best management practices to minimize storm water runoff and preserving stream and estuarine habitats. DP guidelines state that streams should not be channelized except when absolutely necessary and support the establishment of long and short-term ecological monitoring programs, particularly those that are directed at improving water quality.

The proposed project is consistent with the policies and guidelines of this section. By repairing and strengthening a badly eroding stream bank, the project will alleviate ongoing sedimentation and runoff that is contributing pollutants to ‘Aiea Stream. The project will shore up the toe of the stream bank with a CRM wall, but does not harden or channelize the stream. A hydraulic analysis conducted for the project has concluded that the improvements will not alter the water levels of the stream or hydraulic flow.

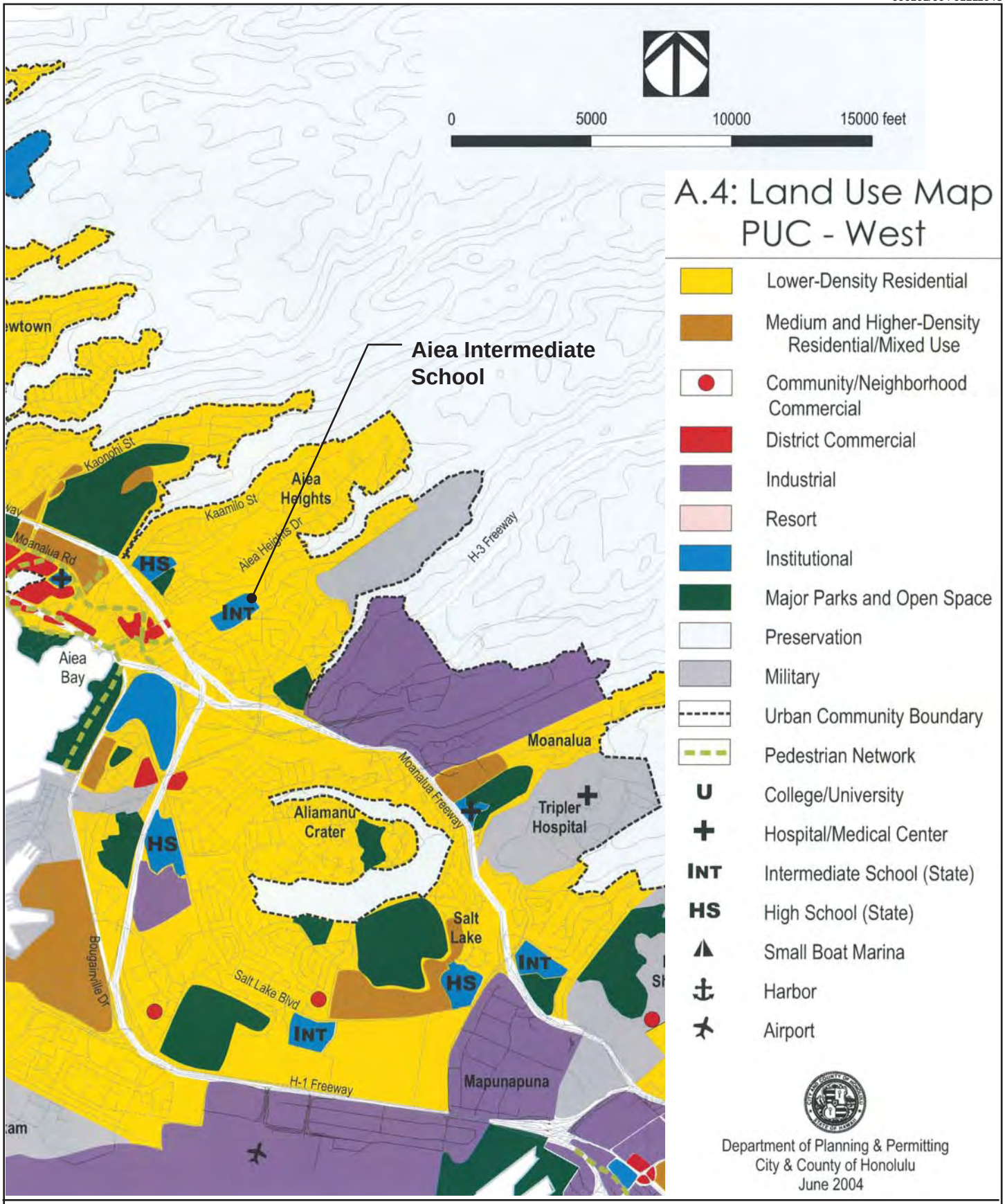


Figure 7

PRIMARY URBAN CENTER DEVELOPMENT PLAN

'Aiea Intermediate School Erosion Control EA

Section 4.7, School and Library Facilities

Section 4.7, School and Library Facilities, addresses these educational facilities within the PUC. A PUC guideline applicable to the proposed project is the need to improve conditions within and near school and college campuses. The project will alleviate severe stream erosion at ‘Aiea Intermediate School which is undermining a fence, roadway and utility structures on campus. Left unchecked, continued erosion of the steep bank could result in severe damage to the school’s electrical system and other infrastructure, as well as pose a physical danger to students and school personnel.

4.2.3 County Zoning

The City and County of Honolulu’s Land Use Ordinance (Section 21, ROH) is its zoning ordinance, which regulates land use in a manner that will encourage orderly development in accordance with adopted land use policies.

The entire project site is zoned R-5 Residential, and is surrounded by single family residential use on all sides. The current school use and erosion control improvements are consistent with this zoning designation.

4.2.4 Special Management Area

Coastal Zone Management objectives and policies (Section 205A-2, HRS) and the Special Management Area (SMA) guidelines (Section 25-3.2 ROH) have been developed to preserve, protect, and where possible, to restore the natural resources of the coastal zone of Hawai‘i. The project area is outside the County’s SMA.

4.3 OTHER CONSIDERATIONS

4.3.1 Unavoidable Adverse Effects

All potential environmental impacts discussed in Chapter 3 can either be avoided or mitigated to an extent that they would not be significant.

4.3.2 Energy Requirements and Conservation Potential of Various Alternatives and Mitigation Measures

By correcting an ongoing erosion problem, the will have a positive long-term impact on stream water quality and the physical environment. Once completed, the project will not have ongoing energy requirements.

4.3.3 Relationship of Short-Term uses and Long-Term Productivity

In the short-term, the project will have temporary construction-related impacts such as noise and dust on the surrounding area. The erosion control improvements will require a commitment of public funds. However, in the long term, the need for temporary, spot repairs will be eliminated, and further, more costly damage to the road and electrical system will be avoided. The increase in long-term productivity far outweighs the short-term tradeoffs.

4.3.4 Irretrievable and Irreversible Resource Commitments

Resources that are committed irreversibly or irretrievably are those that cannot be recovered if the project is implemented. The proposed project will involve the commitment of capital, labor, materials, fuel and equipment. The proposed erosion control improvements are needed to maintain the efficient and safe operation of the school, and irretrievable resource commitments are minor.

5 DETERMINATION, FINDINGS AND REASONS SUPPORTING THE CHAPTER 343 HRS DETERMINATION

5.1 CHAPTER 343 HRS DETERMINATION

Based on the information and analysis in this Environmental Assessment, the State of Hawai'i Department of Education has determined that the project will not result in a significant impact on the environment. As such, it is issuing a Finding of No Significant Impact (FONSI), pursuant to the State of Hawai'i HRS Chapter 343, and an Environmental Impact Statement (EIS) is not required.

5.2 CHAPTER 343 HAWAI'I REVISED STATUTES (HRS) SIGNIFICANCE CRITERIA

In determining whether an action may have significant impact on the environment, the applicant or agency must consider all phases of the project, its expected consequences both primary and secondary, its cumulative impact with other projects, and its short and long-term effects. The State of Hawai'i Department of Health Rules Section 11-200-12 (Hawai'i Administrative Rules, revised 1996) establish 13 "Significance Criteria" to be used as a basis for identifying whether significant environmental impact will occur.

An agency will determine an action may have a significant impact on the environment if it meets any of the following criteria:

1. Involves an irrevocable commitment to loss or destruction of any natural or cultural resources;

The project will not result in an irrevocable commitment to loss or destruction of any natural or cultural resources. The erosion control improvements take place within the already developed school property, and will not affect any significant biological resources. No historic properties were identified or are anticipated to be encountered.

2. Curtails the range of beneficial uses of the environment;

The proposed project does not curtail the range of beneficial uses of the environment. The project improvements will occur within a developed school property, and on a steep steam bank. There are few, if any, alternative beneficial uses.

3. Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS; and any revisions thereof and amendments thereto, court decisions, or executive orders;

The proposed project is consistent with the environmental policies in Chapter 344, HRS, which establishes a state policy to encourage productive and enjoyable harmony between people and their environment, promotes efforts to prevent or eliminate damage to the environment and stimulate community health and welfare, and enriches the understanding of the ecological systems and natural resources important to the people of Hawai'i.

The primary purpose of the project is to correct severe erosion of a stream embankment that is destabilizing a portion of the school campus, and undermining the school's infrastructure. Left untreated, the retreating stream bank will lead to more extensive and costly damage to school facilities. As such, the proposed action is encouraging "productive and enjoyable harmony between people and their environment," and is consistent with the guideline regarding "land, water, mineral, visual, air and other natural resources" *to "encourage management practices which conserve and fully utilize all natural resources"* [§344-4 (2)(A)].

4. Substantially affects the economic or social welfare of the community or state;

The proposed project will not substantially affect the economic or social welfare of the community or State. Construction will have minor, short-term air and noise impacts. However, the project will have beneficial long-term impacts to the state by correcting an erosion problem that left untreated, could cause extensive and costly damage to the school property.

5. Substantially affects public health;

The project will not substantially affect public health. The temporary construction-period noise and dust impacts will be minor and short-term, and are insignificant when weighed against the project's overall, long-term positive impacts.

6. Involves secondary impacts such as population changes or effects on public facilities;

The proposed project will not result in a school population increase, generate additional vehicle traffic, or affect demand for public facilities or utilities. The improvements are intended to support operation of the existing school facilities.

7. Involves a substantial degradation of environmental quality;

Construction period impacts related to noise and air quality will be temporary and short-term. In order to minimize impacts to students, work will be conducted during the summer months to the extent possible. Short-term impacts will be mitigated through equipment noise attenuation, and use of best management practices to contain debris that could enter the stream channel.

8. Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions;

The proposed project is limited to repair and improvements at an existing school, and does not have a cumulative effect or commitment for larger action.

9. Substantially affects a rare, threatened or endangered species, or its habitat;

No rare, threatened or endangered species or its habitat will be impacted by the project. The project area is an urbanized and developed site, and there are no significant biological resources located where improvements are proposed.

10. Detrimentally affects air or water quality or ambient noise levels;

The project will result in short-term construction period increases in fugitive dust and noise that could inconvenience students and faculty when school is in session. Construction work will be audible to residents across the stream, but these impacts will be temporary and short-term, and construction activity limited to day time. Given prevailing trade winds, residences across the stream are upwind of the construction area. There will be no long term impacts to air or water quality or noise.

11. Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters;

The project area is within the designated floodway of ‘Aiea Stream. The improvements will not channelize or harden the stream, and will not alter stream flow. It will not affect the flood capacity of the stream channel or cause a rise in the flood elevation.

12. Substantially affects scenic vistas and viewplanes identified in county or state plans or studies; or

The project will not impact scenic vistas or viewplanes identified in county or state plans or studies.

13. Requires substantial energy consumption.

The project will not require substantial energy consumption. Some energy resources will be consumed during project construction.

6 REFERENCES

City and County of Honolulu, Department of General Planning. *General Plan Objectives and Policies*. 1992.

City and County of Honolulu, Department of Planning and Permitting. Primary Urban Center Development Plan, June 2004.

_____. Land Use Ordinance. May 1999.

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State of Hawai‘i, Commission on Water Resource Management and the National Parks Service. *Hawai‘i Stream Assessment, A Preliminary Appraisal of Hawai‘i’s Stream Resources.* December 1990.

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Yogi Kwong Engineers, LLC, *Geotechnical Exploration and Evaluation Report, Stream Bank Assessment and Roadway Support ‘Aiea Intermediate School, Draft Submittal*. Prepared for Sato and Associates, Inc. and State of Hawaii Department of Education. June 2009.

7 PERSONS AND AGENCIES INVOLVED IN THE PREPARATION OF THE ENVIRONMENTAL ASSESSMENT

7.1 AGENCIES AND ORGANIZATIONS CONSULTED

The following agencies and organizations were contacted during the early consultation for the Draft EA. The comments received during the early consultation are summarized in Section 7.2 and copies of the letters are included at the end of this chapter.

Federal

U.S. Army Engineer Division
- Civil Works Technical Branch
- Regulatory Branch

State

Department of Business, Economic Development & Tourism, Office of Planning
Department of Hawaiian Home Lands
Department of Land and Natural Resources
- Land Division
- State Historic Preservation Division

Department of Education
- Planning Section
- ‘Aiea Intermediate School

Department of Health
- Environmental Planning Office

Office of Environmental Quality Control
Office of Hawaiian Affairs

City and County of Honolulu

Department of Design and Construction
Department of Environmental Services
Department of Facility Maintenance
Fire Department
Department of Planning & Permitting
Department of Parks and Recreation
Police Department
Department of Transportation Services
Board of Water Supply

Other Organizations

Neighborhood Board #20, 'Aiea
Hawaiian Electric Company
Hawaiian TelCom
Oceanic Time Warner Cable

Elected Officials

City Councilmember Gary Okino, Honolulu City Council District 8
Senator Donna Mercado Kim, 14th Senatorial District
Representative Blake Oshiro, 33rd Representative District

7.2 COMMENTS RECEIVED DURING PRE-ASSESSMENT CONSULTATION

Letters soliciting comments were sent to the agencies and organizations listed above in September 2009, and a total of 11 written responses were received. A summary of the comments is included in the table below, and copies of the letters are included at the end of this chapter.

Table 7-1: Summary of Comments Received During Pre-Assessment Consultation

Agency or Individual	Format/Date/Reference	Comments	Action/Response
State of Hawai'i			
Department of Land & Natural Resources	Memorandum dated September 25, 2009 with consolidated comments from various divisions.		
Engineering Division		Project is located in Flood Zones X and AE Floodway (AEF). Project must comply with rules and regulations of National Flood Insurance Program.	Information noted in Draft EA.
Division of Forestry and Wildlife		No objections to project.	No action required.
Commission on Water Resource Management		No comments.	No action required.
Division of State Parks		No comments.	No action required.
Land Division-Oahu District		No objections to project.	No action required.
Division of Boating and Ocean Recreation		No comments.	No action required.
DLNR State Historic Preservation Division	Letter dated October 29, 2009, LOG NO:	Concur that there will be "no historic properties affected" by this project.	No action required.

Agency or Individual	Format/Date/Reference	Comments	Action/Response
	2009.4303, DOC NO: 0910NM50, Archaeology		
Office of Hawaiian Affairs	Letter dated December 21, 2009	1. OHA discourages the hardening of stream channels as this proposal seems to do. 2. OHA recommends allowing "thick" vegetation or "buffer strips" to grown alongside the waterway to filter and slow runoff and soak up pollutants. 3. Diadromous native species (e.g., opae oeha'a and o'opu akupa) require unimpeded mauka to makai connections. 4. Interested in what kinds of best management practices will be in place.	1. Existing stream channel is not being channelized or hardened with concrete. Project will repair section of the stream bank that is severely eroded and retreating into the school property. Hardening at the toe of the stream bank is needed to protect against stream scour. 2. Eroded area is too steep and badly eroded for vegetation stabilization. Vegetation alone will not provide adequate protection from erosive forces at the toe of the stream bank. More resilient protection such as shotcrete is required. 3. Previous aquatic surveys have found no native aquatic species in this area of 'Aiea Stream. This area of stream is expected to be dry during summer when construction will occur. 4. During construction, sandbags will be placed temporarily downstream of the work area to prevent debris from entering stream.
City & County of Honolulu			
Dept. of Design and Construction	Letter dated October 19, 2009	No comments.	No action required.

Agency or Individual	Format/Date/Reference	Comments	Action/Response
Department of Facility Maintenance	Letter dated October 16, 2009	No preliminary comments at this time.	No action required.
Dept. of Planning & Permitting	Letter dated October 13, 2009	1. According to FEMA flood map, appears that project is located within AE floodway district. 2. Unable to determine currently whether grading permit required. DEA shall provide sufficient information to make that determination. 3. Stream Channel Alteration Permit (SCAP) may be required. Consult with DLNR CWRM. 4. DEA should address how project is consistent with Section 4.6, Storm water Systems and Section 4.7 School and Library Facilities of the Primary Urban Center Development Plan.	1. Confirmed that project is within AE-floodway. Will discuss in EA. 2. No grading permit anticipated. 3. Early consultation letter from DLNR CWRM (9/25/09) indicated "no comments." Per follow up phone con with Robert Chong 1/6/10, SCAP not required. 4. DEA will address consistency with PUC DP sections.
Police Department	Letter dated September 24, 2009	No comments.	No action required.
Dept. of Transportation Services	Letter dated October 13, 2009	Map seems to indicate all work will be done outside the public right-of-way. If any construction-related activities impact local street system, traffic control plans must be prepared.	Construction work will occur on school property and will not affect public roads. Contractor will work with school to maintain necessary access. Fire access will be maintained during construction.
Board of Water Supply	Letter dated September 28, 2009	Construction drawings for project should be submitted for approval.	Comment included in EA.
Other			
Hawaiian Telcom	Letter dated September 29, 2009	Hawaiian Telcom has aerial and underground facilities in the vicinity of the project site. Continue to coordinate during project design.	Information and comment included in EA.

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

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October 17, 2009

Mr. Glenn T. Kimura, President
Kimura International, Inc.
1600 Kapiolani blvd. Suite 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: Early Consultation for Draft Environmental Assessment for Aiea Intermediate School Erosion Control Project

Thank you for the opportunity to review and comment on the subject matter. The Department of Land and Natural Resources' (DLNR), Land Division distributed or made available a copy of your report pertaining to the subject matter to DLNR Divisions for their review and comment.

Other than the comments from Division of Forestry & Wildlife, Division of State Parks, Commission on Water Resource Management, Division of Boating & Ocean Recreation, Land Division-Oahu District, Engineering Division, the Department of Land and Natural Resources has no other comments to offer on the subject matter. Should you have any questions, please feel free to call our office at 587-0433. Thank you.

Sincerely,

Morris M. Atta
Administrator

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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September 25, 2009

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MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Oahu District
x Historic Preservation

FROM: Morris M. Atta
SUBJECT: Early Consultation for Draft Environmental Assessment for Aiea Intermediate School Erosion Control Project
LOCATION: Island of Oahu
APPLICANT: Kimura International, Inc. on behalf of Department of Education

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by October 16, 2009.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
( ) We have no comments.
(X) Comments are attached.

Signed:
Date: 10/8/09

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

LD:MorrisAtta
Ref.: EarlyConsultAieaIntSchoolErosionControl
Oahu.724

COMMENTS

( ) We confirm that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Flood Zone ___.

(X) Please take note that based on the maps provided it appears that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Flood Zones X and AE Floodway (AEF). The Flood Insurance Program does not have any regulations for developments within Flood Zone X however; it does regulate developments within Zone AEF as indicated in bold letters below.

( ) Please note that the correct Flood Zone Designation for the project site according to the Flood Insurance Rate Map (FIRM) is ___.

(X) Please note that the project must comply with the rules and regulations of the National Flood Insurance Program (NFIP) presented in Title 44 of the Code of Federal Regulations (44CFR), whenever development within a Special Flood Hazard Area is undertaken. If there are any questions, please contact the State NFIP Coordinator, Ms. Carol Tyau-Beam, of the Department of Land and Natural Resources, Engineering Division at (808) 587-0267.

Please be advised that 44CFR indicates the minimum standards set forth by the NFIP. Your Community's local flood ordinance may prove to be more restrictive and thus take precedence over the minimum NFIP standards. If there are questions regarding the local flood ordinances, please contact the applicable County NFIP Coordinators below:

(X) Mr. Robert Sumitomo at (808) 768-8097 or Mr. Mario Siu Li at (808) 768-8098 of the City and County of Honolulu, Department of Planning and Permitting.

( ) Mr. Frank DeMarco at (808) 961-8042 of the County of Hawaii, Department of Public Works.

( ) Mr. Francis Cerizo at (808) 270-7771 of the County of Maui, Department of Planning.

( ) Mr. Mario Antonio at (808) 241-6620 of the County of Kauai, Department of Public Works.

( ) The applicant should include water demands and infrastructure required to meet project needs. Please note that projects within State lands requiring water service from the Honolulu Board of Water Supply system will be required to pay a resource development charge, in addition to Water Facilities Charges for transmission and daily storage.

( ) The applicant should provide the water demands and calculations to the Engineering Division so it can be included in the State Water Projects Plan Update.

(X) Additional Comments: Because portion of this project is being conducted in a flood zone designated as AEF, strict adherence to the NFIP regulations, specifically 44CFR §60.3(d)(3), must be followed.

( ) Other: _____

Should you have any questions, please call Ms. Suzie S. Agraan of the Planning Branch at 587-0258.

Signed: _____
for ERIC H. HIRANO, CHIEF ENGINEER

Date: 10/8/09

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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September 25, 2009

MEMORANDUM

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TO: **DLNR Agencies:**
x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Oahu District
x Historic Preservation

FROM: Morris M. Atta
SUBJECT: Early Consultation for Draft Environmental Assessment for Aiea Intermediate School Erosion Control Project
LOCATION: Island of Oahu
APPLICANT: Kimura International, Inc. on behalf of Department of Education

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Attachments

(X) We have no objections.
( ) We have no comments.
( ) Comments are attached.

Signed:
Date: OCT - 1 2009

PAUL J. CONRY, ADMINISTRATOR
DIVISION OF FORESTRY AND WILDLIFE

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
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TO: **DLNR Agencies:**
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x Engineering Division
x ~~Div. of Forestry & Wildlife~~
x Div. of State Parks
x Commission on Water Resource Management
x ~~Office of Conservation & Coastal Lands~~
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Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed: Edwin T. Sakuda
Date: 10.1.09

FILE ID: RAD.2489.3
DOC ID: 5487 ✓

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LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 25, 2009

DEPT OF LAND & NATURAL RESOURCES

RECEIVED OCT 20 2009

MEMORANDUM

TO: **DLNR Agencies:**
x Div. of Aquatic Resources
x Div. of Boating & Ocean Recreation
x Engineering Division
x Div. of Forestry & Wildlife
x Div. of State Parks
x Commission on Water Resource Management
x Office of Conservation & Coastal Lands
x Land Division –Oahu District
x Historic Preservation

FROM: Morris M. Atta
SUBJECT: Early Consultation for Draft Environmental Assessment for Aiea Intermediate School Erosion Control Project
LOCATION: Island of Oahu
APPLICANT: Kimura International, Inc. on behalf of Department of Education

Transmitted for your review and comment on the above referenced document. We would appreciate your comments on this document. Please submit any comments by October 16, 2009.

If no response is received by this date, we will assume your agency has no comments. If you have any questions about this request, please contact my office at 587-0433. Thank you.

Attachments

( ) We have no objections.
(✓) We have no comments.
( ) Comments are attached.

Signed:
Date: 9/28/09

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

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Signed:
Date: 9/30/09 BV

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

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LAND DIVISION
2009 SEP 29 P 3:17
DEPT OF LAND & NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

September 25, 2009

MEMORANDUM

RECEIVED OCT 20 2009

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x Div. of Aquatic Resources
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( ) We have no objections.
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Signed:
Date: 9/29/09

LINDA LINGLE
GOVERNOR OF HAWAII

LAURA H. THIELEN
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

RUSSELL Y. TSUJI
FIRST DEPUTY

KEN C. KAWAHARA
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
601 KAMOKILA BOULEVARD, ROOM 555
KAPOLEI, HAWAII 96707

October 29, 2009

Ms. Les Kurisaki
Kimura International Inc
1600 Kapiolani Blvd, Suite 1610
Honolulu, Hawai'i 96814

LOG NO: 2009.4303
DOC NO: 0910NM50
Archaeology

RECEIVED NOV 04 2009

Dear Ms. Kurisaki:

SUBJECT: Chapter 6E-8 Historic Preservation Review –
Environmental Assessment— Early Consultation
Aiea Intermediate School Erosion Control Project DOE Job No. Q71009-07
Aiea Ahupua'a, Ewa District, Oahu, Hawai'i
TMK: (1) 9-9-005: 001

Thank you for providing the opportunity to comment on Environmental Assessment which we received on September 23, 2009. We concur that there will be **"no historic properties affected"** by this project since an archaeological assessment was conducted by Cultural Surveys Hawaii and no historic properties were found although they did recommend archaeological monitoring.

Please contact me at (808) 692-8015 if you have any questions or concerns regarding this letter.

Aloha,

Nancy A. McMahon (Deputy SHPO)
Archaeology and Historic Preservation Manager

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

RECEIVED DEC 24 2009

HRD09/4651

December 21, 2009

Glenn Kimura
Kimura International
1600 Kapi'olani Blvd., Suite 1610
Honolulu, Hawai'i 96814

RE: Request for comments on 'Aiea Intermediate School erosion control project, early consultation, 'Aiea, O'ahu, TMK: 9-9-005:001.

Aloha e Glenn Kimura,

The Office of Hawaiian Affairs (OHA) is in receipt of the above-mentioned letter dated September 23, 2009. OHA has reviewed the project and offers the following comments.

Generally, OHA wishes to see stormwater as a resource to be captured and conserved rather than a nuisance to be channeled and drained away. OHA notes that as stormwater travels down a drainage system, it accumulates industrial waste, pesticides, oils, and chemicals. These pollutants quickly settle into sediments and are re-suspended into the nearshore water column when disturbed. As such, OHA likes to see the use of a stormwater management system that would filter these pollutants out and slow the amount of sediments entering our waters. We discourage the hardening of stream channels as this proposal seems to do.

OHA recommends allowing "thick" vegetation or "buffer strips" to grow alongside the waterway to filter and slow runoff and soak up pollutants. Trees, shrubs, and groundcover absorb up to fourteen times more rainwater than a grass lawn and they don't require fertilizer. Additionally, many of our native species are diadromous and require an unimpeded mauka to makai connection. Such species as opae oeha'a and o'opu-akupa are also listed specifically under the State Water Code §174C-101 Native Hawaiian Water Rights. We ask that data be provided to demonstrate the presence of these resources in the project area, and if so that the project accommodate our diadromous species via aquatic pathways to facilitate their migrations.

OHA will also be particularly interested in seeing what kind of best management practices will be in place as well as what permits will be triggered. We rely on these processes and conditions to mitigate impacts to our beneficiaries.

Thank you for the opportunity to comment. If you have further questions, please contact Grant Arnold by phone at (808) 594-0263 or e-mail him at granta@oha.org.

'O wau iho nō me ka 'oia'i'o,

Clyde W. Nāmu'o
Administrator

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8480 • Fax: (808) 768-4567
Web site: www.honolulu.gov

MUFI HANNEMANN
MAYOR

CRAIG I. NISHIMURA, P.E.
DIRECTOR

COLLINS D. LAM, P.E.
DEPUTY DIRECTOR

October 19, 2009

RECEIVED OCT 21 2009

Mr. Glenn T. Kimura
Kimura International
1600 Kapiolani Boulevard Suite, 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: Aiea Intermediate School Erosion Control Project DOE Job No. Q71009-07 Aiea, Oahu, Hawaii, TMK (1) 9-9-005:001 Environmental Assessment –Early Consultation

Thank you for inviting us to review the above Environmental Assessment. The Department of Design and Construction does not have any comments to offer at this time.

Should you have any questions, please contact Craig Nishimura, Director, at 768-8480.

Very truly yours,

Collins D. Lam

Craig I. Nishimura, P.E.
FOR Director

CN.pg (334181)

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 Ulu`ohia Street, Suite 215, Kapolei, Hawaii 96707
Phone: (808) 768-3343 • Fax: (808) 768-3381
Website: www.honolulu.gov

MUFI HANNEMANN
MAYOR

JEOFFREY S. CUDIAMAT, P. E.
DIRECTOR AND CHIEF ENGINEER

GEORGE "KEOKI" MIYAMOTO
DEPUTY DIRECTOR

IN REPLY REFER TO:

RECEIVED OCT 27 2009

October 16, 2009

Mr. Glenn T. Kimura
President
Kimura International, Inc.
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: 'Aiea Intermediate School Erosion Control Project

Thank you for the opportunity for early consultation on the proposed subject project. We reviewed the location of the project and the proposed methods for repairing eroded areas and stabilizing the bank from further erosion. We have no preliminary comments at this time.

Should you have any questions, please contact Lynel Rabago, Program Coordinator, at 768-3375.

Sincerely,

Jeoffrey S. Cudiamat, P. E.
Director and Chief Engineer

JSC/lr

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 7TH FLOOR • HONOLULU, HAWAII 96813
PHONE: (808) 768-8000 • FAX: (808) 768-6041
DEPT. WEB SITE: www.honoluludpp.org • CITY WEB SITE: www.honolulu.gov

MUFI HANNEMANN
MAYOR

DAVID K. TANOUE
DIRECTOR

ROBERT M. SUMITOMO
DEPUTY DIRECTOR

October 13, 2009

2009/ELOG-2322(df)

RECEIVED OCT 19 2009

Mr. Glenn T. Kimura, President
Kimura International, Inc.
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: Draft Environmental Assessment (DEA) Preparation Notice for Aiea Intermediate School Erosion Control Project, Aiea, TMK: 9-9-005: 001

This is in response to your September 21, 2009 letter requesting our department's input to the subject project. Our preliminary comments are as follows:

1. According to the FEMA Flood Insurance Rate Map (FIRM), it appears that the project is located within the AE floodway district. A licensed professional engineer shall certify that the project will not result in any increase of the regulatory flood elevations.

2. At this moment, we are unable to state whether the project will require a grading permit. The DEA shall provide sufficient information to make that determination.

3. A Stream Channel Alteration Permit may be required. We suggest you consult with the State Department of Land and Natural Resources, Commission on Water Resource Management.

4. The Draft Environmental Assessment should discuss how the project is consistent with Section 4.6, "*Stormwater Systems*", and Section 4.7, "*School and Library Facilities*", of the Primary Urban Center Development Plan (June 2004).

If there are any questions, please contact Mr. Don Fujii of the Site Development Division at 768-8107.

Very truly yours,

for David K. Tanoue, Director
Department of Planning and Permitting

DKT:ky
[727051]
cc: Planning Division
Subdivision Branch

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET · HONOLULU, HAWAII 96813
TELEPHONE: (808) 529-3111 · INTERNET: www.honolulupd.org

MUFI HANNEMANN
MAYOR

PAUL D. PUTZULU
ACTING CHIEF

KARL A. GODSEY
DEPUTY CHIEF

OUR REFERENCE BS-VYH

September 24, 2009

Mr. Glenn T. Kimura, President
Kimura International, Inc.
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814-3806

Dear Mr. Kimura:

This is in response to your letter of September 21, 2009, requesting comments on a Early Consultation Environmental Assessment for the proposed Aiea Intermediate School Erosion Control Project, DOE Job No. Q71009-07, TMK [1] 9-9-005:001.

The Honolulu Police Department has no comments to offer at this time.

If there are any questions, please call Major Dave Kajihiro of District 3 at 723-8803 or Mr. Brandon Stone of the Executive Bureau at 529-3644.

Sincerely,

PAUL PUTZULU
Chief of Police

By Mona a. McCauley for
DEBORA A. TANDAL
Assistant Chief of Police
Support Services Bureau

Serving and Protecting With Aloha

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR
HONOLULU, HAWAII 96813
Phone: (808) 768-8305 • Fax: (808) 523-4730 • Internet: www.honolulu.gov

MUFI HANNEMANN
MAYOR

WAYNE YOSHIOKA
DIRECTOR

SHARON ANN THOM
DEPUTY DIRECTOR

TP9/09-334101R

October 13, 2009

RECEIVED OCT 15 2009

Mr. Glenn T. Kimura
Kimura International, Inc.
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: Aiea Intermediate School Erosion Control Project (Q71009-07)

This responds to your letter of September 21, 2009, requesting preliminary consultation and comments in preparation of a Draft Environmental Assessment for the subject project.

The map provided seems to indicate that all work will be done outside of the public right-of-way. However, we anticipate a more detailed map will be included in the draft EA. If any construction-related activities impact our local street system, traffic control plans must be prepared for each phase of work. We advise avoiding total road closure or blockage of access to private driveways whenever possible.

Thank you for the opportunity to review this matter. Should you have any further questions on the matter, you may contact Mr. Brian Suzuki of my staff at 768-8349.

Very truly yours,

WAYNE Y. YOSHIOKA
Director

cc: Office of Environmental Quality Control

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

September 28, 2009

RECEIVED OCT 02 2009

Mr. Glenn T. Kimura, President
Kimura International, Incorporated
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814

Dear Mr. Kimura:

Subject: Your Letter Dated September 21, 2009 Requesting Comments on the Draft Environmental Assessment for the Aiea Intermediate School Erosion Control Project, TMK: 9-9-5:1

Thank you for the opportunity to comment on the proposed erosion control project.

Construction drawings for the proposed erosion control project should be submitted for our approval.

If you have any questions, please contact Robert Chun at 748-5443.

Very truly yours,

K. Shida

KEITH S. SHIDA
Program Administrator
Customer Care Division

Hawaiian Telcom

September 29, 2009

RECEIVED OCT 01 2009

Kimura International, Inc.
1600 Kapiolani Boulevard, Suite 1610
Honolulu, Hawaii 96814
Attention: Mr. Glenn T. Kimura

Dear Mr. Kimura:

Subject: **Aiea Intermediate School Erosion Control Project**
Environmental Assessment - Early Consultation

Thank you for the opportunity to review and comment on the subject project in preparation of the Environmental Assessment.

Hawaiian Telcom has aerial and underground facilities in the vicinity of the project site. Please continue to include us during the design stages of the project.

If you have any questions or require assistance in the future on this project, please call Les Loo at 546-7761.

Sincerely,

Lynette Yoshida
Senior Manager - OSP Engineering
Network Engineering & Planning

cc: File [Aiea]

Appendix A

Geotechnical Exploration and Evaluation Report
Draft Submittal
Yogi Kwong Engineers, LLC
June 2009

DRAFT SUBMITTAL

GEOTECHNICAL EXPLORATION AND EVALUATION REPORT

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AIEA INTERMEDIATE SCHOOL

AIEA, OAHU, HAWAII

DOE JOB NO. Q71009-07

Prepared for:

Sato and Associates, Inc.
2046 South King Street
Honolulu, HI 96826

and

State of Hawaii
Department of Education
Honolulu School District

June 2009

Prepared by:

Yogi Kwong Engineers, LLC
615 Piikoi Street, Suite 1605
Honolulu, Hawaii 96814-3141

Project No. 09005

June 04, 2009

Ms. Liana Choy, P.E.
Sato and Associates, Inc.
2046 South King Street
Honolulu, HI 96826

Subject: **Draft Submittal**
Geotechnical Exploration and Evaluation Report
Stream Bank Assessment and Roadway Support
Aiea Intermediate School
Aiea, Oahu, HI

Dear Ms. Choy:

Yogi Kwong Engineers, LLC is pleased to submit this Draft Geotechnical Exploration and Evaluation Report for the subject Stream Bank Assessment and Roadway Support at the Aiea Intermediate School in Aiea, Oahu, Hawaii for your review and comment. Our geotechnical engineering services were performed in general accordance with our August 07, 2008 proposal to Sato and Associates, Inc.

We appreciate the opportunity to provide these services to Sato and Associates, Inc. If you have any questions regarding this letter and the attached draft Geotechnical Report, please do not hesitate to contact us.

Yours truly,
Yogi Kwong Engineers, LLC

Kealohi Sandefur, P.E.
Geotechnical Engineer

James Kwong, Ph.D., P.E.
Principal

TABLE OF CONTENTS

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1.0 INTRODUCTION

This report presents the results of our geotechnical exploration and evaluation of an existing stream bank along Aiea Stream and an adjacent roadway on top of the stream bank bluff near the cafeteria building on the Aiea Intermediate School campus at 99-600 Kulawea Street in Aiea, Oahu, Hawaii. Also presented are the geotechnical concepts and recommendations for slope protection and stabilization measures being proposed for the subject stream bank and adjacent roadway. The general project location along the school's northwesterly boundary is shown in Figure 1.

The findings of our initial field reconnaissance of the stream bank and a preliminary geotechnical assessment of the applicable mitigation concepts were presented in a consultation letter report dated April 17, 2009.

1.1 PROJECT DESCRIPTION

We understand that the distressed stream bank area located along the northwesterly perimeter of the school has progressively retreated through the years due to erosion. It appears that the stream bank erosion has resulted in the loss of at least several feet of land atop the stream bank bluff between the stream and the roadway adjacent to the school cafeteria. The erosion and retreat of the stream bank towards the roadway has undermined an electrical manhole box housing the main electrical power supply line to the school in the vicinity of the cafeteria.

Furthermore, we understand that a portion of the fence along the top of the stream bank bluff was partially undermined and was relocated away from the stream in the vicinity of the electrical manhole box.

It is currently proposed by the State Department of Education to protect the distressed stream bank and its adjacent roadway from further erosion and retreat and to restore support to the undermined electrical manhole.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of this geotechnical exploration and evaluation was to explore the stream bank conditions in the vicinity of the undermined electrical manhole and the subsurface conditions below the adjacent roadway, assess the stability of the existing adjacent stream bank and adjacent roadway, and develop geotechnical recommendations for remediation measures. YKE also performed a quick 'walk through' of the stream to identify additional areas of distress that may be present along the stream bank adjacent to the northwest school boundary.

Our services described herein were performed in general accordance with Tasks 1.0 and 2.0 in our fee proposal dated August 7, 2008 to Sato and Associates, Inc. The specific scope of services performed during our geotechnical exploration and evaluation of the subject stream bank was limited to the following:

- Reviewed pertinent available record drawings and geotechnical information;
- Searched and reviewed available historical aerial photographs for evaluation of pertinent site surface condition at the project site and its vicinity;
- Performed an initial site reconnaissance and preliminary stability analyses of the distressed stream bank;
- Submitted a consultation letter report (dated April 17, 2009) summarizing our initial field reconnaissance observations and concepts of our preliminary geotechnical recommendations for mitigation measures for the project team's review and consideration;
- Subsequently drilled and logged two (2) geotechnical exploratory borings on the adjacent roadway in the vicinity of the distressed stream bank and obtained soil and rock core samples for characterization of the geotechnical subsurface conditions;
- Performed geotechnical laboratory tests on samples collected from the boring explorations, including moisture content, wet and dry density, grain size distribution, swell potential and unconfined compression and direct shear strength tests;
- Performed slope stability analyses and evaluation of probable cause(s) of the stream bank retreat in the vicinity of the electrical manhole box based on exploratory boring data and laboratory test results;
- Developed geotechnical recommendations for the protection and stabilization of the distressed stream bank slope and adjacent roadway in the vicinity of the school cafeteria building; and
- Summarized the results of the field exploration and the updated evaluations, and present the updated geotechnical recommendations in this draft report for the project team's review and comment.

A topographic survey was performed by ControlPoint Surveying, Inc. as shown in Figures 2 to 5. For ease of reference, the stream bank is referred to in this report based on the same survey stations along the stream alignment provided on the topographic survey map. The scope of our services presented herein did not include any civil or structural engineering evaluations, environmental, hazardous waste, and/or hydrological assessments of the site.

2.0 SITE RECONNAISSANCE, EXPLORATORY BORINGS AND LABORATORY TESTING

Site reconnaissance and drilling of exploratory borings for this project were conducted between March 10 and 27, 2009. The site reconnaissance was performed on March 10 and

11, 2009 respectively. In the first day, access along the stream bed was not possible due to flowing water in the stream and reconnaissance was limited to observation at a distance from two (2) gated access points located approximately at Station (STA) 1+50 and STA 10+50 respectively. Upon return on the next day, YKE personnel were able to perform a reconnaissance of the distressed stream bank in the vicinity of STA 3+50 to 4+50 as well as conduct a limited "walk-through" reconnaissance of the stream alignment approximately between STA 0+00 and STA 10+00.

Subsequently, two (2) exploratory borings, Borings B-1 and B-2, were drilled to the approximate depths of 29.0 and 16.7 feet below the existing ground surface along the adjacent roadway. Approximate locations of the exploratory borings are shown in Figure 6. A detailed description of the procedures used to perform the exploratory borings, along with the logs of borings, is presented in Appendix A.

Geotechnical laboratory tests were conducted on selected soil samples recovered from the exploratory borings to evaluate the engineering properties of the encountered subsoils. These laboratory tests included moisture content and dry density, grain size distribution by sieve analyses, plasticity index, unconfined compression, and direct shear tests. The geotechnical laboratory test results along with a description of the test methods that were employed are presented in Appendix B.

Select photographs taken during the site reconnaissance are presented in Appendix C and photographs of select soil samples obtained during the boring exploration are presented in Appendix D.

3.0 SITE SURFACE AND SUBSURFACE CONDITIONS

3.1 GENERAL SITE CONDITIONS

As shown on the topographic survey maps in Figures 2 to 5, Aiea Stream meanders for approximately 2,500 feet along the northwest boundary of Aiea Intermediate School. The distressed stream bank is located adjacent to the school cafeteria/kitchen building approximately between STA 3+50 to 4+50. Based on the historic aerial photographs in Figures 7 thru 10, it appears that a majority of the school and neighboring residential developments were built between 1949 and 1969, with some of the residential developments constructed across the distressed stream bank between 1969 and 1998.

Through discussions with the school personnel, we understand that some fills may have been placed to partially backfill the stream bed in the vicinity of the distressed section of stream bank within the past ten (10) years or so. However, development of neighboring residential

properties in the vicinity of the distressed stream bank within this more recent period of time is not discernable based on the available aerial photographs dated 1998 and circa 2008.

A paved asphalt and concrete roadway currently runs between the distressed stream bank and the school cafeteria/kitchen building. Several known utilities are located in the vicinity of the distressed stream bank including telephone and T.V. cables, water, sewer, storm drain as well as overhead and underground electrical lines. We understand that the main electrical power supply line to the school runs through the undermined electrical manhole box located at the top of the stream bank bluff at approximately STA 4+40.

Based on the available topographic plans, a 12-inch storm drain pipe discharges through the stream bank bluff just a few feet downstream of the electrical manhole box and was observed to daylight at mid face of the stream bank bluff. Additionally, a long segment of pipe of similar material and size to the storm drain pipe was observed lying in the stream bed just downstream from where the storm drain daylights, indicating that the stream bank and storm drain likely extended significantly further into the current stream bed alignment in the vicinity of STA 4+40.

3.2 STREAM BANK CONDITIONS

In general, the stream bank along the school boundary was observed to be mostly overgrown with primarily tall Guinea grasses, shrubs and large trees, which limited our observation in most areas outside of the distressed area along the stream bank.

The distressed stream bank bordering the school grounds between STA 3+50 and STA 4+50 (in the vicinity of the manhole box) was observed to be nearly vertical to locally overhanging and ranged from approximately 12 to 14 feet in height with noticeably less vegetation growth in this area. The stream bank bluff was severely scoured, and undermined at the toe approximately between STA 3+90 and STA 4+25, resulting in overhanging outcrops. Vertically orientated tension cracks were observed on the stream bank bluff adjacent to the overhanging outcrops.

The scour and erosion has also resulted in the undermining of the electrical manhole box near STA 4+40 leaving a cavity below most part of the box. The cantilevered electrical manhole box was being supported by two (2) short steel posts erected on a thick concrete footing at the time of our reconnaissance. Scour and evidence of slope sloughing was also observed on the school-side stream bank below a drainage swale at approximately STA 6+75 upstream of the school kitchen building and electrical manhole box.

The opposite stream bank on the side of the neighboring residential properties was also observed to be overgrown with vegetation. Retaining walls of various heights were

commonly located at the rear of the neighboring properties along this side of the stream bank opposite the school grounds as shown on the topographic surveys maps in Figures 2 through 5 and the site reconnaissance photos in Appendix C.

3.3 REGIONAL GEOLOGY AND SEISMIC CONSIDERATIONS

The Island of Oahu was formed by the coalescing of two (2) separate volcanic islands formed by the Waianae and Ko`olau Volcanoes. The Waianae Volcano, in northwest Oahu, moved away from a crustal "hot spot" and ceased eruptions first. The Ko`olau Volcano, in the southeast, actively erupted until the Ko`olau Basalts filled the sea between the two islands, lapping over the older Waianae Basalts, and forming the present Schofield Plateau in the center of Oahu.

After the Ko`olau eruptions ceased, no further volcanic activity occurred on Oahu for about two million years. The island slowly sank some 1,200 feet due to its own weight, spreading laterally in the soft seabed. About 500,000 years ago, a new series of volcanic eruptions called the Honolulu Volcanic Series began (MacDonald et al., 1983), which were much more volatile than the older Ko`olau lava flows. These more recent eruptions consisted of about 30 separate events generally located in the Honolulu District area of Oahu and were scattered over a period of hundreds of thousands of years.

At that same time, the sea level fluctuated due to continental glaciations. During periods of low sea levels, alluvial channels and erosional surfaces developed and extended well below the existing sea level. These erosional processes reworked earlier volcanic cinders, basaltic lava flows, and coralline and alluvial deposits. Sedimentation occurred and some of the erosional channels were in-filled with soft unconsolidated alluvium and marsh deposits during periods of higher sea levels or subsidence of the island due to deflection of the upper magma chamber and/or weight of the island mass. The cycles of advance and retreat of the sea also produced reef deposits at various elevations and various silty lagoons near the paleo-shoreline.

Aiea Stream originates inland on the Ko`olau Mountain Range and meanders between Aiea Heights to the north/northwest and Halawa Heights to the south/southeast. Aiea Intermediate School is located in the town of Aiea, Oahu, Hawaii near the mouth of Aiea Gulch formed by Aiea Stream. Based on the subsurface conditions encountered in the borings and observed along the exposed stream bank, the project site is primarily underlain by Older Alluvium.

The older alluvial deposits have partially filled the valley between Aiea Heights and Halawa Heights, and formed fans of old alluvial sediments laid down at higher stands of the sea as shown in the Regional Geology Map, Figure 11. Deposits of Older Alluvium in the low

lying regions that are not subject to persistent rains are typically consolidated due to concurrent cycles of wetting and drying during its deposition. In the study area, the present day Aiea Stream erodes into the older mountain stream channel in-filled by many rounded cobbles, boulders and conglomerate deposits.

It is our understanding that the Island of Oahu is in the Uniform Building Code (UBC, 1997) Earthquake Zone 2A with a corresponding seismic zone factor of 0.15 (peak horizontal ground acceleration or PGA of 0.15g). UBC provides the zone factor and equivalent earthquake parameters based on earthquake hazards with a 10% probability of exceedance in 50-years (10%/50-years) roughly corresponding to a 500-year return period.

3.4 SUBSURFACE CONDITIONS

Interpretations of the subsurface conditions presented in this report are based on a review of available geologic maps and other published resources as discussed above, the results of the field reconnaissance, the exploratory borings drilled along the roadway adjacent to the distressed stream bank, and YKE's general experience in this area. Based on the available data, the subsurface conditions below the roadway on top the stream bank bluff at the project location primarily consist of pavement and near surface fills underlain by thick deposits of Older Alluvium to the explored depths.

More detailed descriptions of the subsurface conditions encountered in the borings are presented in the boring logs, in Appendix A of this report. Due to the inherent variability of subsoil deposition and weathering, subsurface conditions between the borings may vary significantly from those indicated in this report.

3.4.1 Fills

Fill materials consisting of well graded to silty gravels were encountered at the boring locations beneath the pavement, to the approximate depths of 2.0 to 2.5 feet below ground surface. Pavement thickness was 6.5 and 7.0 inches at borings B-1 and B-2 respectively. Trench backfills are also anticipated in existing utility trenches and manholes that may be present at the project site. In areas where existing utilities and manholes are located, actual trench backfills are anticipated to extend deeper than the depths shown of the existing utilities on available record drawings.

3.4.2 Older Alluvium

Older Alluvium is typically chemically weathered and consolidated alluvium derived from upslope erosion and deposition of primarily river sediments and variously weathered basalt

cobbles and boulders. The Older Alluvium encountered in the borings consisted of primarily dense to very dense sands and gravels with an abundance of cobbles and boulders in a matrix of predominantly brown and grey clays. Based on the results of swell and plasticity index tests, it appears that the older alluvial soils have moderate to high swell potential.

Cores of basalt boulders measuring up to 14 inches in length were recovered in the exploratory borings, while larger boulders were exposed along the stream bank less than 50 to 100 feet away from the boring locations. Unconfined compression (UC) tests performed on selected core samples of the basalt boulders resulted in UC strengths up to 13,757 psi. However, it is anticipated that the stream bank stability is governed by the strength of the soil matrix rather than the very high compressive strength of the basalt cobbles and boulders.

3.4.3 Groundwater

Groundwater was not encountered in the two (2) exploratory borings at the time of the geotechnical field exploration. However, it is anticipated that perched groundwater may develop in the stream bank bluff during and after significant/prolonged rainfall events, and/or high flood stages, based on our past project experience with similar geologic settings.

4.0 DISCUSSION AND GEOTECHNICAL RECOMMENDATIONS

In accordance with the aforementioned limited scope of work, our geotechnical exploration and evaluation efforts for this project primarily focus on assessment of the existing stream bank and adjacent roadway particularly in the vicinity of the undermined electrical manhole box near STA 4+40. The development of geotechnical design concepts and recommendations is also limited to stabilizing this section of the slope and protecting the adjacent roadway from adverse impacts due to progressive stream bank erosion and retreat. The stability of the entire existing stream bank bordering the northwest boundary of the school cannot be properly evaluated because the extensive site clearing, slope reconnaissance and field exploration efforts required are beyond the scope of this study.

4.1 SLOPE STABILITY ANALYSES

To conduct the slope assessment, YKE has performed a series of slope stability analyses of the existing stream bank and adjacent roadway in both *in-situ* and fully saturated conditions under both static and seismic loadings that could probably occur based on the regional and local seismic and hydrologic considerations. The slope stability analyses were performed by using the computer program, SLOPE/W (2004).

SLOPE/W employs two-dimensional limiting equilibrium methods such as the Morgenstern-Price method for the general solution of slope stability problems. To compile inputs into SLOPE/W, the results of our laboratory tests were used to characterize the geotechnical strengths and unit weights of the fill and older alluvial soils encountered in the borings that may exist under various stress states or conditions corresponding to the various loading conditions. The SLOPE/W analyses previously performed in a parametric fashion as part of our April 17, 2009 consultation letter report used a wide range of assumed values for the older alluvial soils based on field strength index tests performed during our site reconnaissance as indicated in the consultation letter.

4.1.1 Psuedo-Static Seismic Stability Analyses

The seismic stability of the existing stream bank slope and adjacent roadway during an earthquake event was evaluated using a *pseudo-static* procedure. The pseudo-static analysis assumes that the earthquake causes an additional horizontal acceleration force on the slope in the direction of failure. The applied force is equal to the seismic coefficient K_{ave} multiplied by the weight of the sliding mass in the slope.

Based on the Hawaii Department of Land and Natural Resources *Guidelines for the Design and Construction of Small Embankment Dams* (1992), a simplistic seismic coefficient factor of 0.15g is recommended for *pseudo-static* seismic stability analyses of earth dam slopes on the island of Oahu in view of the lack of site specific seismic analyses. Therefore, a seismic coefficient of K_{ave}=0.15 was used in the seismic slope stability analysis of the evaluated stream bank section.

4.1.2 Stability of Existing Stream Bank Slope and Adjacent Roadway

Based on the strength data from the laboratory tests and the conditions assumed, the calculated safety factors of the stream bank slope section and adjacent roadway in different stress states under the various loading conditions discussed above are summarized in Table 1 below. The slope stability analysis results are presented in further detail in Appendix E.

FACTOR OF SAFETY			
Static Condition		**Pseudo-Static (Seismic) Condition**	
In-Situ	**Saturated**	***In-Situ***	**Saturated**
3.02	2.07	2.73	2.06

Table 1: Summary of Calculated Factors of Safety of Existing Stream Bank Slope

Based on these calculated factors of safety, the stream bank section evaluated appears to have adequate factor of safety against overall instability but will be susceptible to scour or undermining in areas by future stream erosion and sloughing failure of the cobble and boulder rich stream bank. As the clayey or silty gravel and sand matrix in the Older Alluvium is continuing to be scoured near the stream bed level, the cobbles and boulders will spall from the stream bank toe leaving it undermined and forming more overhang outcrops which are inherently unstable.

The vertical tension cracks observed in the vicinity of the overhanging outcrops substantiates this pattern of scour, spall, and progressive retreat of the stream bank as shown in the following photographs (Figure 12).

Figure 12: Vertical Tension Cracks and Spalled Boulders

Recent spall debris consisting of boulders and cobbles partly embedded in a matrix of silts and clays were also observed lying in the stream bed in the vicinity of the undermined vertical stream bank as shown in Figure 13 below.

Figure 13: Recent Stream Bank Spall Debris and Local Failures

As a result, progressive erosion and retreat of the stream bank in the vicinity of the electrical manhole box will eventually undermine and destabilize the adjacent roadway section if slope protection measures are not promptly taken to prevent further stream bank erosion.

The geotechnical recommendations and design concepts for the required slope protection measures are discussed in Section 4.2 below.

4.2 SLOPE PROTECTION MEASURES

Based on our previous slope stability evaluations in similar geologic settings for other projects and the current analyses, it is apparent that the very steep existing stream bank bluff will be vulnerable to further erosion and progressive sloughing or spall due to surface runoff, stream scour, as well as future vegetative growth that could dislodge the cobbles and boulders from the surrounding soil matrix.

As a first step of the required slope protection measures, we recommended that grouted rip rap or mass concrete be used to backfill where scouring has already undermined the existing stream bank into unsupported outcrops/overhangs approximately between STA 3+90 and 4+25, and the cavity below the undermined electrical manhole box approximately at STA 4+40. Alternately, the unsupported outcrops or overhangs can be trimmed back or removed.

After backfilling and trimming or removal is done, we believe that wire-reinforced shotcrete can be applied on the stream bank bluff surface to protect the slope segment from sloughing or unraveling through the service life of the shotcrete cover, and a Concrete Rubble Masonry (CRM) or gabion wall can be constructed at the toe to reduce future scouring and undermining as shown in Figures 14 and 15. At a minimum, we believe that the stream bank approximately between STA 3+50 and 4+50 should be protected as recommended herein.

4.2.1 Support of Undermined Stream Bank Outcrops and Overhangs

Prior to the application of wire-reinforced shotcrete slope protection, it is recommended that spot mitigation be performed to support the already scoured and undermined outcrop and overhang areas along the distressed stream bank toe approximately between STA 3+90 and 4+25 and possibly other locations that may exist. The spot mitigation work may include backfilling and supporting the undermined toe and overhang areas with grouted rip rap or mass concrete as shown in Figure 15.

Alternately, unsupported outcrops and overhangs may be trimmed and/or removed along vertical tension cracks to reduce angle of the slope and the size of potentially unstable unsupported overhang masses and also reduce the amount of grouted rip rap or mass concrete that may be needed along the scoured and undermined toe areas of the distressed stream bank.

4.2.2 Wire-Reinforced Shotcrete Facing with Subdrain

We recommend that a minimum 8-inch thick, wire-mesh reinforced shotcrete facing be applied over the very steep existing stream bank bluff section as delineated in Figure 14 to protect the near vertical stream bank surface from future scouring, erosion, vegetative growth and related spall or dislodging of the cobbles and boulders from the older alluvial soil matrix. It is recommended that the shotcrete facing be designed with a subdrain system to allow for adequate drainage of anticipated ground seepage through the slope and relieve potential excessive perched groundwater pressure that may otherwise build up behind the slope face protection.

After some clearing and grubbing of the existing slope face to remove loose debris and vegetation, suitable free draining geo-composite drainage sheets approximately 1-foot wide and spaced approximately 6 feet on centers should be securely placed in near vertical columns from the top of the stream bank bluff down to the toe of the protected bluff between the cleared slope face and the reinforced shotcrete facing to be applied. Minimum 4-inch diameter weep holes should be installed in a grid pattern also at a minimum spacing of six (6)

feet on center on the shotcrete facing to help discharge potential seepage. The weep holes should be located on the shotcrete facing between the drainage sheets installed behind in order to provide better drainage coverage.

The geo-composite drain sheets should be connected at the toe with a properly designed drainage system in accordance with the manufacturer's recommendations to remove seepage water that could come from behind the slope now covered with the shotcrete facing. It is our recommendation that the shotcrete design, construction, and quality control sampling/testing should conform with the minimum requirements of Section 1913 of the International Building Code (IBC 2006) for quality assurance and control.

4.2.3 Gabion or CRM Toe Wall

Upon backfilling of the outcrops and overhangs and application of wire-reinforced shotcrete slope protection, it is recommended that a gabion (with PVC protected wire cages) or battered CRM wall be constructed at the toe of the stream bank in concern to provide longer term scour protection to the toe area. If a battered CRM wall is preferred, the toe of the wall should be keyed sufficiently deep to minimize the potential for stream scour to undermine the wall and cause possible toppling or distress of the CRM wall with time. It should be emphasized that the gabion or CRM toe protection wall must not impede or block the discharge of water seepage collected by the subdrain system behind the shotcrete facing.

4.3 SITE GRADING

Due to currently unknown conditions behind where the stream bank is covered by overgrown vegetative cover, it is recommended that the contractor exercise extra caution, when removing vegetation and loose material from the stream bank surface, to avoid destabilizing the stream bank. Furthermore, mobilization of heavy construction equipment that may induce strong ground vibrations should be prohibited in the vicinity of the distressed stream bank and along the adjacent roadway atop the stream bank bluff.

Based on the subsurface conditions at the project site, any excavations into the existing steep stream bank bluff could cave-in readily particularly during rainy periods and/or due to vibrations from construction loadings or other human activities nearby. Construction safety and stability of any temporary excavations must be closely monitored and are the sole responsibility of the contractor, who must strictly comply with all applicable government safety regulations.

It should be cautioned that the proposed slope protection measures may require multiple stream work permits from applicable authorities. The supporting efforts and application of such work permits are beyond our scope of services for this report.

5.0 LIMITATIONS

The geotechnical recommendations and conclusions presented in this report are based on the assumption that the scope of the designed and constructed project as described does not change appreciably, and that significant variations in soil properties from those observed along the exposed stream bank during our reconnaissance and encountered by our exploration do not occur. This report presents our opinion of the subsurface conditions and the properties of the materials anticipated to be encountered during construction. To accomplish this, it was necessary to interpolate between exploratory borings and data points, and extrapolate the data to estimate the conditions. While the properties of the materials encountered in the field are expected to be within the ranges discussed, the actual distribution of materials encountered will likely vary from those discussed in this report.

The descriptions and discussions of anticipated subsurface conditions presented in this report are intended to assist the State of Hawaii Department of Education, Sato and Associates, Inc. and their respective sub-consultants in design considerations and preparation of construction bid documents. If any conditions notably differ from those described herein are encountered during construction, YKE should be immediately notified and be allowed reasonable time to review, analyze and respond to the unforeseen conditions.

This report was prepared for Sato and Associates, Inc. and their designated design consultants in accordance with generally accepted geotechnical engineering practices. The geotechnical opinions and recommendations given in this report are based on our evaluation of the data collected for this project. This study excludes civil and structural engineering evaluations. Additive conclusions or recommendations made from this data by others for other uses are solely their own responsibility.

