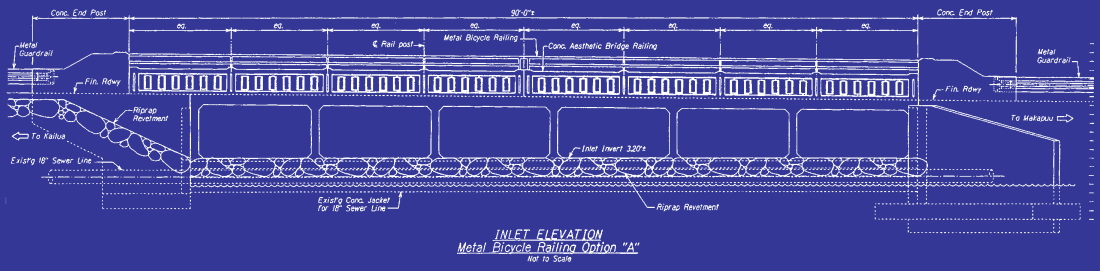
DRAFT ENVIRONMENTAL ASSESSMENT



INLET ELEVATION
Metal Bicycle Railing Option "A"
Not to Scale

Kalaniana'ole Highway Replacement of Inoa'ole Stream Bridge

Federal-Aid Project No. STP-072-1(43)
Waimānalo, Oahu

State of Hawai'i Department of Transportation
Highways Division
869 Punchbowl Street,
Honolulu Hawai'i 96813

March 2009

Kalaniana‘ole Highway
Replacement of Inoa‘ole Stream Bridge
Waimānalo, O‘ahu, Hawai‘i

Federal-Aid Project No. STP-072-1(43)

Prepared for

State of Hawai‘i
Department of Transportation
Highways Division
869 Punchbowl Street
Honolulu, HI 96813

Prepared by

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1600 Kapi‘olani Boulevard, Suite 1610
Honolulu, HI 96814

March 2009

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C. Inoa'ole Stream Bridge Replacement Wetland Survey, Char & Associates, Inc., September 2000
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Glossary of Acronyms and Hawaiian Terms*

AASHTO	American Association of State Highway Transportation Officials
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
AFS	Air Force Station
ahupua'a	a land division usually extending from the uplands to the sea
BAFS	Bellows Air Force Station
BMP	Best Management Practice
cfs	cubic feet per second
CZM	Coastal Zone Management
DEA	Draft Environmental Assessment
DOH	Department of Health, State of Hawaii
EA	Environmental Assessment
FEA	Final Environmental Assessment
FHWA	Federal Highway Administration
FONSI	Finding of No Significant Impact
HDOT	Hawaii Department of Transportation
HRS	Hawai'i Revised Statutes
heiau	Pre-Christian place of worship; shrine
iwi	bones of the dead
kama'āina	native born, one born in a place; acquainted, familiar
LOS	Level of Service
makai	toward the ocean (seaward)
mauka	toward the mountains (landward)
MSL	mean sea level
NPDES	National Pollutant Discharge Elimination System
OEQC	Office of Environmental Quality Control
ORTP	Oahu Regional Transportation Plan
SCP	Sustainable Communities Plan
SHPD	State Historic Preservation Division
SMA	Special Management Area
STIP	State Transportation Improvement Program
TMDL	Total Maximum Daily Load
vph	vehicles per hour

* English definitions of Hawaiian terms from *Hawaiian Dictionary*, Revised and Enlarged Edition (Pukui and Elbert, 1986) and *Dictionary of Hawaiian Legal Land-Terms* (Lucas, 1995)

S.1 PROPOSING AGENCY AND ACTION

Project Name	Kalaniana‘ole Highway, Replacement of Inoa‘ole Stream Bridge
Proposing Agency	State of Hawai‘i, Department of Transportation
Approving Agencies	State of Hawai‘i, Department of Transportation
Project Location	Inoa‘ole Stream Bridge is located on Kalaniana‘ole Highway at approximately milepost 3.88 in Waimānalo, Ko‘olaupoko District, on the island of O‘ahu. The nearest cross streets are Inoa‘ole Street (approximately 580 feet or 0.11 mile on the Kailua side of the bridge) and Tinker Road, the entryway to Bellows Air Force Station (approximately 4,700 feet or 0.89 mile on the Makapu‘u side of the bridge).
Tax Map Keys	Lands *makai* of Kalaniana‘ole Hwy: 4-1-15:1 Lands *mauka* of Kalaniana‘ole Hwy: 4-1-09:262 and 4-1-33:12, 13, 193
Proposed Action	The project proposes replacing the existing single-cell culvert with a six-cell culvert. Ancillary improvements include wing walls, drainage enhancements, guardrails, signs, and striping. The replacement bridge will be constructed in phases to minimize traffic disruptions.
Existing Uses of the Site and Surrounding Area	Project is located within an existing highway right-of-way measuring 50 feet wide. The project area is bordered by a residential subdivision (Hale Aupuni) and polo field on the *mauka* side, and the Bellows Air Force Station (AFS) on the *makai* side.
State Land Use	Urban District
Ko‘olaupoko Sustainable Communities Plan (SCP)	The project is consistent with the Ko‘olaupoko SCP, which seeks to avoid increased roadway capacity, but supports limited highway improvements, including those that improve safety and traffic flow.
Zoning	Portions of the project area are variously located in the R-5 (Residential), F-1 (Military and Federal), and AG-1 (Agriculture) zones
Special Management Area (SMA) Designation	The project area is located within the SMA and will require a SMA-Major permit

S.2 ENVIRONMENAL REVIEW PROCESS

Legal Authority	Chapter 343, Hawai'i Revised Statutes (HRS)
EA Triggers	Use of public (federal and State) funds Use of public lands
Anticipated Determination	Finding of No Significant Impact (FONSI)

S.3 PURPOSE OF AND NEED FOR ACTION

A hydrologic and hydraulic study of Inoa'ole Stream Bridge identified deficiencies that result in periodic flooding of Kalaniana'ole Highway and surrounding land. The study also determined bridge design parameters to increase storm water flow. Replacing the existing single-cell culvert with a new six-cell culvert is needed to mitigate flood conditions on the highway, increase traffic safety for highway users, and address long-term maintenance issues.

S.4 PROJECT ALTERNATIVES

HDOT considered several bridge designs, including single-span and two-span bridges and 10-cell and 6-cell culvert structures. The 6-cell structure was selected as the option that would increase in stream flow capacity without significant drawbacks and environmental impacts. To achieve an adequate increase in storm flow capacity, the other alternatives would have required major adjustments in road geometrics, re-grading to raise the roadway approaches, significant widening of the stream channel, and/or acquisition of public or private lands for additional road right-of-way—and, consequently, were dismissed.

For comparative purposes, the potential impacts and mitigation measures of the no-action alternative and the preferred alternative (replacement with a 6-cell culvert structure) are summarized in the next section.

S.5 IMPACTS AND MITIGATIONS

No Action Alternative	(Preferred) Alternative Bridge Replacement with 6-Cell Culvert
LANDFORM AND SOILS	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Potential for soil erosion when stream banks are modified.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation.	Mitigation. BMPs, including timely repaving and revegetation, will be implemented to minimize erosion.
FLORA	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Vegetation may be cleared for stream bank modification and stabilization.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None required.	Mitigation. Any disturbance to riparian restoration efforts using native plants will be restored after construction.
FAUNA	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. No impact expected on the habitats of threatened or endangered waterbirds.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None required.	Mitigation. BMPs will be implemented to avoid and minimize the introduction of pollutants into the stream, with a contingency plan in case of accidental petroleum spills. To control erosion and siltation, excavation activities will be minimized, siltation containment devices used, and a revegetation plan developed.
NATURAL HAZARDS	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Severe rainy weather during construction may delay project completion.
Long-term or Operational Impacts. Past experience with the existing single-cell culvert indicates that floodwaters may overtop the highway and cause flooding of surrounding properties. Hazardous conditions render the possibility of highway closure.	Long-term or Operational Impacts. By increasing the stream flow capacity, the new multi-cell culvert is expected to reduce the incidences of flooding.
Mitigation. HDOT crews will need to monitor and clear clogged debris before and during heavy rainfalls. Additional clean-up efforts may be needed.	Mitigation. The phasing plan provides for stream flow capacity that is equal to or greater than the existing flow capacity throughout the construction period.

No Action Alternative	(Preferred) Alternative Bridge Replacement with 6-Cell Culvert
WATER RESOURCES	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. During construction, impacts on water resources will be associated with erosion and sedimentation associated with excavation activities.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None.	Mitigation. Storm water runoff and erosion during project construction will be mitigated through the use of BMPs.
AIR QUALITY	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. During construction, fugitive dust emissions will be generated by activities such as earthmoving and material blown from stockpiles and exposed areas.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None required.	Mitigation. Best Management Practices (BMPs) will be used to control fugitive dust, including watering, as needed, and limiting areas of exposure.
NOISE	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Construction noise will increase with the most noticeable impact on residences near the project site.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. Noise levels will not increase appreciably over current levels since highway capacity and operating conditions will not change after the new bridge is built.
Mitigation. None required.	Mitigation. Specifications stipulated in the State Department of Health community noise control standards will be followed.
VISUAL AND AESTHETIC RESOURCES	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Temporary visual disturbance to streetscape during construction.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None required.	Mitigation. None.

No Action Alternative	(Preferred) Alternative Bridge Replacement with 6-Cell Culvert
HISTORIC AND ARCHAEOLOGICAL RESOURCES	
Immediate or Construction Impacts. None	Immediate or Construction Impacts. SHPD determined "no effect" on significant historic sites.
Long-term or Operational Impacts. None	Long-term or Operational Impacts. None.
Mitigation. None	Mitigation. Chapter 6E, HRS protocols will be followed in the event of inadvertent discovery of human remains or cultural artifacts.
LAND USE	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Temporary disruptions and inconveniences to surrounding land uses
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. Bridge improvements are located on public lands. The project will not cause displacement of any residential or commercial use.
Mitigation. None required.	Mitigation. See Transportation.
SOCIAL AND ECONOMIC	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Project expenditures will temporarily boost the local economy, supporting short-term employment and local purchase of goods and services.
Long-term or Operational Impacts. Higher costs of maintaining an older bridge.	Long-term or Operational Impacts. Community's transportation infrastructure will be improved.
Mitigation. None required.	Mitigation. None required.
TRANSPORTATION	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. Potential for short-term congestion and inconveniences. Access to surrounding properties will not be affected.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. New bridge and roadway approaches will be designed to current standards.
Mitigation. None required.	Mitigation. Traffic controls, barriers, and signs will be placed to provide for safe movement through the project area. Public notices, electronic signboards will be used to notify the public about roadwork.
COMMUNITY SERVICES AND FACILITIES	
Immediate or Construction Impacts. None.	Immediate or Construction Impacts. None.
Long-term or Operational Impacts. None.	Long-term or Operational Impacts. None.
Mitigation. None.	Mitigation. Emergency access will be maintained at all times.

S.6 APPROVALS AND PERMITS

Government permits required or potentially required to implement the proposed action:

Federal	Department of Army Permit, Section 404, Clean Water Act
State	Stream Channel Alteration Permit, (SCAP), Commission on Water Resources Management, State Department of Land and Natural Resources
	National Pollutant Discharge Elimination System (NPDES) Permit, Department of Health
	401 Water Quality Certification, Department of Health
	Construction Noise Permit, Department of Health
	Consistency Review, Coastal Zone Management Act, Office of Planning
City and County	Special Management Area Permit, City and County of Honolulu

S.7 CONSULTATION AND COORDINATION

The following agencies, organizations, and individuals provided input and comments prior to and during the Draft EA preparation stage:

Federal Agencies	Army Corps of Engineers
	U.S. Fish and Wildlife Service
State Agencies	Department of Land and Natural Resources: Commission on Water Resource Management, Division on Boating and Ocean Recreation, Engineering Division, Land Division
	Office of Civil Defense
	State Historic Preservation Division
City Agencies	Board of Water Supply
	Department of Parks and Recreation
	Department of Planning and Permitting
	Department of Transportation Services
	Fire Department
Utilities	Verizon Hawai'i (now Hawaiian Telcom)
Community	Ms. Margaret Tanner (neighbor)
	Waimānalo Neighborhood Board

The Draft EA will be distributed to the following agencies, organizations, and individuals for review and comment:

Federal Agencies	U.S. Air Force
	U.S. Army Corps of Engineers: Civil Works Branch, Regulatory Branch
	U.S. Fish and Wildlife Service
State Agencies	Department of Education, Waimānalo Elementary & Intermediate School
	Department of Health
	Department of Land and Natural Resources
	Office of Hawaiian Affairs
	Office of Planning
	State Historic Preservation Division
City Agencies	Board of Water Supply
	Department of Design and Construction
	Department of Environmental Services
	Department of Facility Maintenance
	Department of Parks and Recreation
	Department of Planning and Permitting
	Department of Transportation Services
	Honolulu Fire Department
	Honolulu Police Department
Utilities	Hawaiian Electric Co.
	Hawaiian Telcom
	Oceanic Time Warner Cable
Elected Officials	State Representative Chris Lee
	State Senator Fred Hemmings
	City Councilmember, District 3
Community	Hale Aupuni Community Association
	Honolulu Polo Club
	Waimānalo Health Center
	Waimānalo Neighborhood Board, No. 32
Libraries and Media	Waimānalo Public Library
	Honolulu Advertiser
	Honolulu Star Bulletin

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1 INTRODUCTION

1.1 PROPOSING AGENCY AND ACTION

The State of Hawai‘i, Department of Transportation, Highways Division (HDOT) proposes to replace an existing bridge on Kalaniana‘ole Highway (State Route 72) which crosses Inoa‘ole Stream. The bridge is located in Waimānalo, in the Ko‘olaupoko District of O‘ahu. Figure 1 shows the project location. Figure 2 shows the project location on an aerial photo. The bridge is bordered properties identified by the following Tax Map Keys (see Figure 3):

- TMK 4-1-15: Parcel 01, U.S. Air Force Bellows Air Force Station (BAFS) to the north, northeast and south (on the *makai* or seaward side of Kalaniana‘ole Highway);
- TMK 4-1-09: Parcel 262, Department of Land and Natural Resources (owner), Waimānalo Polo Club (lessee) to the southwest; Parcel 281, Hawaiian Homes Lands (owner), Honolulu Polo Club (lessee) to the southwest;
- TMK 4-1-33: various parcels, Hale Aupuni Subdivision to the northwest. The stream bank on the Kailua side of Inoa‘ole Stream (TMK 4-1-33: 193) is under the jurisdiction of the Hawai‘i Housing Finance and Development Corporation.

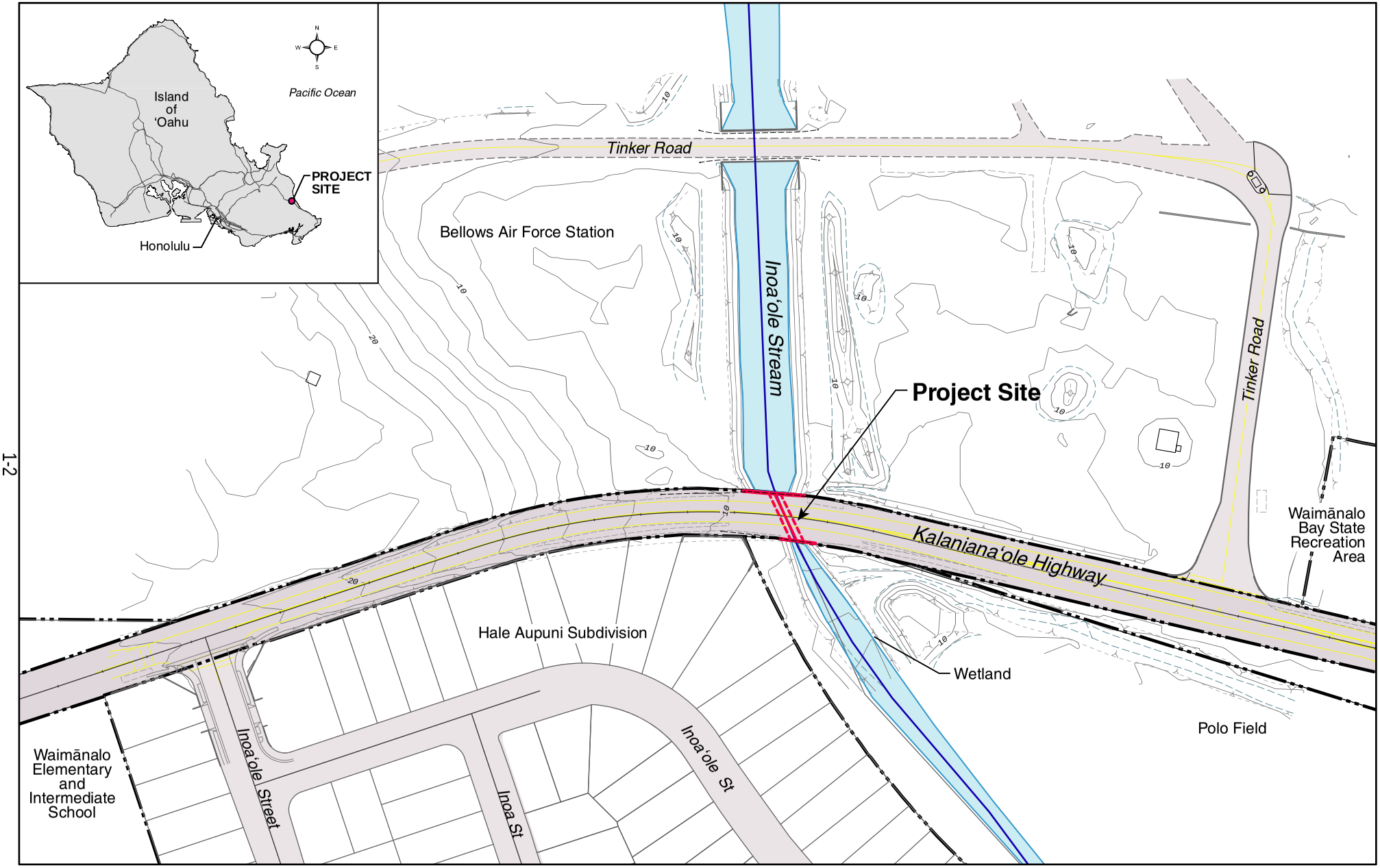
HDOT owns and operates the highway and bridge structure, and is the lead agency for this project. The project, titled “Kalaniana‘ole Highway, Replacement of Inoa‘ole Stream Bridge,” is listed in the State Transportation Improvement Program (STIP) for FY 2010 (right-of-way acquisition) and FY 2011 (design and construction). The STIP is the capital improvement program for near-term transportation projects in the state. As a federal-aid project, the U.S. Department of Transportation, Federal Highway Administration (FHWA) will fund a portion of the improvements.

1.2 PROJECT AREA

Inoa‘ole Stream Bridge is located within the existing Kalaniana‘ole Highway right-of-way, which measures 50 feet wide through the project site. In this area, Kalaniana‘ole Highway is an undivided two-lane highway with one lane in either direction. The travel lanes are 12 feet wide and there are paved shoulders on both sides varying in width from 4-6 feet. No permanent changes are proposed in the roadway approaches to the bridge or to the alignment of the highway itself. The construction area will extend for a distance of approximately 525 feet, encompassing the area from milepost 3.95 on the Kailua side of the bridge to milepost 4.05 on the Makapu‘u side. Drainage improvements in support of the bridge structure will extend approximately 100 feet upstream or *mauka* of the bridge and 40 feet downstream or *makai* of the bridge.

Inoa'ole Bridge Replacement
Kalaniana'ole Highway, Waimānalo

f01 loc map/012209 r2



1-2

0 35 70 140 Feet

Figure 1
Location Map
February 2009

Inoa'ole Bridge Replacement
Kalaniana'ole Highway, Waimānalo

f01B loc map/012209 r2

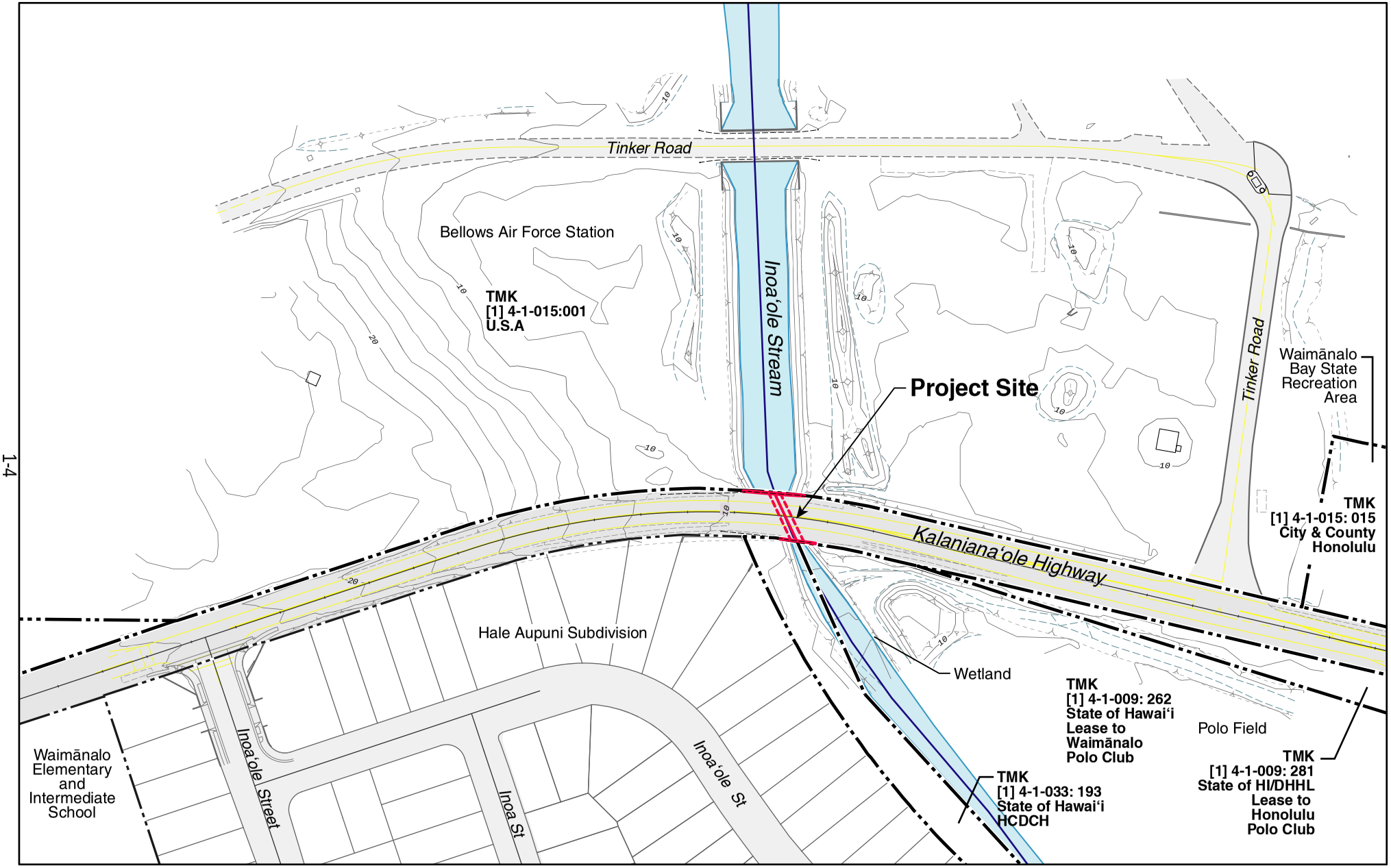
1-3

0 35 70 140 Feet

Figure 2
Location Map
February 2009

Inoa'ole Bridge Replacement
Kalaniana'ole Highway, Waimānalo

f02 tax map/012209 r2



1-4

0 35 70 140 Feet

Figure 3
Tax Map
February 2009

1.3 PROJECT PURPOSE AND NEED

HDOT is responsible for maintaining the functional and structural integrity of bridges on State highways. The existing Inoa'ole Stream Bridge is a reinforced concrete, single-cell culvert that was constructed in 1983. The bridge has experienced flooding on several occasions in the past. Damages due to flooding included embankment erosion on the downstream side of the bridge and debris accumulation on the travel lanes and metal guardrails and blockages in the culvert itself. There has been flooding of the polo field but the extent of damage is unknown.

In 1996, HDOT completed a "Hydrologic and Hydraulic Report for Inoa'ole Stream Bridge" which examined floods that occurred in January 1988, January 1990, and March 1991. The study (see Appendix A) found that certain factors contributed to previous flooding:

- The single-cell culvert has an inadequate opening size limiting its capacity.
- Three existing utility lines located in the existing culvert contribute to clogging during heavy rainfall. Debris entangled around the utility lines reduce the culvert's effective flow area.
- HDOT maintenance crews have been called to remove roadway debris on numerous occasions.

Based on the findings of the study, a multi-cell bridge structure is required to mitigate flood conditions on Kalaniana'ole Highway. The improvements are needed to increase traffic safety for motorists and pedestrians and to address bridge maintenance concerns.

1.4 PURPOSE OF THE DRAFT ENVIRONMENTAL ASSESSMENT

This Draft Environmental Assessment (Draft EA or DEA) was prepared for the proposed action pursuant to Chapter 343, Hawai'i Revised Statutes (HRS); and State Department of Health Title 11, Chapter 200, Administrative Rules. The proposed action "triggers" Chapter 343 because State funds and public land will be used to replace the bridge. This EA is also being submitted to the City and County of Honolulu pursuant to Chapter 205A, HRS, and Chapter 25, Revised Ordinances of Honolulu, for the Special Management Area Permit.

The project will be funded, in part, by the U.S. Department of Transportation, Federal Highway Administration (FHWA). HDOT is coordinating with FHWA to satisfy the requirements of the National Environmental Policy Act.

1.5 STEPS IN THE ENVIRONMENTAL REVIEW AND IMPLEMENTATION PROCESS

Once completed, the Draft EA is submitted to the State Office of Environmental Quality Control (OEQC) for processing. OEQC will notify the public that the Draft EA is available for review with an announcement in a bimonthly bulletin called the *OEQC Environmental Notice*. Publication in the *Notice* initiates a 30-day comment period during which government agencies and interested members of the public can review and comment on the EA findings. After the review period has ended, HDOT will review all comments and determine whether the EA warrants a Finding of No Significant Impact (FONSI).

Additional channels for public input will be available after the environmental assessment is completed. The project will need permits that have their own procedural requirements for public involvement (see Section 1.4, below).

1.6 PERMITS AND APPROVALS REQUIRED OR POTENTIALLY REQUIRED

The following government permits required or potentially required to implement the proposed action:

- Department of Army Permit, Section 404, Clean Water Act
- Stream Channel Alteration Permit, State Department of Land and Natural Resources
- National Pollutant Discharge Elimination System (NPDES) Permit, State Department of Health
- Construction Noise Variance, State Department of Health
- 401 Water Quality Certification, State Department of Health
- Consistency Review, Coastal Zone Management Act, State Office of Planning
- Special Management Area Permit, City and County of Honolulu

1.7 PROJECT SUMMARY

Project Name	Kalaniana'ole Highway, Replacement of Inoa'ole Stream Bridge
Proposing Agency	State of Hawai'i, Department of Transportation
Approving Agency	State of Hawai'i, Department of Transportation
Anticipated Determination	Finding of No Significant Impact (FONSI)
Tax Map Keys	Island of O'ahu, 4-1
Existing Uses of the Site	Project is located within an existing highway right-of-way. The project area is bordered by a residential subdivision (Hale Aupuni) and polo field on the *mauka* side, and the Bellows Air Force Station (AFS) on the *makai* side.
Proposed Project	The project proposes replacing the existing single-cell culvert with a multi-cell culvert. Ancillary improvements include wing walls, drainage enhancements, guardrails, signs, and striping. The replacement bridge will be constructed in phases to minimize traffic disruptions.
State Land Use	Urban District
Ko'olaupoko Sustainable Communities Plan (SCP)	Project is consistent with the Ko'olaupoko SCP, which opposes increased roadway capacity, but supports limited highway improvements, including those that improve safety and traffic flow.
Zoning	Zoning in the project area is influenced by the surrounding land uses. Portions of the project area are variously located in the R-5 (Residential), F-1 (Military and Federal), and AG-1 (Agriculture) zones.
Special Management Area (SMA) Designation	The project area is located within the SMA and will require a SMA-Major permit.

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2. PROJECT ALTERNATIVES

2.1 PROJECT BACKGROUND

Inoa'ole Stream flows under Kalaniana'ole Highway via Inoa'ole Stream Bridge, a single-cell culvert constructed out of reinforced concrete. The bridge measures approximately 66 feet long and 48 feet wide. The single-cell opening for stream flow is approximately 13.5 feet wide by 4.5 feet high. The bottom of the culvert cell opening at both the inlet and outlet is higher than the stream. It is estimated that when the culvert cell is dry, the stream depth at the inlet is approximately 1 foot and the stream depth at the outlet is 1-2 feet.

The upstream or *mauka*-side stream channel is unimproved and embankments are overgrown with weeds, shrubs, and trees. The Kailua-side embankment rises approximately 20 feet high with a slope of approximately 3 to 1 (vertical to horizontal ratio). The embankment abuts private house lots within the Hale Aupuni Subdivision. The Makapu'u-side embankment rises approximately 10 feet high with a slope of approximately 3 to 1 (vertical to horizontal ratio). Adjacent to this embankment is a gravel pathway, which appears to be used for vehicular access.

The downstream or *makai*-side stream channel is improved, trapezoidal in shape with a base width of approximately 55 feet and a 2 to 1 (vertical to horizontal ratio) side slopes. Embankments on both sides are lined with "concrete sacks" and extend from Inoa'ole Stream Bridge to the Tinker Road stream crossing located approximately 500 feet downstream inside Bellows Air Force Station. The improved channel appears to be in good condition.

There is an existing 12-inch reinforced concrete pipe (rcp) on the *makai*, southeastern side of Inoa'ole Bridge along the roadway's side shoulder. Runoff from the grassy area sheet flows into an existing roadside ditch and enters the 12-inch pipe. The pipe outlets at the "concrete sack" stream embankment.

Kalaniana'ole Highway is a corridor for a number of utility lines. There are three utility lines routed within and through the culvert that belong to Hawaiian Telcom and the Signal Corps. An underground, concrete-jacketed 18-inch sewer line is located on the upstream side of the bridge and belongs to the City and County of Honolulu. Utility poles are located on both sides of the bridge along the highway and support overhead cables belonging to Hawaiian Electric Company and Hawaiian Telcom.

Refer to Photographs 1 through 8.

Photo 1. Kalaniana'ole Highway and Inoa'ole Stream Bridge (looking toward Makapu'u)

Photo 2. *Makai* side of Inoa'ole Stream Bridge

Photo 3. Kalaniana'ole Highway on Kailua side of Inoa'ole Stream Bridge

Photo 4. Kalaniana'ole Highway on Makapu'u side of Inoa'ole Stream Bridge. Tinker Road (to Bellows Air Force Station) intersects the highway approx. 480 feet from Inoa'ole Bridge.

Photo 6. Upstream view (*mauka*) from bridge

Photo 5. Downstream (*makai*) view from bridge

Photo 7. Inflow into single-cell culvert (*mauka* side of bridge)

Photo 8. Outflow from single-cell culvert (*makai* side of bridge)

2.1.1 Drainage Basin

The drainage basin contributing runoff to Inoa'ole Stream is approximately 1,523 acres and extends from the upper ridges of the Koolau mountain range from an elevation of approximately 1,500 feet to the existing Inoa'ole Stream culvert beneath Kalaniana'ole Highway. The terrain slope ranges from approximately 40-95 percent near the ridges and gradually flattens to 0.5 to 5 percent at the lower end near the highway crossing. Most of the land, especially in the upper slopes, is undeveloped. There are some developed areas, mainly residential in the lower lying areas of the drainage basin.

A main stream (Inoa'ole) and two feeders contribute to the flow at Inoa'ole Stream Bridge. Each of the streams flow separately beneath Hīhīmanu Street and eventually merge into a single stream just *mauka* of Kalaniana'ole Highway. Stream flows are intermittent.

2.1.2 Storm Water Flow

The HDOT "Hydrologic and Hydraulic Report for Inoa'ole Stream Bridge" included information on existing culverts at the project site relative to storm water capacity and storm water flows generated during a 50- and 100-year storm event. It should be noted that all capacities and flows are based on clear water and do not take into consideration water carrying sediment and debris.

Culvert Capacity

- The existing Inoa'ole Stream Bridge single-cell culvert has a capacity of 470 cubic feet per second (cfs).
- The capacity of the existing 8-cell culvert on Tinker Road, inside Bellows Air Force Station, is 2,510 cfs.

Storm Water Flow Discharge

- A 50-year storm event discharge is approximately 3,700 cfs.
- A 100-year storm event discharge is approximately 4,300 cfs.

2.2 ALTERNATIVES CONSIDERED

A range of alternatives were considered in relation to the project purpose and need, including no action, alternative structural designs, and detour routes. These options are described below.

2.2.1 No Action

The no-action or no-build alternative would retain the existing condition at the Inoa'ole Bridge stream crossing. Environmental impacts would be avoided, construction costs spared, and there would be no need to obtain permits. However, without improving the Inoa'ole Stream drainage way beneath Kalaniana'ole Highway, periodic storm water flooding would continue and Kalaniana'ole Highway may be overtopped at the bridge site. The no action alternative would continue to pose a hazard to the adjacent property owners and residents, the Waimānalo community, and to motorists using the highway.

2.2.2 Culvert Structure Design

HDOT evaluated two structural alternatives to determine which design would best accommodate the 50-year storm water flow for the Inoa'ole Stream Bridge.

2.2.2.1 Single-Span and Two-Span Bridge Alternatives

HDOT evaluated both the single-span and two-span alternatives to accommodate the 50-year storm water flow; however, due to the existing topography, both bridges would have a limited vertical clearance from the bottom of the bridge deck to the invert (low point) of the stream. Limited clearance means increased susceptibility to debris clogging and the increased likelihood of maintenance difficulties during and after a rainstorm event.

In order to provide adequate vertical clearance, the bridge and roadway approaches would need to be raised by 3 to 4 feet. The engineering required would include adjusting the road geometrics, re-grading further away from the bridge, and adding retaining walls. The scale of construction would negatively affect the surrounding residents, nearby institutional uses, and the military.

2.2.2.2 Multi-Cell Concrete Box Culvert Alternative

HDOT evaluated the multi-cell alternative and found that it would not require as thick a top deck, thus allowing for a larger opening. Advantages of the larger opening are: (1) to minimize potential debris from clogging the culvert and (2) to maintain the existing roadway elevations. This alternative would also limit environmental effects to neighboring land uses.

Two multi-cell box culvert designs were analyzed by HDOT.

10-Cell Culvert Structure - HDOT calculations concluded that a 10-cell structure would be required to pass the 50-year flow under Kalaniana'ole Highway without

overtopping. However, calculations indicated that the existing upstream and downstream conditions cannot support a 50-year storm flow. The storm water would be at the top of the embankments of the existing downstream channel. On the existing upstream side, analysis indicated that the flow will overtop the south embankment and possibly flood Kalaniana'ole Highway.

In order for the 10-cell culvert structure to function without overtopping the highway and embankment approaches, the following would be required:

- Widen the existing upstream channel from 35 feet to approximately 130 feet
- Widen the improved downstream channel from 55 feet to approximately 130 feet
- Raise the existing stream channel embankments to contain the flow within the stream
- Improve the overall stream system from Kalaniana'ole Highway to Hīhīmanu Street
- Raise both roadway approaches of Kalaniana'ole Highway
- Acquire private and public lands for new roadway right-of-way
- Relocate utilities and electrical power poles
- Relocate the existing gravel roadway

6-Cell Culvert Structure - HDOT considered the above conditions impractical and modified the culvert criteria based on existing site conditions. The modified criteria include the following:

1. The proposed culvert will have an equal or greater capacity than the improved downstream channel and the 8-cell culvert system under BAFS Tinker Road of 2,510 cfs (approximately equivalent to a 30-year storm).

2. The culvert will provide the largest waterway opening the existing downstream channel will allow without major reconstruction.

3. Since the existing stream bed elevation will be lower than the proposed culvert inlet and outlet bottom, protection of the inlet and outlet is recommended.

4. The top of the culvert will match the existing elevations of the existing roadway approaches.

Based on the above, modified criteria, a 6-cell culvert with six 12-feet by 4.75-feet rectangular openings was designed for Kalaniana'ole Highway bridge crossing over Inoa'ole Stream. The 6-cell culvert has a capacity of 2,840 cfs, which exceeds the capacity of the 8-cell culvert on Tinker Road. Dumped riprap with filter materials is proposed on the upstream western embankment. Dumped riprap in conjunction with concrete cutoff walls are proposed at the inlet and outlet ends of the structure to

prevent undermining. A new 18-inch concrete encased sewer line will be installed on the *mauka* side.

The bridge structure would be approximately 90 feet long and 50 feet wide. The width of the bridge contains two 12-foot wide travel lanes and 12-foot wide shoulders on both sides. A 5-foot wide pedestrian pathway is integrated into both shoulders. The 6-cell concrete box culvert structure will improve the storm water flow beneath the bridge and reduce storm water overtopping of Kalaniana'ole Highway at the bridge site.

2.2.3 Detour Routes

HDOT studied alternative detour routes before selecting phased construction as the method for implementing the project. The detour routes considered are shown in Figure 4 and summarized below (see also Appendix E for the Detour Road Study).

2.2.3.1 Makai Detour Route through BAFS

A potential *makai* detour route would close Kalaniana'ole Highway immediately north of the BAFS entry at Tinker Road and south of the Kalaniana'ole Highway/ Inoa'ole Street intersection. Various scenarios were developed, of which the two main options were:

- Alternate A: Relocate the BAFS guard house to the north side of the 8-cell culvert and utilize a portion of Tinker Road as the detour route with a new, temporary roadway connection between Kalaniana'ole Highway and Tinker Road. Create a new roadway intersection to facilitate a relocated BAFS entrance driveway on the north side of the 8-cell culvert.