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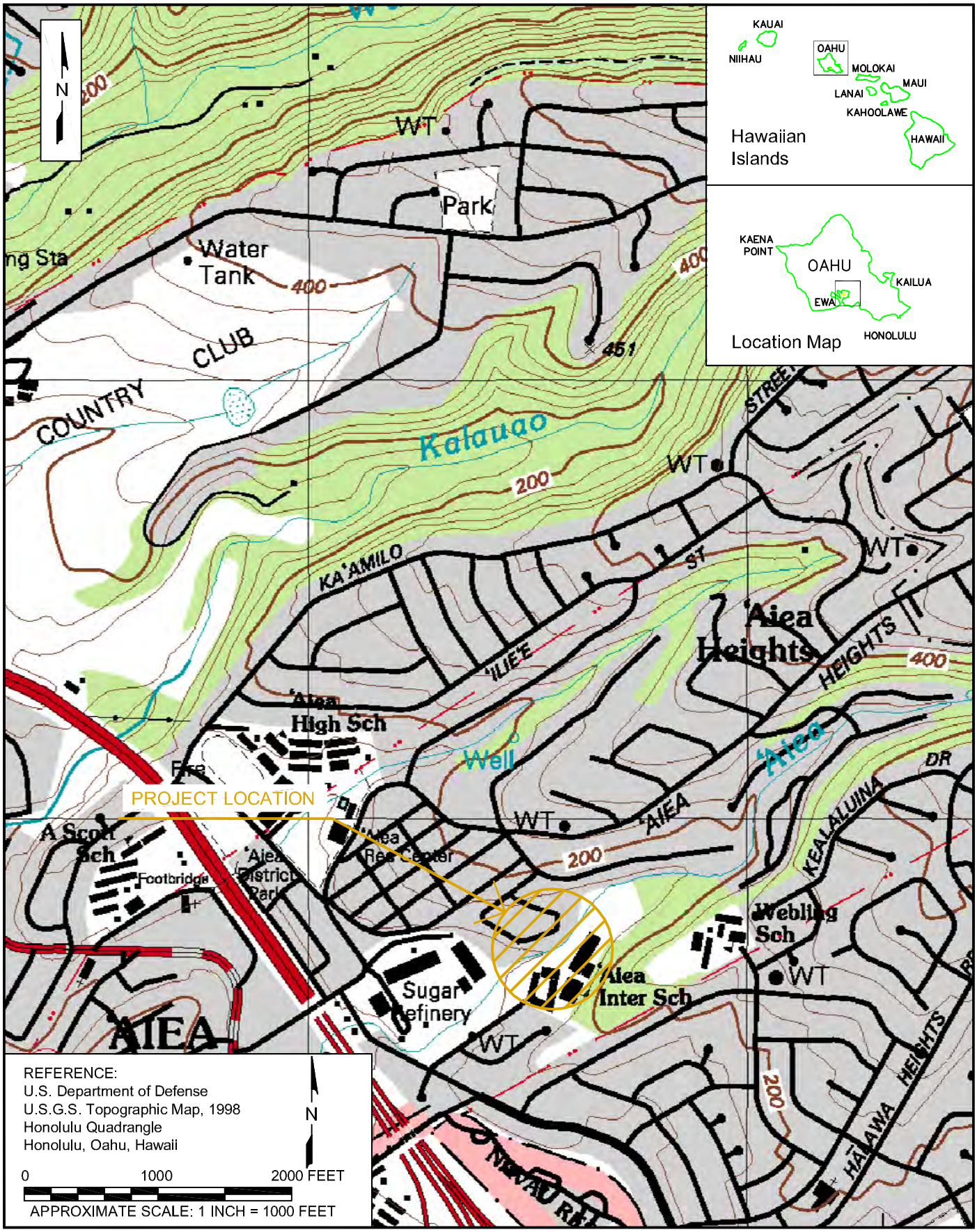


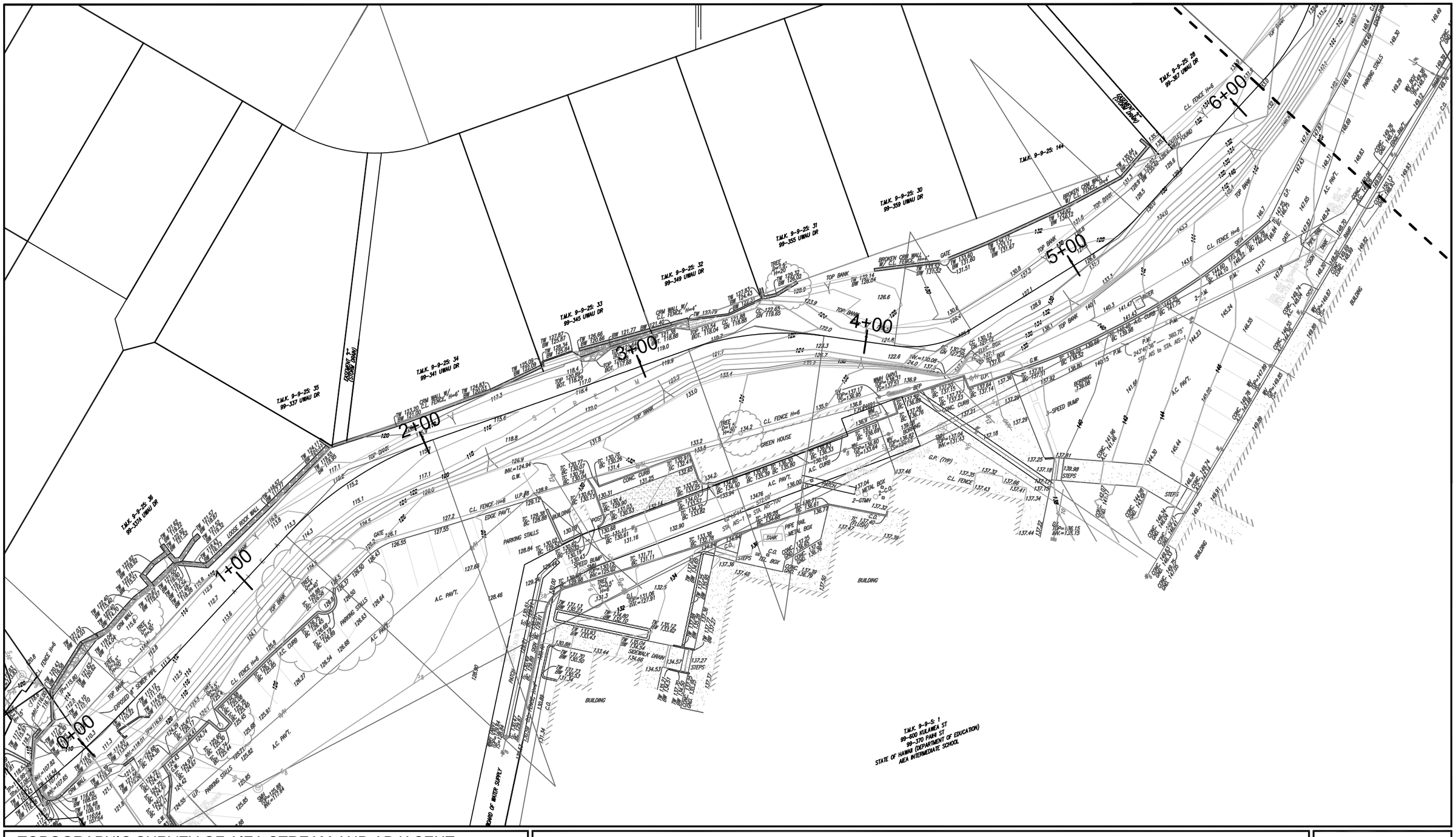
PROJECT LOCATION MAP

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE 1



TOPOGRAPHIC SURVEY OF AIEA STREAM AND ADJACENT INTERMEDIATE SCHOOL GROUNDS STA 0+00 TO 6+00

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

REFERENCE:
1) Controlpoint Surveying Inc.
Topographic Survey Map
State Doe - Aiea Intermediate School
Erosion Control, DOE Job No. Q71009-07
Aiea, Ewa, Oahu, Hawaii

N

SCALE:
0 40 80 FEET
APPROXIMATE SCALE: 1 INCH = 40 FEET

Yogi Kwong Engineers, LLC

FIGURE 2

TOPOGRAPHIC SURVEY OF AIEA STREAM AND ADJACENT INTERMEDIATE SCHOOL GROUNDS STA 6+00 TO 11+00

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

REFERENCE:
1) Controlpoint Surveying Inc.
Topographic Survey Map
State Doe - Aiea Intermediate School
Erosion Control, DOE Job No. Q71009-07
Aiea, Ewa, Oahu, Hawaii

N

SCALE:
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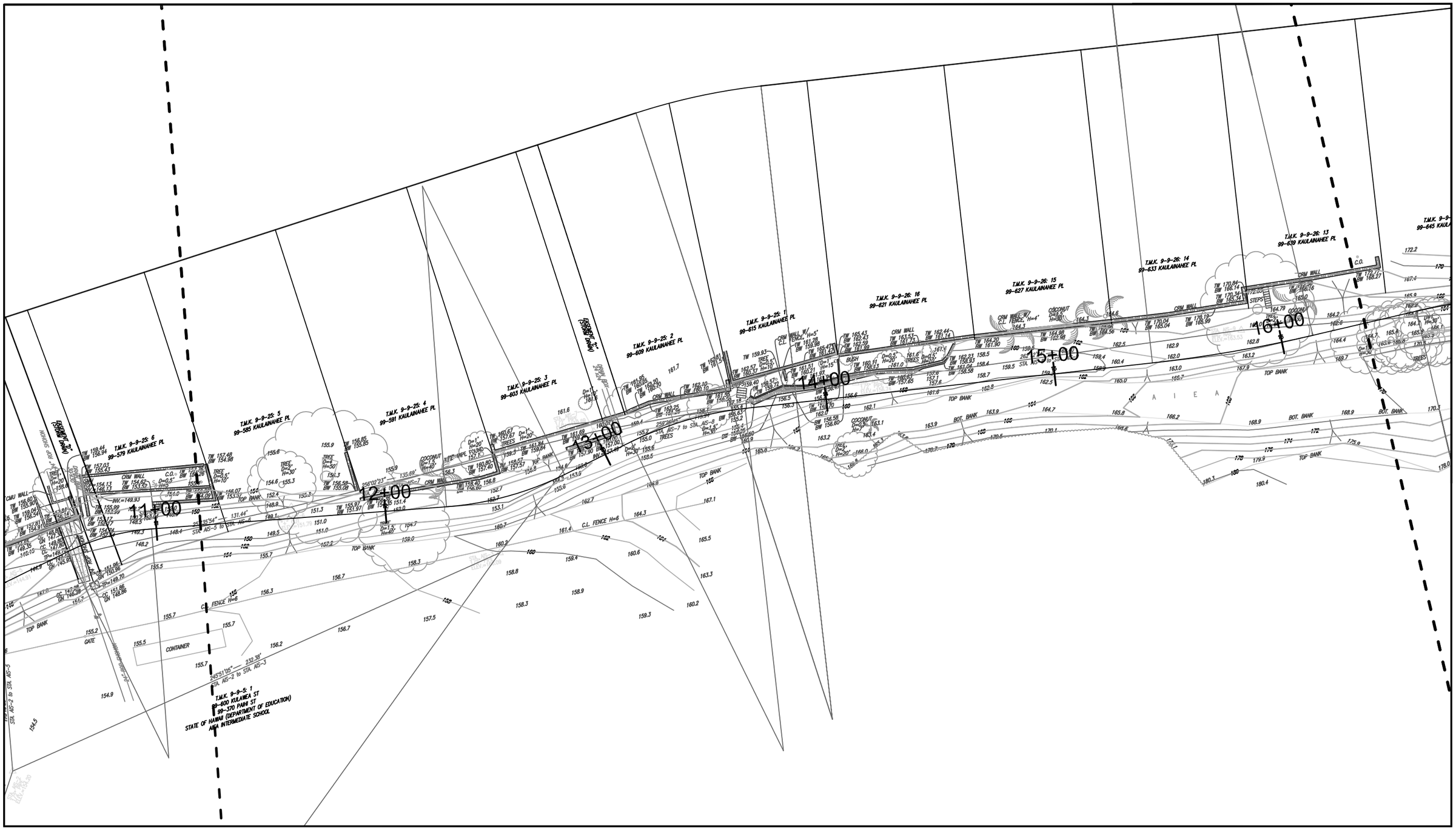
APPROXIMATE SCALE: 1 INCH = 40 FEET

Yogi Kwong Engineers, LLC

FIGURE 3



TOPOGRAPHIC SURVEY OF AIEA STREAM AND ADJACENT INTERMEDIATE SCHOOL GROUNDS STA 11+00 TO 16+00

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

REFERENCE:
1) Controlpoint Surveying Inc.
Topographic Survey Map
State Doe - Aiea Intermediate School
Erosion Control, DOE Job No. Q71009-07
Aiea, Ewa, Oahu, Hawaii

N

SCALE:
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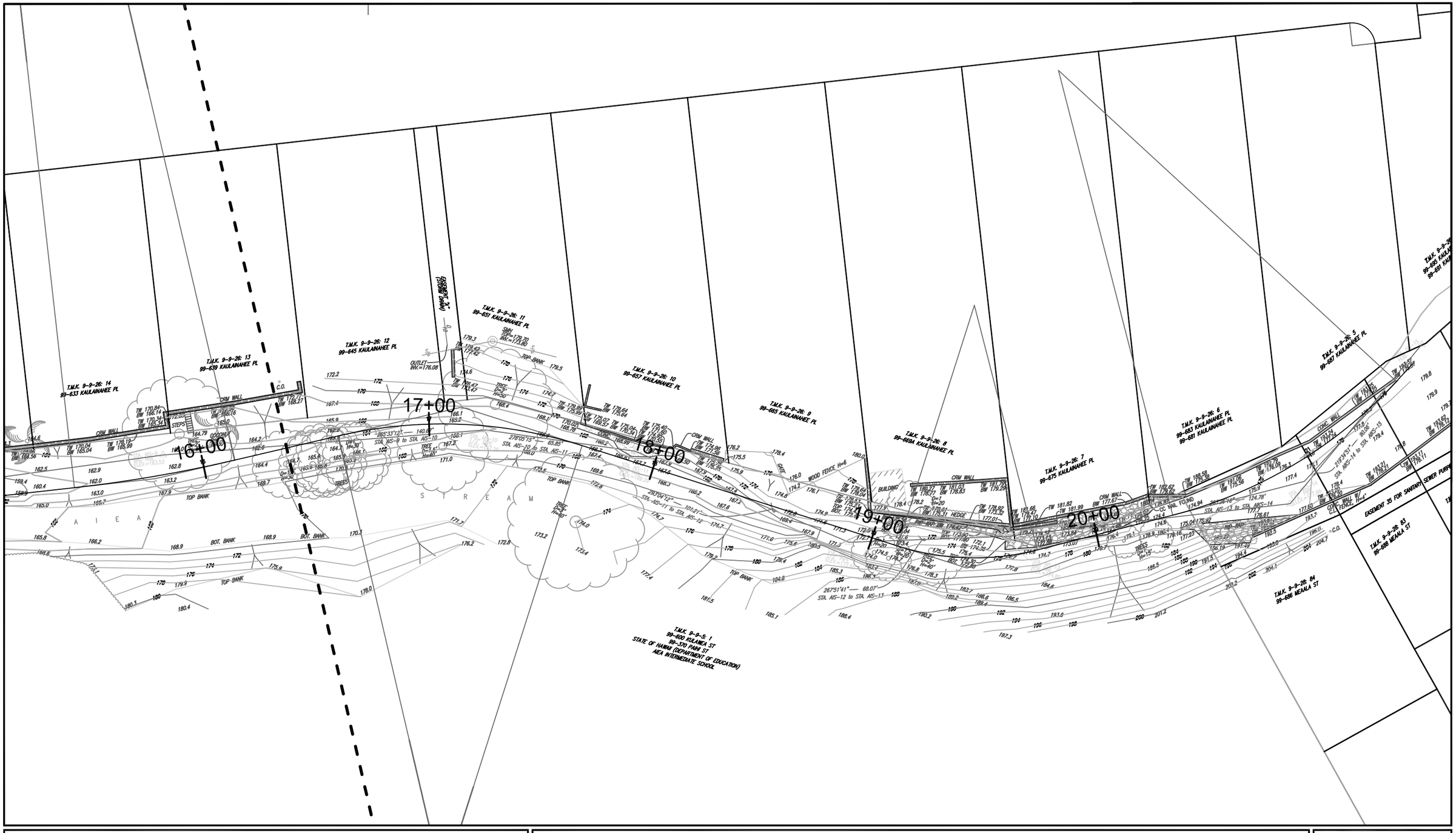
APPROXIMATE SCALE: 1 INCH = 40 FEET

Yogi Kwong Engineers, LLC

FIGURE 4



TOPOGRAPHIC SURVEY OF AIEA STREAM AND ADJACENT INTERMEDIATE SCHOOL GROUNDS STA 16+00 TO 20+00

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

REFERENCE:
1) Controlpoint Surveying Inc.
Topographic Survey Map
State Doe - Aiea Intermediate School
Erosion Control, DOE Job No. Q71009-07
Aiea, Ewa, Oahu, Hawaii

N

SCALE:
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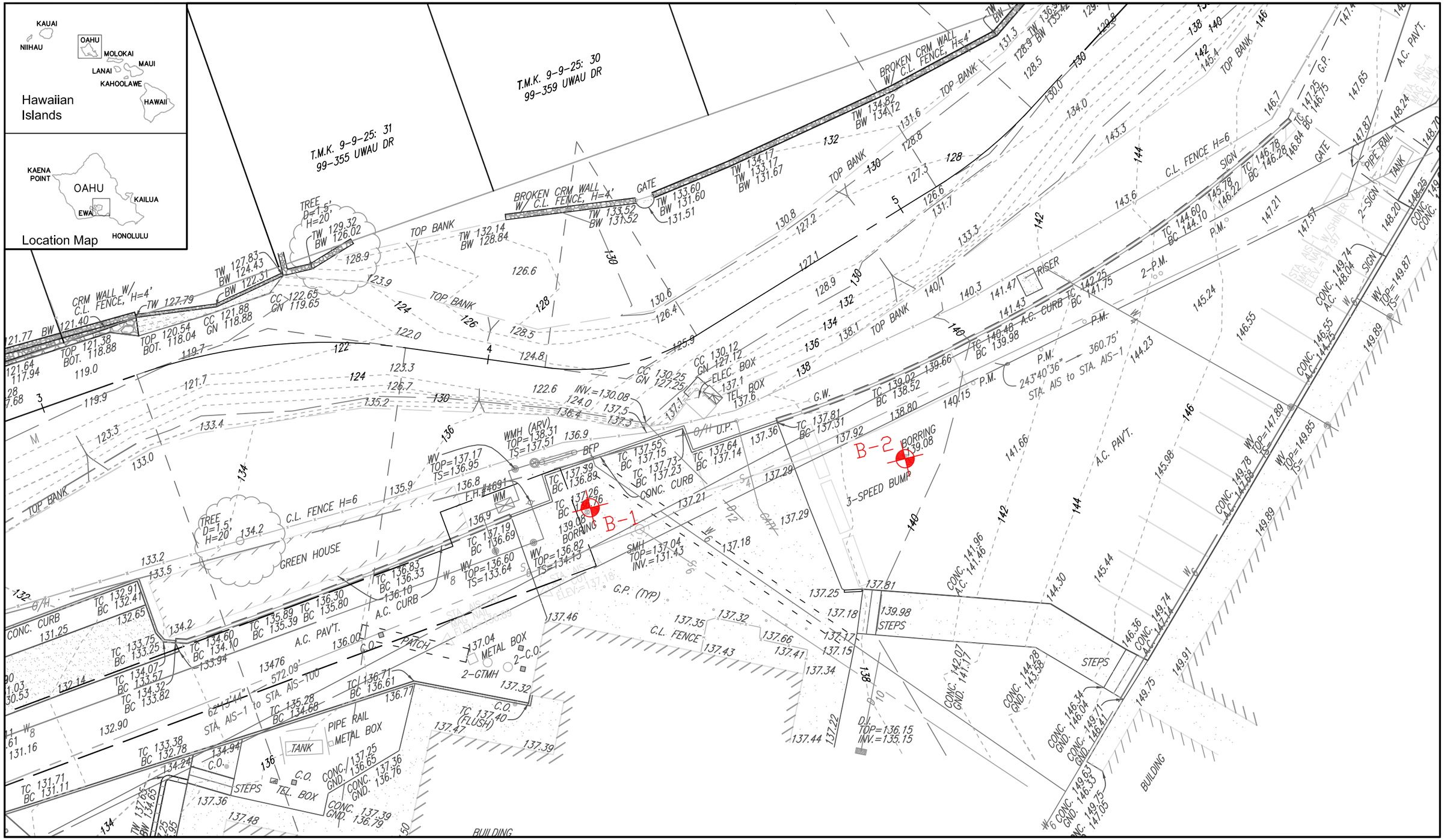
APPROXIMATE SCALE: 1 INCH = 40 FEET

Yogi Kwong Engineers, LLC

FIGURE 5



BORING LOCATION MAP

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

NOTES:

Approximate Boring Location

0 20 40 FEET
APPROXIMATE SCALE: 1 INCH = 20 FEET

Yogi Kwong Engineers, LLC

FIGURE 6

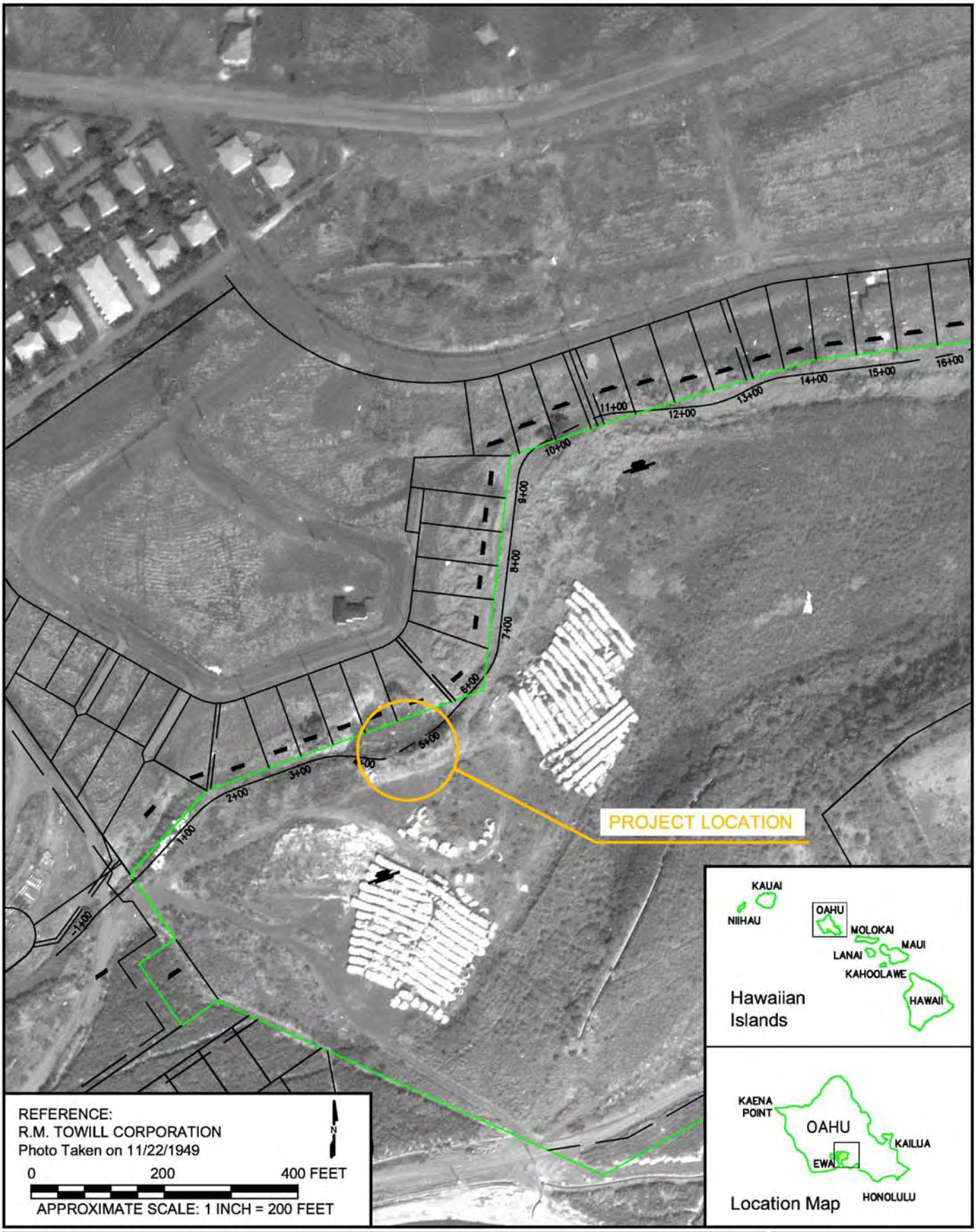
1969 AERIAL PHOTOGRAPH OF PROJECT LOCATION

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE 8



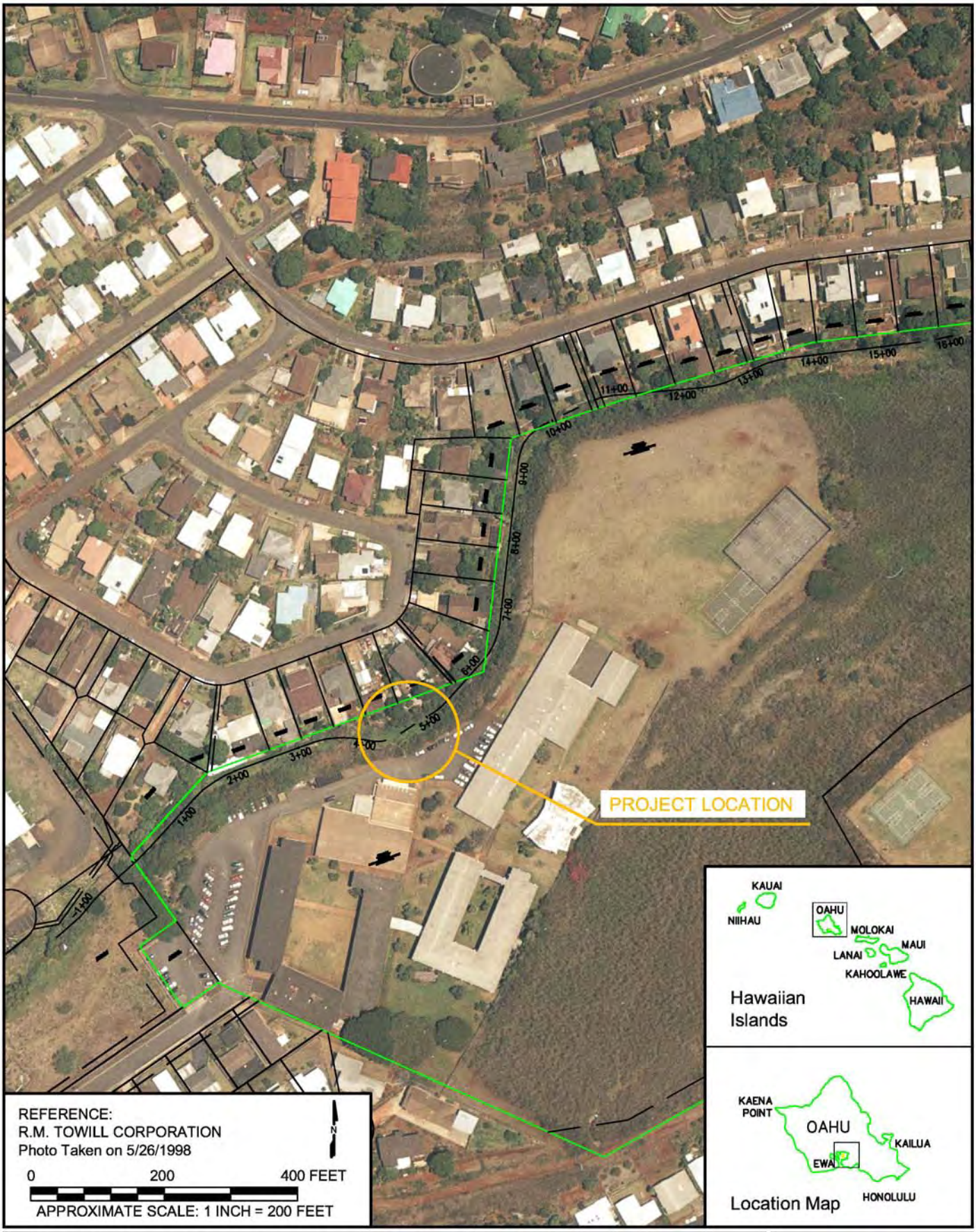
1949 AERIAL PHOTOGRAPH OF PROJECT LOCATION

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE 7



1998 AERIAL PHOTOGRAPH OF PROJECT LOCATION

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

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FIGURE 9

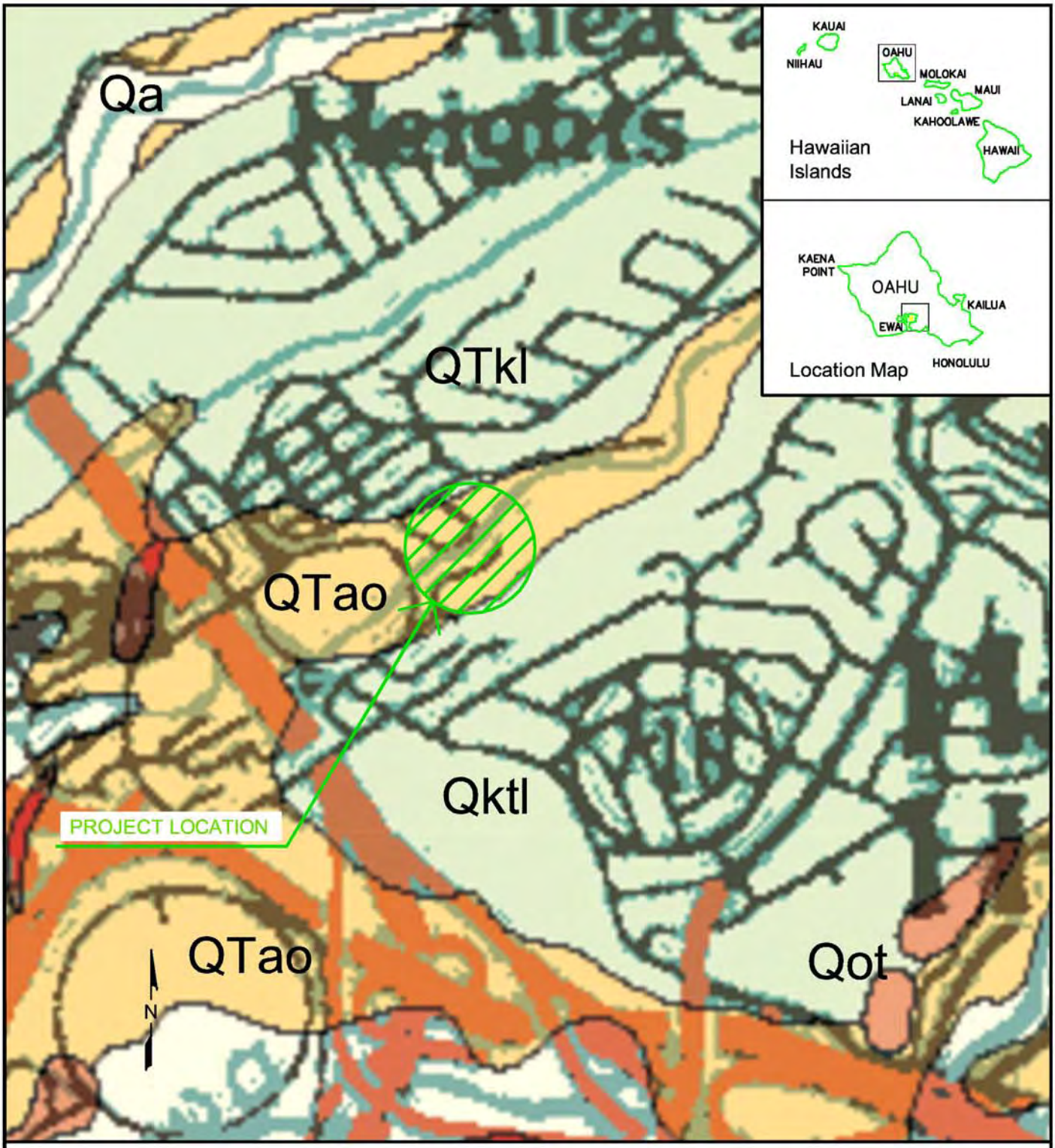
2008 AERIAL PHOTOGRAPH OF PROJECT LOCATION

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE 10



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Sherrod, D. R., Sinton, J. M., Watkins, S. E., & Brunt, K. M., 2007, Geologic Map of the State of Hawaii - Island of Oahu: USGS Open-file Report.

0 1000 2000 FEET

APPROXIMATE SCALE: 1 INCH = 1000 FEET

LEGEND:

QTkl	LAVA FLOWS	QTao	OLDER ALLUVIUM
Qot	TUFF CONE DEPOSITS	Qa	ALLUVIUM

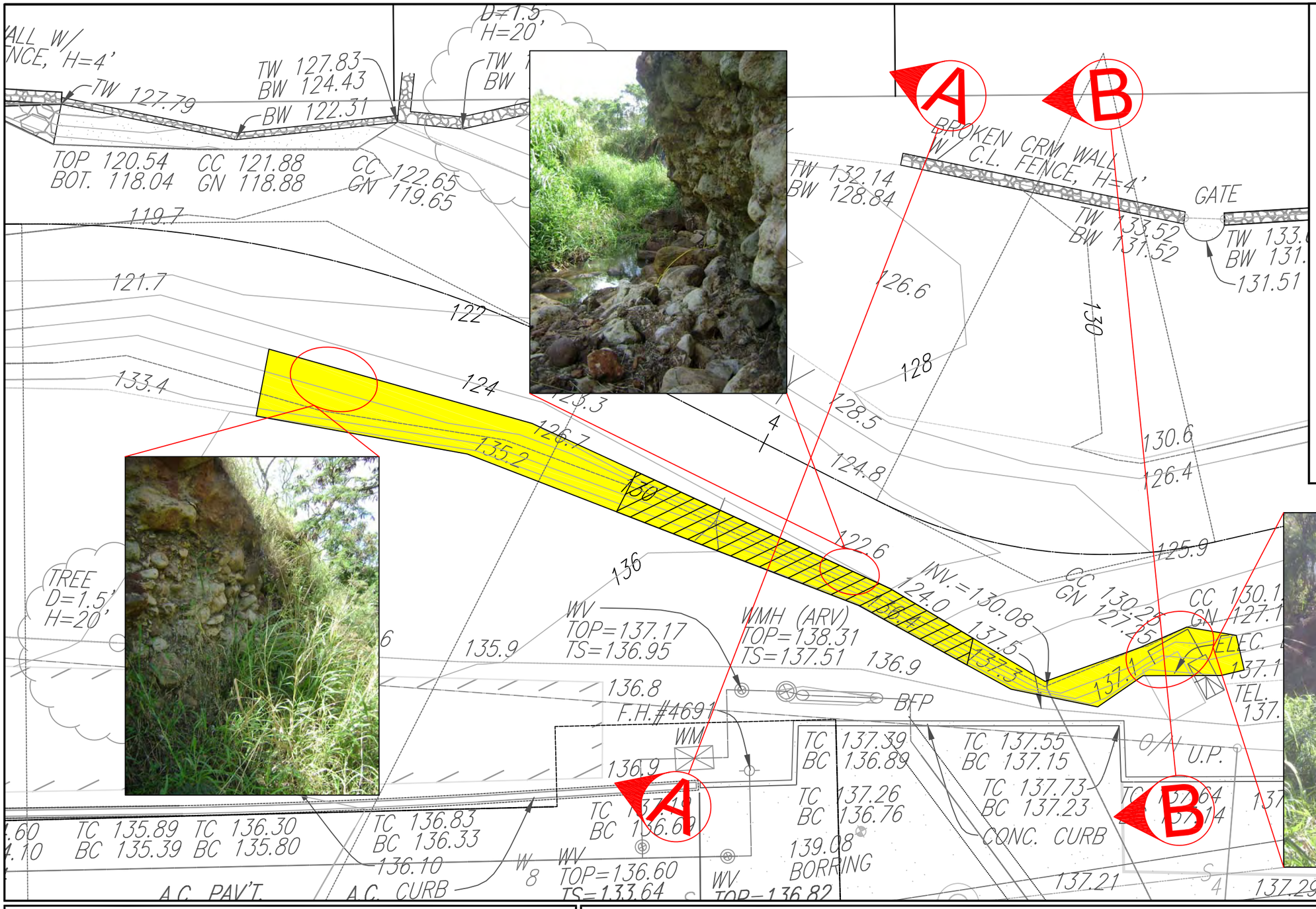
REGIONAL GEOLOGY MAP

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE 11



LEGEND

- APPROXIMATE EXTENT OF EXPOSED STREAM BANK BLUFF SURFACE TO BE PROTECTED WITH WIRE-REINFORCED SHOTCRETE AND A CRM OR GABION SCOUR PROTECTION WALL AT THE TOE
- APPROXIMATE LOCATION OF OBSERVED OVERHANG ROCK OUTCROP AND UNDERMINED STREAM BANK BLUFF TOE DURING FIELD RECONNAISSANCE

NOTES:

1. THIS FIGURE IS ONLY INTENDED TO SHOW THE CONCEPTUAL SLOPE STABILIZATION MEASURES USING REINFORCED SHOTCRETE AND CRM OR GABION WALL CONSTRUCTION AT TOE
2. REFER TO FIGURE 17 FOR MORE INFORMATION
3. DETAILED SLOPE PROTECTION RECOMMENDATIONS TO BE PROVIDED IN GEOTECHNICAL EXPLORATION REPORT TO BE SUBMITTED UPON COMPLETION OF FIELD EXPLORATION, LAB TESTING, AND DETAILED ANALYSES.

STREAM BANK SLOPE PROTECTION CONCEPT

GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

REFERENCE:
1) Controlpoint Surveying Inc.
Topographic Survey Map
State Doe - Aiea Intermediate School
Erosion Control, DOE Job No. Q71009-07
Aiea, Ewa, Oahu, Hawaii

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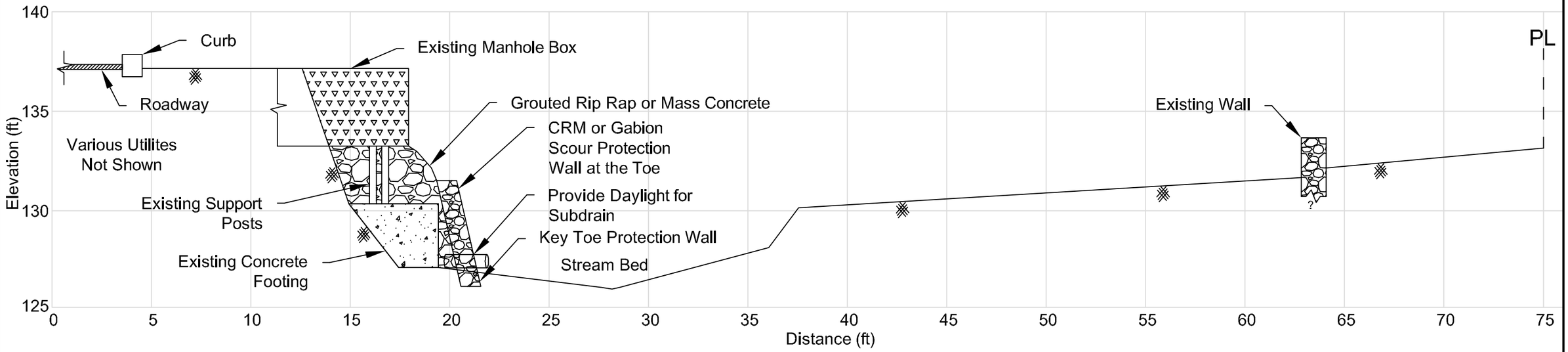
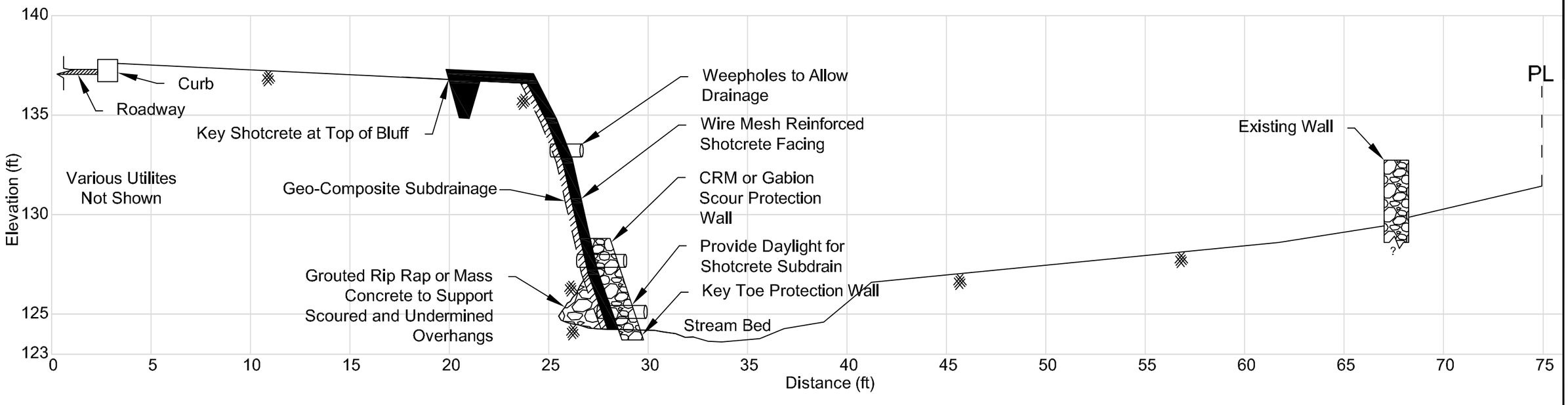
SCALE:
0 10 20 FEET
APPROXIMATE SCALE: 1 INCH = 10 FEET

Yogi Kwong Engineers, LLC

FIGURE 14



Section B: STA 4+41



Section A: STA 4+05

STREAM BANK SLOPE PROTECTION CROSS-SECTIONS
GEOTECHNICAL EXPLORATION AND EVALUATION
STREAM BANK ASSESSMENT AND ROADWAY SUPPORT
Aiea Intermediate School, Aiea, Oahu, Hawaii Project No. 09005

REFERENCE:
1) Refer to Figure 14 for section locations

SCALE:
0 5 10 FEET
APPROXIMATE SCALE: 1 INCH = 5 FEET

Yogi Kwong Engineers, LLC

FIGURE 15

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

APPENDIX A FIELD EXPLORATION

This appendix summarizes the results of field explorations and soil sampling performed by YKE for the stream bank assessment and roadway support design at the Aiea Intermediate School at 99-600 Kulewa Street in Aiea, Hawaii.

The location of the project site and approximate boring locations are shown on Figure 1.

A.1 SLOPE RECONNAISSANCE

YKE performed an initial stream bank reconnaissance on March 10 and 11, 2009. Older Alluvium deposits with an abundance of cobbles and boulders packed in a matrix of grey and brown, gravelly and sandy silt and clay along the exposed vertical stream bank in the vicinity of the electrical manhole box adjacent to the cafeteria building. Photos taken during the slope and site reconnaissance are presented in Appendix C.

A.2 EXPLORATORY BORINGS

Field explorations for the stream bank assessment consisted of a two (2) exploratory borings, B-1 and B-2, that were completed on March 26 and 27, 2009. The approximate locations of the borings are shown on Figure 2.

The borings were drilled by Hawaii test Boring, Inc. using a truck mounted Mobile B-53 drill rig with 4-inch solid-stem continuous flight augers and wash boring methods using casing core barrels and rockbits. The Logs of Borings are presented on Figures A-4 and A-5.

A.3 SOIL SAMPLING

Soil sampling was conducted under the observation of YKE engineering personnel, who logged the materials encountered in each boring, and obtained samples for further examination and laboratory testing.

Relatively undisturbed and disturbed soil samples were obtained using either a Standard Penetration Test (SPT) sampler or a Dames & Moore type “U” sampler. The SPT and Dames & Moore samplers were driven into the ground by successive blows of a 140-pound hammer falling 30 inches. The sampler is typically driven for a total distance of 18 inches, and blow counts for each 6 inches of penetration were recorded. Where the SPT sampler was used, the procedure followed the ASTM D3441 standard for determining the standard penetration resistance of soil. Blow counts for the last 12 inches of an 18 inch penetration are noted on the Log of Borings, unless indicated otherwise.

Cores of basalt cobbles and boulders were obtained using either NX or PQ core barrel. Core recovery and rock quality designations are indicated on the Log of Borings at the appropriate depths.

Soil samples recovered from the field were initially classified according to the American Society of Testing and Materials (ASTM) D-4288 standards and the Unified Soil Classification System, shown on Figure A-1. These classifications were later refined according to ASTM D-2487 based on the results of laboratory tests performed on selected samples. Samples recovered during the field exploration program were transported to our office in Honolulu for further examination and laboratory testing. The borings were backfilled using cuttings, gravel and concrete grout backfill.

SOIL CLASSIFICATION CHART

	Major Divisions		Symbol	Typical Names	Other Criteria
COARSE GRAINED SOILS More than 50% of material larger than No. 200 sieve size	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravel** Little or no fines (<5%)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Cu>4 and 1<=Cc=3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting Cu and Cc criteria for GW
		Gravels with Fines Appreciable amount of fines (>12%)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limit below A-line or PI<4
			GC	Clayey gravels, gravel-sand-silt mixtures	Atterberg limit above A-line with PI>7
	Sands More than 50% of coarse fraction passing No. 4 sieve	**Clean Sands** Little or no fines (<5%)	SW	Well-graded sands, gravelly sands, little or no fines	Cu>6 and 1<=Cc=3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting Cu and Cc criteria for SW
		Sands with Fines Appreciable amount of fines (>12%)	SM	Silty sands, sand-silt mixture	Atterberg limit below A-line or PI<4
			SC	Clayey sands, sand-clay mixture	Atterberg limit above A-line with PI>7
FINE GRAINED SOILS More than 50% of material smaller than No. 200 sieve size	**Silts and Clays** Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Atterberg limit below A-line
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clay	Atterberg limit above A-line
			OL	Organic silts and organic silty clays flow plasticity	Atterberg limit below A-line
	Silts and Clays Liquid limit larger than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Atterberg limit below A-line
			CH	Inorganic clays of high plasticity, fat clays	Atterberg limit above A-line
			OH	Organic clays of high plasticity, organic silts	Atterberg limit below A-line
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils	

Notes: 1. Cu = D60/D10, Cc = (D30)^2/(D60 x D10) where D60, D30 and D10 are diameters associated with 60%, 30% and 10% smaller in gradation curves.
2. Dual symbols are used to indicate borderline classifications such as GP/SP.

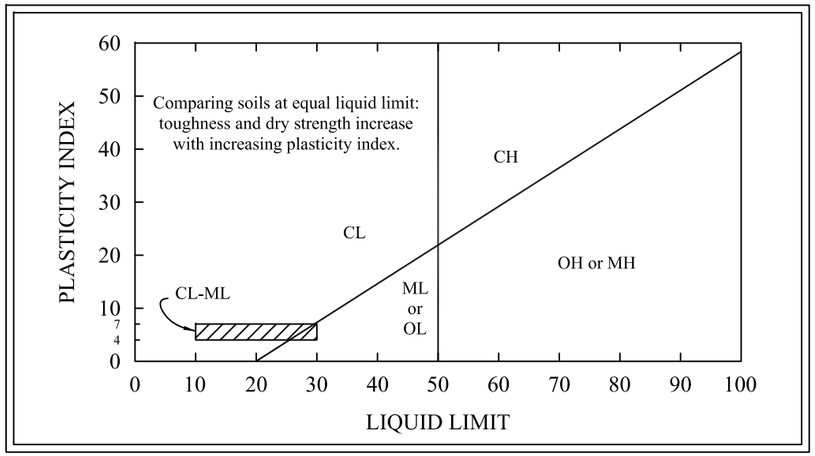
GRADATION CHART

Soil Fraction	Size Range			
	Lower Limit		Upper Limit	
	Millimeters	Sieve	Millimeters	Sieve
Boulders	304.8	12*	914.4	36*
Cobbles	76.2	3*	304.8	12*
Gravel				
Coarse	2	10**	4.76	4**
Medium	0.42	40**	2	10**
Fine	0.074	200**	0.42	40**
Fines			0.074	200**

* U.S. standard sieve opening in inches

** U.S. standard sieve number

PLASTICITY CHART



UNIFIED SOIL CLASSIFICATION

Geotechnical Exploration and Evaluation
Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

YOGI KWONG ENGINEERS, LLC
PROJECT NO. 09005

FIGURE A-1

DESCRIPTION OF ROCK MATERIALS

A. DEGREE OF WEATHERING

The following terms were used to describe the chemical weathering of rock:

Extremely Weathered: The original minerals of the rock have been almost entirely altered to secondary minerals, even though the original fabric may be intact.

Highly Weathered: The rock is weakened to such an extent that a 2-inch diameter core can be broken readily by hand across the rock fabric.

Moderately Weathered: Rock is discolored and noticeably weakened, but a 2-inch diameter core cannot usually be broken by hand, across the rock fabric.

Slightly Weathered: Rock is slightly discolored, but not noticeably lower in strength than fresh rock.

Unweathered: Rock shows no discoloration, loss of strength, or any other effect of weathering.

B. HARDNESS

The following terms were used to describe the hardness of rock and soil:

Soft: Reserved for plastic material.

Friable: Easily crumbled, pulverized, or reduced to powder.

Low Hardness: Can be gouged deeply or carved with pocket knife.

Moderately Hard: Can be readily scratched by a knife blade; scratch leaves heavy trace of dust and scratch is readily visible after the powder has been blown away.

Hard: Can be scratched with difficulty, scratch produces little powder and is often faintly visible.

Very Hard: Cannot be scratched with pocket knife.

C. ROCK FRACTURE CHARACTERISTICS

The general fracture spacing is described in the boring log according to the following criteria:

Crushed: Less than 5 microns (mechanical clay) to 0.1 foot.

Intensely Fractured: 0.05 to 0.1 foot (contain no clay).

Closely Fractured: 0.1 to 0.5 feet.

Moderately Fractured: 1.0 to 3.0 feet.

Very Widely Fractured: Over 3 feet.

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL

LOG OF BORING KEY

LOCATION: 99-600 KULAWEA STREET, AIEA, OAHU, HAWAII
DATE(S) DRILLED:
GROUND SURFACE ELEVATION:
LOGGED BY:
CHECKED BY:
GROUNDWATER LEVEL / DATE:
HAMMER TYPE:
HAMMER WEIGHT/DROP:
CONTRACTOR:
DRILLING METHOD:
DRILL EQUIP:
BOREHOLE BACKFILL:

DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTANCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psi	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
0							STRATA SYMBOLS						
							Concrete						
							Asphalt						
5							Well Graded Gravel (GW)						
							Silty Sand (SM)						
							Clayey Gravel (GC)						
							Clayey Sand (SC)						
10							Cobbles and/or Boulders						
							SAMPLER SYMBOLS						
15							Dames and Moore (D&M) sampler						
							Standard Penetration Test (SPT) sampler						
							Core Sample (PQ or NX core as indicated)						
20			10				Number of blows to advance sampler 12 inches or distance indicated						
							ABBREVIATIONS FOR TESTS						
25							PP = Pocket Penetrometer test, tsf TV = Torvane test, tsf DS = Direct Shear test (See Appendix) SIEVE = Grain Size Distribution test (See Appendix B) SWELL = Expansion Potential test (See Appendix B)						CWR = Core Water Returns
30													

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FIGURE A-3

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL

LOG OF BORING B-1

Sheet 1 of 1

LOCATION: 99-600 KULAWEA STREET, AIEA, OAHU, HAWAII
DATE(S) DRILLED: 3-26-09 - 3-27-09
GROUND SURFACE ELEVATION: N/A
LOGGED BY: K. SANDEFUR, E. NG
CHECKED BY: JK
GROUNDWATER LEVEL / DATE:
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 lb./30-inch
CONTRACTOR: HAWAII TEST BORING, INC.
DRILLING METHOD: 4-INCH S.S.A., ROCK BIT, WASH BORING
DRILL EQUIP: MOBILE DRILL B-53
BOREHOLE BACKFILL: CUTTINGS, GRAVEL, ROCK BIT,CEMENT GROUT

DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTANCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psi	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
0							Concrete pavement (6.5 inch)						
							FILL Grey well graded angular gravel (GW), moist						
		1	50-2"	100				12.8	93.6		45	22	DS, SIEVE
		2	100-5"	100			OLDER ALLUVIUM (Conglomerate) Basaltic cobbles and boulders in light brown with grey and black clayey sand to clayey gravel matrix, (SC to GC) very dense, moist	16.2					
		NX1		48	0		contains hard basalt cobbles						
5			20-0"										
		NX2		50	17		cobbles and boulders						TV = 1.1 TSF
							grades to light grey, brown with less sand and more gravel layers	35.3 37.6					PP = 3.15 TSF
		3	98-11" 15-0"	53				31.9	94.2		83	54	DS, SIEVE PP = 2.95 TSF
10							grades to hard basaltic cobbles and boulders						Sampler Refusal
		NX3		79	32		cobbles and boulders			13,757			
		4	88	100			soil matrix grades with less gravel and more sand and fines	32.4			66	38	SIEVE TV = 0.98 TSF PP = 4.3 TSF
15							large cobble or boulder						Rock bit grinding and slow advance
							grades to primarily soil matrix						faster advance and less grinding
							large cobble or boulder						grinding and slow advance Sampler refusal at 20 ft.
20													
		NX4		56	0		contain more gravel and less sand cobbles	31.9			64	34	SIEVE
			100-2"	100			slightly weathered, hard basalt cobbles and boulders						Sampler refusal Resume drilling on 3/27/09
25		NX5		79	0								grayish brown water return slow core advance use rock bit
		NX6		92	92		gray, slightly weathered, hard basalt boulder			13,300			rock bit refusal grayish brown CWR SPT refusal at 29 ft
30							End of boring @ 29.0 feet below existing ground surface on March 27, 2009						

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FIGURE A-4

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL

LOG OF BORING B-2

Sheet 1 of 1

LOCATION: 99-600 KULAWEA STREET, AIEA, OAHU, HAWAII
DATE(S) DRILLED: 3-27-09
GROUND SURFACE ELEVATION: 139.08 FEET (MSL)
LOGGED BY: E. NG
CHECKED BY: JK
GROUNDWATER LEVEL / DATE:
HAMMER TYPE: SAFETY
HAMMER WEIGHT/DROP: 140 lb./30-inch
CONTRACTOR: HAWAII TEST BORING, INC.
DRILLING METHOD: 4-INCH S.S.A., ROCK BIT, WASH BORING
DRILL EQUIP: MOBILE DRILL B-53
BOREHOLE BACKFILL: CUTTINGS, GRAVEL, ROCK BIT, CEMENT GROUT

DEPTH (FT)	SAMPLE TYPE	SAMPLE NO.	SAMPLING RESISTANCE	RECOVERY, %	RQD, %	GRAPHIC LOG	DESCRIPTION	WATER CONTENT, %	DRY UNIT WEIGHT, pcf	UCS, psi	LIQUID LIMIT	PLASTICITY INDEX	OTHER TESTS AND REMARKS
0							Asphalt Concrete Pavement (7-inches)						
							FILL Brown silty sand with gravel and cobbles (SM), dense, moist	14.0					sampler refusal
		1	100-3"	100									
		2	30-0"	100			OLDER ALLUVIUM (conglomerate) Basaltic cobbles and boulders with light brown clayey sand with gravel matrix (SC), very dense, moist	31.3			54	25	SIEVE sampler refusal
		3	50-2"	100				31.0	88.4				SWELL sampler refusal
5							slightly weathered hard basalt cobbles and boulders			10,158			auger grinding
		PQ1		77	65								grayish brown water return
							cobbles and boulders			3,907			sampler bouncing and refusal
10		PQ2		100	67		cobbles and boulders						grayish brown water return
													PP = 2.75 TSF
		4	92-10"	100				28.2			77	52	SIEVE
							cobbles and boulders						50 blows per final 4 inches
15		NX3		97	18								sampler refusal rock bit to 14 ft. grayish brown water return
							Boring terminated at 16.7 feet below existing ground surface on March 27, 2009.						
20													
25													
30													

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FIGURE A-5

APPENDIX B LABORATORY TESTING

To verify field soil sample descriptions and classifications, selected soil samples obtained during the field exploration were laboratory tested for moisture content, grain size distribution by washed sieve analyses, plasticity index, expansion potential and unconfined compressive and direct shear strength tests. The tests and results are described in the following paragraphs.

B.1 MOISTURE CONTENT AND DRY DENSITY

Selected soil samples were tested to measure their moisture contents and dry densities. The tests were performed in accordance with American Society for Testing and Materials (ASTM) Method D2216. Results of the moisture contents and dry densities are presented on the Log of Borings at the appropriate sample depths.

B.2 GRAIN SIZE DISTRIBUTION

Gradation analyses were performed on selected samples using the washed sieve method to evaluate grain size distribution. Gradation analysis tests were performed in accordance with ASTM D422 (3/4-inch through -#200 sieve). Results of sieve tests are presented on Figures B-1 and B-2.

B.3 ATTERBERG LIMITS (PLASTICITY INDEX)

To assist in classifying the soils, Plasticity Index tests were performed on selected samples. These tests were performed in accordance with ASTM D4318. The results are presented on Figure B-3, and are also indicated on the Log of Borings.

B.4 UNCONFINED COMPRESSION STRENGTH

Rock core samples were tested under unconfined compression (UC) conditions according to ASTM D2938 to evaluate compressive strength. The unconfined compressive strengths of the selected rock cores are included on the Log of Borings and summarized in Table B-1 below.

Table B-1
Unconfined Compression Strength Test Results

Boring	Depth[1] (feet)	UCS (psi)
B-1	12	13,757
B-1	28.5	13,300
B-2	5.5	10,158
B-2	8.5	3,907

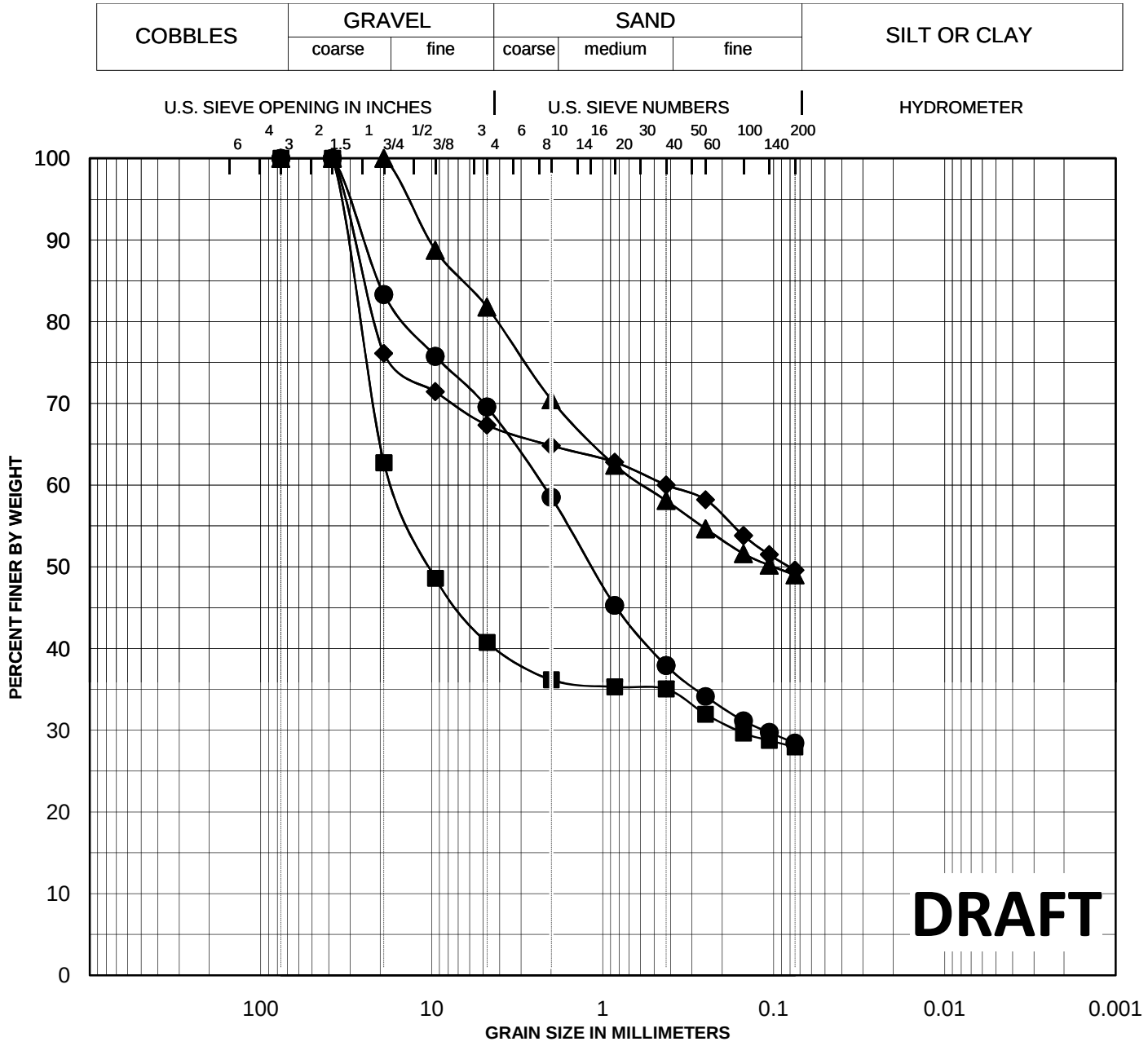
[1] Below ground surface

B.5 DIRECT SHEAR

The Direct Shear test was performed to determine the consolidated drained shear strength of a soil material in direct shear. The test was performed by deforming a specimen at a controlled strain rate on or near a single shear plane determined by the configuration of the apparatus. Three specimens are tested for each sampled depth, each under a different normal load, to determine the effects upon shear resistance and displacement, and strength properties such as Mohr strength envelopes. These tests were performed in accordance with ASTM D3080. The results are presented in Figures B-4 and B-5.