- Alternate B: Route a new temporary road between Kalaniana'ole Highway and Tinker Road and install a prefabricated modular bridge over Inoa'ole Stream.

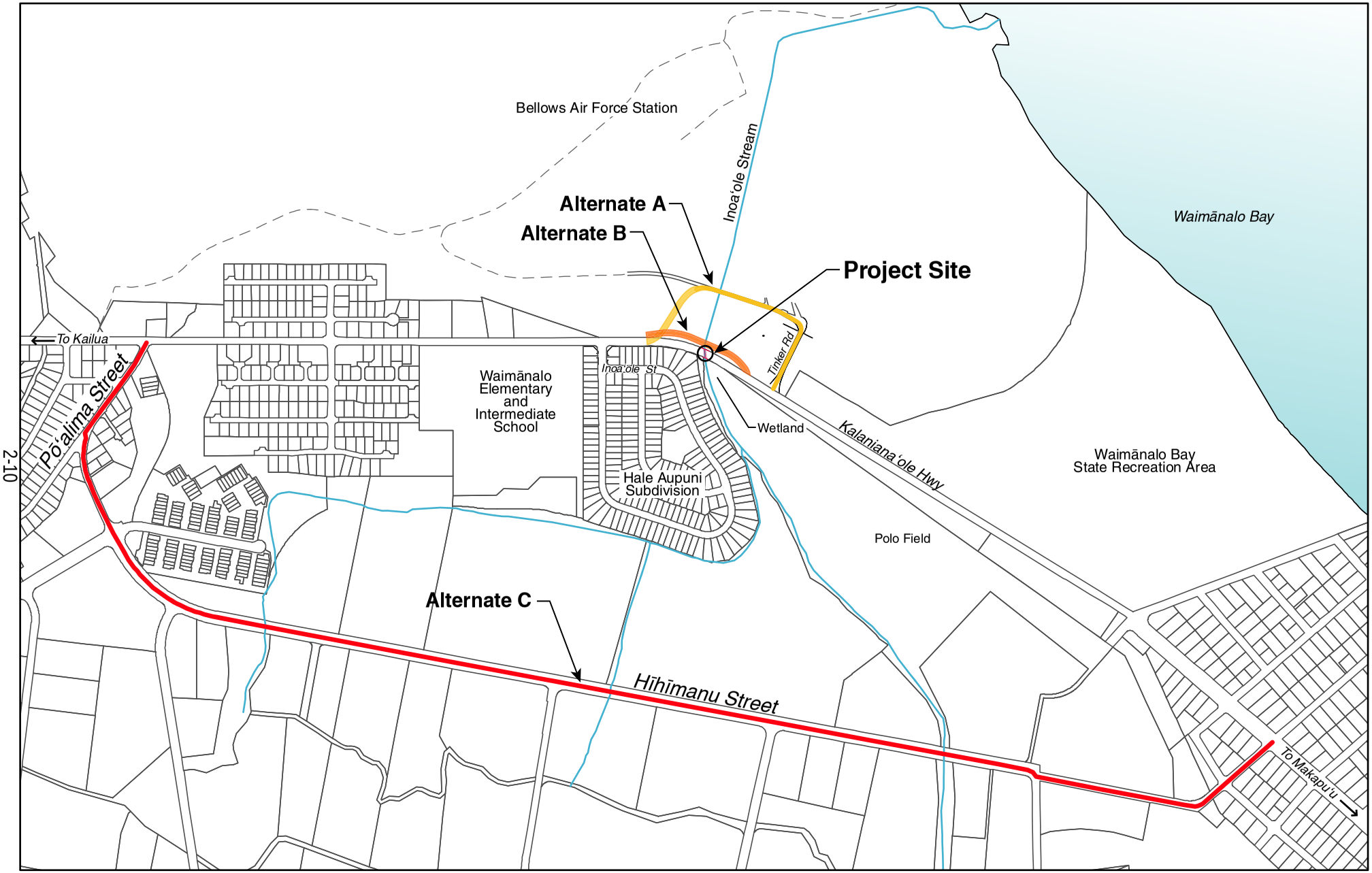
The *makai* detour options were discussed with representatives of the Air Force, but ultimately determined to be infeasible because of concerns for military security, uncertainty that the detour route would be available for the entire construction period, and potential impacts on subsurface cultural artifacts within the installation.

2.2.3.2. Mauka Detour Route

This alternative (not shown in Figure 4) considered closing Kalaniana'ole Highway immediately north of the BAFS entry at Tinker Road and south of the Kalaniana'ole Highway/ Inoa'ole Street intersection with a detour road routed through the Hale Aupuni subdivision. This alternative would have required a temporary crossing over Inoa'ole Stream and removing improvements within private property, including residential structures, to accommodate the detour road.

Inoa'ole Bridge Replacement
Kalaniana'ole Highway, Waimānalo

f13 detour alts/012209 r2



N

0 200 400 800 Feet

Figure 4
Detour Route: Alternates A, B, C
February 2009

The *mauka* detour route was dismissed because of major disruptions to Hale Aupuni residents and possible long- or short-term displacements.

2.2.3.3 Utilize Existing Local Roadways

Another detour alternative involved closing Kalaniana'ole Highway immediately north of the BAFS entry at Tinker Road and south of the Kalaniana'ole Highway/ Inoa'ole Street intersection. This alternative proposed using existing, local roads within the area to serve as a detour road during construction. Traffic along Kalaniana'ole Highway would be routed *mauka* of the highway along Hīhīmanu Street and Pō'alima Street (shown as Alternate C on Figure 4).

This alternative was not recommended because:

- Increased traffic movement through residential areas would be disruptive to the residents and increase the risk of accidents.
- Increased traffic on Hīhīmanu and Pō'alima Streets may cause accelerated wear and deterioration of the roadway.
- An unnamed bridge/culvert on Hīhīmanu Street appears to be one-lane wide and does not have a bridge load rating. This bridge would need to be improved.
- Commercial businesses at the southern end of the Waimānalo Bay State Recreation Area would experience temporary reduced vehicular traffic, except for local traffic and traffic going to and from Bellows Air Force Station, Waimānalo Bay State Recreation Area, and the Waimānalo and Honolulu Polo Fields.

Given the serious disadvantages and infeasibility of constructing a detour route, HDOT selected phased construction as the method of implementing replacing the bridge.

2.3 PREFERRED ALTERNATIVE

Based on findings of the Hydrologic and Hydraulic Report for Inoa'ole Stream Bridge prepared by HDOT, the preferred alternative is to replace the existing bridge with a 6-cell culvert bridge. This document examines the environmental affects of the preferred alternative (also referred to as the "proposal" or "proposed action"). Comparison with the no-action (or no-build) alternative is shown in the Summary at the front of this document.

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3. PROJECT DESCRIPTION

3.1 PROJECT DESCRIPTION

The replacement bridge will be in the same location as the existing bridge in order to maintain the existing alignment of Kalaniana'ole Highway. The highway will not be widened, except for the bridge approaches in order to comply with design guidelines provided by the American Association of State Highway and Transportation Officials (AASHTO), Hawai'i Statewide Uniform Design Manual for Streets and Highways, and the Americans with Disabilities Act. Refer to Figure 5.

The existing single-cell box culvert will be replaced with a new 6-cell box culvert bridge structure in order to provide a wider drainage way below the bridge. The new bridge will be approximately 90 feet long and 50 feet wide. Major elements of the proposed structure are described below.

Bridge Structure (see Figures 5-7)

1. The proposed replacement bridge will consist of two 12-foot wide travel lanes, 12-foot shoulders that will include 5-foot wide accessible walkways on both sides, and guardrails.

2. The 6-cell culvert will be comprised of six cells, each with an opening approximately 12.0 feet wide by 4.75 feet high.

3. Bridge approach guardrails will be provided on both sides of the bridge and extend approximately 25 feet. The bridge roadway shoulders will merge back to the existing highway shoulders.

4. The roadway speed limit will remain at the level currently posted of 25 miles per hour.

Drainage Improvements (see Figures 8-10)

5. On the upstream side, the stream channel will be widened to facilitate the flow of storm water to the culvert. A concrete wingwall on the southeast (Makapu'u) end of the culvert will extend approximately 28 feet upstream and merge into the southeastern stream bank. A riprap revetment on the southwest (Kailua) end of the culvert will extend approximately 100 feet on the southwestern stream bank. The concrete wingwall and riprap revetment will channel the storm water stream flow into the culvert. A 3-foot thick riprap revetment will extend 7 feet upstream.

6. On the downstream side, the 6-cell culvert will utilize concrete wingwalls to merge into the existing lined stream banks. A 3-foot thick riprap revetment will extend 12 feet downstream.

Sewer Replacement (see Figures 11-12)

7. An existing City and County of Honolulu 18-inch concrete encased sewer line is located on the mauka side of the existing bridge. A new 18-inch concrete encased sewer line will be structurally attached to the new culvert on the mauka side to replace the existing sewer line.

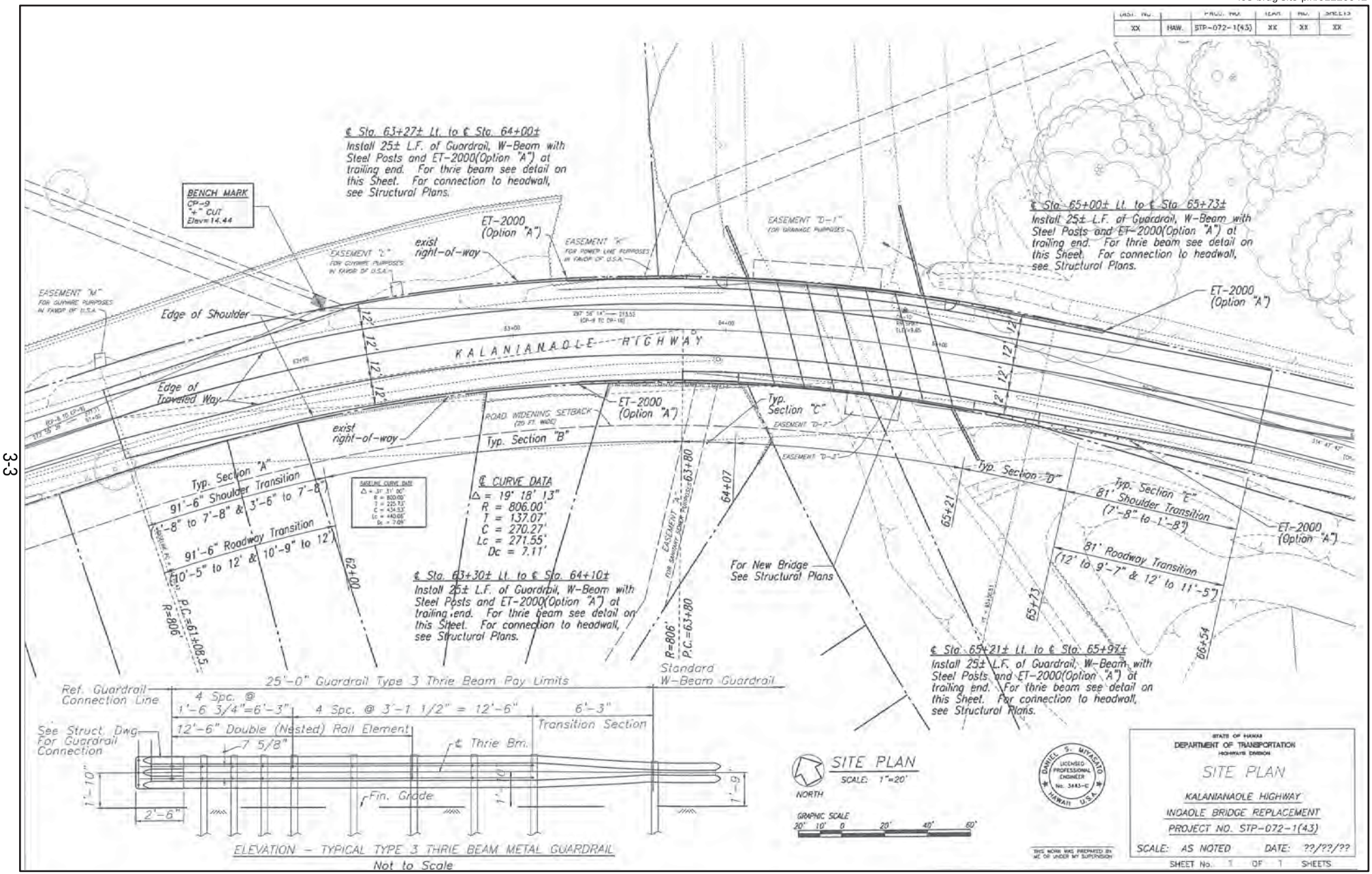


Figure 5
Bridge Site Plan
February 2009

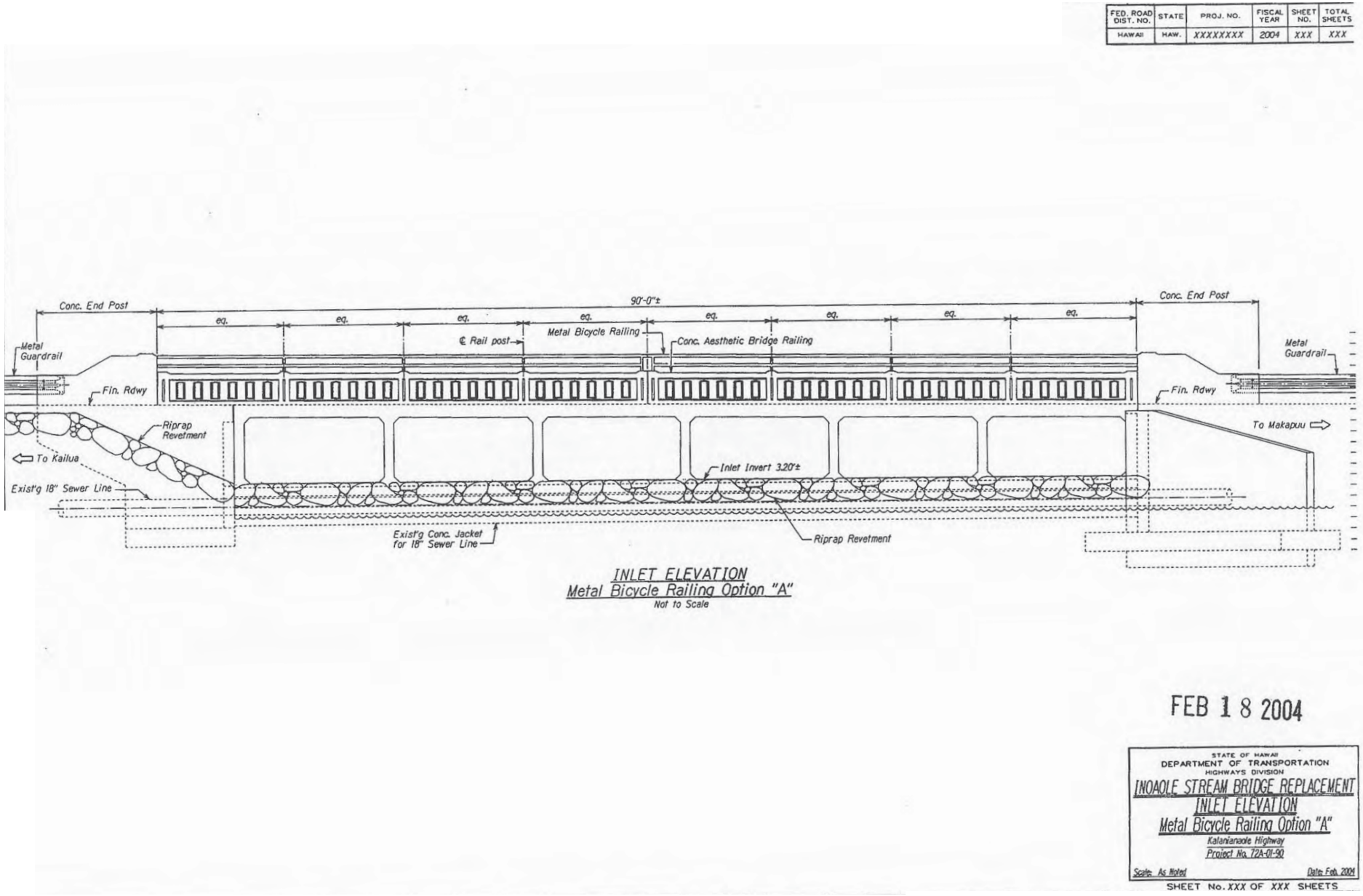
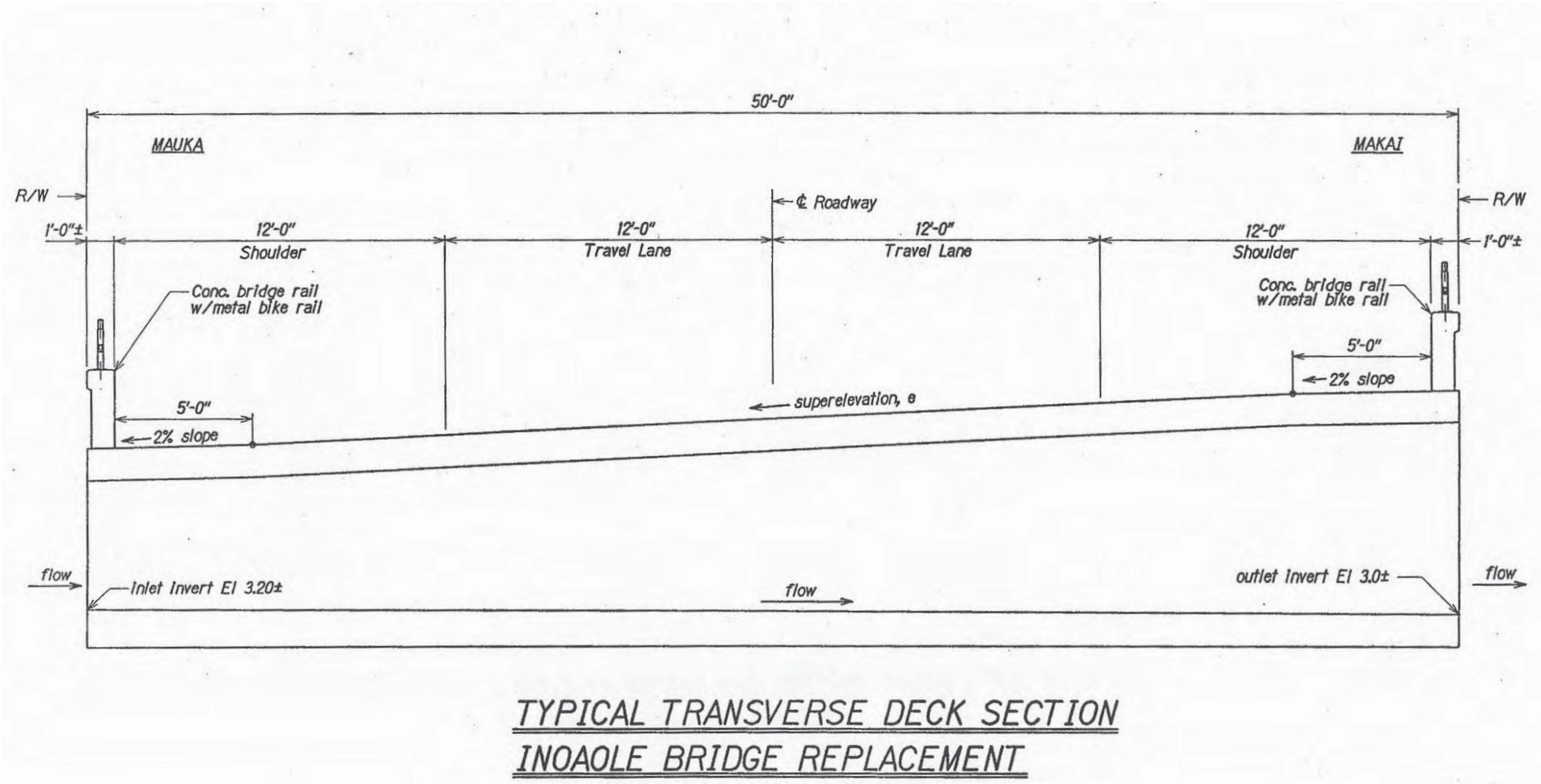


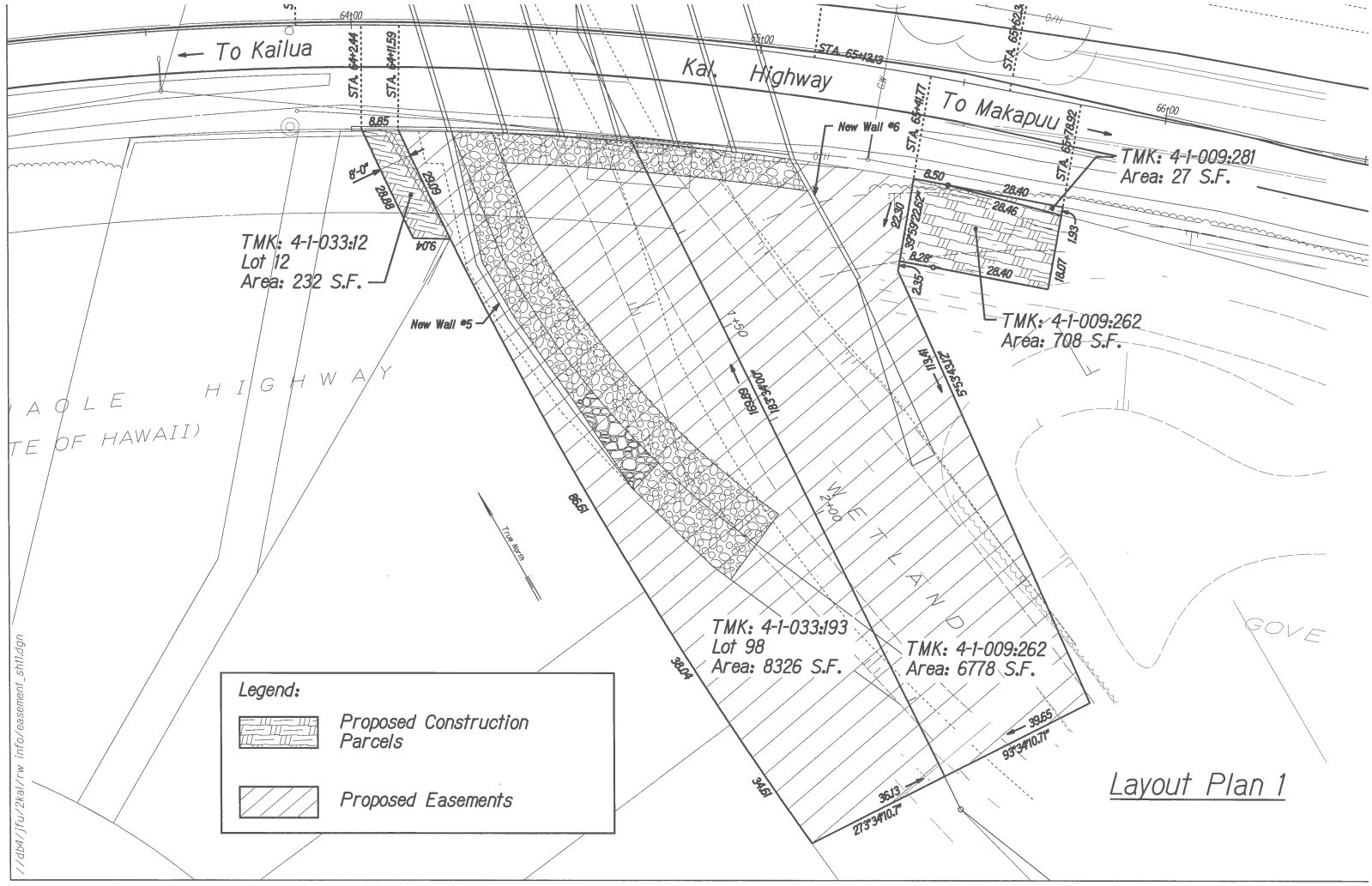
Figure 6
Bridge Elevations
February 2009

Not to Scale



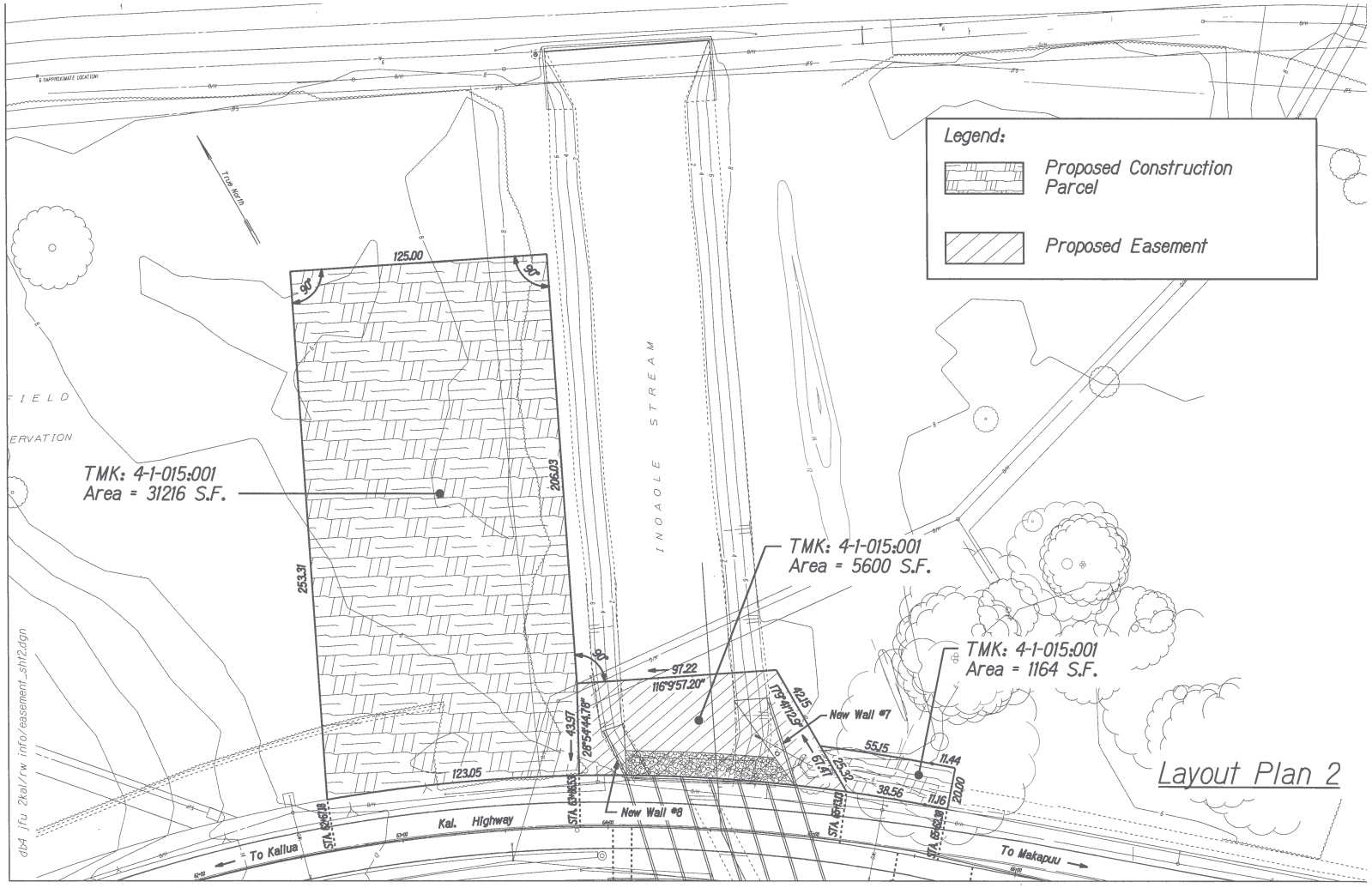
Not to Scale

Figure 7
Bridge Sections
February 2009



0 10 20 30 40 Feet

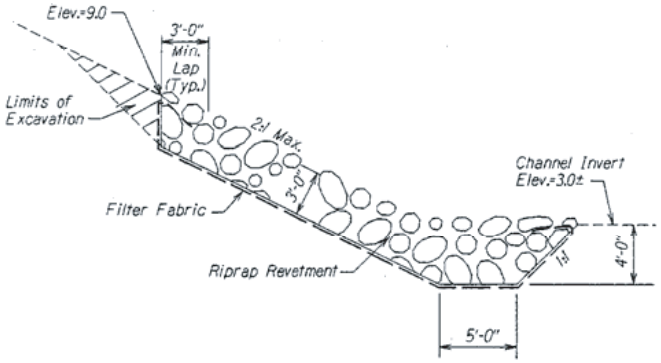
Figure 8
Bridge Drainage Plan - Mauka
February 2009



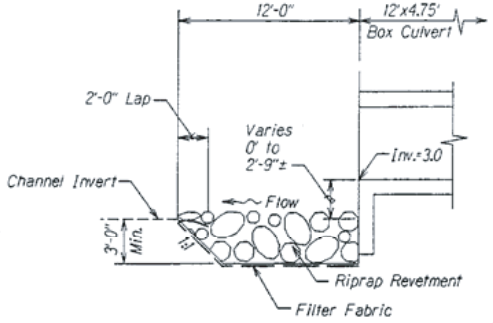
0 20 40 60 80 Feet

Figure 9
Bridge Drainage Plan - Makai
February 2009

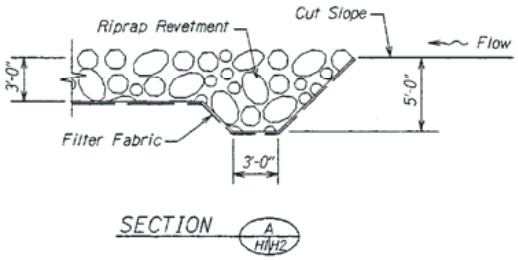
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	72A-01-90	1996	0	0

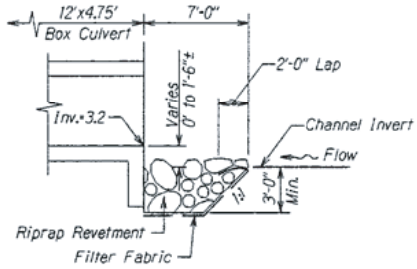


TYPICAL SECTION OF RIPRAP REVETMENT AT CUT SLOPE



DETAILS OF RIPRAP REVETMENT AT 12'X4.75' CONCRETE BOX CULVERT OUTLET





DETAILS OF RIPRAP REVETMENT AT 12'X4.75' CONCRETE BOX CULVERT INLET

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

DRAINAGE DETAILS

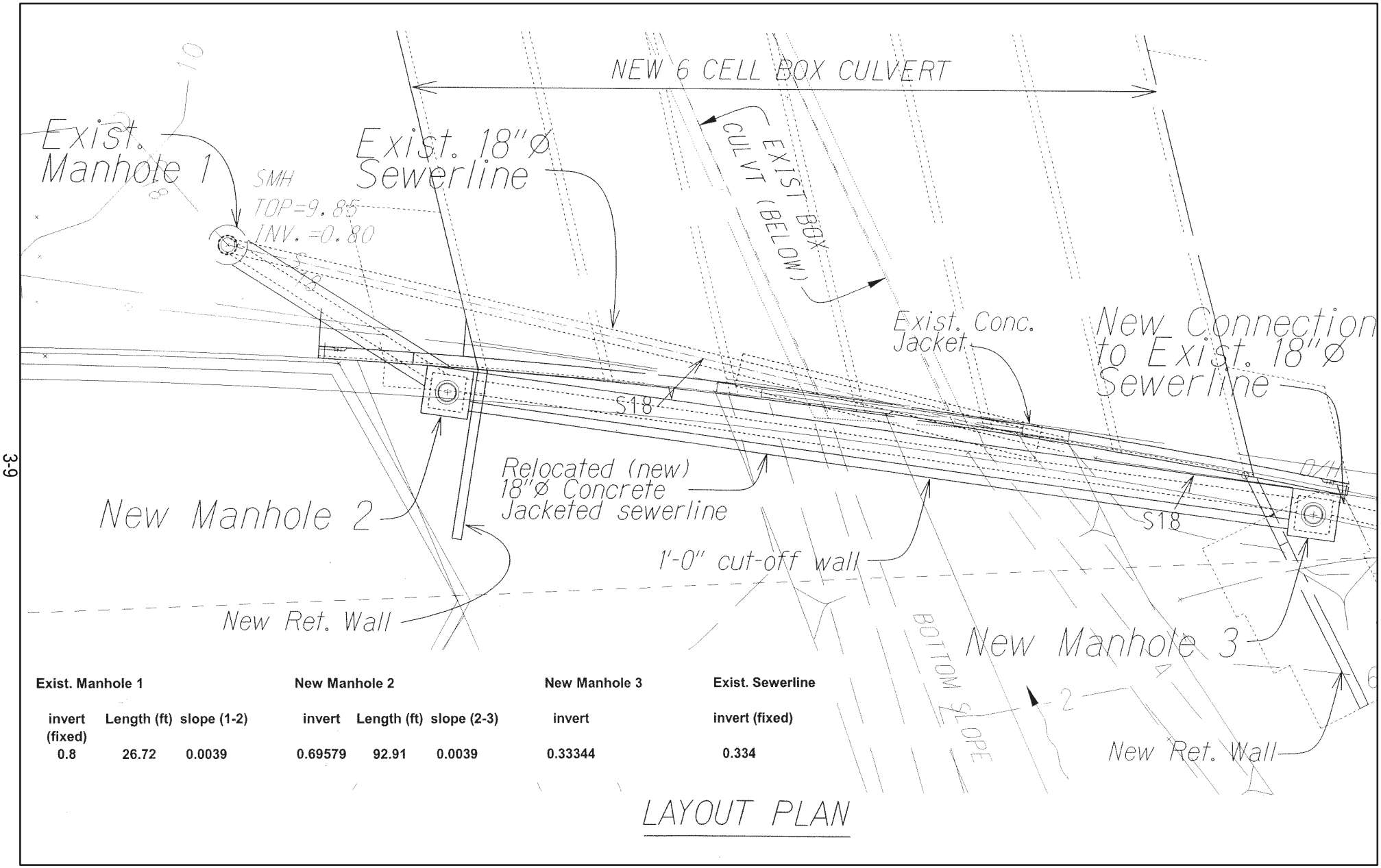
KALANIANAOLE HIGHWAY
Inoaole Stream Bridge Replacement
Project No. 72A-01-90

Date: May 1996

SHEET No. H2 OF 4 SHEETS

Not to Scale

Figure 10
Bridge Drainage Details
February 2009

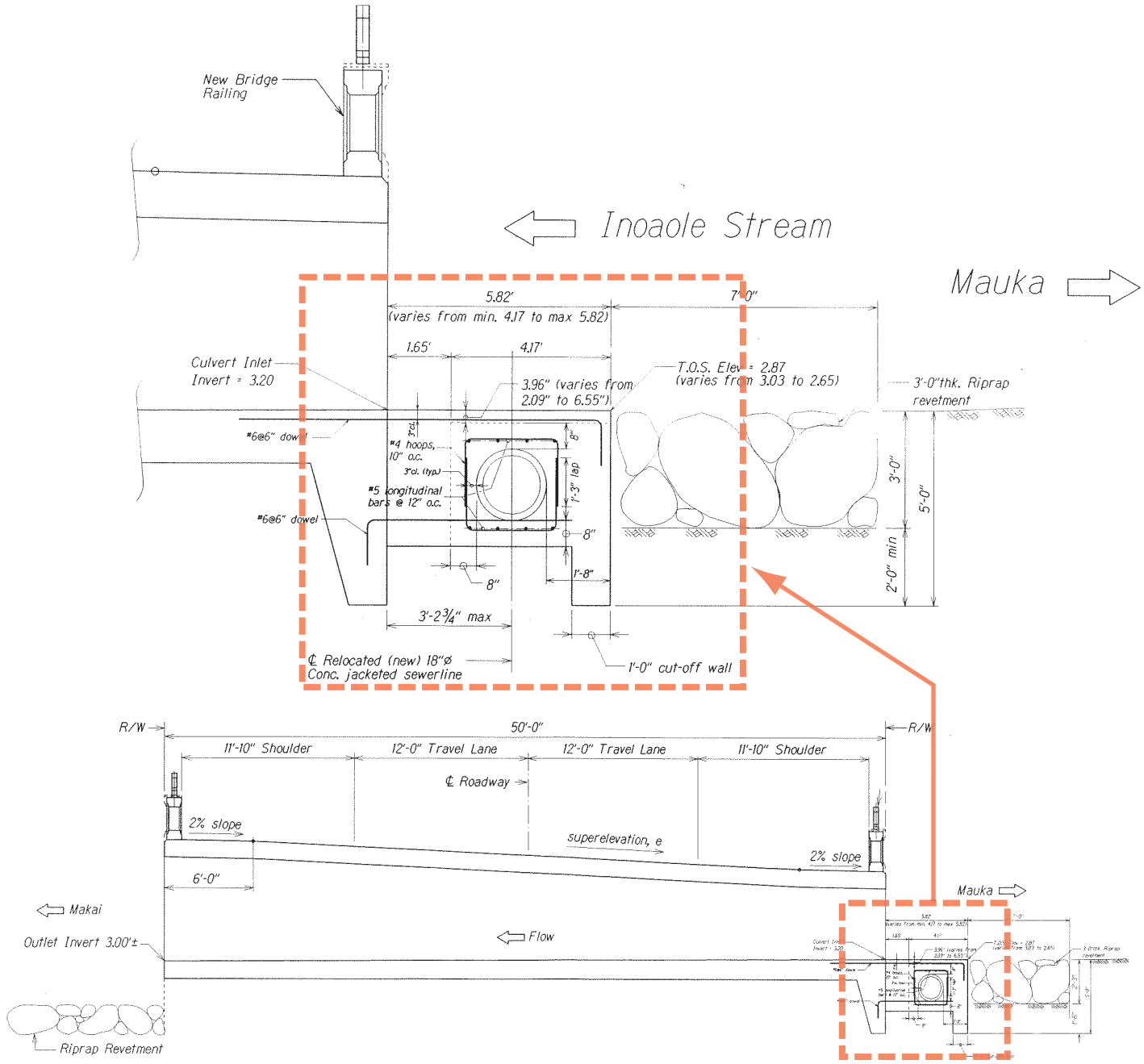


Exist. Manhole 1			New Manhole 2			New Manhole 3	Exist. Sewerline
invert (fixed)	Length (ft)	slope (1-2)	invert	Length (ft)	slope (2-3)	invert	invert (fixed)
0.8	26.72	0.0039	0.69579	92.91	0.0039	0.33344	0.334

LAYOUT PLAN

Not to Scale

Figure 11
Sewer Plan
February 2009



3-10

Figure 12
Sewer Section
February 2009

Not to Scale

3.2 BRIDGE CONSTRUCTION PHASING

In order to maintain an active roadway on Kalaniana'ole Highway and keep an open stream channel to facilitate potential storm water flows during construction, HDOT proposes to construct the new multi-cell culvert structure in phases. The phases are illustrated in Figures 13and 14 and described below:

Phase 1. Phase 1 is located at the southern side of the 6-cell culvert structure and involves relocation of the 18-inch sewer line, two new sewer manholes, and portions of retaining walls 5 and 6. The work will be done off of the existing structure and should have limited effects on the active roadway.