B.6 ONE DIMENSIONAL SWELL POTENTIAL

A one-dimensional swell potential test was performed on a relatively undisturbed cohesive soil sample obtained during exploration. The test was performed in general accordance with ASTM D4546 Method B. The relatively undisturbed sample was tested in thin-walled brass rings measuring 2.5-inch in diameter by 1-inch in height. The soil was tested at in-situ dry-density and was allowed to air dry prior to saturation in water and the amount of swell was measured until the time rate of swell slows. The test results are presented in Figure B-6.



Location		Depth (ft)	Description	LL %	PI %	Gravel %	Sand %	Fines %
●	B-1	2.0	Clayey sand with gravel (SC)	45	22	30.4	41.1	28.4
■	B-1	10.0	Clayey gravel (GC)	83	54	59.2	12.8	27.9
▲	B-1	15.0	Clayey sand with gravel (SC)	66	38	18.2	32.8	49.0
◆	B-1	22.0	Clayey gravel with sand (GC)	64	34	32.7	17.8	49.6

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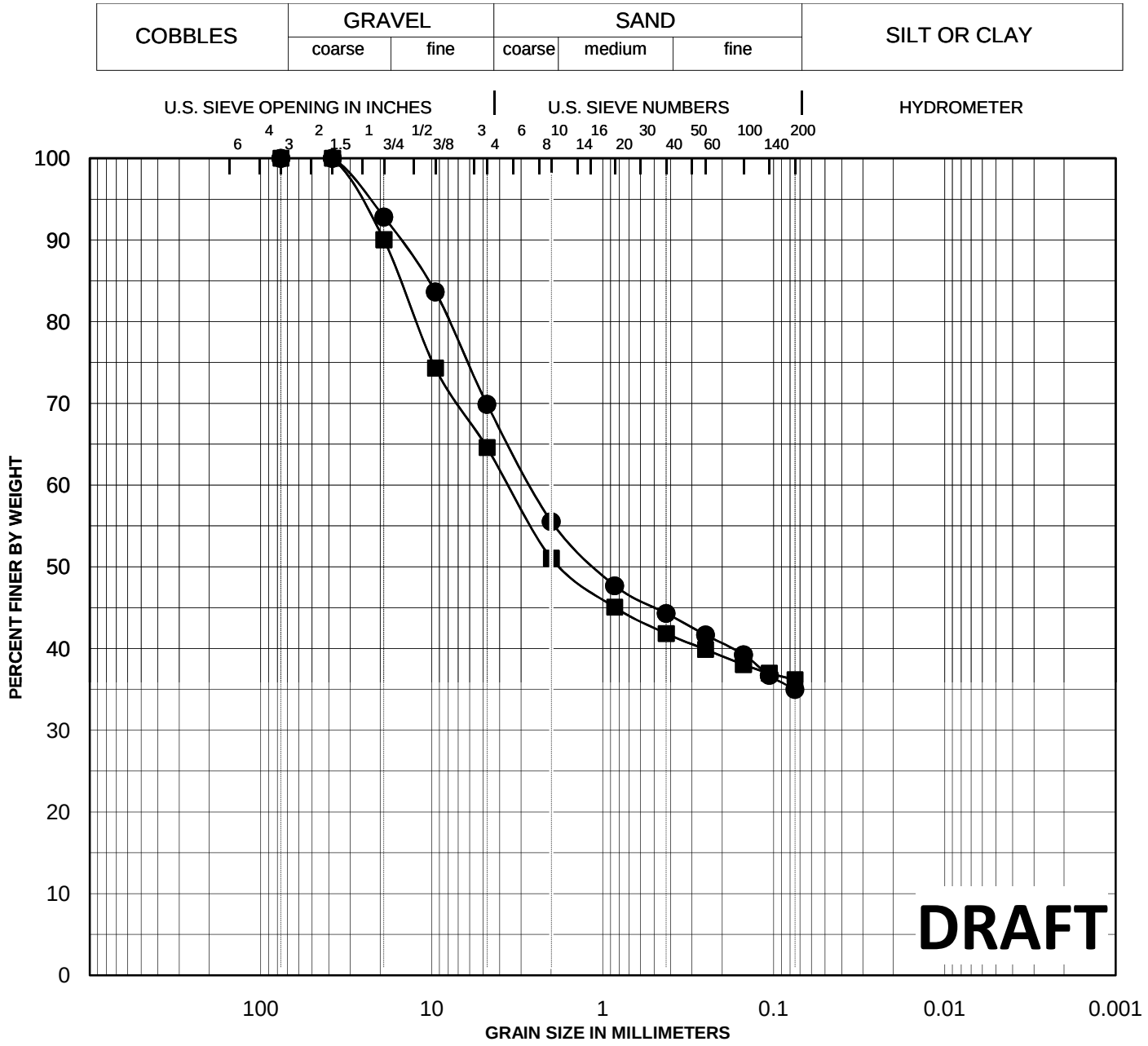
GRAIN SIZE DISTRIBUTION

FIGURE B-1



Location		Depth (ft)	Description	LL %	PI %	Gravel %	Sand %	Fines %
●	B-2	2.5	Clayey sand with gravel (SC)	54	25	30.1	34.9	35.0
■	B-2	12.0	Clayey gravel with sand (GC)	77	52	35.4	28.4	36.2
▲			N/A					
◆			N/A					

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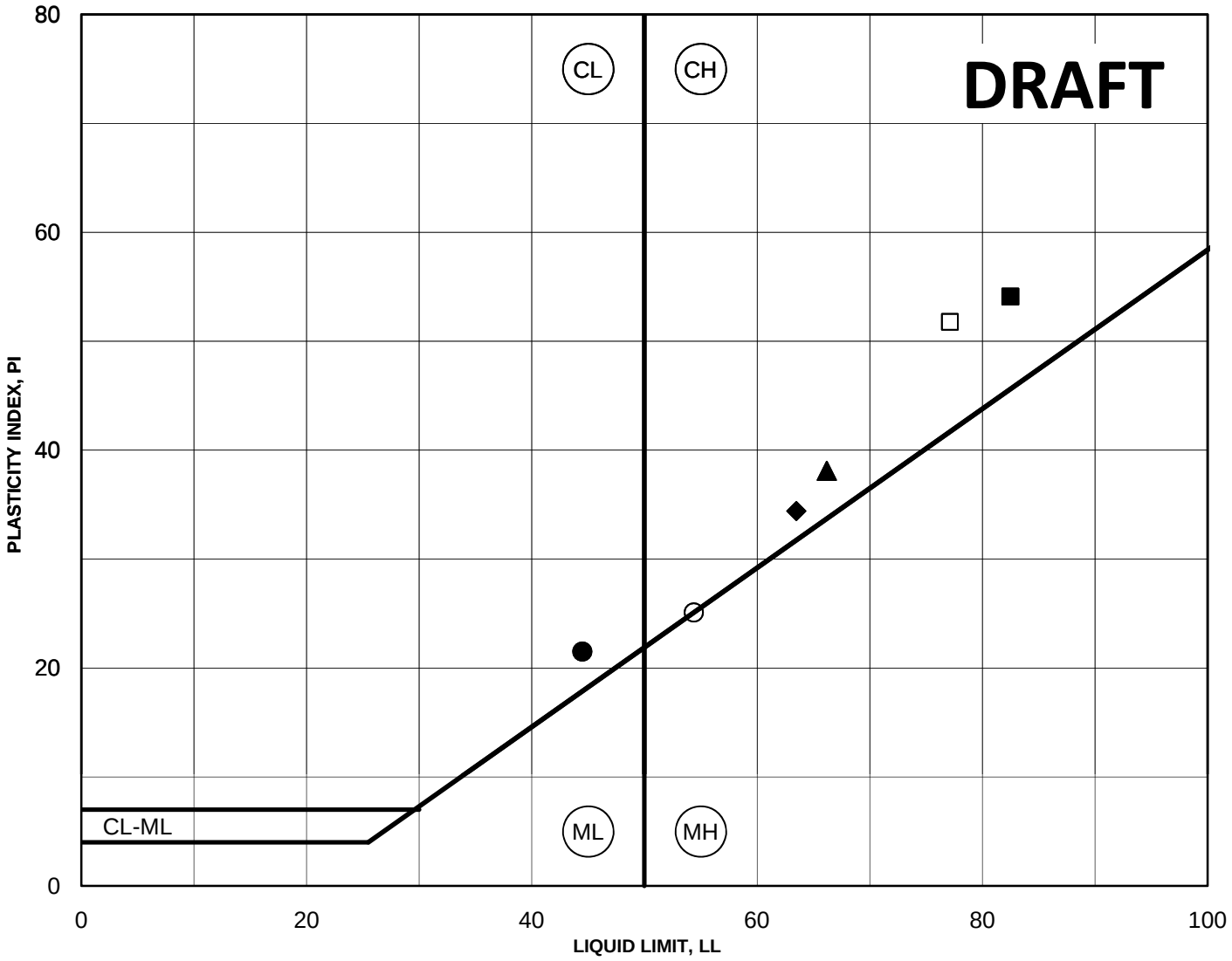
GRAIN SIZE DISTRIBUTION

FIGURE B-2



Boring		Depth (ft)	LL %	PL %	PI %	Classification
●	B-1	2.0	45	23	22	Lean Clay (CL)
■	B-1	10.0	83	28	54	Fat Clay (CH)
▲	B-1	15.0	66	28	38	Fat Clay (CH)
◆	B-1	22.0	64	29	34	Fat Clay (CH)
○	B-2	2.5	54	29	25	Fat Clay (CH)
□	B-2	12.0	77	25	52	Fat Clay (CH)

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PLASTICITY CHART

FIGURE B-3

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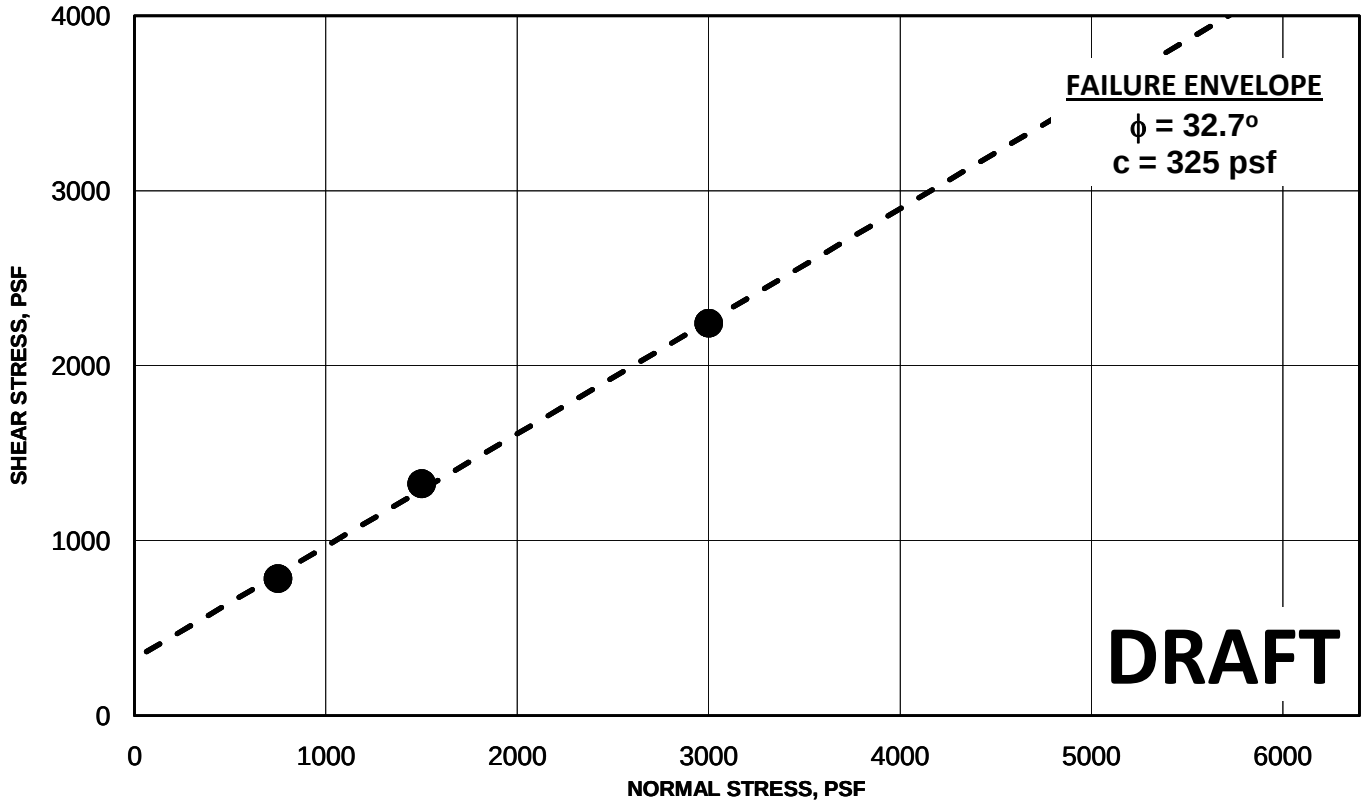

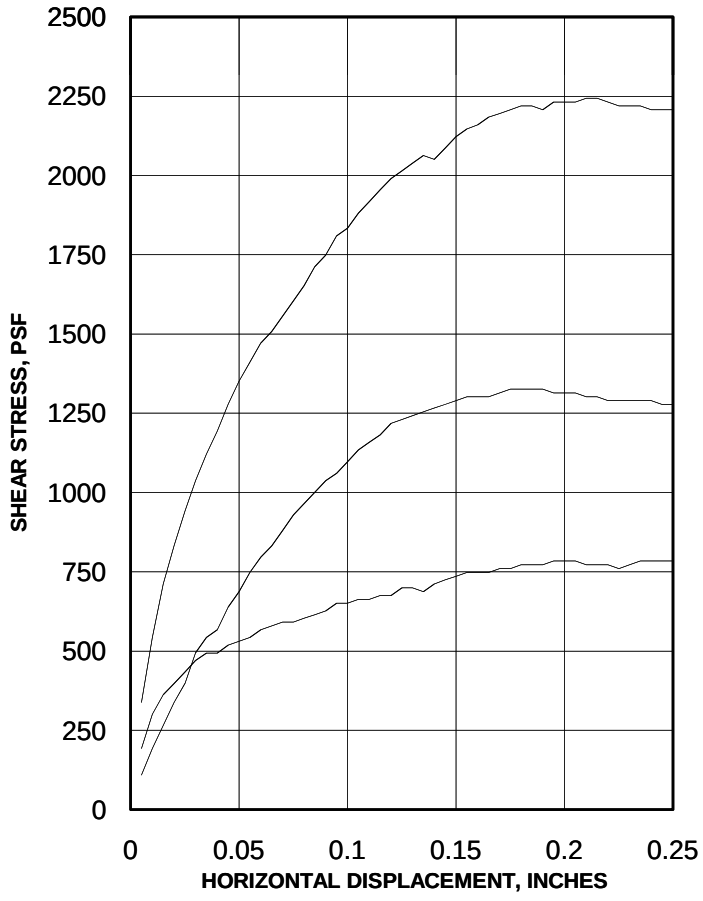

Boring		B-1	Depth	2
Description		**OLDER ALLUVIUM**: Brown and grey clayey sand with gravel (SC) LL=45%, PI=22% Gravel=31%, Sand=41%, Fines=28%		
Sample No.		1	2	3
Initial	Water Content, %	18.1	8.4	11.9
	Dry Density, pcf	85.0	99.0	96.7
	Diameter, inches	2.41	2.41	2.41
	Height, inches	1.0	1.0	1.0
Final	Water Content, %	25.5	15.2	23.1
	Dry Density, pcf	104.2	115.3	100.3
	Diameter, inches	2.41	2.41	2.41
	Height, inches	0.816	0.859	0.964
Strain Rate, in./minute		0.0086	0.0086	0.0086
Normal Stress, psf		**3000**	**1500**	**750**
Peak Stress, psf		**2243**	**1326**	**784**
Displacement, in.		0.210	0.175	0.195
Ultimate Stress, psf		**2207**	**1278**	**784**
Displacement, in.		0.250	0.250	0.250

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DIRECT SHEAR TEST

FIGURE B-4

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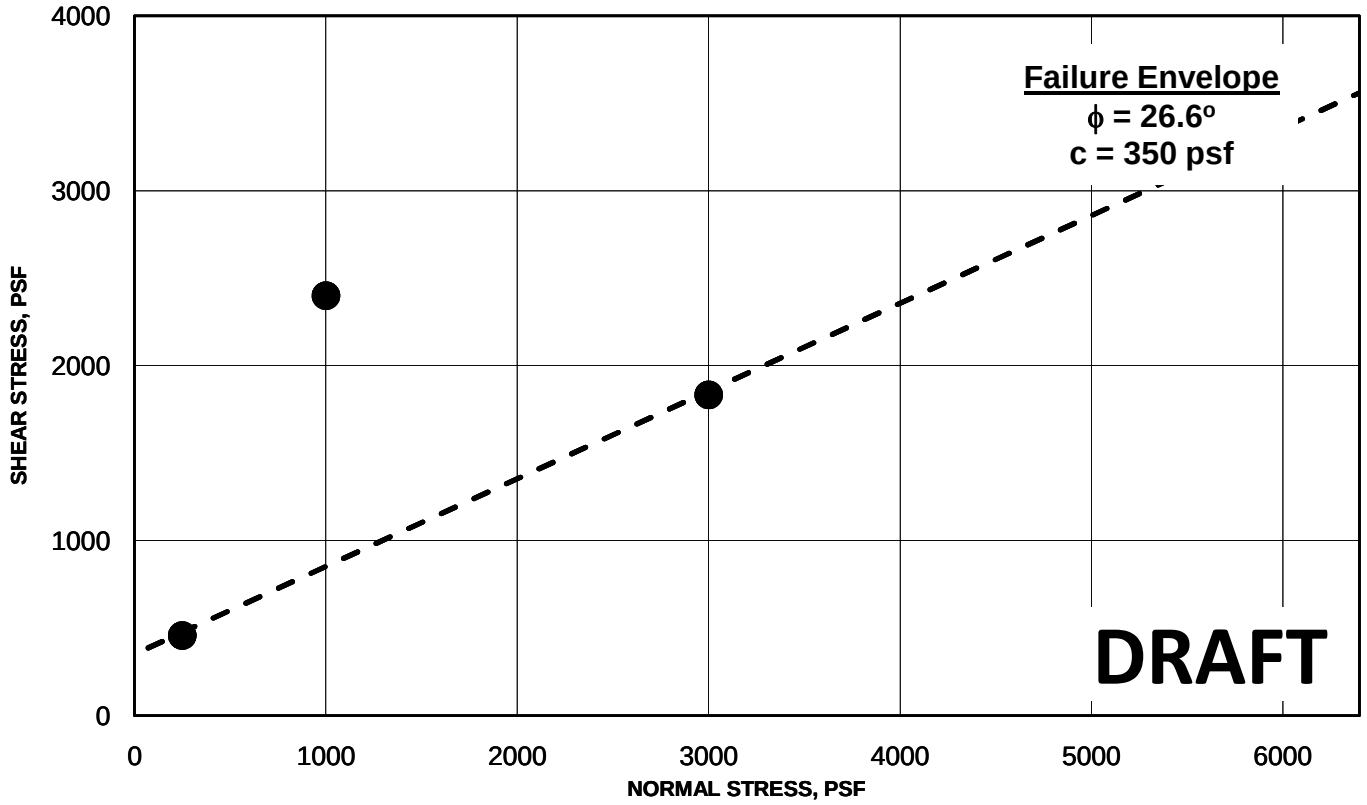

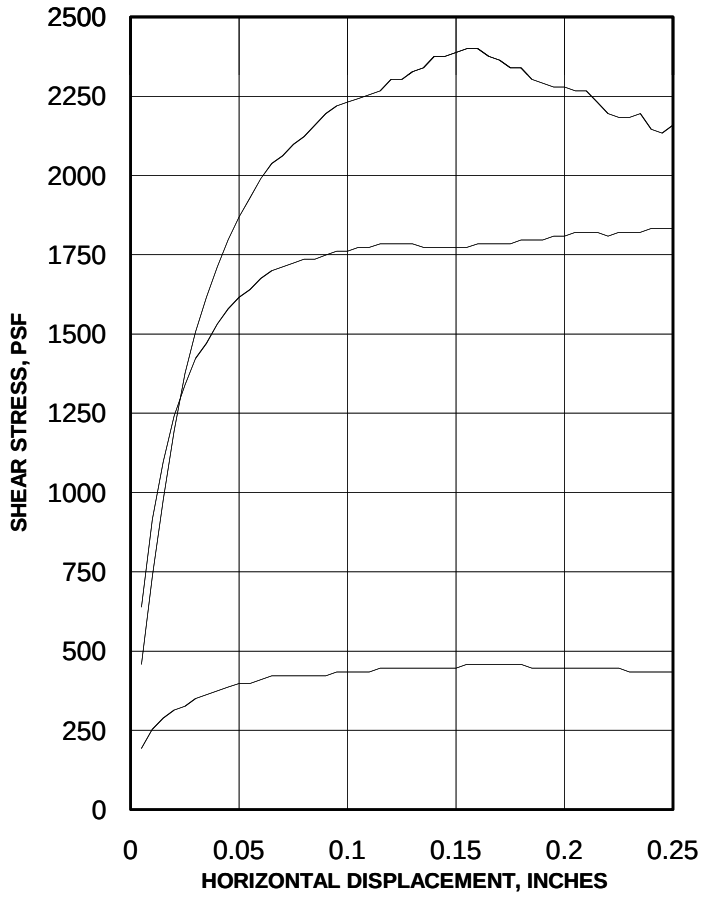

Boring	B-1	Depth	10
Description	**OLDER ALLUVIUM**: Light brown and grey clayey gravel (GC) LL=83%, PI=54% Gravel=59%, Sand=13%, Fines=28%		

Sample No.		1	2	3
Initial	Water Content, %	35.4	23.8	36.3
	Dry Density, pcf	92.2	102.7	87.8
	Diameter, inches	2.41	2.41	2.41
	Height, inches	1.0	1.0	1.0
Final	Water Content, %	37.0	26.6	39.4
	Dry Density, pcf	95.7	103.7	87.9
	Diameter, inches	2.41	2.41	2.41
	Height, inches	0.963	0.991	0.999
Strain Rate, in./minute		0.002	0.002	0.002
Normal Stress, psf		**3000**	**1000**	**250**
Peak Stress, psf		**1833**	**2400**	**458**
Displacement, in.		0.240	0.155	0.155
Ultimate Stress, psf		**1833**	**2159**	**434**
Displacement, in.		0.250	0.250	0.250

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DIRECT SHEAR TEST

FIGURE B-5

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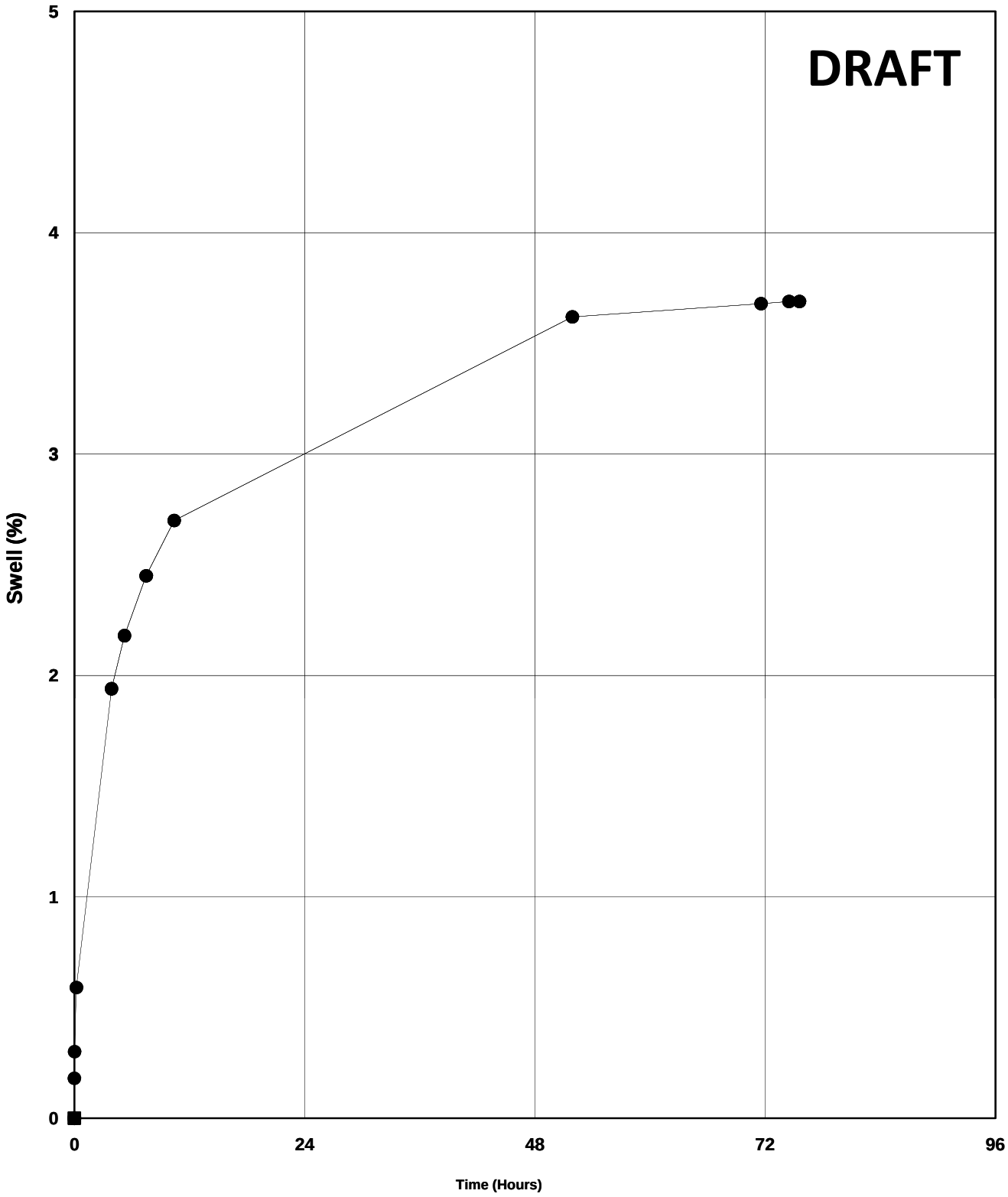

Sample Information				Initial		Air Dry	Soaked	TEST RESULTS			
	Location	Depth (ft, bgs)	Description	Dry Density	Water Content (%)	Water Content	Water Content (%)	Surface Load	Shrinkage	Swell	
●	B-2	4.0	Fat Clay	88.4	31%	27%	41%	100 psf	**0.7%**	**3.7%**	

Project: Stream Bank Assessment and Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

Project Number: 09005

ONE-DIMENSIONAL SWELL POTENTIAL

FIGURE B-6

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APPENDIX C

PHOTOGRAPHS OF SLOPE AND SITE RECONNAISSANCE

Boulder Dislodged from Stream Bank

Exposed Cobbles and Boulders in Grey Clay Matrix

Exposed Cobbles and Boulders in Grey Clay Matrix

Exposed Cobbles and Boulders in Grey Clay Matrix

STREAM BANK RECONNAISSANCE (STA 3+50 to STA 4+50)

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

APPENDIX C-1

Exposed Cobbles and Boulders in Grey Clay Matrix

Exposed Cobbles and Boulders in Grey Clay Matrix

Exposed Cobbles and Boulders in Grey Clay Matrix

Scour at the Base of the Stream Bank

STREAM BANK RECONNAISSANCE (STA 3+50 to STA 4+50)

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

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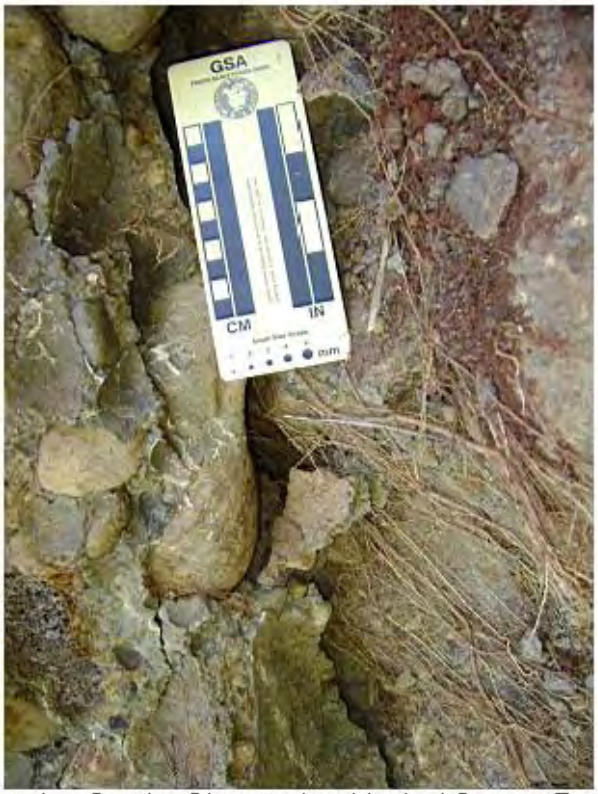
APPENDIX C-2

Scour at the Base of the Stream Bank

Sloughing Failure

Storm Drain Discharge Downstream of Electrical Box



Tension Cracks Observed on Vertical Stream Bank

Tension Cracks Observed on Vertical Stream Bank

Tension Cracks Observed on Vertical Stream Bank

Undermined Electrical Box and Vertical Stream Bank Downstream

Undermined Electrical Box Supported on Footing

STREAM BANK RECONNAISSANCE (STA 3+50 to STA 4+50)

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

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APPENDIX C-4

Vertical Stream Bank with Exposed Cobbles and Boulders in Grey Clay Matrix

Vertical Stream Bank with Exposed Cobbles and Boulders in Grey Clay Matrix

Vertical Stream Bank with Exposed Cobbles and Boulders in Grey Clay Matrix

Vertical Stream Bank with Exposed Cobbles and Boulders in Grey Clay Matrix

STREAM BANK RECONNAISSANCE (STA 3+50 to STA 4+50)

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

APPENDIX C-5

APPENDIX D

PHOTOGRAPHS OF SELECT SOIL SAMPLES

Boring B-1, Depth 2.5', Sample #1

Boring B-1, Depth 3', Sample #2

Boring B-1, Depth 3' to 5', Sample # NX-1


Boring B-1, Depth 5' to 9', Sample # NX-2

Boring B-1, Depth 5' to 9', Sample # NX-2

Boring B-1, Depth 5' to 9', Sample # NX-2

BORING B-1 PHOTOGRAPHS

Stream Bank Assessment & Roadway Support

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Boring B-1, Depth 5' to 9', Sample # NX-2

Boring B-1, Depth 9' to 10.4', Sample #3

Boring B-1, Depth 10.4' to 14', Sample # NX-3

Boring B-1, Depth 10.4' to 14', Sample # NX-3

Boring B-1, Depth 10.4' to 14', Sample # NX-3

Boring B-1, Depth 14' to 15.5', Sample #4

BORING B-1 PHOTOGRAPHS

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

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Yogi Kwong Engineers LLC

APPENDIX D-2

Boring B-1, Depth 19' to 24', Sample # NX-4

Boring B-1, Depth 19' to 24', Sample # NX-4

Boring B-1, Depth 19' to 24', Sample # NX-4

Boring B-1, Depth 19' to 24', Sample # NX-4

Boring B-1, Depth 24' to 26.8', Sample # NX-5

Boring B-1, Depth 24' to 29', Sample # NX-5 and NX-6

BORING B-1 PHOTOGRAPHS

Stream Bank Assessment & Roadway Support

Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers LLC

APPENDIX D-3

Boring B-2, Depth 2', Sample #1

Boring B-2, Depth 2.5' to 3.5', Sample #2

Boring B-2, Depth 2.5' to 3.5', Sample #2

Boring B-2, Depth 3.5', Sample #3

Boring B-2, Depth 4' to 9', Sample #PQ-1

Boring B-2, Depth 4' to 9', Sample #PQ-1

BORING B-2 PHOTOGRAPHS

Stream Bank Assessment & Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

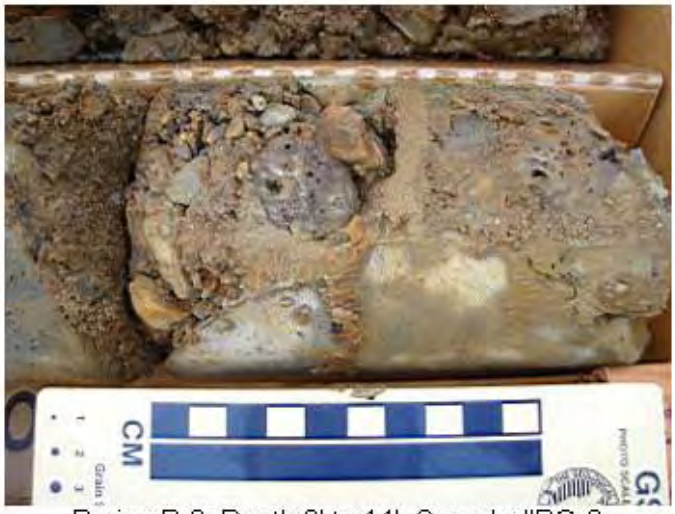
Project No. 09005

Yogi Kwong Engineers LLC

APPENDIX D-4

Boring B-2, Depth 12' to 13', Sample #4

Boring B-2, Depth 9' to 14', Sample #PQ-2


Boring B-2, Depth 9' to 14', Sample #PQ-2

Boring B-2, Depth 14' to 16'8", Sample #NX-3

Boring B-2, Depth 14' to 16'8", Sample #NX-3

Boring B-2, Depth 14' to 16'8", Sample #NX-3

BORING B-2 PHOTOGRAPHS

Stream Bank Assessment & Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers LLC

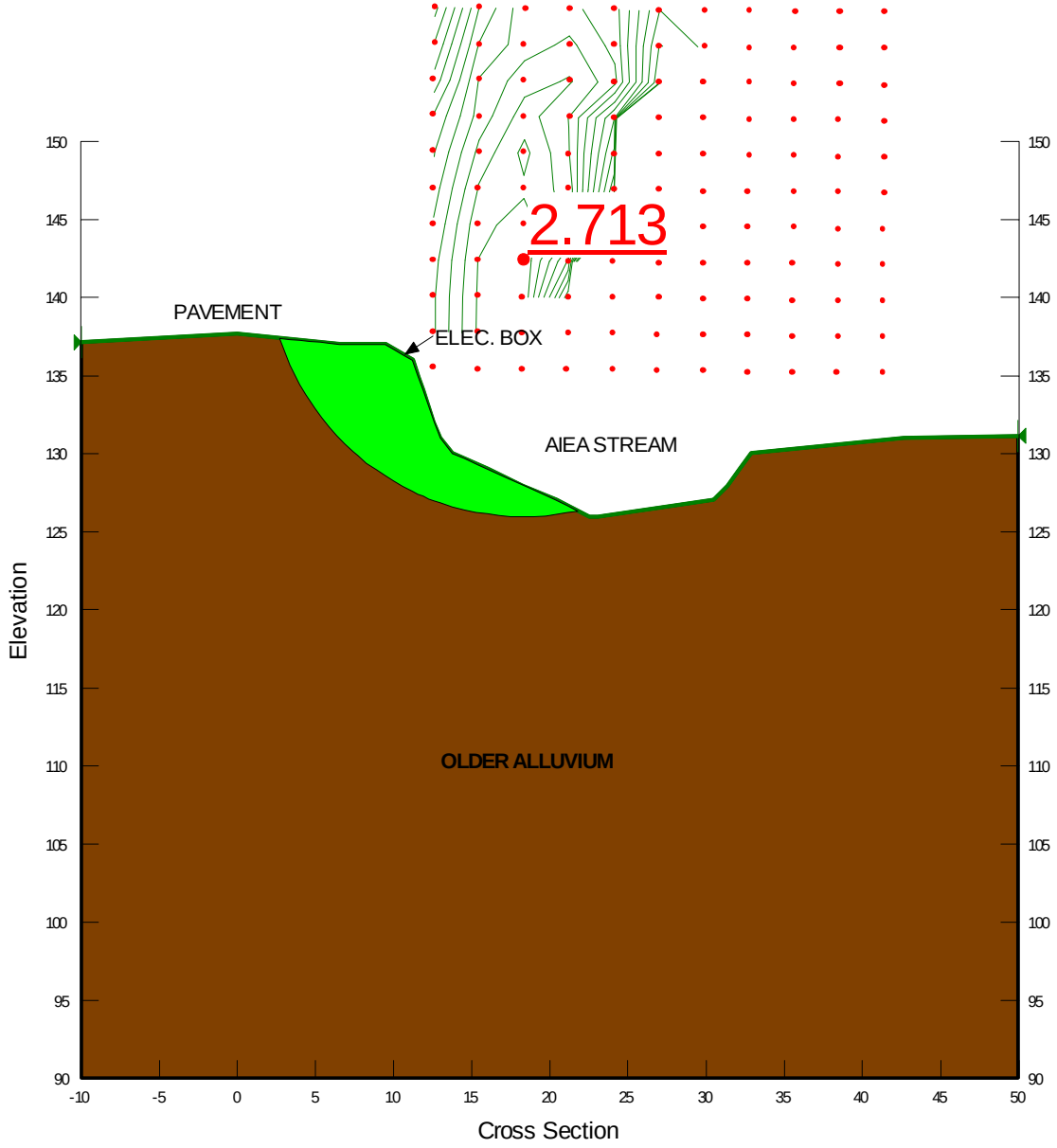
APPENDIX D-5

APPENDIX E

SLOPE STABILITY ANALYSES

OLDER ALLUVIUM
Unit Weight = 125 pcf
Cohesion = 350 psf
Phi = 26.6 degrees

SEISMIC LOADING:
Horizontal = 0g
Vertical = 0g



SLOPE STABILITY ANALYSIS: EFFECTIVE STRENGTH – STATIC & UNSATURATED CONDITION

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

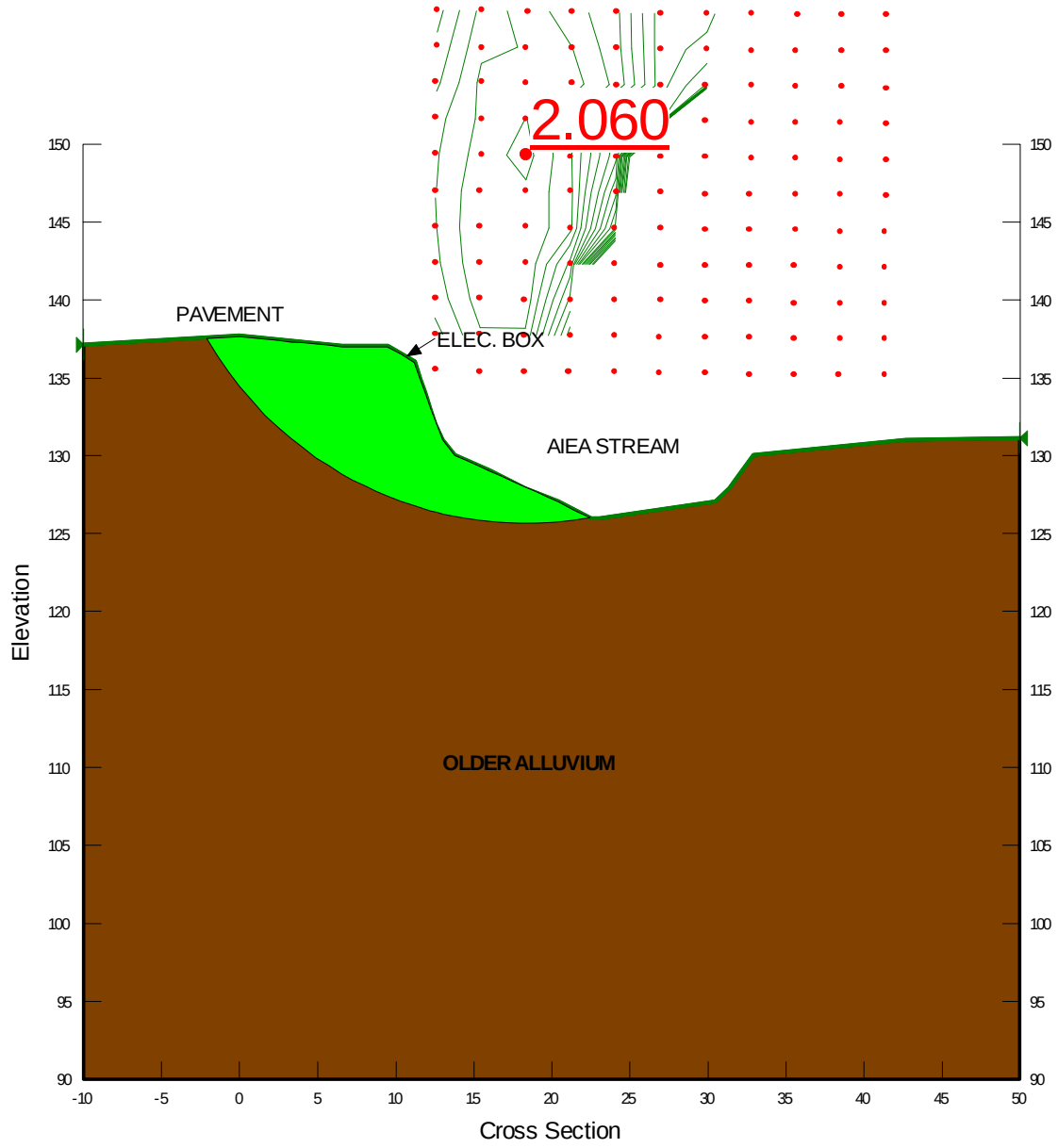
Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-1

OLDER ALLUVIUM
Unit Weight = 125 pcf
Cohesion = 350 psf
Phi = 26.6 degrees

SEISMIC LOADING:
Horizontal = 0.15g
Vertical = 0.1g



SLOPE STABILITY ANALYSIS: EFFECTIVE STRENGTH – UNSATURATED CONDITIONS WITH PSEUDOSTATIC SEISMIC LOADING

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

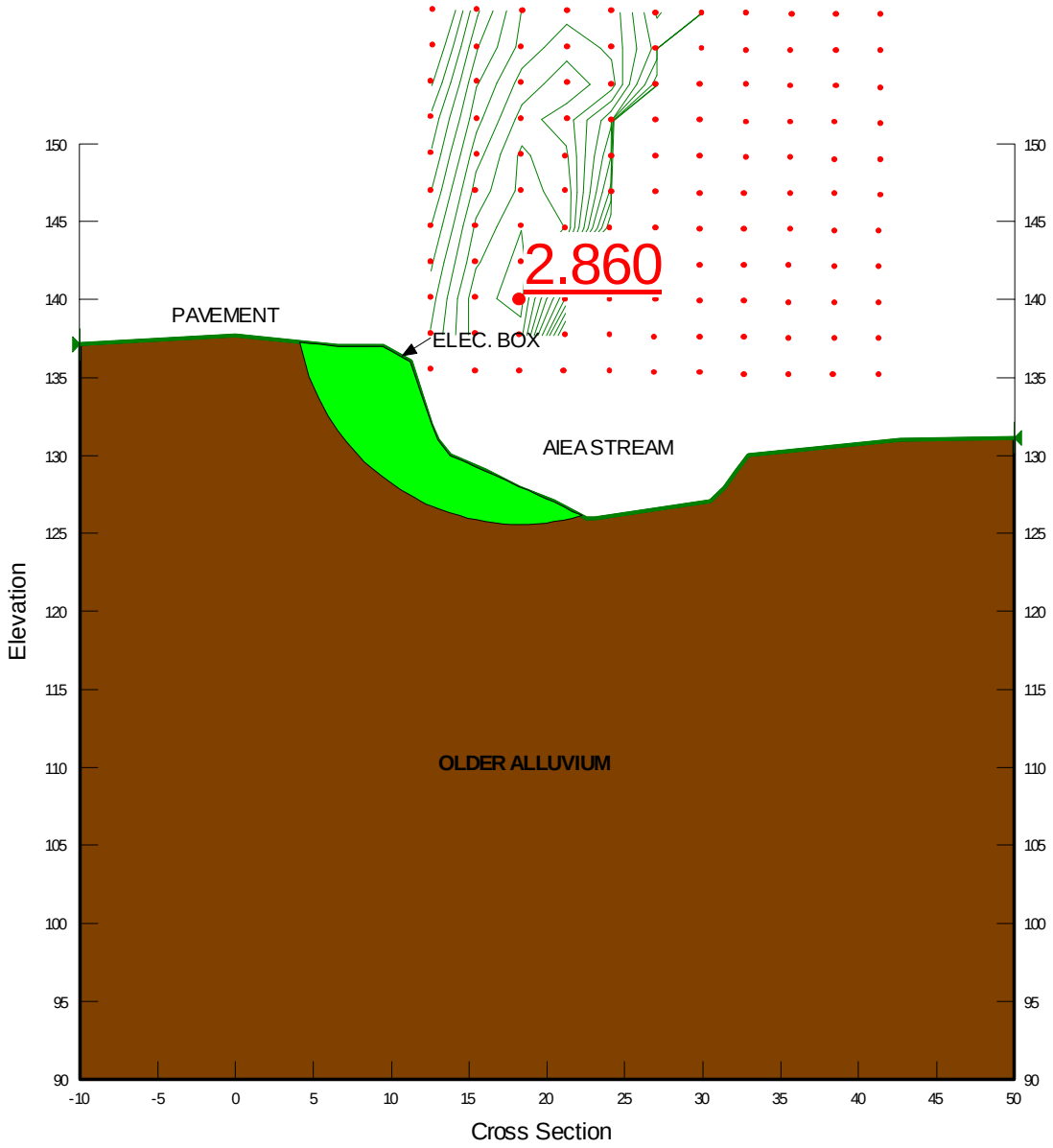
Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-2

OLDER ALLUVIUM
Unit Weight = 125 pcf
Cohesion = 325 psf
Phi = 32.7 degrees

SEISMIC LOADING:
Horizontal = 0g
Vertical = 0g



SLOPE STABILITY ANALYSIS: EFFECTIVE STRENGTH – STATIC & UNSATURATED CONDITION

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

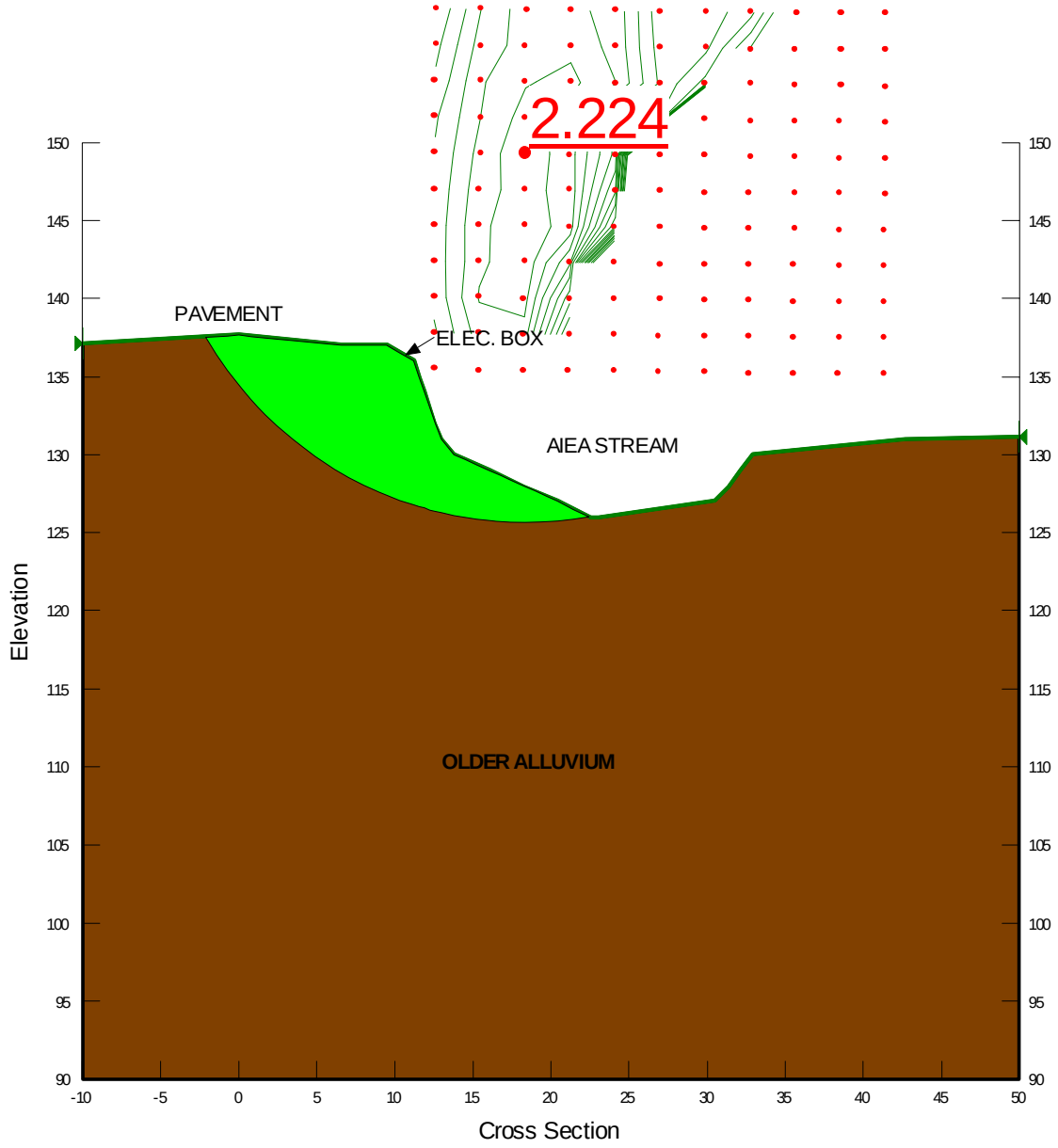
Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-3

OLDER ALLUVIUM
Unit Weight = 125 pcf
Cohesion = 325 psf
Phi = 32.7 degrees

SEISMIC LOADING:
Horizontal = 0.15g
Vertical = 0.1g



SLOPE STABILITY ANALYSIS: EFFECTIVE STRENGTH – UNSATURATED CONDITIONS WITH PSEUDOSTATIC SEISMIC LOADING

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

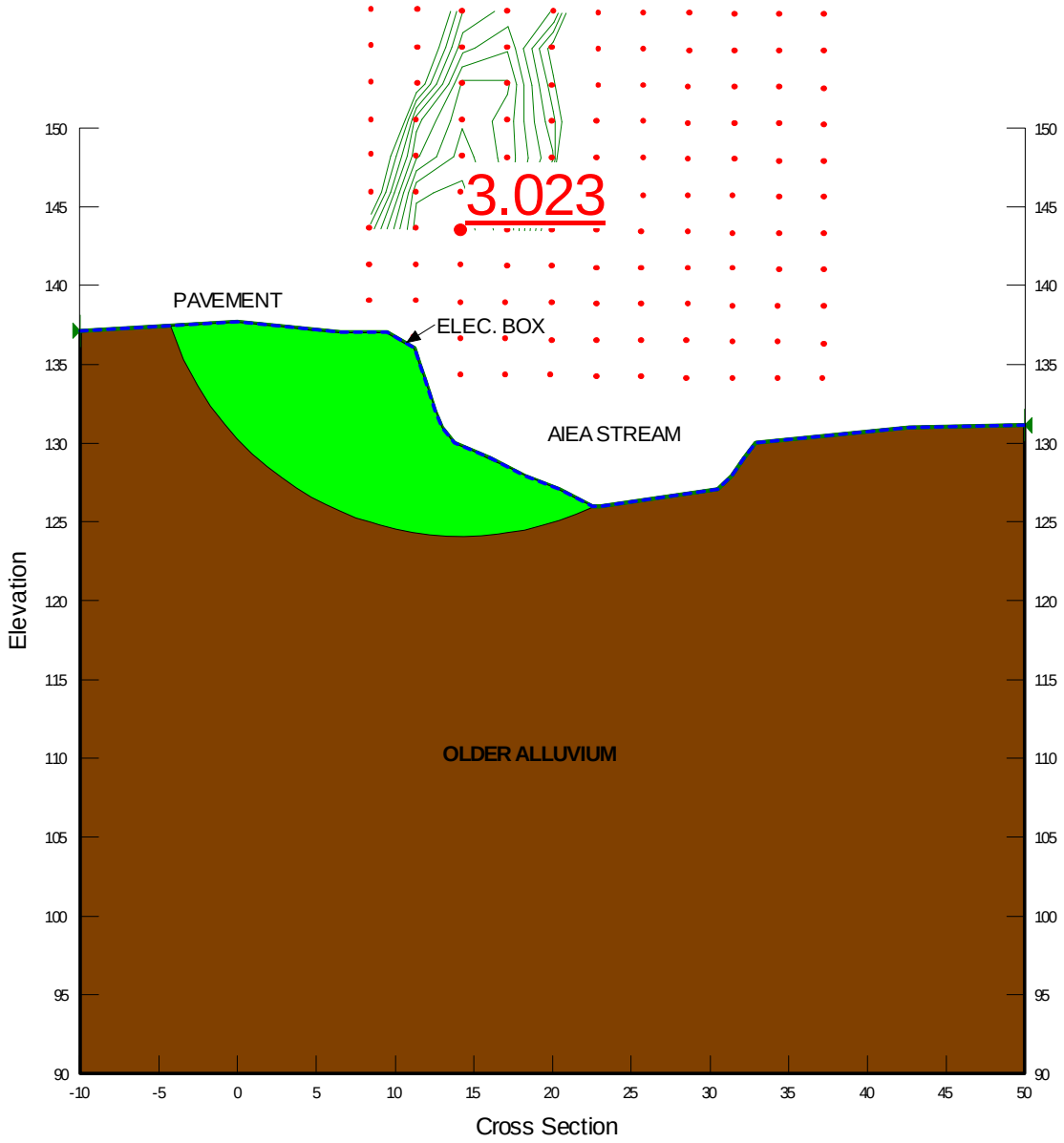
Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-4

OLDER ALLUVIUM
Unit Weight = 125 pcf
Saturated Unit Weight = 130 pcf
Cohesion = 750 psf
Phi = 0 degrees

SEISMIC LOADING:
Horizontal = 0g
Vertical = 0g



SLOPE STABILITY ANALYSIS: TOTAL STRENGTH – STATIC WITH SATURATED RAPID DRAWDOWN CONDITIONS

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

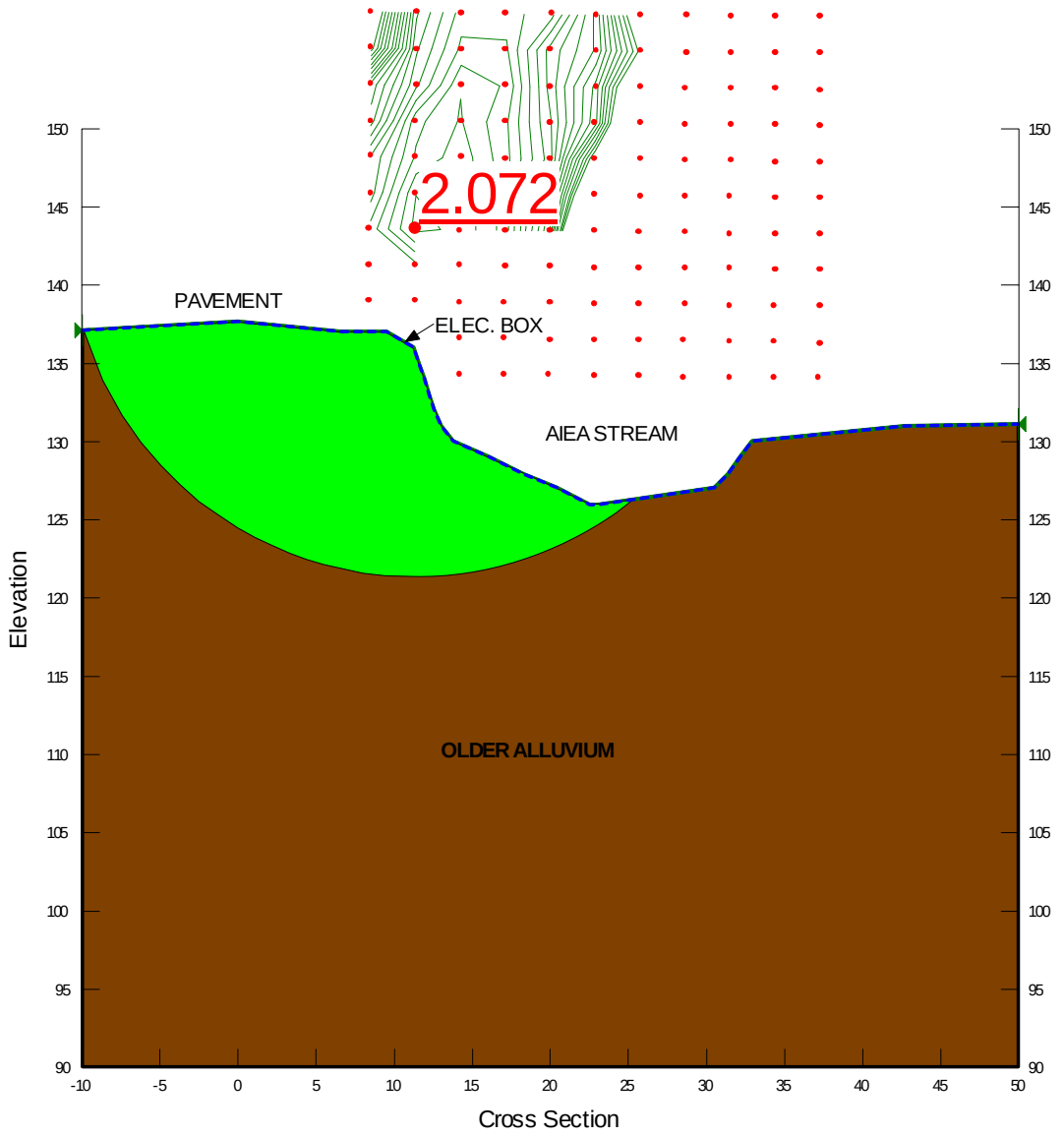
Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-5

OLDER ALLUVIUM
Unit Weight = 125 pcf
Saturated Unit Weight = 130 pcf
Cohesion = 750 psf
Phi = 0 degrees

SEISMIC LOADING:
Horizontal = 0.15g
Vertical = 0.1g



SLOPE STABILITY ANALYSIS: TOTAL STRENGTH – SATURATED RAPID DRAWDOWN CONDITIONS WITH PSEUDOSTATIC SEISMIC LOADING

Stream Bank Assessment and Roadway Support
Aiea Intermediate School, Aiea, Oahu, Hawaii

Project No. 09005

Yogi Kwong Engineers, LLC

FIGURE E-6

Appendix B

Stream Analysis for ‘Aiea Stream at
‘Aiea Intermediate School
Sato & Associates, Inc.
December 2009

DOE Job No Q71009-07

STREAM ANALYSIS

for

Aiea Stream
at Aiea Intermediate School

Aiea, Ewa, Oahu
99-600 Kulawea Street
TMK: 9-9-005: 001

Prepared for:

Facilities Development Branch
Department of Education
State of Hawaii

Prepared by:

Sato & Associates, Inc.
Consulting Engineers
2046 South King Street
Honolulu, Hawaii 96826
www.satoandassociates.com

December 2009

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LIST OF FIGURES

1 GENERAL

1.1 Purpose and Scope

The purpose of this study is to recommend slope protection measures to minimize further erosion that may be detrimental to the Aiea Intermediate School's improvements.