Phase 2. Phase 2 is located at the northeast corner of the 6-cell culvert structure and involves demolition of the northeast corner portion of the existing culvert and construction of a portion of two cells of the 6-cell culvert. Two travel lanes, a shoulder, and a mauka sidewalk are provided. A temporary guardrail separates the construction area from the active roadway.

Phase 3. Phase 3 is located at the eastern center portion of the 6-cell culvert structure and involves demolition of an eastern center portion of the existing culvert, next to the newly constructed Phase 2 portion, and construction of the eastern center portion of two cells of the 6-cell culvert. Two travel lanes, shoulders, and a mauka sidewalk are provided. Temporary guardrails separate the construction area from the active roadway.

Phase 4. Phase 4 is located at the southeast corner of the 6-cell culvert structure and involves demolition of the southeast corner portion of the existing culvert and construction of a portion of two cells of the 6-cell culvert. Two travel lanes, a shoulder, and a makai sidewalk are provided. A temporary guardrail separates the construction area from the active roadway.

During Phases 1, 2, 3 and 4, potential storm water flows, which may occur during construction, would continue to flow through the existing culvert's single cell opening.

Phase 5. Phase 5 is located at the northwest corner of the 6-cell culvert structure and involves demolition of a northwest corner portion of the existing culvert and construction of the remaining four cells of the 6-cell culvert. Two travel lanes, a shoulder, and a mauka sidewalk are provided. A temporary guardrail separates the construction area from the active roadway. The existing culvert's single cell opening is aligned with the new 6-cell culvert to facilitate potential storm water flows during construction.

Phase 6. Phase 6 is located at the western center portion of the 6-cell culvert structure and involves demolition of the eastern center portion of the existing culvert, next to the newly constructed Phase 5 portion, and construction of the eastern center portion of the remaining four cells of the 6-cell culvert. Two travel lanes, shoulders, and a mauka sidewalk are provided. Temporary guardrails separate the construction area from the active roadway.

Similar to Phase 5, the existing culvert's single cell opening is aligned with the new 6-cell culvert to facilitate potential storm water flows during construction.

Phase 7. Phase 7 is located at the southwest corner of the 6-cell culvert structure and involves demolition of the remaining southwest corner portion of the existing culvert and construction of the remaining four cells of the 6-cell culvert. Two travel lanes, a shoulder, and a makai sidewalk are provided. A temporary guardrail separates the construction area from the active roadway. The completed Phase 2, 3, and 4 cells would facilitate potential storm water flows during construction of Phase 7.

Phase 8. Phase 8 is located at the southern side of the 6-cell culvert structure and involves the construction of retaining walls. The work will be done off of the completed structure and should have limited effects on the active roadway.

3.3 PROJECT SCHEDULE AND COST ESTIMATE

Project mobilization and construction is anticipated to occur over 18 months.

HDOT and FHWA are jointly funding the project through the Statewide Transportation Improvement Program (STIP), which indicates programmed amounts of $500,000 for land acquisition in FY 2010 and $6,600,000 for construction in FY 2011.

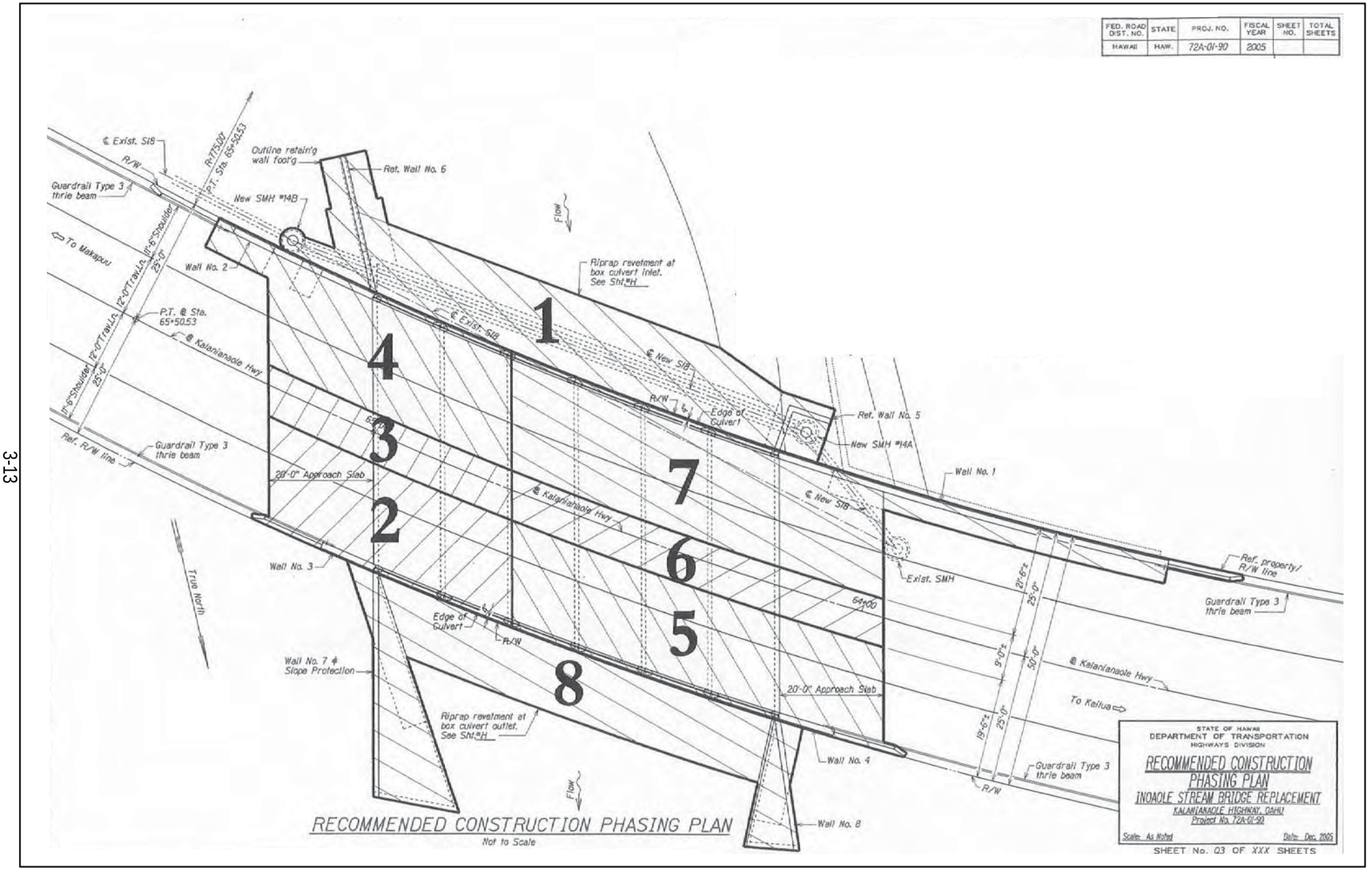


Figure 13
Bridge Construction Phasing Plan

Not to Scale

February 2009

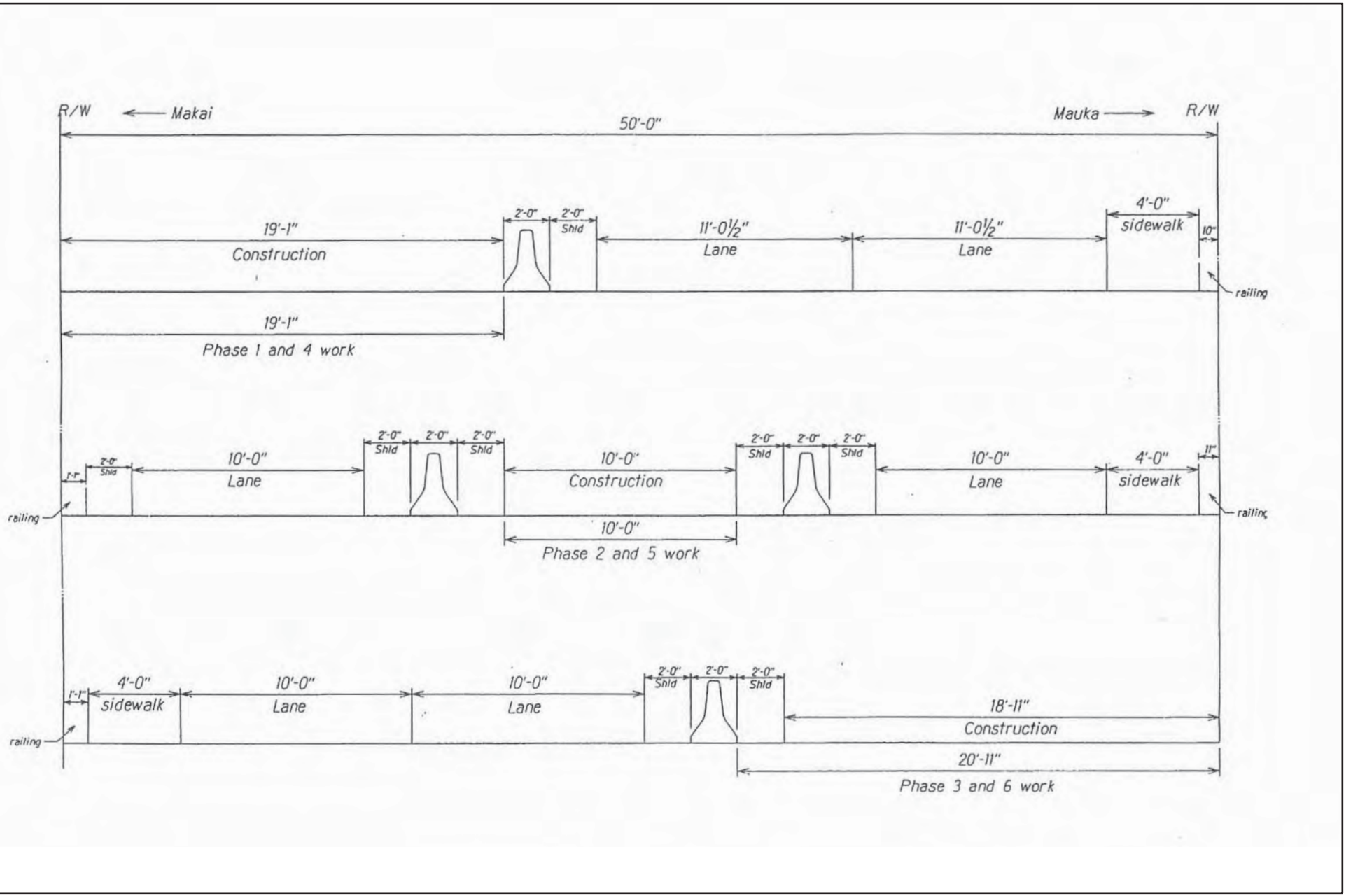


Figure 14
Bridge Construction Phasing Details

Not to Scale

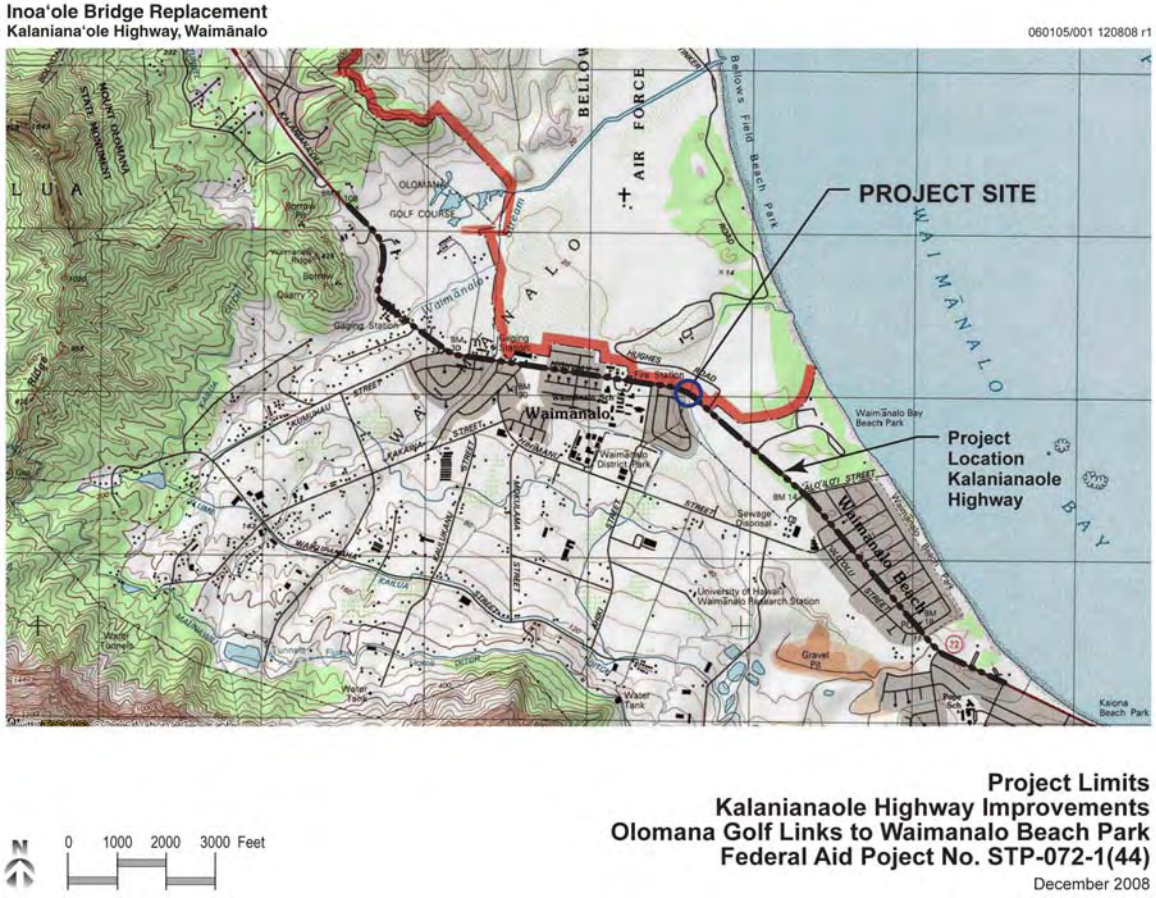
February 2009

3.4 PROJECT COORDINATION

Other Transportation Projects

HDOT has proposed more extensive highway improvements under a project titled: Kalaniana'ole Highway Improvements, Olomana Golf Course to Waimānalo Beach Park Project, FAP No. STP-072-1(44). The FEA/FONSI for this project was completed in March 2007. Like the Inoa'ole Stream Bridge replacement, the proposed highway improvements are not intended to increase traffic capacity, but to improve the operation and safety of the existing facility and enhance highway aesthetics. According to project and environmental documents, improvements will be made to roadway medians and turn lanes, sidewalks and crosswalks, bike lanes, signage, and bus stops. Still under consideration when the FEA was completed were options to place utility lines underground or to relocate utility poles.

The highway improvements project extends for approximately 3.5 miles and is planned for implementation in four phases: (1) median improvements in the vicinity of Olomana Golf Links, (2) Olomana Golf Links to Pō'alima Street, (3) Pō'alima Street to 'Ālo'ilo'i Street, and (4) 'Ālo'ilo'i Street to Waimānalo Beach Park. Inoa'ole Stream Bridge is located between Pō'alima Street and 'Ālo'ilo'i Street.



HDOT is actively coordinating the highway improvements and Inoa‘ole Stream Bridge projects; however, these are separate projects to allow funding from different sources and greater flexibility in scheduling. Moreover, replacement of Inoa‘ole Stream Bridge has independent utility, even without the larger highway improvements project. The bridge is programmed to occur before the Pō‘alima Street to ‘Ālo‘ilo‘i Street phase of Kalaniana‘ole Highway improvements, but the roadway approaches are being designed to fully integrate with future highway modifications.

Waimānalo Watershed Restoration

A number of federal and State agencies and community organizations are involved in an effort to improve the water quality of Waimānalo Stream and its tributaries. In 2001, the U.S. Environmental Protection Agency and Hawai‘i Department of Health prepared the Waimānalo Stream TMDL Implementation Plan, under which the total maximum daily load (or TMDL) is the maximum amount of nutrients or sediments that can enter into Waimānalo Stream without violating the State’s water quality standards. The plan covers five segments of Waimānalo and Kahawai Streams, but does not cover Inoa‘ole Stream. Nevertheless, the plan adopts a watershed perspective that is relevant to Inoa‘ole Stream. In recent years, there have been community-based efforts that address Inoa‘ole Stream’s role in the overall watershed. For example, native vegetation was planted along the banks of the Inoa‘ole Stream, including a section adjacent to the bridge project. Bridge improvements will be coordinated with any ongoing riparian restoration effort.

4 AFFECTED ENVIRONMENT, IMPACTS, AND MITIGATION

4.1 PHYSICAL RESOURCES

4.1.1 Geology and Soils

Existing Conditions

The general geology of Waimānalo is characterized by three major geological units. These units are basaltic bedrock, alluvium, and coralline deposits. Basaltic bedrock defines the western, southern, and eastern boundaries of Waimānalo and generally consists of basaltic flows and dikes of the Ko'olau dike complex. Alluvium generally lies at the foot of the basalt and primarily consists of highly weathered basaltic sand, gravel, cobbles, and boulders in a matrix of non-calcareous clays and silts. Marine calcareous deposits are expected to occur seaward of the alluvium and generally consists of recent beach and dune sand and other coralline deposits, including older lithified dunes. The alluvium is typically interlayered with coralline deposits in the Waimānalo area.

The topography varies considerably as the terrain rises inland from the shoreline to the Ko'olau Mountain Range. The valley floor consists of a flat coastal plain that transitions into gentle rising lands with less than 12 percent slope in the inland regions. At the foot of the Ko'olau s, the slope ranges from 12 to 20 percent. In the remaining mountain region to the crest of the Ko'olau Range, slopes range from 20 percent to nearly vertical.

According to the U.S. Department of Agriculture Soils Conservation Service, soils at the project site are classified as the Ka'ena-Waialua Association which occurs on the coastal plains, talus slopes, and in drainage ways (see Figure 15). The soils developed in alluvium and have a wide range of texture and drainage characteristics. The soils of this association occurring in Waimānalo include Ka'ena, Waialua, Hanalei, Kawaihāpai, Jaucas, Hale'iwa, Kaloko, Mokulē'ia, and coral outcrop.

Potential Impacts and Mitigation Measures

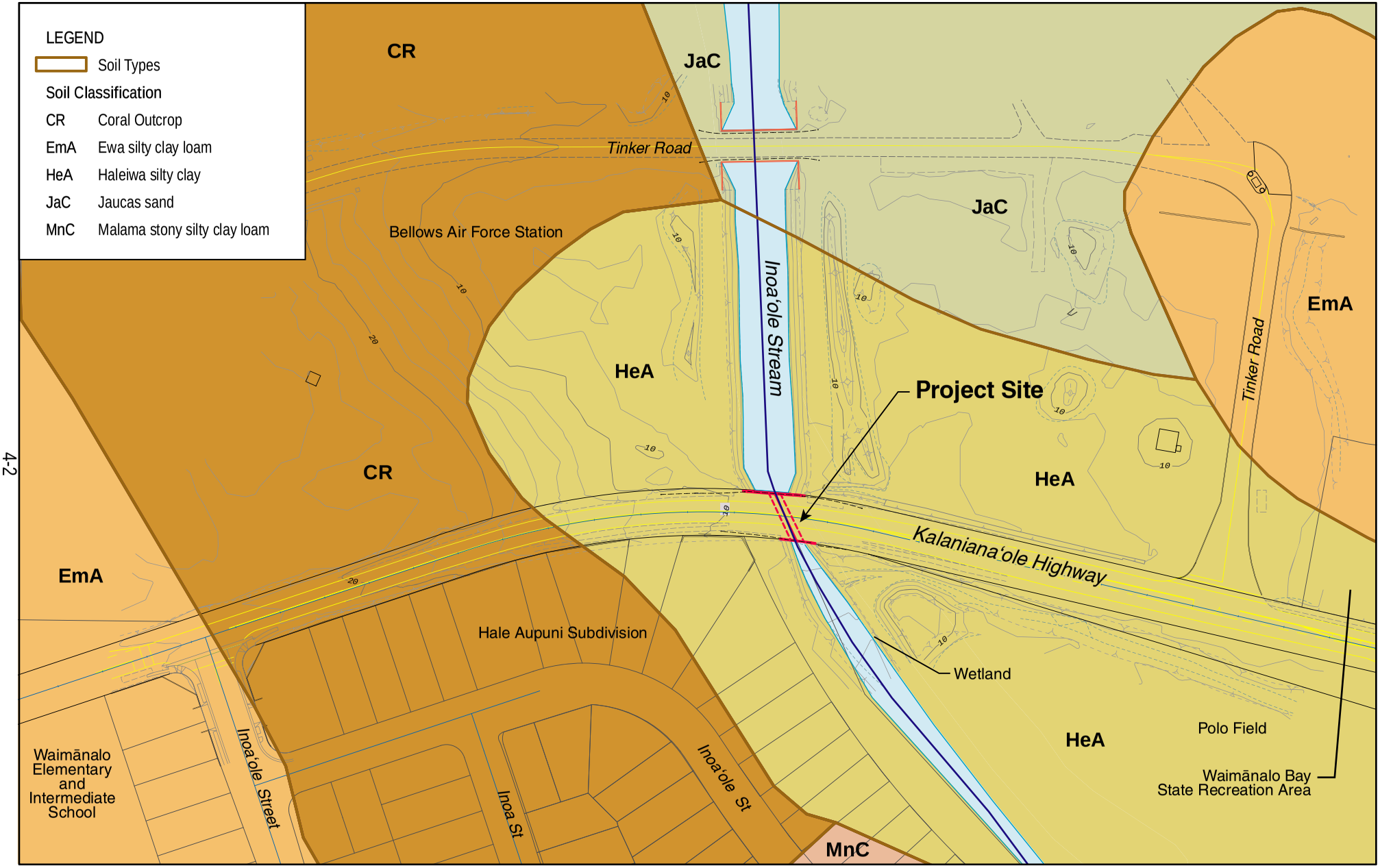
Excavation will be required to accommodate the new culvert structure and up-stream grading is also required to widen the stream banks in order to direct the stream flow into the widened culvert structure.

To address erosion control, the following mitigation measures will be implemented:

- Riprap will be placed along the upstream, Kailua-side of the stream embankment to minimize erosion.
- Riprap will be placed at the inlet and outlet of the culvert to prevent undermining.

Inoa'ole Bridge Replacement
Kalaniana'ole Highway, Waimānalo

f14 soils/012209 r2



4-2

Figure 15
Soils Map
February 2009

- Approved site-specific BMPs will be carried out following each phase of the culvert construction process, including backfilling excess excavation and paving or revegetating soils exposed by grading to minimize erosion.

No adverse impact to adjacent structures is anticipated during bridge construction.

4.1.2 Climate and Air Quality

Existing Conditions

The climate of Waimānalo is generally representative of Windward O'ahu. The temperatures in the area are typically mild and uniform, with the monthly average ranging from 70 degrees F in January to 78 degrees F in August. The average annual temperature is 74 degrees F. Average annual rainfall in the Waimānalo area varies considerably with elevation. At the shoreline, average annual rainfall is approximately 40 inches while the average annual rainfall is approximately 100 inches in the Ko'olau Mountain Range. Seasonal variation in rainfall occurs with higher rainfall during the months of November through April. Prevailing winds are northeasterly trade-winds which occur approximately 70 percent of the time. Trade-wind frequency ranges from about 45 percent in January to more than 90 percent in July. High winds are most likely to occur during the winter months. Humidity in the area ranges between 70 to 80 percent with higher humidity levels occurring during the winter months and lower during the summer months.

The State Department of Health operates a network of air quality monitoring stations at various locations on O'ahu. The air quality monitoring stations located closest to the project site are in Honolulu and Sand Island, more than 15 miles to the west and separated by the Ko'olau Mountain Range. In general, however, it can be assumed that air quality in the project area is good. The predominant source of air emissions is vehicular traffic that produces carbon monoxide (CO) and carbon dioxide (CO_2). Persistent trade winds contribute to favorable climatic conditions for air quality, and there are no large, stationary industrial facilities in the immediate vicinity. Although agricultural activities in rural areas can contribute to air pollution, there is no large scale agricultural activity in the project vicinity.

Potential Impacts and Mitigation Measures

Construction activities will result in temporary and localized impacts on air quality in areas adjacent to the construction site. Equipment used during the construction phase will emit exhaust and airborne particulates, and construction work will produce dust. Due to the low background levels of pollutants in the area and favorable climatic conditions, increased vehicular emissions are not expected to be significant. Construction vehicles will arrive and depart during non-peak hours. The contractor will use vehicles that are properly maintained.

During demolition and construction, the contractor will sprinkle water, as necessary, to control dust. Transported or stored soils will be covered. Areas graded and cleared of vegetation will be revegetated as soon as possible to reduce dust.

Construction activities will employ fugitive dust emission control measures in compliance with provisions of the State Department of Health 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.

In the long-term, the proposed bridge replacement project is not expected to produce changes in traffic volume that would have a marked effect on vehicular air emissions.

4.1.3 Hydrology and Water Quality

4.1.3.1 Groundwater

Existing Conditions

Three major hydrologic units occur in the Waimanalo area and include the high-level water in dike-intruded lava flows in the upper mountain regions; basal water in dike complexes in the coastal area; and basal water in coastal plain sediments. Dikes are dense, poorly permeable remnant conduits through which lava extruded from the Ko'olau volcanic shield.

The permeable compartments behind the dikes form natural reservoirs for groundwater. In the coastal regions, the dike complex underlies alluvium and coastal plain deposits. These alluvium and coastal plain deposits form a cap over the dike complex that confines the groundwater under artesian pressure. This groundwater is commonly described as basal water. Basal groundwater also occurs at shallow depths in the sedimentary deposits underlying the coastal plain in the Waimānalo area. The groundwater floats on the heavier seawater due to the density difference between fresh water and saline water. The fresh water characteristically forms a lens-shape body floating over the saline water. The fresh water lens is dynamic due to variations in water discharge from pumpage, tidal action, and recharge.

Potential Impacts and Mitigation Measures

Construction methods anticipated for this project will not affect groundwater underlying the project site. Nor are construction activities expected to introduce or release any materials into the soil that could adversely affect the groundwater.

4.1.3.2 Surface Water Drainage System

Existing Conditions

The drainage shed of the Waimānalo is defined by the Ko'olau Mountain Range, Aniani Nui Ridge, and Keolu Hills. Within these boundaries the entire valley encompasses a land area of approximately 11 square miles, and has a topography which varies from low lying coastal plain along the shoreline to gently rising lands in the middle section, and steep Ko'olau Mountain cliffs at the upper regions.

The existing Waimānalo Valley drainage system consists primarily of overland flow to numerous natural water courses which reduce to three major stream outlets discharging into Waimānalo Bay. The three outlets are the perennial Waimānalo Stream, which drains about 4.8 square miles, intermittent Inoa'ole Stream, which drains about 3.3 square miles, and an unnamed stream (sometimes referred to as Kahawai Stream) which drains about 0.5 square miles (Hawai'i Department of Land and Natural Resources, 1976).

The proposed bridge will replace an existing bridge which spans over Inoa'ole Stream. Most of the stream lies in the coastal plain and, in this flat area, the stream is a tidal channel. There are no drainage improvements in the vicinity of the project site, except for the downstream Bellows AFS multi-cell culvert below Tinker Road. The proposed project will provide additional storm drainage capacity at the bridge structure during rainstorm conditions.

Clean Water Act, Section 303(d)

The federal Clean Water Act requires states to collect and review surface water quality data and related information, and to prepare and submit to the U.S. Environmental Protection Agency biennial lists of waterbodies that are impaired (i.e., not expected to meet state water quality standards). For all impaired waters, the Hawai'i Department of Health (DOH) is required to compute the Total Maximum Daily Load (TMDL), which is the maximum amount of a pollutant (from point and nonpoint sources) that a waterbody can receive and still meet water quality standards, and to establish an allocation of that amount to the pollutant's sources.

The Department of Health estimated TMDLs for Waimānalo Stream in March 2001. As noted in the report, TMDLs were calculated for only the perennial freshwater portions of Waimānalo Stream because it was the only portion included in the 1988 303(d) List of Impaired Waterbodies. The TMDL Implementation Plan (DOH, August 2001) calls for pollutant reductions in five segments of the Waimānalo Stream Watershed: Upper Kahawai, Middle Kahawai, Upper Waimānalo, Middle Waimānalo, and Lower Tributary. Inoa'ole Stream was not included in the TMDL studies.

Potential Impacts and Mitigation Measures

The bridge replacement project is not expected to have an adverse impact on water resources. Stream flow will be maintained through the duration of construction activities. Drainage improvements will include placing riprap in the stream channel and require a Department of Army (DA) permit from the Army Corps of Engineers. Proposed modifications to the stream banks and channel will require a Stream Channel Alteration Permit (SCAP) from the Commission on Water Resources Management in the Department of Land and Natural Resources. A best management practices plan will be submitted with the DA and SCAP applications to mitigate impacts on Inoa'ole Stream.

4.1.4 Natural Hazards

4.1.4.1 Flood and Tsunami

Existing Conditions

According the Federal Emergency Management's Flood Insurance Rate Map (FIRM), lands at the project site are designated as Zone AE, or areas of 100-year flooding with determined base flood elevations (see Figure 16).

Flooding of large areas in Waimānalo during severe rainstorms has primarily been attributed to the small carrying capacities of streams, inadequate road under crossings, and the topography of the low-lying coastal plains.

The project area is near a tsunami evacuation zone, which extends *makai* of the highway between Bellows AFS and Waimānalo Beach Park (see Figure 17).

Potential Impacts and Mitigation Measures

The new culvert will improve storm flow at the bridge site and is not anticipated to adversely impact Inoa'ole Stream. The new culvert will accommodate a flow capacity equivalent to a 30-year storm event which is approximately six times greater than the existing box culvert. Culvert repairs may be required after the 100-year and 50-year storm events but the culvert will continue to be usable. Flooding is anticipated during the 100-year and 50-year storm events due to the existing upstream and downstream conditions, which cannot support either storm event. Even if a bridge structure were to support the the 50- and 100-year storm events, flooding might still occur unless major reconstruction is done to the existing stream channel. Backwater calculations were not performed by HDOT since the new culvert span is anticipated to be equal or greater than the stream channel bottom. HDOT developed the culvert design in compliance with all applicable flood zone standards.

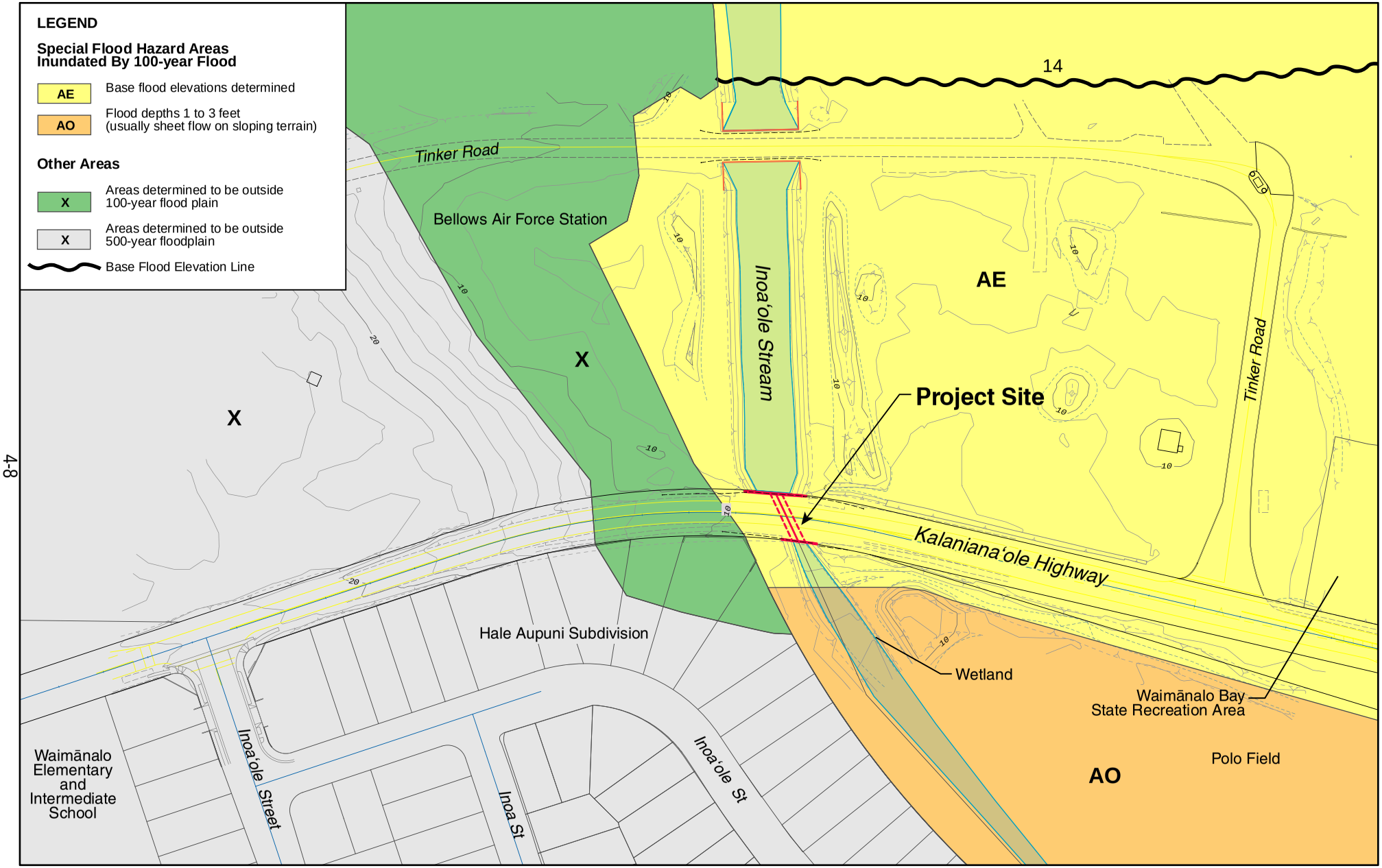
The phasing plan has been designed to allow the bridge to be reconstructed in place. Kalaniana'ole Highway will operate with one travel lane in either direction throughout the construction period. The new multi-cell culvert will be constructed in stages to maintain openings that accommodate stream flow.

4.1.4.2 Seismic Activity

The island of O'ahu rarely experiences earthquakes because the island is not situated in a highly seismic area. The Uniform Building Code (UBC) provides minimum design criteria to address the potential for damages due to seismic disturbances. The UBC seismic provisions 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). O'ahu is in UBC Seismic Zone 2A.

Potential Impacts and Mitigation Measures

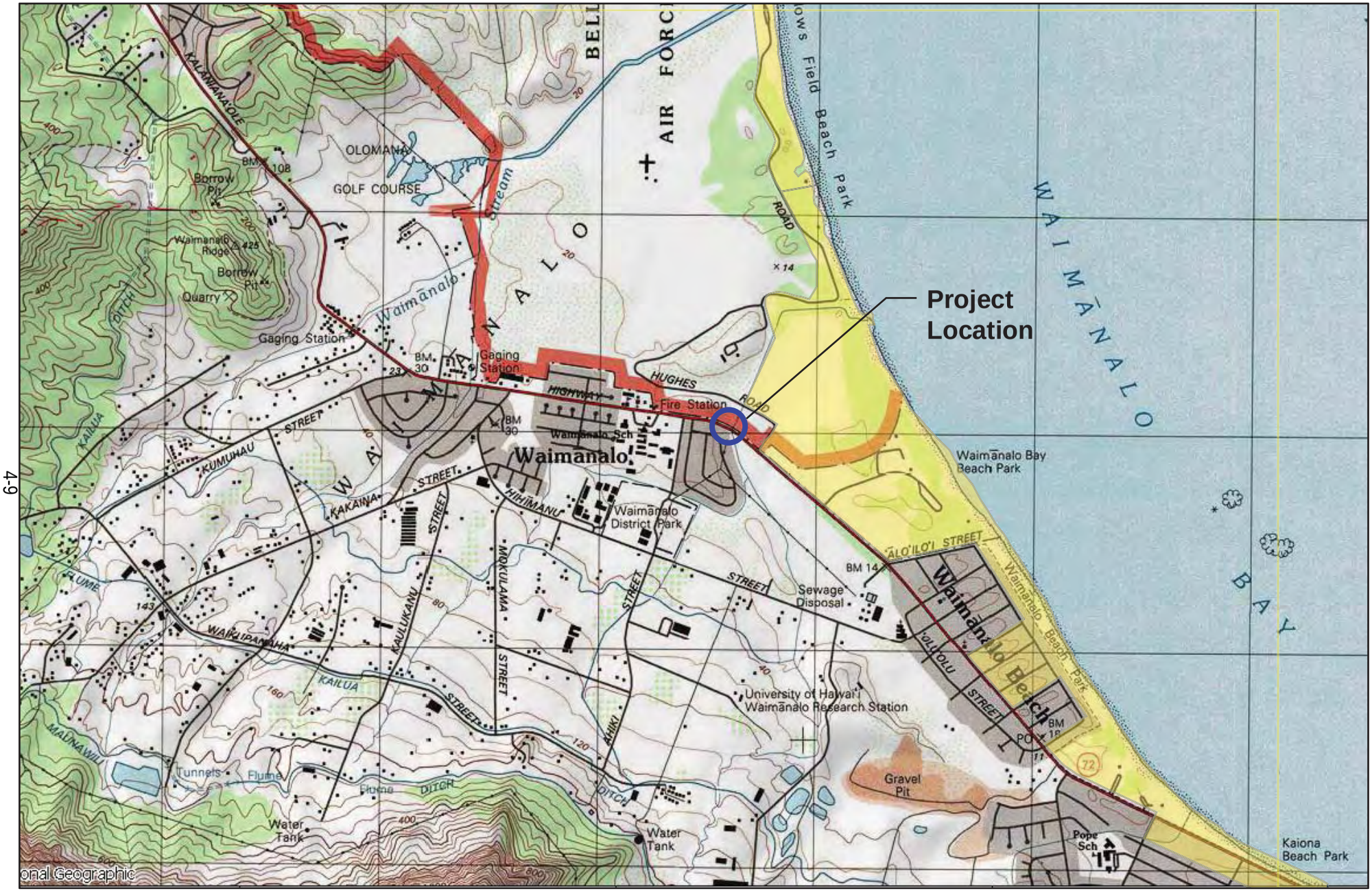
The replacement bridge, roadway approaches, and auxiliary structures will be designed to current seismic standards.



Source: FIRM Map, Map Number 15003C0385F, Sept. 30, 2005

0 35 70 140 Feet

Figure 16
Flood Insurance Rate Map
February 2009



N

0 500 1000 2000 Feet

LEGEND

Tsunami Evacuation Zone

Figure 17
Tsunami Evacuation Zone Map
February 2009

4.1.5 Noise

Existing Conditions

A noise assessment was conducted for the Kalaniana'ole Highway Improvements project by D.L. Adams in 2004. The study evaluated the existing acoustical environment by taking ambient noise level measurements at three locations on Kalaniana'ole Highway. The locations closest to Inoa'ole Bridge were Kalaniana'ole Highway near Pō'alima Street (north of the bridge) and Kalaniana'ole Highway near Hilu Street (south of the bridge). The Pō'alima Street location is characterized as neighborhood scale commercial, while the Hilu Street location is residential in character. Adjacent to the Inoa'ole Bridge project area, residences in the Hale Aupuni subdivision are located along the northern bank (Kailua side) of Inoa'ole Stream and along Kalaniana'ole Highway.

The 2004 D.L. Adams noise study found that at 15 feet from the highway, sound levels range from approximately 70 dBA during the daytime hours to approximately 60 dBA during the night. Therefore, existing daytime noise levels exceed the FYWA guildines of 67 dBA (maximum) at the exterior of the nearest residences. Noise predictions indicated that any residence within 60 feet of the edge of Kalaniana'ole Highway exceeds the FHWA guidelines. Although traffic was the dominant noise source at the measurement locations, other noise sources included wind, birds, and small aircraft.

Potential Impacts and Mitiation Measures

Construction-related Noise

Construction noise impacts are unavoidable, but will be temporary. The surrounding residential properties may be impacted by project construction noise due to their proximity. Actual noise levels produced during construction will be a function of the methods employed during each stage of construction. Equipment likely to be used include drill rig, crane, excavator, backhoe, front-end loader, grader, forklift, semi-trucks, dump trucks, concrete trucks, compactors, paving equipment, and compressors. Typical ranges of construction equipment noise vary between 70 and 95 dBA, which exceeds permissible levels. Earthmoving equipment, e.g., backhoes, front loaders, bulldozers, and diesel-powered trucks, will probably be the loudest equipment used during construction. The contractor will be required to maintain and properly muffle construction equipment and on-site vehicles that exhaust gas or air.

In cases where construction noise exceeds, or is expected to exceed the State's "maximum permissible" property line noise levels, a permit must be obtained from the State Department of Health under Hawai'i Administrative Rules Chapter 11-46, Rules on Community Noise. In order for the DOH to issue a construction noise permit, the contractor must submit a noise permit application to the DOH which describes the construction activities for the project. Before issuing the permit, the DOH may require the contractor to incorporate noise mitigation into the construction plan. The DOH may also

require the contractor to conduct a noise monitoring or community meeting inviting the neighboring residences and businesses to discuss construction noise.

The contractor should use reasonable and standard practices to mitigate noise, such as using mufflers on machines with diesel and gasoline engines, using property tuned and balanced machines, and so forth. The DOH may require additional noise mitigation treatments, such as a temporary barrier around a generator.

Specific permit restrictions required for construction projects by the DOH are:

- No permit shall allow construction activities creating excessive noise before 7:00 am and after 6:00 pm of the same day
- No permit shall allow construction activities which emit noise in excess of 95 dBA except between 9:00 am and 5:30 pm of the same day
- No permit shall allow construction activities which exceed the allowable noise levels on Sundays and on certain holidays. Pile driving and other activities exceeding 95 dBA will be prohibited on Saturdays.

The DOH noise permit does not limit the noise level generated at the construction site, but rather the times at which noisy construction can take place. Therefore, noise mitigation for construction activities will be addressed using project management to ensure compliance with time constraints.
In addition to the noise permit, a noise variance may be requested from the DOH for the specific occasions when work hours need to be extended into the evenings and/or on weekends to implement the overall construction schedule.

Long-term Noise Impacts

The 2004 D.L. Adams noise study also modeled changes in noise levels that could be attributed to the proposed highway improvements. Like that project, replacing Inoa'ole Stream Bridge will not change traffic counts or operational conditions (i.e., the posted speed limit). The traffic study predicted that noise levels after the project is completed would be the same, or within 1dB of the existing noise levels prior to construction.

The noise study concluded that since the existing traffic noise currently exceeds FHWA guidelines for residences within 60 feet of Kalaniana'ole Highway, the traffic noise after the new road is completed is also likely to exceed the FHWA guidelines. However, the project's impact on traffic noise is not considered significant because the change in noise level due to the project is approximately 1 to 2 dB. Changes in noise level less than 3dB are considered insignificant because a 3dB change is not perceptible to most listeners. Noise mitigation of traffic noise to the residences should not be required because the project should not change the existing traffic noise levels after construction of the new road is complete. Similar conclusions would apply to the Inoa'ole Stream Bridge project.

4.2 BIOLOGICAL RESOURCES

4.2.1 Flora

Existing Conditions

A Botanical Resources Assessment was conducted by Char & Associates in February 2004 for the Kalaniana'ole Highway Improvements project. That study investigated flora within the highway easement from Olomana Golf Links to Waimānalo Beach Park, which includes Inoa'ole Stream Bridge and vicinity. The 2004 Char study characterized the vegetation as mostly grassy mowed strips, especially in the residential areas. Koa haole scrub with Guinea grass and a few scattered trees were found on undeveloped areas bordering the highway easements. No threatened and endangered species as identified by the U.S. Fish and Wildlife Service occur within the highway easements. The native plant species, *ma'o*, which is considered a species of concern by the Service was found along Kahawai and Inoa'ole Streams. However, the plants are horticulturally obtained material (planted for riparian restoration purposes) and not a naturally occurring population. No sensitive native plant-dominated communities occur within the highway easements. And no Exceptional Trees, protected by the City and County of Honolulu Ordinance 78-91 and 81-32 occur within the highway easements.

4.2.2 Terrestrial and Avian Fauna

Existing Conditions

A Wildlife Survey was conducted in February 2004 by certified biologist Tim Ohashi for the Kalaniana'ole Highway Improvements project. The wildlife survey found introduced birds common to the lowlands of O'ahu within the highway corridor. Those seen most frequently included the common myna (*Acridotheres tristis*) and the red-vented bulbul (*Pnycnonotus cafer*). The migratory Pacific golden plover (*Pluvialis dominica*) and Wandering tattler (*Heteroscelus incanus*) were also observed in the study area.

No mammals were seen during the wildlife survey, although biologist Ohashi reported that there are likely to be feral cats (*Felis cattus*), mongoose (*Herpestes auropuncttus*), rats (*Rattus spp*), and mice (*Mus musculus*) in the area.

4.2.3 Stream Fauna

Existing Conditions

An Aquatic Resources Survey report was completed for Inoa'ole Stream at Kalaniana'ole Highway by AECOS, Inc in September 2000. Excerpts from the survey are included in this section, and the report in its entirety is included as Appendix B.

Inoa'ole Stream at the project site is essentially a large pond which only flows occasionally. There may be a slow exchange of water between local groundwater and coastal waters through the beach, resulting in slight movement of water at this part of the stream. Seemingly isolated coastal ponds are also subject to small changes in water level from ocean tidal action transmitted through the basal aquifer. Aquatic environments upstream of the highway bridge are generally quite poor and water quality is indicative of stagnant water. Overall, there are no aquatic resources in the project area that would be adversely impacted by the proposed construction of a new bridge or any temporary structures associated with the construction process. No aquatic species listed as threatened or endangered were observed in the project area. While certain listed water birds, such as Hawaiian stilt (*Himantopus mexicanus knudsen*i), and the State-protected black-crowned night heron (*Nycticorax nycticorax hoactli*) are potential visitors to the *muliwai* or mouth of the stream (indeed, heron have been observed on lower Inoa'ole Stream by the report's author), the project area was not assessed to be a critical habitat for these species and is likely to be used only incidentally, if at all, in the immediate project vicinity.

Technical Assistance Consultation, U.S. Fish and Wildlife Service

The Pacific Island Ecoregion of the U.S. Fish and Wildlife Service was contacted by letter dated August 9, 2000 with a request for technical assistance on the Inoa'ole Stream Bridge replacement project. The Service responded by letter dated September 22, 2000 (see Appendix G). The letter stated that "records do not indicate the presence of any threatened or endangered species in the immediate project area" although "it is possible that such species are present but not recorded." The letter went on to note that "downstream of the project area, the lower reaches of Inoa'ole Stream provides wetland habitat suitable for endangered waterbirds and migratory shorebirds." The Service recommended six measures to minimize impacts to aquatic and riparian resources. The six recommendations are listed as mitigation measures below.

Potential Impacts and Mitigation Measures

There are no flora or fauna in the project area which are listed or proposed candidates for threatened or endangered species with protection under federal or State law. The wildlife habitat in the area is not unique. Most of the fauna found in the area are common introduced species, with the exception of the endangered water birds that may forage in the area.

Adverse impacts to native stream biota are not anticipated as the result of construction of the new bridge. As reported by an Aquatic Resources Survey, existing water quality is poor, particularly upstream of the bridge, and the proposed action will not alter or divert water flow either during or after construction.

Phasing of the bridge demolition and new culvert construction will require excavation within the stream bed and widening of the *mauka* stream channel. These actions may affect the riparian restoration effort that planted native vegetation along the banks of the

Inoa'ole Stream. Salvageable plants may be removed temporarily and replanted or new planting stock of the same native species may be planted when construction has concluded.

Six mitigation measures were recommended by the U.S. Fish and Wildlife Service (letter dated September 22, 2000; see Appendix G). The first five mitigation measures are incorporated verbatim into this environmental assessment. The sixth recommendation has been modified because removal of riparian vegetation is likely, although the effects of such removal can be mitigated.

1. All project-related materials will be placed or stored in ways to avoid or minimize disturbance to the aquatic environment
2. All project-related material will be free of pollutants
3. No contamination of the aquatic environment (trash, debris disposal, etc.) will result from the project activities
4. A contingency plan to control accidental spills of petroleum products will be developed. Absorbent and contaminant booms will be stored on site to facilitate the clean-up of petroleum spills.
5. Turbidity and siltation from excavation activities will be minimized and contained to the immediate vicinity of excavation though the use of silt containment devices and the curtailment of excavation during averse weather conditions
6. Removal of riparian vegetation will be avoided whenever possible. If removal is unavoidable, a revegetation plan will be developed to ensure that impacts are minimized and the banks are restored close to their original condition.

4.2.4 Wetland Resources

Existing Conditions

A Wetland Survey of the area was conducted in August 2000 by Char & Associates. The survey indicates that a small wetland area was present on the *mauka* side of the existing bridge structure. The wetland area generally follows the banks of the stream and ends on the *mauka* side bridge structure stream drainage opening. Refer to Figure 18 and Appendix C.

Potential Impacts and Mitigation Measures

The wetland area affected by the project tapers from approximately 25 feet to 40 feet wide and extends approximately 100 feet upstream. The affected wetland area measures approximately 3,250 square feet. The culvert inlet is approximately 83 feet wide and the stream will be widened to facilitate the storm water stream flow to the culvert. Therefore, the wetland area is anticipated to increase due to the stream widening from approximately 3,250 square feet to approximately 8,300 square feet.

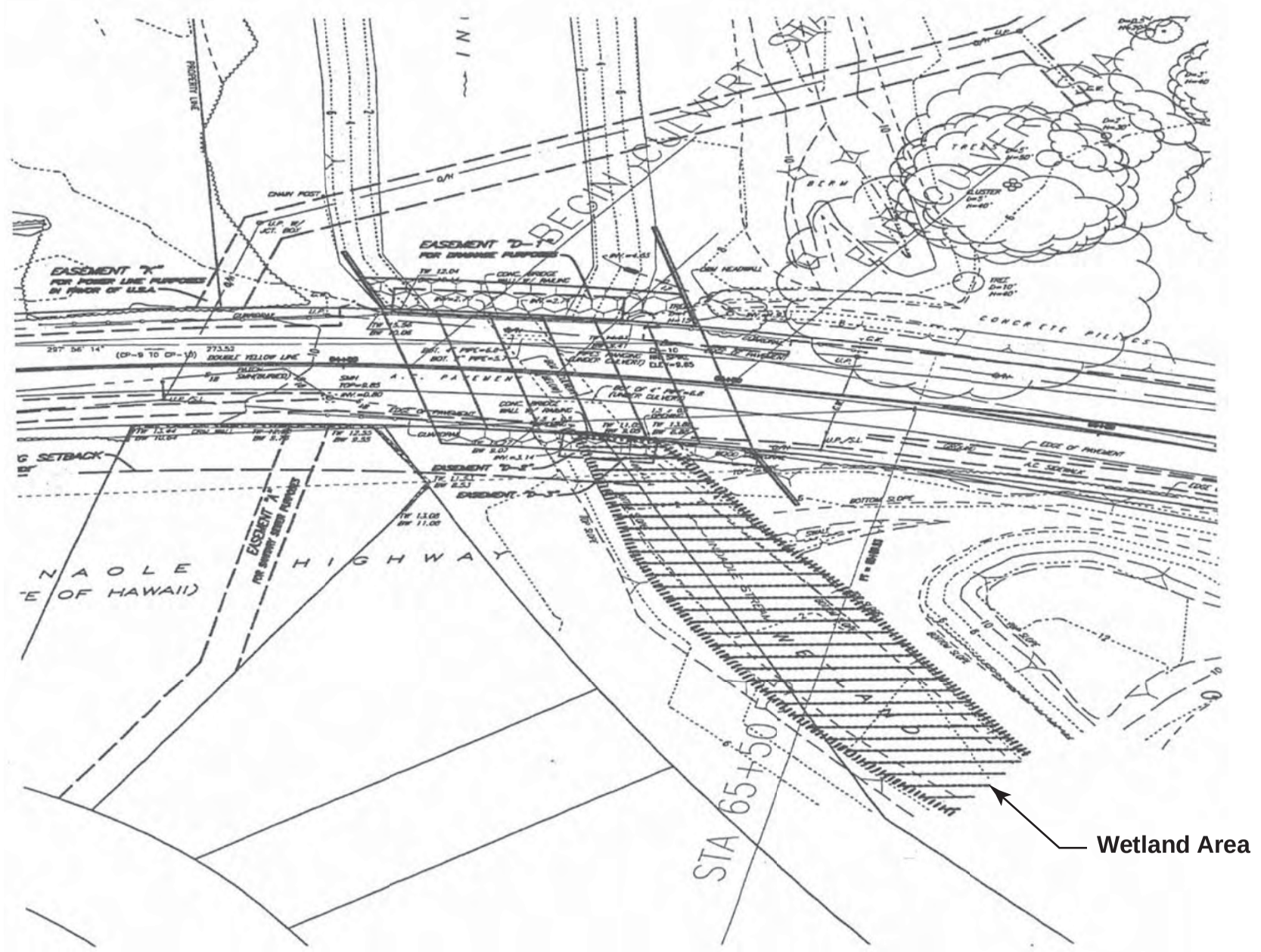


Figure 18
Wetland Map
February 2009

4.3 CULTURAL RESOURCES

4.3.1 Archaeological and Historic Resources

Existing Conditions

A study by Cultural Surveys Hawai'i, prepared for the Kalaniana'ole Highway Improvements project in June 2005, included an historical review of the Waimānalo *ahupua'a*. The following material is extracted from the study's description of previous archaeological research (p. 28):

> The major foci in archaeological research in Waimānalo has been the Bellows area and to a much lesser extent the Waimānalo State Recreation Area. Bellows Air Force Station is one of the most extensively studied areas on O'ahu. Beginning in the 1960s, approximately 70 separate reconnaissance, survey, excavation and monitoring projects have taken place, most in conjunction with construction activity. Human burials, lithic scatters, soil features and/or occupation layers have been found almost everywhere archaeological investigation ahs taken place.
>
> Approximately a dozen archaeological studies were carried out at the Waimānalo State Recreation area just south of Bellows mostly between 1976 and 1980. There as hope that the occupation layers documented just to the north might be present in the State Recreation Area but findings thus far have been rather disappointing.

Table 1 lists an inventory of historic sites at Bellows, as presented in the Final EIS for the Bellows AFS Land Use and Development Plan, December 1995. The majority of the ancient Hawaiian sites at Bellows AFS are subsurface deposits rather than surface structures. The investigation indicates that the Bellows AFS lowlands may have comprised a single site at one time. Agricultural development followed by construction activities during World War II had a major effect on archaeological remains. Much of the area was leveled or filled, and Waimānalo Stream was rechanneled at its mouth. In spite of the construction, significant deposits from earlier periods are thought to remain.

Figure 19 shows the site locations. When detour routes were being considered, there was a possibility of aligning a temporary road through Bellows AFS. Such an action would have the potential to disturb cultural sites within the military installation. However, the Bellows detour options were dismissed because of security and other issues.

Among the archaeological studies described in the 2005 Cultural Survey Hawai'i report (p. 29), two studies are particularly relevant because the excavations occurred adjacent to and near the Kalaniana'ole Highway right-of-way. Both studies involve sites located 0.8 mile and farther to the south and east of the project site (in the Makapu'u direction).

> The McGuire and Hammatt (2000a) study was an archaeological monitoring report on excavations for the installation of six light poles for a ball field at Waimānalo

Beach Park immediately adjacent to the southwest portion of the project area *[Kalaniana'ole Highway]*. No cultural findings were reported (dirt fill over sterile sand) but the actual area monitored was very small.

The Perzinski et al. 2001 report covers monitoring for a similar Sandwich Isles Communications project in three areas: at the intersection of Oluolu and Ehukai Streets, at the *mauka* end of 'Ālo'ilo'i Street and at Nakini Street. This project thus included monitoring immediately adjacent to the present project area *[Kalaniana'ole Highway]*. Along Nakini Street the observed sediments were sandy clay loam with modern trash mixed in extending to the base of excavation (Perzinski et al. 2001: 15). No sites, burials, cultural layers, or significant finds were observed in the course of this work but a relatively small portion of this project was actually monitored.

Historic Preservation Review, Chapter 6E, HRS and Section 106, National Historic Preservation Act

The State Historic Preservation Division was asked to review the proposed bridge replacement improvements. By letter dated February 25, 2003, SHPD found that:

> Although subsurface cultural deposits (temporary habitation, traditional agriculture) have been found in the Inoa'ole Stream segment on the bellows Air Force Station parcel the portion along the stream at the project location ahs been extensively modified with rip rap revetments on the *makai* side of the bridge. The upstream (*mauka*) although not previously installed with revetments has been previously cleared and modified making it unlikely that significant subsurface deposits still exist in the area proposed for improvements. Therefore, we believe that the proposed bridge replacement improvements will have "no effect" on significant historic sites.

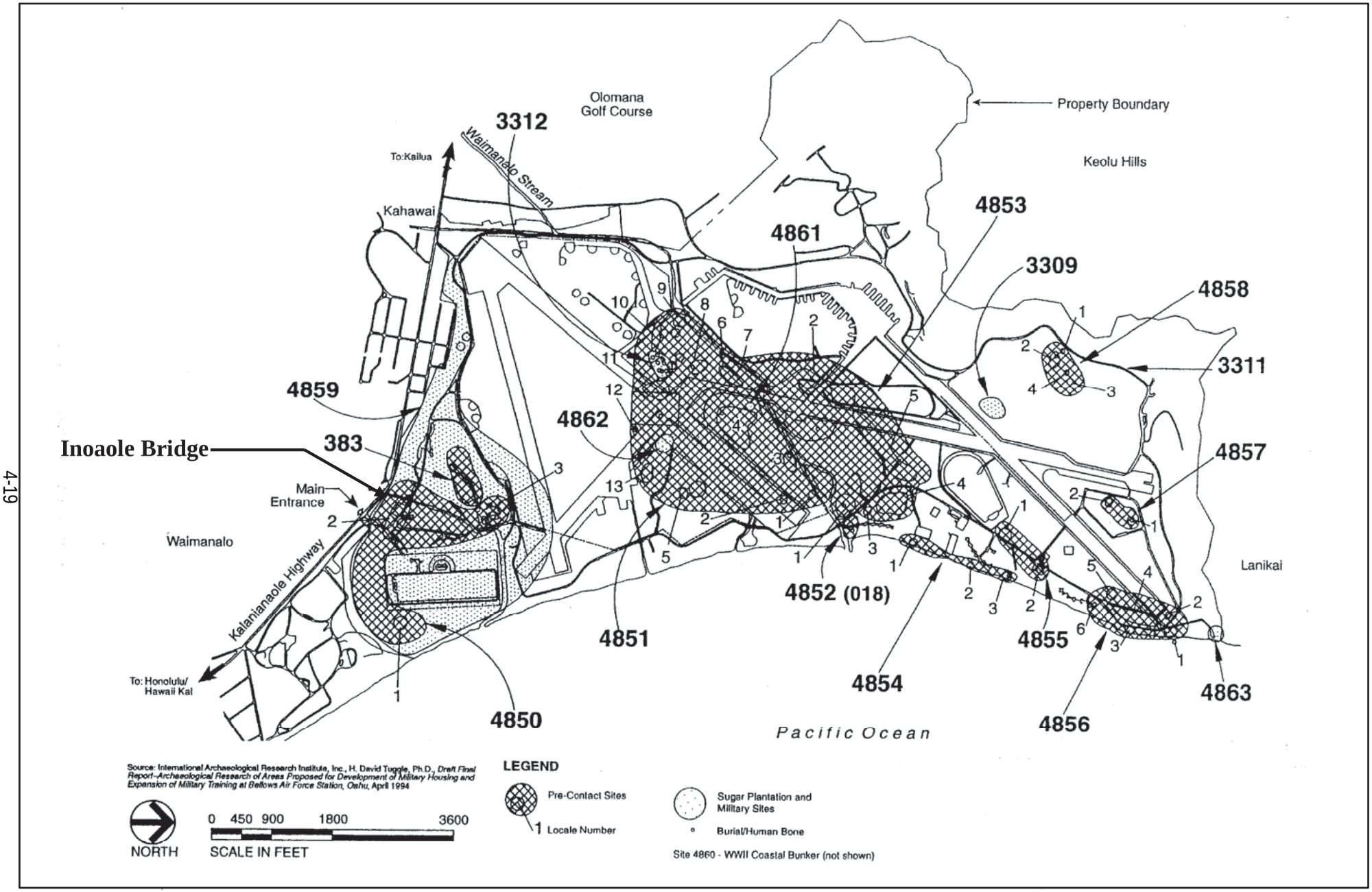
Potential Impacts and Mitigation Measures

The new bridge will be located at the existing bridge location and disturbance to possible archaeological subsurface deposits on the *makai* side of the bridge is not anticipated. The State Historic Preservation Division has made a determination that the project will have "no effect" on significant historic sites based on their records and a brief staff inspection. However, should any archaeological resource be encountered during construction, all work in the immediate vicinity will cease and the appropriate authorities will be contacted promptly. The contractor for this project will be required to follow all procedures specified in Section 6E-46.6, Hawai'i Revised Statutes and Chapter 13-300, Hawai'i Administrative Rules in the event that inadvertent discoveries are made.

Table 1
Inventory of Historic Properties, Bellows AFS

Site No.	Site Feature/Type	Site Feature/Function	Burials or Bone
383	• *wahi pana* (special place)	• *pu'uhonua* (place of refuge)	
4850	• soil horizon • basalt stone pile	• agricultural soil • unknown	
4851	• deposit, lithics • deposit, lithics • deposit, burials • lithics • deposit, lithics • deposit (waterlogged) • deposit, lithics • deposit, disturbed? • deposit, lithics • lithics • human remains • deposits	• habitation, workshop • habitation, workshop • habitation, agriculture?, burial • workshop • habitation, workshop • *lo'i*/pond • habitation, agriculture? • disturbed habitation? • habitation, workshop • workshop • burials • habitation, agriculture?	 To be determined x x x
4852	• deposits, human remains • deposits • deposits, disturbed?	• habitation, burial • habitation • habitation, disturbed?	x
4853	• deposits • deposits, human remains • deposits • soil horizon • pits, lihics	• habitation • habitation, burial, agriculture? • habitation, disturbed • agriculture? • agriculture?, workshop	To be determined x
4854	• isolated hearth • human remains • human emains	• habitation • burial • burial	 x x
4855	• deposits • soil horizon	• habitation • agriculture?	 x
4856	• deposits • human remains • deposits • deposits • deposits • human bone, isolated?	• habitation • burial • habitation • habitation • habitation • burial?	x x To be determined
4857	• deposit, human remains • deposit	• habitation, burial • habitation	x
4858	• lithics • stone piles; C-shapes? • stone platform • stone platform	• quarry, workshop • agriculture? • temple? • temple?	 To be determined
3309	• water catchment, channels	• sugar cultivation	
3311	• irrigation canal	• sugar irrigation	
3312	• gravestone complex	• early 20th century cemetery	
4859	• concrete pads, structures	• WWII military complex	
4860	• concrete bunkers	• WWII coastal defense	
4861	• concrete foundations/artifacts	• WWII activity area	
4862	• military debris	• WWII activity area	
4863	• house(s)	• WWII officer's house?	

Source: Final EIS for Land Use and Development Plan, Bellows AFS, December 1995



Source: Belt Collins Hawaii, December 1995

Figure 19
Historic Sites
February 2009

4.3.2 Cultural Impact Assessment

A Cultural Impact Assessment for the Kalaniana'ole Highway Improvements project was conducted by Cultural Surveys Hawai'i in June 2005. In addition to a historical background review of Waimānalo, the researchers published summaries of interviews with six kama'āina interviewees. Based on the assessment findings, the researchers concluded that the highway improvements project would have minimal or no impact on Hawaiian culture, its practices, and traditions.

Gathering for Plant Resources. During this assessment there were no ongoing practices related to traditional gathering of plant resources that were identified in the project area in Waimānalo (where project area includes the Kalaniana'ole Highway right-of-way from Olomana Golf Links to Waimānalo Beach Park). None of the individuals contacted or interviewed identified any native plant gathering practices within the project area. It is likely that there is far greater emphasis on gathering plan resources further inland.

The cultural impact assessment noted, however, that subsurface properties associated with Hawaiian activities in the project area, such as burials, artifacts and cultural layers, may be present despite no studies specific to the highway corridor. In particular, there is potential for cultural artifacts and burials where deposits of Jaucas sand are encountered. Figure 15 shows the distribution of soil types in the project vicinity, where the Jaucus sand classification is present within Bellows AFS and the Waimānalo Bay State Recreation Area, some 200 feet *makai* of Kalaniana'ole Highway.

4.4 SOCIO-ECONOMIC ENVIRONMENT

4.4.1 Demographic and Economic Characteristics

Existing Conditions

Waimānalo consists of diverse neighborhoods including small subdivisions, large lot beachside residences, farm/agricultural lots, and remnants of plantation villages and Hawaiian Homesteads. Kalaniana'ole Highway is the community's main thoroughfare. The 2000 U.S. Census reported the following:

- Resident population was 10,919.
- There were 2,657 households with an average household size of 4.03.
- Persons 25 years and over with a college bachelor's degree or higher was 7.5%.
- Median household income was $54,185 based on 1999 dollars.

Tourism, military presence, and agriculture have been O'ahu's major economic components in the 20th century. Statewide, tourism currently provides the largest share of the state gross product, with the military next and agriculture the smallest of the three.

Potential Impacts and Mitigation Measures

Demographic Impacts. Replacing the existing bridge will have no effect on the number or demographic characteristics of people who live in the area. The proposed project does not anticipate a redistribution or change of density to the population of Waimānalo.

The project will not cause residential or business displacement along Kalaniana'ole Highway. The project will not disrupt the integrity of any existing neighborhood.

Economic Impacts. The proposed action is anticipated to have several types of economic impacts. One type is construction related employment and income. With a preliminary estimated cost of several million dollars, the project is expected to support a number of engineers and construction workers for the duration of the project (approximately 18 months). Unless the economy expands significantly and existing firms are working at full capacity, this project is more likely to help sustain existing employment and income levels rather than to create new jobs. However, because a substantial portion of project funds are coming from (federal) sources outside the region, the wages paid to workers on this project (direct income), payments to suppliers (indirect income), and their subsequent expenditures (induced income) could have a large cumulative impact as the monies circulate through the local economy.

It is unlikely that any long-term employment opportunities would be realized by this bridge replacement project since the project would have little, if any, effect on employment-producing development.

Fiscal Impacts. The majority of funds for this project will be obtained from federal sources; however, State funds will also be used. Additionally, State funds will be needed to maintain the facility. In the long term, the new bridge design and modern materials will result in reduced maintenance costs.

4.4.2 Environmental Justice

Executive Order 12898 on Environmental Justice (EJ) requires each federal agency and recipients of federal funds to take appropriate steps to identify and address "disproportionately high and adverse human health or environmental effects" of federal projects on minority or low income populations. Similar non-discrimination protection is provided under Title VI of the Civil Rights Act of 1964, U.S. DOT Order 5610.2 on Environmental Justice, and other related regulations and directives.

For census purposes, Waimānalo is comprised of Census Tracts 113.01 and 113.02. During the most recent census in 2000, 33.2 percent of the total population in these two census tracts identified themselves as Native Hawaiian/Pacific Islander (one race). In comparison, this category contained 9.4 percent of the population statewide and 8.9 percent in the City and County of Honolulu. Poverty levels in Waimanalo were more similar to state and county levels. According to the 2000 census, 9.5 percent of Waimanalo residents reported incomes below poverty level, compared to 10.4 percent in the state and 9.6 percent in the county.

Potential Impacts. The proposed action will not have disproportionately high or adverse impacts on minority or low-income populations. Rather, the proposed bridge replacement will have a positive effect to the community. The roadway system will essentially remain the same—a general preference that has been expressed in various community forums, for example, the public meetings conducted as part of the Kalaniana'ole Highway Improvements project. At the same time, the new bridge structure will improve the storm drainage flow without major reconstruction to Inoa'ole Stream. Improving storm drainage flow will reduce storm water damage to adjacent properties and roadways and enhance emergency vehicle response capability on Kalaniana'ole Highway.

4.5 SCENIC AND VISUAL RESOURCES

Existing Conditions

Kalaniana'ole Highway offers scenic views from many locations along its route. Parks, beaches, and open spaces are found in the nearby vicinity. However, the project site is not a part of a scenic view corridor. Also, Inoa'ole Stream is not a designated wild, scenic, or recreational river.

Potential Impacts and Mitigation Measures

From the project area, ocean views are obscured by dense vegetation within BAFS and mountain views are partially obscured by dense vegetation and homes within the Hale Aupuni Subdivision. The scenic quality of the area will not be adversely affected by the new bridge.

4.6 TRAFFIC AND CIRCULATION

4.6.1 Vehicular Traffic

Existing Conditions

Waimānalo is approximately 14 miles from downtown Honolulu via the Pali Highway (State Route 61). Kalaniana'ole Highway (State Route 72) provides a westbound route to Honolulu around Makapu'u Point, a distance of approximately 20 miles between

Waimānalo and downtown Honolulu. In the project vicinity, Kalaniana'ole Highway is a two-lane roadway, one-lane in each direction, and the major thoroughfare in Waimānalo. Residential and commercial developments have been established along both sides of the highway. The posted speed limits in Waimānalo are 25 and 35 miles per hour. The posted speed limit in the Inoa'ole Bridge section is 25 miles per hour.

Traffic Volumes

The information in this section is based on the Traffic Engineering Report prepared for the Kalaniana'ole Highway Improvements project (Traffic Management Consultant, 2003). According to the traffic report, the average daily traffic (ADT) volume on Kalaniana'ole Highway in 2002 was 21,500 vehicles between Olomana Golf Links and Bellows Field, and 16,700 vehicles between Bellows Field and Wailea Street. Future growth in the ADT was forecasted to be relatively small, increasing only 0.8 percent annually.

AM and PM Peak Hour Traffic

The AM peak hour of traffic occurs between 7:15 AM and 8:15 AM. Kalaniana'ole Highway carried between 1,300 vehicles per hour (vph) and 1,900 vph, total for both directions, during the AM peak hour of traffic.

Inoa'ole Street is the cross street closest to the project site. During the AM peak hour, Inoa'ole Street carried approximately 170 vph, total for both directions. Inoa'ole Street operated at a level of service (LOS)[1] "F" at its T-intersection with Kalaniana'ole Highway.

The PM peak hour of traffic occurred between 3:45 PM and 4:45 PM. Kalaniana'ole Highway carried between 1,400 vph and 2,000 vph, total for both directions in the afternoon.

Inoa'ole Street carried about 170 vph at Kalaniana'ole Highway, total for both directions, during the PM peak hour. The LOS rating was "F."

Proposed Kalaniana'ole Highway Improvements, Olomana Golf Links to Waimānalo Beach Park

Independent from the proposed replacement of Inoa'ole Stream Bridge, is a project to improve Kalaniana'ole Highway from Olomana Golf Links to Waimānalo Beach Park. At Inoa'ole Street, the widened highway will provide an exclusive left-turn lane for vehicles turning into the subdivision, and a median shelter lane for vehicles making a left turn from the subdivision onto Kalaniana'ole Highway. Bus bays are proposed on both sides of the

[1] Level of Service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream. Several factors are included in determining LOS, such as speed, delay, vehicle density, freedom to maneuver, traffic interruptions, driver comfort, and safety. LOS "A," "B," and "C" are considered satisfactory levels of service. LOS "D" is generally considered a "desirable minimum" operating level of service. LOS "E" is an undesirable condition and LOS "F" is an unacceptable condition.

highway so that buses can pull off the travel lane to pick up and drop off passengers. The proposed bus bays would be located to the west (Kailua side) of the Inoa'ole Street intersection. These improvements are expected to improve the LOS at Inoa'ole Street from "F" to "C."

Potential Impacts and Mitigation Measures

Because two-way traffic flow will be maintained during the construction period, there will be no significant adverse impact on the existing roadway system. Traffic will be disrupted for short periods of time when travel lanes are realigned to accommodate the phased demolition and construction process, and for movement of construction equipment and materials. The speed limit at the project site will remain at 25 miles per hour during the phased demolition and construction process.

Measures that will be implemented to minimize construction-related traffic impacts:

- To minimize traffic impacts during construction, construction will not take place during peak traffic times, to the extent possible.
- The contractor will be required to make provisions for emergency access and will be required to provide full access during non-working hours. Emergency services, including police, fire, and ambulance services, will be notified prior to implementation of any required detours or street closures.
- It may be necessary for the contractor to use the public right-of-way and/or adjacent property for parking and temporary storage of vehicles and construction materials/equipment.
- The contractor will be required to mitigate vehicular and pedestrian traffic problems and hazards through the use of appropriate traffic control and safety devices. Barriers, cones, signage, lighting, and other devices to promote safe passage of vehicles and pedestrians through the construction zone must conform to Part 6 (Temporary Traffic Control) of the FHWA Manual on Uniform Traffic Control Devices.
- Area residents and businesses will be kept informed of the project prior to and during construction work. Information will be published in the major daily newspapers with a schedule of major construction work, road closures, detours, and suggested alternate routes. Electronic roadside signs will also be used to warn motorists of current and upcoming work.
- Special-duty police officers and/or contractor personnel will be stationed to facilitate vehicular and pedestrian movement and to minimize hazards.
- Temporary fencing or other appropriate barriers, as necessary, to deter the public from unauthorized entry into restricted or hazardous construction zones during working and non-working hours.