The scope of work includes:

- Topographic survey of the entire stream along the school' property
- Field investigation
- Geotechnical surveys and recommendations
- Proposed slope protection measures based on the Geotechnical Surveys
- Hydrology to determine peak design discharges
- Hydraulic analysis to determine effects of the stream due to the recommended slope protection measures.

1.2 Project Location

The project site is located at Aiea Intermediate School in Aiea, within the Ewa district on the island of Oahu. The campus parcel is 30.889 acres at the end of Kulawea Street and identified by Tax Map Key (TMK) TMK: 9-9-005: 001. See Location Maps and Tax Map Key in Appendix A.

The parcel is bounded by Aiea Stream on its north side and residential lots on its remaining sides. Gus Webling Elementary School occupies approximately 6.5 acres of the parcel and is situated 130 feet east above the Aiea Intermediate School campus. Access to the Gus Webling's campus is from Paihi Street.

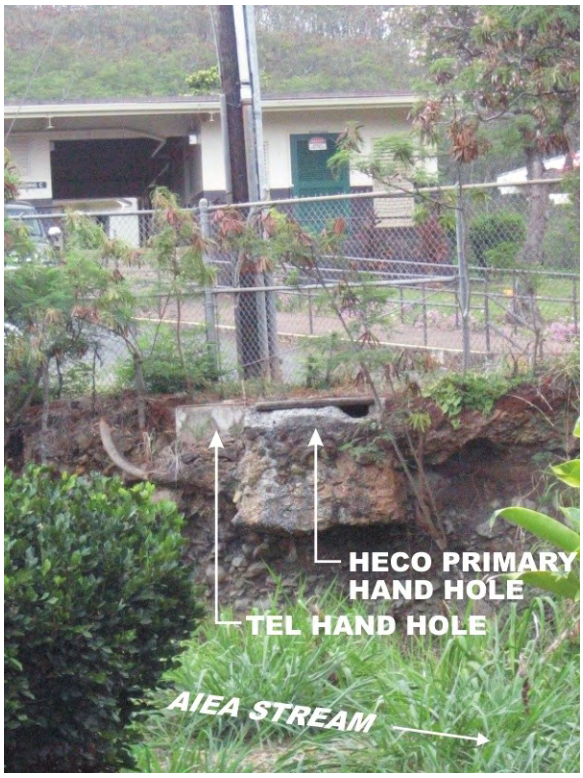
The length of the stream along the campus runs approximately 2,050 linear feet. Majority of the stream centerline is within the school's property with a couple of instances where the stream flow meanders into the residential lots. Roadway and parking is located within the school site along the stream.

1-1 | Aerial View of Project Site

1.3 Background

In 1968 a chain link fence was constructed along the north side of the campus on the top of the stream embankment. Plans called for a minimum 10 feet setback from the top of the embankment. Over time the top of the embankment has receded towards the fence line and undercut the electrical and telephone hand holes located between the fence and the top bank in the vicinity of the kitchen. The electrical box houses Hawaiian Electric Company's (HECO) primary power lines which services the entire campus. In addition to the schools sole source for electrical service are the main lines for water and sewer service. These are located in the roadway alongside the stream and fence line. The roadway is the school's only vehicular access to the backside of the intermediate school campus. The roadway is regularly utilized by delivery trucks to the school's cafeteria for meal service operations.

In May of 2008 a concrete block was poured and struts were placed to support the underside of the hand holes from collapsing into the stream. This fix was temporary. Rerouting of the primary power cables was addressed in an electrical upgrade project constructed in the summer of 2009. Stabilization measures of the slope embankment is being addressed under this project.



1-2 | Area of Erosion Near Hand Holes

1-3 | Hand Holes Supported by Concrete Block

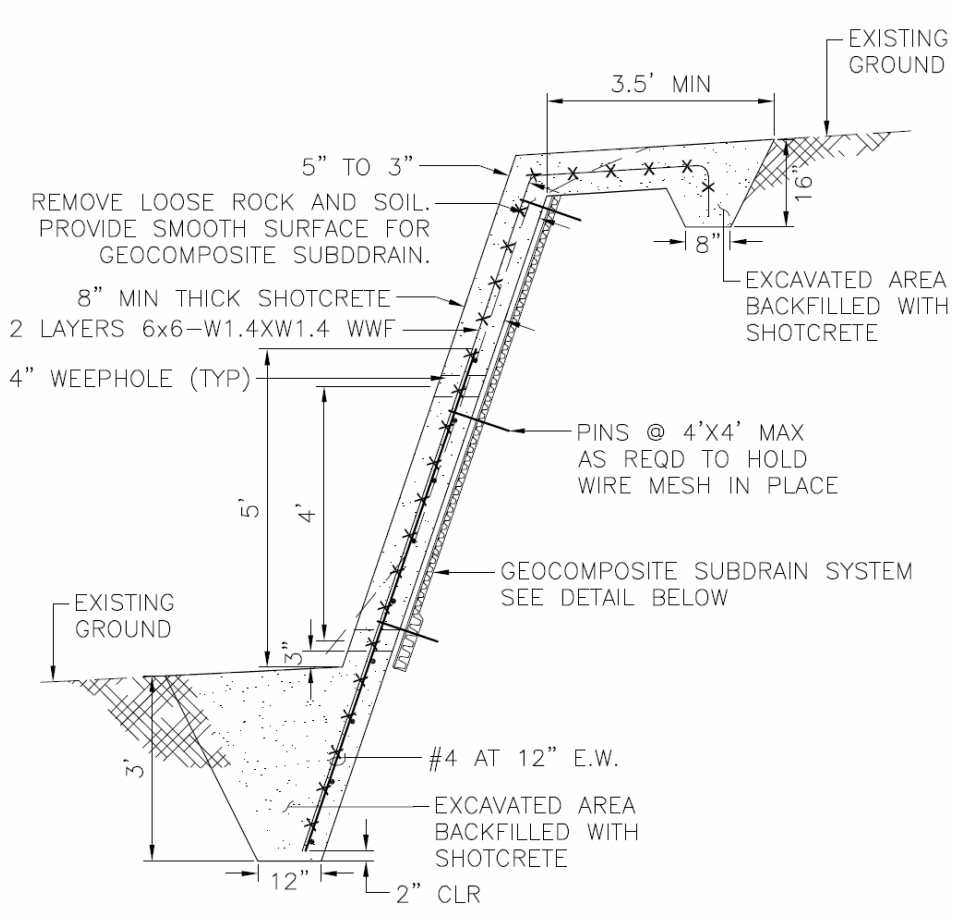
1.4 Proposed Project

Field investigations were performed by Yogi Kwong Engineers, LLC (YKE) in conjunction with Sato and Associates, Inc. Results of YKE's findings, including stream bank analysis and recommendations, are presented in the Consultation Letter Report, Preliminary Geotechnical Assessment and Site Reconnaissance, Mitigation of Stream Bank Erosion and Distress, dated April 17, 2009, and Geotechnical Exploration and Evaluation Report, Stream Bank Assessment and Roadway Support, dated June 2009, both for the subject project.

A general topographic survey showing stream location and depth was performed by ControlPoint Surveying Inc., on February 11, 2009. Additional detailed surveys were later performed in the areas of the proposed improvements.

YKE recommends stabilizing approximately 150 linear feet of the severely eroded stream bank adjoining the campus from further erosion. See the Pre Final Construction Plans in Appendix B. Stabilization measures include backfilling the undermined areas with grouted rip rap or mass concrete and applying wire-reinforced shotcrete (concrete applied by high pressure spray) to the prepared bank surface. Preparation of the bank surface will include removal of loose debris and vegetation and placement of geo-composite drainage strips on the slope. The bottom three (3) feet below grade will also

be reinforced with reinforcing steel. The additional reinforcing will minimize sections of the shotcrete from breaking off.



1-4 | Typical Section Detail

Design of the slope protection should minimize changes to the hydraulic characteristics of the stream. Shotcrete with a lower Manning "n" value (0.025) will have a smoother flow than with the existing earth condition with a higher Manning "n" value (0.050). Hydraulic calculations indicates that the water depth in the stream does not change significantly (±0.07 feet) with the inclusion of the proposed improvement from the existing conditions.

Calculations indicate that scour could go as deep as 9.6 feet. Protection against scour to this depth is not practical. It is recommended that the shotcrete be extended three (3) feet below grade. The shotcrete should be inspected regularly at least after each rainfall to check for excessive cracking, spalling and undermining at the base. Repairs should be made immediately.

2 Hydrology

2.1 Watershed

The project site is situated within the Aiea watershed. The watershed is positioned on the lower leeward slopes of the Koolau Mountains. The basin-like landform is defined by Aiea Heights on its west side and the ridgeline of Halawa Heights on its east side. Storm water generated within the watershed is channeled into soils, groundwaters and storm drainage systems making its way to Aiea Stream and eventually Aiea Bay within Pearl Harbor. The watershed is approximately four (4) miles long and two-thirds (⅔) mile wide with a maximum elevation of 1560 ft. The total area is approximately 1,300 acres (2.0 square miles).

2-1 | 3-D View of Aiea Watershed

2.2 Soils

The predominant soil types in the watershed consists of rock land, silty clay, silty clay loam and stony clay loam. The *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii* by the United States Department of Agriculture, Soil Conservation Service and the University of Hawaii Agricultural Experiment Station, issued August 1972, classifies the soil series as Hanalei, Kawaihapai, Lahaina, Manana, Waipahu, Rock Land and Rough Mountainous Land.
The lower portion of the watershed in the flood plain of the stream is within the Hanalei Silty Clay series. The upper portion of the watershed within the stream is classified as Rock Land and Rough Mountainous Land.

2.3 Land Use

The Land Use Ordinance zoning districts of the watershed consists of Residential and Preservation (general, restricted, military and federal). The upper portion of the watershed is primarily preservation with the lower portion residential.

The State Land Use District designates the upper portion of the watershed as Conservation and the lower portion as Urban. Conservation lands are comprised primarily of lands in forest and water reserve zones. Urban lands generally include areas characterized by developments that concentrate people, structures and services.

2.4 Drainage Conditions

Existing Conditions

Majority of the storm water runoff generated within the intermediate school campus sheet flows towards the stream. Balance of runoff is collected by inlets and conveyed by the school's drainage system with outfall into the stream.

Flood Hazard

Flood Insurance Rate Maps (FIRM) published by the Federal Emergency Management Agency (FEMA) indicate that the project campus site is located within Zones AE, X and D.

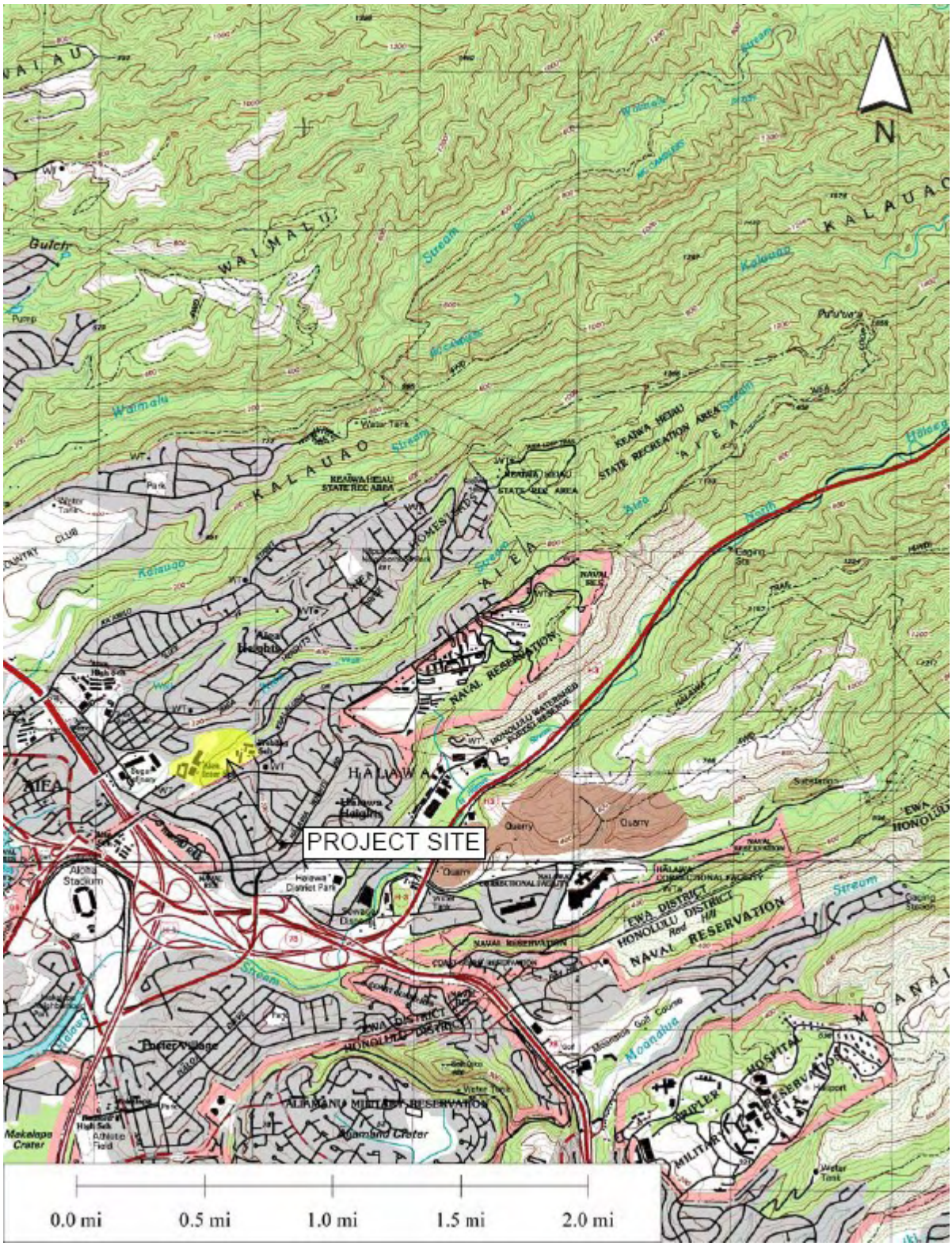
Zone AE lies in the vicinity of the stream alignment. Within this zone Base Flood Elevations (BFE) have been determined by studies. It is the computed elevation to which floodwater is anticipated to rise during the base flood. The base flood has a one percent annual chance or greater flood and is also referred to as the '100-year flood'.

Zone X spreads halfway into the campus parcel. Zone X is designated as areas with a 0.2% annual chance flood or 500 year flood.

Zone D lies within the south side of the campus parcel. Zone D is designated as areas which flood hazards are undetermined, but possible. See partial copy of FIRM map and associated flood profile in Appendix A.

Proposed Conditions

Current and existing drainage patterns will be maintained.



2-2 | USGS Topographic Survey

2.5 Hydrologic Design Criteria

The design discharge criteria for the stream is outlined in *Design Criteria for Highway Drainage*, State of Hawaii, Department of Transportation, Highways Division, 5/15/06.

The following watershed input data was derived from Geographic Information System (GIS) layers downloaded from the City and County of Honolulu's GIS Data Server, ftp://gisftp.hicentral.com/layers, the State of Hawaii, Office of Planning's website, http://hawaii.gov/dbedt/gis/ and the National Weather Service's Precipitation Frequency Data Server (PFDS), ftp://hdsc.nws.noaa.gov/pub/hdsc/data/hi/.

COVERAGE	DATASET SOURCE
parcel	digitized from hand drafted linen maps TMK assigned based on Tax Map books produced by City Finance Department
40-ft contours	USGS 1983 1:24,000 topographic quad shts
perennial and intermittent streams	USGS 1983 1:24,000 topographic quad shts
Land Use Ordinance zones	Dept of Land Utilization
State Land Use districts	State Land Use Commission 1:24,000 mylar maps
watershed	USGS Digital Elevation Model (DEM) data
soils	USDA Soil Survey
precipitation	NOAA Atlas 14 Volume 4 Version 2.0 May 29, 2009

Hydrologic Method

The Soil Conservation Service (SCS) Tabular Hydrograph Method was used to estimate the amount of stream peak discharge. The method was developed by SCS [currently called National Resources Conservation Service (NCRS)] to estimate runoff from small to medium sized watersheds. The method computes peak discharges from rural and urban areas and is based on the potential for the soil to absorb a certain amount of moisture. This potential is related to a 'curve number' CN which is a characteristic of the soil type, land use and initial degree of saturation.

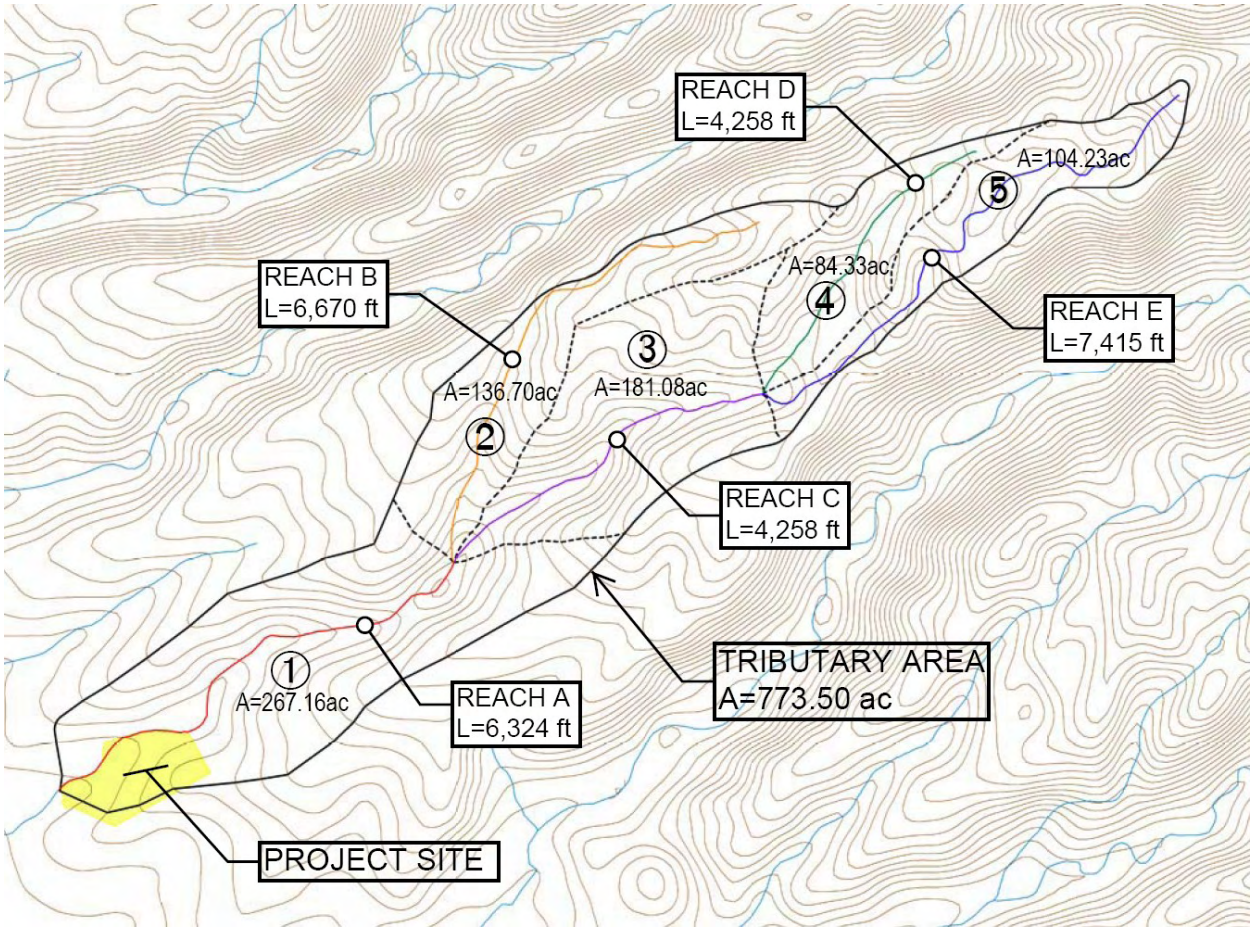
The SCS Method was computed by WinTR-55 Version 1.00.08, a computer program developed by the United States Department of Agriculture, Natural Resources Conservation Service. The program is limited to a maximum watershed area of 25 square miles (16,000 acres).

Tributary Area (A)

The tributary drainage area for the portion of Aiea Stream along the school's campus is 773.50 acres, approximately 60 percent of the Aiea Watershed. The tributary area consists of five (5) sub-areas and five (5) stream reaches. The stream reach lengths total to 29,363 linear feet.

Sub-Area Identifier	Area (acres)
①	267.16
②	136.70
③	181.08
④	84.33
⑤	104.23
Total	773.50

Reach	Length (ft)
A	6,324
B	6,670
C	4,696
D	4,258
E	7,415
Total	29,363



2-3 | Sub Areas and Reaches within Tributary Area

Design Storm Recurrence Interval (T_m)

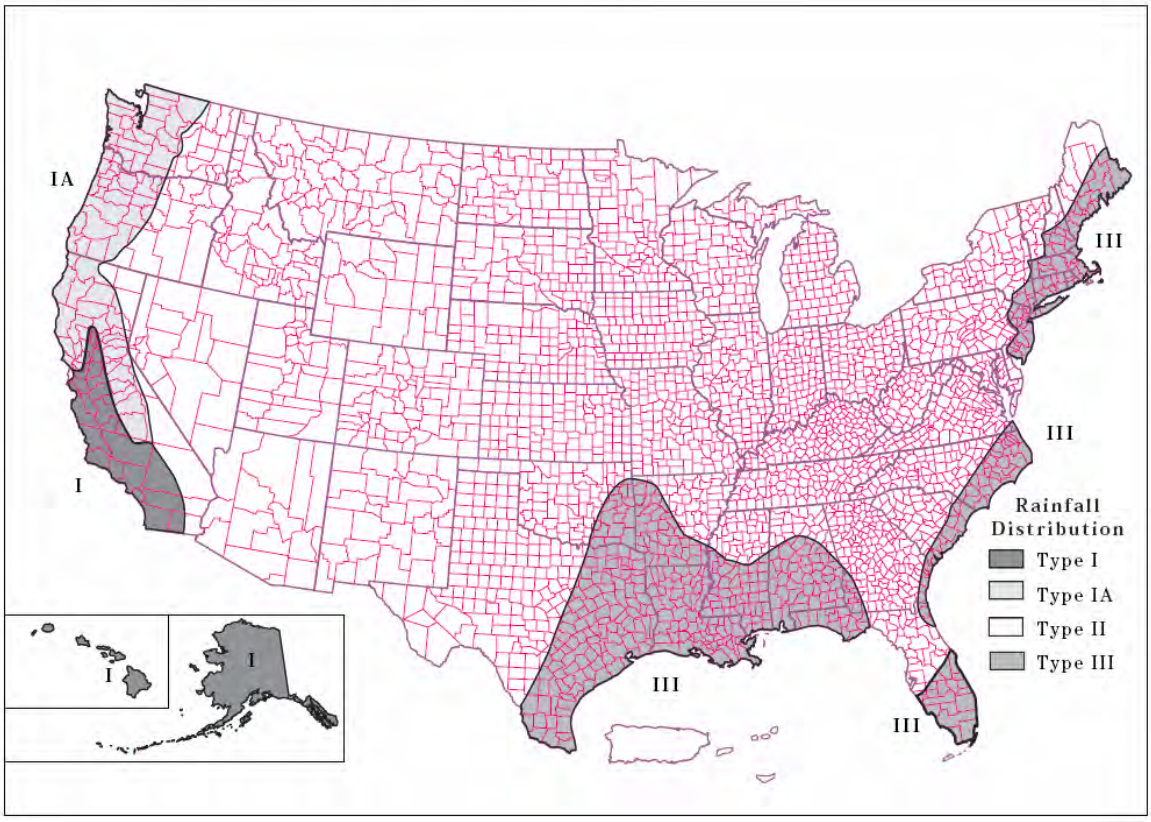
T_m = 100 year

Rainfall Depth (P)

P = 14 inches (24-hr)

The intensity of rainfall varies during a storm event as much as its geographic region. The National Resource Conservation Service (NCRS) developed four (4) synthetic 24-hour distributions (I, IA, II and III) from available National Weather Service (NWS) duration-frequency data or local storm data. Type I and IA represent the Pacific maritime climate with wet winters and dry summers. Hawaii is associated with a Type I distribution.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions

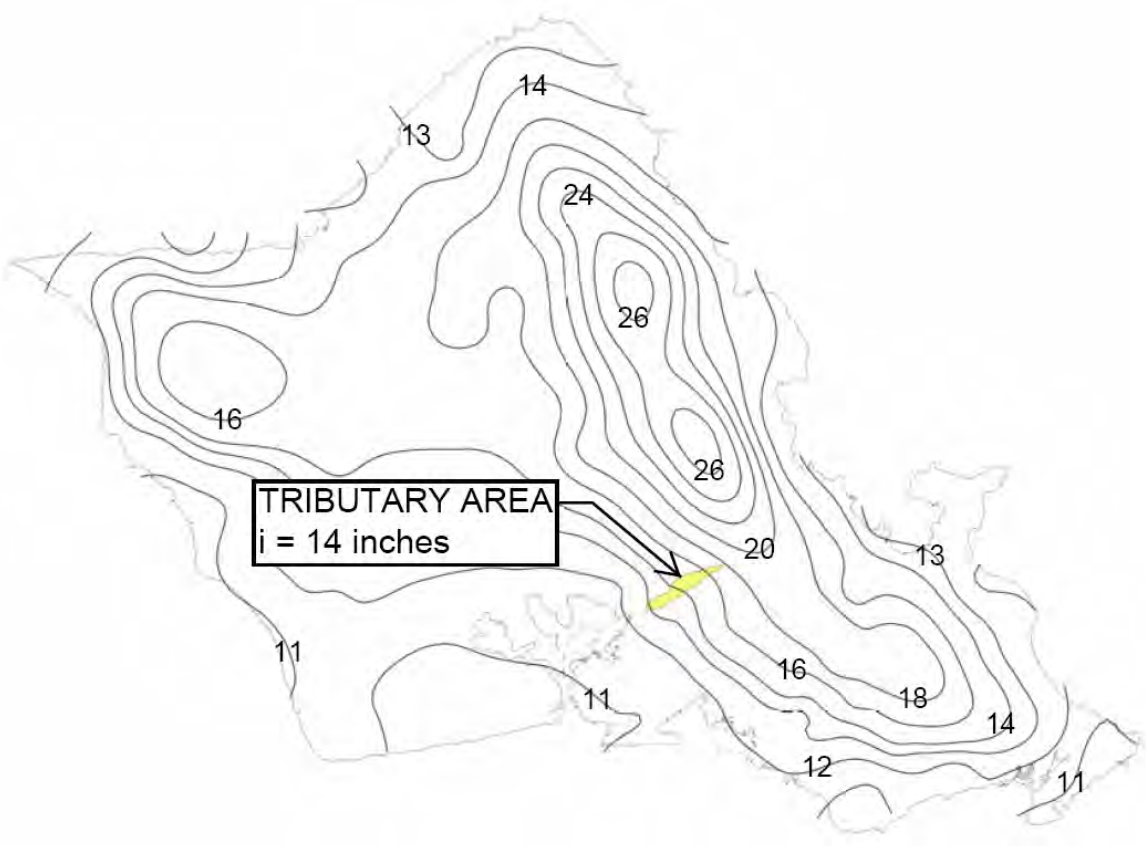


2-4 | Approximate Geographic Boundaries for NRCS (SCS) Rainfall I Distributions
Technical Paper No. 43, Rainfall-Frequency Atlas of the Hawaiian Islands

The rainfall frequency atlases and technical papers published by the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) are the national standards for rainfall intensity at specified frequencies and durations in the United States. The precipitation frequency estimates for the Hawaiian Islands were

recently updated in May of 2009 based on more recent and extended data sets, currently accepted frequency approaches and improved spatial interpolation and mapping techniques. NOAA Atlas 14 Volume 4 supersedes Technical Paper No. 43, "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (U.S. Weather Bureau, 1962).

The isopluvial (lines of equal rainfall) for 24 hour precipitation (inches) with an average recurrence interval of 100 years range from 13 to 18 inches across the tributary area. The rainfall intensity of 14-inches was used in the computations since its isopluvial was located midway of the tributary area.



2-5 | 100-yr 24-hr Rainfall (in)
NOAA Atlas 14 Precipitation-Frequency Atlas of the United States
Volume 4 Version 2.0: Hawaiian Islands, 2009

Curve Number (CN)

The major factors that determine CN are the hydrologic soil group, cover type, treatment, hydrologic condition and antecedent runoff condition (an index of runoff potential for a storm event).

The hydrologic soil group refers to the infiltration potential of the soil after prolonged wetting.

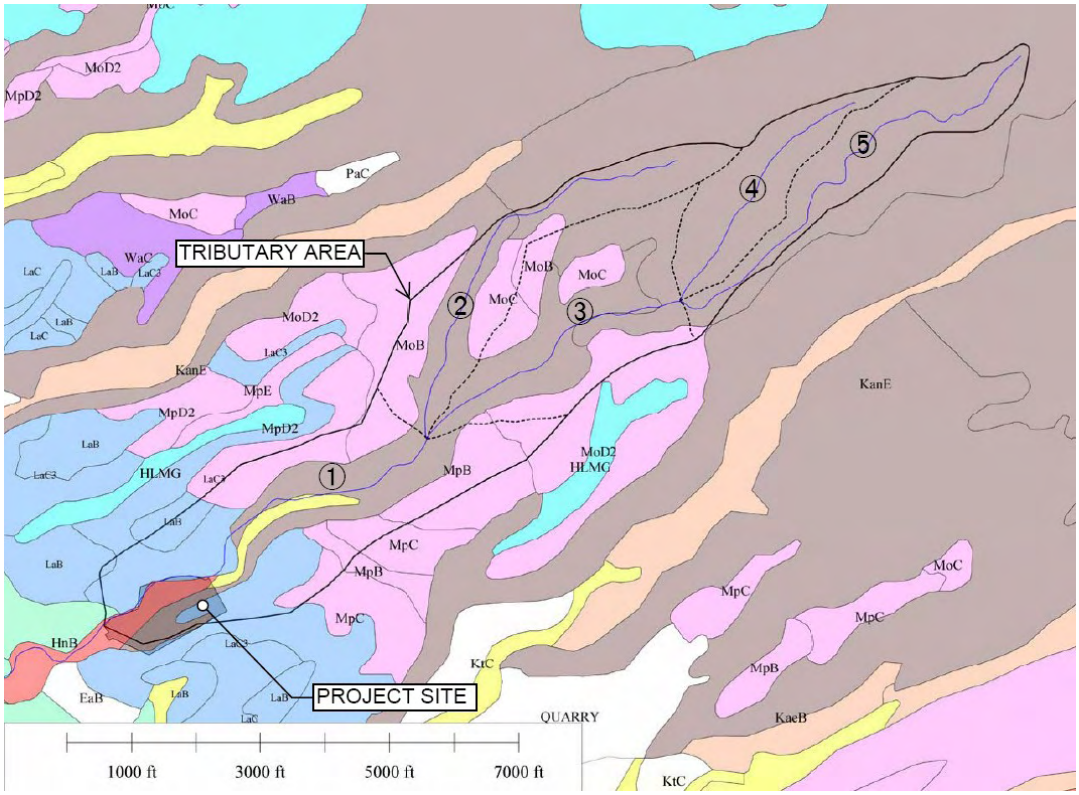
Group A Soils: High infiltration (low runoff). Sand, loamy sand, or sandy loam. Infiltration rate > 0.3 inch/hr when wet.

Group B Soils: Moderate infiltration (moderate runoff). Silt loam or loam. Infiltration rate 0.15 to 0.3 inch/hr when wet.

Group C Soils: Low infiltration (moderate to high runoff). Sandy clay loam. Infiltration rate 0.05 to 0.15 inch/hr when wet.

Group D Soils: Very low infiltration (high runoff). Clay loam, silty clay loam, sandy clay, silty clay, or clay. Infiltration rate 0 to 0.05 inch/hr when wet.

Hydrologic soil types and soil groups within the tributary drainage area were determined from the Soil Survey. Cover type was based on the designated Land Use Ordinance (LUO) district. Hydrologic condition was based on aerial photos.



2-6 | SCS Soil Survey Map

Table 2-2a Runoff curve numbers for urban areas [1/]

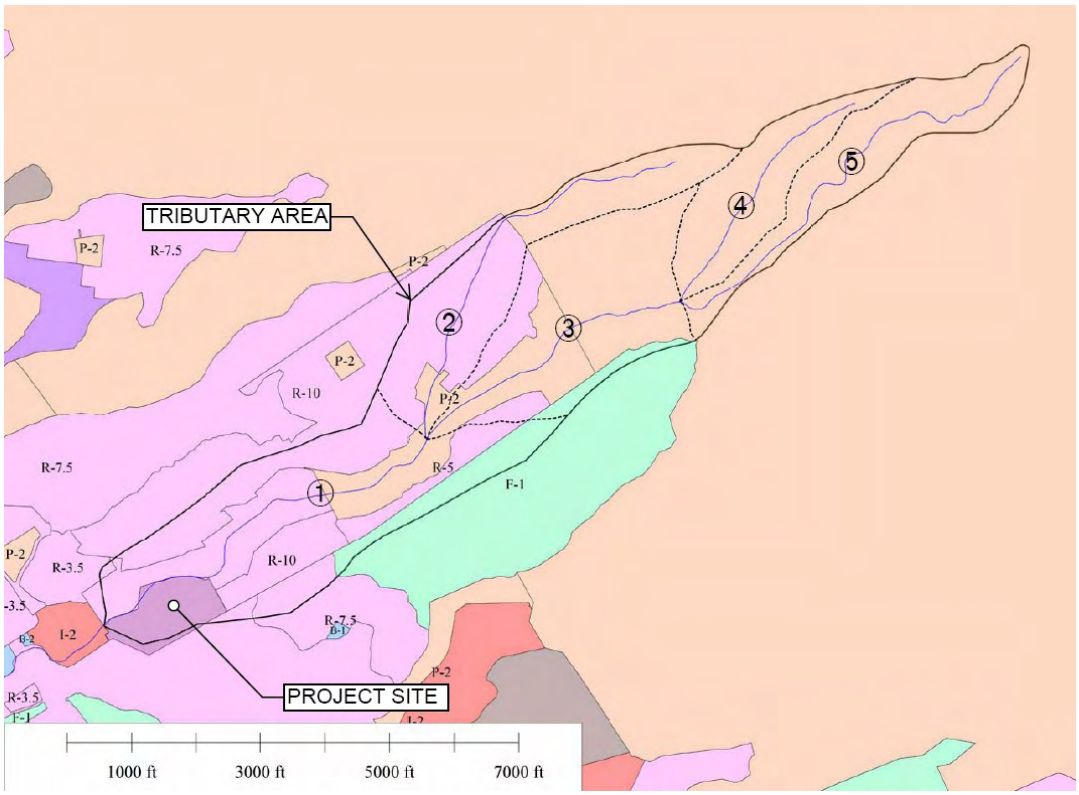
Cover description: Cover type and hydrologic condition	Average percent impervious area [2/]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses) R-3.5, R-5	65	77	85	90	92
1/4 acre R-7, R-10	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

2-7 | Runoff Curve Numbers for Urban Areas
Technical Release 55, Urban Hydrology for Small Watersheds

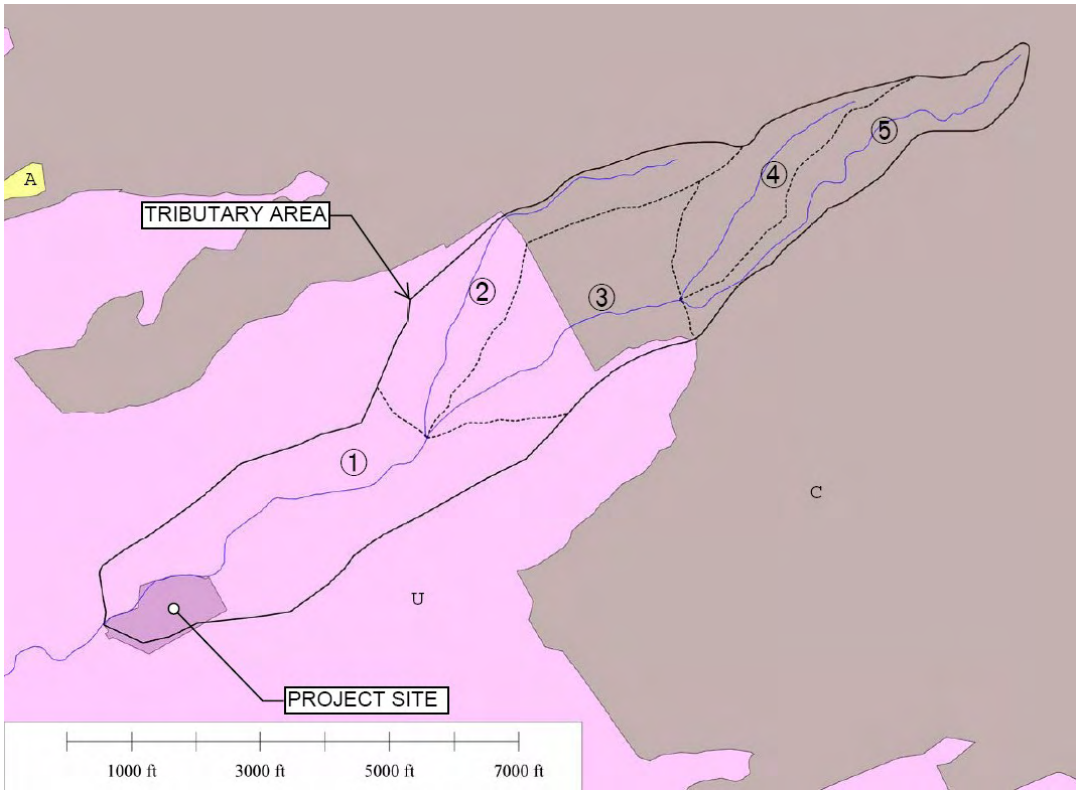
Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description: Cover type	Hydrologic condition	Curve numbers for hydrologic soil group: A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

2-8 | Runoff Curve Numbers for Other Agricultural Lands
Technical Release 55, Urban Hydrology for Small Watersheds



2-9 | Land Use Ordinance (LUO) Zoning Districts



2-10 | State Land Use Districts

Area ①

LUO Zoning District	Soil Type	Hydrologic Soil Group	Sub-Area (ac)
R-3.5	LaB	B	0.72
	LaC3	B	0.16
R-5	HnB	C	12.52
	KlbC	B	9.89
	LaB	B	0.14
	LaC3	B	33.06
	MoD2	C	1.43
	MpB	C	10.62
	MpC	C	3.95
	MpD2	C	1.70
	rRK	D	31.25
	WzA	C	0.63
R-7.5	LaC3	B	6.93
	MpC	C	6.89
R-10	KlbC	B	0.18
	LaB	B	8.78
	LaC3	B	28.53
	MoB	C	12.30
	MpB	C	3.71
	MpC	C	1.57
	MpD2	C	20.34
	rRK	D	11.72
F-1	MoD2	C	6.22
	MpB	C	19.26
	MpC	C	3.92
P-2	KlbC	D	1.55
	rRK	B	29.19
			267.16

Area ②

LUO Zoning District	Soil Type	Hydrologic Soil Group	Sub-Area (ac)
R-10	MoB	C	26.73
	MoC	C	16.64
	rRK	D	32.76
	rRT	D	0.43
P-1	MoB	C	3.08
	rRK	D	0.76
	rRT	D	47.88
P-2	rRK	D	8.42
			267.16

Area ③

LUO Zoning District	Soil Type	Hydrologic Soil Group	Sub-Area (ac)
R-5	MoD2	C	6.28
	MpB	C	1.06
	rRK	D	0.87
R-10	MoB	C	5.13
	MoC	C	8.70
	rRK	D	3.04
P-1	MoB	C	4.23
	MoC	C	12.58
	MoD2	C	10.45
	rRK	D	21.09
	rRT	D	50.97
P-2	MoB	C	0.77
	MoC	C	0.71
	MoD2	C	1.32
	MpB	C	0.04
	rRK	D	42.90
	rRT	D	0.31
			181.08

Area ④

LUO Zoning District	Soil Type	Hydrologic Soil Group	Sub-Area (ac)
P-1	rRT	D	84.33
			84.33

Area ⑤

LUO Zoning District	Soil Type	Hydrologic Soil Group	Sub-Area (ac)
P-1	MoD2	C	0.77
	rRT	D	103.46
			104.23

Time of Concentration (T_c) and Travel Time (T_t)

Travel time (T_t) is the time it takes water to travel from one location to another within the watershed. Time of concentration (T_c) is the time for runoff to travel to a point of interest from the hydraulically most distant point. Time of concentration (T_c) is the sum of travel time (T_t) values for the various consecutive flow segments. Factors that affect the time of concentration include surface roughness, flow pattern and slope. The time of concentration data was estimated for each sub-area. Length and slope for each individual flow type (sheet, shallow concentrated and channel flow) were obtained from the digitized 40-ft contours. Surface roughness was based on aerial photos. Manning's n value were based on the following:

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods: [3]	
Light underbrush	0.40
Dense underbrush	0.80

2-11| Table 3-1. - Roughness Coefficients (Manning's n) for Sheet Flow
Technical Release 55, Urban Hydrology for Small Watersheds

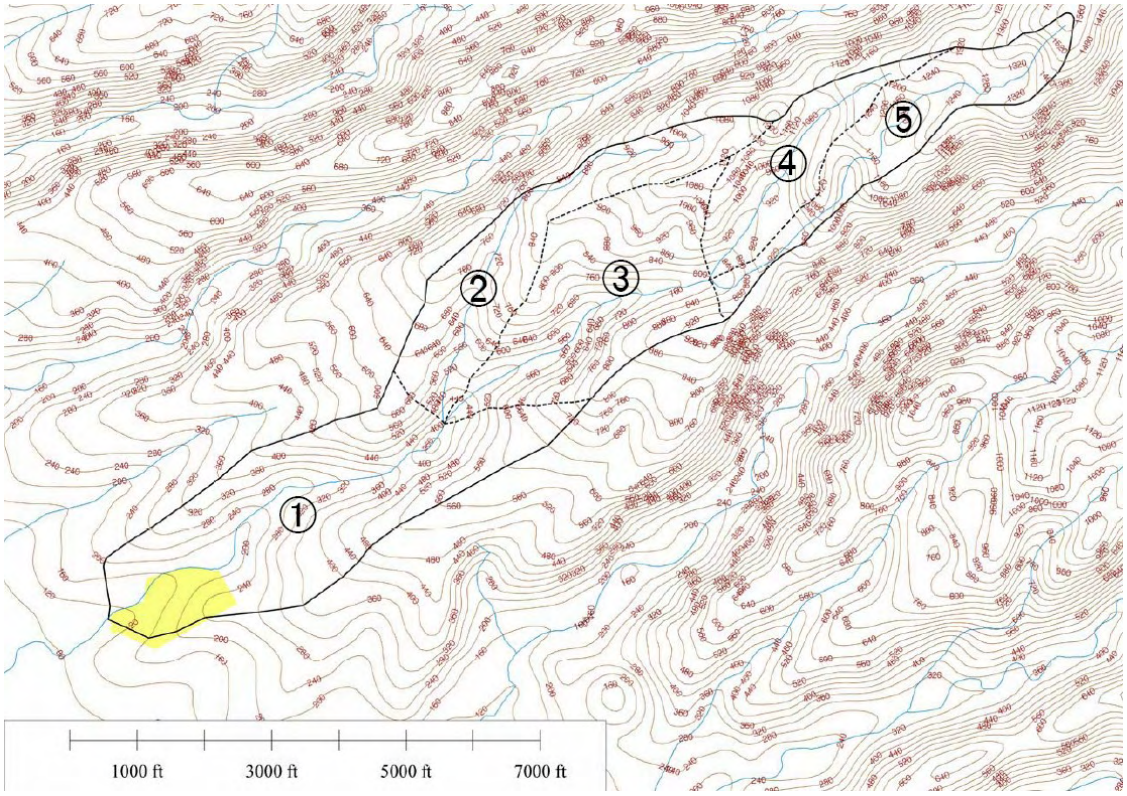
TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage <100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

2-12 | Values of the Roughness Coefficient n for Channel Flow
Chow. Open-Channel Hydraulics. 1959

For shallow concentrated flow the following Manning roughness coefficient, n, were used:
0.050 for unpaved areas 0.025 for paved areas

Area Identifier	Flow Length (ft)	Slope (ft/ft)	Manning's n
①	100	0.0100	0.400
	2,131	0.1937	0.050
	6,324	0.0443	0.050
②	100	0.0100	0.400
	950	0.1579	0.050
	6,670	0.1199	0.050
③	100	0.0100	0.800
	1,855	0.1725	0.050
	4,696	0.0852	0.050
④	100	0.0100	0.800
	933	0.1072	0.050
	4,258	0.1221	0.050
⑤	100	0.0100	0.800
	7,415	0.1025	0.050

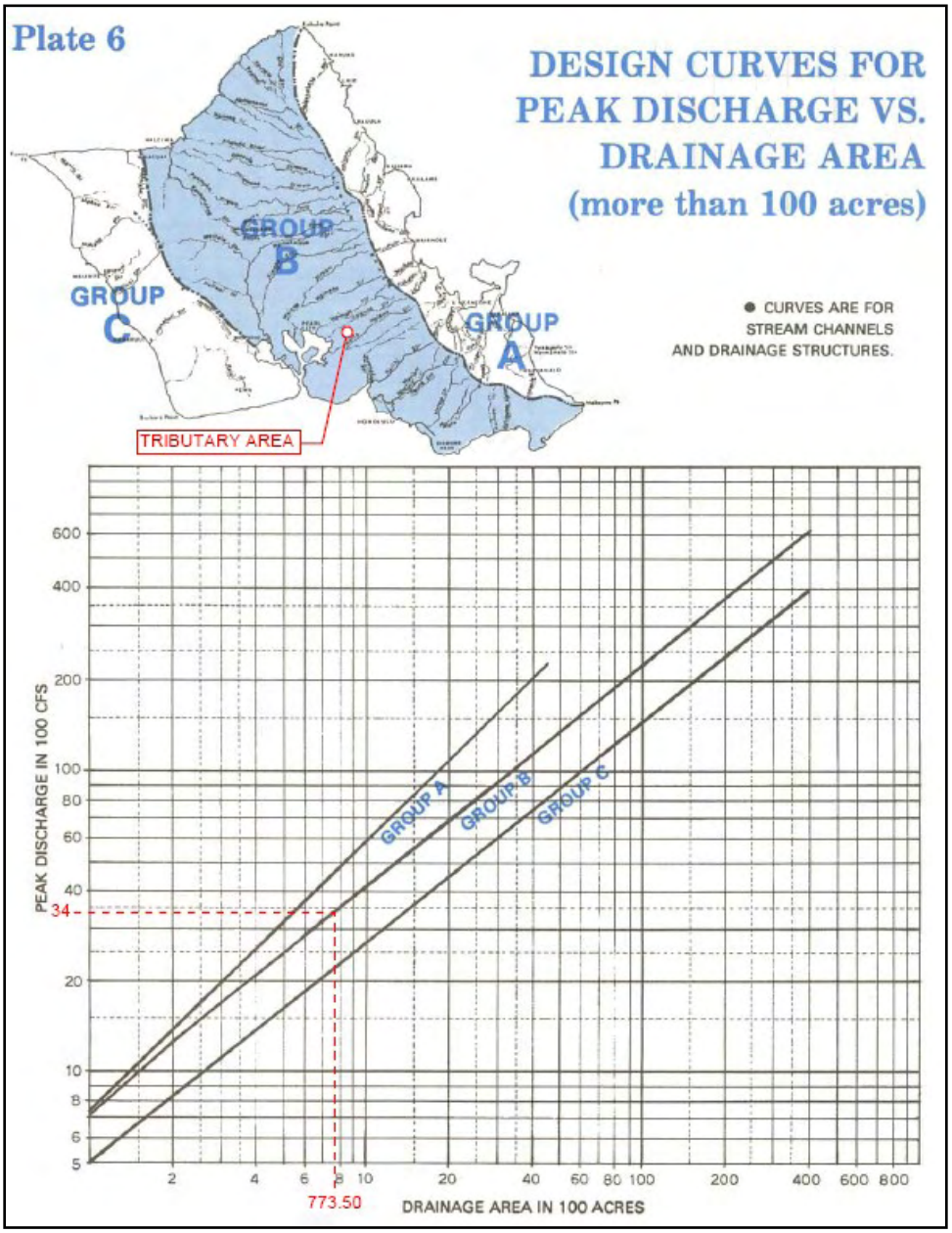


2-13 | Contour Elevations of Tributary Area

2.6 Peak Flow (Q)

The calculated peak flow at Aiea Stream on the south side of the campus for the 100 year, 24 hour storm was calculated to be 3,372 cfs, for the 773.5 acre watershed area using the Soil Conservation Service (SCS) Tabular Hydrograph Method. Input data, details and summary tables for the WinTR-55 program is included in Appendix C.

A check with the Plate 6 of the City's Storm Drainage Standards indicate a peak discharge of 3,400 cfs which is in line with the SCS Tabular Hydrographic Method..



2-14 | Design Curves for Peak Discharge vs. Drainage Area (more than 100 acres)
Data from USGS rev May 1988. (Plate 6 of the City and County Storm Drainage Standards)

The Federal Emergency Management Agency (FEMA), Flood Insurance Study, Revised September 28, 1990, indicates a 100 year peak discharge of 2,140 cfs for 672 acres. Adjusted to the projects 773.5 acres, the peak discharge is 2,475 cfs which is approximately 27 percent lower than the above calculated methods. FEMA discharges for Aiea Stream was determined by statistical reports done by the USGS. Although the FEMA discharge is considerably lower, the SCS Tabular Method discharge of 3,372 cfs will be used in this report.

3 Hydraulics

3.1 Purpose

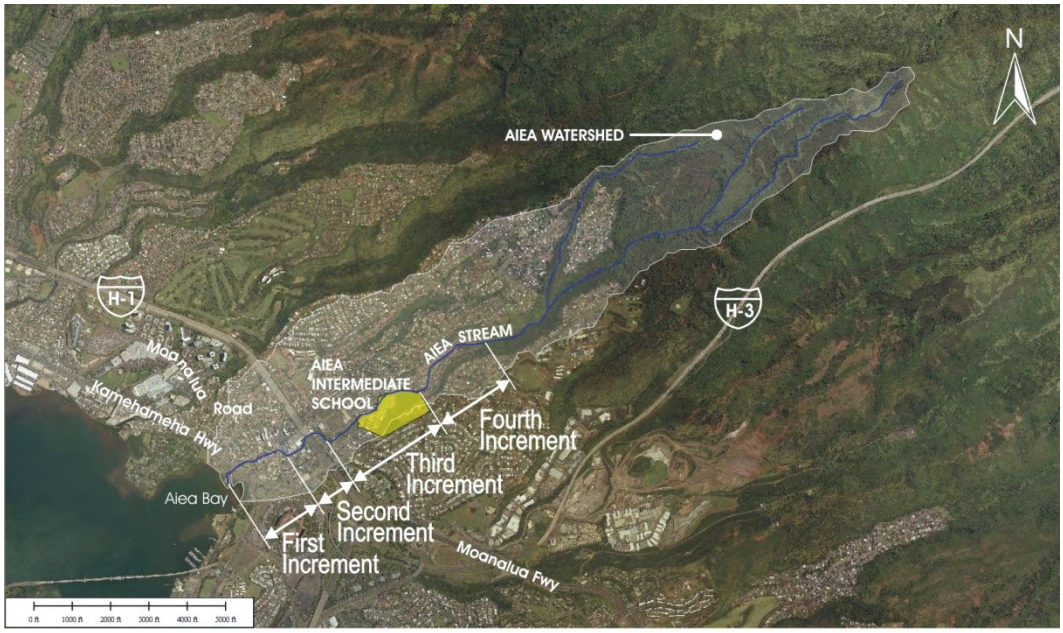
Slope protection proposed for this project should have no adverse changes to the hydraulics of the stream. Water surface elevation and stream velocity should be relatively unchanged for the existing and proposed conditions**.** Scour depths were calculated to determine the depth below grade of the slope protection.

3.2 Stream Description

Along the campus property, the stream ranges in elevation from 175 feet to 110 feet at an average slope of 3 percent. The stream is heavily vegetated. The stream bed is very irregular probably due to low flow scour. Residential walls adjoin the stream on the opposite side of the school campus. The banks along the school side is steep and mostly bare with overhanging vegetation.

3.3 Existing Stream Improvements

Aiea Stream flows through the Aiea community and discharges into the East Loch of Pearl Harbor at Aiea Bay. The stream is over six (6) miles long extending from Pearl Harbor to the Puʻuʻuaʻu mountain summit. In the mid 1970s, the lower portion of the stream between Kamehameha Highway and Moanalua Road was channelized and lined with concrete to alleviate flood problems on the low-lying reach of Aiea Stream. That was one of four (4) increments of flood and erosion control improvements proposed by the City. The second increment consisted of extending the lining upstream to the vicinity of the Aiea Industrial Subdivision, the site of the former C&H Refinery. Future improvements (third and fourth increments) included improvements to the stream from the former refinery to the end Kaulainahee Place. The third and fourth increments includes the portion of the stream along the school. In a 1969 study done by the Corp of Engineers it was determined that flooding above Moanalua Road was not as serious as the lower-lying reach in Increment I due to the steeper topography. Improvements for the subsequent increments has not been implemented.



3-1 | Site Map of Existing Aiea Stream Improvements

3.4 Stream Characteristics and Geomorphology

Aiea stream is an alluvial stream. The stream is formed in materials that have been and can be transported by the stream. In alluvial stream systems it is typical that the banks erode, sediments are deposited and side channels undergo modification over time.

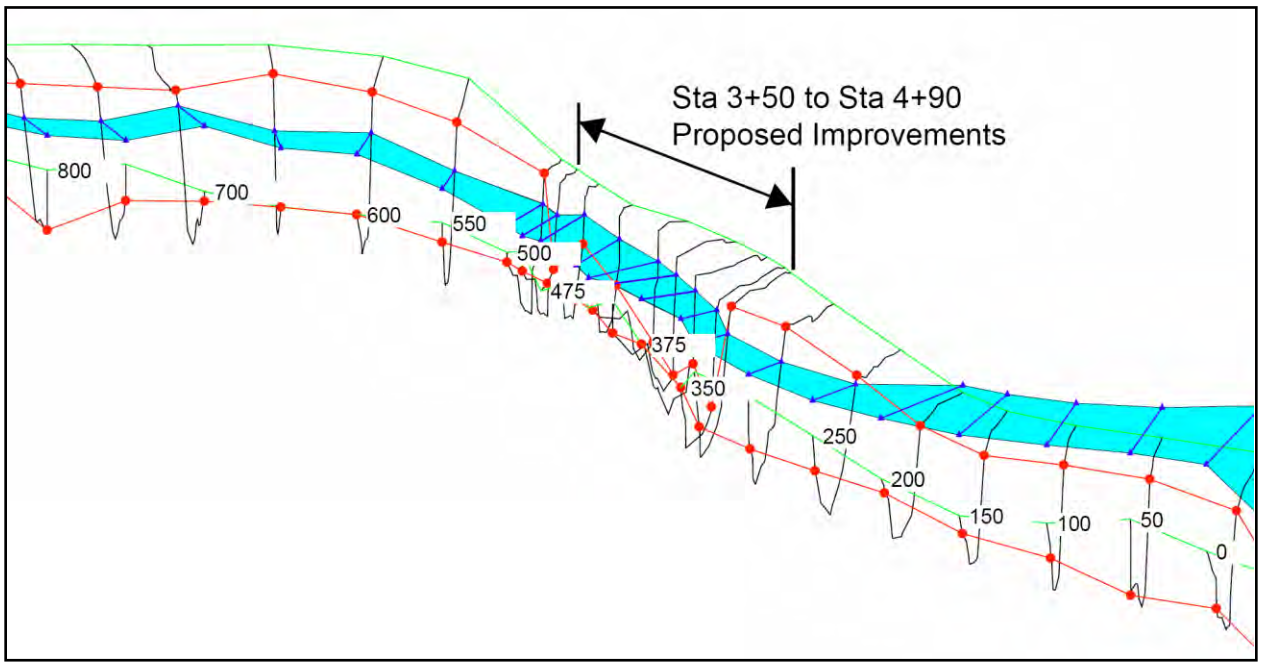
3.5 Modeling

The 2,050 linear feet of natural stream adjoining the campus was analyzed using HEC-RAS version 4.0. The software was developed by the Hydraulic Engineering Center (HEC), a division of the U.S. Army Corp of Engineers. It was used to compute the water surface profile of the stream for the existing and proposed conditions and analyze the scour at the proposed improvements for the 100 year storm event.

In creating the steady flow simulation model for the water surface profiles, 50 feet cross-sectional data was entered to define the stream geometry. The flow was assumed to be subcritical, therefore, only a downstream boundary was needed to define the starting water surface elevation The starting water surface elevation of 118.6 feet at the road crossing located just downstream of the school. The starting elevation was taken from Gray, Hong, Bills & Associates, Inc., “Stream Analysis of Aiea Stream Fronting Aiea Industrial Subdivision”, 23 October 1998. The elevation was adjusted due to a difference in elevation datum.

3.6 Water Surface Elevations

Water surface elevations did not change significantly between existing conditions and with the construction of the slope protection measures. Water level changes ranged from (+)0.07 to (-) 0.07 feet. Input data and results for the HEC RAS Version 4 hydraulic program is included in Appendix D.



3-2 | 3-D View of Water Surface and Stream at Sta 0+00 to Sta 8+00

3.7 Scour

Scour depths of 9.59 feet were calculated using the HEC RAS progrom. Results are included in Appendix D.