4.6.2 Bicycle and Pedestrian Facilities

Currently, the existing bridge has 8-feet wide paved shoulders on both sides of the roadway which are also used as sidewalks. However, on the approaches to the bridge, there is a 3-foot wide asphalt concrete sidewalk on the *mauka* side of the highway only (see photo below). The narrow sidewalk does not meet the requirements of the Americans with Disabilities Act (ADA), but this deficiency will be addressed by the separate Highway Improvements project. In the vicinity of Inoa'ole Stream Bridge, the elementary and intermediate school, library, and residential subdivision (Hale Aupuni) are located on the *mauka* side of the highway. There is no sidewalk on the *makai* side of the highway.

Sidewalk on *mauka* side of Kalaniana'ole Highway

Potential Impacts and Mitigation Measures

Pedestrians and bicyclists may be temporarily inconvenienced during construction; however, the phasing plan will enable pedestrian and bicyclists to use the bridge. Safe walkways around construction areas will be designated for pedestrians.

In the long term, the replacement bridge will provide 12-foot wide, paved shoulders, including 5-foot wide, accessible sidewalks that comply with ADA requirements. The proposed bridge structure will provide a more defined pedestrian and bicycle crossing over the bridge. The bridge will also have guardrails that meet the height requirement for bicycle safety.

4.6.3 Bus Transit

Three bus lines provide service to Waimānalo and pass through the project area: Routes 57, 77, and 89.

	Service on Kalaniana'ole Hwy at Nalu St. in Waimānalo (2 miles south of Inoa'ole Stream Bridge)		
Route	**Weekdays**	**Saturday**	**Sunday**
57/57A: Ala Moana through downtown and via Pali Hwy to Kailua, Waimānalo, Sea Life Park Westbound: to Kailua, Waimānalo Eastbound: to Ala Moana Ctr	Westbound 42 trips First trip: 5:10 am Last trip: 11:27 pm Eastbound 35 trips First trip: 5:10 am Last trip: 9:30 pm	Westbound 20 trips First trip: 5:39 am Last trip: 11:27 pm Eastbound 16 trips First trip: 6:27 am Last trip: 9:30 pm	Westbound 17 trips First trip: 6:20 am Last trip: 9:34 pm Eastbound 16 trips First trip: 6:25 am Last trip: 9:40 pm
77: Waimānalo-Kāne'ohe Westbound: to Waimānalo Eastbound: to Kāne'ohe	Westbound 9 trips First trip: 6:03 am Last trip: 6:16 pm Eastbound 8 trips First trip: 6:05 am Last trip: 4:50 pm	None None	None None
89: Waimānalo Express—Waimānalo to Downtown (Alapa'i) via Pali Hwy AM: to Downtown only PM: to Waimānalo only	To Downtown 2 trips First trip: 5:42 am Last trip: 6:20 am To Waimānalo 2 trips First trip: 4:55 pm Last trip: 5:35 pm	None None	None None

Route 57/57A runs between Ala Moana Center through downtown and via Pali Highway to Kailua, Waimānalo, and Sea Life Park. Bus service on the 57/57A route is relatively frequent with as many as 42 trips westbound and 35 trips eastbound. According to the published bus schedule, westbbound bus service at the Nalu/Kal Hwy stop in Waimānalo is between 5:00 a.m. and 11:30 p.m. on weekdays, and eastbound between 5:00 and 9:30 p.m. on weekdays. Bus service is also provided on Saturdays and Sundays, although less frequently and more limited hours.

Route 77 travels between Waimānalo and Kāne'ohe, passing Castle Memorial Hospital, Hawai'i Pacific University, Windward Community College, and Windward Mall.

There are 9 trips to Waimānalo and 8 trips to Kāne'ohe each weekday. Service in Waimānalo begins at about 6:00 am and ends in the evening. No service is provided on this route on the weekends.

Route 89, the Waimānalo Express, runs on weekdays only. Two trips are made from Waimānalo to Downtown Honolulu in the morning, and two trips are made from Downtown to Waimānalo in the late afternoon. No weekend service is provided on the express route.

Potential Impacts and Mitigation Measures

The proposed project is not expected to have adverse impacts on bus service. Existing bus routes will be unaffected since there are no detours. There are no bus stops in the anticipated construction zone. There is a potential for the bus stops serving the Hale Aupuni subdivision to be relocated temporarily, depending on traffic congestion and temporary roadway alignments to accommodate bridge phasing. Any relocation would be coordinated with the bus transit operator. O'ahu Transit Service will be contacted at least two weeks prior to the start of any construction affecting bus stops and/or bus routes.

4.7 PARKS AND RECREATIONAL FACILITIES

Existing Conditions

Several recreational facilities are located near the project area, including beach parks on Waimānalo Bay and the Waimānalo Polo Field.

Waimānalo Bay is a wide crescent-shaped bay with a sandy beach that stretches for almost 5.5 miles. Bellows AFS occupies the northern portion of the bay. The Bellows AFS Recreation Center includes one- and two-bedroom cabins, campsites, and pavilions. Use of these facilities is restricted to uniformed services personnel and their families and other authorized users. Access is via Tinker Road, which is located approximately 0.25 mile from Inoa'ole Stream Bridge. The beach area is closed to the public Monday through Friday, but is open to the public on weekends and many holidays.

Waimānalo Bay State Recreation Area, also known as Sherwood Forest, occupies the central portion of the bay. Distinctive features include the rolling parkland with a heavily wooded ironwood forest. The recreation area is bordered by Puha Stream and Bellows Air Force Base on the north and 'Ālo'ilo'i Street to the south. The entrance road is located at milepost 4.34, about 0.4 mile from Inoa'ole Stream Bridge.

Waimānalo Polo Field is located on land leased from the State Department of Land and Natural Resources and Department of Hawaiian Home Lands. The boundary of the leased acreage lies adjacent to Inoa'ole Stream (on the *mauka*- Makapu'u side). The polo field is a private facility operated by the Honolulu Polo Club.

Section 4(f), USDOT Act

Section 4(f) is not triggered because there is no taking of publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites.

Potential Impacts and Mitigation Measures

The construction zone will not affect access to Waimānalo beaches or the polo field. Bridge construction may have short-term impacts on traffic flow in the project vicinity. The posted speed limit crossing Inoa'ole Stream is currently 25 mph. Travel speeds may decrease because of lane constrictions; however, the phasing plan calls for one travel lane to be open in each direction while the new bridge is being constructed. On occasion, traffic barriers will need to be relocated. At such times, more restrictive traffic controls may be deployed for the safety of construction workers and highway users. Because use of recreational areas is heavier on the weekends, construction work during normal weekday hours is less likely to impede traffic to nearby beaches or the polo field.

In the long-term the bridge improvements may require drainage easements, utility easements, and/or grading easements. Temporary construction parcels will be needed in the short-term to store and stage equipment and materials in a safe, efficient manner. The easements may affect land being leased by the private polo club. Any land requirement would be on the outer perimeter of the leased property, adjacent to the stream, and would not affect any active recreational area.

4.8 SCHOOLS

Existing Conditions

Waimānalo Elementary and Intermediate School and Waimānalo Public Library share a common campus that is located on the *mauka* side of Kalaniana'ole Highway. The school services students from PrePlus (4 years old) through Grade 8, and has an enrollment of approximately 530 students. The public library, co-located with the school, operates six days a week from Monday through Saturday. The school and library complex is located approximately 800 feet northwest of Inoa'ole Stream Bridge. There is one-way vehicular flow through the parking area. The entrance is on the Kailua side at approximately milepost 3.70 and the exit is on the Makapu'u side at milepost 3.77.

Potential Impacts and Mitigation Measures

The proposed project is not expected to adversely impact the operations of the education and library facilities. However, because of proximity between the construction site and the school driveway, conditions will be monitored to determine what traffic control measures may be necessary, particularly during the morning drop-off period and afternoon pick-up period. For students who walk or bicycle to school, the construction phasing plan has been

designed to allow continuous use of Inoa'ole Bridge. When the walkway and bikeway shift to the *makai* side of the highway, signs will be posted to demarcate safe passage through the construction area. Crossing assistance will be provided as necessary.

4.9 PUBLIC HEALTH AND SAFETY

4.9.1 Police Protection Services

Waimānalo falls under the jurisdiction of the Honolulu Police Department's District 4 command which covers the entire Windward side of the island. Police officers serving the area operate out of the Kailua Substation located at 56-470 Ku'ulei Road.

4.9.2 Fire Protection Services

The Windward Coast of O'ahu is under the jurisdiction of Battalion 3 of the Honolulu Fire Department. The Waimānalo Fire Station is located on Kalaniana'ole Highway, approximately 1,200 feet northwest of the project site. An Emergency Medical Services (EMS) ambulance unit is based at the Waimanalo Fire Station.

4.9.3 Health Care Services

Castle Medical Center is the regional major hospital facility, located in Kailua, and provides medical services which include 24-hour emergency, critical care, surgical, outpatient and other health improvement and wellness services.

The Waimānalo Health Center and Clinic is located on Kalaniana'ole Highway, approximately 1,500 feet northwest of the project site. The center provides pediatric, women and adult clinic services, and cultural wellness programs.

Potential Impacts and Mitigation Measures

Necessary measures to assure public health and safety will be provided throughout all phases of construction. The contractor will maintain access by emergency vehicles through the construction site for the duration of the project. The contractor will provide, install, and maintain all necessary signs, lights, flares, barricades, markers, cones, and other safety facilities. These safety precautions will conform with the "Rules and Regulations Governing the Use of Traffic Control Devices at Work Sites on or Adjacent to Public Streets and Highways," as adopted by the Highway Safety Coordinator and the U.S. Federal Highway Administration. The contractor will also contact District 4 police personnel to coordinate adequate police coverage and response.

During construction, the Contractor will maintain fire apparatus access throughout the construction site and notify the Fire Communication Center of any interruption in the existing fire hydrant system.

4.10 PUBLIC INFRASTRUCTURE AND FACILITIES

4.10.1 Water System

Potable water in Waimānalo is provided by the City and County of Honolulu Board of Water Supply.

Potential Impacts and Mitigation Measures

There are no potable water lines in the project area and, consequently, no project impacts.

4.10.2 Wastewater System

Approximately 65 percent of Waimānalo's households are serviced by the Waimānalo wastewater collection and treatment system. The remaining households are serviced by individual wastewater systems, such as cesspools and septic tanks. The wastewater collection and treatment system is comprised of over 50,000 feet of gravity sewers, the Kahawai Stream Wastewater Pump Station and force main, and the Waimānalo Wastewater Treatment Plant. An existing 18-inch concrete encased gravity sewer line is located on the *mauka* side of the existing bridge.

Potential Impacts and Mitigation Measures

Prior to the phased demolition of the existing culvert and construction of the new culvert, a temporary sewer line will be installed to maintain continuous sewer operations.

All bridge improvements will be coordinated with the City and County of Honolulu, Department of Environmental Services and Department of Design and Construction. The contractor will be responsible for maintaining the temporary sewer line during construction. After the completion of the new bridge and sewer line, the contractor will be responsible for removing the temporary sewer line.

4.10.3 Solid Waste Management

Single-family solid waste collection service is provided by the City and County of Honolulu on a twice weekly basis.

Potential Impacts and Mitigation Measures

Waste and debris material will be generated by the project during the demolition and new construction work.

Prior to construction, an acceptable solid waste management plan will be prepared for the disposal of waste from the demolition work and debris during the new construction work. The contractor will remove and dispose of all waste and debris off-site, at a State-licensed landfill operation or licensed waste disposal facility.

4.10.4 Electrical and Telecommunications Systems

Electric and telephone services are provided to the area via overhead utility lines. Services are provided by Hawaiian Electric Company, Hawaiian Telcom, and the United States Army Signal Corp.

Potential Impacts and Mitigation Measures

All existing utilities in the project area will need to be protected from damage during construction and to remain functional through the construction period. Overhead and underground utility lines may need to be temporarily relocated during construction. To mitigate the potential for adverse impacts, project engineers will coordinate with affected utility companies at the design and engineering stage. Utility agreements will be obtained as necessary.

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5 LAND USE PLANS, POLICIES, AND CONTROLS

5.1 HAWAI'I STATE PLAN AND FUNCTIONAL PLANS

The Hawai'i State Plan, Chapter 226, HRS, is the umbrella document in the statewide planning system. It serves as a written guide for the 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.

The State functional plans provide more detail to the State Plan. They guide State and County actions in specific areas of governance. The following from the Transportation Plan are relevant to this project:

Transportation Functional Plan

Objective I.A: Expansion of the transportation system.
Policy I.A.1: Increase transportation capacity and modernize transportation infrastructure in accordance with existing master plans.

Discussion: Bridge replacement is proposed to upgrade the transportation infrastructure on Kalaniana'ole Highway and to improve roadway safety. The project is consistent with existing State and County master plans and land use ordinances.

5.2 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. The project site and surrounding properties are located within the Urban District. No change in State land use classification is required for this project.

5.3 O'AHU REGIONAL TRANSPORTATION PLAN (ORTP) 2030

The O'ahu Regional Transportation Plan (ORTP) is a guide for the development of major surface transportation facilities and programs on O'ahu. It is based on projected transportation needs, financial resources, and community inputs. The plan identifies short- and long-range strategies and actions to promote the development of an integrated intermodal surface transportation system that facilitates the safe, efficient, and economic movement of people and goods.

Discussion: Kalaniana'ole Highway is designated by the FHWA as part of the National Highway System (NHS), which has been called the centerpiece of America's effort to provide a safe, modern, and efficient transportation system. The highway, with connection to Bellows Air Force Station, is further classified as a constituent of the Strategic Highway Network, providing defense access, continuity and emergency capabilities for defense purposes. Upgrading the bridge will better enable Kalaniana'ole Highway to function as part of a major transportation network, particularly under inclement weather conditions. Because of its NHS status, Kalaniana'ole Highway is also important to state and regional transportation planning.

5.4 CITY AND COUNTY OF HONOLULU LAND USE REGULATIONS

5.4.1 O'ahu General Plan

The O'ahu General Plan establishes the City and County of Honolulu's long range objectives and represents its commitment to a desirable and attainable future of the Island of O'ahu. The General Plan establishes, among other objectives, long-term goals for population allocation among the various areas of O'ahu. The General Plan identifies the Primary Urban Center (Honolulu) as the major center for growth for O'ahu, and 'Ewa as a Secondary Urban Center. The implication is that windward O'ahu is not intended for significant further urbanization. This project does not increase roadway capacity and is not intended to promote urban development in Waimānalo or the broader Ko'olaupoko district.

5.4.2 Ko'olaupoko Sustainable Communities Plan

Pursuant to Chapter 226, HRS, each County is required to implement the Hawai'i State Plan through the adoption and implementation of a County General Plan. In the case of the City and County of Honolulu, regional plans (either Development Plans or Sustainable Communities Plans) have been established as a policy "bridge" between the City's General Plan and its zoning powers. The City and County is divided into eight regions. The project area is located in the Ko'olaupoko region, which spans the area from Ka'ō'io Point at the northern end of Kāne'ohe Bay to Makapu'u Point, and extends inland to the Ko'olau Mountains.

The existing Ko'olaupoko Sustainable Communities Plan (SCP), adopted August 2000, reflects the region's intent to maintain the largely rural character of Waimānalo. Under the current SCP, the existing low-density, residential community will continue to be surrounded by diversified agriculture activities.

Consistent themes of the SCP are to focus on maintaining and improving the existing road infrastructure, minimizing increases in roadway capacity, and enhancing facilities for pedestrians, bicycles, and public transit.

> Avoid street or right-of-way widening, except where necessary to improve pedestrian and bicycle safety or provide bus shelters and more efficient bus loading (p. 4-7)

Discussion: The proposed action is consistent with the SCP policies regarding the roadway network by improving the safety and reliability of the existing transportation infrastructure without increasing capacity.

Figure 20 shows a portion of the SCP land use plan in the project vicinity.

The Ko'olaupoko SCP is undergoing a periodic updating process known as the five-year review. The proposed action will not require any change to the Ko'olaupoko Sustainable Communities Plan.

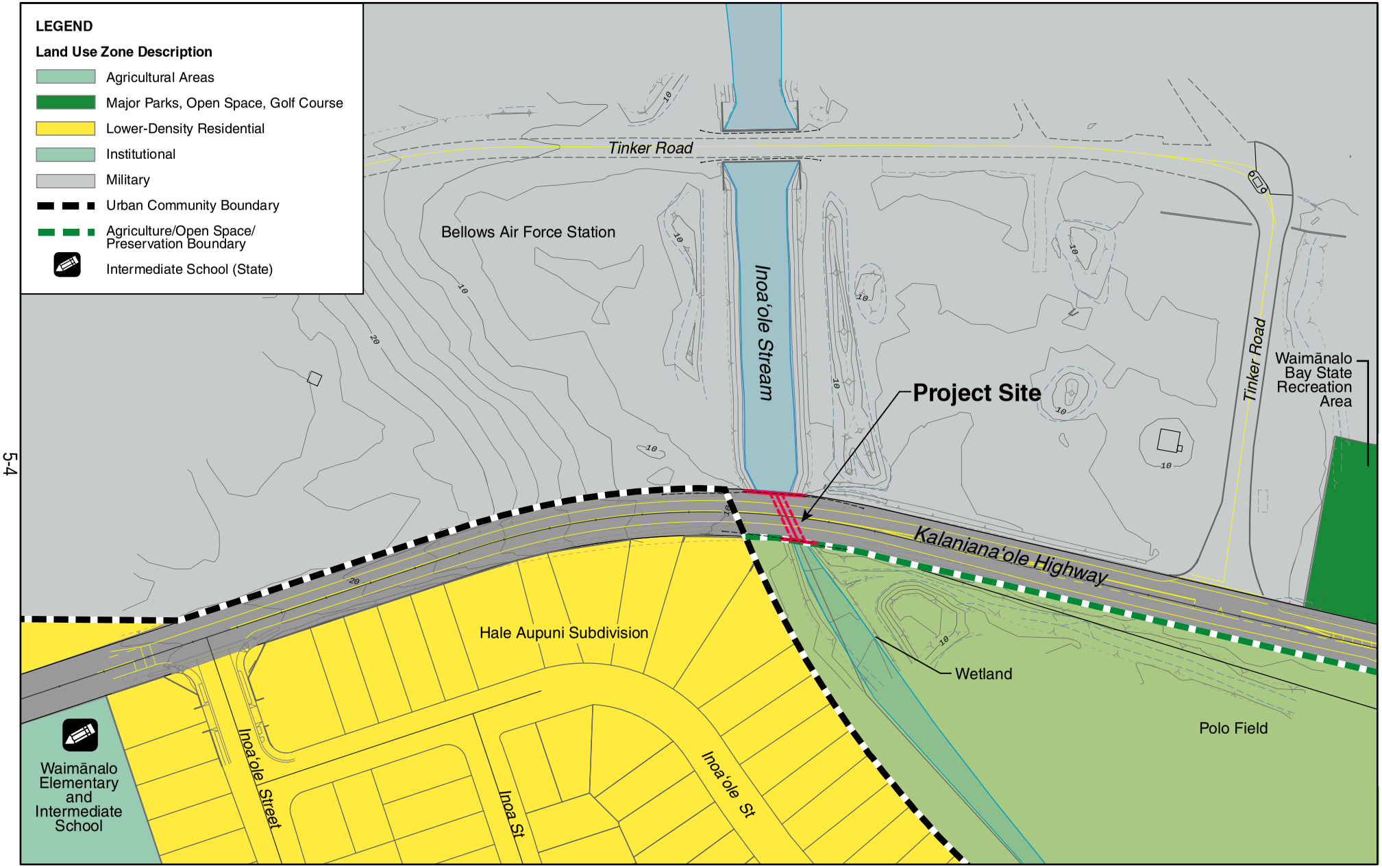
5.4.3 Zoning

County zoning provides the most detailed set of regulations affecting land development, prior to actual construction. Zoning is typically limited to lands classified in the Urban District under the State land use system. As shown in Figure 21, the project site is located in zoning districts F-1 Military, R-5 Residential, and AG-1 Agriculture. The proposed action will not require any zoning change.

5.4.4 Special Management Area (SMA)

Coastal Zone Management objectives and policies (Section 205A-2, HRS) were developed to preserve, protect, and, where possible, restore the natural resources of the coastal zone of Hawai'i. The permitting process provides a heightened level of government and public scrutiny to ensure consistency with SMA objectives.

During a consultation meeting with the Department of Planning and Permitting in September 2002, it was determined that the SMA boundary runs through the center line of Kalaniana'ole Highway and that a SMA permit is required. Because this project has a development cost exceeding $125,000, it will require a Special Management Area Permit-Major.



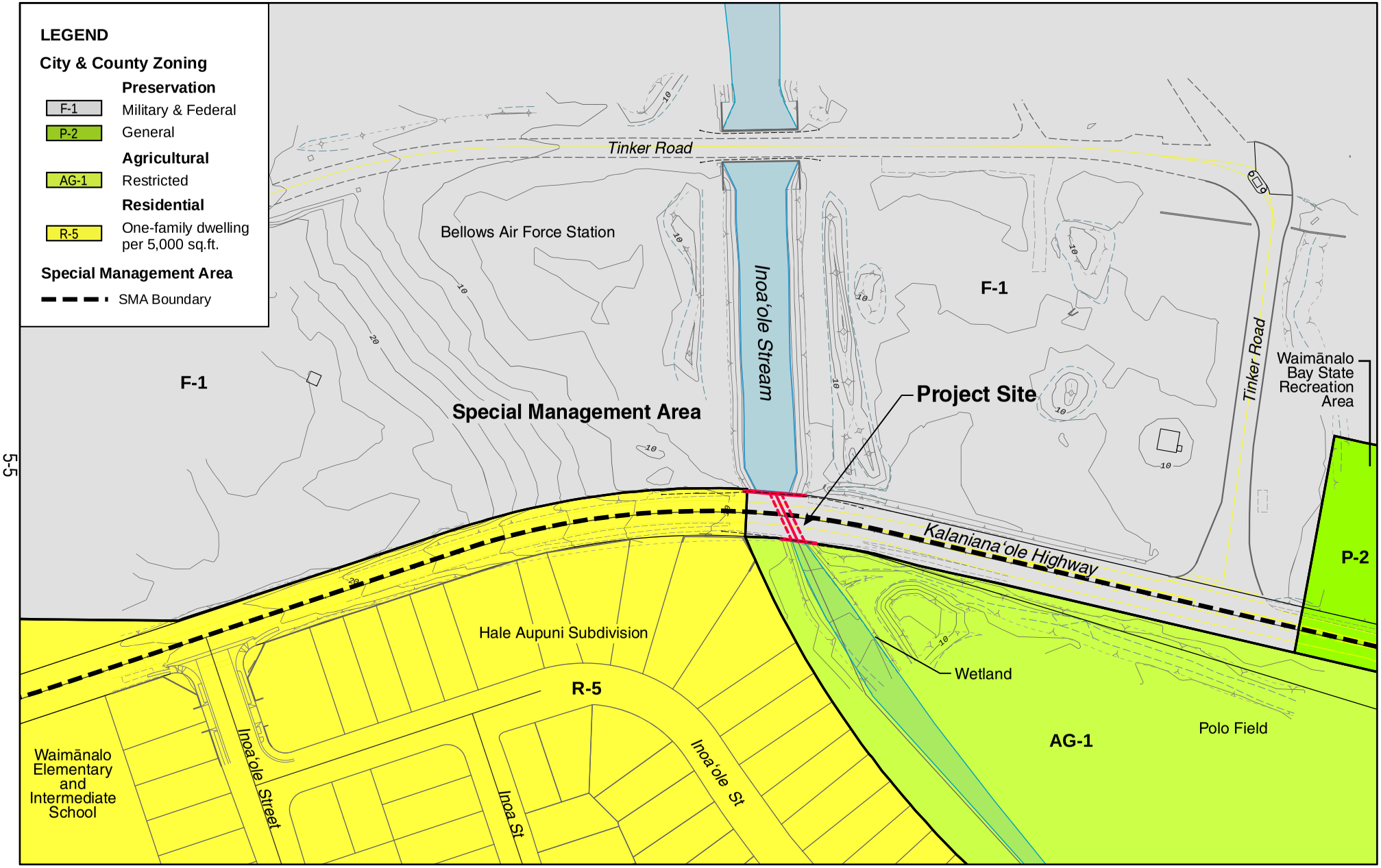
Source: Ko'olaupoko Sustainable Communities Plan, August 2000

0 35 70 140 Feet

Figure 20
Ko'olaupoko Sustainable Communities Plan, Land Use Map
February 2009

Inoa‘ole Bridge Replacementzzz
Kalaniana‘ole Highway, Waimānalo

f20 zone sma/012209 r2



5-5

Figure 21
Zoning and Special Management Area (SMA)
February 2009

5.4.5 Consistency with the Coastal Zone Management Program

The Hawai'i Coastal Zone Management (CZM) program is intended to manage, protect, and where possible, restore the state's coastal areas and resources. Coastal resources are defined as beaches, fishponds, scenic areas, marinas, wetlands, recreational areas, anchialine ponds, fish, open spaces, whales, sea turtles, harbors, historic sites, and ecosystems. County governments play a crucial role in implementing the Hawai'i CZM program by regulating development in geographically designated Special Management Areas (SMAs). Through the County's SMA permit system, development proposals within the SMA are evaluated for compliance with the CZM objectives and policies and SMA guidelines. These are set forth in Chapter 205A, HRS, and the Special Management Area (SMA) guidelines in Section 25-3.2, Revised Ordinances of Honolulu (ROH). No development can occur in the SMA unless the appropriate agency first issues an approval.

5.4.5.1 Consistency with SMA Objectives

The following objectives from Section 205A-2, HRS, are used by the City and County of Honolulu to review proposed developments within the SMA.

Recreational Resources

CZM Objective: Provide coastal recreational opportunities accessible to the public

Discussion: The project area is adjacent to the privately owned Waimānalo Polo Field, and in close proximity to popular beaches at Bellows Field, Waimānalo State Recreation Area, and Waimānalo Beach Park. One of the primary functions of Kalaniana'ole Highway is to provide access to the region's recreational resources and this function will be improved by replacing the existing bridge.

Historic Resources

CZM Objective: Protect, preserve, and where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

Discussion: The State Historic Preservation Division reviewed the project and determined that it would have "no effect" on significant historic sites (LOG NO: 1740; DOC NO: 0302EJ26 dated February 25, 2003).

Scenic and Open Space Resources

CZM Objective: Protect, preserve, and where desirable, restore and improve the quality of coastal scenic and open space resources.

Discussion: The proposed improvements are located on Kalaniana'ole Highway, which passes through the scenic countryside with towering cliffs as a backdrop. There are no ocean vistas in the project area. The project will not affect view planes or open space resources since there will be no change in highway alignment or viewing perspectives.

Coastal Ecosystems

CZM Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.

Discussion: This project sill not adversely impact coastal ecosystems or water quality. There will be no work within the shoreline setback area and no increased drainage runoff from the site as a result of the improvements.

Economic Uses

CZM Objective: Provide public or public facilities and improvements important to the State's economy in suitable locations.

Discussion: This project will improve an existing public highway. Officially designated as part of the National Highway System, Kalaniana'ole Highway provides an important transportation facility between Windward O'ahu and Honolulu for both people and goods.

Coastal Hazards

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

Discussion: A primary objective of this project is to reduce disruptions to highway service from overtopping storm water. Stream flow capacity will increase six-fold, from 470 cfs to 2,840 cfs. Stream flow capacity of the new 6-cell culvert bridge on Kalaniana'ole Highway will exceed the 2,510-cfs capacity of the existing 8-cell on Tinker Road. Drainage improvements ancillary to the new bridge, including wingwalls, streambank stabilization, and riprap in the stream channel, will also improve flood control.

Managing Development

CZM Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

Discussion: This project has no impact on the CZM objective for managing development.

Public Participation

CZM Objective: Stimulate public awareness, education, and participation in coastal management.

Discussion: This project has no impact on the CZM objective for public participation.

Beach Protection

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

Discussion: The project site is not located directly on the ocean, and will not affect the beach or public access to the shoreline.

Marine Resources

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

Discussion: The proposed improvements will not affect the sustainability of marine or coastal resources.

5.4.5.2 SMA Significance Criteria

In reviewing and assessing the significance of a development in relation to the Special Management Area, the Department of Planning and Permitting will consider the following guidelines from Section 25-3.2, ROH, Special Management Area Review Guidelines.

(a) All development in the special management area shall be subject to reasonable terms and conditions set by the (City) council to ensure

- Adequate access to publicly owned or used beaches and recreation areas
- Adequate and properly located public recreation areas
- Appropriate solid and liquid waste treatment, disposition and management
- Alterations to existing land forms and vegetation cause minimum adverse effect to water resources and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation or failure in the event of earthquake.

Discussion: The proposed improvements will take place within the existing highway right-of-way and the Inoa'ole Stream channel adjacent to the bridge crossing. The project is being phased to provide one lane of travel in either direction throughout the construction period. This level of access will also serve motorists going to nearby recreational areas,

including Waimānalo State Recreation Area, the Waimānalo Polo Field, and Waimānalo Beach Park.

The project itself will not generate wastewater, but reconstruction of the bridge will require relocation of the existing 18-inch wastewater pipeline. This element of the project is being designed to avoid disruptions in sewage service and will be fully coordinated with the City and County Department of Environmental Services.

Dismantling the existing bridge will generate solid waste. A solid waste management plan will be implemented as part of the construction contract. Solid waste disposal will comply with all applicable State and City regulations.

There will be no alteration to the surface land form; i.e., the highway alignment will be unchanged either horizontally or vertically. The stream channel on the *mauka* side of the bridge is proposed for widening in order to facilitate stream flow through the culvert. The stream bottom will be modified to prevent undermining of the bridge structure and to make it level with the bottom of the box culvert to improve stream flow during drier periods.

The proposed alterations will not affect water resources and scenic and recreational amenities.

(b) No development shall be approved unless the (City) council has first found that:

- The development will not have any substantial, adverse environmental or ecological effect unless minimized to the extent practicable…
- The development is consistent with the objectives and policies set forth in Section 25-3.1 and area guidelines contained in HRS Section 205A-26;
- The development is consistent with the county general plan, development plans and zoning.

Discussion: The proposed improvements ill not have any significant adverse environmental effect that cannot be mitigated. A number of archaeological studies have been conducted in the area, and areas known or likely to contain archaeological artifacts have been identified in nearby areas. However, the project covers a limited area and is confined primarily to the previously disturbed highway right-of-way. Jaucus soils that have a potential to contain human remains or cultural artifacts lie 200 feet *makai* of the highway, within Bellows Air Force Station and Waimānalo State Recreation Area. If inadvertent finds are made, all work will stop and the contractor will follow protocols for immediately contacting the State Historic Preservation Division, in accordance with Chapter 6E, HRS.

The project is consistent with the County general plan, Ko'olaupoko Sustainable Communities Plan (2000), and zoning.

(c) The council shall seek to minimize:

- Any development which would reduce the size of any beach or other area usable for public recreation;
- Any development which would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the special management area and the mean high tide line where there is no beach;
- Any development which would substantially interfere with or detract from the line of sight toward the sea from the state highway nearest the coast; and
- Any development which would adversely affect water quality, existing areas of open water free from visible structures, existing and potential fisheries and fishing grounds, wildlife habitats, or potential or existing agricultural uses of land.

Discussion: The project will not reduce the size of any beach or public recreation area or restrict public access. No changes will be made to coastal view planes. There will be no adverse effect on water quality, fishing grounds, or wildlife habitat.

6 FINDINGS AND REASONS SUPPORTING THE ANTICIPATED DETERMINATION

This Environmental Assessment, prepared in accordance with Chapter 343, HRS, as amended, has found that potential impacts associated with the proposed action will not be significant. Environmental impacts will be temporary and are not expected to adversely impact the long-term environmental quality of the area.

The potential short-term, long-term, and cumulative effects of the proposed project were evaluated based on the significance criteria in Section 11-200-12 (Hawai'i Administrative Rules, revised in 1996). The following summarizes the potential effects of the action.

SIGNIFICANCE CRITERIA

1. Irrevocable commitment to loss or destruction of natural or cultural resources.

The proposed project will not adversely impact natural or cultural resources. There will be no destruction or loss of threatened or endangered plant or animal species. The existing bridge, constructed in 1983, is not an historic structure. The replacement bridge will be located within the existing highway right-of-way and adjoining areas; therefore, construction work is not expected to disturb possible archaeological subsurface deposits on the *makai* side of the bridge. However, should any archaeological resources be encountered during construction, all work in the immediate vicinity will cease and the State Historic Preservation Division shall be contacted immediately in compliance with Chapter 6E, HRS.

2. Curtailment of the range of beneficial uses of the environment.

The project area serves both transportation and drainage functions. These functions will be improved by the replacement bridge without significantly curtailing or altering other beneficial uses of the environment.

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 action complies with State and County environmental policies, plans, and guidelines. In particular, the project is consistent with the policies in Chapter 344, HRS, related to improving the transportation infrastructure in a manner consistent with the local lifestyle and environment.

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

The proposed action is intended to meet level of service and safety standards for a major arterial that is used by area residents, businesses, and visitors. This project will positively affect the welfare of the region by minimizing storm water overtopping of Kalaniana'ole Highway at the project site.

5. Substantially affects public health.

Public health—as mediated by water quality, air quality, and noise levels—will be minimally affected or unaffected by the construction and operation of the replacement bridge. The project contractor will be required to follow appropriate Best Management Practices to mitigate short-term, construction impacts.

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

The proposed action, in and of itself, is not expected to generate population growth in the Ko'olaupoko District or the Waimānalo area. As a replacement bridge, the project will accommodate current and planned future levels of vehicular and pedestrian traffic.

7. Involves substantial degradation of environmental quality.

The assessment of air and water quality, noise levels, and traffic impacts has determined that the replacement bridge will not substantially degrade environmental quality. Appropriate mitigation measures will be employed during construction to reduce potential adverse impacts.

8. Is individually limited but cumulatively has considerable effect on the environment, or involves a commitment for large actions.

The proposed replacement project is part of HDOT's overall commitment to maintain safe and efficient transportation facilities, but does not involve a commitment for larger actions. HDOT has a separate project to improve a section of Kalaniana'ole Highway that encompasses the Inoa'ole Stream Bridge site. Although every effort is being made to coordinate the two projects, they are independent from a programmatic stand point since there are two different funding sources at the federal level.

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

The proposed replacement bridge is not expected to have a significant adverse effect on rare, threatened or endangered species, or their habitat. The project area, including the stream bed and adjacent banks, are currently overgrown with introduced grass species. Given the scale and location of the bridge reconstruction, no habitats or natural environments are anticipated to be adversely affected by the proposed project.

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

Short-term impacts on air quality and noise levels are unavoidable during the construction period. Appropriate mitigation measures will be implemented to minimize construction-related impacts. Because the proposed action will not increase capacity or change the alignment or speed limit, significant worsening of air quality, water quality, and ambient noise levels is not expected.

11. Affect 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, freshwater, or coastal waters.

The proposed bridge is located in a flood plain and has been designed with special consideration for anticipated flood conditions. Additionally, conditions attached to the following permits will minimize the potential for adverse impacts.

- Department of the Army (DA) Corps of Engineers (COE) Nationwide permit
- Department of Health (DOH) Water Quality Certification (WQC) 401 Permit
- Office of State Planning (OSP) Coastal Zone Management (CZM) Certification
- Department of Land and Natural Resources (DLNR) Stream Channel Alternation Permit (SCAP)

12. Substantially affects scenic vistas and view planes identified in county or state plans or studies.

At present the State does not have an official scenic highways or byways program; however, the Koʻolaupoko SCP notes that Kalanianaʻole Highway serves as a scenic route for travel between Kailua/ Waimānalo and Honolulu (p. 4-1). The proposed project is not anticipated to adversely impact scenic vistas or view planes in the project corridor. Ocean views are obscured by dense vegetation within BAFS and mountain views are partially obscured by dense vegetation and homes within the Hale Aupuni Subdivision. The new bridge will be slightly different in appearance from the existing bridge. The most prominent change will the supporting structure,

which is seen from the banks upstream or downstream and will be most noticeable from the bridge on Tinker Road (within Bellows which crosses Inoa'ole Stream at a point further *makai*.

13. Requires substantial energy consumption.

Fuel will be consumed by construction vehicles and equipment, but this use is not expected to be extraordinary. In the long-term, the project is not anticipated to create additional demands for energy consumption.

CONCLUSION

In accordance with the provisions set forth in Chapter 343, HRS, and the significance criteria in Section 11-200-12 of Title 11, Chapter 200, Hawai'i Administrative Rules, this assessment has determined that the project will not have significant adverse impacts to water quality, air quality, noise levels, social welfare, archaeological sites, or wildlife habitat. Anticipated impacts are temporary and related to construction activities. These impacts have been mitigated through bridge planning and design, and will be further mitigated by implementing best management practices (BMPs) during construction. Because the assessment has determined that the project will not adversely impact environmental quality in the project area and vicinity, the State of Hawai'i, Department of Transportation anticipates filing a Finding of No Significant Impact (FONSI) with the State Office of Environmental Quality Control.

7 ANTICIPATED DETERMINATION

Based on the information presented and examined in this document, the proposed project is not expected to result in significant social, economic, cultural, or environmental impacts. Consequently, a finding of no significant impact is anticipated, pursuant to the provisions of Subchapter 6 of Chapter 200, Title 11, Hawai'i Administrative Rules of the Department of Health.

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8 BIBLIOGRAPHY

Adams, D.L. Associates, Ltd. April 2004. *Environmental Nosie Assessment Report, Kalanianiole [sic] Highway Improvements, Kalanianiole [sic] Highway, Waimanalo, Oahu, Hawaii*.

AECOS, Inc. September 2000. *Aquatic Resources Survey for Kalanianaole Highway Bridge Improvements at Inoaole Stream in Waimanalo, Oahu.*

American Association of State Highway and Transportation Officials. 1999. *Guide for the Development of Bicycle Facilities.*

Belt Collins Hawaii. 1995. *Final Environmental Impact Statement, Land Use Development Plan, Bellows Air Force Station.*

Char & Associates, Inc. September 2000. *Inoaole Stream Bridge Replacement Wetland Survey.*

Cultural Surveys Hawaii (Auli'i Mitchell and Hallett H. Hammatt). June 2005. *Cultural Impact Assessment for the Kalanianaole Improvement Project, Waimanalo Ahupua'a, Ko'olaupoko District, Island of O'ahu.*

Hawaii Army National Guard, Facilities Management Office. November 1998. Draft Environmental Assessment - Establishment of the Regional Training Institute Complex, Hawaii Army National Guard, 298th Regiment, Bellows Air Force Station, Waimanalo, Oahu, Hawaii.

Hawaii, Department of Business, Economic Development and Tourism. 2002. *State of Hawai'i Data Book*, online edition. http://www2.hawaii.gov/DBEDT/index.cfm?section=READ_Databook445

Hawaii, Department of Health, Environmental Planning Office. December 2002. *Final 2002 List of Impaired Waters in Hawai'i Prepared under Clean Water Act, Section 303(d).*

Hawaii, Department of Health, Environmental Planning Office and U.S. Environmental Protection Agency. August 2001. *Waimanalo Stream TMDL Implementation Plan.*

Hawaii, Department of Health, Environmental Planning Office. March 2001. *Maximum Daily Loads Estimated for Waimanalo Stream, Island of Oahu, Hawaii.*

Hawaii, Department of Land and Natural Resources, Commission on Water Resource Management and the U.S. National Park Service. December 1990. *Hawaii Stream Assessment.*

Hawaii, Department of Land and Natural Resources, Division of Water and Land Development. 1976. *Flood Management Plans and Preliminary Engineering Studies for the Waimanalo Flood Control Project, Oahu, Hawaii*. Prepared by Fukunaga and Associates.

Hawaii, Department of Transportation. January 1996. *Hydrologic and Hydraulic Report for Inoaole Stream.*

Hawaii, Department of Transportation and Federal Highway Administration. March 2007. *Final Enviornmental Assessment/Finding of No Significant Impact, Kalanianaole Highway Improvements, Olomana Golf Course to Waimanalo Beach Park.*

Hawaii Pacific Engineers, Inc. July 1998. *Draft Supplemental Environmental Impact Statement, Waimanalo Wastewater Facilities Plan, Koolaupoko, Oahu, Hawaii.*

Honolulu, Department of Planning and Permitting. August 2000. *Ko'olaupoko Sustainable Communities Plan.*

Juvik, Sonia P. 1998. *Atlas of Hawaii, 3rd Ed.* Honolulu, HI: University of Hawaii Press.

McGuire, Kaohulani and Hallett H. Hammatt. 2000. *Archaeological Monitoring Report for the Installation of Light Poles for a Ballfield at Waimanalo Beach Park, Waimanalo, Koolaupoko District, Island of Oahu (TMK: 4-1-003-016).*

Ohashi, Tim J. February 2004. *Wildlife Survey, Kalanianaole Highway Widening, Olomana Golf Course to Waimanalo Beach Park, Waimanalo, Oahu, Hawaii.*

Perzinski, David, John Winieski, and Hallatt H. Hammatt. 2001. *An Archaeological Monitoring Report for Waimanalo, Sandwich Isles Communication Project, Waimanalo, Koolaupoko District, Oahu, Hawaii (TMK: 4-1-19, 20, 21).*

Traffic Management Consultant. October 2003. *Final Traffic Engineering Report for the Proposed Kalanianaole Highway Improvements, Flamingo Road to Aloiloi Street.*

Tuggle, H. David. December 1995. "Archeological Research of Areas proposed for Development of Military Family Housing and Expansion of Military Training at BAFS, Oahu," in Appendix F, *Final Environmental Impact Statement, Land Use and Development Plan, Bellows Air Force Station, Waimanalo, Hawaii.*

U.S. Federal Emergency Management Agency, Hawaii Flood Insurance Rate Map, Community-Panel Number 150001 0095B, 1987.

U.S. Census Bureau, website. http://factfinder.census.gov

U.S. Department of Agriculture, Soil Conservation Service, In Cooperation with the University of Hawai'i Agriculture Experiment Station. *Soil Survey of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii*. August 1972.

U.S. Department of Transportation, Federal Highway Administration and Hawaii, Department of Transportation. March 2007. *Final Environmental Assessment/Finding of No Significant Impact for Kalanianaole Highway Improvements, Olomana Golf Course to Waimanalo Beach Park*. Federal Aid Project No. STP-072-1(44).

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9 CONSULTATION AND COORDINATION

9.1 ORGANIZATIONS CONSULTED DURING PREPARATION OF THE DRAFT EA

As part of the early consultation process, the following agencies and organizations were sent a pre-assessment letter requesting comments prior to completion of the Draft Environmental Assessment.

A copy of the letter requesting pre-assessment comments is reproduced after the listing.

Federal

- U.S. Army Corps of Engineers, Pacific Ocean Division
- Department of Interior, Fish & Wildlife Services
- U.S. Air Force, Bellows Air Force Station

State of Hawai‘i

- Department of Defense
- Department of Education
- Waimānalo Elementary and Intermediate School
- Waimānalo Public and School Library
- Department of Hawaiian Home Lands
- Department of Health, Environmental Planning Office
- Department of Land and Natural Resources (DLNR)
- DLNR, State Historic Preservation Office
- Office of Planning
- Office of Hawaiian Affairs
- Senator Fred Hemmings
- Representative Tommy Waters

City and County of Honolulu

- Department of Planning and Permitting
- Department of Environmental Services
- Department of Design and Construction
- Department of Parks and Recreation
- Department of Facility Maintenance
- Department of Transportation Services
- Honolulu Fire Department
- Fire Department, Waimānalo Station
- Honolulu Police Department
- Board of Water Supply
- Council Member Charles Djou

- Waimānalo Neighborhood Board

Utilities

- Hawaiian Electric Company
- Verizon Hawai‘i (now Hawaiian Telcom)
- Oceanic Time Warner Cable
- The Gas Company

Organizations

- Waimānalo Polo Club
- Honolulu Polo Club
- Waimānalo Community Development Corp.

Individuals

- Resident 41-673 Inoa‘ole Street
- Resident 41-675 Inoa‘ole Street
- Resident 41-677 Inoa‘ole Street
- Resident 41-678 Inoa‘ole Street
- Resident 41-679 Inoa‘ole Street
- Resident 41-682 Inoa‘ole Street
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- Resident 41-694 Inoa‘ole Street
- Resident 41-695 Inoa‘ole Street
- Resident 41-697 Inoa‘ole Street
- Mr. Wilson Kekoa Ho, Waimānalo Neighborhood Board
- Ms. Lisa Ferentinos

9.2 EARLY CONSULTATION COMMENT LETTERS

A total of 17 agencies, organizations, and individuals responded to the request for pre-assessment consultation. Substantive comments are summarized below, and have been incorporated into relevant sections of the DEA. Letters are reproduced in full at the end of this chapter.

Agency	Date	Comments
Commission on Water Resource Management (DLNR)	2-6-03	Proposed modifications altering the bed and/or banks of the stream will require a Stream Channel Alteration Permit
U.S. Fish and Wildlife Service	9-22-00	Records do not indicate the presence of threatened or endangered species in the immediate project area. Possible that such species are present, but not recorded. Lower reaches of Inoa'ole Stream provide wetland suitable for endangered waterbirds and migratory shorebirds. FWS recommends the following measures to minimize impacts to aquatic and riparian resources: • All project-related materials should be placed or stored in ways to avoid or minimize disturbance to the aquatic environment • All project-related material should be free of pollutants • No contamination of the aquatic environment (trash, debris disposal, etc.) should result from project activities • A contingency plan to control accidental spills of petroleum products should be developed. Absorbent and contaminant booms should be stored on-site to facilitate the clean-up of petroleum spills • Turbidity and siltation from excavation activities should be minimized and contained to the immediate vicinity of excavation through the use of silt containment decivces and the curtailment of excavation during adverse weather conditions • Removal of riparian vegetation should not occur FWS recommends that impacts to streambank restoration efforts be avoided.
State Historic Preservation Division (DLNR)	2-25-03	Review based on historic reports, maps, and aerial photos. Brief staff inspection of bridge area on 2-20-03. Records show no known historic sites within the "stream" at the project location. Subsurface cultural deposits have been found in the Inoa'ole Stream segment on the Bellows Air Force Station parcel, but the stream at the project location has been extensively modified with rip rap revetments. The upstream area,

Agency	Date	Comments
		although not previously installed with revetments, has been previously cleared and modified making it unlikely that significant subsurface deposits still exist in the project area. Proposed bridge replacement will have "no effect" on significant historic sites.
Office of Civil Defense, State Department of Defense	2-7-03	Coordinate with State Floodplain Manager, DLNR.
Land Division (DLNR)	2-7-03	Project will impact ingress and egress to neighboring State lands identified by TMK 4-1-08: 8, 4-1-09: 262, 269, and 271.
Engineering Division (DLNR)	2-7-03	All construction work within the flood zone to be done according to County flood ordinances If utilities are to be suspended along the bridge structure, they should be located and constructed to minimize flood damage, leakage, and prevent snagging of debris. A scour analysis should be conducted to ensure that the design of the structure will minimize erosion at the foundation. If the channel opening at the structure is widened, evaluate downstream reaches to provide for adequate capacity and erosion. Proposed bridge should not impeded storm water carrying capacity of the body of water it crosses. The proposed project site, according to FEMA Map Number 15003C0380 E is located in Zone AE. Zone AE is an area within the 100-year flood plain with base flood elevations determined.
Division of Boating and Ocean Recreation (DLNR)	1-23-03	Bridge needs to span the river. Existing structures (piers) in the river cause flooding.
Honolulu Department of Parks and Recreation	2-4-03	Department supports this flood control project. Based on experience in sugar industry, single-cell culvert believed to be superior in design to multi-cell culvert for storm drains and flood control.
Honolulu Fire Department	2-4-03	Maintain fire apparatus access throughout construction site for duration of project. Notify the Fire Communication Center regarding any interruption in the existing fire hydrant system during the project.
Honolulu Department of Transportation Services	2-11-03	All shoulders and sidewalks on the bridge must meet or exceed the Americans with Disabilities Act Accessibility Guidelines. The draft EA should include discussion of the construction phase of the project that addresses proposed detour routes, if any, and expected duration of project (roadway closures and

Agency	Date	Comments
		detours). Kalanianaole Highway should be kept open during the peak travel periods to minimize the project's impact on surrounding neighborhoods. A traffic impact study should be conducted. Based on the results of this study, a traffic management plan that address the period prior to and during construction should be developed. The area neighborhood board, as well as area residents, businesses, and emergency and public transit service providers, should be kept apprised of the details of the proposed project and the impacts the project may have on the surrounding area.
Board of Water Supply	2-3-03	There are no water facilities in the area of Inoa'ole Bridge.
Verizon Hawai'i (now Hawaiian Telcom)	2-23-03	Coordinate with Buried Cable Group to identify underground telephone lines in the project vicinity.
Margaret Tanner, neighbor	1-5-03	Existing native plants on *mauka* side of the bridge should be preserved as much as possible. New equipment access should be provided on the *mauka*/ Kailua side of bridge. Access from the polo field alone is inadequate to maintain both sides of the stream New bridge design should enable continuous water flow so that stagnant water, and problem with mosquitoes and bacteria, are avoided. Address noise due to increased traffic on Kalaniana'ole Highway, including possible noise barrier for residences in the Hale Aupuni subdivision.
The following agencies responded with "no comment" at this time: Hawai'i Department of Education Aquatics Division (DLNR) State Parks Division (DLNR) Honolulu Department of Design and Construction		

9.3 WAIMĀNALO NEIGHBORHOOD BOARD

The Waimānalo Neighborhood Board was given a project update at its regularly scheduled meeting on August 11, 2008. Comments and concern expressed by Board members and community residents included the following:

- Access into and out of the Hale Aupuni subdivision during construction
- Obsolescence of the replacement within a few years
- Drainage issues originating from the Hīhīmanu Road area.
- Upstream debris in flood waters; debris getting caught in the culvert opening
- Need for drainage improvements on the *mauka* side of the highway
- Access for equipment (such as an excavator) to clear out debris in and around the bridge

9.4 CONSULTATION AND COORDINATION RELATED TO FEDERAL COMPLIANCE

9.4.1 Section 106, National Historic Preservation Act

The National Historic Preservation Act (NHPA) sets forth government policy and procedures regarding "historic properties"—that is, districts, sites, buildings, structures, and objects included in or eligible for the National Register of Historic Places. Section 106 of the NHPA requires that federal agencies consider the effects of their actions on such properties.

Consultation and Coordination: Notification of the project was sent to the State Historic Preservation Division (SHPD) in January 2003. In the response letter, dated February 25, 2003, SHPD stated that previous stream clearings and modifications make it unlikely that significant subsurface deposits sill exist in the area proposed for improvements. Based on this finding, the agency determined that the proposed action would have "no effect" on significant historic sites.

9.4.2 Section 7, Endangered Species Act

The Endangered Species Act (ESA) requires that actions that are federally funded, authorized, or carried out be done in a manner so that it does not jeopardize the continued existence of any plant or animal species listed as threatened or endangered, or destroy or adversely modify any designated critical habitat. The Section 7 process included consultation with the U.S. Fish and Wildlife Service (FWS) for protected aquatic and avian species and the National Marine Fisheries Service (NMFS) for protected marine mammal species.

Consultation and Coordination: A letter requesting technical assistance was sent to the Fish and Wildlife Service in August 2000. The Service responded by letter dated September 22, 2000 that lower reaches of Inoa'ole Stream provide wetland habitat suitable for endangered waterbirds and

migratory shorebirds. It recommended that six measures be incorporated into the project to minimize impacts to aquatic and riparian resources. These measures—related to storage of project materials, use of pollutant-free materials, no contamination of the aquatic environment, contingency plan to control accidental spills of petroleum products, minimization of turbidity and siltation, and avoidance, and avoidance of riparian vegetation removal—are included in Sections 4.2.1 through 4.2.3 of the EA, Potential Impacts and Mitigation Measures.

The Service also recommended coordination with stream bank restoration efforts, undertaken by the Waimānalo Health Center Water Quality Project and the Kailua Bay Advisory Council (2002-2004).

9.4.3 Section 404, Clean Water Act

Section 404 of the Clean Water Act regulates the discharging of dredged or fill material into the waters of the United States.

Consultation. An informal meeting was held with Lolly Silva of the Army Corps of Engineers, Honolulu District, Regulatory Branch on April 6, 2006. The purpose of this meeting was to review the project description and obtain a preliminary assessment of permitting requirements. Based on the scope of work, Ms. Silva indicated that the proposed action is likely to qualify for a nationwide permit. If the project schedule allows, she advised submitting the permit application after the nationwide permits are reissued in 2007.

9.4.4 Executive Order 11990, Protection of Wetlands

Executive Order 11990 was issued to minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. This executive order requires Federal agencies, in their planning actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided.

The project is located adjacent to a wetland area on the *mauka* side of the bridge, but will not take or reduce the size of the wetland. The *mauka* stream channel will be widened to facilitate stream flow through the new, multi-cell culvert. Natural vegetation is expected to regrow on the stream bank.

9.4.5 Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with occupancy in and modification of floodplains. It also requires agencies to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Portions of the proposed path are located within designated floodplains based upon the Flood Insurance Rate Map (FIRM) for the area. As discussed in Section 4.1 of this document, the planned improvement will not increase the base flood elevation.

The proposed improvements will not change the roadway alignment or height and, therefore, will not provide any new horizontal obstructions within the floodplain. The new bridge configuration will reduce the potential for flooding by increasing stream flow to a level that exceeds the capacity of the downstream bridge on Tinker Road.

Coordination: As part of the environmental review process, the DEA will be sent to the FEMA coordinator at the Department of Land and Natural Resources for review and comment.

9.4.6 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) encourages the management of coastal areas. When conducting activities affecting a coastal zone, the CZMA requires federal agencies to be consistent with the enforceable policies of State coastal zone management programs (in Hawai‘i, under the jurisdiction of the State Office of Planning). The CZMA is intended to ensure that federal activities are consistent with State programs for the protection and, where possible, enhancement of the nation’s coastal zones.

The State’s Coastal Zone Management policies and regulations are prescribed under Chapter 205A, HRS. The coastal zone management area (also known as the special management area or SMA) is defined to include all lands of the State and the areas extending seaward from the shoreline to the limit of the State’s management authority. As a result, the project corridor is within this CZM/SMA area and subject to consistency with the CZM programs objectives and policies.

Coordination: The federal CZM consistency review will be carried out in conjunction with the Department of Army permit application. The proposed replacement is also required to obtain an SMA (Major) permit from the County (also refer to Section 5.4.5, Consistency with the Coastal Zone Management Program).

9.4.7 Section 4(f), U.S. Department of Transportation Act

Section 4(f) of the U.S. Department of Transportation (USDOT) Act of 1966 (49 USC §303(c)) applies to publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and private historical sites. The provisions of Section 4(f) are limited to projects that require approval by the FHWA or another USDOT agency. Such projects must avoid the use of any Section 4(f) resource, as defined above, unless there is no prudent and feasible alternative to that use. If a use must occur, all possible planning and measures to minimize harm to that resource must be demonstrated and documented.

Coordination: The proposed action will not affect any Section 4(f) resource; therefore, Section 4(f) coordination is not needed.

9.4.8 Executive Order 12898 on Environmental Justice and Title VI of the Civil Rights Act of 1964

Executive Order 12898 on Environmental Justice (EJ) requires each federal agency and recipients of federal funds to take appropriate steps to identify and address "disproportionately high and adverse human health or environmental effects" of federal projects on minority or low income populations. Similar non-discrimination protection is provided under Title VI of the Civil Rights Act of 1964, U.S. DOT Order 5610.2 on Environmental Justice, and other related regulations and directives.

Consultation: Outreach efforts for this project included a pre-assessment information letter and request for comments that was sent to neighboring residents and community organizations in April 2004. A project briefing was given to the Waimānalo Neighborhood Board in August 2008. This meeting, in particular, raised a diverse range of opinions by members of the neighborhood board and residents of the community. Concerns were expressed about traffic congestion during the construction period and upstream flooding issues; however, there was consensus that bridge replacement is necessary and has been anticipated by the community for a long time. Although the Waimānalo community has a high proportion of minority and low-income households, the proposed action will not impose disproportionately high and adverse effects that are safeguarded per E.O. 12898 regarding environmental justice.

9.4 AGENCIES, ORGANIZATIONS, AND INDIVIDUALS TO BE CONTACTED DURING THE DRAFT ENVIRONMENTAL ASSESSMENT REVIEW PERIOD

Federal
U.S. Air Force, Commander, Bellows Air Force Station
U.S. Army Corps of Engineers
U.S. Department of Interior, Fish and Wildlife Service

State of Hawaii
Department of Education
  Waimanalo Elementary & Intermediate School
Department of Health
Department of Land and Natural Resources
  State Historic Preservation Division
Office of Hawaiian Affairs
Office of Planning, Department of Business, Economic Development, and Tourism
Representative Chris Lee, District No. 49
Senator Fred Hemmings, District No. 25

City and County of Honolulu
Board of Water Supply
Department of Design and Construction
Department of Environmental Services
Department of Facility Maintenance
Department of Parks & Recreation
Department of Planning & Permitting
Department of Transportation Services
Honolulu Fire Department
Honolulu Police Department
Councilmember, District No. 3

Utility
Hawaiian Electric Company
Hawaiian Telcom
Oceanic Times Warner Cable

Community Groups and Organizations
Hale Aupuni Community Association
Honolulu Polo Club
Waimanalo Health Center
Waimanalo Neighborhood Board, No. 32

Media
Honolulu Advertiser
Honolulu Star-Bulletin

Pre-assessment Comment Letters and Responses

LL

RECEIVED
SEP 25 2000
SATO & ASSOC., INC.

United States Department of the Interior

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

In Reply Refer To: GCS

SEP 22 2000

Loren G.S. Lau, Project Manager
Sato and Associates, Inc.
2046 King St.
Honolulu HI 96826

Re: Inoa'ole Bridge Replacement Project, Waimanalo, Oahu

Dear Ms. Lau:

The U.S. Fish and Wildlife Service (Service) received your August 9, 2000 letter requesting technical assistance on the Inoa'ole Bridge Replacement Project, located on the island of Oahu. The project involves replacement of the existing single cell box culvert with a multi-cell box culvert. Your letter requested information on the presence of any federally listed threatened or endangered species in the project area.

Our records do not indicate the presence of any threatened or endangered species in the immediate project area. However, we are not aware of any detailed biological surveys from that area and it is possible that such species are present but not recorded.

Please note that downstream of the project area, the lower reaches of Inoa'ole Stream provides wetland habitat suitable for endangered waterbirds and migratory shorebirds. The Service recommends that the following measures be incorporated into the project to minimize impacts to aquatic and riparian resources:

1) all project-related materials should be placed or stored in ways to avoid or minimize disturbance to the aquatic environment;

2) all project-related material should be free of pollutants;

3) no contamination of the aquatic environment (trash, debris disposal, etc.) should result from project activities;

4) a contingency plan to control accidental spills of petroleum products should be developed. Absorbent and containment booms should be stored on-site to facilitate the clean-up of petroleum spills;

5) turbidity and siltation from excavation activities should be minimized and contained to the immediate vicinity of excavation through the use of silt containment devices and the curtailment of excavation during adverse weather conditions; and

6) removal of riparian vegetation should not occur.

Also, the Service is cooperating in a riparian restoration effort that involves planting native vegetation along several sections of Inoa'ole Stream bank. One of these riparian restoration sites is adjacent to the project area in the upstream direction. We recommend that you consult with Ms. Lisa Ferentinos, Waimanalo Health Center Water Quality Project Coordinator to avoid impacting streambank restoration efforts.

The Service appreciates your concern for threatened and endangered species and we thank you for requesting our technical assistance at this early stage of project planning. If you have any questions, please contact Gordon Smith, of my staff, at 541-3441.

Sincerely,

Paul Henson

Paul Henson
Field Supervisor
Ecological Services

HWY-DS 2.5647

Mr. Paul Henson, Field Supervisor
U. S. Fish and Wildlife Service
Pacific Islands Ecoregion
United States Department of the Interior
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

Dear Mr. Henson:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated September 22, 2000, concerning the subject project.

We acknowledge that your records do not indicate the presence of any threatened or endangered species in the immediate project area.

We also offer the following responses in the respective order of the comments:

1. The Draft EA will discuss a general best management practice plan that briefly discusses comments 1-6.
2. Please see the attached memo for the initial consultation with Ms. Lisa Ferentinos. As you requested, she will be kept appraised of the details and impacts of the proposed project.

We appreciate your interest and participation in the EA review process. Your letter along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
SATO & ASSOC., INC.

00030 Faxed

Sato & Associates, Inc.
Consulting Engineers
2046 S. King Street, Honolulu, Hawaii 96826 Tel: (808) 955-4441
OFFICES IN HONOLULU AND MAUI Fax: (808) 942-2027

MEMORANDUM

Date: 20 September 2000

To: Henry Kennedy SDOT-HWY

From: Loren Lau

Re: Inoaole Stream Bridge

I received a phone call from Ms. Lisa Ferentinos. She is a resident of Waimanalo, a member of the Neighborhood Board for 1.5 years, and is involved with a project on the mauka side of Inoaole Bridge.

Her project involves demonstrating methods of restoring stream banks utilizing native plants. The project receives funds from the U.S. Fish and Wildlife Service. We had forwarded a letter to the U.S. Fish and Wildlife Service on 9 August 2000 requesting a review of the site for any information relative to presence of any federally listed (or proposed for listing) endangered or threatened flora/fauna species or critical habitat in the project area. The U.S. Fish and Wildlife Service then informed Ms. Ferentinos of the project.

Ms. Ferentinos requested plans which would indicate the project construction in order to determine impact to her project. I informed her that those documents were not yet available. She expressed a strong desire to participate in the project planning.

I informed her that we are in process of completing a Detour Road Study, then will proceed with a Draft Environmental Assessment (DEA) and Final Environmental Assessment (FEA) with the project design progressing concurrently with the DEA and FEA. I also informed her that the DEA requires pre-consultation with the community and governmental agencies/representatives. I informed her that she and the neighborhood board would participate during the EA process.

Ms. Ferentinos mentioned that the Waimanalo Neighborhood Board did not have a favorable experience with a previous EA about a year ago. I suggested that they contact the Office of Environmental Quality Control (OEQC) and obtain a copy of the EA & EIS Guidelines to become informed on the environmental permitting process.

She requested the SDOT-HWY contact so we informed her of you position as the Project Manager. Should you wish to contact her, she can be reached at:

Ms. Lisa Ferentinos	Ph:	783-7890
41-041 Hinalea Street	Fax:	259-5376
Waimanalo, HI 96795	e:mail	lf@lava.net

Please contact me should you have any questions.

LINDA LINGLE
GOVERNOR

BRIGADIER GENERAL ROBERT G. F. LEE
DIRECTOR OF CIVIL DEFENSE

EDWARD T. TEIXEIRA
VICE DIRECTOR OF CIVIL DEFENSE

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE DIRECTOR OF CIVIL DEFENSE
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

PHONE (808) 733-4300
FAX (808) 733-4287

February 7, 2003

Mr. Henry Kennedy
Project Manager
Technical Design Services Office
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Draft Environmental Assessment
Kalanianaole Highway, Replacement of Inoaole Stream Bridge

Thank you for the opportunity to provide comments on the replacement of the Inoaole Bridge in Waimanalo. We are pleased that this project will alleviate the persistent flooding problem in this area. At this time, we do not have any substantive comments for the draft environmental assessment.

Please include Mr. Sterling Yong on all future correspondence for this project. He is the State Floodplain Manager in the Department of Land and Natural Resources. He can be reached at 587-0248.

If you have any questions, please call me or Mr. Larry Kanda at 733-4300.

Sincerely,

EDWARD T. TEIXEIRA
Vice Director of Civil Defense

HWY-DS 2.5661

TO: EDWARD T. TEIXEIRA
VICE DIRECTOR OF CIVIL DEFENSE
DEPARTMENT OF DEFENSE

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE TO PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for your letter dated February 7, 2003, concerning the subject project.

We acknowledge that you have no comments to offer at this time. Please be assured that Mr. Sterling Yong, State Floodplain Manager, Engineering Division, Department of Land and Natural Resources, will be included on all future correspondence as you requested.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

LINDA LINGLE
GOVERNOR

PATRICIA HAMAMOTO
SUPERINTENDENT

STATE OF HAWAI'I
DEPARTMENT OF EDUCATION
P.O. BOX 2360
HONOLULU, HAWAI'I 96804

OFFICE OF THE SUPERINTENDENT

RECEIVED
FEB 5 1 56 PM '03
DEPT. OF TRANSPORTATION
HIGHWAYS DIVISION

RECEIVED
'03 FEB -8 P3:13
DESIGN BRANCH
HIGHWAYS DIVISION
DEPT. OF TRANSPORTATION

February 4, 2003

MEMO TO: Mr. Rod Haraga, Director
Department of Transportation

A T T N: Mr. Henry Kennedy, Project Manager
Technical Design Services Office

F R O M: Patricia Hamamoto, Superintendent
Department of Education

SUBJECT: Replacement of Inoaole Stream Bridge
Waimanalo, Oahu

The Department of Education (DOE) has received your pre-consultation letter regarding the replacement of the Inoaole Stream Bridge on Kalanianaole Highway in Waimanalo. The DOE has no comment at this time.

Thank you for the opportunity to respond.

Should you have any questions, please call Ms. Heidi Meeker of the Facilities and Support Services Branch at 733-4862.

PH:HM:mp

cc: A. Suga, OBS

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER

HWY-DS 2.5654

TO: THE HONORABLE PATRICIA HAMAMOTO
SUPERINTENDENT OF EDUCATION

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE TO PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for your letter dated February 4, 2003, concerning the subject project.

We acknowledge that you have no comments to offer at this time.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
SATO & ASSOC., INC.

HWY 251

LINDA LINGLE
GOVERNOR OF HAWAII

DIRECTOR'S OFFICE
DEPT. OF
TRANSPORTATION

2003 FEB 27 P 3:43

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

RECEIVED
03 MAR 3 P1:36

PETER T. YOUNG, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCES MANAGEMENT

DEPUTY
ERNEST Y. W. LAU

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

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

February 25, 2003

Rodney K. Haraga
Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813-5097

LOG NO: 31740
DOC NO: 0302EJ26

Dear Mr. Haraga:

SUBJECT: Chapter 6E-8 Historic Preservation Review – Pre-Draft Environmental Assessment for Replacement of Inoaole Stream Bridge, Kalanianaole Highway
HWY-DS 2.8871
Waimanalo, Ko`olaupoko, O`ahu
TMK (1) 4-1-33

Thank you for the opportunity to provide comment for the Environmental Assessment for the proposed bridge replacement at Inoaole Stream in Waimanalo. Our review is based on historic reports, maps, and aerial photographs maintained at the State Historic Preservation Division. Staff also made a brief inspection of the bridge area on February 20, 2003. We received notification of this undertaking from your office on January 23, 2003, and provide the following comment.

A review of our records shows that there are no known historic sites within the "stream" at this location. Archival records indicate that this drainage was constructed as a result of sugarcane cultivation in the area. Although subsurface cultural deposits (temporary habitation, traditional agricultural) have been found in the Inoaole Stream segment on the Bellows Air Force Station parcel the portion along the stream at the project location has been extensively modified with rip rap revetments on the *makai* side of the bridge. The upstream (*mauka*) although not previously installed with revetments has been previously cleared and modified making it unlikely that significant subsurface deposits still exist in the area proposed for improvements. Therefore, we believe that the proposed bridge replacement improvements will have "no effect" on significant historic sites.

If you have any questions please call Sara Collins at 692-8026 or Elaine Jourdane at 692-8027.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Acting Administrator
State Historic Preservation Division

EJ:jk

RECEIVED
03 MAR 3 8 40 AM '03
DEPT OF TRANSPORTATION
HIGHWAYS DIVISION

HWY-DS 2.5648

TO: MS. P. HOLLY McELDOWNEY, ACTING ADMINISTRATOR
STATE HISTORIC PRESERVATION DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE TO PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for your letter dated February 25, 2003, concerning the subject project.

We acknowledge that based on your records, the proposed bridge replacement improvements will have "no effect" on significant historic sites.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
SATO & ASSOC., INC.

DLK 0167

LINDA LINGLE
GOVERNOR OF HAWAII

PETER T. YOUNG
CHAIRPERSON

MEREDITH J. CHING
CLAYTON W. DELA CRUZ
CHIYOME L. FUKINO, M.D.
BRIAN C. NISHIDA
HERBERT M. RICHARDS, JR.

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

FEB - 6 2003

RECEIVED
'03 FEB 13 P6:04
DESIGN BRANCH
HIGHWAYS DIVISION
DEPT OF TRANSPORTATION

Mr. Rodney K. Haraga, Director
Department of Transportation
State of Hawaii
869 Punchbowl Street
Honolulu, HI 96817

Dear Mr. Haraga:

Draft Environmental Assessment, Replacement of
Inoaole Stream Bridge, Kalanianaole Highway

This is in response to your letter dated January 13, 2003, requesting whether a Stream Channel Alteration Permit (SCAP) would be required for the proposed culvert replacements as part of the Inoaole Stream bridge replacement at Kalanianaole Highway. If the proposed modifications alter the bed and/or banks of the stream, a Stream Channel Alteration Permit would be required.

Thank you for consulting us in this matter. Should you have any questions, please contact David Higa of the Commission staff at 587-0249.

Sincerely,

DEAN A. NAKANO
Acting Deputy Director

SKS:sd

G:\WORK\REGULATE\TEMP\DOT Inoaole bridge replacement.rfd.doc

HWY-DS 2.5659

TO: DEAN A. NAKANO
PLANNING BRANCH CHIEF
COMMISSION ON WATER RESOURCE MANAGEMENT
DEPARTMENT OF LAND AND NATURAL RESOURCES

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE TO PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for your letter dated February 6, 2003, concerning the subject project.

We acknowledge that a stream channel alteration permit will be required due to the proposed modifications that will alter the bed and banks of the stream within the construction area.

We appreciate your interest and participation in the EA review process. Your letter, along with this response will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
SATO & ASSOC., INC.

LINDA LINGLE
GOVERNOR

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

ERNEST LAU
DEPUTY DIRECTOR

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

February 7, 2003

DOTINOAOLEBRIDGE.RCM
LD-NAV

L-387/279/346/431/243

Glenn M. Okimoto, Interim Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813-5097

Attn: Mr. Henry Kennedy, Project Manager

Dear Mr. Okimoto:

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Thank you for the opportunity to review and comment on the subject matter.

A copy of your letter (summary of project) covering the subject matter was distributed to the following Department of Land and Natural Resources' Divisions for their review and comment:

Division of Aquatic Resources - Division of Forestry & Wildlife - Na Ala Hele Trails - Division of State Parks - Division of Boating & Ocean Recreation - Engineering Division - Commission on Water Resource Management - Land Division Planning and Technical Services - Land Division - Oahu District Land Office

Attached herewith is a copy of the Division of Aquatic Resources, Engineering Division and Oahu District Land Office comments.

Based on the attached responses, the Department of Land and Natural Resources has no other comment to offer on the subject matter at this time.

Should you have any questions, please contact Nicholas A. Vaccaro of the Land Division Support Services Branch at 587-0384.

Very truly yours,

Charlene E. Unoki

for DIERDRE S. MAMIYA
Administrator

C: ODLO

LINDA LINGLE
GOVERNOR

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

January 23, 2003
LD/NAV
Ref.: DOTINOAOLEBRIDGE.CMT

L-279
Suspense Date: 2/04/03

MEMORANDUM:

FROM: ~~TO:~~
XXX Division of Aquatic Resources
XXX Division of Forestry & Wildlife
XXX Na Ala Hele Trails
XXX Division of State Parks
XXX Engineering Division
XXX Division of Boating and Ocean Recreation
XXX Commission on Water Resource Management
Land Division Branches:
XXX Planning and Technical Services
~~XXX Oahu District Land Office~~

TO: ~~FROM:~~ Charlene E. Unoki, Acting Assistant Administrator
Land Division Charlene

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment Covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Please review the attached letter (summary) with attachments covering the subject matter and submit your comments (if any) on Division letterhead within the time requested above.

Should you need more time to review the subject matter, please contact Nick Vaccaro at ext.: 7-0384.

If this office does not receive your comments on or before the suspense date, we will assume there are no comments.

( ) We have no comments.

(X) Comments attached.

Name: Dan

Signed:

Date: 1/29/03
for

LINDA LINGLE
GOVERNOR

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

Ref: LD-SL

MEMORANDUM

To: Charlene Unoki
Acting Assistant Administrator

Attn: Nicholas Vaccaro

From: Steve Lau
Land Agent

Subject: Pre-Assessment Consultation-Preparation of a Draft Environmental Assessment covering the Replacement of Inoaole Stream Bridge, Oahu, Hawaii.

The above project will impact ingress and egress to the neighboring State lands identified by TMK:4-1-08:8, TMK:4-1-09:262, 269 and 271.

LINDA LINGLE
GOVERNOR

CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

TO:
___ ADMINISTRATOR
___ ASST ADMIN
___ DEV BR
___ PLAN BR
___ RES MGT BR
___ CLERICAL
___ ADMIN ASST
___ INTERP BR

FOR:
___ CIRC/POST/STAFF RM
___ COMMENTS DUE
___ DRAFT REPLY
___ FILE
___ FOLLOW UP
___ INFO
___ RUN COPIES_____
___ RUSH DUE_____
___ SEE ME
___ FAX/SEND COPY TO_____

January 23, 2003 L-279
LD/NAV
Ref.: DOTINOAOLEBRIDGE.CMT Suspense Date: 2/04/03

MEMORANDUM:

TO: XXX Division of Aquatic Resources
XXX Division of Forestry & Wildlife
XXX Na Ala Hele Trails
√ XXX ~~Division of State Parks~~
XXX Engineering Division
XXX Division of Boating and Ocean Recreation
XXX Commission on Water Resource Management
Land Division Branches:
XXX Planning and Technical Services
XXX Oahu District Land Office

FROM: Charlene E. Unoki, Acting Assistant Administrator
Land Division

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment Covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Please review the attached letter (summary) with attachments covering the subject matter and submit your comments (if any) on Division letterhead within the time requested above.

Should you need more time to review the subject matter, please contact Nick Vaccaro at ext.: 7-0384.

If this office does not receive your comments on or before the suspense date, we will assume there are no comments.

(√) We have no comments. ( ) Comments attached.

Name:
Signed: Daniel S. Quinn
Date: 1/25/03

LINDA LINGLE
GOVERNOR

DIVISION OF AQUATIC RESOURCES
Suspense Date:
Draft Reply ☐
Reply Direct ☐
Comments ☐
Information ☐
Comp Act & File ☐
Return to:
Copies to:

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

January 23, 2003
LD/NAV
Ref.: DOTINOAOLEBRIDGE.CMT

L-279
Suspense Date: 2/04/03

MEMORANDUM:

TO: [redacted]
XXX Division of Forestry & Wildlife
XXX Na Ala Hele Trails
XXX Division of State Parks
XXX Engineering Division
XXX Division of Boating and Ocean Recreation
XXX Commission on Water Resource Management
Land Division Branches:
XXX Planning and Technical Services
XXX Oahu District Land Office

RECEIVED
JAN 24 2003
AQUATIC RESOURCES

FROM: Charlene E. Unoki, Acting Assistant Administrator
Land Division Charlene

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment Covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Please review the attached letter (summary) with attachments covering the subject matter and submit your comments (if any) on Division letterhead within the time requested above.