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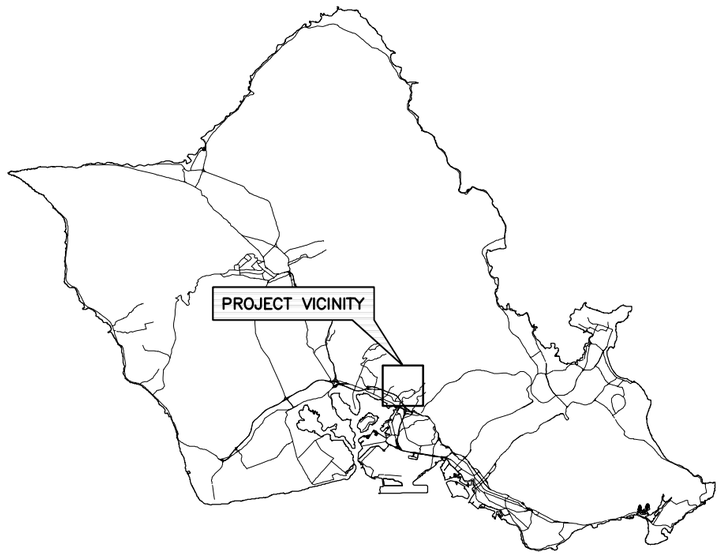
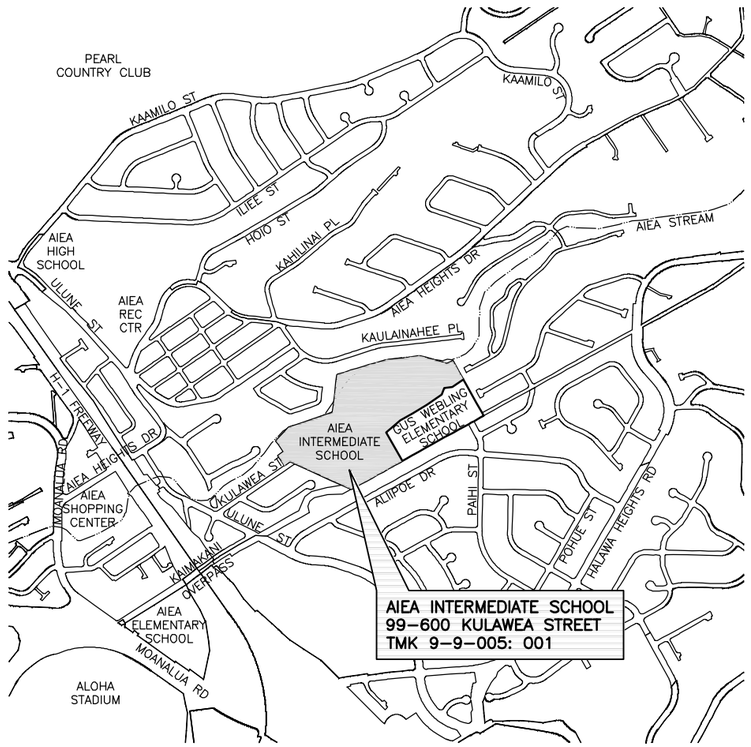
APPENDIX A

- Location Maps
- Tax Map Key
  9-9-005: 001
- As-Built Plan
  Chain Link Fence
  Aiea Intermediate School
  Sept 1968
  DAGS Job No 02-16-5444
- Flood Insurance Rate Map (FIRM)
  Map Number 15003C0245F
  Map Revised September 30, 2004
- Flood Insurance Study | Flood Profiles
  Revised: September 28, 1990
  Aiea Stream – Panel 95P



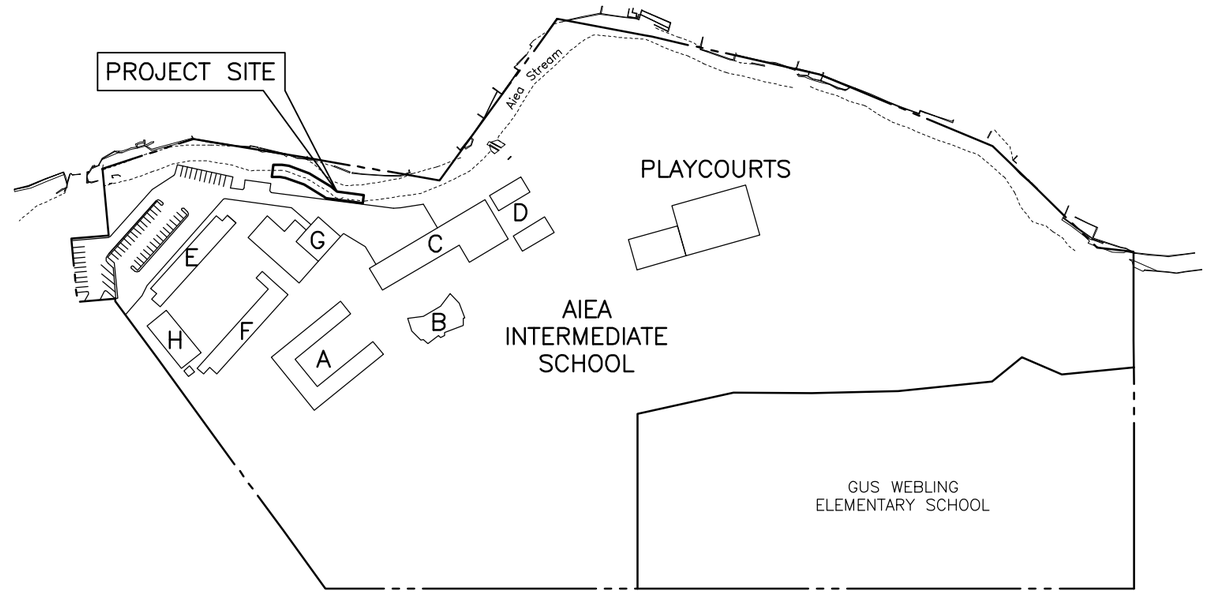
VICINITY MAP
NOT TO SCALE

NORTH



LOCATION MAP
NOT TO SCALE

NORTH



CAMPUS MAP
NOT TO SCALE

NORTH

K A L A U A O

SEC. 8

To Pearl City

"Split Rock" Rd. To Waiau

TRUE NORTH
Scale: 1 in. = 200 Ft.

PLAT 40

PLAT 38

HELEGONIA ST.

INTERSTATE F.A.P. No. I-H-1-(16)

MAHIKO Pl.

ULUNE STREET

AIEA RECREATION CENTER
6.671 Ac.

PLAT 70

DRIVE

AIEA HEIGHTS

WILIKO ST.

GLORANA ST.

LALANI ST.

PLAT 39

UHALOA ST.

HONOHONO ST.

PLAT 36

AHEAHE ST.

PLAT 35

HAPUKU ST.

KAHALOA ST.

PILIKOA ST.

HAKINA ST.

KAHILINAI ROAD

PLAT 24

KAULAINAHEE RD.

To Aiea Hgts.

PLAT 25

PLAT 26

PLAT 10

PLAT 51

PLAT 53

PLAT 56

PLAT 42

PLAT 44

PLAT 03

AIEA HEIGHTS DRIVE

Access permitted across Grade Separation Structure (Overpass)

Access Permitted across Grade Separation Structure (Overpass)

AIEA ROAD

UKAPAU DR.

LAULIMA STREET (DEPOT RD.)

MOANALUA

UAHI DR.

NANU PLACE

PUAKALU STREET

KULINA DRIVE

PLAT 43
(4936.40 N, 7218.05 W)
Salt Lakes

Gr. 8945

Gr. 10203

U.S.A.
Por. Civil No. 535
(2.633 Ac.)

U.S. Naval
3.179 Acs.

Reservation
(0.448 Ac.)

KAIMAKANI (OVERPASS)

See Below 20

AIEA ELEMENTARY SCHOOL
Exec. Ord. No. 226
8.179 Acs.
(6.137 Acs.)

Exec. Ord. No. 752

Por. (1634 sq. ft. (0.038 Ac.))
Por. Exec. Ord. No. 2907

Easmt. "S" (16,271 sq. ft.)

Por. Exec. Ord. No. 2907
(2.013 Acs.)

20' U. S. NAVAL RESERVATION
Por. Civil No. 535

HALEWILIKO ST.

PŌHAI PLACE

INDUSTRIAL PARK

PLAT 79

HALEWILIKO PLACE

Exec. Ord. No. 2837
(21,594 sq. ft. or 0.495 Ac.)

AIEA INTERMEDIATE SCHOOL
30.889 Acs.
(23.833 Acs.)

Aiea Stream

KULAWEA STREET

ESTATES SUB'D. NO. 4
6849
68
1008

KULAWEA PLACE

HALAWA HILLS UNIT
PLAT 1017

HALAWA ST.

HALAWA HEIGHTS ELEMENTARY SCHOOL
(2.691 Acs.)

KEALALUINA DRIVE

PAAHI ST.

ALIIPOE STREET

Reserved 30-Ft. R/W in favor of United States of America

To Honolulu

HALE ST.

Por. AIEA EWA OAHU

Parcels Dropped: 3, 7, 14, 11, 16, 17, 8, 18, 9, 19, 21, 24, 12, 19, 2, 13, 22, 6, 25,

FIRST DIVISION		
ZONE	SEC.	PLAT
9	9	05

CONTAINING PARCELS

SCALE: 1 in = 200 ft.

PRINTED

ADVANCE SHEET
SUBJECT TO CHANGE

Dwg. No. 1891
By: U.S.C. Dec. 1933
Source: Tax Map Bureau
Survey Dept.

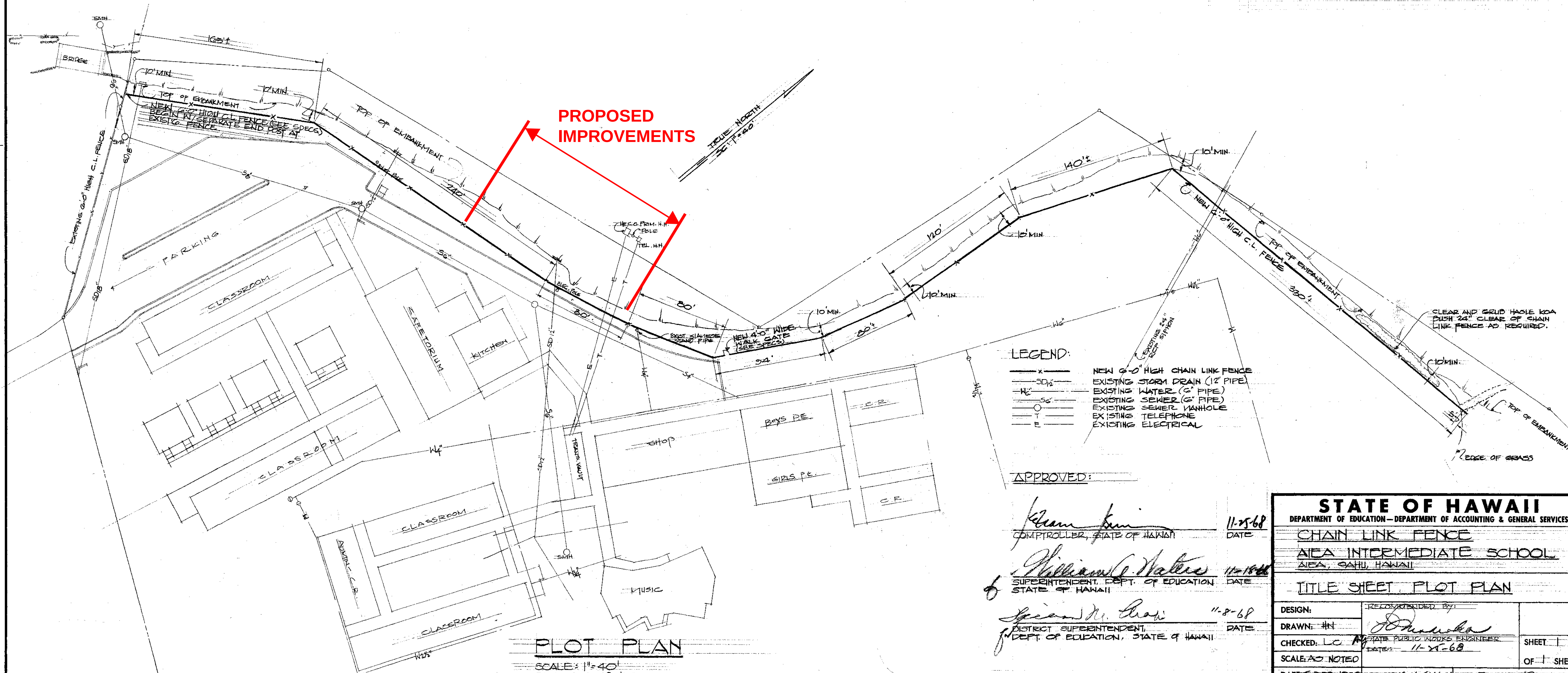
CHAIN LINK FENCE
AIEA INTERMEDIATE SCHOOL
AIEA, OAHU, HAWAII

FOR THE DEPARTMENT OF EDUCATION
BY THE DEPARTMENT OF ACCOUNTING & GENERAL SERVICES
DIVISION OF PUBLIC WORKS
STATE OF HAWAII

D.A.G.S. JOB NO. 02-16-5444.2A

GENERAL NOTES:

1. ALIGNMENT OF THE NEW 6'-0" HIGH FENCE, AS SHOWN, SHALL BE STAKED OUT BY THE CONTRACTOR IN THE FIELD AND APPROVED BY THE ENGINEER BEFORE THE FENCE IS INSTALLED.
2. THE CHAIN LINK FABRIC SHALL BE FASTENED TO THE AIEA INTERMEDIATE SCHOOL SIDE OF THE POST.
3. THE LOCATION OF EXISTING UNDERGROUND UTILITY LINES SHOWN ARE APPROXIMATE ONLY. THE CONTRACTOR SHALL VERIFY EXACT LOCATION AT THE JOBSITE BEFORE PROCEEDING WITH HIS WORK.



PLOT PLAN
SCALE: 1"=40'
T.M.K. 9-9-05:1

APPROVED:

COMPTROLLER, STATE OF HAWAII — DATE 11-25-68

SUPERINTENDENT, DEPT. OF EDUCATION STATE OF HAWAII — DATE 11-18-68

DISTRICT SUPERINTENDENT, DEPT. OF EDUCATION, STATE OF HAWAII — DATE 11-8-68

STATE OF HAWAII
DEPARTMENT OF EDUCATION—DEPARTMENT OF ACCOUNTING & GENERAL SERVICES

CHAIN LINK FENCE
AIEA INTERMEDIATE SCHOOL
AIEA, OAHU, HAWAII

TITLE SHEET, PLOT PLAN

DESIGN:	RECOMMENDED BY:	
DRAWN: HN		
CHECKED: LC	STATE PUBLIC WORKS ENGINEER DATE: 11-25-68	SHEET 1
SCALE: AS NOTED		OF 1 SHEETS
DATE: SEPT. 1968	JOB NO. 02-16-5444.2A	FILE 5 DRAW 19 FOLDER 3

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

MF

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0245F

FIRM

FLOOD INSURANCE RATE MAP

CITY AND COUNTY
OF HONOLULU,
HAWAII

PANEL 245 OF 395

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

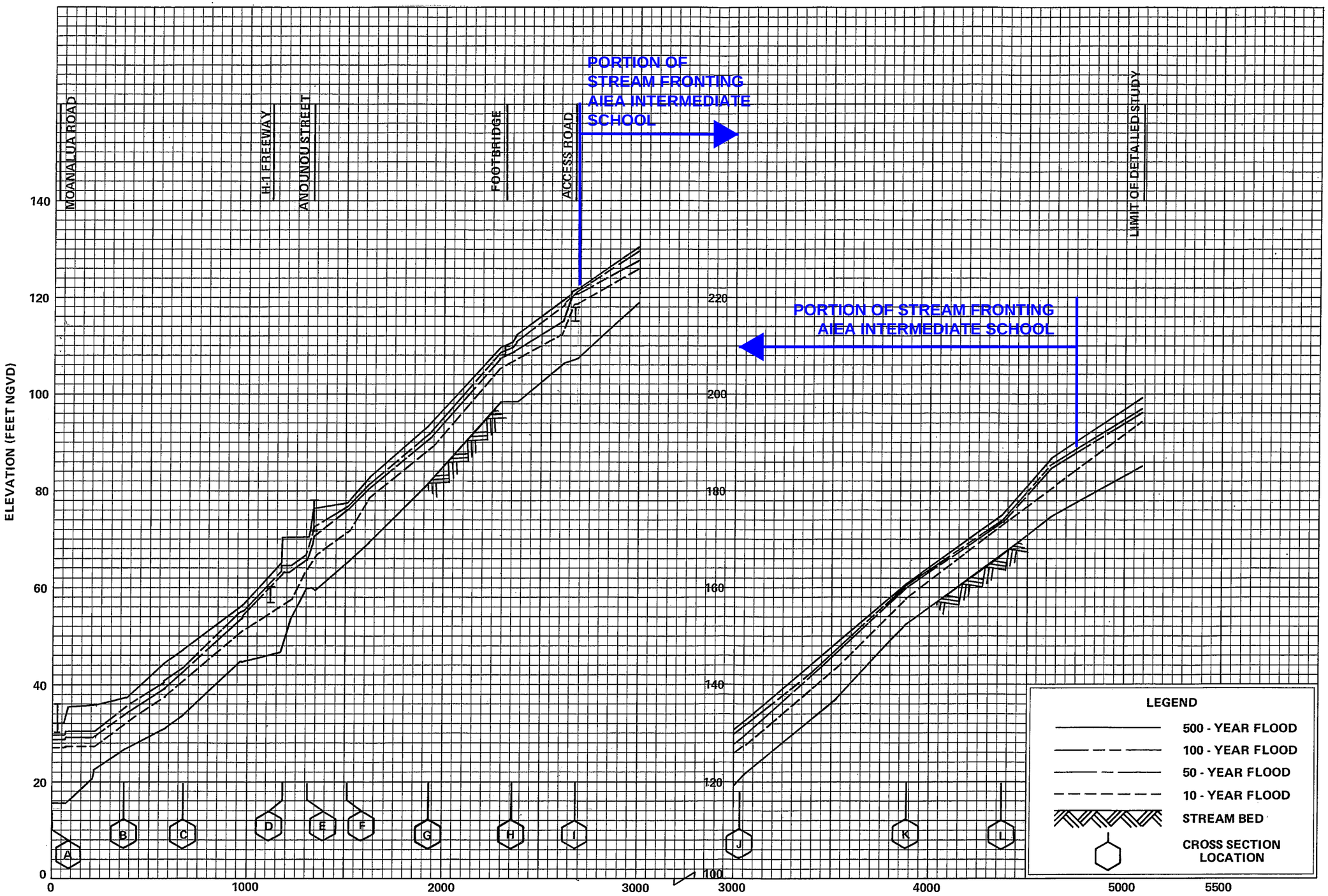
COMMUNITY	NUMBER	PANEL	SUFFIX
HONOLULU, CITY AND COUNTY OF	150001	0245	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
15003C0245F

MAP REVISED
SEPTEMBER 30, 2004

Federal Emergency Management Agency



FLOOD PROFILES

AIEA STREAM

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY AND COUNTY OF HONOLULU, HI

95P

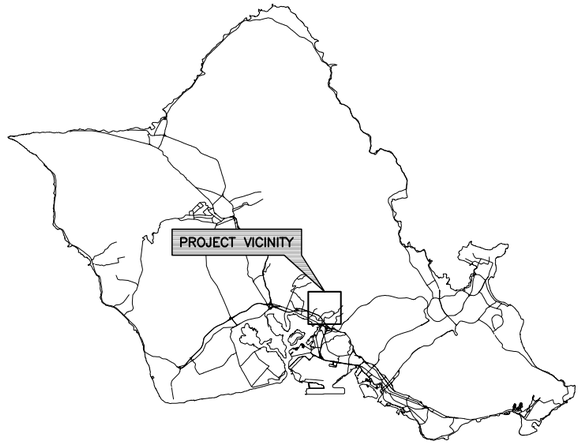
APPENDIX B

- Pre Final Construction Plans

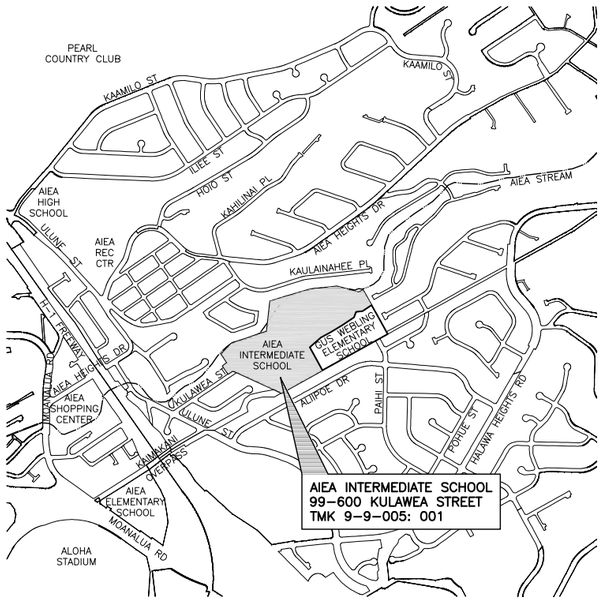
AIEA INTERMEDIATE SCHOOL
EROSION CONTROL

AIEA OAHU HAWAII

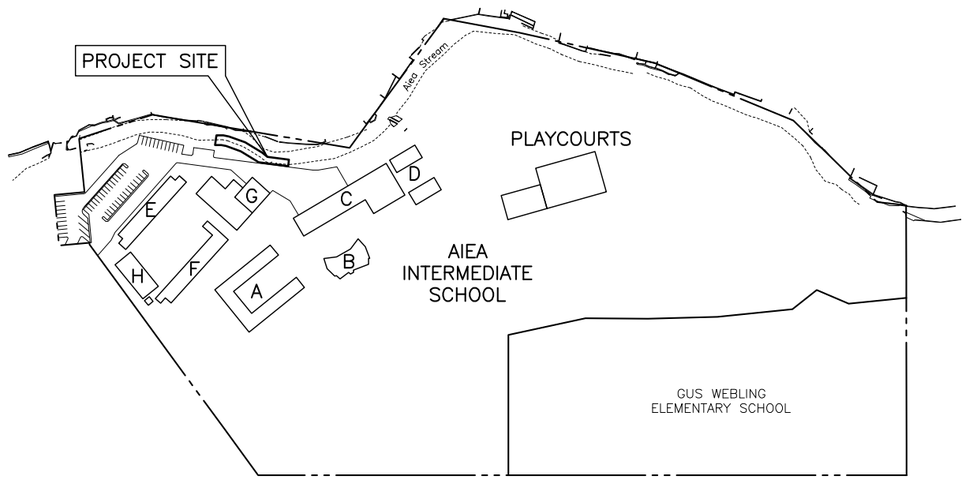
DEPARTMENT OF EDUCATION
STATE OF HAWAII
DOE JOB NO. Q71009-07



VICINITY MAP
SCALE: 1" = 5 MILES
NORTH



LOCATION MAP
SCALE: 1" = 800'
NORTH



CAMPUS MAP
1" = 150'
NORTH

INDEX TO DRAWINGS

SHT NO	DWG NO	DESCRIPTION
1	C-0	TITLE SHEET AND LOCATION MAPS
2	C-1	BORING LOGS
2	C-2	GENERAL PLAN, NOTES AND EROSION CONTROL DETAILS
3	C-3	SITE PLAN
4	C-4	SECTION DETAILS
5	C-5	SECTION DETAILS

APPROVED:

FACILITIES DEVELOPMENT ADMINISTRATION — DATE
DEPARTMENT OF EDUCATION
STATE OF HAWAII

REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

LIANA S.F. CHOY
LICENSED PROFESSIONAL ENGINEER
No. 9209-C
HAWAII U.S.A.

SIGNATURE EXP DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL
EROSION CONTROL
AIEA OAHU HAWAII

TITLE SHEET AND LOCATION MAPS

SATO & ASSOCIATES, INC.

DESIGNED BY:	CHECKED BY:	DOE PROJECT NO.	DRAWING NO.
LC	CA	Q71009-07	C-0
DRAWN BY: LC	APPROVED BY: LC	DATE: NOV 2009	SHEET: 1 OF 6 SHTS
SCALE: AS SHOWN			

FILE ____ DRAWER ____ FOLDER ____

r:\08040-doe-aiea-inter\dwg\title.dwg [title] - 11/25/2009

SOIL CLASSIFICATION CHART

	Major Divisions		Symbol	Typical Names	Other Criteria
COARSE GRAINED SOILS More than 50% of material larger than No. 200 sieve size	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravel** Little or no fines (<5%)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Cu>4 and 1<=Cc<=3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting Cu and Cc criteria for GW
		Gravels with Fines Appreciable amount of fines (>12%)	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limit below A-line or PI<4
			GC	Clayey gravels, gravel-sand-silt mixtures	Atterberg limit above A-line with PI>7
	Sands More than 50% of coarse fraction passing No. 4 sieve	**Clean Sands** Little or no fines (<5%)	SW	Well-graded sands, gravelly sands, little or no fines	Cu>6 and 1<=Cc<=3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting Cu and Cc criteria for SW
		Sands with Fines Appreciable amount of fines (>12%)	SM	Silty sands, sand-silt mixture	Atterberg limit below A-line or PI<4
			SC	Clayey sands, sand-clay mixture	Atterberg limit above A-line with PI>7
FINE GRAINED SOILS More than 50% of material smaller than No. 200 sieve size	**Silts and Clays** Liquid limit less than 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Atterberg limit below A-line
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clay	Atterberg limit above A-line
			OL	Organic silts and organic silty clays flow plasticity	Atterberg limit below A-line
	Silts and Clays Liquid limit larger than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Atterberg limit below A-line
			CH	Inorganic clays of high plasticity, fat clays	Atterberg limit above A-line
			OH	Organic clays of high plasticity, organic silts	Atterberg limit below A-line
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils	

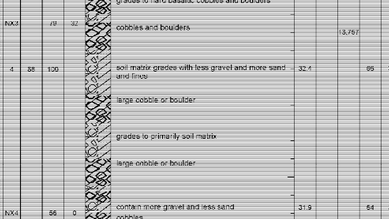
Notes: 1. Cu = D60/D10, Cc = (D30)^2/(D60 x D10) where D60, D30 and D10 are diameters associated with 60%, 30% and 10% smaller in gradation curves.
2. Dual symbols are used to indicate borderline classifications such as GP/SP.

GRADATION CHART

Soil Fraction	Size Range			
	Lower Limit		Upper Limit	
	Millimeters	Sieve	Millimeters	Sieve
Boulders	304.8	12*	914.4	36*
Cobbles	76.2	3*	304.8	12*
Gravel				
Coarse	2	10**	4.76	4**
Medium	0.42	40**	2	10**
Fine	0.074	200**	0.42	40**
Fines			0.074	200**

* U.S. standard sieve opening in inches
** U.S. standard sieve number

PLASTICITY CHART



DESCRIPTION OF ROCK MATERIALS

A. DEGREE OF WEATHERING

The following terms were used to describe the chemical weathering of rock:

Extremely Weathered: The original minerals of the rock have been almost entirely altered to secondary minerals, even though the original fabric may be intact.

Highly Weathered: The rock is weakened to such an extent that a 2-inch diameter core can be broken readily by hand across the rock fabric.

Moderately Weathered: Rock is discolored and noticeably weakened, but a 2-inch diameter core cannot usually be broken by hand, across the rock fabric.

Slightly Weathered: Rock is slightly discolored, but not noticeably lower in strength than fresh rock.

Unweathered: Rock shows no discoloration, loss of strength, or any other effect of weathering.

B. HARDNESS

The following terms were used to describe the hardness of rock and soil:

Soft: Reserved for plastic material.

Friable: Easily crumbled, pulverized, or reduced to powder.

Low Hardness: Can be gouged deeply or carved with pocket knife.

Moderately Hard: Can be readily scratched by a knife blade; scratch leaves heavy trace of dust and scratch is readily visible after the powder has been blown away.

Hard: Can be scratched with difficulty, scratch produces little powder and is often faintly visible.

Very Hard: Cannot be scratched with pocket knife.

C. ROCK FRACTURE CHARACTERISTICS

The general fracture spacing is described in the boring log according to the following criteria:

Crushed: Less than 5 microns (mechanical clay) to 0.1 foot.

Intensely Fractured: 0.05 to 0.1 foot (contain no clay).

Closely Fractured: 0.1 to 0.5 feet.

Moderately Fractured: 1.0 to 3.0 feet.

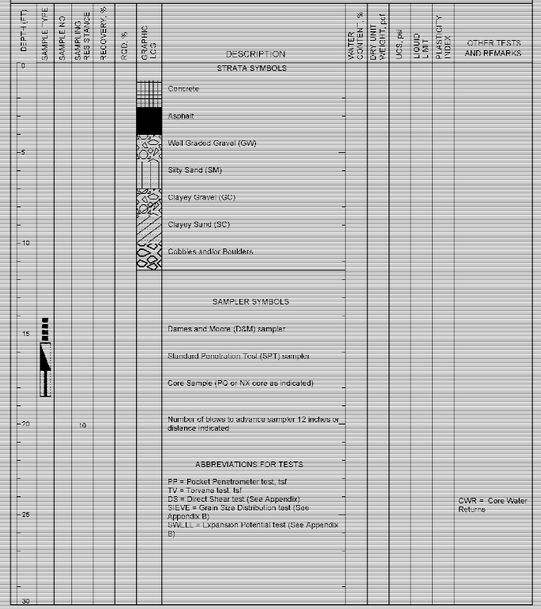
Very Widely Fractured: Over 3 feet.

GENERAL NOTES:

1. A geotechnical engineering report entitled *Geotechnical Exploration and Evaluation Report, Stream Bank Assessment and Roadway Support, Aiea Intermediate School,* dated June 2009. A copy of the report is on file at the office of the Contracting Officer for review by the Contractor.
2. Logs of boring andn other information shown on this sheet were taken from the geotechnical engineering report noted above.
3. For boring locations, see Sheet C-3.
4. The information presented in the logs of borings depict the subsurface conditions encountered at that specified location and at the time of the field exploration only. Variations of subsoil conditions from those depicted in the logs of borings may occur between and beyond the borings.
5. The penetration resistance shown on the logs of borings indicate the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts. The data given is for general information only. Bidders shall examine the site and the boring data and draw their own conclusions therefrom as to the character of materials to be encountered. The Contracting Officer will not assume responsibility for variations of subsoil quality or conditions other than at the boring locations shown and at the time the borings were taken.

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL — LOG OF BORING KEY

LOCATION: 99-000 KULAWEA STREET, AIEA, OAHU, HAWAII — **DATE(S) DRILLED:**
GROUND SURFACE ELEVATION: — **LOGGED BY:** — **CHECKED BY:**
GROUNDWATER LEVEL / DATE: — **HAMMER TYPE:** — **HAMMER WEIGHT/DROP:**
CONTRACTOR: — **DRILLING METHOD:**
DRILL EQUIP: — **BOREHOLE BACKFILL:**

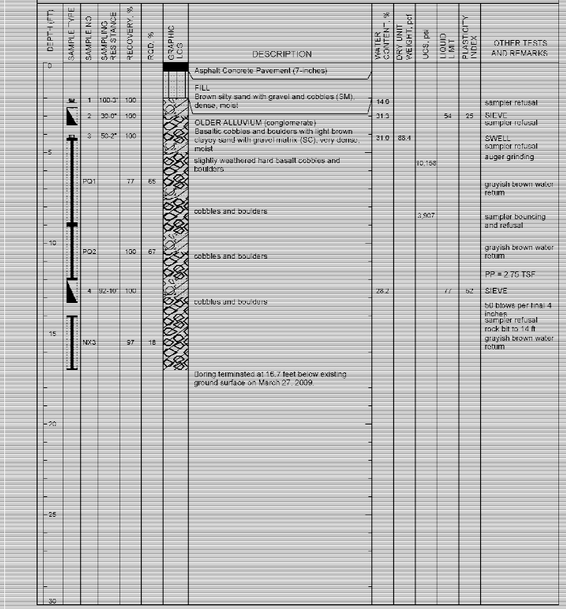


STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL — LOG OF BORING B-1

LOCATION: 99-000 KULAWEA STREET, AIEA, OAHU, HAWAII — **DATE(S) DRILLED:** 3-26-09 - 3-27-09
GROUND SURFACE ELEVATION: N/A — **LOGGED BY:** K. SANDEFUR; E. NG — **CHECKED BY:** JK
GROUNDWATER LEVEL / DATE: — **HAMMER TYPE:** SAFETY — **HAMMER WEIGHT/DROP:** 140 lb/30-inch
CONTRACTOR: HAWAII TEST BORING, INC. — **DRILLING METHOD:** 4-INCH S.S.A., ROCK BIT, WASH BORING
DRILL EQUIP: MOBILE DRILL B-53 — **BOREHOLE BACKFILL:** CUTTINGS, GRAVEL, ROCK BIT, CEMENT GROUT

STREAM BANK ASSESSMENT AND ROADWAY SUPPORT AT AIEA INTERMEDIATE SCHOOL — LOG OF BORING B-2

LOCATION: 99-000 KULAWEA STREET, AIEA, OAHU, HAWAII — **DATE(S) DRILLED:** 3-27-09
GROUND SURFACE ELEVATION: 139.98 FEET (MSL) — **LOGGED BY:** E. NG — **CHECKED BY:** JK
GROUNDWATER LEVEL / DATE: — **HAMMER TYPE:** SAFETY — **HAMMER WEIGHT/DROP:** 140 lb/30-inch
CONTRACTOR: HAWAII TEST BORING, INC. — **DRILLING METHOD:** 4-INCH S.S.A., ROCK BIT, WASH BORING
DRILL EQUIP: MOBILE DRILL B-53 — **BOREHOLE BACKFILL:** CUTTINGS, GRAVEL, ROCK BIT, CEMENT GROUT



REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

LIANA S.F. CHOY
LICENSED PROFESSIONAL ENGINEER
No. 9209-C
HAWAII U.S.A.

SIGNATURE EXP DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL EROSION CONTROL

AIEA OAHU HAWAII

BORING LOGS

SATO & ASSOCIATES, INC.		DOE PROJECT NO.	DRAWING NO.
DESIGNED BY: LC	CHECKED BY: CA	Q71009-07	C-1
DRAWN BY: LC	APPROVED BY: LC	DATE: NOV 2009	SHEET: 2 OF 6 SHTS
SCALE: AS SHOWN			

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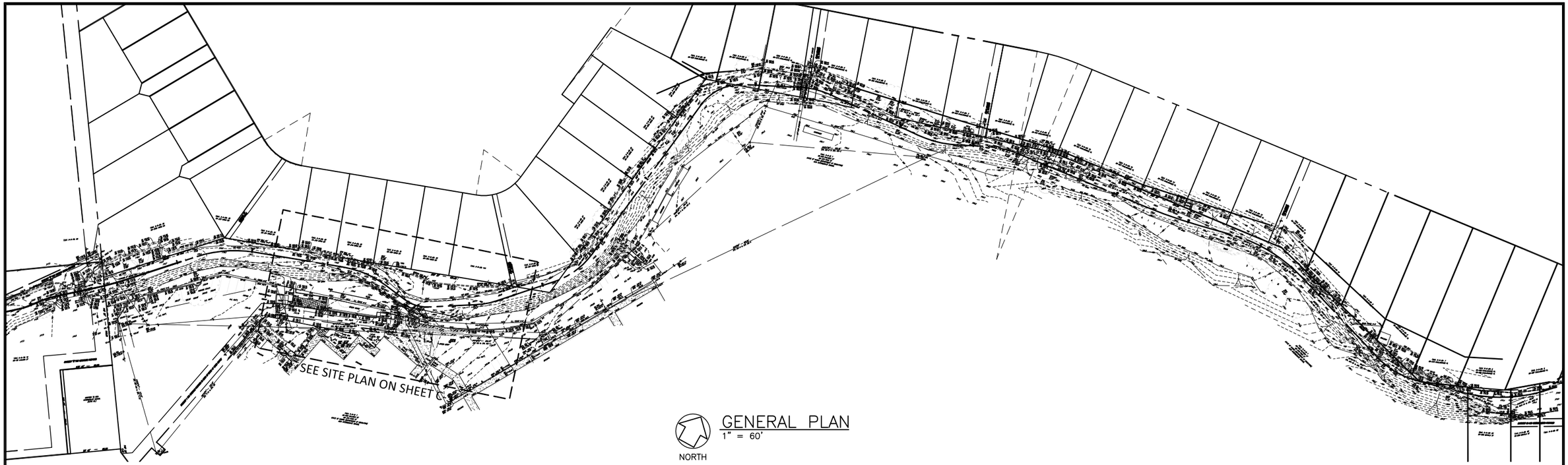


GENERAL PLAN
1" = 60'
NORTH

CONSTRUCTION NOTES

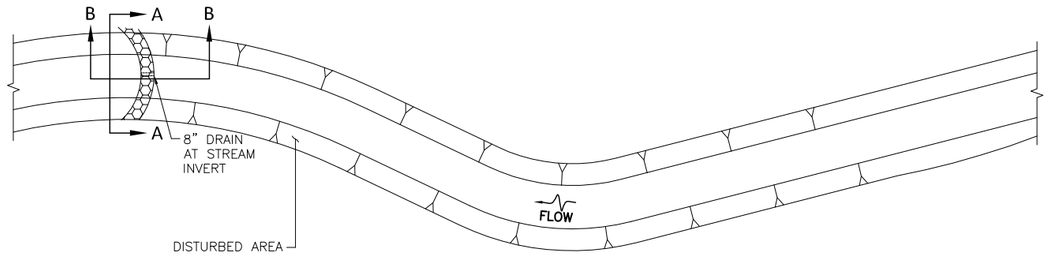
1. ALL APPLICABLE CONSTRUCTION WORK SHALL BE DONE IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION, SEPTEMBER 1986 AND STANDARD DETAILS FOR PUBLIC WORKS CONSTRUCTION, SEPTEMBER 1984, AS AMENDED, OF THE DEPARTMENT OF PUBLIC WORKS, CITY AND COUNTY OF HONOLULU AND THE COUNTIES OF KAUAI, MAUI, AND HAWAII.

2. THE UNDERGROUND PIPES, CABLES OR DUCTLINES KNOWN TO EXIST BY THE ENGINEER FROM HIS SEARCH OF RECORDS ARE INDICATED ON THE PLANS. THE CONTRACTOR SHALL VERIFY THE LOCATIONS AND DEPTHS OF THE FACILITIES AND EXERCISE PROPER CARE IN EXCAVATING IN THE AREA. WHEREVER CONNECTIONS OF NEW UTILITIES TO EXISTING UTILITIES ARE SHOWN ON THE PLANS, THE CONTRACTOR SHALL EXPOSE THE EXISTING LINES AT THE PROPOSED CONNECTIONS TO VERIFY THEIR LOCATIONS AND DEPTHS PRIOR TO EXCAVATION FOR THE NEW LINES.

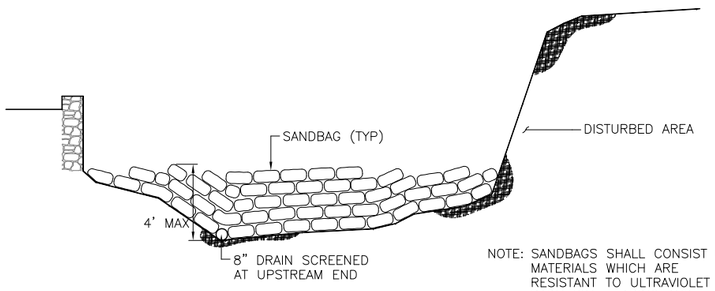
3. NO CONTRACTOR SHALL PERFORM ANY CONSTRUCTION OPERATION SO AS TO CAUSE FALLING ROCKS, SOIL OR DEBRIS IN ANY FORM TO FALL, SLIDE OR FLOW INTO EXISTING CITY DRAINAGE SYSTEMS, OR ADJOINING PROPERTIES, STREETS OR NATURAL WATERCOURSES. SHOULD SUCH VIOLATIONS OCCUR, THE CONTRACTOR MAY BE CITED AND THE CONTRACTOR SHALL IMMEDIATELY MAKE ALL REMEDIAL ACTIONS NECESSARY.

4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFORMANCE WITH THE APPLICABLE PROVISIONS OF THE WATER QUALITY AND WATER POLLUTION CONTROL STANDARDS CONTAINED IN HAWAII ADMINISTRATIVE RULES, TITLE 11, CHAPTER 54, "WATER QUALITY STANDARDS", AND TITLE 11, CHAPTER 55, "WATER POLLUTION CONTROL", AS WELL AS CHAPTER 14 OF THE REVISED ORDINANCES OF HONOLULU, AS AMENDED. BEST MANAGEMENT PRACTICES SHALL BE EMPLOYED AT ALL TIMES DURING CONSTRUCTION.

8. PURSUANT TO CHAPTER 6E, HRS, IN THE EVENT ANY ARTIFACTS OR HUMAN REMAINS ARE UNCOVERED DURING CONSTRUCTION OPERATIONS, THE CONTRACTOR SHALL IMMEDIATELY SUSPEND WORK AND NOTIFY THE HONOLULU POLICE DEPARTMENT, THE STATE DEPARTMENT OF LAND AND NATURAL RESOURCES–HISTORIC PRESERVATION DIVISION (692–8015).

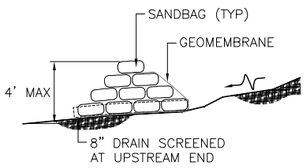


PLAN
SCALE: 1/16" = 1'–0"



SECTION A–A
SCALE: 1/4" = 1'–0"

NOTE: SANDBAGS SHALL CONSIST OF MATERIALS WHICH ARE RESISTANT TO ULTRAVIOLET RADIATION, TEARING AND PUNCTURE, AND WOVEN TIGHTLY ENOUGH TO PREVENT LEAKAGE OF FILL MATERIAL (I.E. SAND FINE GRAVEL, ETC).



SECTION B–B
SCALE: 1/4" = 1'–0"

EROSION CONTROL DETAILS

BEST MANAGEMENT PRACTICES (BMPS)

1. EROSION AND SEDIMENT CONTROL DEVICES SHALL BE IN PLACE PRIOR TO COMMENCEMENT OF WORK.

2. WATER SPRAYED THROUGH NOZZLES SHALL BE USED TO CONTROL DUST.

3. EROSION AND SEDIMENT CONTROL DEVICES SHALL NOT BE REMOVED UNTIL PERMANENT EROSION CONTROLS ARE IN PLACE.

REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

LIANA S.F. CHOY
LICENSED PROFESSIONAL ENGINEER
No. 9209–C
HAWAII U.S.A.

SIGNATURE EXP DATE

THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION AND CONSTRUCTION OF THIS PROJECT WILL BE UNDER MY OBSERVATION

DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL
EROSION CONTROL

AIEA OAHU HAWAII

GENERAL PLAN, NOTES
AND EROSION CONTROL DETAILS

SATO & ASSOCIATES, INC.

DESIGNED BY:	CHECKED BY:	DOE PROJECT NO.	DRAWING NO.
LC	CA	Q71009–07	C-2
DRAWN BY: LC	APPROVED BY: LC	DATE	SHEET
SCALE: AS SHOWN		NOV 2009	3 OF 6 SHTS

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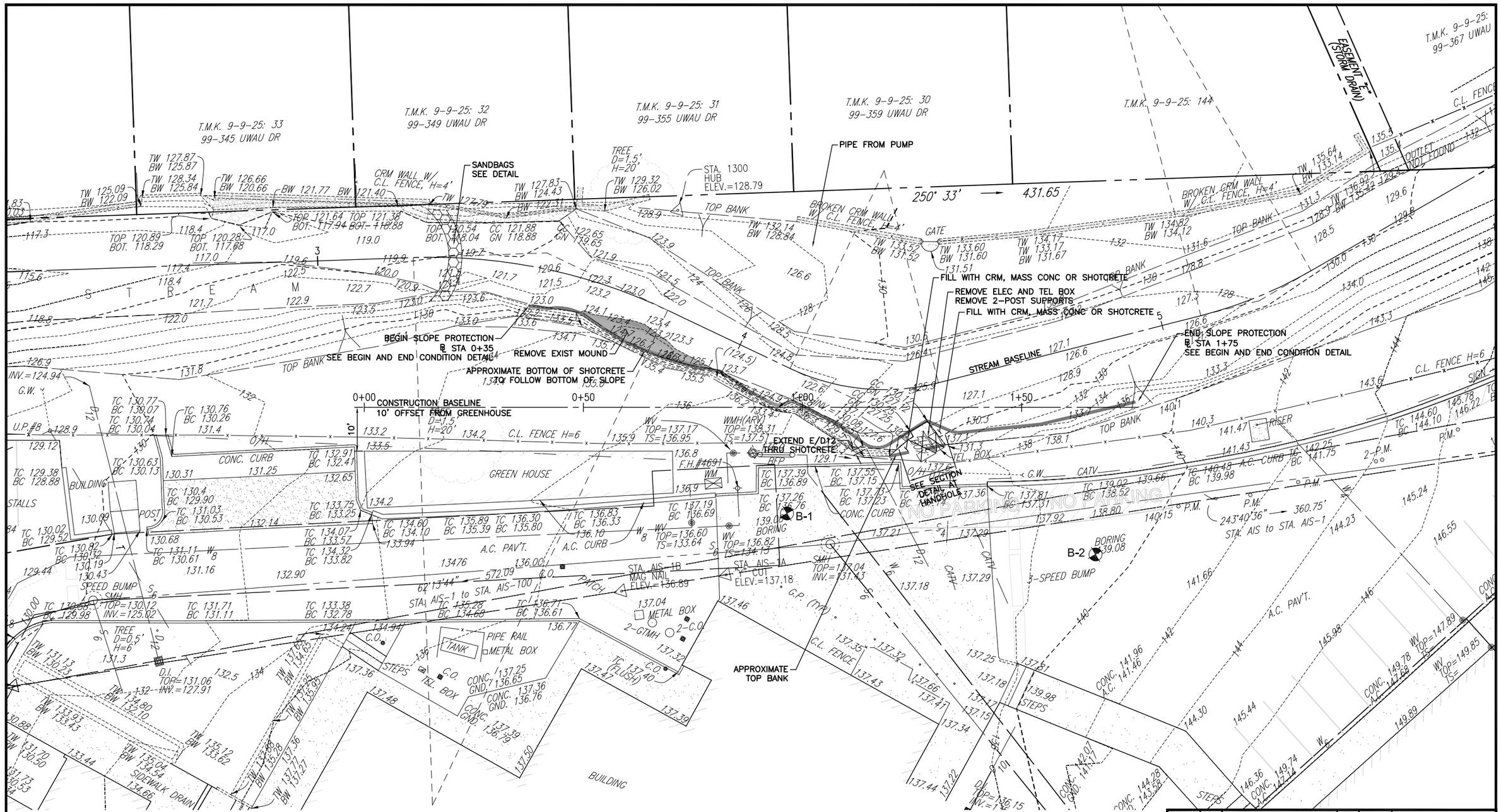

SITE PLAN
1" = 10'

NORTH

REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

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LICENSED PROFESSIONAL ENGINEER
No. 9209-C
HAWAII U.S.A.

SIGNATURE EXP DATE

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DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL EROSION CONTROL

AIEA OAHU HAWAII

SITE PLAN

SATO & ASSOCIATES, INC.

DESIGNED BY:	LC	CHECKED BY:	CA	DOE PROJECT NO.	DRAWING NO.
DRAWN BY:	LC	APPROVED BY:	LC	Q71009-07	C-3
SCALE:	AS SHOWN			DATE: NOV 2009	SHEET 4 OF 6 SHTS

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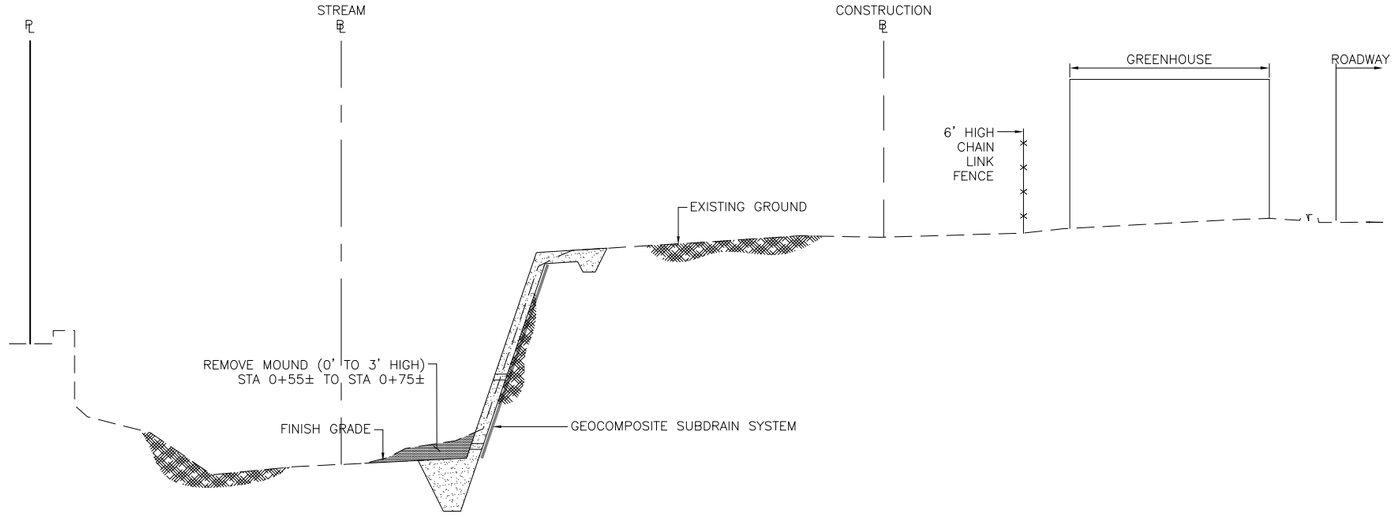
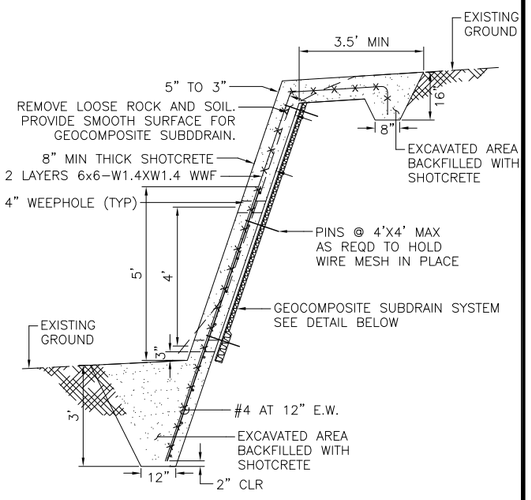


SECTION

℄ STA 0+35± TO 0+80±
℄ STA 1+00± TO 1+22±
℄ STA 1+30± TO 1+75±

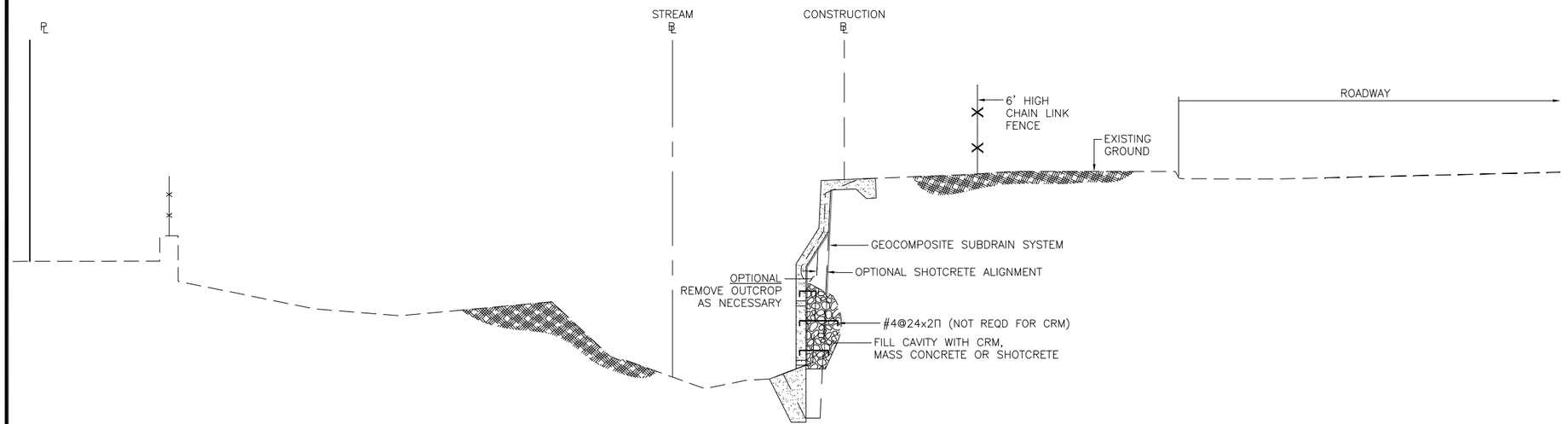
SCALE: 1/4" = 1'-0"

NOTE: SEE TYPICAL SECTION DETAIL FOR ADDITIONAL INFORMATION



TYPICAL SECTION DETAIL

SCALE: 1/2" = 1'-0"

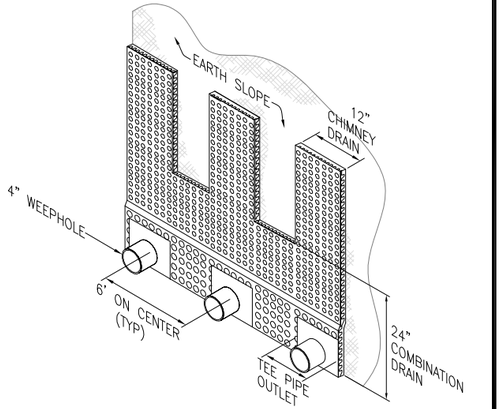


SECTION

℄ STA 0+80± TO 1+00±

SCALE: 1/4" = 1'-0"

NOTE: SEE TYPICAL SECTION DETAIL FOR ADDITIONAL INFORMATION



NOTE: GEOCOMPOSITE SUBDRAIN SYSTEM BY AMERICAN WICK DRAIN COORPORATION OR APPROVED EQUAL. SEE SPECIFICATIONS.

GEOCOMPOSITE SUBDRAIN SYSTEM

NOT TO SCALE

REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

LIANA S.F. CHOY
LICENSED PROFESSIONAL ENGINEER
No. 9209-C
HAWAII U.S.A.

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DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL
EROSION CONTROL
AIEA OAHU HAWAII

SECTION DETAILS

SATO & ASSOCIATES, INC.			DOE PROJECT NO. Q71009-07	DRAWING NO. C-4
DESIGNED BY: LC	CHECKED BY: CA			
DRAWN BY: LC	APPROVED BY: LC		DATE NOV 2009	SHEET 5 OF 6 SHTS
SCALE: AS SHOWN				

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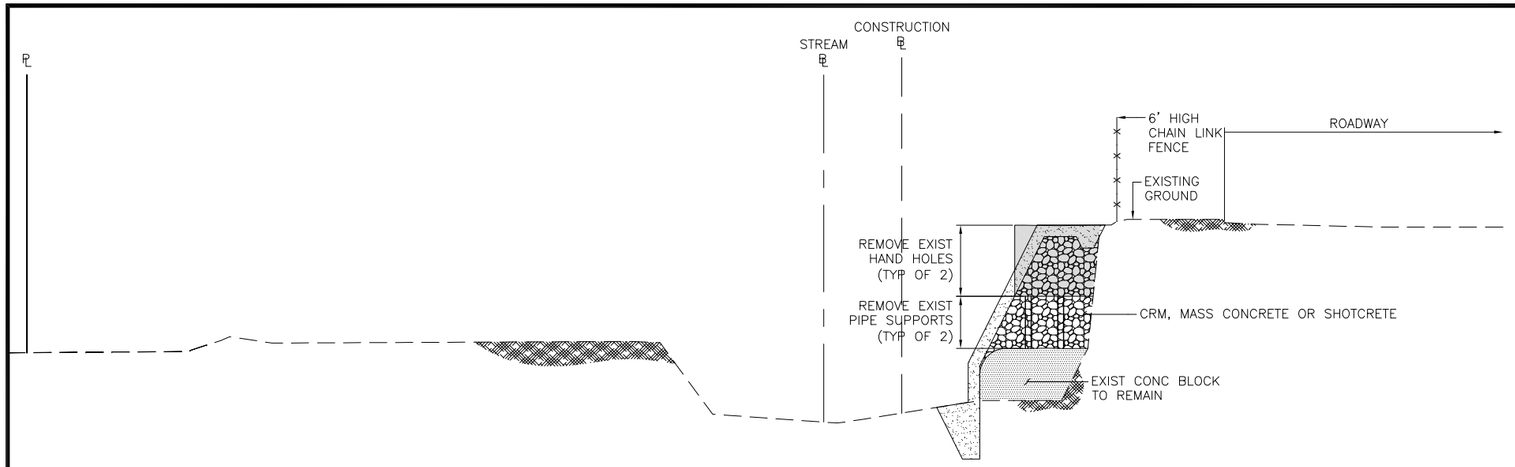
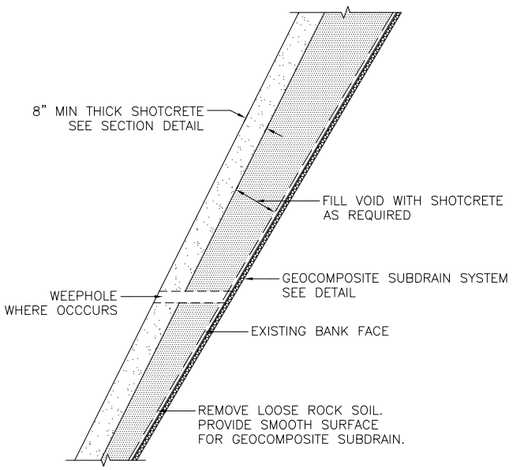


SECTION AT HANDHOLES

℄ STA 1+22± TO 1+30±

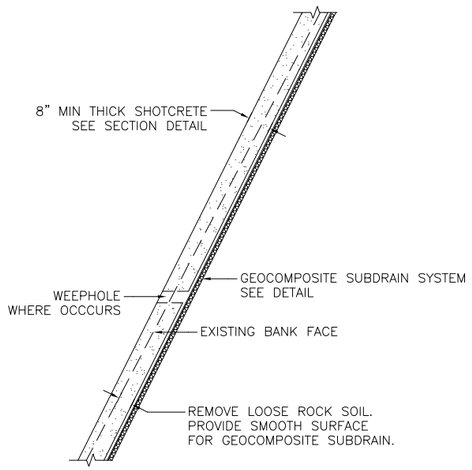
SCALE: 1/4" = 1'-0"

NOTE: SEE TYPICAL SECTION DETAIL FOR ADDITIONAL INFORMATION



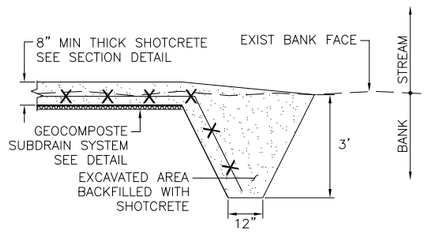
CONDITION FOR FILL

SCALE: 1/2" = 1'-0"



CONDITION FOR EXC

SCALE: 1/2" = 1'-0"



CONDITION AT BEGIN/END

SCALE: 1/2" = 1'-0"

REV. NO.	SYM.	DESCRIPTION	SHT ___ OF ___	DATE

LIANA S.F. CHOY
LICENSED PROFESSIONAL ENGINEER
No. 9209-C
HAWAII U.S.A.

SIGNATURE EXP DATE

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DEPARTMENT OF EDUCATION
FACILITIES BRANCH
STATE OF HAWAII

AIEA INTERMEDIATE SCHOOL EROSION CONTROL

AIEA OAHU HAWAII

SECTION DETAILS

SATO & ASSOCIATES, INC.			DOE PROJECT NO. Q71009-07	DRAWING NO. C-5
DESIGNED BY: LC	CHECKED BY: CA			
DRAWN BY: LC	APPROVED BY: LC	DATE NOV 2009		SHEET 6
SCALE: AS SHOWN				OF 6 SHTS

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APPENDIX C

- WinTR-55 Results

WinTR-55 Current Data Description
Identification Data
Sub-Area Data
Storm Data
Rainfall Depth by Rainfall Return Period
Peak Flow by Rainfall Return Period
Peak flow and Peak Time (hr) by Rainfall Return Period
Sub-Area Summary Table
Reach Summary Table
Sub-Area Time of Concentration Details
Sub-Area Land Use and Curve Number Details
Reach Channel Rating Details

WinTR-55 Current Data Description

--- Identification Data ---

User: LC
Project: Aiea Intermediate School
SubTitle: Erosion Control
State: Hawaii
County: Honolulu
Filename: R:\08040-DOE-Aiea-Inter\stream study\calcs\hydrology\aiea.w55

Date: 12/1/2009
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Area 1		Reach A	267.16	81	.577
Area 2		Reach B	136.7	79	.449
Area 3		Reach C	181.08	73	.755
Area 4		Reach D	84.33	73	.715
Area 5		Reach E	104.23	73	.712

Total area: 773.50 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
6.0	6.5	8.5	10.0	12.0	14.0	3.5

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type I
Dimensionless Unit Hydrograph: <standard>

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
6.0	6.5	8.5	10.0	12.0	14.0	3.5

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type I
Dimensionless Unit Hydrograph: <standard>

LC

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 100-Yr (cfs)
SUBAREAS	
Area 1	1353.95
Area 2	769.61
Area 3	717.19
Area 4	344.06
Area 5	426.48
REACHES	
Reach A	3373.35
Down	3371.68
Reach B	769.61
Down	768.81
Reach C	1474.00
Down	1472.11
Reach D	344.06
Down	343.21
Reach E	426.48
Down	426.40
OUTLET	3371.68

LC

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 100-Yr (cfs) (hr)
SUBAREAS	
Area 1	1353.95
	10.22
Area 2	769.61
	10.14
Area 3	717.19
	10.33
Area 4	344.06
	10.30
Area 5	426.48
	10.32
REACHES	
Reach A	3373.35
	10.28
Down	3371.68
	10.36
Reach B	769.61
	10.14
Down	768.81
	10.22
Reach C	1474.00
	10.36
Down	1472.11
	10.41
Reach D	344.06
	10.30
Down	343.21
	10.39
Reach E	426.48
	10.32
Down	426.40
	10.41
OUTLET	3371.68

LC

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Area 1	267.16	0.577	81	Reach A	
Area 2	136.70	0.449	79	Reach B	
Area 3	181.08	0.755	73	Reach C	
Area 4	84.33	0.715	73	Reach D	
Area 5	104.23	0.712	73	Reach E	

Total Area: 773.50 (ac)

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Reach Summary Table

Reach Identifier	Receiving Reach Identifier	Reach Length (ft)	Routing Method
Reach A	Outlet	6324	CHANNEL
Reach B	Reach A	6670	CHANNEL
Reach C	Reach A	4696	CHANNEL
Reach D	Reach C	4258	CHANNEL
Reach E	Reach C	7415	CHANNEL

LC

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Area 1							
SHEET	100	0.0100	0.400				0.345
SHALLOW	2131	0.1783	0.050				0.087
CHANNEL	6324	0.0443	0.050	75.00	28.00	12.115	0.145
					Time of Concentration		.577
Area 2							
SHEET	100	0.0100	0.400				0.345
SHALLOW	950	0.1579	0.050				
CHANNEL	6670	0.0960	0.050	75.00	28.00	17.815	0.104
					Time of Concentration		.449
Area 3							
SHEET	100	0.0100	0.800				0.600
SHALLOW	1855	0.1725	0.050				0.077
CHANNEL	4696	0.0852	0.050	75.00	28.00	16.724	0.078
					Time of Concentration		.755
Area 4							
SHEET	100	0.0100	0.800				0.600
SHALLOW	933	0.1072	0.050				0.049
CHANNEL	4258	0.0986	0.050	75.00	28.00	17.921	0.066
					Time of Concentration		.715
Area 5							
SHEET	100	0.0100	0.800				0.600
CHANNEL	7415	0.1025	0.050	75.00	28.00	18.390	0.112
					Time of Concentration		.712

Aiea Intermediate School
Erosion Control
Honolulu County, Hawaii

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Area 1	Residential districts (1/8 acre)		B	43.97	85
	Residential districts (1/8 acre)		C	30.85	90
	Residential districts (1/8 acre)		D	31.25	92
	Residential districts (1/4 acre)		B	44.42	75
	Residential districts (1/4 acre)		C	44.81	83
	Residential districts (1/4 acre)		D	11.72	87
	Brush - brush, weed, grass mix	(good)	B	1.55	48
	Brush - brush, weed, grass mix	(good)	C	29.4	65
	Brush - brush, weed, grass mix	(good)	D	29.19	73
	Total Area / Weighted Curve Number			267.16	81
				======	==
Area 2	Residential districts (1/4 acre)		C	43.37	83
	Residential districts (1/4 acre)		D	33.19	87
	Brush - brush, weed, grass mix	(good)	C	3.08	65
	Brush - brush, weed, grass mix	(good)	D	57.06	73
	Total Area / Weighted Curve Number			136.7	79
				=====	==
Area 3	Residential districts (1/8 acre)		C	7.34	90
	Residential districts (1/8 acre)		D	.87	92
	Residential districts (1/4 acre)		C	13.83	83
	Residential districts (1/4 acre)		D	3.04	87
	Brush - brush, weed, grass mix	(good)	C	40.73	65
	Brush - brush, weed, grass mix	(good)	D	115.27	73
	Total Area / Weighted Curve Number			181.08	73
				======	==
Area 4	Brush - brush, weed, grass mix	(good)	D	84.33	73
	Total Area / Weighted Curve Number			84.33	73
				=====	==
Area 5	Brush - brush, weed, grass mix	(good)	C	.77	65
	Brush - brush, weed, grass mix	(good)	D	103.46	73
	Total Area / Weighted Curve Number			104.23	73
				======	==

LC

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Reach Channel Rating Details

Reach Identifier	Reach Length (ft)	Reach Manning's n	Friction Slope (ft/ft)	Bottom Width (ft)	Side Slope
Reach A	6324	0.05	0.0443	20	2 :1
Reach B	6670	0.05	0.096	20	2 :1
Reach C	4696	0.05	0.0852	20	2 :1
Reach D	4258	0.05	0.0986	20	2 :1
Reach E	7415	0.05	0.1025	20	2 :1

Reach Identifier	Stage (ft)	Flow (cfs)	End Area (sq ft)	Top Width (ft)	Friction Slope (ft/ft)
Reach A	0.0	0.000	0	20	0.0443
	0.5	39.829	10.5	22	
	1.0	128.186	22	24	
	2.0	420.673	48	28	
	5.0	2179.854	150	40	
	10.0	8426.597	400	60	
	20.0	37047.721	1200	100	
Reach B	0.0	0.000	0	20	0.096
	0.5	58.631	10.5	22	
	1.0	188.701	22	24	
	2.0	619.267	48	28	
	5.0	3208.937	150	40	
	10.0	12404.692	400	60	
	20.0	54537.503	1200	100	
Reach C	0.0	0.000	0	20	0.0852
	0.5	55.235	10.5	22	
	1.0	177.770	22	24	
	2.0	583.394	48	28	
	5.0	3023.051	150	40	
	10.0	11686.115	400	60	
	20.0	51378.264	1200	100	
Reach D	0.0	0.000	0	20	0.0986
	0.5	59.420	10.5	22	
	1.0	191.239	22	24	
	2.0	627.597	48	28	
	5.0	3252.101	150	40	
	10.0	12571.550	400	60	
	20.0	55271.098	1200	100	
Reach E	0.0	0.000	0	20	0.1025
	0.5	60.583	10.5	22	
	1.0	194.985	22	24	
	2.0	639.889	48	28	
	5.0	3315.794	150	40	
	10.0	12817.765	400	60	
	20.0	56353.587	1200	100	

APPENDIX D

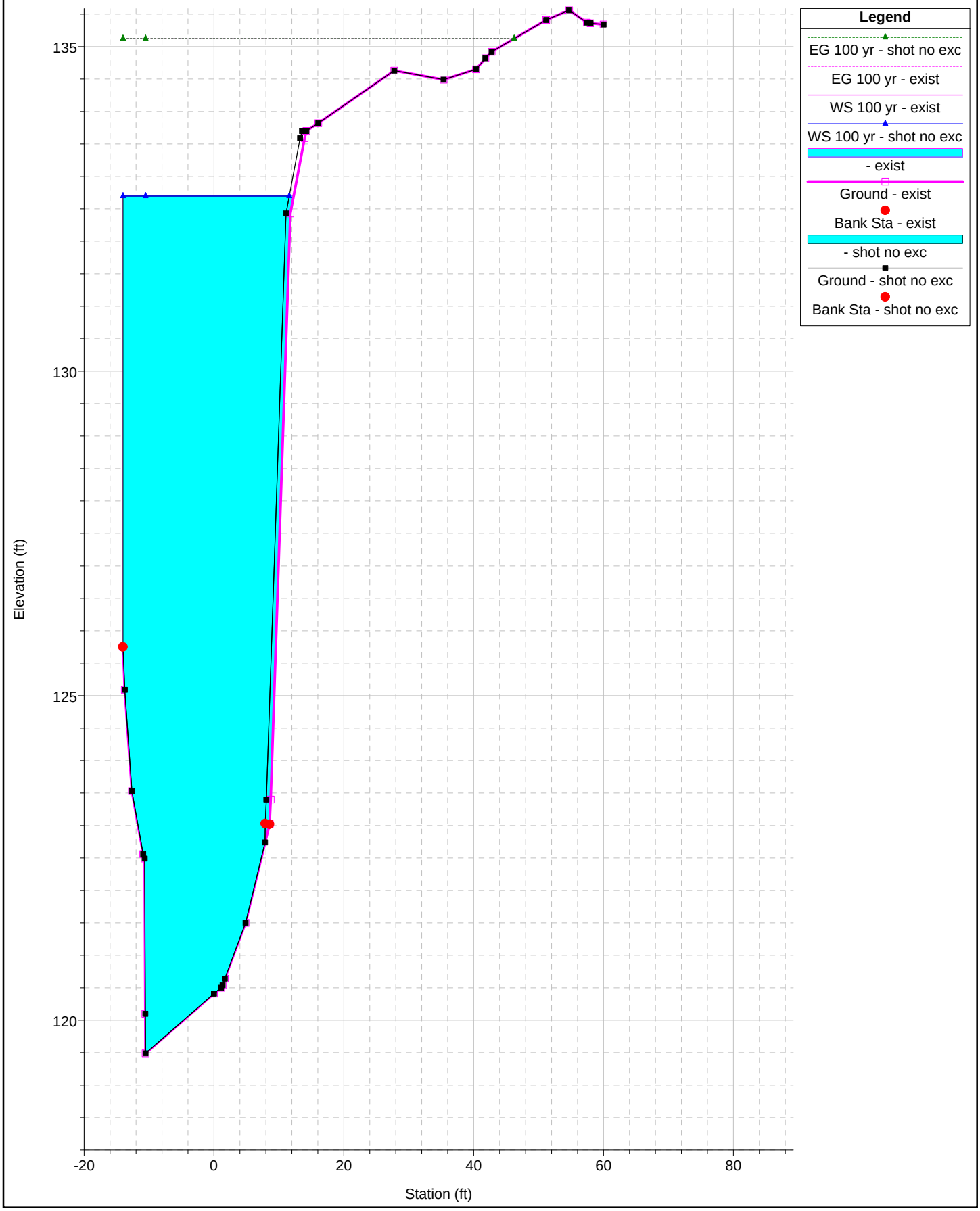
- HEC-RAS Results

Cross Section Geometry and Detailed Output
Sta 3+50
Sta 3+75
Sta 4+00
Sta 4+25
Sta 4+50
Sta 4+75
Sta 4+90
Profile Plot
X-Y-Z Perspective Plot
Profile Output Table | Sta 2+50 to Sta 6+00
Scour Analysis

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 350



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 350 Profile: 100 yr

E.G. Elev (ft)	135.12	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.41	Wt. n-Val.		0.050	0.050
W.S. Elev (ft)	132.71	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)		Flow Area (sq ft)		262.32	16.36
E.G. Slope (ft/ft)	0.011936	Area (sq ft)		262.32	16.36
Q Total (cfs)	3372.00	Flow (cfs)		3300.84	71.16
Top Width (ft)	26.30	Top Width (ft)		22.55	3.75
Vel Total (ft/s)	12.10	Avg. Vel. (ft/s)		12.58	4.35
Max Chl Dpth (ft)	13.22	Hydr. Depth (ft)		11.63	4.36
Conv. Total (cfs)	30864.6	Conv. (cfs)		30213.2	651.3
Length Wtd. (ft)	10.00	Wetted Per. (ft)		34.38	10.55
Min Ch El (ft)	119.49	Shear (lb/sq ft)		5.69	1.16
Alpha	1.06	Stream Power (lb/ft s)		71.54	5.02
Frctn Loss (ft)	0.17	Cum Volume (acre-ft)	0.45	3.41	0.65
C & E Loss (ft)	0.17	Cum SA (acres)	0.05	0.29	0.20

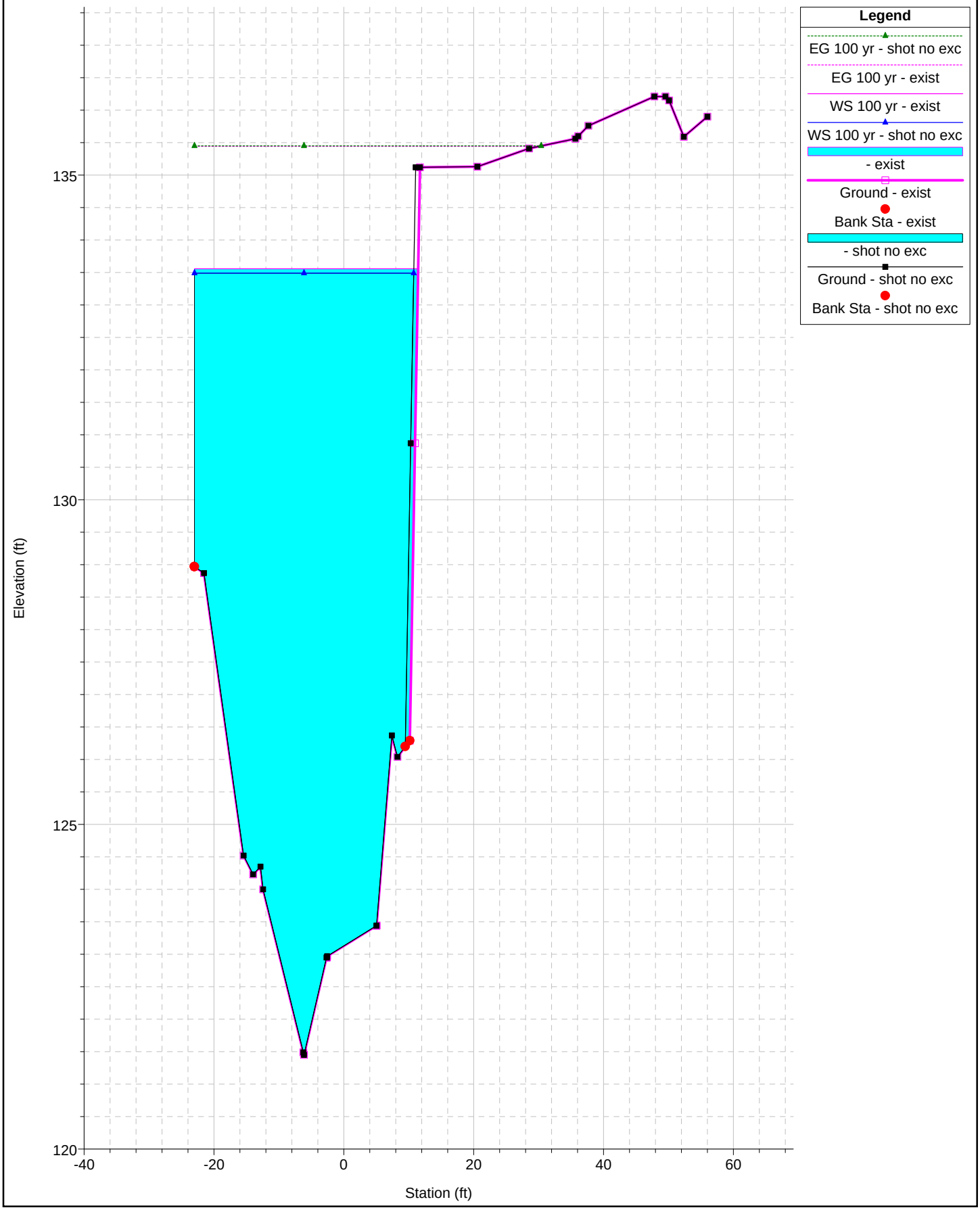
Plan: shot no exc Aiea Stream Aiea RS: 350 Profile: 100 yr

E.G. Elev (ft)	135.12	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.43	Wt. n-Val.		0.050	0.025
W.S. Elev (ft)	132.70	Reach Len. (ft)	10.00	10.00	10.00
Crit W.S. (ft)		Flow Area (sq ft)		255.78	16.03
E.G. Slope (ft/ft)	0.012235	Area (sq ft)		255.78	16.03
Q Total (cfs)	3372.00	Flow (cfs)		3232.28	139.72
Top Width (ft)	25.61	Top Width (ft)		21.91	3.70
Vel Total (ft/s)	12.41	Avg. Vel. (ft/s)		12.64	8.72
Max Chl Dpth (ft)	13.21	Hydr. Depth (ft)		11.67	4.33
Conv. Total (cfs)	30484.4	Conv. (cfs)		29221.3	1263.1
Length Wtd. (ft)	10.00	Wetted Per. (ft)		33.93	10.50
Min Ch El (ft)	119.49	Shear (lb/sq ft)		5.76	1.17
Alpha	1.02	Stream Power (lb/ft s)		72.76	10.17
Frctn Loss (ft)	0.17	Cum Volume (acre-ft)	0.45	3.41	0.65
C & E Loss (ft)	0.17	Cum SA (acres)	0.05	0.29	0.20

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 375



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 375 Profile: 100 yr

E.G. Elev (ft)	135.44	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.89	Wt. n-Val.		0.050	0.050
W.S. Elev (ft)	133.56	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)		Flow Area (sq ft)		304.60	4.77
E.G. Slope (ft/ft)	0.009706	Area (sq ft)		304.60	4.77
Q Total (cfs)	3372.00	Flow (cfs)		3361.57	10.43
Top Width (ft)	34.45	Top Width (ft)		33.15	1.30
Vel Total (ft/s)	10.90	Avg. Vel. (ft/s)		11.04	2.19
Max Chl Dpth (ft)	12.11	Hydr. Depth (ft)		9.19	3.66
Conv. Total (cfs)	34226.9	Conv. (cfs)		34121.0	105.9
Length Wtd. (ft)	25.00	Wetted Per. (ft)		41.62	7.38
Min Ch El (ft)	121.45	Shear (lb/sq ft)		4.43	0.39
Alpha	1.02	Stream Power (lb/ft s)		48.94	0.86
Frctn Loss (ft)	0.27	Cum Volume (acre-ft)	0.45	3.57	0.66
C & E Loss (ft)	0.05	Cum SA (acres)	0.05	0.31	0.20

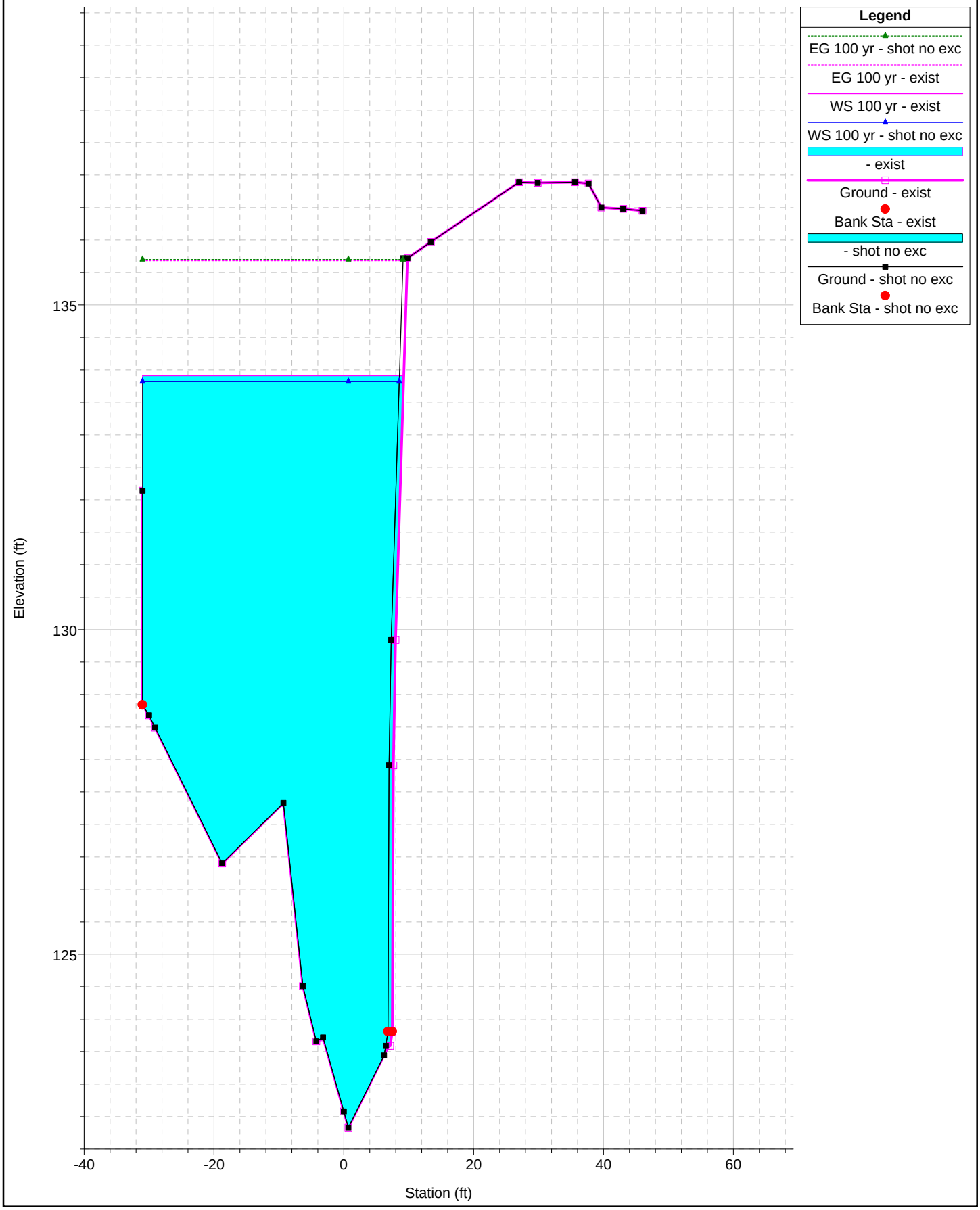
Plan: shot no exc Aiea Stream Aiea RS: 375 Profile: 100 yr

E.G. Elev (ft)	135.45	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.96	Wt. n-Val.		0.050	0.025
W.S. Elev (ft)	133.49	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)		Flow Area (sq ft)		297.44	4.72
E.G. Slope (ft/ft)	0.010192	Area (sq ft)		297.44	4.72
Q Total (cfs)	3372.00	Flow (cfs)		3351.05	20.96
Top Width (ft)	33.77	Top Width (ft)		32.48	1.29
Vel Total (ft/s)	11.16	Avg. Vel. (ft/s)		11.27	4.44
Max Chl Dpth (ft)	12.04	Hydr. Depth (ft)		9.16	3.65
Conv. Total (cfs)	33400.1	Conv. (cfs)		33192.6	207.6
Length Wtd. (ft)	25.00	Wetted Per. (ft)		40.88	7.40
Min Ch El (ft)	121.45	Shear (lb/sq ft)		4.63	0.41
Alpha	1.01	Stream Power (lb/ft s)		52.16	1.80
Frctn Loss (ft)	0.28	Cum Volume (acre-ft)	0.45	3.56	0.66
C & E Loss (ft)	0.05	Cum SA (acres)	0.05	0.31	0.20

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 400



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 400 Profile: 100 yr

E.G. Elev (ft)	135.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.77	Wt. n-Val.	0.025	0.050	0.050
W.S. Elev (ft)	133.91	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)		Flow Area (sq ft)	0.03	314.22	5.61
E.G. Slope (ft/ft)	0.008425	Area (sq ft)	0.03	314.22	5.61
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3361.82	10.18
Top Width (ft)	40.23	Top Width (ft)	0.01	38.45	1.77
Vel Total (ft/s)	10.54	Avg. Vel. (ft/s)	0.19	10.70	1.82
Max Chl Dpth (ft)	11.58	Hydr. Depth (ft)	3.42	8.17	3.17
Conv. Total (cfs)	36737.8	Conv. (cfs)	0.1	36626.8	110.9
Length Wtd. (ft)	25.00	Wetted Per. (ft)	5.07	40.45	10.32
Min Ch El (ft)	122.33	Shear (lb/sq ft)	0.00	4.09	0.29
Alpha	1.03	Stream Power (lb/ft s)	0.00	43.71	0.52
Frctn Loss (ft)	0.23	Cum Volume (acre-ft)	0.45	3.75	0.66
C & E Loss (ft)	0.01	Cum SA (acres)	0.05	0.33	0.20

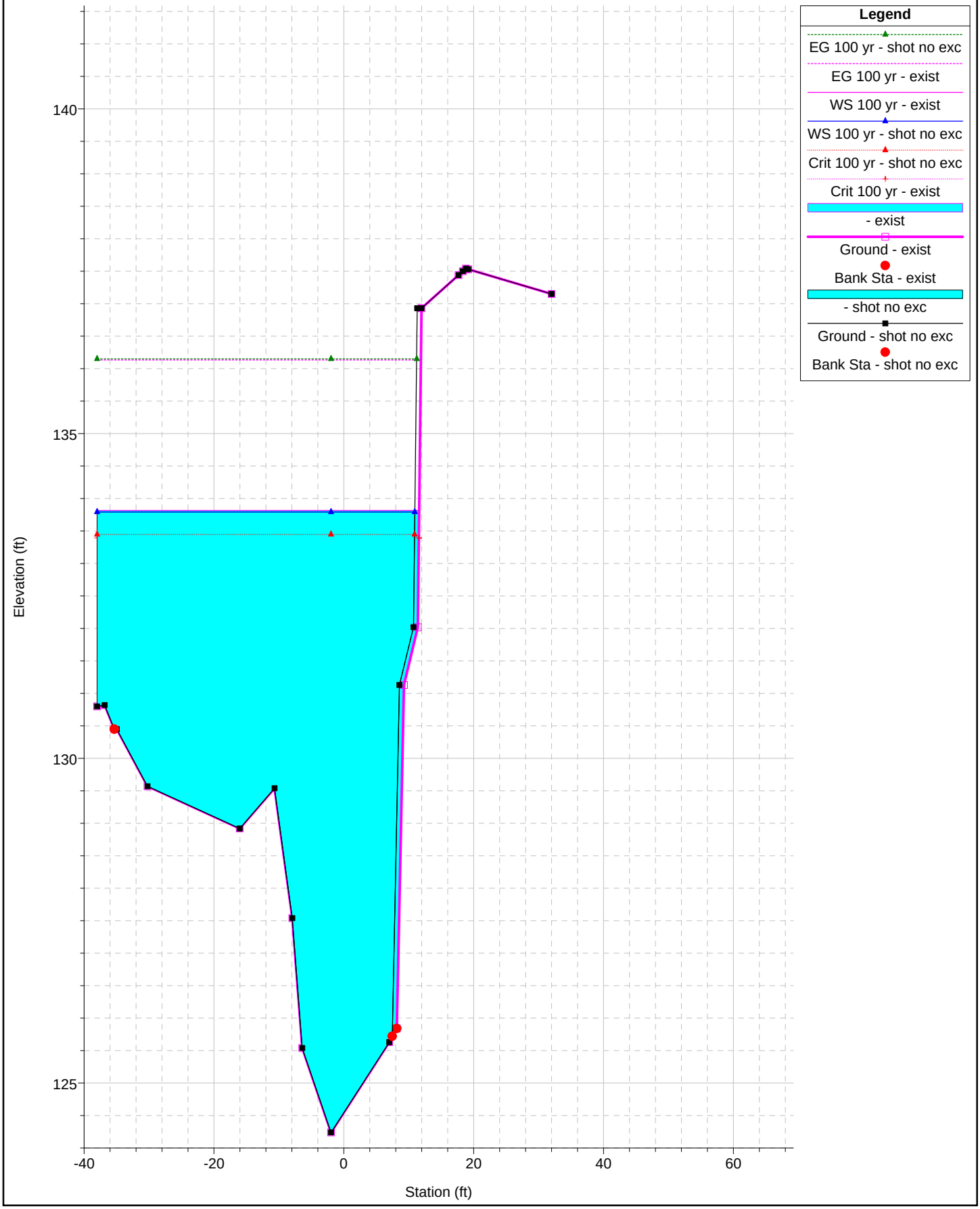
Plan: shot no exc Aiea Stream Aiea RS: 400 Profile: 100 yr

E.G. Elev (ft)	135.70	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.88	Wt. n-Val.	0.025	0.050	0.025
W.S. Elev (ft)	133.82	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)		Flow Area (sq ft)	0.03	303.99	5.45
E.G. Slope (ft/ft)	0.009153	Area (sq ft)	0.03	303.99	5.45
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3351.61	20.38
Top Width (ft)	39.53	Top Width (ft)	0.01	37.78	1.74
Vel Total (ft/s)	10.90	Avg. Vel. (ft/s)	0.20	11.03	3.74
Max Chl Dpth (ft)	11.49	Hydr. Depth (ft)	3.33	8.05	3.14
Conv. Total (cfs)	35245.7	Conv. (cfs)	0.1	35032.6	213.0
Length Wtd. (ft)	25.00	Wetted Per. (ft)	4.98	39.81	10.23
Min Ch El (ft)	122.33	Shear (lb/sq ft)	0.00	4.36	0.30
Alpha	1.02	Stream Power (lb/ft s)	0.00	48.11	1.14
Frctn Loss (ft)	0.24	Cum Volume (acre-ft)	0.45	3.74	0.66
C & E Loss (ft)	0.01	Cum SA (acres)	0.05	0.33	0.20

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 425



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 425 Profile: 100 yr

E.G. Elev (ft)	136.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.32	Wt. n-Val.	0.025	0.050	0.050
W.S. Elev (ft)	133.82	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	133.39	Flow Area (sq ft)	8.26	262.98	10.88
E.G. Slope (ft/ft)	0.016660	Area (sq ft)	8.26	262.98	10.88
Q Total (cfs)	3372.00	Flow (cfs)	80.97	3245.47	45.56
Top Width (ft)	49.61	Top Width (ft)	2.66	43.49	3.46
Vel Total (ft/s)	11.95	Avg. Vel. (ft/s)	9.80	12.34	4.19
Max Chl Dpth (ft)	9.58	Hydr. Depth (ft)	3.11	6.05	3.14
Conv. Total (cfs)	26124.6	Conv. (cfs)	627.3	25144.3	353.0
Length Wtd. (ft)	25.00	Wetted Per. (ft)	5.72	45.57	9.54
Min Ch El (ft)	124.24	Shear (lb/sq ft)	1.50	6.00	1.19
Alpha	1.04	Stream Power (lb/ft s)	14.71	74.07	4.97
Frctn Loss (ft)	0.29	Cum Volume (acre-ft)	0.45	3.91	0.66
C & E Loss (ft)	0.16	Cum SA (acres)	0.05	0.35	0.20

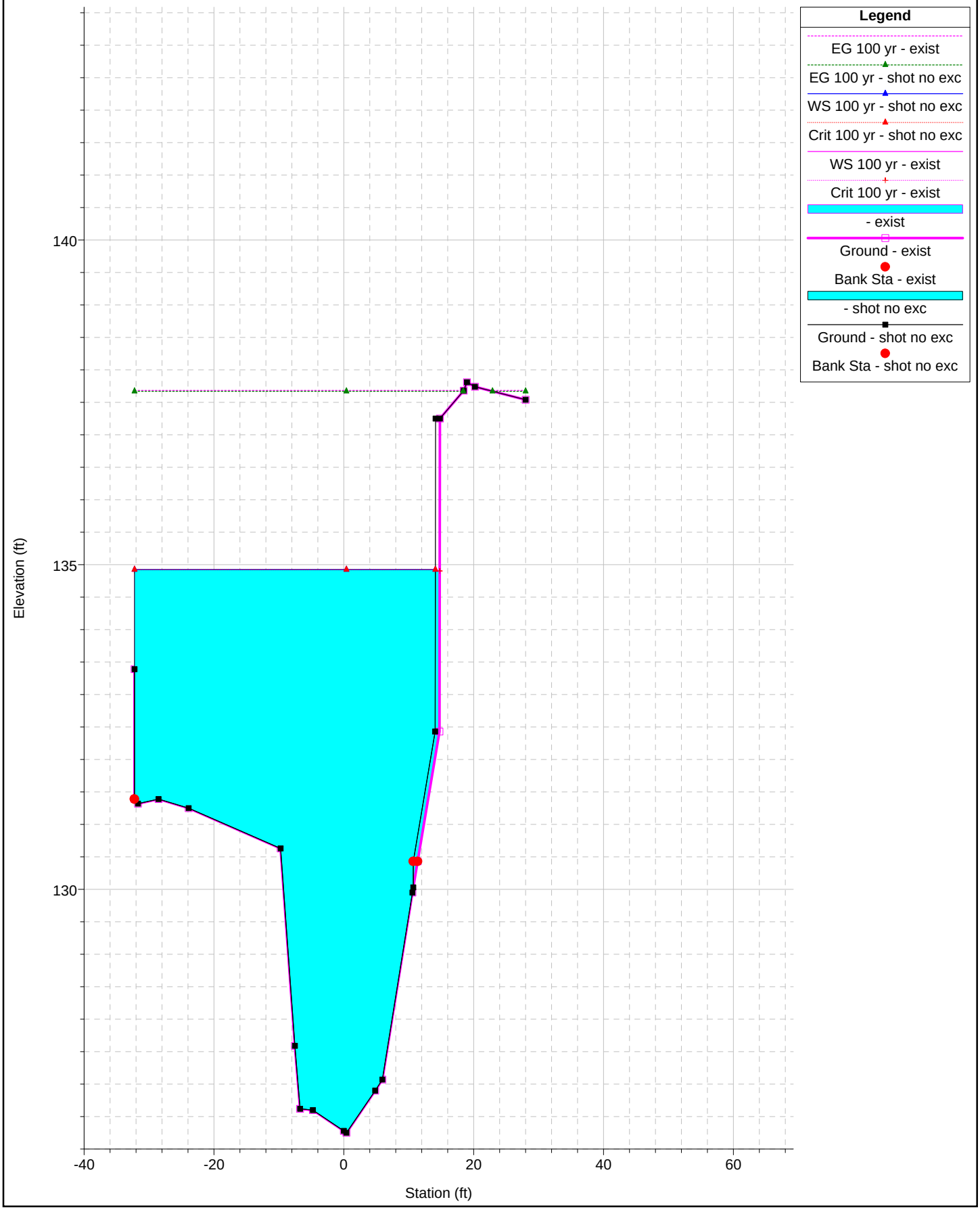
Plan: shot no exc Aiea Stream Aiea RS: 425 Profile: 100 yr

E.G. Elev (ft)	136.15	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.36	Wt. n-Val.	0.025	0.050	0.025
W.S. Elev (ft)	133.79	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	133.45	Flow Area (sq ft)	8.20	256.54	10.86
E.G. Slope (ft/ft)	0.017230	Area (sq ft)	8.20	256.54	10.86
Q Total (cfs)	3372.00	Flow (cfs)	81.49	3198.72	91.79
Top Width (ft)	48.94	Top Width (ft)	2.66	42.82	3.46
Vel Total (ft/s)	12.24	Avg. Vel. (ft/s)	9.94	12.47	8.45
Max Chl Dpth (ft)	9.55	Hydr. Depth (ft)	3.08	5.99	3.14
Conv. Total (cfs)	25689.1	Conv. (cfs)	620.8	24369.0	699.3
Length Wtd. (ft)	25.00	Wetted Per. (ft)	5.70	44.89	9.63
Min Ch El (ft)	124.24	Shear (lb/sq ft)	1.55	6.15	1.21
Alpha	1.01	Stream Power (lb/ft s)	15.38	76.65	10.25
Frctn Loss (ft)	0.31	Cum Volume (acre-ft)	0.45	3.90	0.66
C & E Loss (ft)	0.14	Cum SA (acres)	0.05	0.35	0.20

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 450



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 450 Profile: 100 yr

E.G. Elev (ft)	137.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.78	Wt. n-Val.	0.025	0.050	0.050
W.S. Elev (ft)	134.90	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	134.90	Flow Area (sq ft)	0.03	243.98	11.75
E.G. Slope (ft/ft)	0.022724	Area (sq ft)	0.03	243.98	11.75
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3293.00	78.99
Top Width (ft)	47.02	Top Width (ft)	0.01	43.60	3.41
Vel Total (ft/s)	13.18	Avg. Vel. (ft/s)	0.33	13.50	6.72
Max Chl Dpth (ft)	8.65	Hydr. Depth (ft)	2.51	5.60	3.45
Conv. Total (cfs)	22369.0	Conv. (cfs)	0.1	21844.9	524.0
Length Wtd. (ft)	25.00	Wetted Per. (ft)	3.51	46.66	6.39
Min Ch El (ft)	126.25	Shear (lb/sq ft)	0.01	7.42	2.61
Alpha	1.03	Stream Power (lb/ft s)	0.00	100.13	17.53
Frctn Loss (ft)	0.48	Cum Volume (acre-ft)	0.45	4.06	0.67
C & E Loss (ft)	0.14	Cum SA (acres)	0.05	0.38	0.21

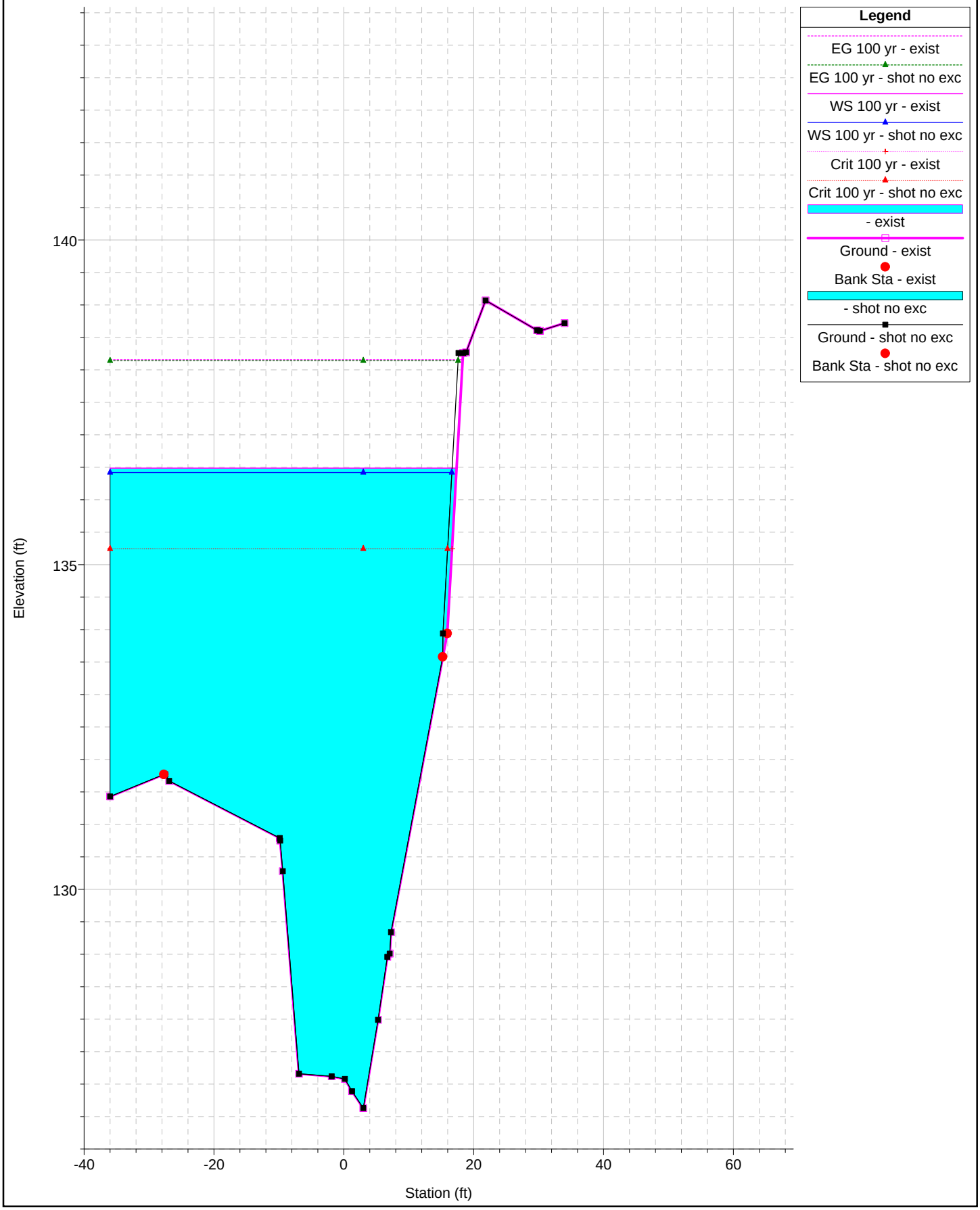
Plan: shot no exc Aiea Stream Aiea RS: 450 Profile: 100 yr

E.G. Elev (ft)	137.67	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.75	Wt. n-Val.	0.025	0.050	0.025
W.S. Elev (ft)	134.92	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	134.92	Flow Area (sq ft)	0.03	241.63	11.81
E.G. Slope (ft/ft)	0.022127	Area (sq ft)	0.03	241.63	11.81
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3215.02	156.97
Top Width (ft)	46.35	Top Width (ft)	0.01	42.93	3.41
Vel Total (ft/s)	13.30	Avg. Vel. (ft/s)	0.33	13.31	13.29
Max Chl Dpth (ft)	8.67	Hydr. Depth (ft)	2.53	5.63	3.47
Conv. Total (cfs)	22668.9	Conv. (cfs)	0.1	21613.6	1055.3
Length Wtd. (ft)	25.00	Wetted Per. (ft)	3.53	46.27	6.41
Min Ch El (ft)	126.25	Shear (lb/sq ft)	0.01	7.21	2.55
Alpha	1.00	Stream Power (lb/ft s)	0.00	95.97	33.82
Frctn Loss (ft)	0.49	Cum Volume (acre-ft)	0.45	4.04	0.67
C & E Loss (ft)	0.12	Cum SA (acres)	0.05	0.38	0.21

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 475



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 475 Profile: 100 yr

E.G. Elev (ft)	138.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.67	Wt. n-Val.	0.025	0.050	0.050
W.S. Elev (ft)	136.49	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	135.24	Flow Area (sq ft)	40.50	287.41	1.82
E.G. Slope (ft/ft)	0.010149	Area (sq ft)	40.50	287.41	1.82
Q Total (cfs)	3372.00	Flow (cfs)	508.18	2859.83	3.98
Top Width (ft)	53.35	Top Width (ft)	8.29	43.63	1.43
Vel Total (ft/s)	10.23	Avg. Vel. (ft/s)	12.55	9.95	2.19
Max Chl Dpth (ft)	9.86	Hydr. Depth (ft)	4.89	6.59	1.27
Conv. Total (cfs)	33471.4	Conv. (cfs)	5044.3	28387.5	39.6
Length Wtd. (ft)	25.00	Wetted Per. (ft)	13.35	47.44	2.92
Min Ch El (ft)	126.63	Shear (lb/sq ft)	1.92	3.84	0.40
Alpha	1.03	Stream Power (lb/ft s)	24.11	38.20	0.86
Frctn Loss (ft)	0.36	Cum Volume (acre-ft)	0.46	4.21	0.67
C & E Loss (ft)	0.11	Cum SA (acres)	0.05	0.40	0.21

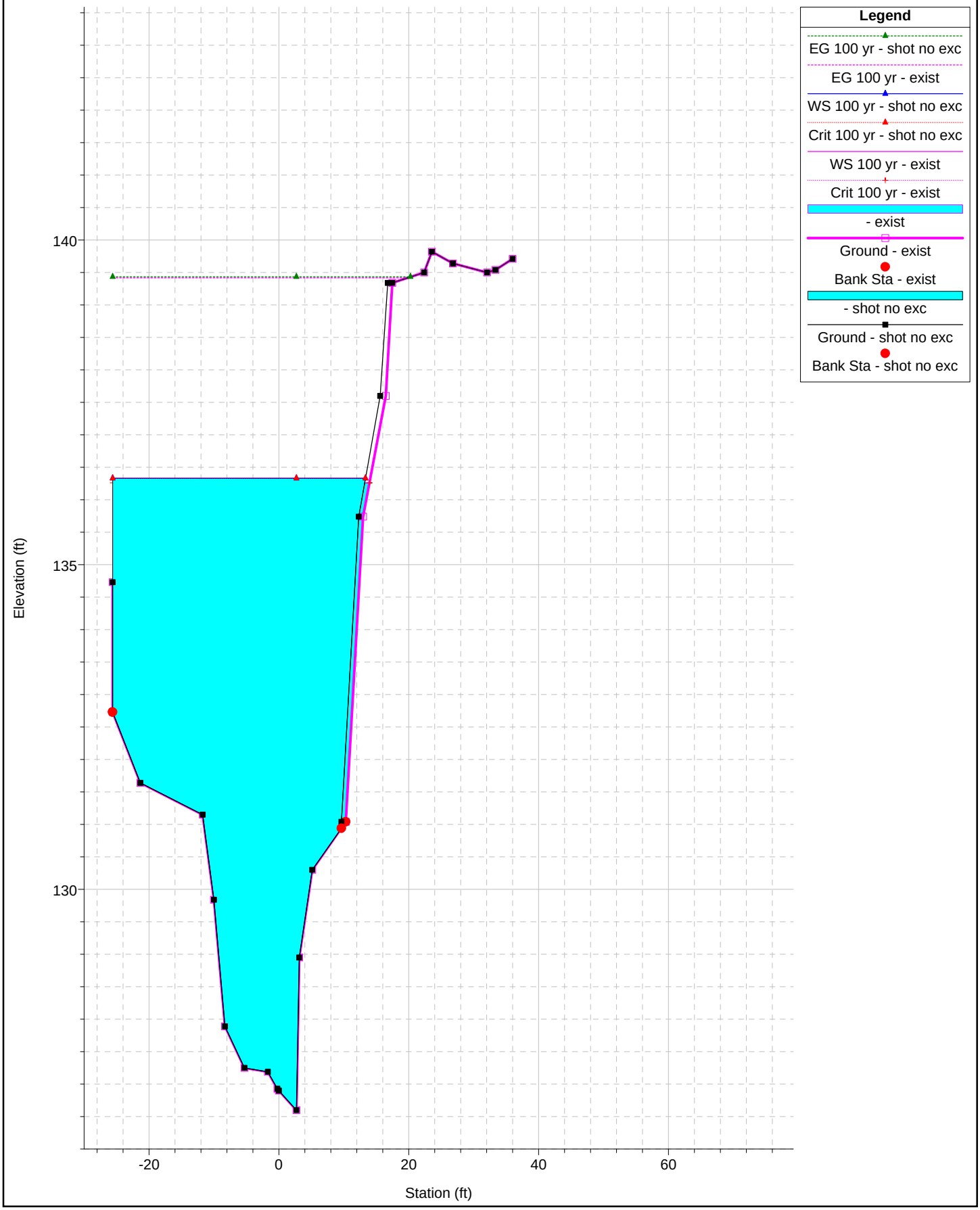
Plan: shot no exc Aiea Stream Aiea RS: 475 Profile: 100 yr

E.G. Elev (ft)	138.14	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.72	Wt. n-Val.	0.025	0.050	0.025
W.S. Elev (ft)	136.42	Reach Len. (ft)	25.00	25.00	25.00
Crit W.S. (ft)	135.24	Flow Area (sq ft)	39.97	282.78	1.76
E.G. Slope (ft/ft)	0.010471	Area (sq ft)	39.97	282.78	1.76
Q Total (cfs)	3372.00	Flow (cfs)	506.51	2858.33	7.16
Top Width (ft)	52.65	Top Width (ft)	8.29	42.95	1.41
Vel Total (ft/s)	10.39	Avg. Vel. (ft/s)	12.67	10.11	4.07
Max Chl Dpth (ft)	9.79	Hydr. Depth (ft)	4.82	6.58	1.25
Conv. Total (cfs)	32952.7	Conv. (cfs)	4949.9	27932.8	70.0
Length Wtd. (ft)	25.00	Wetted Per. (ft)	13.29	46.67	3.21
Min Ch El (ft)	126.63	Shear (lb/sq ft)	1.97	3.96	0.36
Alpha	1.03	Stream Power (lb/ft s)	24.92	40.04	1.46
Frctn Loss (ft)	0.37	Cum Volume (acre-ft)	0.46	4.19	0.67
C & E Loss (ft)	0.10	Cum SA (acres)	0.05	0.40	0.21

Aiea IS - Erosion Control Plan: 1) shot no exc 2) exist

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm

RS = 490



1 in Horiz. = 20 ft 1 in Vert. = 2 ft

Plan: exist Aiea Stream Aiea RS: 490 Profile: 100 yr

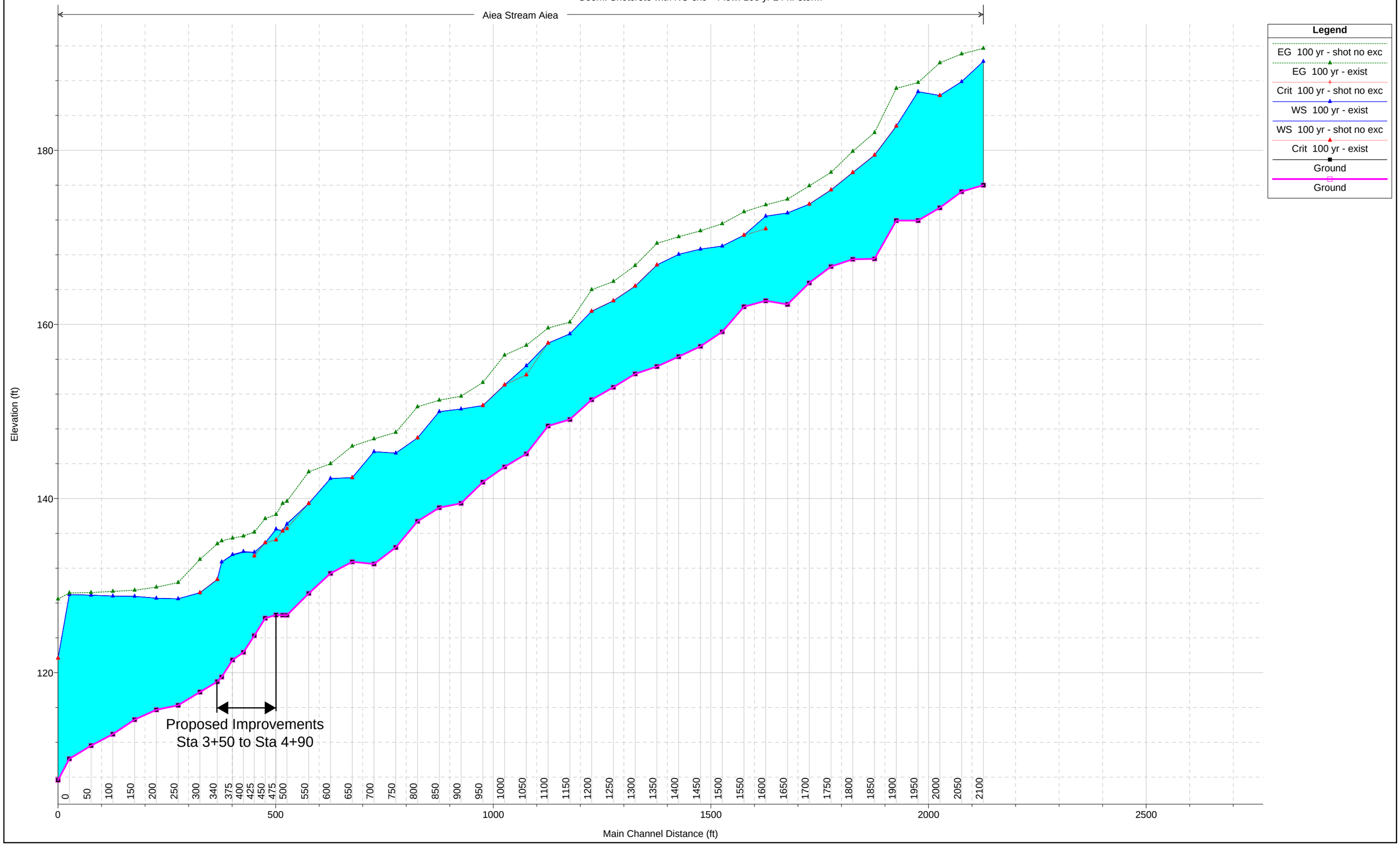
E.G. Elev (ft)	139.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.16	Wt. n-Val.	0.025	0.050	0.050
W.S. Elev (ft)	136.26	Reach Len. (ft)	15.00	15.00	15.00
Crit W.S. (ft)	136.26	Flow Area (sq ft)	0.03	232.51	7.89
E.G. Slope (ft/ft)	0.022202	Area (sq ft)	0.03	232.51	7.89
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3332.26	39.74
Top Width (ft)	39.56	Top Width (ft)	0.01	35.91	3.64
Vel Total (ft/s)	14.03	Avg. Vel. (ft/s)	0.33	14.33	5.03
Max Chl Dpth (ft)	9.66	Hydr. Depth (ft)	2.53	6.47	2.17
Conv. Total (cfs)	22630.1	Conv. (cfs)	0.1	22363.4	266.7
Length Wtd. (ft)	15.00	Wetted Per. (ft)	3.53	39.93	6.51
Min Ch El (ft)	126.60	Shear (lb/sq ft)	0.01	8.07	1.68
Alpha	1.03	Stream Power (lb/ft s)	0.00	115.67	8.46
Frctn Loss (ft)	0.22	Cum Volume (acre-ft)	0.47	4.30	0.68
C & E Loss (ft)	0.45	Cum SA (acres)	0.05	0.42	0.21

Plan: shot no exc Aiea Stream Aiea RS: 490 Profile: 100 yr

E.G. Elev (ft)	139.43	Element	Left OB	Channel	Right OB
Vel Head (ft)	3.10	Wt. n-Val.	0.025	0.050	0.025
W.S. Elev (ft)	136.33	Reach Len. (ft)	15.00	15.00	15.00
Crit W.S. (ft)	136.33	Flow Area (sq ft)	0.03	231.35	8.18
E.G. Slope (ft/ft)	0.021508	Area (sq ft)	0.03	231.35	8.18
Q Total (cfs)	3372.00	Flow (cfs)	0.01	3290.52	81.47
Top Width (ft)	38.96	Top Width (ft)	0.01	35.23	3.72
Vel Total (ft/s)	14.08	Avg. Vel. (ft/s)	0.33	14.22	9.96
Max Chl Dpth (ft)	9.73	Hydr. Depth (ft)	2.60	6.57	2.20
Conv. Total (cfs)	22992.4	Conv. (cfs)	0.1	22436.9	555.5
Length Wtd. (ft)	15.00	Wetted Per. (ft)	3.60	39.24	6.70
Min Ch El (ft)	126.60	Shear (lb/sq ft)	0.01	7.92	1.64
Alpha	1.01	Stream Power (lb/ft s)	0.00	112.59	16.32
Frctn Loss (ft)	0.22	Cum Volume (acre-ft)	0.47	4.28	0.68
C & E Loss (ft)	0.41	Cum SA (acres)	0.05	0.41	0.21

Aiea IS - Erosion Control Plan: 1) shot no exc 12/2/2009 2) exist 12/2/2009

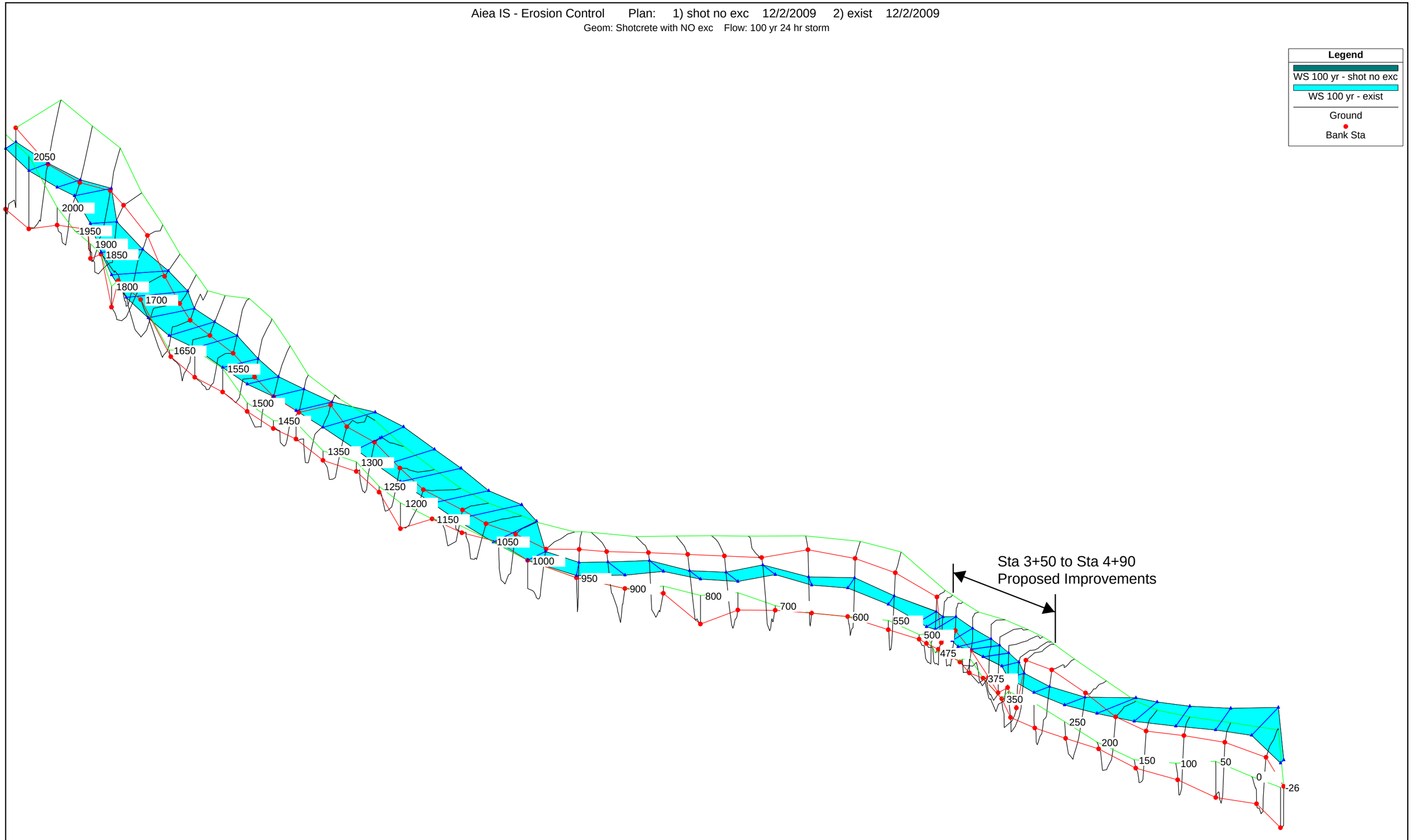
Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm



1 in Horiz. = 200 ft 1 in Vert. = 10 ft

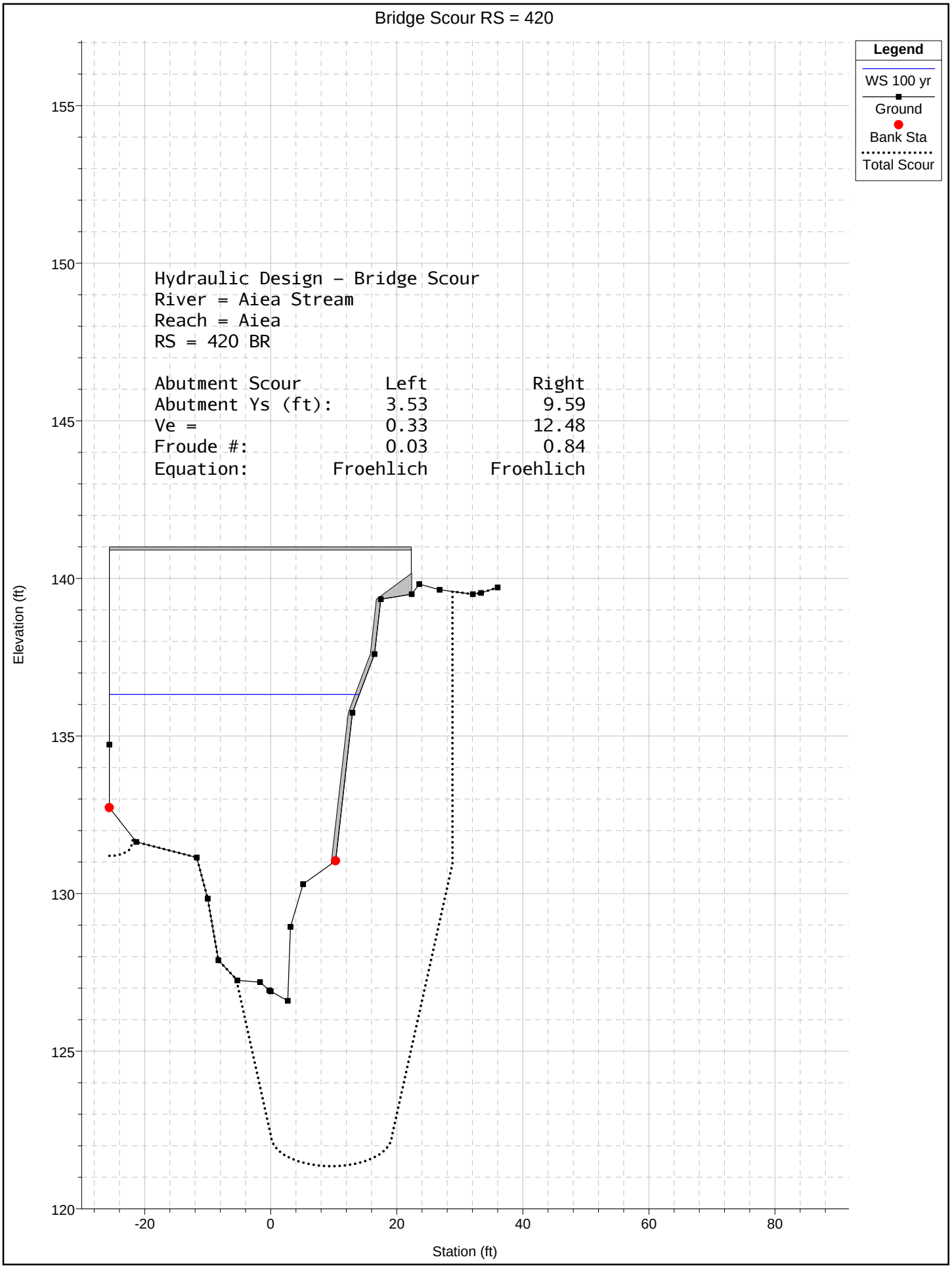
Aiea IS - Erosion Control Plan: 1) shot no exc 12/2/2009 2) exist 12/2/2009

Geom: Shotcrete with NO exc Flow: 100 yr 24 hr storm



HEC-RAS Locations: User Defined Profile: 100 yr

River	Reach	River Sta	Profile	Plan	E.G. Elev	W.S. Elev	Vel Total	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght
					(ft)	(ft)	(ft/s)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)			
Aiea Stream	Aiea	600	100 yr	shot no exc	143.99	142.29	10.46	0.75	0.19		3372.00		38.37		0.050	
Aiea Stream	Aiea	600	100 yr	exist	143.99	142.29	10.46	0.75	0.19		3372.00		38.37		0.050	
Aiea Stream	Aiea	550	100 yr	shot no exc	143.05	139.42	15.29	1.06	0.31	0.02	3371.98		30.62	0.025	0.050	
Aiea Stream	Aiea	550	100 yr	exist	143.05	139.42	15.29	1.07	0.30	0.02	3371.98		30.62	0.025	0.050	
Aiea Stream	Aiea	500	100 yr	shot no exc	139.69	137.11	12.90	0.20	0.05	0.01	3371.99		39.53	0.025	0.050	
Aiea Stream	Aiea	500	100 yr	exist	139.68	137.05	13.01	0.21	0.05	0.01	3371.99		39.50	0.025	0.050	
Aiea Stream	Aiea	490	100 yr	shot no exc	139.43	136.33	14.08	0.22	0.41	0.01	3290.52	81.47	38.96	0.025	0.050	0.025
Aiea Stream	Aiea	490	100 yr	exist	139.42	136.26	14.03	0.22	0.45	0.01	3332.26	39.74	39.56	0.025	0.050	0.050
Aiea Stream	Aiea	475	100 yr	shot no exc	138.14	136.42	10.39	0.37	0.10	506.51	2858.33	7.16	52.65	0.025	0.050	0.025
Aiea Stream	Aiea	475	100 yr	exist	138.16	136.49	10.23	0.36	0.11	508.18	2859.83	3.98	53.35	0.025	0.050	0.050
Aiea Stream	Aiea	450	100 yr	shot no exc	137.67	134.92	13.30	0.49	0.12	0.01	3215.02	156.97	46.35	0.025	0.050	0.025
Aiea Stream	Aiea	450	100 yr	exist	137.68	134.90	13.18	0.48	0.14	0.01	3293.00	78.99	47.02	0.025	0.050	0.050
Aiea Stream	Aiea	425	100 yr	shot no exc	136.15	133.79	12.24	0.31	0.14	81.49	3198.72	91.79	48.94	0.025	0.050	0.025
Aiea Stream	Aiea	425	100 yr	exist	136.13	133.82	11.95	0.29	0.16	80.97	3245.47	45.56	49.61	0.025	0.050	0.050
Aiea Stream	Aiea	400	100 yr	shot no exc	135.70	133.82	10.90	0.24	0.01	0.01	3351.61	20.38	39.53	0.025	0.050	0.025
Aiea Stream	Aiea	400	100 yr	exist	135.68	133.91	10.54	0.23	0.01	0.01	3361.82	10.18	40.23	0.025	0.050	0.050
Aiea Stream	Aiea	375	100 yr	shot no exc	135.45	133.49	11.16	0.28	0.05		3351.05	20.96	33.77		0.050	0.025
Aiea Stream	Aiea	375	100 yr	exist	135.44	133.56	10.90	0.27	0.05		3361.57	10.43	34.45		0.050	0.050
Aiea Stream	Aiea	350	100 yr	shot no exc	135.12	132.70	12.41	0.17	0.17		3232.28	139.72	25.61		0.050	0.025
Aiea Stream	Aiea	350	100 yr	exist	135.12	132.71	12.10	0.17	0.17		3300.84	71.16	26.30		0.050	0.050
Aiea Stream	Aiea	340	100 yr	shot no exc	134.79	130.69	16.24	1.02	0.08	404.25	2967.75		25.44	0.025	0.050	
Aiea Stream	Aiea	340	100 yr	exist	134.79	130.69	16.24	1.02	0.08	404.25	2967.75		25.44	0.025	0.050	
Aiea Stream	Aiea	300	100 yr	shot no exc	132.99	129.17	15.61	0.73	0.59	147.78	3224.23		29.00	0.025	0.050	
Aiea Stream	Aiea	300	100 yr	exist	132.99	129.17	15.61	0.73	0.59	147.78	3224.23		29.00	0.025	0.050	
Aiea Stream	Aiea	250	100 yr	shot no exc	130.34	128.48	10.87	0.35	0.18	85.46	3286.54		37.71	0.025	0.050	
Aiea Stream	Aiea	250	100 yr	exist	130.34	128.48	10.87	0.35	0.18	85.46	3286.54		37.71	0.025	0.050	



1 in Horiz. = 20 1 in Vert. = 4

Appendix C

Archaeological Review and Field Inspection Report for the ʻAiea Intermediate School Erosion Control Project, Cultural Surveys Hawaiʻi August 2009

DRAFT Cultural Impact Assessment for ʻAiea Intermediate School Erosion Control Project Cultural Surveys Hawaiʻi January 2010

DRAFT

Literature Review and Field Inspection Report for the ʻAiea Intermediate School Erosion Control Project, ʻAiea Ahupuaʻa, ʻEwa District, Oʻahu

TMK: [1] 9-9-005:001

Prepared for

Kimura International

Prepared by

Kendy Altizer, B.A, Nifae Hunkin, B.A.,

Douglas F. Borthwick, B.A.

and

Hallett H. Hammatt, Ph.D.