Should you need more time to review the subject matter, please contact Nick Vaccaro at ext.: 7-0384.

If this office does not receive your comments on or before the suspense date, we will assume there are no comments.

(X) We have no comments, at This Time
Will review The DEA when it becomes available

( ) Comments attached.

Name: W. Devick
Signed: Administrator

Date: 1/27/03

LINDA LINGLE
GOVERNOR

RECEIVED
2003 JAN 27 P 1:12

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

January 23, 2003
LD/NAV
Ref.: DOTINOAOLEBRIDGE.CMT

L-279
Suspense Date: 2/04/03

MEMORANDUM:

TO: XXX Division of Aquatic Resources
XXX Division of Forestry & Wildlife
XXX Na Ala Hele Trails
XXX Division of State Parks
XXX Engineering Division
XXX Division of Boating and Ocean Recreation
XXX Commission on Water Resource Management
Land Division Branches:
XXX Planning and Technical Services
XXX Oahu District Land Office

FROM: Charlene E. Unoki, Acting Assistant Administrator
Land Division Charlene

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment Covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Please review the attached letter (summary) with attachments covering the subject matter and submit your comments (if any) on Division letterhead within the time requested above.

Should you need more time to review the subject matter, please contact Nick Vaccaro at ext.: 7-0384.

If this office does not receive your comments on or before the suspense date, we will assume there are no comments.

( ) We have no comments.

(X) Comments attached.

Needs a bridge that spans the river. Existing structures (piers) in the river causes flooding

Name: W McGourty
Signed:

Date: 1/27/03

LINDA LINGLE
GOVERNOR

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEAN A. NAKANO
ACTING DEPUTY DIRECTOR FOR
THE COMMISSION ON WATER
RESOURCE MANAGEMENT

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

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
LAND DIVISION
P.O. Box 621
HONOLULU, HAWAII 96809

January 23, 2003
LD/NAV L-279
Ref.: DOTINOAOLEBRIDGE.CMT Suspense Date: 2/04/03

MEMORANDUM:

TO: XXX Division of Aquatic Resources ✓
XXX Division of Forestry & Wildlife
XXX Na Ala Hele Trails
XXX Division of State Parks ✓
~~XXX Engineering Division~~ ✓
XXX Division of Boating and Ocean Recreation ✓
XXX Commission on Water Resource Management
Land Division Branches:
XXX Planning and Technical Services
XXX Oahu District Land Office ✓

FROM: Charlene E. Unoki, Acting Assistant Administrator
Land Division Charlene

SUBJECT: Pre-Assessment Consultation - Preparation of a Draft Environmental Assessment Covering the Replacement of the Inoaole Stream Bridge, Oahu, Hawaii

Please review the attached letter (summary) with attachments covering the subject matter and submit your comments (if any) on Division letterhead within the time requested above.

Should you need more time to review the subject matter, please contact Nick Vaccaro at ext.: 7-0384.

If this office does not receive your comments on or before the suspense date, we will assume there are no comments.

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

Name: _____

Signed: _____

Date: _____

DEPARTMENT OF LAND AND NATURAL RESOURCES
Engineering Division

COMMENTS

For the proposed replacement of the existing bridge and its related improvements, we offer the following suggestions:

1. The proposed construction work should be done according to all applicable County Flood Ordinances, related to work within a flood zone.

2. If utilities (sewer, gas, water, etc.) are to be suspended along the bridge structure, they should be located and constructed to minimize flood damage, leakage and prevent snagging of debris.

3. A scour analysis should be conducted to ensure that the design of the structure will minimize erosion at the foundation. If the channel opening at the structure is widened, evaluate downstream reaches to provide for adequate capacity and erosion.

4. The proposed bridge should not impede the storm water carrying capacity of the body of water it crosses.

For your information, the proposed project site, according to FEMA Map Number 15003C0380 E, is located in Zone AE. Zone AE is an area within the 100-year flood plain, with base flood elevations determined.

Signed: Carolyn M. Houde
for ERIC T. HIRANO, CHIEF ENGINEER

Date: 1/30/03

N:\WLD\MAKAI\DENNIS\WORD\Waimanalo_InoaoleStrmBridgeReplace_PreConsLtr_com_04.doc

HWY-DS 2.5660

RECEIVED
OCT 20 2004
SATO & ASSOC., INC.

TO: CHARLENE UNOKI
ASSISTANT ADMINISTRATOR, LAND DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE OF PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for the responses from the various DLNR agencies, concerning the subject project.

We acknowledge that the Division of State Parks has no comments to offer at this time and the Division of Aquatic Resources will reserve comments until the Draft EA becomes available.

To address the comments made by the following agencies, we offer the following responses in the respective order of the comments:

1. Engineering Division

   a. All construction work within the flood zone shall be done according to the County flood ordinances.

   b. There will be no utilities suspended along the bridge structure.

   c. Based on past experiences, scour analysis for box culverts do not indicate reasonable results; however, a cutoff wall will be provided along with dumped riprap on the inlet side to protect the proposed box culverts from being undermined. Evaluating the downstream reaches will not be necessary. The hydraulic opening for the proposed box culverts were solely based on the downstream channel capacity designed by the Corps of Engineers. For your information, the downstream channel is protected with concrete filled sacks.

   d. The proposed multi-celled culvert will improve the drainage conditions at the Kalanianaole Highway crossing. The existing box culvert is under capacity; and, as a result, Kalanianaole Highway becomes inundated during severe storm events. The proposed box culverts will have a much greater hydraulic capacity than the original box and designed to match the downstream channel capacity.

   e. The Draft EA will briefly discuss the flood zone of the proposed project.

2. Division of Boating and Ocean Recreation

   A single span bridge/box was originally intended for the drainage improvements. However, a single span structure would require a top slab thickness of between three to four feet and limit the vertical clearance between the invert of the stream and the soffit to two+ feet. For this reason, multi-celled culverts were designed.

3. Land Division: Oahu District Land Office

   The phasing of the construction should have minimal impact to the ingress and egress of the neighboring State lands. The Draft EA will discuss the roadway and traffic impacts and mitigation measures for the proposed project.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 11TH FLOOR
HONOLULU, HAWAII 96813
PHONE: (808) 523-4564 • FAX: (808) 523-4567
WEB SITE ADDRESS: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

RAE M. LOUI, P.E.
DIRECTOR

GEORGE T. TAMASHIRO, P.E.
ASSISTANT DIRECTOR

February 5, 2003

CDD-A 03-0006

Mr. Henry Kennedy, Project Manager
Technical Design Services Office
Department of Transportation
State of Hawaii
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Subject: Kalanianaole Highway, Replacement of
Inoaole Stream Bridge

We are responding to your pre-consultation letter dated January 13, 2003, concerning your intent on preparing a Draft Environmental Assessment for the subject project.

We do not have any comments at this time.

Should you have any questions, please contact Dennis Toyama of our Civil Division at 523-4756.

Very truly yours,

RAE M. LOUI, P.E.
Director

DT:FK:cmdc

HWY-DS 2.5654

Mr. Timothy Steinberger
Department of Design and Construction
City and County of Honolulu
650 S. King Street
Honolulu, Hawaii 96813

Dear Mr. Steinberger:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 5, 2003, concerning the subject project.

We acknowledge that you have no comments to offer at this time.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU
1000 ULUOHIA STREET, SUITE 309 • KAPOLEI, HAWAII 96707
TELEPHONE: (808) 692-5561 • FAX: (808) 692-5131 • INTERNET: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

WILLIAM D. BALFOUR, JR.
DIRECTOR

EDWARD T. "SKIPPA" DIAZ
DEPUTY DIRECTOR

February 4, 2003

Mr. Henry Kennedy, Project Manager
Technical Design Services Office
State of Hawaii
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Subject: Draft Environmental Assessment
Replacement of Inoaole Bridge on Kalanianaole Highway

Thank you for the opportunity to submit any comments at this pre-consultation stage of the Environmental Assessment process relating to the Replacement of the Inoaole Bridge on Kalanianaole Highway.

The Department of Parks and Recreation supports this flood control project, but I would like to add that though I am not a professional engineer, it has been my experience of 40 years in the sugar industry that a single cell culvert, albeit a large one, is of superior design to a multi-cell culvert for storm drains and flood control.

Should you have any questions, please contact Mr. John Reid, Planner, at 692-5454.

Sincerely,

W. D. Balfour

WILLIAM D. BALFOUR, JR
Director

WDB:mk (J. Reid, ESO)
(20491)

cc: Mr. Don Griffin, Department of Design and Construction

HWY-DS 2.5650

Mr. William D. Balfour, Jr., Director
Department of Parks and Recreation
City and County of Honolulu
1000 Uluohia Street, Suite 309
Kapolei, Hawaii 96707

Dear Mr. Balfour:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 4, 2003, concerning the subject project.

A single span bridge/box was originally intended for the drainage improvements. However, a single span structure would require a top slab thickness of between three to four feet and limit the vertical clearance between the invert of the stream and the soffit to two+ feet. For this reason, multi-celled box culverts were designed.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

Rodney K. Haraga

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
3375 KOAPAKA STREET, SUITE H425 • HONOLULU, HAWAII 96819-1869
TELEPHONE (808) 831-7761 • FAX (808) 831-7750 • INTERNET: www.honolulufire.org

JEREMY HARRIS
MAYOR

ATTILIO K. LEONARDI
FIRE CHIEF

JOHN CLARK
DEPUTY FIRE CHIEF

February 4, 2003

Mr. Henry Kennedy, Project Manager
Technical Design Services Office
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Subject: Draft Environmental Assessment
Kalanianaole Highway, Replacement of Inoaole Stream Bridge

We received a letter from Glenn Okimoto, Interim Director of Transportation, dated January 13, 2003, requesting our comments on the above-mentioned project. The Honolulu Fire Department requires that the following be complied with:

1. Maintain fire apparatus access throughout the construction site for the duration of the project.

2. Notify the Fire Communication Center at 523-4411 regarding any interruption in the existing fire hydrant system during the project.

Should you have any questions, please call Battalion Chief Lloyd Rogers of our Fire Prevention Bureau at 831-7778.

Sincerely,

Attilio K. Leonardi

ATTILIO K. LEONARDI
Fire Chief

AKL/SK:bh

HWY-DS 2.5645

Mr. Attilio K. Leonardi
Fire Chief
City and County of Honolulu
3375 Koapaka Street, Suite H425
Honolulu, Hawaii 96812

Dear Mr. Leonardi:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 4, 2003, concerning the subject project. We offer the following responses in the respective order of the comments:

1. The Draft EA will discuss phasing the bridge construction to maintain an active roadway (two-12' travel lanes) through the site for the duration of the project.

2. There are no fire hydrants or water lines in the proposed construction area, therefore, the existing fire hydrant system should not be affected.

We appreciate your interest and participation in the environmental assessment review process. Your letter, along with this response will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Sincerely,

Rodney K. Haraga

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB,MKO)
Sato & Associates, Inc. (Clifford Arakawa

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 3RD FLOOR • HONOLULU, HAWAII 96813
TELEPHONE: (808) 523-4529 • FAX: (808) 523-4730 • INTERNET: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

CHERYL D. SOON
DIRECTOR

GEORGE "KEOKI" MIYAMOTO
DEPUTY DIRECTOR

TPD1/03-20532R

February 11, 2003

Mr. Henry Kennedy, Project Manager
Technical Design Services Office
State Department of Transportation
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge

In response to the January 13, 2003 State Department of Transportation letter, we reviewed the project information provided and have the following comments to offer:

1. All shoulders and sidewalks on the bridge must meet or exceed the Americans with Disabilities Act Accessibility Guidelines.

2. The draft EA should include a discussion of the construction phase of the project that addresses proposed detour routes, if any, and expected duration of project (roadway closures and detours). Kalanianaole Highway should be kept open during the peak travel periods to minimize the project's impact on surrounding neighborhoods.

3. A traffic impact study for the proposed project should be conducted. Based on the results of this study, a traffic management plan that addresses the period prior to and during construction should be developed.

4. The area neighborhood board, as well as area residents, businesses, and emergency and public transit service providers, should be kept apprised of the details of the proposed project and the impacts the project may have on the surrounding area.

Should you have any questions regarding these comments, please contact Faith Miyamoto of the Transportation Planning Division at 527-6976.

Sincerely,

CHERYL D. SOON
Director

HWY-DS 2.5646

Mr. George Miyamoto
Director of Transportation Services
City and County of Honolulu
650 S. King Street, 3rd Floor
Honolulu, Hawaii 96813

Dear Mr. Miyamoto:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 11, 2003, concerning the subject project. We offer the following responses in the respective order of the comments:

1. No sidewalk will be provided. Five (5) feet of the 12-foot wide shoulders on the bridge will meet or exceed the Americans with Disabilities Act Accessibility Guidelines.

2. The Draft EA will discuss the bridge construction phasing to maintain an active roadway to minimize the projects impact on the surrounding neighborhoods and to maintain an open stream channel.

3. A traffic study will not be conducted due to construction phasing of the project. The Draft EA will discuss each phase maintaining an active roadway as well as the detour alternatives that were not recommended due to the disruptions to the area.

4. The area residents, businesses, and emergency and public transit service providers shall be kept apprised of the details and impacts of the proposed project.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

BOARD OF WATER SUPPLY

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

February 3, 2003

Mr. Henry Kennedy, Project Manager
Technical Design Services Office
601 Kamokila Boulevard, Room 688
Kapolei, Hawaii 96707

Dear Mr. Kennedy:

Subject: Your Letter of January 13, 2003 on the Draft Environmental Assessment for the Inoale Bridge Replacement Project

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

We do not have any water facilities in the area of the Inoale Bridge.

If you have any questions, please contact Joseph Kaakua at 527-6123.

Very truly yours,

K. Sinda

for CLIFFORD S. JAMILE
Manager and Chief Engineer

HWY-DS 2.5654

Mr. Clifford S. Jamile
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 S. Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Jamile:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 3, 2003, concerning the subject project.

We acknowledge that you have no comments to offer at this time.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:asf

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

GTE Hawaiian Tel
Beyond the call

GTE Hawaiian Telephone Company Incorporated
P.O. Box 2200 • Honolulu, HI 96841 • 808 546-4511

February 23, 2003

Mr. Henry Kennedy
Project Manager, Technical Design Services Office
601 Kamokila Blvd., Room 688
Kapolei, HI 96707

Dear Henry,

I received the pre-consultation letter pertaining to the "Kalanianaole Highway, Replacement of Inoaole Stream Bridge" Project. Thank you for the notification that your office will be preparing a Draft Environmental Assessment.

Please contact our buried cable group at 840-1444 to identify underground telephone lines in the vicinity. Your consideration will eliminate accidental damage to our extensive network and avoid inconvenience to our customers.

I appreciate the opportunity to communicate my concern.

Very truly yours,

Harlan Hashimoto
Verizon Hawaii
Environmental Affairs
546-2562

RECEIVED
'03 MAR -5 P12:13
DEPT. OF TRANSPORTATION
HIGHWAYS DIVISION

FORM 90006055

HWY-DS 2.5644

Mr. Harlan Hashimoto
Verizon Hawaii
Environmental Affairs
1177 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Hashimoto:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated February 23, 2003, concerning the subject project.

Please be assured that your buried cable group will be contacted to identify the underground telephone lines in the vicinity to eliminate accidental damage to your extensive network.

We appreciate your interest and participation in the environmental assessment review process. Your letter along with this response will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
SATO & ASSOC., INC.

Margret A. Tanner
41-691 Inoaole Street
Waimanalo, Hawaii 96795

05 January 2003

j
Henry Kennedy
Project Manager
Techn. Design Services Office
601 Kamokila Blvd.. Rm. 688
Kapolei, Hawaii 96707

Subject: HWY-DS-2.8871 – Replacement of Inoaole Stream Bridge

Dear Mr. Kennedy:

Thank you for providing me the opportunity to submit comments for this project.

The existing Native Hawaiian Medicinal Plants on the Mauka side of the bridge should be preserved as much as possible. Additionally a new access for equipment to enter on the Mauka/Kailua side of the stream is important for stream maintenance. The existing access from the polo field is inadequate for maintenance of the stream on both sides.

I would like to point out for consideration that stagnant water tends to collect at the Mauka side of the existing bridge. Mosquitoes and bacteria are a constant health problem. I am suggesting that the new bridge design enable continuous positive water flow from the mountains to the ocean.

I am requesting that noise due to increased traffic at Kalanianaole Hwy. will be addressed during the new bridge design. Maybe easing the turning radius and implementation of some kind of noise barrier could be incorporated to reduce noise pollution for families living at Hale Aupuni subdivision.

Please keep me advised of further design progress and sketches in the future.

Respectfully,

Margret A. Tanner

HWY-DS 2.5649

Ms. Margaret A. Tanner
41-691 Inoaole Street
Waimanalo, Hawaii 96795

Dear Ms. Tanner:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated January 5, 2003, concerning the subject project. We offer the following responses in the respective order of the comments:

1. The Draft EA will discuss that there were no plant species listed or proposed as candidates for threatened or endangered species with protection under Federal or State law in the project area.

2. The intent of the project is to improve the drainage opening and alleviate flooding of Kalanianaole Highway. The Highways Division will not be addressing the stream channel mauka of the highway since the State has no jurisdiction in those areas.

3. The Draft EA will discuss that the noise level near the project area is generally low due to the posted speed limit of 25 miles per hour. The new bridge will not affect the speed limit, thus, noise levels should not increase due to this project.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

RECEIVED
2004
SATO & ASSOC., INC.

Appendices

A Hydrologic and Hydraulic Report for Inoaole Stream Bridge, State of Hawaii, Department of Transportation, Highways Division, January 1996

B. Aquatic Resources Survey for Kalanianaole Highway Bridge Improvements at Inoaole Stream in Waimanalo, Oahu, AECOS, Inc., September 2000

C. Inoaole Stream Bridge Replacement Wetland Survey, Char & Associates, Inc., September 2000

D. General Best Management Practices Plan

E. Detour Road Study, Sato & Associates, Inc., November 2000

F. Historic Preservation Review, State Historic Preservation Division

G. Technical Assistance Consultation, U.S. Fish & Wildlife Service

APPENDIX A

Hydrologic and Hydraulic Report for Inoaole Stream Bridge, State of Hawaii, Department of Transportation, Highways Division, January 1996

HYDROLOGIC AND HYDRAULIC REPORT
for
INOAOLE STREAM BRIDGE

Kalanianaole Highway
Inoaole Stream Bridge Replacement
Project No.: 72A-01-90

Prepared by:

State of Hawaii
Department of Transportation
Highways Division
January 1996

TABLE OF CONTENTS

LIST OF FIGURES

DRAINAGE REPORT
INOAOLE STREAM CROSSING AT KALANIANAOLE HIGHWAY
ISLAND OF OAHU

Project Name and Number:

Kalanianaole Highway
Inoaole Stream Bridge Replacement
Project No.: 72A-01-90

I. INTRODUCTION

This report contains the hydrologic and hydraulic methods and computations for the proposed improvements of Inoaole Stream crossing at Kalanianaole Highway. The crossing is located just west of the Main Entrance Gate to Bellows Air Force Base, in Waimanalo. (See Figure 1 and 5)

II. SCOPE OF CONSTRUCTION WORK

Proposed construction work will include and not limited to the following:

A. Replacing existing single-box culvert with a 6-celled reinforced concrete box culvert at the Inoaole Stream - Kalanianaole Highway crossing. (See Figure 7)

B. Improving channel conditions upstream of the proposed culvert crossing.

C. Constructing temporary detour road on the makai side of Kalanianaole Highway.

D. Transitioning roadway approaches at the proposed culvert crossing.

E. Relocating existing CORPS and HTCO utilities.

F. Adjusting existing 12" RCP outlet.

III. EXISTING CONDITION

Box Culvert at Kalanianaole Highway:

On September 28, 1995, the Hydraulic Design Section conducted a field investigation at the proposed site. (See Figure 5 and Photos in Appendix III) Runoff from Inoaole Stream flows under Kalanianaole Highway via existing 13.5' x 4.5' concrete box culvert. (See Figure 4) The box culvert inverts at both the inlet and outlet ends are at a higher elevation than the stream invert. The difference in elevation is noticeable since the stream depth is estimated at 1' to 2' while the box culvert is virtually dry.

There are three utility lines aligned parallel to Kalanianaole Highway running through the box culvert opening. There is substantial amount of debris, mainly vines and small tree branches entangled around these utility lines decreasing the effective waterway opening. As-builts show that these utility lines belong to HTCO and the CORPS. As-builts also show an existing concrete-jacketed 18" sewer line aligned parallel to Kalanianaole Highway located adjacent to the upstream culvert headwall. Majority of the jacket is embedded in the inlet's bottom slab and cut-off wall. It appears that unless the existing sewer line can be lowered, the proposed culvert inlet elevation will be governed by the jacket's top elevation.

The channel upstream from the culvert is unimproved with embankments overgrown with weeds, shrubs, and trees; with invert overgrown with California grass. The Kaneohe-side embankment rises to a vertical height of approximately 20 feet with side-slope of approximately 3 to 1. Currently, there are several homes situated just beyond the top of embankment. The Waimanalo-side embankment rises to vertical height of approximately 10 feet with side-slopes of approximately 3 to 1. There is an existing bench area (gravel pathway) along the embankment that appears to be use for vehicular access.

The downstream channel is improved; trapezoidal in shape having a base width of approximately 54' with 2:1 side slopes. From a hydraulic standpoint, the channel is in good condition with minor vegetation growth along the toe of embankment. Both embankments are lined with "concrete sacks" that extends from the box culvert headwall to Hughes Road (Bellows AFB) crossing located approximately 500' downstream.

8-Cell Box Culvert at Hughes Road:

There is an 8-cell reinforced concrete box culvert located beneath Hughes Road approximately 500' downstream of Kalanianaole Highway. The culvert and approach sections are in good condition. The downstream channel is trapezoidal in shape with

dimensions similar to the improved section upstream. There is vegetation growth along both embankments. Overall, the downstream channel is stable and in good condition.

Steel Bridge Downstream of Hughes Road:

The steel bridge spans the entire width of the channel. There are steel beams running across the channel that may potentially become a waterway obstruction during high flood stages. From a hydraulic standpoint, the obstructions will not create a significant amount of backwater.

Concrete Box Culvert at Hihimanu Street (C & C of Honolulu):

The concrete box culvert and downstream channel appears to be inadequate to accommodate large flows. The dimensions of the box culvert is 13.5' x 2.75' with downstream embankment height approximately 3' to 5'. The inlet cutoff wall and wingwalls has been scoured approximately 1-2 feet below existing grade.

Our staff spoke with Harry Akagi-a Hihimanu Street resident, during the field investigation. Harry mentioned that overtopping occurred several times in the past resulting in hazardous roadway conditions; vehicular accidents, pavement washouts, rocks and other debris left on the roadway. At times, the flow overtops the downstream embankment flooding the existing polo field. Harry estimated that the water depth at the polo field during high floods ranges from 1-2'. There are two smaller culvert crossings beneath Hihimanu Street located Kaneohe-side of the box culvert. According to Harry, these crossing overflows, but not nearly as severe as the box culvert.

Drainage Along Kalanianaole Highway in Vicinity of Box Culvert:

Field observations indicate that runoff currently sheet flows off the pavement and into either Inoaole Stream, or nearby earth ditches. There is an existing 12" RCP located on the Makai-Waimanalo side shoulder area. Runoff contributing to the 12" RCP appears to be from the grassy area adjacent to the Bellows AFB Main Entrance. Runoff from the grassy area sheet flows into an existing roadside ditch and into the 12" RCP. The inlet has no headwall and the pipe outlet ends at the "concrete sack" embankment.

IV. BACKGROUND OF PAST FLOODING PROBLEMS

Inoaole Stream Bridge at Kalanianaole Highway has had several flooding problems in the past; overtopping of the highway and

flooding of the existing polo field located on the Mauka-Waimanalo side of the culvert crossing. The most recent floods occurred on March 23, 1991, January of 1990, and January of 1988. The March 23th flood recorded a 930 cfs flow rate at the Hihimanu Street Gage Station. On numerous occasions, traffic along Kalanianaole Highway had to be rerouted as Highways Division maintenance crew were called upon to remove roadway debris.

V. LEVEL 1: QUALITATIVE ANALYSES

Stream Characteristics:

The stream characteristics were based on field investigation conducted on September 28, 1995, and the USGS 7.5 Minute Series topographic maps. The results of the evaluation are summarized in Figure 6.

Evaluate Land Use Changes:

Records of historical changes in land use are unavailable. Current land use in the upper portion of the watershed (Elevations 200'-2000') are undeveloped and heavily vegetated. The USGS map also shows existing irrigation ditches and flumes in the upper portion indicating presents of agricultural growth. The lower portion is considered rural, consisting of undeveloped land, as well as residents and business developments.

Field observations from Kalanianaole Highway and Hihimanu Street stream crossings indicate that the watershed's overall condition can be considered as "heavily vegetated".

Assess Overall Stream Stability:

The existing stream in the vicinity of the Kalanianaole Highway crossing is slightly curved. (See Figure 3) Field observations show the upstream banks and invert heavily vegetated. The downstream channel alignment is straight and uniformed with side slopes protected with concrete sacks. The downstream invert consist mainly of silt-clay material and minor vegetation overgrowth. There was no indication of erosion in the vicinity of the proposed site. Overall assessment of the stream stability is good.

Evaluate Lateral Stability:

There are no signs of bank failures or lateral stream migration

along the existing channel. Field conditions show that the embankments both up and downstream are stable.

Evaluate Vertical Stability:

Field observation show no signs of erosion or undermining of the existing box culvert. Although the current stream invert is approximately 1'-2' below the invert of the culvert, as-builts show that the culvert was originally designed and constructed as such.

Evaluate Channel Response to Change:

The existing channel upstream will be widened and excavated to accommodate the proposed 6-cell box culvert. Minor erosion is anticipated during and after the reconstruction of the embankments until vegetation has been reestablished. The proposed side-slopes will be graded no steeper than the existing side-slopes to minimize erosion.

VI. LEVEL II ANALYSIS

A. HYDROLOGY (See Appendix I for calculations)

Description of Drainage Area:

The drainage basin contributing to Inoaole stream extends from the existing box culvert beneath Kalanianaole Highway to the upper ridges of the Kooalau mountain range. (See Figure 2) The slope ranges from approximately 40-95 percent near the ridges and gradually flattens to 0.5 to 5 percent at the lower end near the highway crossing. Majority of the land use, especially in the upper slopes is undeveloped. There are some developed areas, mainly residential in the lower lying areas of the drainage basin.

There exists a main stream (Inoaole) and two feeders contributing to the flow at Inoaole Stream Bridge. Each of the streams flow separately beneath Hihimanu Street and eventually merges into a single stream just mauka of Kalanianaole Highway. All stream flows are intermittent.

Criteria:

The following are the criteria used to calculate the peak flow:

Recurrence Interval - 50 and 100 years
Storm Duration - 6 hours (SCS and Rational Formula)

Note: No correction factor (Cf) was used in the Rational Formula computations.

Hydrology Methods Considered in Determining Peak Runoff:

1. Soils Conservation Services
2. Design Curves for Peak Discharge
3. Rational Formula
4. Log-Pearson Type III
5. Regression Method

Results of the Hydrology Calculations:

Drainage Area = 2.38 square miles (1523 acres)
Time of Concentration (Tc) = 103 minutes
50 yr rainfall frequency (I50) = 9.5 in/hr.
100 yr rainfall frequency (I100) = 10.5 in/hr.
Runoff Coefficient (C) = 0.3

	Q50 (cfs)	Q100 (cfs)
SCS Method	3600	4000
Rational Method	4300	4800
Design Curves	Peak Discharge= 9000	
Log-Pearson Type III (1.22 acres-Hihimanu)	2000*	2300*
Log-Pearson Type III (2.38 acres-projected)	3900**	4500**
Regression	7100	8900

* The Log-Pearson Type III method was based on data collected from an existing gage station located near the intersection of Hihimanu street and Inoaole Stream. The drainage basin area above the gage station is approximately 1.22 square miles (780 acres). The 50 and 100 year discharges were developed based on the highest annual peak flows that occurred in the past 35 years. The annual peak flows ranged from 20 cfs to 1600 cfs.

** The projected discharge values were interpolated using a multiplying factor of 1.95 based on the additional drainage basin

area contributing to Inoaole Stream at Kalanianaole Highway. (2.38 ac / 1.22 ac = 1.95)

From previous experience with estimating peak runoff for various streams, the Soils Conservation Services Method (SCS) and the Log Pearson Type III Method are generally most reliable. Based on the hydrology results, the SCS discharge values and the projected Log Pearson discharge values were similar. For the hydraulic analysis of the proposed design, runoff values will be determined by taking the average of both methods. The results are as follows:

Q50 = 3700 cfs and

Q100 = 4300 cfs

B. HYDRAULICS (See Appendix II for calculations)

Design Criteria:

The hydraulic analysis of the existing and proposed channels were calculated using the Manning's and Continuity Equations. Channel sections were derived from a 20 scale topographic map.

Manning's Equation: $Q = (1.486/n)(A)(R)^{2/3}(S)^{1/2}$

Continuity Equation: $Q = VA$

Analysis of existing and proposed box culverts were calculated using the HYDRAIN Program Version 5.0 and HEC #12 "Hydraulic Design of Highways".

Backwater computations were not performed since the proposed culvert span is anticipated to be equal or greater than the stream channel bottom. The approach embankments at the culvert will not be extended into the normal channel section.

Capacity of culverts was based on "0" freeboard.

Only the analysis of the rectangular reinforced concrete boxes will be included in this report. The dimensions of each concrete box "cell" will be 12' x 4.75'. The invert elevation of the existing and proposed box culvert at Kalanianaole Highway will remain the same.

The results of the channel and culvert analysis are tabulated below:

Channel Location	"n"	d (ft)	V (ft/s)	Froude No.
Upstream of Kal Hwy (Existing)	0.04	8.9	5.7	0.33
Upstream of Kal Hwy (Proposed)	0.04	8.6	5.7	0.34
Downstream of Kal Hwy	0.033	7.8	6.7	0.43
Downstream of Hughes Road	0.035	7.7	6.2	0.39

Culvert Crossing Location	Capacity (cfs)
Existing Culvert @ Hihimanu Street	260
Existing Culvert @ Kal Hwy	470
Existing 8-Cell Culvert @ Hughes Road	2510

Culvert Crossing Location	Capacity (cfs)
Alternative 4-Cell Culvert @ Kal Hwy	1890
Alternative 5-Cell Culvert @ Kal Hwy	2360
Alternative 6-Cell Culvert @ Kal Hwy	2840
Alternative 7-Cell Culvert @ Kal Hwy	3250
Alternative 8-Cell Culvert @ Kal Hwy	3330
Alternative 9-Cell Culvert @ Kal Hwy	3360
Alternative 10-Cell Culvert @ Kal Hwy	3670

Calculations show that a box culvert design of approximately 10-12'x 4.75' will be required to pass the 50 year flow under Kalanianaole Highway without overtopping. (Q50=3700 cfs) Calculations also show that the water surface elevations at the existing downstream channel will be at the top of embankment. On the upstream side, calculations show that the flow will overtop the Waimanalo-side embankment and possibly flood Kalanianaole Highway.

Spanning 10- 12'x 4.75' box culvert will require a minimum channel width of 130'. Currently, the existing channel width upstream ranges from 35' to 55' and the existing downstream channel width is approximately 55'. A considerable amount of construction work; widening and raising the embankments to contain the flow within the stream, raising the approach sections of Kalanianaole Highway, acquiring new R/W, relocating electrical power poles and gravel roadways will need to be done for a 10-cell box culvert to function as designed without overtopping the highway and embankment approaches. Improvements to the overall stream system; from Kalanianaole Highway to Hihimanu Street will also be necessary to alleviate flooding to the floodplain areas mauka of the highway.

The CORPS of Engineers has recently improved the section downstream from Kalanianaole Highway. The improvements included lining of the channel embankments, and adding 6- 10.5'x 6' concrete box culvert at the Hughes Road crossing. According to the hydraulics report done by the CORPS, the capacity of the Hughes Road culvert system was calculated at 2430 cfs. The Hydraulic Design Section performed a independent hydraulic analysis that show the culverts capacity to be 2510 cfs.

VII. DESIGN AND CONSTRUCTION

Based on the present field conditions, the recent improvements done by the CORPS downstream, and results from our hydrologic and hydraulic analysis, the Inoaole stream crossing at Kalanianaole Highway will be designed using on the following criteria:

A. The proposed culvert(s) crossing at Kalanianaole Highway shall have a capacity of equal or greater then the improved downstream channel and the culvert system under Hughes Road. (Q=2510 cfs minimum)

B. The proposed culvert(s) shall at minimum, span the downstream channel width and be provided with the largest waterway opening possible.

C. Since the existing stream bed elevation will be lower than the proposed culvert invert, protection of the proposed inlet and outlet are recommended.

Based on the above criteria, 6- 12'x 4.75' rectangular concrete box culvert will be designed for the Kalanianaole Highway crossing. (See Figure 7) Hydrologic analysis was further performed to determine the equivalent recurrence interval for a culvert capacity of 2840 cfs. Additional peak flows using recurrence intervals of 5, 10, and 25 years were calculated using the SCS method.

The results are as follows:

Recurrence Interval (yr)	Flow Q (cfs)
5	1780
10	2270
25	2720

The Recurrence Interval -vs- Flow Q were plotted on a log-log graph paper. Through extrapolation, the 6- 12'x 4.75' concrete box culvert will accommodate a flow capacity equal to a **30 year-6 hours** recurrence interval.

Our calculations also show that the capacity of the proposed box culvert system will be approximately six times greater than the existing box culvert. (2840 cfs -vs- 470 cfs).

Dumped riprap w/ filter (granular or fabric) should be constructed along the proposed Kailua-side embankment.

Dumped riprap in conjunction with concrete cutoff walls should be designed at both inlet and outlet ends of the structure to prevent undermining.

VIII. REFERENCES:

DESIGN CRITERIA FOR HIGHWAY DRAINAGE State of Hawaii, Department of Transportation, Highways Division; December 1985.

SCS NATIONAL ENGINEERING HANDBOOK Section 4-Hydrology, SCS Conservation Services U.S. Department of Agriculture; August 1972.

STORM DRAINAGE STANDARDS City and County of Honolulu, Division of Engineering; May 1988.

AN INVESTIGATION OF FLOODS IN HAWAII THROUGH SEPTEMBER 30, 1972 U.S. Department of the Interior, Water Resources Division; March 1973.

WATER RESOURCES DATA HAWAII AND OTHER PACIFIC AREAS WATER YEARS 1973-1974 U.S. Department of the Interior, Water Resources Division; 1973 thru 1994.

TECHNICAL PAPER NO. 43 RAINFALL-FREQUENCY ATLAS OF THE HAWAIIAN ISLANDS U.S. Department of Commerce Weather Bureau; 1962.

AN ANALYSIS OF THE MAGNITUDE AND FREQUENCY OF FLOODS ON OAHU, HAWAII U.S. Geological Survey, Water-Resources Investigation 80-45; June 1980.

USGS TOPOGRAPHIC MAP, ISLAND OF OAHU, 7.5 Minute Series; 1983.

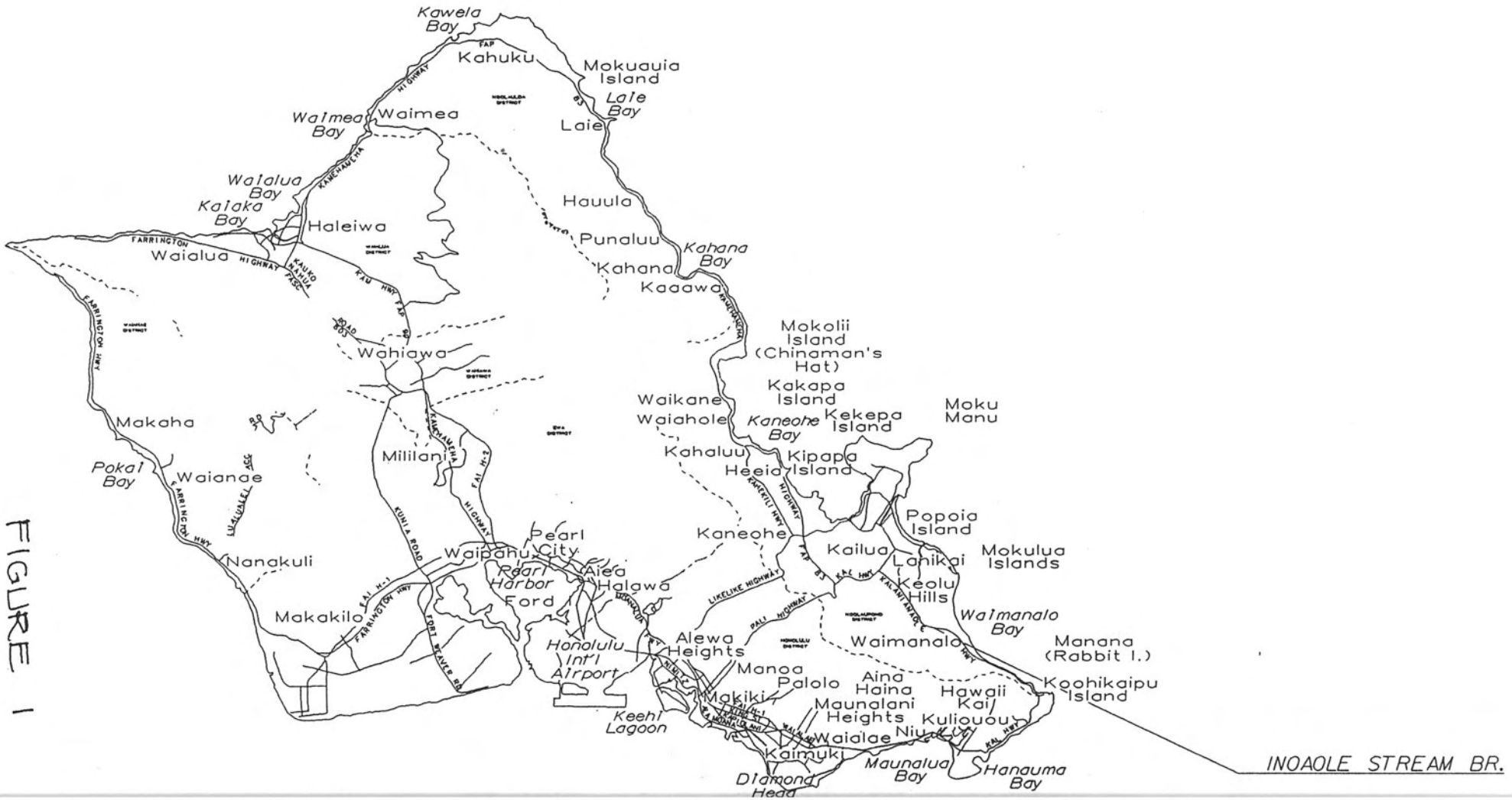

Kawela Bay
Kahuku
Mokuauia Island
Laie Bay
Laie
Waimea Bay
Waimea
Waialua Bay
Kaiaka Bay
Haleiwa
Hauula
Punaluu
Kahana Bay
Kahana
Kaaawa
Waialua
Wahiawa
Mokolii Island (Chinaman's Hat)
Kakapa Island
Waikane
Waiahole
Kaneohe Bay
Kekepa Island
Moku Manu
Kahaluu
Kipapa
Heeia Island
Makaha
Pokai Bay
Waianae
Mililani
Popoia Island
Kaneohe
Pearl City
Waipahu
Kailua
Lanikai
Mokulua Islands
Nanakuli
Pearl Harbor
Aiea
Halawa
Keolu Hills
Ford
Waimanalo Bay
Makakilo
Alewa Heights
Waimanalo
Manana (Rabbit I.)
Honolulu Int'l Airport
Manoa
Palolo
Aina Haina
Hawaii Kai
Koohikaipu Island
Makiki
Maunalani Heights
Kuliouou
Keehi Lagoon
Waialae
Niu
Kaimuki
Maunalua Bay
Hanauma Bay
Diamond Head
INOAOLE STREAM BR.