Cultural Surveys Hawaiʻi, Inc.

Kailua, Hawaiʻi

(Job Code: AIEA 1)

August 2009

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Management Summary

Reference	Literature Review and Field Inspection Report for the ‘Aiea Intermediate School Erosion Control Project, ‘Aiea Ahupua‘a, ‘Ewa District, O‘ahu TMK: [1] 9-9-005:001 (Altizer et al 2009)
Date	August 2009
Project Number (s)	DOE Job No. Q71009-07; Cultural Surveys Hawai‘i (CSH) Job Code: AIEA 1
Investigation Permit Number	The field inspection was conducted under archaeological permit number 09-20 issued by the Hawai‘i State Historic Preservation Division (SHPD), Department of Land and Natural Resources (DLNR), per Hawai‘i Administrative Rules (HAR) Chapter 13-282.
Project Location	The school is located on TMK: [1] 9-9-005:001 and is bounded by ‘Aiea Stream on the northeast, and Ali‘ipoe Street on the southeast. Several cul-de-sac streets are present to the northeast and southwest, however they do not intersect with parcel boundaries. The parcel is present within the Ahupua’a of ‘Aiea, District of ‘Ewa, on the Island of Oahu. The project area and APE are depicted on the 1998 Waipahu U.S. Geological Survey 7.5 Minute Series Topographic Quadrangle.
Land Jurisdiction	City and County of Honolulu
Agencies	SHPD/DLNR; DOE
Project Description	The purpose of the project is to assess erosion of the stream bank and its effect on school utilities.
Project Acreage	30.78 acres
Area of Potential Effect (APE) and Survey Acreage	The 30.78-acre project area includes an eroded 150-foot portion of the ‘Aiea Stream corridor. The school’s primary power electric manhole is on top of an eroded stream bank and is connected to the backside access road and fire lane which houses the school’s main waterline. For purposes of this report the project area is defined as the entire school parcel, while the Area of Potential Effect is the 150-foot long by 10-foot wide (0.034 acres) portion of ‘Aiea Stream corridor.`

Document Purpose	This investigation is not an archaeological inventory survey, per the requirements of HAR Chapter 13-276; however, through detailed historical, cultural, and archaeological background research, and a field inspection of the APE, this investigation identifies cultural resources that may be affected by the project. The document is intended to facilitate the project's planning and support the project's historic preservation compliance. Based on findings, cultural resource management recommendations are presented. A companion cultural impact assessment (CIA) study (Cruz et al. *in prep.*), prepared to support the project's Hawai‘i state environmental review, per the guidelines of the Hawai‘i State Department of Health's Office of Environmental Quality Control "*Guidelines for Assessing Cultural Impacts*", further evaluates the project's potential impacts to cultural resources. Both documents will support the project's historic preservation consultation effort.
Fieldwork Effort	Fieldwork was conducted on July 28, 2009 by CSH archaeologists, Rosanna Runyon, B.A. and Kendy Altizer, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator). The fieldwork required 4 person-hours to complete.
Results Summary	Research of historic documents and previous archaeological studies indicate there is little potential for intact cultural deposits in the project area and APE. No cultural deposits were observed in the APE during the field inspection.
Recommendations	No historic properties were observed within the project's APE, therefore Cultural Surveys Hawai‘i recommends no further archaeological work for the proposed project. In the unlikely event that previously unidentified subsurface historic properties are encountered by project construction, the project proponents should immediately stop work in the vicinity and contact SHPD's O‘ahu Office.

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Section 1 Introduction

1.1 Project Background

In January 2009, Kimura International contracted Cultural Surveys Hawai'i (CSH) to conduct a literature review and field inspection, and cultural impact evaluation for the ‘Aiea Intermediate School project area. The school is located on TMK: [1] 9-9-005:001 and is bounded by ‘Aiea Stream on the northeast, and Ali‘ipoe Street on the southeast. Several cul-de-sac streets are present to the northeast and southwest, however they do not intersect with parcel boundaries. The parcel is present within the *ahupua'a* of ‘Aiea, District of ‘Ewa on the Island of Oahu. The project area and APE are depicted on the 1998 Waipahu U.S. Geological Survey 7.5 Minute Series Topographic Quadrangle (Figure 1, Figure 2, and Figure 3).

Potential cultural impacts will be addressed in a separate report (Cruz et al. *in prep*). This document includes relevant background historical research, previous archaeological research, results of the field inspection, and management recommendations. The 30.78-acre project area that includes the ‘Aiea Intermediate School parcel, also includes an eroded 150-foot portion of the ‘Aiea Stream corridor. The school's primary power electric manhole is located on top of the eroded stream bank and is connected to the backside access road and fire lane which houses the school's main waterline. The purpose of the project is to assess erosion of the stream bank and its effect on school utilities. For purposes of this report the project area is defined as the entire school parcel, while the Area of Potential Effect is the 150-foot portion of ‘Aiea Stream corridor. This archaeological field inspection was conducted only within the project APE.

1.2 Scope of Work

The scope of work for the Literature Review and Field Inspection includes:

1. Historical and previous archaeological background research including study of archival sources, historic maps, Land Commission Awards and previous archaeological reports to construct a history of land use and determine if archaeological sites have been recorded on or near this property.
2. Field inspection of the project area to identify any surface archaeological features and to investigate and assess the potential for impact to such sites. This inspection was undertaken to identify sensitive areas that may require further investigation or mitigation before the project proceeds.
3. Preparation of the report including results of historical research and the fieldwork with an assessment of archaeological potential based on that research, with recommendations for further archaeological work, if appropriate. Mitigation recommendations, if there are archaeologically sensitive areas that need to be taken into consideration, are also provided.

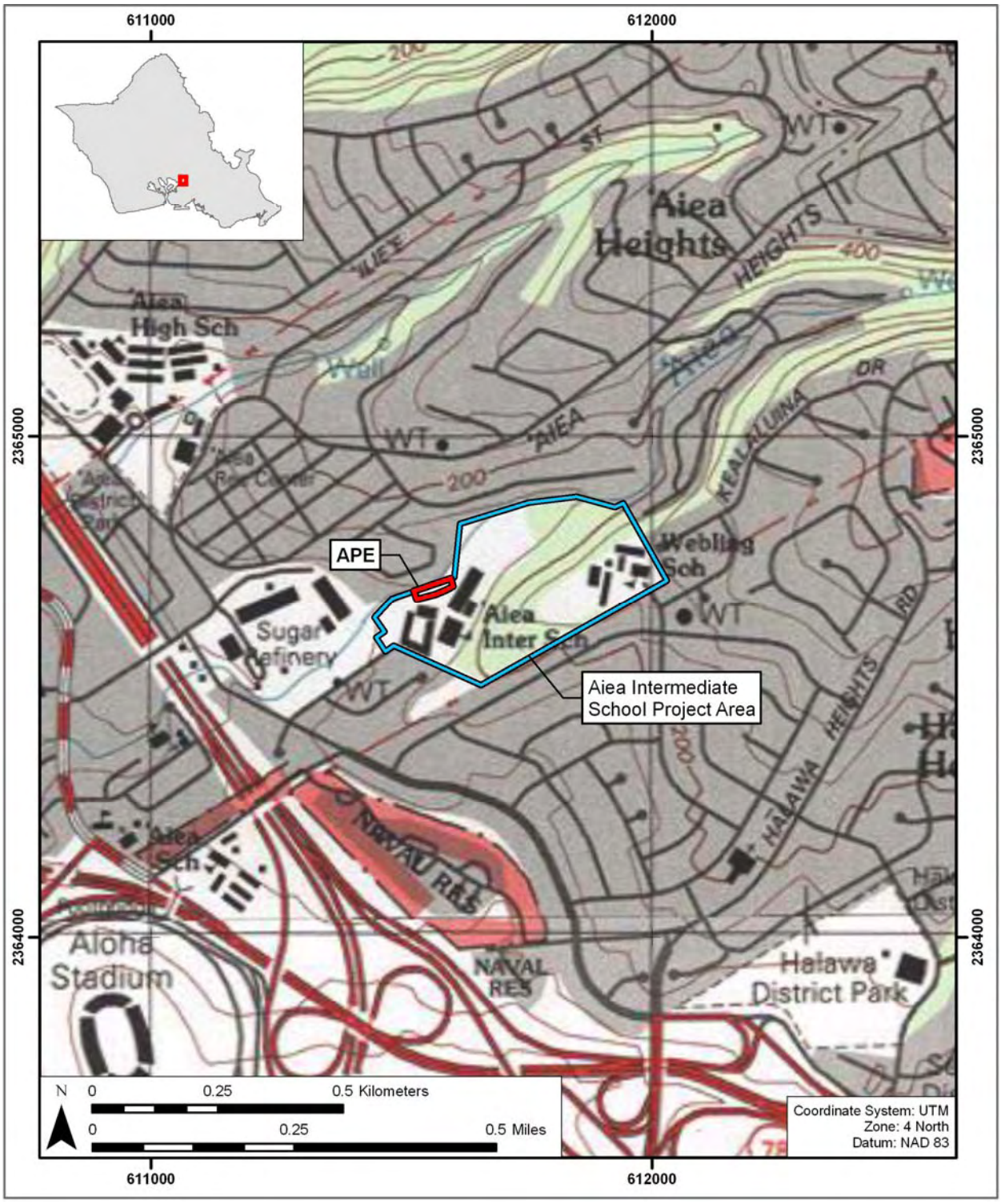

Figure 1. 1998 Waipahu USGS 7.5 Minute Series Topographic Quadrangle showing the APE and school property boundary.

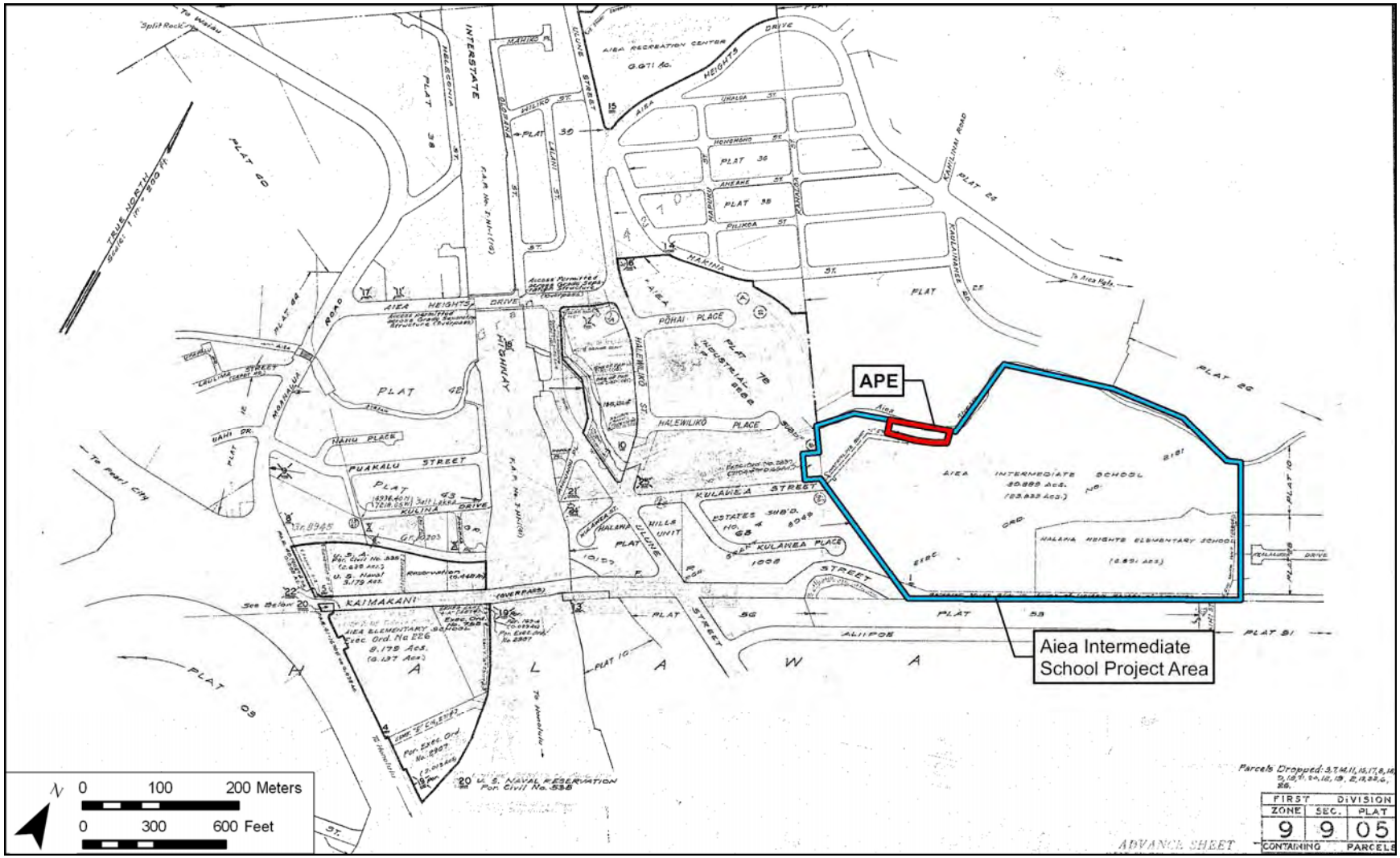

Figure 2. TMK [1] 9-9-005:001 showing the APE and school property boundary (Hawai‘i TMK Service n.d.).

Figure 3. Aerial photo of the APE and school property boundary (USGS Orthoimagery 2005).

1.3 Environmental Setting

1.3.1 Natural Environment

The project area elevation is approximately 61 masl (meters above sea level). Annual rainfall in the vicinity ranges from 800-1000mm, with soils consisting primarily of Lahaina Series silty clay with 7 to 15 percent slopes (LaC3). Waipahu silty clay with 0 to 2 percent slopes (WzA) is also present (Figure 4) (Giambelluca et al. 1986; Foote et al 1972). Lahaina silty clay is of good quality for producing pineapple and sugarcane, while Waipahu silty clay is of good quality for sugarcane and house lots (Foote et al 1972). The majority of the school parcel area is characterized by Rock Land (rRK) and Hanalai Series sillty clay with 2 to 6 percent slopes. The APE is characterized by Lahaina silty clay that is severely eroded. Vegetation present in the project area consists of plumeria, kiawe, cactus, and various tall riparian grasses.

1.3.2 Built Environment

The built environment of the project area consists of school buildings and open fields used for sporting events. The school grounds are surrounded by urban housing subdivisions and streets, as well as ‘Aiea Stream (Figure 3).

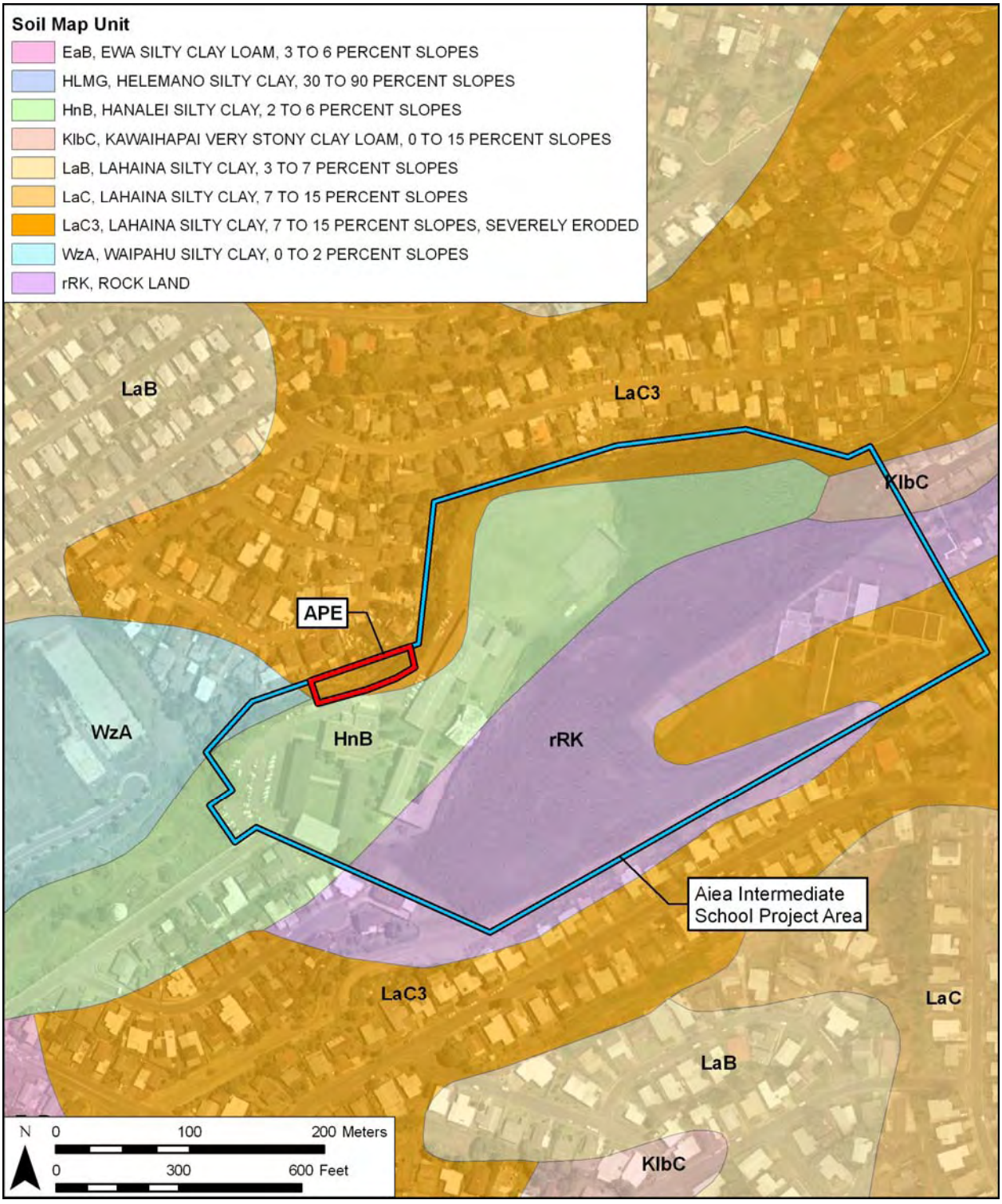

Figure 4. 1998 Waipahu USGS 7.5 Minute Series Topographic Quadrangle showing the APE and school property boundary with soil overlay (Foote et al 1972).

Section 2 Methods

2.1 Field Methods

Rosanna Runyon, B.A. and Kendy Altizer, B.A., under the supervision of Hallett H. Hammatt, Ph.D. (principal investigator) completed the field inspection on July 28, 2009. Fieldwork was conducted under state archaeological fieldwork permit No. 09-20 issued by SHPD, per HAR Chapter 13-13-282. The field effort required 4 person hours to complete.

Background research included: a review of previous archaeological studies on file at SHPD; review of documents at Hamilton Library of the University of Hawai‘i, the Hawai‘i State Archives, the Mission Houses Museum Library, the Hawai‘i Public Library, and the Archives of the Bishop Museum; study of historic photographs at the Hawai‘i State Archives and the Archives of the Bishop Museum; and study of historic maps at the Survey Office of the Department of Land and Natural Resources. Historic maps and photographs from the CSH library were also consulted. In addition, Māhele records were examined from the Waihona ‘Aina database (Waihona ‘Aina 2000).

This research provided the environmental, cultural, historic, and archaeological background for the project area. The sources studied were used to formulate a predictive model regarding the expected types and locations of historic properties in the project area.

Section 3 Traditional Background

3.1 Traditional and Historical Background

The project area lies within the plateau portion of ‘Aiea Ahupua‘a, which lies between the *ahupua‘a* of Kalauao and Hālawa in the traditional ‘Ewa District (‘*Ewa Moku*). There are numerous references to Kalauao and Hālawa in traditional literature; however ‘Aiea is rarely mentioned. Discussions of surrounding *ahupua‘a* may provide preliminary clues to the character of life—including patterns of settlement and land usage—during pre-western contact times.

Considering its rich and varied environment -- coastal and stream resources, central plains for *lo‘i*, and upland forest regions, information regarding pre-historic and early historic life in ‘Aiea is sketchy, especially for the upland sections. The majority of the early historic references speak of the fishponds at Pu‘uloa (a Hawaiian name for Pearl Harbor), the coastal resources and excursions by early visitors to the Pearl River. Specific references to ‘Aiea itself are few and brief. Most early references in the traditional literature are one-line passages that merely mention ‘Aiea in passing with little attention to detail. People traveled through ‘Aiea from ‘Ewa to Honolulu or vice versa, but most of these travels seem to have taken place nearer the lowland plains and shoreline. Since the coastal areas were rich in ocean resources — clams, pearl oysters and several varieties of fish and the nearby lowland area filled with *lo‘i kalo*, there would be no need for passers-by to go off the beaten path and travel further *mauka* into the valley unless they had a specific purpose for doing so, such as catching birds for their highly prized feathers or gathering *olonā* (*Touchardia latifolia*) for cordage. This is not to imply that ‘Aiea has little or no prehistory and is, therefore, insignificant. It clearly does have significance, but . . . *ua hala nā kūpuna, a he `ike kōli`uli`u wale nō kō kēia lā, i nā mea i ke au i hope lilo, iō kikilo.* (The ancestors have passed on; today’s people see but dimly times long gone and far behind.) Taking this into consideration, information regarding traditional lifestyle and land-use patterns must be looked at within the greater context of bordering *ahupua‘a* and the *moku* of ‘Ewa, of which ‘Aiea is a part.

In 1873, S. K. Kuhano wrote about ancient O‘ahu land divisions. O‘ahu was divided into 6 *kalana*; Kona, ‘Ewa, Wai‘anae, Waialua, Ko‘olauloa and Ko‘olaupoko. These *kalana* were further divided into 86 *ahupua‘a*. Within ‘Ewa, there were 12 *ahupua‘a*. They were listed as Hālawa, ‘Aiea, Kalauao, Waimalu, Waiau, Waimano, Manana, Wai‘awa, Waipi‘o, Waikele, Hō‘ae‘ae and Honouliuli. (Kame‘eleihiwa 1992:330) Modern maps and land divisions still generally follow the ancient system and use the same land divisions.

Handy (1940) describes the agricultural area of Aiea as:

> The small area of low flatland coverd by plantation camp, railroad, et.c below the old highway was formerly in terraces. . . The neighborhood of the Pearl River is very extensive, rishing backwards with a gentle slope toward the woods. . . .
>
> The neighborhood of the Pearl River is very extensive, rishing backwards with a genrlt slpe toward the woods, but is woulthou cultivation , eccept arun the outskits to about half a mile from the wate. The country is dividied into separate famrs or

> allotments belonging to the chiefs and enclosed with walls from 4 to 6 feet high, made of a mixture of mud and stone.

An early visitor, George Mathison (1825:416-417), described the general Aiea area as it was in 1821-22.

> We passed over a long cultivated plain, varied by occasional ravines, for a distance of twenty miles, and about two o'clock reached Pearl River, so called from the pearls wich are found in small quantities in its bed. . . . The sea here forms a small bay, which has the appearance of a salt-water lake, being landlocked on every side except at the narrow entrance. Two or three small streams, too insignifiant to merit the appellation of rivers discharge their united waters into the bay, which is full six miles in length and two in breadth. The adjoining low country is overflowed both naturally and by artifical means, and is well stocked with tarrow-plantatons, bananas, &c. The land belongs to many different proprietors; and on every estate there is a fishpond surrounded by a stone wall, where the fish are strictly preserved for the use of their rightful owners, or tabooed, as the native express it. One of particularly large dimensions belongs to the King.

3.2 Nā Moʻolelo o ʻEwa: ʻEwa Traditions

Much about early Hawaiian life can be learned by looking at the many *moʻolelo* (stories), both oral and written, which have been passed down through time. From *moʻolelo* come place names; where events took place; and people - their names, their history, and what they did. A sense of environment and land use can also be learned. These *moʻolelo* can provide details about the past.

Following are accounts of traditional references to the greater ʻEwa area, and Ahupuaʻa surrounding ʻAiea, which give a sense of pre-contact life and help to better understand times long past.

3.2.1 How ʻEwa Was Named

The following is a paraphrased account from Sites of Oʻahu. (Sterling & Summers 1978:1)

> On their travels around the islands, the gods Kāne and Kanaloa stopped at Red Hill on Oʻahu and viewed the broad plain spread below. To mark the various land boundaries they would throw a stone. The boundary was marked by the spot where the stone fell. It is said that when they saw the beautiful expanse of flat land below them, it was their intent to include as much of this land as possible. They threw the stone as far as they could toward the Waiʻanae range and the stone landed somewhere in the section of Waimānalo. Upon looking for the stone, they were unable to find it and could not locate where it fell. It is said that the stone "strayed" and this land division was called ʻEwa from that time on.

ʻEwa: ʻĀina koi ʻula i ka lepo: ʻEwa, land reddened by the rising dust (Pukui 1943: O.N. 2357)

This *‘ōlelo no‘eau* (saying or proverb) refers to ‘Ewa’s reputation for being very dusty and because during rainy seasons the sea would be colored red from the red dirt and mud. ‘Ewa (which means crooked or unequal; Pukui & Elbert 1986:42) was at one time the political center for O‘ahu chiefs. An endearing name for ‘Ewa was *‘Ewa, ka ‘āina o nā ali‘i* or ‘Ewa, land of chiefs, because it was a favorite residence of theirs. (Sterling and Summers 1978:1) This was most likely because of its abundant resources which supported the households of the chiefs; particularly, the many fishponds around the lochs of Pu‘uloa (lit. “long hill”; Pukui, et al. 1974:201), better known today as Pearl Harbor. (Handy and Handy 1972:470)

3.2.2 Descriptions of ‘Ewa

Handy says about `Ewa:

> The salient feature of ‘Ewa, and perhaps its most notable difference, is its spacious coastal plain, surrounding the deep bays (“lochs”) of Pearl Harbor, which are actually the drowned seaward valleys of ‘Ewa’s main streams, Waikele and Waipi‘o . . . The lowlands, bisected by ample streams, were ideal terrain for the cultivation of irrigated taro. The hinterland consisted of deep valleys running far back into the Ko‘olau range. Between the valleys were ridges, with steep sides, but a very gradual increase of altitude. The lower parts of the valley sides were excellent for the culture of yams and bananas. Farther inland grew the *‘awa* for which the area was famous. The length or depth of the valleys and the gradual slope of the ridges made the inhabited lowlands much more distant from the *wao,* or upland jungle, than was the case on the windward coast. Yet the *wao* here was more extensive, giving greater opportunity to forage for wild foods in famine time. (Handy & Handy 1972:469)

Except for the numerous varieties of shellfish and abundance of mullet, Handy describes ‘Ewa as being like the rest of O‘ahu.

> In the interior was the same avifauna, including the birds whose feathers were prized for feather capes, helmets, and lei making. In fact this, with its spacious wao inland, was the region where these birds were most numerous. There were more extensive areas also where wauke and māmaki, which supplied bast for the making of tapa, grew in abundance. In fact, ‘Ewa was famous for its māmaki. There was, too, much olonā grown in the interior, and wild bananas and yams flourished. (op cit.:470)

‘Ewa was also known for a special and tasty variety of *kalo* (*Colocasia esculenta*) called *kāī* which was native to the district. In 1931, Handy collected four varieties; the kāī ‘ula‘ula (red *kāī*), *kāī koi* (*kāī* that pierces), *kāī kea* or *kāī ke‘oke‘o* (white *kāī*), and *kāī uliuli* (dark *kāī*). A *kama‘āina* (native) of ‘Ewa described the *kāī kea* as being very fragrant. The *kāī ke`oke`o* made an exceptionally good poi and was said to be reserved for the *ali‘i* (chiefs). An 1899 newspaper account says of the *kāī koi*, “That is the taro that visitors gnaw on and find it so good that they want to live until they die in ‘Ewa. The poi of *kāī koi* is so delicious.” (*Ka Loea Kālai‘āina* June 3, 1899) So famous was the kāī variety that ‘Ewa was sometimes affectionately called Kāī o ‘Ewa. (Handy & Handy 1972:471) Another *‘ōlelo no‘eau* that reflects the importance of the kāī

is “*Ua ‘ai i ke kāī koi o ‘Ewa*, said of someone who has eaten of this very choice *kalo* of ‘Ewa. The *kaona* (hidden meaning) of this proverb refers to a “sweetheart one can’t forget”. (Pukui & Elbert 1986:115)

3.2.3 Pearl Harbor - Ke awa lau o Pu‘uloa (The many harbors of Pu‘uloa.)

Pu‘uloa is the Hawaiian name for the area we know as Pearl Harbor today. Pu‘uloa means “long hill” (Pukui et al. 1986:201) and it specifically refers to “the rounded area projecting into the sea at the long narrow entrance of the harbor.” (Handy & Handy 1972:469) Early 19th century visitors often referred to Pu‘uloa as the “Pearl” or the “Pearl River” in reference to the pearl oysters which were so abundant there. Another poetic Hawaiian reference to the area is Awāwa Lei or “garland of harbors”. (Ibid.)

In Hawaiian lore, Pu‘uloa (Pearl Harbor) is where “human beings” are said to have landed first on the island of O‘ahu. It is also said that there were many caves (*ka lua ‘ōlohe*) of the *‘ōlohe* (warriors who plucked their hairs and greased their bodies and were skilled in the art of *lua* or bone-breaking and wrestling) in the surrounding area. (Beckwith 1970:343)

Pu‘uloa is also the home of the shark goddess, Ka‘ahupahau, the sister of Kānehunamoku, Kamohoali‘i and Kahi‘ukā, said to live in an underwater cave at the entrance to Pu‘uloa Harbor. She was born of human parents, with light hair and had the ability to change into shark form. Along with her brother, Kahi‘ukā, they were both friendly to man and were not known as man-eating sharks. Their *kahu* (guardian) fed them daily and kept their backs scraped clean from barnacles. It is said that the chiefess Papio reproached the kahu for wearing a beautiful *lei pāpahi* of *‘ilima* (*Sida fallax*). The *‘ilima* blossoms were sacred to Ka‘ahupahau. Papio wanted the lei, but the *kahu* refused to give it up. Papio threatened the kahu with death. It is said that Ka‘ahupahau retaliated by killing Papio. For this crime, Ka‘ahupahau was tried and punished. Years later, when Ka‘ahupahau got into some trouble, she received help from Kupiapia and Laukahi‘u, the sons of Kuhaimoana. Since that time, a *kanawai* (law) was established that the waters of O‘ahu, from Pu‘uloa to ‘Ewa, were protected from man-eating sharks by Ka‘ahupahau and her brother, Kahi‘ukā. (Kamakau 1964:73; Beckwith 1970:138-39)

Field work conducted by J. Gilbert McAllister in 1930 noted that, more than any other location on O‘ahu, fishponds were most numerous along the shore of Pearl Harbor (McAllister 1933) Most of these ponds have since been destroyed. Pearl Harbor was also famous for the *pipi* or pearl oysters which were eaten raw. Along with being a popular delicacy, the *pipi* shells were used as shanks for fish hooks. Some of the varieties of *pipi*, which were once abundant there, are *pāpaua*, *‘owā‘owaka*, *nahawele*, *kupekala*, *mahamoe*, *‘ōkupe* and *‘ōlepe*. (Handy and Handy 1972:470) Following is the story of why the pipi of `Ewa vanished and can no longer be found at Pearl Harbor.

> The *kahu* of the sea and *pipi* lived at Palea. One day, a woman from Mānana (Pearl City) went crabbing in the sea of Kaholona. The pipi were thick and plentiful there. As she thought no one was watching, she grabbed some pipi at the same time as she reached for crabs. She was found out and her hulilau gourd container was broken and thrown into the sea. The kahu also fined her 25 cents. The woman consented to pay the fine saying, “The money is at home.” So the kahu went home with her to get the quarter. He knotted it in a flap of his malo and

> returned to Palea. When he reached his home, he discovered that he had lost the quarter and he was very disappointed.
>
> Kānekua‘ana was the famous mo‘o (lizard) god of ‘Ewa and it was Kānekua‘ana who was credited with bringing the pipi to Pu`uloa from Kahiki. Continuing the story, the kahu, after returning to Palea, became possessed by Kānekua`ana. The mo‘o god said to those in the house, “I am returning to Kahiki and am taking all the pipi with me. They will not return until all the descendants of this woman are dead. Only then shall the pipi be returned. I go to sleep. Do not awaken my medium until he wakes up of his own accord.” The kahu slept for four days and four nights. During that time, the pipi vanished from all the places where they were once so abundantly found. To this day, they have not returned to the shores of Pu‘uloa. (A paraphrased account taken from Ka Loea Kālai`Āina June 3, 1899)

In 1870, the pipi could still be found at Pu‘uloa (Ibid.; Handy & Handy 1972 471). Sometime between 1870 and 1899, when the above story was published, the *pipi* disappeared from Pu‘uloa.

3.3 ‘Ewa as a Political Center

There are many documented references to the chiefs of ‘Ewa which support Handy’s statement (Handy and Handy 1972:470) that chiefs resided in `Ewa and that it was a political center in its day. Oral accounts of chiefs and chiefesses recorded by noted Hawaiian historian, Samuel Kamakau, date back to at least the 12th century. He tells us that:

> The chiefs of Līhu‘e, Wahiawā, and Halemano on O‘ahu were called lō ali‘i. Because the chiefs at these places lived there continually and guarded their kapu, they were called lō ali‘i [from whom a “guaranteed” chief might be obtained, *loa‘a*]. They were like gods, unseen, resembling men (Kamakau 1991a:40).

Kalani-manuia, an *ali‘i kapu* chiefess (one with sacred taboos attached) who lived *mauka* at Wahiawā, was born at Kūkaniloko, at Kapu‘ahu‘awa in A.D. 1100. It is recorded that her *piko* (naval cord) was cut at Ho‘olono-pahu heiau. When she was grown, she was taken to Kalauao, where she made her home at Kūki‘iahu, and where she continued to live even after becoming ruler of the kingdom. She was well loved by the people, chiefs and commoners alike, and hers was a reign of peace. She did not levy taxes upon the people and the island of O‘ahu was made productive through cultivation. (Kamakau 1991a.:57)

A 14th century account speaks of the reign of Mā‘ili-kūkahi, an *ali‘i kapu* who was born at Kūkaniloko in Wahiawā around the 14th century A.D. (Pukui et al. 1974:113) Upon consenting to become *mō‘ī* (king) at the age of 29, he was taken to Kapukapu-ākea heiau (temple) at Pa`ala`a-kai in Wai`alua to be consecrated. Soon after becoming king, Mā‘ili-kūkahi was taken by the chiefs to live at Waikīkī. The story tells us that he was probably one of the first chiefs to live there. Up until this time the chiefs had always lived at Wai‘alua and ‘Ewa. Under his reign, the land divisions were reorganized and redefined.

In reference to the productivity of the land and the population during Mā‘ili-kūkahi’s reign, Kamakau writes:

> In the time of Mā‘ili-kūkahi, the land was full of people. From the brow, lae, of Kulihemo to the brow of Maunauna in ‘Ewa, from the brow of Maunauna to the brow of Pu‘ukea [Pu‘u Ku‘ua] the land was full of chiefs and people. From Kānewai to Halemano in Wai`alua, from Halemano to Paupali, from Paupali to Hālawa in ‘Ewa the land was filled with chiefs and people. (Kamakau 1991a:55)

The picture presented here is that the whole *moku* of ‘Ewa, including ‘Aiea, was one of prosperity and productivity and the land was heavily populated in all the *ahupua‘a* of ‘Ewa.

‘Ewa continued to be a political center until the 18th century when Kahahana, a Maui chief, was chosen by the O‘ahu chiefs to rule over the whole island. Somewhere between 1883 and 1885, Kahahana was killed by Kahekili of Maui. Kahahana’s father ‘Elani, along with other O‘ahu chiefs, plotted to kill Kahekili and his chiefs who were residing at Kailua, O‘ahu, as well as his chiefs residing at ‘Ewa and Wai‘alua. The plot was discovered by Kahekili and a messenger was sent to warn Hū‘eu at Wai‘alua. For some reason, the messenger never reached Hū‘eu and he and his retinue were killed. This slaughter became known as the Waipi‘o *Kīmopō* or the Waipi‘o assassination because it originated there. Kahekili avenged the death of Hū‘eu by pillaging and destroying the districts of Kona and ‘Ewa. It is said that the streams of Makaho and Niuhelewai in Kona, as well as Hō‘ae‘ae in ‘Ewa were choked with the bodies of the slain. It was during this time that the O‘ahu chiefly lines were nearly exterminated. It is said that one of the Maui chiefs, Kalaikoa, used the bones of the slain to build a wall around his house at Lapakea in Moanalua. The house was known as *Kauwalua* and could be seen as one passed by the “old upper road to ‘Ewa” (Fornander 1996:226).

Even though Waikīkī was a favorite playground for the chiefs of Kona, as with ‘Ewa chiefs, there were no deep harbors where large ships could enter port. With the introduction of trade and foreign goods, along with Kamehameha’s unifying the islands, attention shifted to Kou (old name for Honolulu, used until about 1800) (Pukui et al. 1976:117) which had a deep enough harbor for ships to pull in and anchor. Kou became the center of activity as royalty moved away from the outer districts toward the center of commerce. The general populace as well moved away from the rural areas as they, too, became dependent on a cash economy. Archibald Campbell writes about O‘ahu in 1809:

> Although only of secondary size, it has become the most important island in the group, both on account of its superior fertility, and because it possesses the only secure harbour to be met with in the Sandwich islands.
>
> In consequence of this, and of the facility with which fresh provisions can be procured, almost every vessel that navigates the North Pacific puts in here to refit. This is probably the principal reason why the king has chosen it as his place of residence; (Campbell 1967:109-110)

‘Ewa is depicted as an abundant and populated land where chiefs of distinguished lineages were born and resided. The land was fertile and well fed by mountain streams that helped sustain the agricultural lifestyle needed to support the chiefs, their households and their people. An examination of the place names reveal that water was a very important factor in this district. Six of the twelve ahupua`a names begin with *wai*, the Hawaiian word for water (Waikele, Waipi‘o,

Waiawa, Waimano, Waiau, and Waimalu). The fact that there were so many fishponds in the `Ewa district and in the Pu‘uloa area, more than any other district on O‘ahu, indicates that agricultural/ aquacultural intensification was a direct link to the chiefs who resided there and, also, to the increasing needs of the population. ‘Ewa’s part in the politics and history of O‘ahu is of particular importance. Bearing all of this in mind, ‘Aiea must be looked at within the context of the totality of the district of ‘Ewa.

3.4 Early Post-Contact Period 1778-1848

Sometime after Kamehameha conquered O‘ahu in the battle of Nu‘uanu in 1795 he gave his most trusted foreign advisors, Isaac Davis and John Young, some lands as a reward for their loyal service to him. As part of this award, each one received half of the ahupua‘a of Hālawa. As was the usual custom at the time, the king divided the land among his chiefs who supported him throughout his conquests of the islands.

Archibald Campbell lived with Isaac Davis for a short period and says that Kamehameha “always treated [them] with greater confidence than any of the native chiefs.” Of Davis’ lands, Campbell writes:

> Upon Wahoo [O‘ahu] alone he had estates on which were four or five hundred people, who cultivated the land, and paid him rent in kind. These were exempted from the taxes paid by the other chiefs for their lands; but Davis frequently made the king presents of feather cloaks, and other valuable articles (Campbell 1967:98).

These lesser chiefs (Young and Davis) were allowed to work the land as long as they lived. But, as was the traditional custom, upon their death the land reverted back to the ali‘i nui. This rule held true even for these two most faithful advisors. John Young tried to make his lands inheritable by requesting that his children, and those of Isaac Davis whom he adopted, be allowed to retain the lands given to him by the king upon his death. Even by the late date of 1834, Kamehameha III refused to honor Young’s request. It is interesting to note that even though his request was denied, in the Māhele, John Young’s children were allowed to keep lands as ‘āina ho‘olina or inherited lands. Lilikalā Kame‘eleihiwa notes that in all of the Buke Māhele, these were the only lands given under this designation (Kame‘eleihiwa 1992:60).

Prior to John Young’s death in 1835, he attempted to make his lands inheritable by willing Hālawa to his daughter, Grace Kama‘iku‘i. His will states:

> . . . in behalf of my deceased friend Isaac Davis and for his children as he died without will, the King Kamehameha gave me all the said Isaac Davises [Davis’] lands to take care of them and his children until the children came of age, and now they are come of age so I think it right to leave my last wishes and will that the King, Ka‘ahumanu, Adams and Rooke and all the Chiefs will let Isaac Davises children keep their father’s lands that King Kamehameha gave to him as a reward for assisting the King in his wars in conquering the islands of Hawai‘i, Maui, Molokai, and O‘ahu, and which we have an undoubted right to leave to our children, which I hope in God our young king will fulfill the wishes of his

> honored father. My own lands, I wish my children to enjoy as I have done, likewise my wife . . . (Claim: #595 F.R. 67-72 V2).

The first cattle were brought to O‘ahu from Kaua‘i in 1809 by both John Young and Kamehameha I (Kamakau 1992:268). Campbell confirms this and writes:

> . . . at the time I was there he [John Young] had a herd of nine or ten upon the north side of the island.

It is probable that Young had cattle at his Hālawa lands as well. By the above mentioned account, we can see that sheep and goats were already very numerous.

> Several individuals had large flocks of them. The queen had one [sic], consisting of about one hundred and fifty; and Manina had several hundreds on the island [Moku‘ume‘ume or Ford Island] in Pearl river. The cattle lately introduced are pastured upon the hills, and those parts of the country not under cultivation, the fences not being sufficient to confine them [Campbell 1967:117-18].

Isaac Davis died of poisoning in 1810. It is said he uncovered a plot to kill Kaumuali‘i of Kaua‘i. Although he was successful in preventing the act from occurring, his own life was, perhaps, taken in revenge. Others have speculated that Davis fell out of favor with the other more ambitious chiefs. At any rate, Kamehameha I was still living on O‘ahu at the time and it is most likely that Davis’s lands were returned to the King as was the usual custom.

The exact outcome of Davis’ portion of Hālawa is unclear from the period of 1810, when Davis died, to the Māhele in 1848. Early visitors have left a few clues. It is speculated that Davis’ half portion of Hālawa was returned to Kamehameha I, who redistributed the lands as he saw fit. Oliver Holmes served as a governor for the king, probably sometime after Davis was murdered. It is very probable that Holmes received Davis’ portion (Klieger 1995:38). Archibald Campbell was also given land along the Pearl River, though it is not certain exactly where his portion was located within the ahupua‘a or if it was given to him after the death of Isaac Davis. At any rate, Campbell only lived in Hawai‘i for a short period, from 1809 to 1810. Part of that time was spent living with Isaac Davis. Campbell’s portion was probably not part of Davis’ Hālawa portion.

In 1816-1817, the Russian explorer, Kotzebue wrote about his visit to the west side of Honolulu:

> The scenery is here uncommonly picturesque; fields and villages intermingled with woods of cocoa and banana trees . . . We passed the possessions of Young and Holmes, which the King had given them; and which were considerable, and well cultivated [Kotzebue 1967:345-346].

From this reference, it is speculated that perhaps Oliver Holmes received Isaac Davis’ lands in Hālawa.

When the French botanist, Chamisso, made a tour of the lands west of Honolulu in 1816, he made some observations about the landscape and the Pearl River area. Glynn Barratt gives a paraphrased account from Chamisso’s journal:

> There were other settlements of no great size and other coconut plantations, as well as properties presented by Kamehameha I to his “minister,” John Young and to a well-respected Massachusetts man, Oliver Holmes. . .The estates were beautifully tended by Hawaiian labourers. Even though the sun was high, the air was suddenly made noisy by Hawaiian bats (‘opeape‘a), and Kotzebue shot one so he could examine it [Barratt 1988:59].

3.4.1 Mid- to late-1800s

The Organic Acts of 1845 and 1846 initiated the process of the *Māhele* - the division of Hawaiian lands - which introduced private property into Hawaiian society. In 1848, the crown and the ali‘i (royalty) received their land titles. *Kuleana* awards for individual parcels within the *ahupua‘a* were subsequently granted in 1850. These awards were presented to tenants, native Hawaiians, naturalized foreigners, non-Hawaiians born in the islands, or long-term resident foreigners who could prove occupancy on the parcels before 1845. The entire *ahupua‘a* of ‘Aiea was declared Crown lands as a result of the *Māhele* (Unknown Author 1889).

The first Chinese laborers arrived in Hawai‘i in 1852 under contract to work on sugar plantations. As the demand for *kalo* declined and importation of Chinese laborers to the west coast of California and Hawai‘i increased, a market for rice developed. *Lo‘i* lands were ideal for growing rice and as these lands lay in disuse and became more available, the Chinese farmers snatched them up. Most of the land was “. . . near sea level--undrained areas at the mouths of streams: lowlands, which could be reclaimed without great expense” (Coulter & Chun 1937:11). The Royal Hawaiian Agricultural Society encouraged rice as a new crop. The first rice harvest occurred in 1862. By the mid 1860's much of the *lo‘i* on O‘ahu had been transformed into rice fields By 1892, there were approximately 76 acres of land planted in rice in the lowlands of ‘Aiea and Kalauao (Coulter & Chun 1937:21).

In many *ahupua‘a*, the lands which were not claimed by *kuleana* claimants, were leased out to entrepreneurs who started ranching and sugar plantations on a large scale (Conde and Best 1972). Such was the case with upper ‘Aiea. In the 1850s J.R. Williams cultivated sugar cane in the area; however his endeavor was short lived as there was no railroad in operation for transporting cane to the mill and the mill itself burned to the ground three times. After the third time, the land reverted back to ranching for approximately 25 years (Figure 6 and Figure 6) (Conde and Best 1972:327). The Honolulu Sugar Company leased the land in 1899 and built a sugar mill in ‘Aiea (Land Grant 4270) just southwest of the current project area. It became the Honolulu Plantation Company in 1900 and had an active refinery in operation next to the mill by 1905.

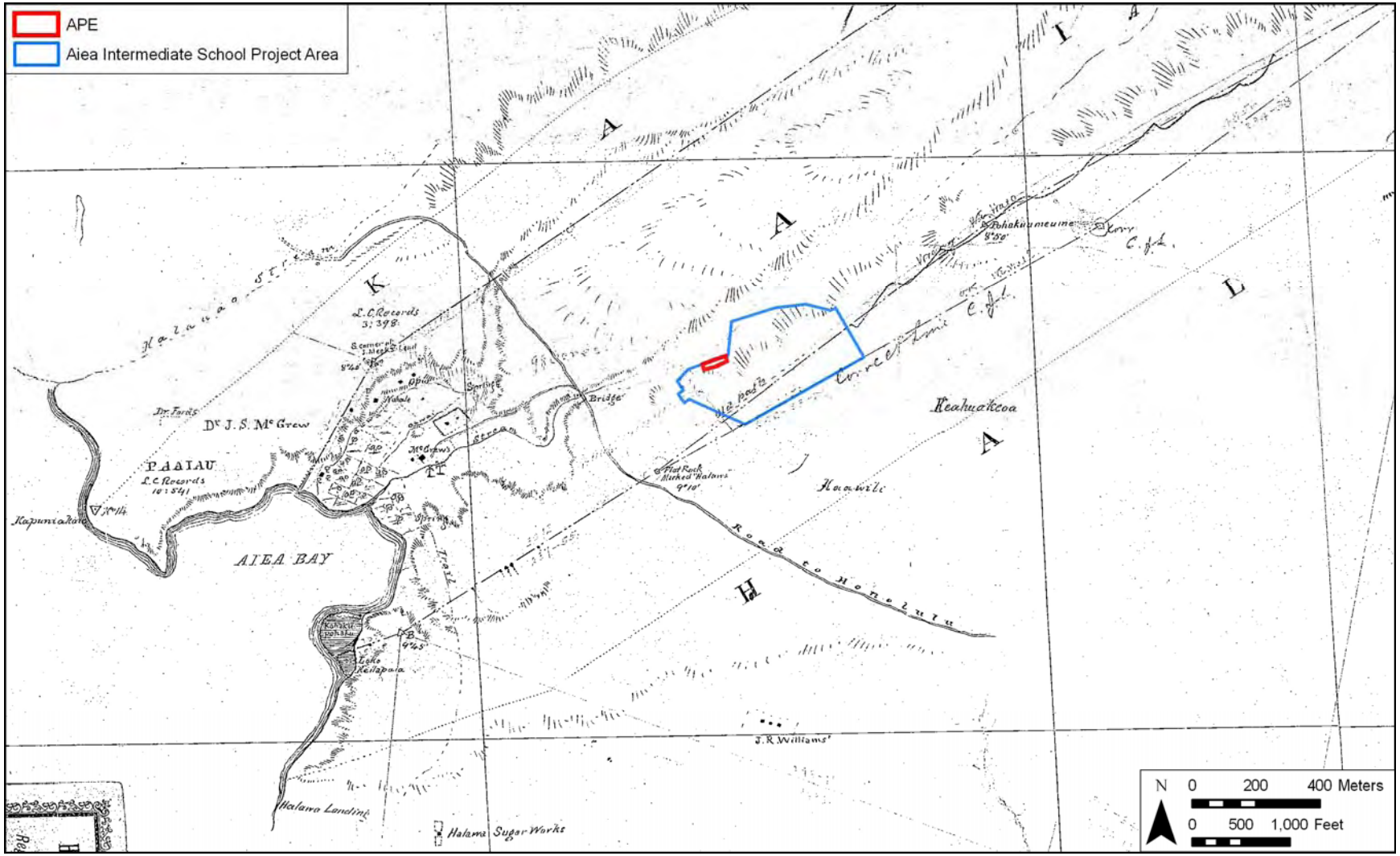

Figure 5. 1874 map showing the project area, note there is little development in the vicinity (Lyons 1874).

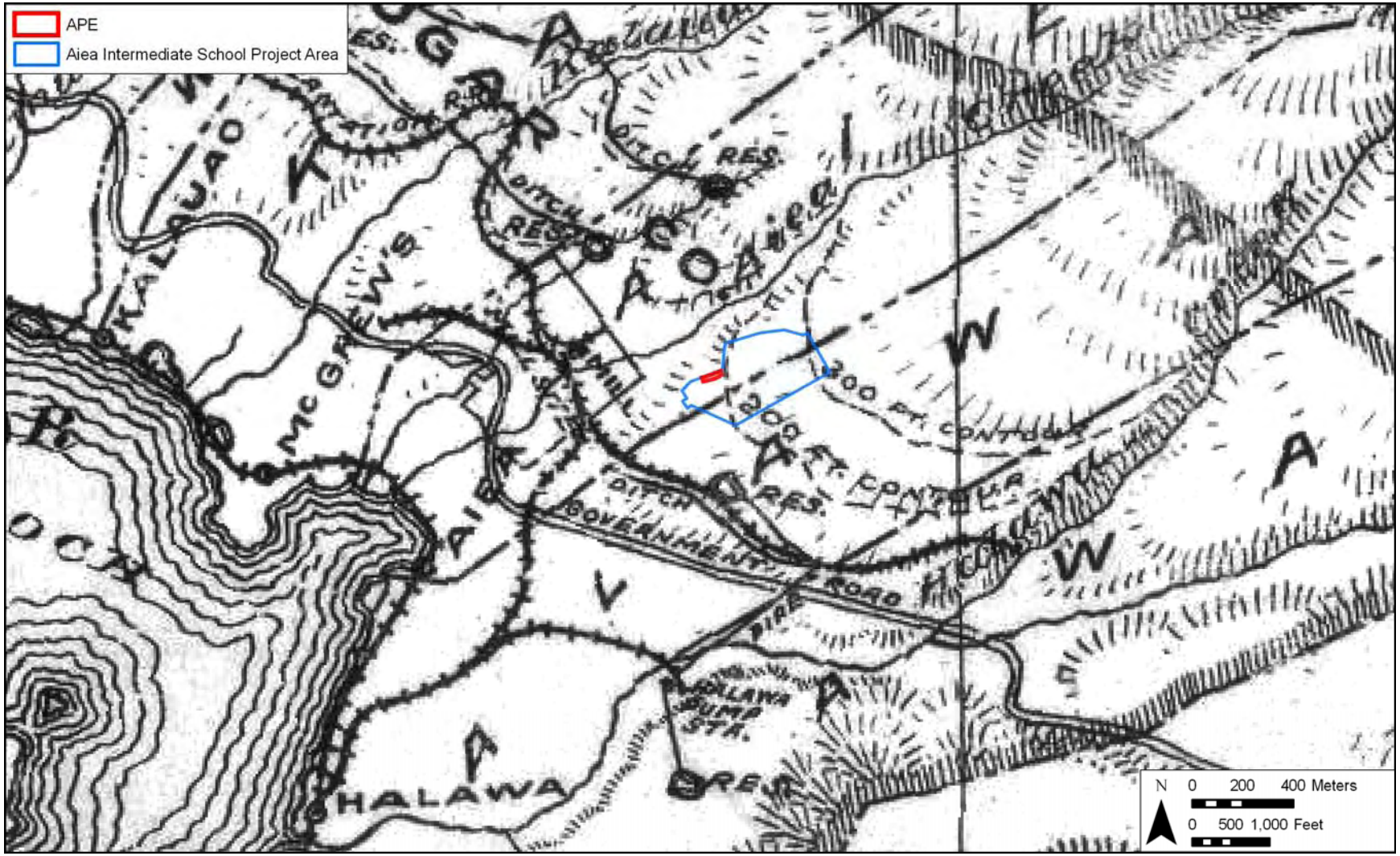

Figure 6. 1899 Map of ‘Aiea showing the project area (Beasley 1899).

3.4.2 1900s

By the mid-1930s the Honolulu Plantation Company had more than 23,000 acres of land leased in and around ‘Aiea. Sugar cane planting also extended seaward and a sugar plantation community developed at Puuloa Camp circa 1930. Another community called Watertown developed adjacent to the east side of the Pearl Harbor entrance.

In 1901, the U.S. Navy had begun condemning the Hālawa lowlands in order to build the naval base at Pearl Harbor. By the early 1900's, virtually all of the ‘Ewa plains had been transformed and planted in cane. In spite of this, the Honolulu Plantation Company kept expanding until the sugar harvest peaked in 1920 (Klieger 1995:93). Eventually, the lower portions of ‘Aiea were transformed into the H-1 and H-3 Interchange and the Pearl Harbor Navy base. Sugar production continued into the 1950's and early 1960's by the Oahu Sugar Company (Figure 7, Figure 8, and Figure 9). In the 1960's these lower portions were re-zoned for residential housing and industrial use. M<ajor developments in the area included an animal quarantine and the Aloha stadium (Klieger 1995:96).

Pearl Harbor had been the focus of American interests in the Hawaiian Islands for many decades prior to annexation. Following annexation in 1898 and with an eye on the need to establish a coaling station for American warships running to the Philippines and beyond improvements at the Pearl Harbor entrance was a major concern. Some 429 acres were purchased from Queen Emma Kaleleonalani for $28,285 which was developed as Fort Upton (changed to Fort Kamehameha in 1909). An additional 400 acres were purchased from the Damons in 1911. In 1908 the Navy undertook the dredging of the Pearl Harbor channel that was blocked by a shallow sand bar that had greatly restricted earlier development efforts. Much of the fill from this and later dredging efforts was used to fill in low-lying lands. Five separate coastal defense batteries were built (including Battery Selfridge and Battery Hawkins). The Fort Kamehameha post housed Hawaii’s first aviation unit in 1917/1918. The population of the base remained about 1800 until World War II.

The Hickam Air Force Base web site offers the following brief history of the bases early development:

> In 1934, the Army Air Corps saw the need for another airfield in Hawaii and assigned the Quartermaster Corps the job of constructing a modern airdrome from tangled brush and sugar cane fields adjacent to Pearl Harbor on the island of Oahu. The site consisted of 2,200 acres of ancient coral reef, covered by a thin layer of soil, located between Oahu's Waianae and Koolau mountain ranges, with the Pearl Harbor channel and naval reservation marking its western and northern boundaries, John Rodgers Airport to the east, and Fort Kamehameha on the south. The new airfield was dedicated May 31, 1935 and named in honor of Lt. Col. Horace Meek Hickam, a distinguished aviation pioneer killed Nov. 5, 1934, at Fort Crockett in Galveston, Texas (Hickam Air Force Base 2008).
>
> Hickam AFB now consists of 2,850 acres of land and facilities valued at more than $444 million.

During the 1940's, the U.S. military began buying additional land from the Damon family for the construction of the Tripler Army Medical Center Facility. Construction began in 1944 and the hospital was completed in 1950. Following statehood, the lands of ‘Aiea were greatly developed for residential and light industrial uses (Figure 10 and Figure 12).

In 1963 Executive Order 2121 gave land to the State of Hawai‘i, Department of Education for the construction of ‘Aiea Intermediate School. A section of the parcel was also designated for Halāwa Heights Elementary School (Figure 11). Both schools are present in the 1977-78 aerial photo (Figure 12).

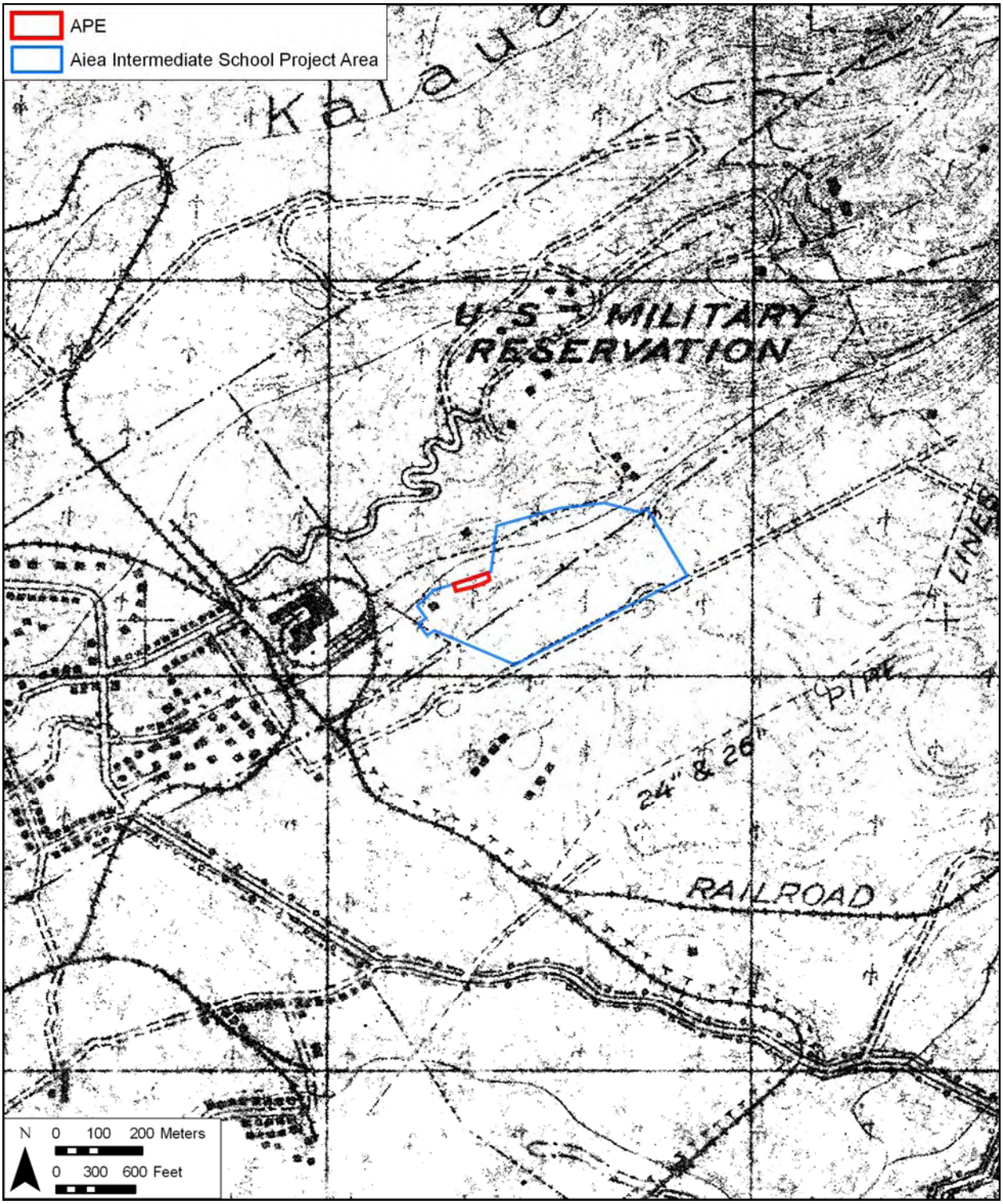

Figure 7. 1919 War Department map showing the project area.

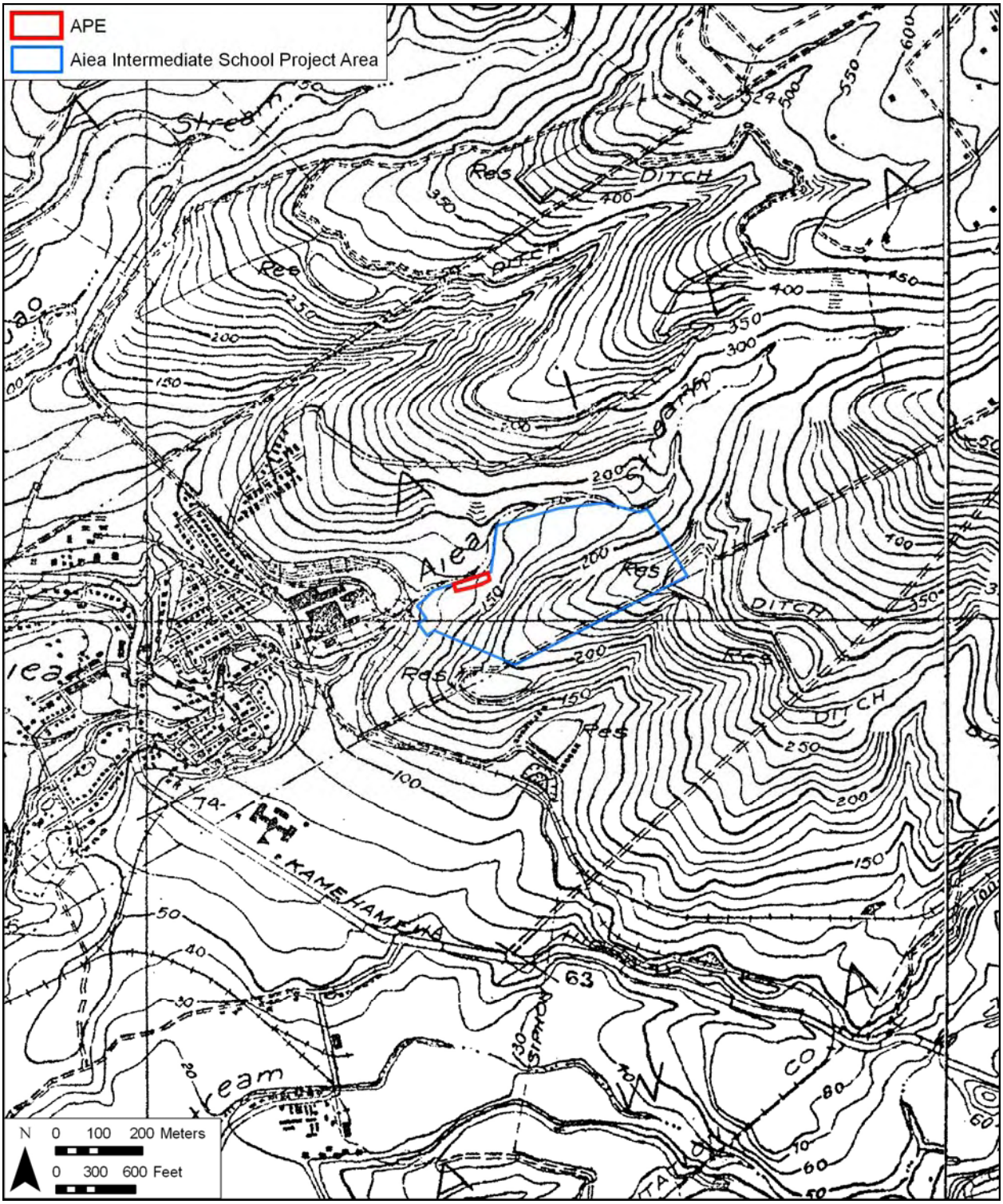

Figure 8. 1927-1928 USGS Waipahu quadrangle showing the project area.

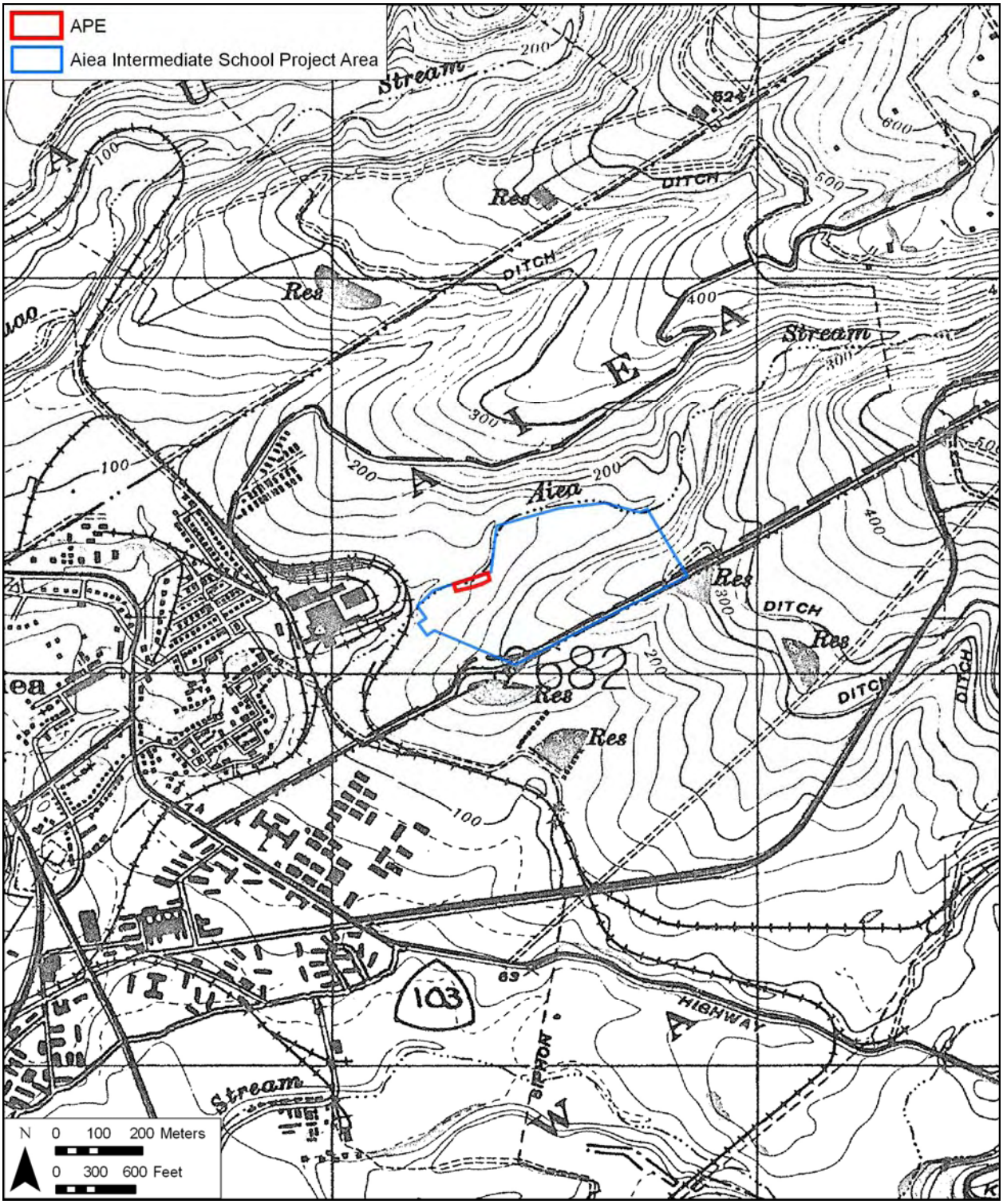

Figure 9. 1943 War Department map showing the project area.

Figure 10. 1954 AMS Waipahu Quadrangle showing the project area; note development in the vicinity.

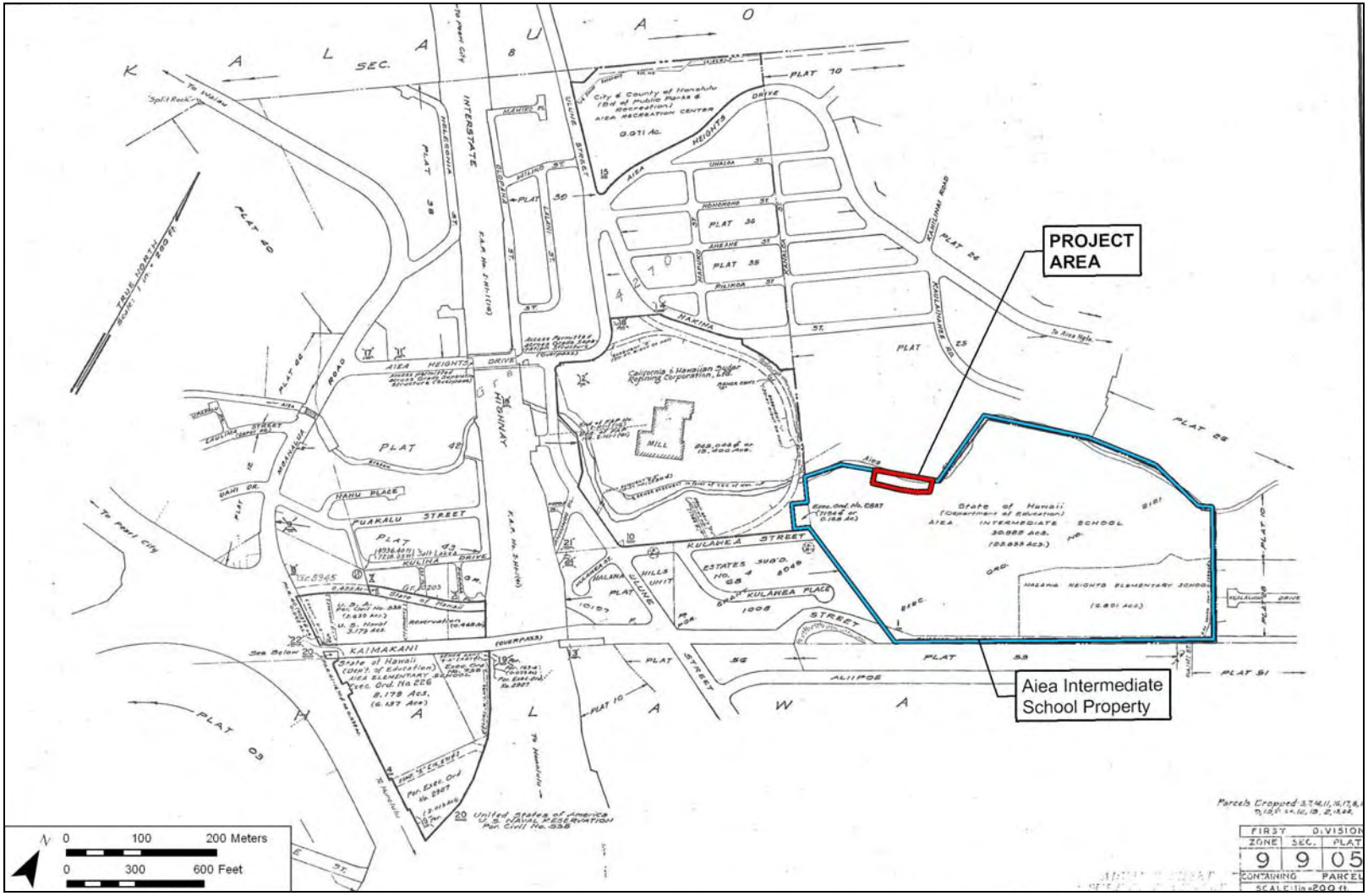

Figure 11. 1963 TMK map showing the project area as designated for an intermediate school per Executive Order 2121; note the sugar mill adjacent to the project area.

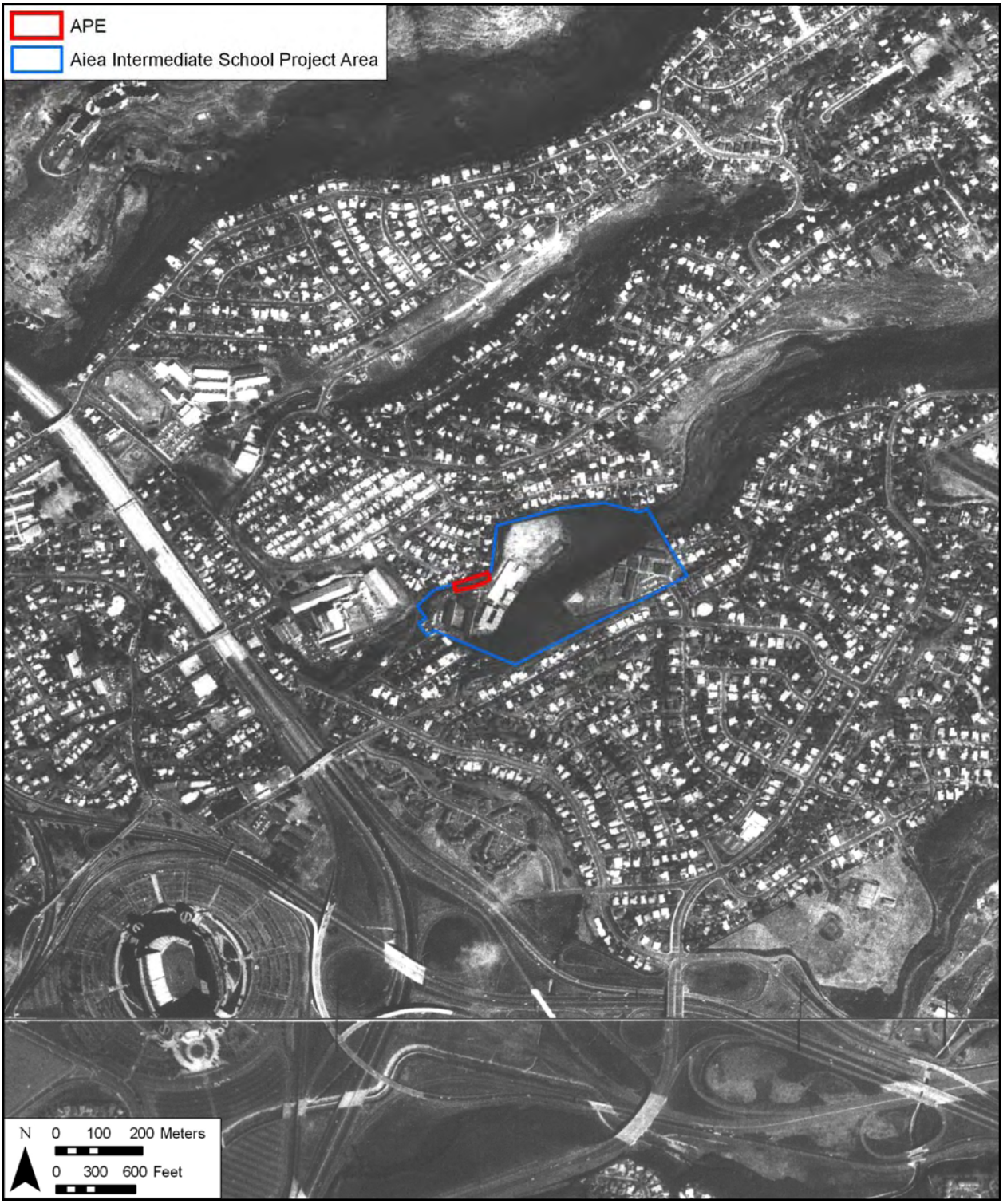

Figure 12. 1977-1978 aerial photo showing the project area (USGS 1977).

3.5 Previous Archaeological Research

The first recorded sites were documented during a pioneering attempt at a comprehensive survey of archaeological sites on the island of O‘ahu by J. Gilbert McAllister of the Bishop Museum in 1930.

McCallister recorded two sites, 107 and 146, of interest to this report. Site 107, Kiaiwa Heiau, is described as northeast of ‘Aiea and consisting of a small rectangular structure with one terrace and low perimeter walls. Site 146 is ‘Ewa coral plains, of which ‘Aiea is a part. McCallister describes them as a " …great extent of old stone walls, particularly near the Puuloa Salt Works, which belongs to the ranching period of about 75 years ago [1880s]" (McCallister 1933:199).

In 1969, Deborah Cluff of the DLNR conducted an archaeological surface survey for the construction of the Hālawa Interchange for Interstate H-1. Of the total 28 acres of the region studied, only a narrow strip of land was intensively investigated, measuring 42 meters wide and 344 meters long. A total of eight features were located including a stone house platform, several grave structures, and a possible site of a *heiau* (Cluff 1970). The area studied for this survey is approximately 1 kilometer south of the current project area.

In 1971, a letter report was written by William Barrera, addressed to the DLNR, regarding marked and unmarked graves among housing near the construction of Aloha Stadium (Barrera 1971). It appears that the graves were not given an SIHP number. The letter report is currently unavailable through the Hawai‘i State Historic Preservation Division. It appears no other archaeological resources were encountered during the investigation. It is possible that this letter report could be referring to the historic use of the State of Hawaii-owned ‘Aiea Cemetery immediately *‘Ewa* of Aloha Stadium on the *mauka* side of Kamehameha Highway.

In 1981, the Division of State Parks conducted an archaeological reconnaissance survey at Rainbow Bay State Park on the East Loch of Pearl Harbor. No archaeological resources were observed, and intense land disturbance was noted (Yent and Ota 1981)

In 1986, Eric Komori and Dr. Aki Sinoto conducted an archaeological surface survey for the Pearl Promenade Project in Kalauao, ‘Ewa (Sinoto 1986). Because of extensive previous land alterations (e.g., filling of the marshland) in the project area, no archaeological resources were observed.

In 1989 a cultural resources reassessment study for the 1989 Ford Island Causeway was prepared. The purpose was to assess potential effects the proposed Ford Island Causeway may have on cultural resources of the area. For this study, no additional fieldwork was necessary because the requirements of the reassessment were addressed by a review of available literature and documentation at the time. At the time of this assessment the only site that warranted in situ preservation was Site 50-80-09-108, Loko Pa‘aiau, fishpond at Kalauao (Sinoto 1989).

A reconnaissance survey was conducted in 1994 for a non-potable well to supply water for irrigation purposes. All evidence of early historic or pre-contact Hawaiian activity, including habitation and agriculture within this area, was eradicated by development of the area in the late 19th century for commercial sugar cultivation. The original landscape both in and around the project area has been extensively modified as a result of this activity (Hammatt and Winieski 1994).

In 1995 a study on the northeastern end of Ford Island was conducted. A total of eight test trenches were excavated and examination of trench profiles revealed no cultural deposits or archaeological sites. Charcoal was recovered from one of the test trenches, however no cultural features associated with the charcoal were observed. Further research concluded the charcoal recovered had originated from a historically introduced species of flora, and therefore dated post-nineteenth century. No archaeological resources were observed during this survey (Erkelens 1995).

An archaeological reconnaissance survey was conducted in the neighboring *ahupua‘a* of Kalauao, which lies on the northern side of the current project area. Substantial evidence of historic plantation agriculture, possibly pineapple, was apparent; however, the level natural terrace area contained no archaeological sites and no evidence of subsurface cultural material (Hammatt 1996).

An Literature Review and Field Inspection of an approximately 7.6 kilometer portion of the H-1 Highway from Hālawa to the H-1/H-2 Interchange at Waiawa Ahupua‘a was performed in 1998. During the reconnaissance survey of the project area, no archaeological sites were identified (Hammatt and Chiogioji 1998).

An archaeological inventory survey was conducted for the Hālawa Bridge Replacement Environmental Assessment in 1999. This survey was located approximately 2 kilometers southwest of the current project area, and approximately 300 meters from the mouth of Hālawa Stream. As a result of extensive land modifications, including drainage pipe installation, and deposition of fill materials associated with these activities, it was concluded that any archaeological sites that may have been present were likely destroyed (Dye 1999).

A survey of sediment core sampling was conducted in 2000. The objective of the survey was to investigate the development of fishponds along the coastal areas in and around *Pu‘uloa* (Pearl Harbor). Core samples were collected for analysis and dating. Only one fishpond in this survey was located within the ‘Aiea Ahupua‘a boundary. This fishpond had been filled in and resembles a small peninsula protruding into East Loch, on the eastern side of ‘Aiea Bay (Athens 2000). The name of this fishpond is *Loko Kahakupohaku*, and is described as a “small filled fishpond located along the east shoreline of East Loch….No field investigations were undertaken at this pond due to possible hazardous waste contamination of the overlying fill” (Athens 2000:31).

Table 1. Archaeological Studies in the Vicinity of ‘Aiea Intermediate School, ‘Aiea Ahupua‘a

Source	Nature of Study	TMK [1] - -	Location
McCallister 1933	Island Wide Survey	9-9	‘Ewa District
Cluff 1970	Inventory Survey	9-9-	Hālawa Interchange
Barrera 1971	Archaeological Site Survey	9-9-	Honolulu Stadium
Yent and Ota 1981	Reconnaissance Survey	9-8-, 9-9-	Proposed Rainbow Bay State Park
Sinoto 1986	Archaeological Surface Survey	9-8-014:003, 9-8-014:006, 9-8-014:007, 9-8-015:044, 9-8-015:045	Proposed Pearl Promenade, Kalauao
Sinoto 1989	Cultural Resources Reassessment	9-8-014, 9-8-015:057, 9-8-015:058 ,9-8-019:003, 9-9-001:008, 9-9-001:015, 9-9-001:016, 9-9-003:032	Ford Island Causeway Study
Avery, et al. 1994	Paleo-environmental Study	9-9-001, 9-9-003:	Hālawa Stream Mouth
Hammatt and Wineski 1994	Reconnaissance Survey	9-9-003:035	Proposed Hālawa Well – 2 acres
Erkelens 1995	Archaeological Study	9-9-001:	Ford Island Bridge
Hammatt 1996	Archaeological Reconnaissance	9-8-11:1 (Por.)	4-acre parcel in the Ahupua‘a of Kalauao, O‘ahu
Hammatt and Chiogioji 1998	Assessment	9-4-011	Approximately 7.6 kilometer-long portion of the H-1 from Hālawa to the H-1/H-2 Interchange
Dye 1999	Archaeological Resources Survey	9-9-001:001; 9-9-002:004; 9-9-003:026, 9-9-003:029, 9-9-003:056	Hālawa Bridge, Hālawa
Athens 2000	Hawaiian Fishpond Study	Various	U.S. Navy Lands Pearl Harbor

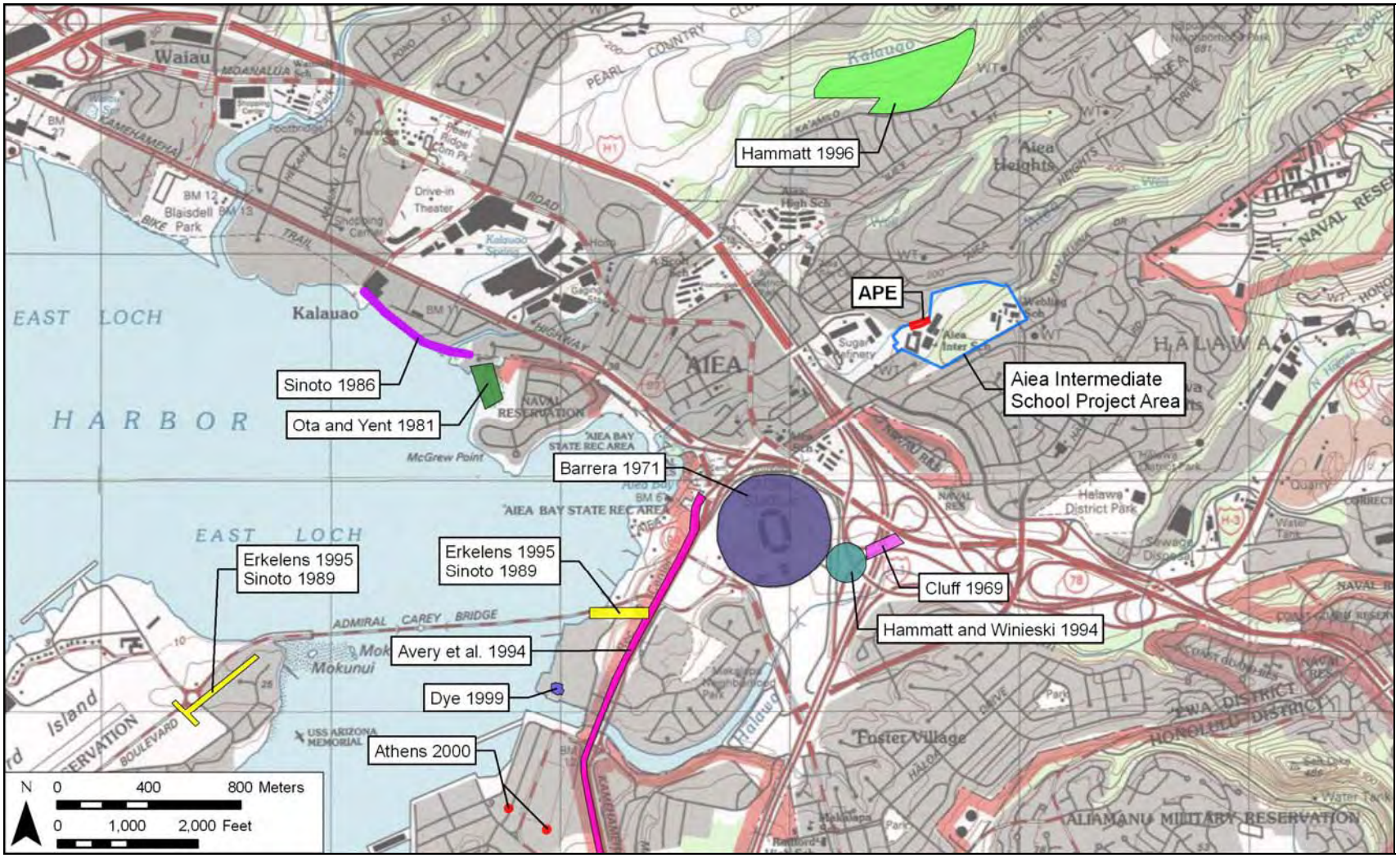

Figure 13. Previous archaeology in the vicinity of the current project area.

3.6 Background Summary and Predictive Model

3.6.1 Background Summary

Though ‘Aiea is a rich and varied *ahupua‘a* with coastal resources, rich central plans, and upland forest regions, little information is available regarding pre-contact and early historic land use. Most early references in traditional literature are brief and only mention ‘Aiea in passing with little attention to detail. Early visitors to the area describe ‘Aiea as an agricultural plain with coastal resources, populated primarily near the Pearl River and the coast line (Handy 1940; Mathison 1825). Therefore, information regarding pre-contact land use in ‘Aiea comes from surrounding *ahupua‘a* and the *Moku* of ‘Ewa. Early descriptions of ‘Ewa document it as a large coastal plain with deep bays around Pearl Harbor. Deep valleys and steep ridges are in abundance and flow back into the Ko‘olau Range. The lowlands were characterized by smaller drainages and plains ideal for agricultural use.

Traditionally, ‘Ewa was a political center and many *ali‘i* resided there because of abundant resources. There are many traditional stories of ‘Ewa as a land well populated and rich in natural resources. In the 18th century attention shifted to Honolulu and Waikīkī after the battle between the O‘ahu chiefs and Kahekili, which resulted in the near extermination of the O‘ahu chiefly lines. After Kamehameha united the islands, the center of commerce shifted to Honolulu and the general population gravitated toward the city as well, in response to the shift from an agricultural to cash economy.

There is little documentation between the conquest of Kamehameha in 1795 and the division of Hawaiian lands in 1845 and 1846. The entire *ahupua‘a* of ‘Aiea was declared Crown lands as a result of the *Māhele* (Unknown Author 1889). Early maps of ‘Aiea show the project area as undeveloped. The 1899 Beasley map shows the surrounding area as sparsely populated and used for agricultural purposes.

The government leased lands that were not claimed during the *Mahēle,* and the land in the current project area was used for commercial sugar cane production. By the early 1900s almost all of ‘Ewa was converted to sugar cane fields. The U.S. Navy took control of the lowlands in Halāwa by 1901 and began building the Pearl Harbor base. In the 1940s the military bought a large portion of upper ‘Aiea and constructed Tripler Army Medical Center. Sugar cane production continued in most of the lower plains into the late 1960s when the land was subdivided for urban housing developments and light industrial use. In 1963, an executive order gave land to the State of Hawai‘i, Department of Education for the construction of ‘Aiea Intermediate School and Halāwa Heights Elementary School (Figure 11). Both schools still function today. Private parcels have impacted ‘Aiea stream on the northwest side by instituting erosion control measures, however it has not been impacted on the southeast side where the proposed project will take place, and the natural course of the stream has not been significantly altered over time.

3.6.2 Predictive Model

Previous document research of the project area vicinity indicates this portion of ‘Aiea was sparsely populated before western contact. Types of deposits associated with pre-contact culture

include sediments related to *lo‘i* terraces and dry land agriculture, evidence of habitation, and midden remains. It is likely that any pre-contact cultural deposits were destroyed by almost a century of commercial agricultural and ranching activities, which affected the project area. Types of post-contact agricultural infrastructure and ranching activities that could be encountered in the APE include terraces, historic artifact scatters, and water control features. However, previous archaeological research indicates little possibility of cultural material in the project area and vicinity. For these reasons, as well as the relatively small Area of Potential Effect and its presence in a stream channel, there is little possibility of encountering cultural material.

Section 4 Results of Fieldwork

4.1 Survey Findings

The fieldwork component of this field inspection was conducted on July 28, 2009 by CSH archaeologists, Rosanna Runyon, B.A. and Kendy Altizer, B.A., under the general supervision of Hallett H. Hammatt, Ph.D. (principal investigator). The fieldwork required 4 person-hours to complete.

The project area has been extensively modified by the construction of ‘Aiea Intermediate School in the southwestern portion of the project area and Hālawa Heights Elementary School in the southeastern portion of the project area; however the field inspection was conducted only within the APE defined as a 150-foot portion of the ‘Aiea stream corridor. Archaeologists carefully inspected the APE by walking the corridor section. Both sides of the cut bank, as well as the stream bed, were visually inspected for evidence of cultural material. Pedestrian inspection of the APE confirmed the findings of background research and the predictive model. No cultural deposits were observed within the APE. As anticipated, the APE showed signs of extensive erosion. The eroded stream wall contains a substantial layer of large stream boulders and cobbles that are presently eroding out of the wall (Figure 14-Figure 17). Soil consists of a top layer of sandy reddish-brown alluvial sediment (Stratum Ia) present from 0-20 cmbs, overlying a thin layer of dark brown sandy clay (Stratum Ib) at a depth of 20-45 cmbs. Alluvial sand and sediment is mixed with the bottom layer of large boulders and cobbles (Stratum II) present at 40-315 cmbs (Figure 17). The stream bed held approximately 30 cm of water at the time of the field visit, and was covered with tall riparian grasses. Boulders and cobbles were also present intermittently. Vegetation observed includes plumeria, cactus, kiawe, and various tall riparian grasses.

Figure 14. Streambed view of the project area, view northeast.

Figure 15. Project overview, view southwest.

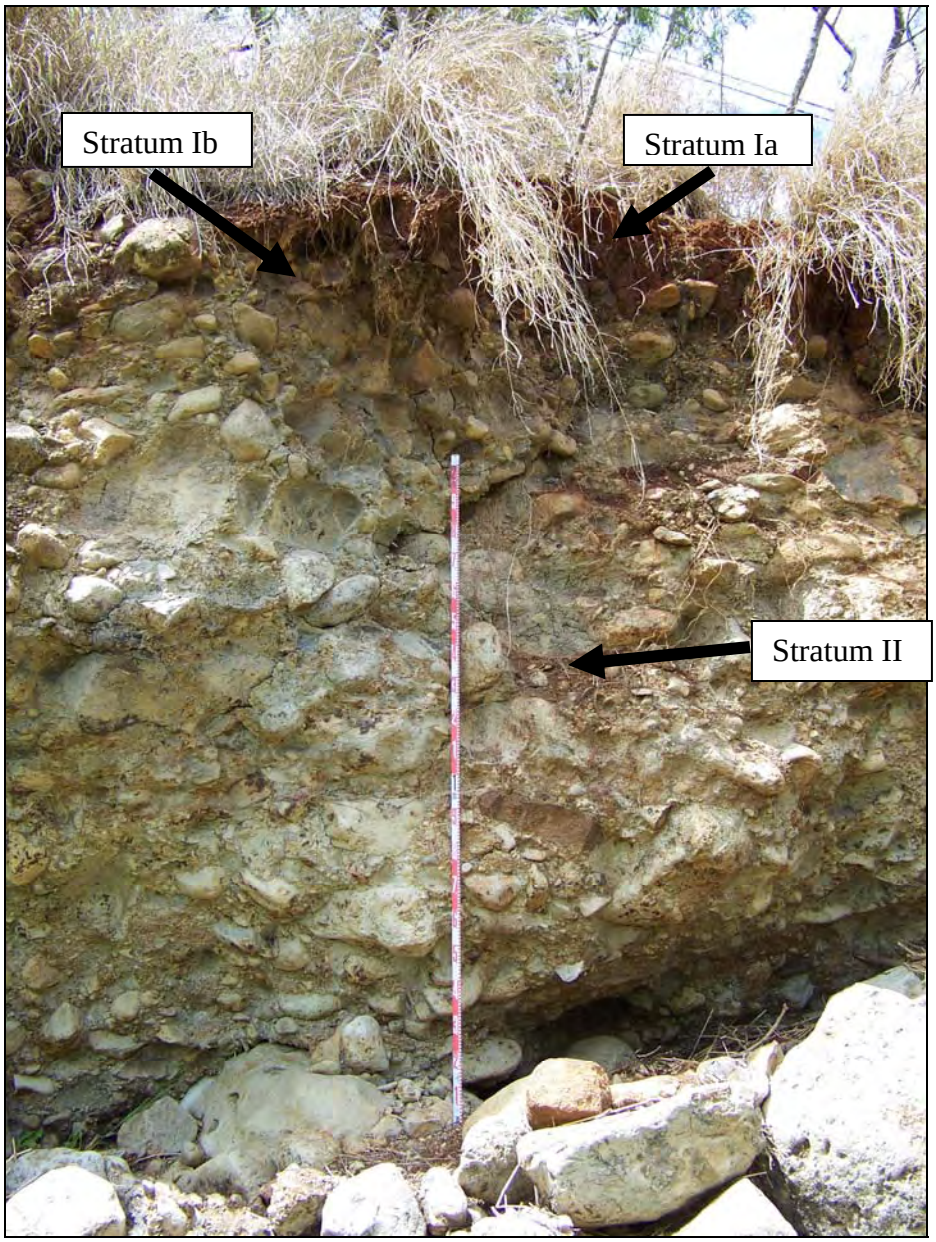

Figure 16. Stratigraphy of ‘Aiea Stream.

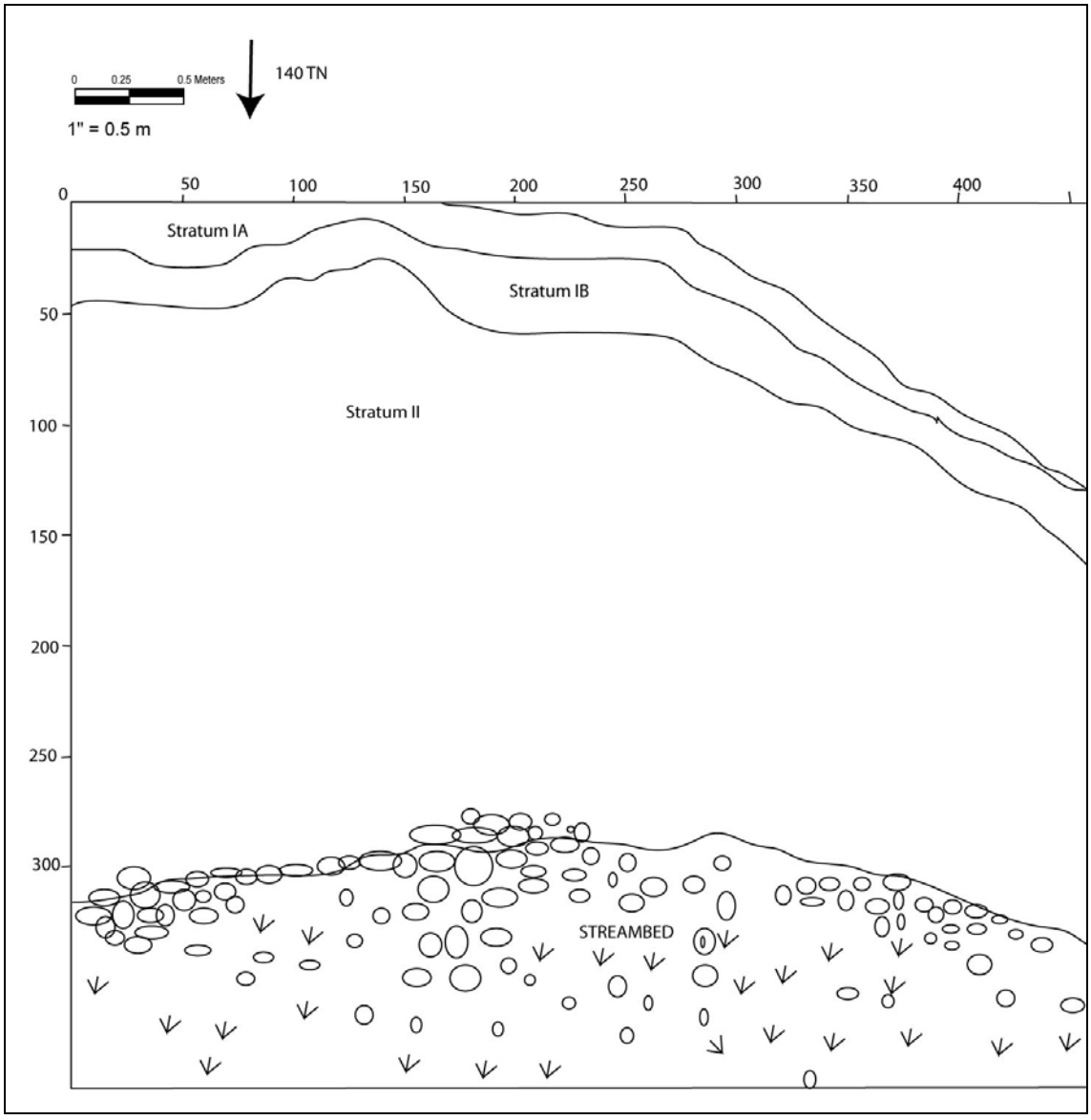

Figure 17. Soil profile of the south wall of ‘Aiea Stream.

Section 5 Summary and Recommendations

At the request of Kimura International, Cultural Surveys Hawai'i (CSH) completed this field inspection for the ‘Aiea Stream Improvements project. The 30.78-acre project area that includes the ‘Aiea Intermediate School parcel, also includes an eroded 150-foot portion of the ‘Aiea Stream corridor. The school's primary power electric manhole is located on top of the eroded stream bank and is connected to the backside access road and fire lane which houses the school's main waterline. For purposes of this report the project area is defined as the entire school parcel, while the APE is the 150-foot portion of the ‘Aiea Stream corridor. The purpose of this archaeological literature review and field inspection study was to determine if there are any archaeological resources within APE. Fieldwork was conducted on July 28, 2009, by archaeologists Rosanna Runyon, B.A. and Kendy Altizer, B.A, working under the overall supervision of Hallett H. Hammatt PhD (principal investigator).

Background research indicated little possibility of subsurface cultural material related to pre-contact agricultural practices and plantation-era agricultural and ranching activities. No historic properties were observed within the project's APE, therefore Cultural Surveys Hawai‘i recommends no further archaeological work for the proposed project. However, in the unlikely event that intact cultural resources, including human remains or other significant cultural deposits, are encountered during the course of construction activities, all work in the immediate area should stop and the State Historic Preservation Division should be promptly notified.

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AECOS No. 1230

Stream biological and water quality surveys for the ʻAiea Intermediate School Erosion Control Project ʻAiea, Oʻahu

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February 22, 2010

Stream biological and water quality surveys for the ʻAiea Intermediate School Erosion Control Project. ʻAiea, Oʻahu.

February 22, 2010 | ***Draft*** | *AECOS* No. 1230

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Introduction

In January 2010, *AECOS*, Inc. biologists conducted biological and water quality surveys of ʻAiea Stream on Oʻahu (Fig. 1). The right (southeastern) bank of the stream is eroding below the campus of ʻAiea Intermediate School. Erosion has already undermined an electrical box that was serving the school, forcing the relocation of the box and associated electrical lines in 2009. An erosion control project is scheduled for June 2010, to begin immediately after school adjourns for summer break. The project plans to stabilize a 150-ft (45-m) segment of stream bank by removing a defunct electrical box, backfilling eroded areas, trimming outcrops, and applying shotcrete to the slope. *AECOS*, Inc. was contracted by Kimura International, Inc.[1] to ascertain aquatic resources and assess water quality for the proposed project. This report details findings of those surveys.

Stream Description

ʻAiea Stream arises from three branches originating at elevations of 1460 ft (445 m), 1200 ft (366 m), and 980 ft (299 m), southwest of Puʻu Uaʻu on the western slopes of the Koʻolau Mountain. The total stream length is 6.8 mi (11 km), with the main branch flowing from the Keāiwa Heiau State Park and Recreation Area, southwest between ʻAiea Heights and Camp Smith, and beside ʻAiea Intermediate School before emptying into a small cove known as ʻAiea Bay in East Loch of Pearl Harbor, approximately 1 mi (1.6 km) downstream from the

[1] This document will be incorporated into the Environmental Assessment (EA) for the ʻAiea Intermediate Erosion Control Project and will become part of the public record.

project site. The 2.9 sq mi (5.3 sq km) watershed, which is bound partially in its upper reach by the 'Aiea Loop Trail, is diminutive compared to adjacent watersheds: Hālawa to the southeast and Kalauao to the northwest.

Figure 1. The general location of the project site in central O'ahu.

At the project site, the stream bed consists of basalt bedrock and boulders overgrown by sedges (*Cyperus* spp.), Guinea grass (*Urochloa maxima*), and California grass (*Urochloa mutica*). The stream banks adjacent to the school are nearly vertical and heavily eroded (see cover photo). The banks on the opposite side of the stream, as well as further upstream and downstream, are generally modified with concrete or concrete reinforced masonry (CRM). A small bridge crossing the stream is located downstream of the project site near the terminus of a Halewiliko Place, adjacent to the former C & H Sugar Mill. Pools were present within the stream bed next to the school; however, water flow connecting these pools was not apparent in most cases. The stream bed downstream from the school was dry.

Survey Methods

AECOS, Inc. biologists surveyed a 0.5 mi (0.8 km) segment of 'Aiea Stream on January 22, 2010 to identify any aquatic biota present and sample water quality. The survey area extended from upstream of 'Aiea Intermediate School, near an elevation of 180 ft (55 m), down to the stream opposite the former C & H Sugar Mill, at an elevation near 100 ft (30 m). Field measurements and water quality samples were collected from three stations located in the survey area. Table 1 lists analytical methods and instrumentation used in the analysis of water quality.

Table 1. Analytical methods and instruments used for water quality analyses of 'Aiea Stream waters sampled on January 22, 2010.

Analysis	Method	Reference	Instrument
Ammonia	EPA 350.1 M	Grasshoff et al. (1986)/ EPA (1993)	Technicon AutoAnalyzer II
Conductivity	SM 2510-B	Standard Methods, 20th Edition (1998)	Hydach pH/conductivity meter
Dissolved Oxygen	SM 4500-O G	Standard Methods 20th Edition (1998)	YSI Model 550A Dissolved Oxygen Meter
Nitrate + Nitrite	EPA 353.2 Rev 2.0	EPA (1993)	Technicon AutoAnalyzer II
pH	SM 4500 H+	Standard Methods 20th Edition (1998)	Hannah pocket pH meter
Temperature	thermister calibrated to NBS. Cert. thermometer SM 2550 B	Standard Methods 20th Edition (1998)	YSI Model 550A Dissolved Oxygen Meter
Total Nitrogen	persulfate digestion/EPA 353.2	Grasshoff et al (1986)/ EPA (1993)	Technicon AutoAnalyzer II
Total Phosphorus	persulfate digestion/EPA 365.1 Rev 2.0	Grasshoff et al. (1986)/EPA (1993)	Technicon AutoAnalyzer II
Total Suspended Solids	Method 2540 D	Standard Methods 20th Edition (1998)	Mettler H31 balance
Turbidity	EPA 180.1 Rev 2.0	EPA (1993)	Hach 2100N Turbidimeter

EPA. 1993. Methods for the Determination of Inorganic Substances in Environmental Samples. EPA 600/R-93/100.

Grasshoff, K., M. Ehrhardt, & K. Kremling (eds). 1986. Methods of Seawater Analysis (2nd ed). Verlag Chemie, GmbH, Weinheim.

Table 1 (continued)

Standard Methods. 1998. Standard Methods for the Examination of Water and Wastewater. 20th Edition. 1998. (Greenberg, Clesceri, and Eaton, eds.). APHA, AWWA, & WEF. 1220 p.

Station "Upstream" was collected from an isolated pool located near the northern end of the school's property, approximately 700 ft (213 m) upstream of the project site. Station "Project Site" was collected from a small pool with flowing water within the stream segment where modifications to the stream banks are planned. Station "Downstream" was collected from an isolated pool located 200 ft (60 m) downstream of the project site. Fig. 2 depicts the locations of the three water quality stations. All water samples were collected on January 22, 2010 and delivered to *AECOS*, Inc. in Kaneʻohe for analyses (*AECOS* Log No 25875).

Figure 2. Location of water quality monitoring stations in ʻAiea Stream for the ʻAiea Intermediate Erosion Control Project.

Survey Results

Water Quality

Table 2 lists water quality characteristics of waters sampled from ʻAiea Stream during the January survey. Stream waters contain very low concentrations of dissolved oxygen (DO) at all stations. High ammonia concentrations—like those

present at all three stations—are typical of stagnant water as biotic waste from fish and invertebrates accumulates over time. Stas. "Project Site" and "Downstream" have low concentrations of other nutrients (nitrate-nitrite, total nitrogen, and total phosphorus) relative to Sta. "Upstream."

Table 2. Water quality characteristics of 'Aiea Stream on January 22, 2010.

Station	Time (hh:mm)	Temp. (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (% sat.)	pH --	Conductivity (µmhos/cm)
Upstream	1210	20.0	1.12	12	7.45	510
Project Site	1142	20.9	1.85	21	7.22	617
Downstream	1125	20.8	1.48	16	7.18	605

	TSS (mg/l)	Turbidity (ntu)	Ammonia (µg/l)	Nitrate+ Nitrite (µg/l)	Total N (µg/l)	Total P (µg/l)
Upstream	5.5	8.42	85	146	791	54
Project Site	5.0	6.60	42	25	242	45
Downstream	3.0	4.50	50	45	209	38

Aquatic Biota

The aquatic biota identified from 'Aiea Stream on January 22 is presented in Table 3 along with historical data from a previous *AECOS*, Inc. survey, conducted in March 1997. American crayfish (*Procambarus clarkii*) and guppies (*Poecilia reticulata*) are common in both isolated pools and flowing segments of 'Aiea Stream. These two species constitute the bulk of the aquatic biota found near the project site. Marine toads (*Bufo marinus*) are sighted occasionally and bullfrogs (*Rana catesbeiana*) rarely. Two chlorophyte algae (*Mougeotia capucina* and *Oedogonium* sp.) are growing on gravel and bedrock in a large, unshaded pool upstream from the project site.

Table 3. Checklist of aquatic biota observed on January 22, 2010 and March 17, 1997 by *AECOS*, Inc. biologists in 'Aiea Stream.

PHYLUM, CLASS, ORDER, FAMILY *Genus species*	Common name	Abundance	Status	Notes
ALGAE				
CHLOROPHYTA				
OEDOGONIACEAE				
Oedogonium sp.		R	Ind	<1>
ZYGNEMATACEAE				
Mougeotia capucina (Bory) Agardh		R	Ind	<1>
INVERTEBRATES				
ARTHROPODA, INSECTA, DIPTERA				
CULICIDAE				
Aedes albopictus Skuse	day mosquito	C	Nat	<1,2>
ARTHROPODA, INSECTA, ODONATA				
LIBELLULIDAE				
unid.	dragonfly	R	--	<2>
MOLLUSCA,PULMONATA				
LYMNAEIDAE				
unid. sinistral	pond snail	O	Nat	<2>
ARTHROPODA, MALACOSTRACA, DECOPODA				
CAMBARIDAE				
Procambarus clarkii Girard	American crayfish	C	Nat	<1,2>
FISHES				
CHORDATA, ACTINOPTERYGII				
POECIILIDAE				
Gambusia affinis Baird and Girard	mosquitofish	U	Nat	<1>
Poecilia reticulata Peters	guppy	C	Nat	<1,2>
AMPHIBIANS				
CHORDATA, AMPHIBIA, ANURA				
BUFONIDAE				
Bufo marinus L.	giant toad	O	Nat	<1,2>
RANIDAE				
Rana catesbeiana Shaw	American bullfrog	R	Nat	<1,2>

BIRDS

CHORDATA, AVES				
ANSERIFORMES				
ANATIDAE				
Branta hutchinsii Richardson	Cackling goose	R	Ind.	<1>

KEY TO SYMBOLS USED:

Abundance categories:

R – Rare – only one or two individuals observed.
U – Uncommon – several to a dozen individuals observed.
O – Occasional – seen irregularly in small numbers
C – Common -observed everywhere, although generally not in large numbers.
A – Abundant – observed in large numbers and widely distributed.

Status categories:

End – Endemic – species found only in Hawaii
Ind. – Indigenous – species found in Hawaii and elsewhere
Nat. – Naturalized – species were introduced to Hawaii intentionally, or accidentally.

Identification codes:

<1> – field identification during Jan. 22, 2010 survey.
<2> – field identification during Mar. 17,1997 survey (AECOS, 1997).

Assessment

ʻAiea Stream is classified as a perennial stream by the State of Hawaiʻi, Division of Aquatic Resources (DAR, 2009) and assigned a stream code of 3-4-003. Stream waters are classified as Class 2 inland waters. The protected uses of Class 2 waters include recreational use, support and propagation of fish and other aquatic life, and agricultural and industrial water supply. ʻAiea Stream appears on the Hawaiʻi Department of Health (HDOH) 2006 list of impaired waters in Hawaiʻi, prepared under Clean Water Act §303(d) (HDOH, 2008). The stream is listed as impaired for nitrate-nitrite nitrogen and total nitrogen based on a combination of data from both wet and dry seasons. The stream is also listed as impaired for turbidity and trash based on a visual assessment. A Total Maximum Daily Load (TMDL) study on ʻAiea Stream is currently being conducted by the State of Hawaiʻi to identify activities that may help reduce pollutant loads, improve water quality, and increase the water bodies ability to support its legally-protected uses.

Stream waters, sampled on January 22 from three stations near the project site, have elevated conductivity and depressed DO relative to State of Hawaiʻi water quality criteria for streams (Table 4). Turbidity, nitrate-nitrite, total nitrogen, and total phosphorus concentrations were particularly elevated at a station upstream of the project site. A single sampling event, however, does not imply impairment for these parameters, as a geometric mean of at least three

sampling events would be required to make a comparison with state water quality standards.

Table 4. State of Hawai'i water quality criteria for streams (geometric mean values) for wet (Nov. 1-Apr. 30) and dry (May 1-Oct. 31) seasons from HAR §11-54-05.2(b).

Parameter	Total Nitrogen (µg N/l)	Nitrate + Nitrite (µg N/l)	Total Phosphorus (µg P/l)	Turbidity (NTU)	Total Suspended Solids (mg/l)
Not to exceed given value					
(dry season)	180.0	30.0	30.0	2.0	10.0
(wet season)	250.0	70.0	50.0	5.0	20.0
Not to exceed more than 10% of the time					
(dry season)	380.0	90.0	60.0	5.5	30.0
(wet season)	520.0	180.0	100.0	15.0	50.0
Not to exceed more than 2% of the time					
(dry season)	600.0	170.0	80.0	10.0	55.0
(wet season)	800.0	300.0	150.0	25.0	80.0

- pH – shall not deviate more than 0.5 units from ambient and not be lower than 5.5 nor higher than 8.0.
- Dissolved oxygen – not less than 80% saturation.
- Temperature – shall not vary more than 1 °C from ambient.
- Conductivity – not more than 300 micromhos/cm.

Only non-native aquatic species were identified in 'Aiea stream waters near the project site. None of the aquatic species observed during these surveys is listed as threatened or endangered by the U.S. Fish and Wildlife Service under the Endangered Species Act of 1973, as amended, or by the State of Hawaii under its endangered species program (DLNR 1998; USFWS, 2009). A Best Management Practices (BMP) plan should be designed and implemented to minimize environmental impacts to water quality in the vicinity of or downstream of the project site.

References

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