FIGURE 1

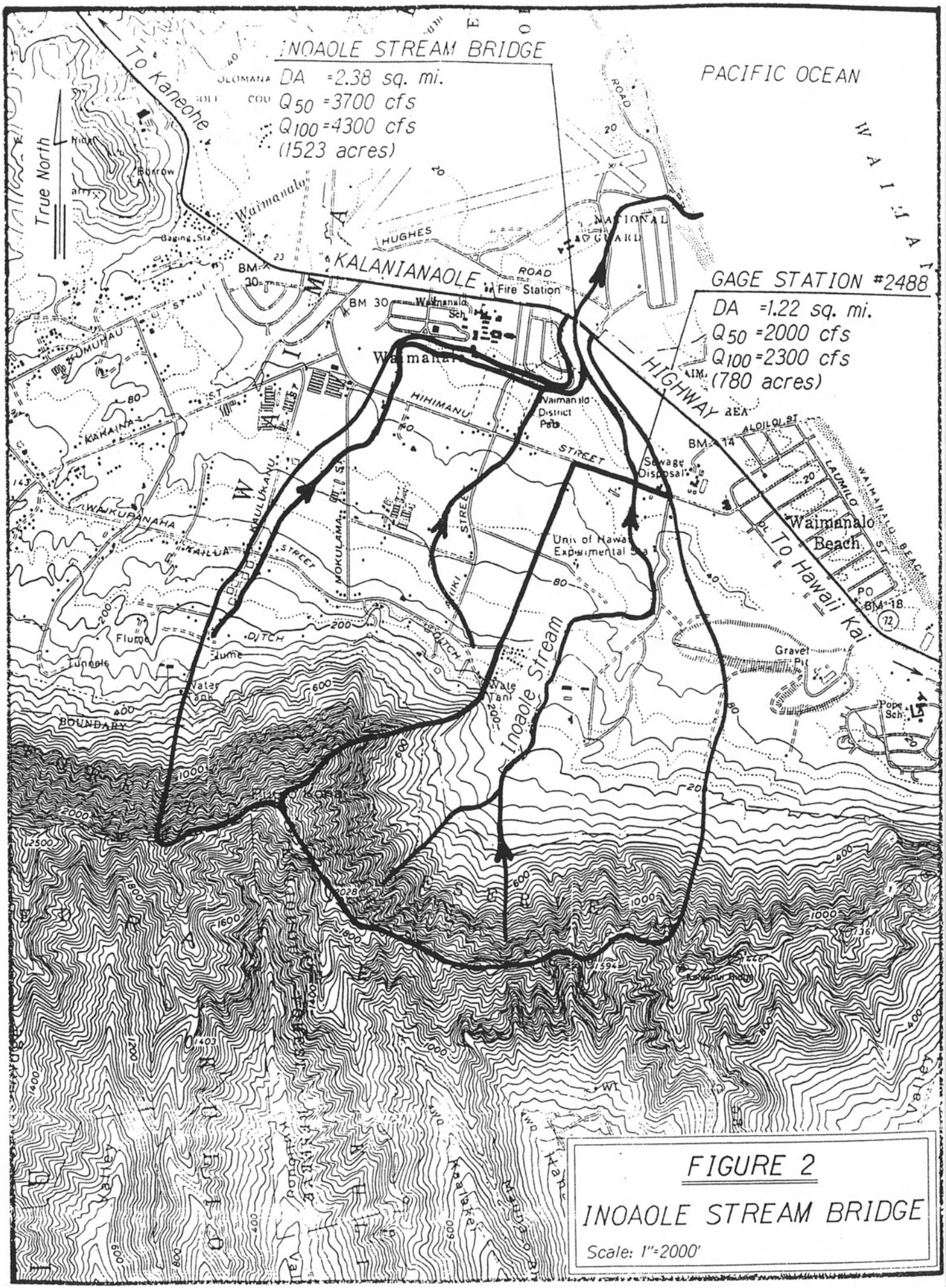
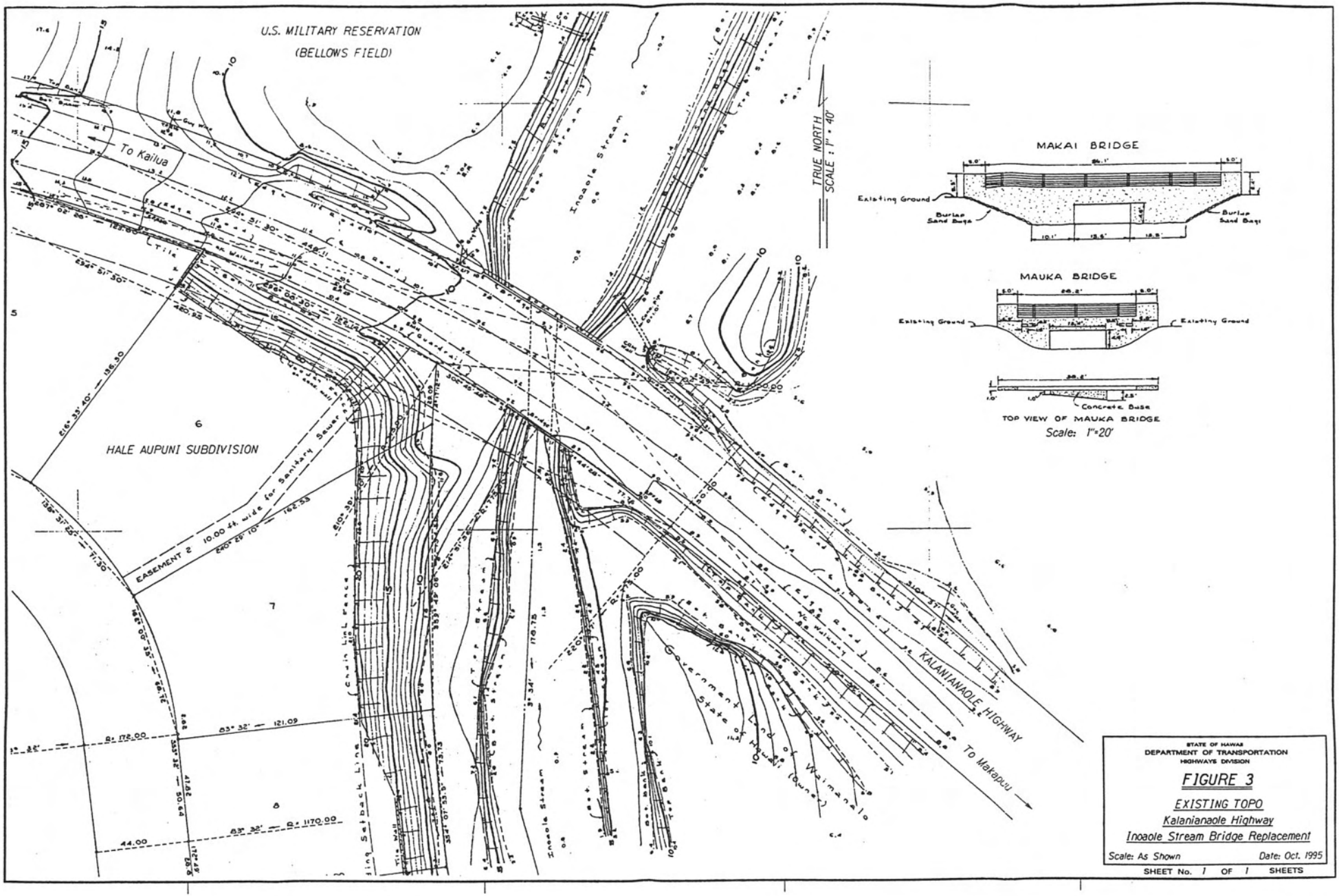


FIGURE 2

INOAOLE STREAM BRIDGE

Scale: 1"=2000'



STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

FIGURE 3

EXISTING TOPO
Kalanianaole Highway
Inoaole Stream Bridge Replacement

Scale: As Shown Date: Oct. 1995

SHEET No. 1 OF 1 SHEETS

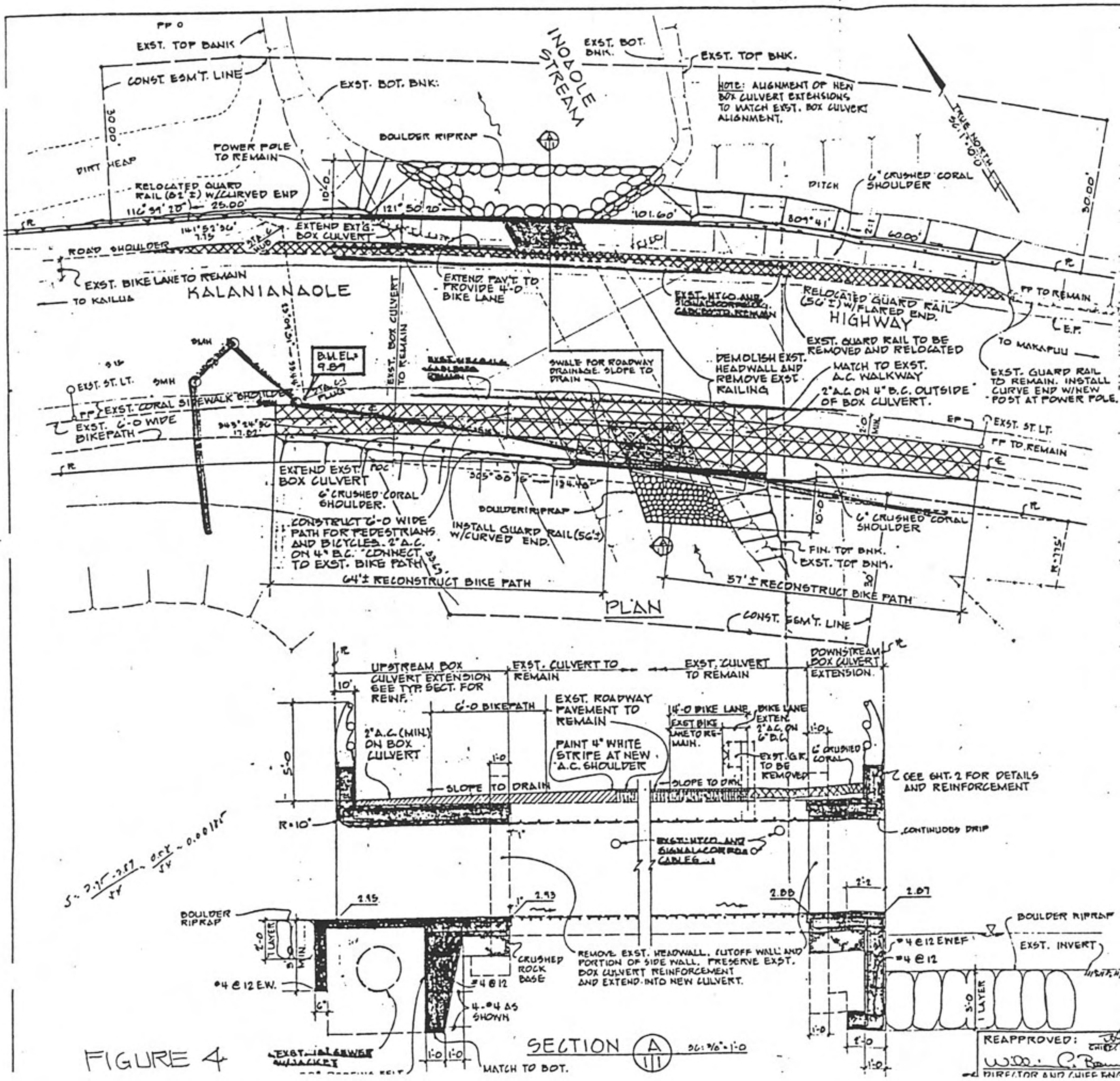


FIGURE 4

GENERAL NOTES:

I. DESIGN DATA
A. LOADING:
LIVE LOAD: HS 20-44 (AASHTO, 1977)
COVER: 1.0 FT. (MAX.)
B. ALLOWABLE STRESSES
CONCRETE
f'c = 3000 psi @ 28 DAYS
fc = 1200 psi @ 28 DAYS
MILD STEEL
fs = 20,000 psi

II. GENERAL
A. THE CONTRACTOR SHALL VERIFY ALL EXISTING CONDITIONS BEFORE COMMENCING WITH THE WORK.
B. ALL CONSTRUCTION SHALL BE DONE IN ACCORDANCE WITH THE STANDARD DETAILS, D.P.W. AUG. 1976 AND THE STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION MAY 1975, C & C OF HONOLULU.
C. THE CONTRACTOR SHALL PROVIDE A 5'-0 WIDE WALKWAY FOR PEDESTRIAN TRAFFIC AT ALL TIMES.

III. GRADING
A. ALL GRADING WORK SHALL CONFORM TO CHAPTER 23, REVISED ORDINANCES OF HONOLULU 1978, AS AMENDED (ORDINANCE NOS. 3960, 4294, AND 4558).
B. THE CONTRACTOR SHALL REMOVE ALL SILT AND DEBRIS RESULTING FROM HIS WORK AND DEPOSITED IN DRAINAGE FACILITIES, ROADWAYS AND OTHER AREAS. THE COSTS INCURRED FOR ANY NECESSARY REMEDIAL ACTION BY THE CHIEF ENGINEER SHALL BE PAID BY THE CONTRACTOR.
C. THE CONTRACTOR, AT HIS OWN EXPENSE, SHALL KEEP THE PROJECT AREA AND SURROUNDING AREA FREE FROM DUST NUISANCE. THE WORK SHALL BE IN CONFORMANCE WITH THE AIR POLLUTION CONTROL STANDARDS AND REGULATIONS OF THE STATE DEPARTMENT OF HEALTH.

IV. FOUNDATION AND FILL
A. ALL FOUNDATIONS SHALL REST ON FIRM, UNDISTURBED GROUND.
B. ALL FILL MATERIALS SHALL BE NON-EXPANSIVE, FREE FROM ORGANIC AND OTHER DELETERIOUS MATTER AND COMPACTED IN 6" LAYERS TO 95% OF AASHTO T180-57.

V. MATERIALS
A. CONCRETE
1. ALL CONCRETE SHALL BE C & C CLASS "A" CONCRETE.
2. EXPOSED CORNERS OF CONCRETE SHALL RECEIVE A ROUNDED TOOL EDGE.
B. REINFORCING
1. ALL REINFORCING BARS SHALL CONFORM TO ASTM DESIGNATION A 615, GRADE 40.
2. ALL CONTINUOUS REINFORCING BARS SHALL BE LAPPED 34 BAR DIAMETERS (1'-9" MIN.) AT ALL SPLICES, CORNERS, AND INTERSECTIONS UNLESS OTHERWISE SHOWN. STAGGER SPLICES WHENEVER POSSIBLE.
3. UNLESS SHOWN OTHERWISE CONCRETE COVER OVER REINFORCING BARS SHALL BE AS FOLLOWS:
a. SOFFIT OF TOP SLAB = 2" CLEAR
b. SOFFIT OF BOTTOM SLAB = 3" CLEAR
c. SLABS AND WALLS = 2" CLEAR
d. ALL OTHERS = 2" CLEAR

VI. HAWAIIAN TELEPHONE & HAWAIIAN ELECTRIC NOTE:
A. THE CONTRACTOR SHALL EXERCISE CAUTION AND MAINTAIN ADEQUATE CLEARANCE FOR HIS EQUIPMENT AT ALL TIMES WHEN WORKING BENEATH OR NEAR THE OVERHEAD LINES.

VII. SEWER NOTE:
A. THE CONTRACTOR SHALL EXERCISE CAUTION WHEN WORKING AROUND THE SEWER LINE AND JACKET. NO CONSTRUCTION EQUIPMENT WILL BE ALLOWED TO CROSS OVER THE JACKET.

VIII. TRAFFIC NOTES:
A. A PERMIT SHALL BE OBTAINED FROM THE DEPARTMENT OF TRANSPORTATION SERVICES BEFORE WORK ON ANY PORTION OF A PUBLIC STREET OR HIGHWAY MAY BEGIN.
B. THE CONTRACTOR SHALL PROVIDE, INSTALL, AND MAINTAIN ALL NECESSARY SIGNS AND OTHER PROTECTIVE FACILITIES, WHICH SHALL CONFORM WITH THE "RULES AND REGULATIONS GOVERNING THE USE OF TRAFFIC CONTROL DEVICES AT WORK SITES ON OR ADJACENT TO PUBLIC STREETS AND HIGHWAYS" ADOPTED BY THE HIGHWAY SAFETY COORDINATOR, AND THE FEDERAL HIGHWAY ADMINISTRATION'S "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS, PART VI-TRAFFIC CONTROLS FOR HIGHWAY CONSTRUCTION AND MAINTENANCE OPERATIONS.
C. WORK ON ANY CITY STREET AREA MAY BE PERFORMED ONLY BETWEEN THE HOURS OF 8:00 A.M. TO 3:30 P.M., MONDAY THROUGH FRIDAY, UNLESS OTHERWISE PERMITTED BY THE DEPARTMENT OF TRANSPORTATION SERVICES.
D. DURING WORKING HOURS, THE CONTRACTOR SHALL MAINTAIN A ROADWAY SUITABLE FOR TWO-WAY TRAFFIC. DURING NON WORKING HOURS, ALL TRENCHES SHALL BE COVERED WITH A SAFE NON-SKID BRIDGING MATERIAL.
E. AS REQUIRED BY THE DEPARTMENT OF TRANSPORTATION SERVICES, THE CONTRACTOR SHALL HIRE SPECIAL DUTY POLICE OFFICERS TO CONTROL THE FLOW OF TRAFFIC.
F. WHERE PEDESTRIAN WALKWA[YS EXIST] THEY SHALL BE MAINTAINED [IN SAFE] CONDITION OR OTHER FACILI[TIES FOR] PEDESTRIANS SHALL BE PR[OVIDED.] PASSAGE BETWEEN WALKWA[YS AT] INTERSECTIONS SHALL LIKEW[ISE BE] PROVIDED.
G. THE CONTRACTOR SHALL R[ESTORE] TRAFFIC SIGNS, POSTS AN[D] MARKINGS DISTURBED DU[RING] CONSTRUCTION. (SEE SHT. [...]) ADDITIONAL TRAFFIC NOTES[...]
H. THE CONTRACTOR SHALL REST[ORE] PAVEMENT AND BIKE LANE LI[NES...] LIMITS OF WORK AS REQUIR[ED BY] D.T.S.

IX. ELECTRICAL & MAINTENANCE SE[RVICES] DIVISION NOTES:
A. THE CONTRACTOR SHALL NOT[IFY THE] POLE COMMITTEE TWO (2) W[EEKS IN] ADVANCE OF ANY RELOCATI[ON OF ANY] POLE THAT MAY BE NECESS[ARY.]
B. STREET LIGHTING SHALL BE [OPER]ATIONAL DURING CONSTRU[CTION.] RELOCATION REQUIRED SH[ALL BE] APPROVED BY THE ELECTR[ICAL &] MAINTENANCE SERVICES DI[VISION,] DEPARTMENT OF TRANSPOR[TATION] SERVICES AND PAID FOR BY [THE CON]TRACTOR.
C. THE CONTRACTOR SHALL BE [RESPON]SIBLE FOR ANY DAMAGES TO [THE] STREET LIGHTING FACILITI[ES.] DAMAGES SHALL BE REPAI[RED BY THE] CONTRACTOR.

DATE OF FINAL INSPECTIO[N]

APPROVED:
DIRECTOR AND CHIEF ENGINEER, DPW
DIRECTOR, DEPT. OF TRANSP. SERVIC[ES]

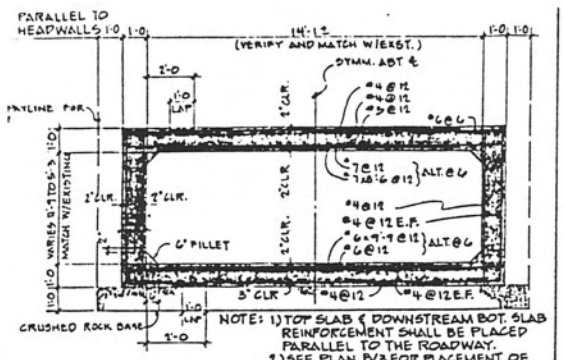
NO.	DATE	DESCRIPTION
		REVISIONS

DEPARTMENT OF PUBLIC WOR[KS]
CITY AND COUNTY OF HONOLULU
DIVISION OF ENGINEERI[NG]
KALANIANAOLE HWY.
CULVERT @ INOAOLE [STREAM]
WAIMANALO, OAHU,
PLAN & SECTIO[N]

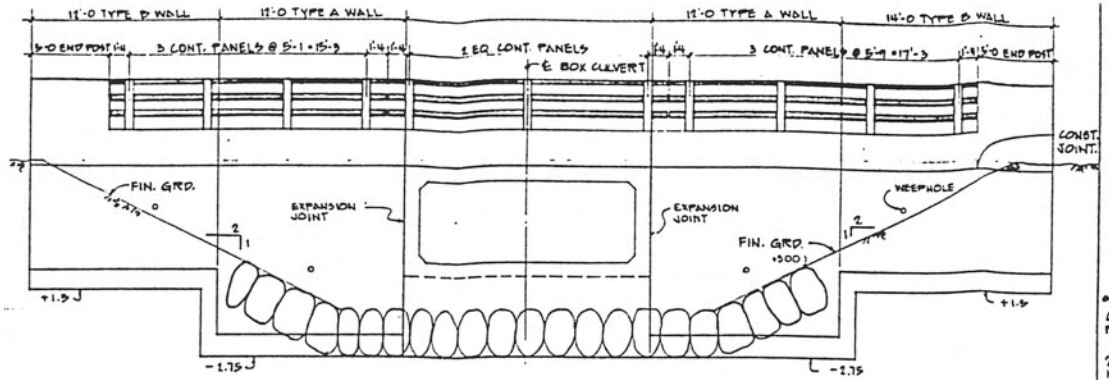
REAPPROVED: CHIEF, DIVISION OF ENGINEERING 6/30/83 DIRECTOR AND CHIEF ENGINEER DPW DATE

REAPPROVED: DIRECTOR, DEPT. OF TRANSP. SERVICES DATE

JOB NO. 28-82 (DD-72A-0[...]



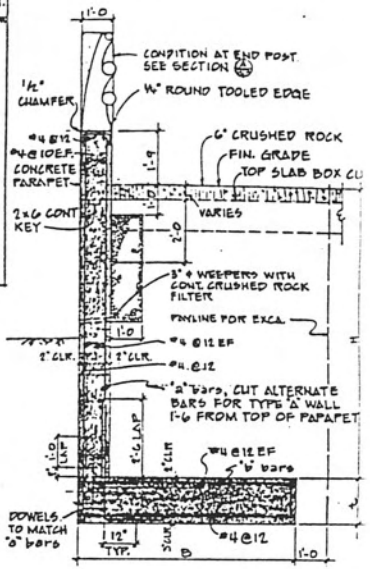
TYPICAL SECTION SC: 3/8" = 1'-0



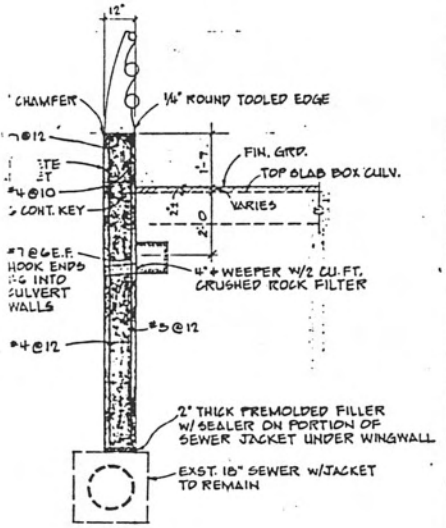
DOWN STREAM ELEV. SC: 1/4" = 1'-0

TABLE

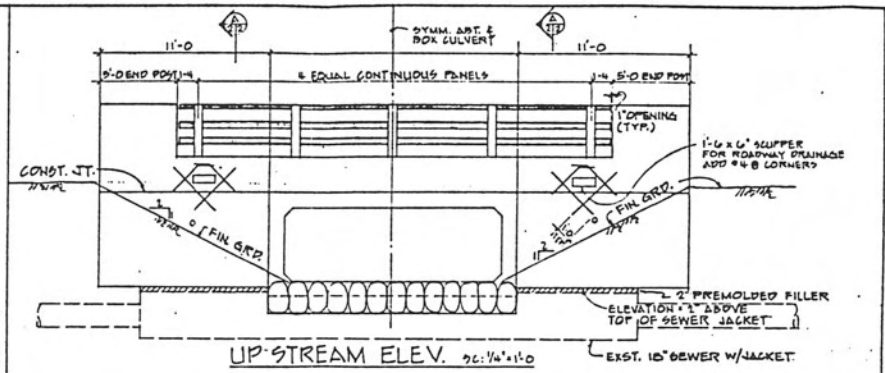
TYPE WALL	H	B	t	a bars	b bars
A	11.5	7'-6	1'-6	#7@6	#7@6
B	7.0	5'-6	1'-3	#7@12	#7@12



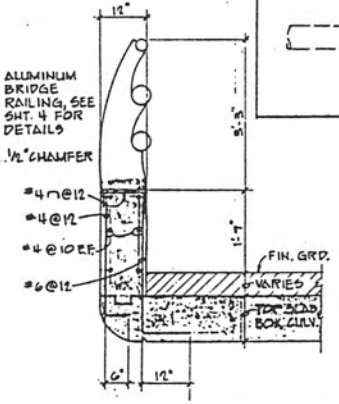
DOWNSTREAM WINGWALL SECTION SC:



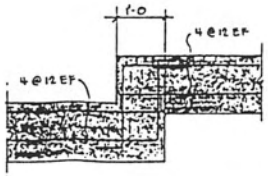
SECT. A 2/2 SC: 1½" = 1'-0



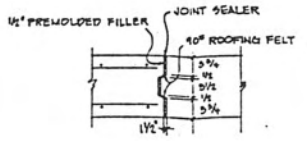
UP STREAM ELEV. SC: 1/4" = 1'-0



TYP. RAILING SECT. SC: 3/4" = 1'-0



STEPPED FOOTING DETAIL SC: 3/4" = 1'-0



EXPANSION JOINT DETAIL SC: 1" = 1'-0

NO	DATE	DESCRIPTION	ENGR
REVISIONS			

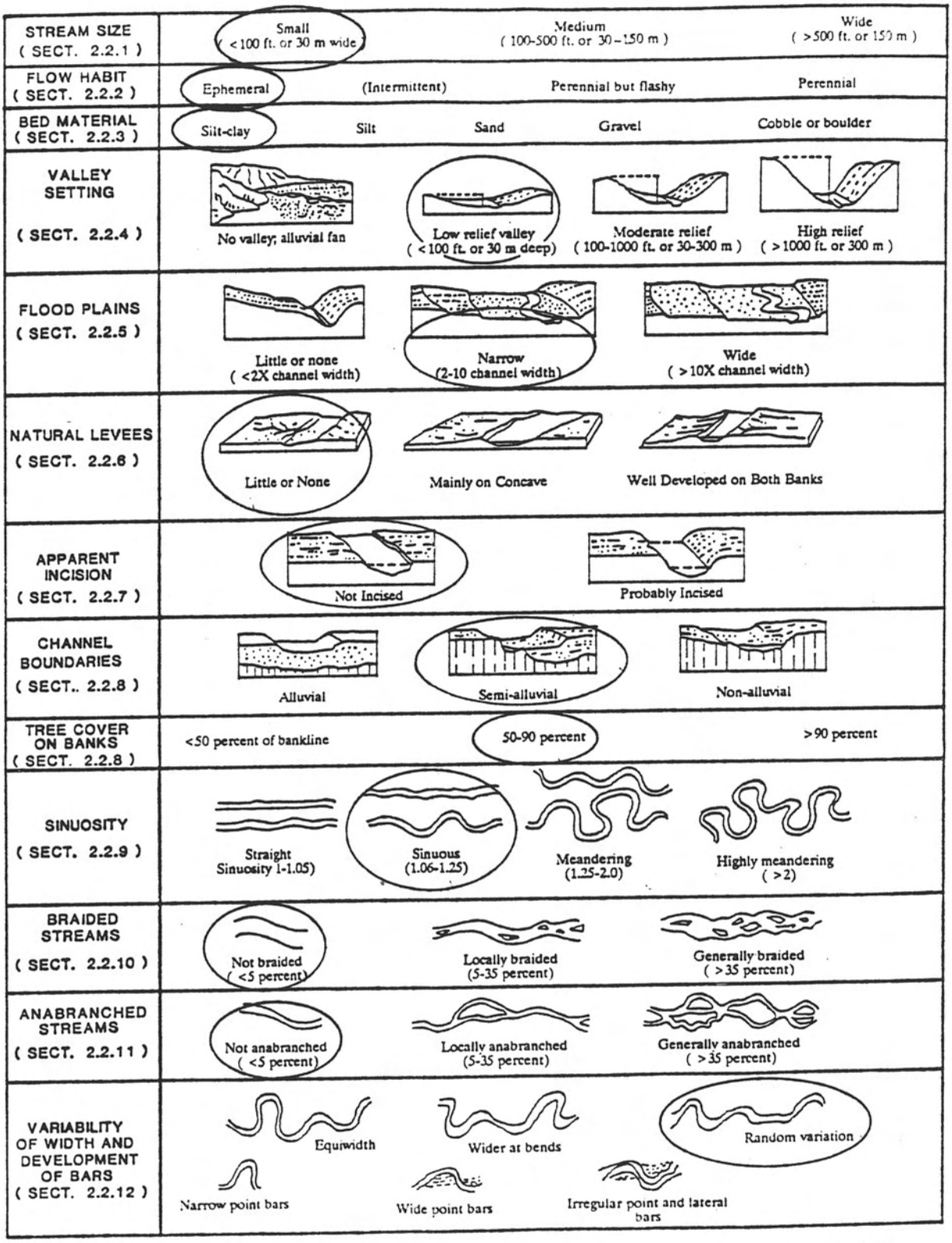
DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
DIVISION OF ENGINEERING
KALANIANAOLE HWY. BOX CULVERT @ INOAOLE STR
WAIMANALO, OAHU, HAWAII
DETAILS

DESIGNED RH DATE 7/23/81
DETAILED AR CHECKED DT
APPROVED 7/9/82
RECOMMENDED 7/5/82

JOB NO. 28-82 IDD-72A-01-8

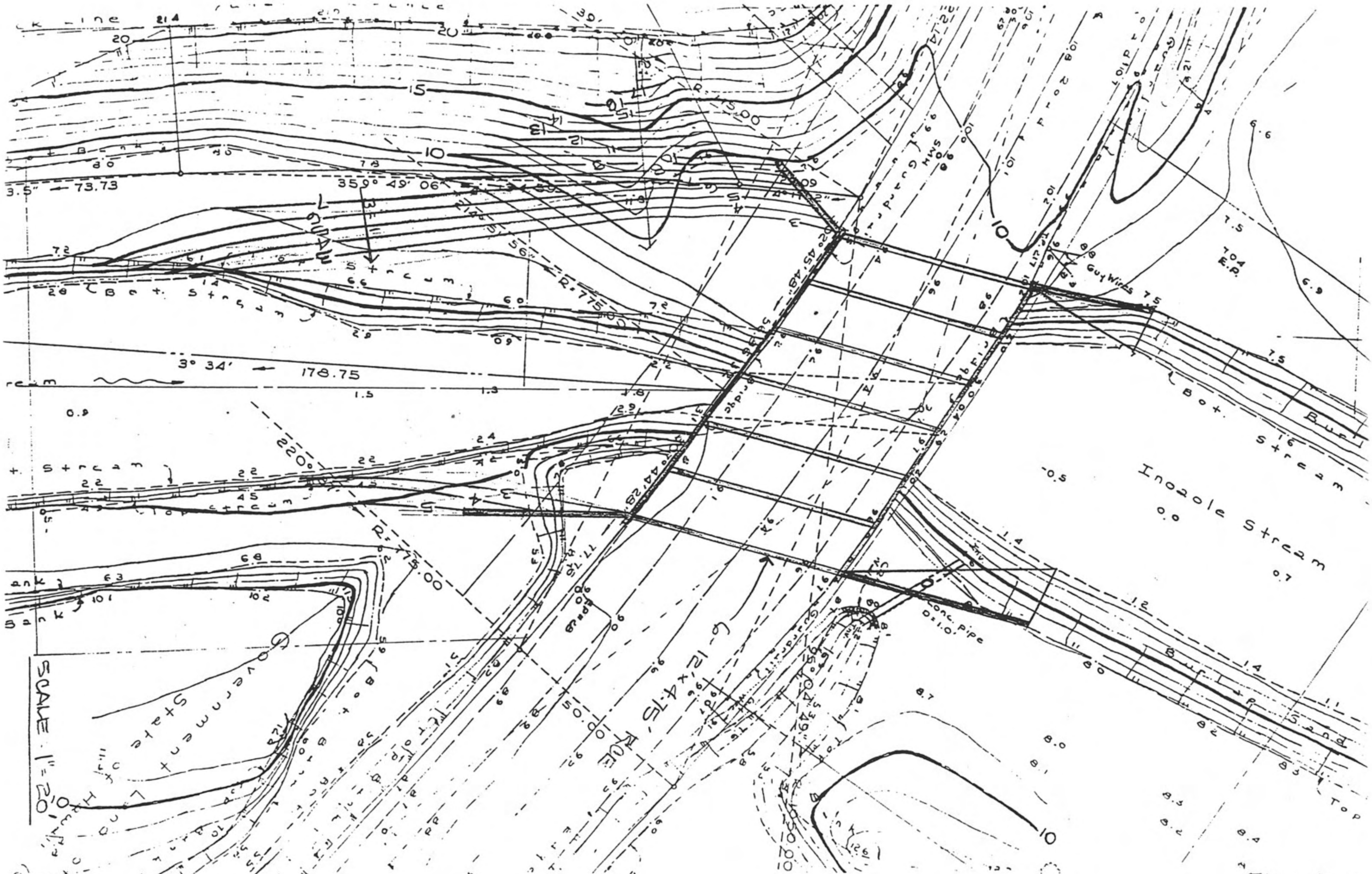
Sheet 2 of 4 Sheets

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
FIGURE 5
VICINITY MAP
Kalanianaole Highway
Inoaole Stream Bridge Replacement
Scale: 1"=1,000'
Date: Oct. 1995
SHEET No. 1 OF 1 SHEETS
TRUE NORTH
AIR FORCE
COMMUNICATION SYSTEM
BASE
BELLOWS AFB
KALANIANAOLE HWY.
CONCRETE BOX CULVERT
STEEL BRIDGE
INOAOLE STREAM OUTLET
HUGHES ROAD
8-CELL BOX CULVERT
HUGHES ROAD
KALANIANAOLE HIGHWAY
Waimanalo Sch
Waimanalo
HIHIMANU STREET
POLO FIELD
Crest-stage gage 2488
Univ of Hawaii Experimental Sta
AHIKI STREET
HIHIMANU ST. CONCRETE BOX CULVERT
PUUOLU STREET
TAUMILO ST
WAIMANALO BEACH
Waimanalo Beach
Stream
Water
Inoaole
DITCH
FOOT



Geomorphic factors that affect stream stability (Adapted from [1]).

FIGURE 6



Inozole Stream
Bot. Stream
6-12'x4.75' RCE
Guardrail
Bridge
Guy Wires 7.5
SMH
Conc. Pipe
Government State
SCALE 1" = 20'
178.75
3° 34'
359° 49' 06"
R=775.00
77.75
50.00
220°
3.5" — 73.73

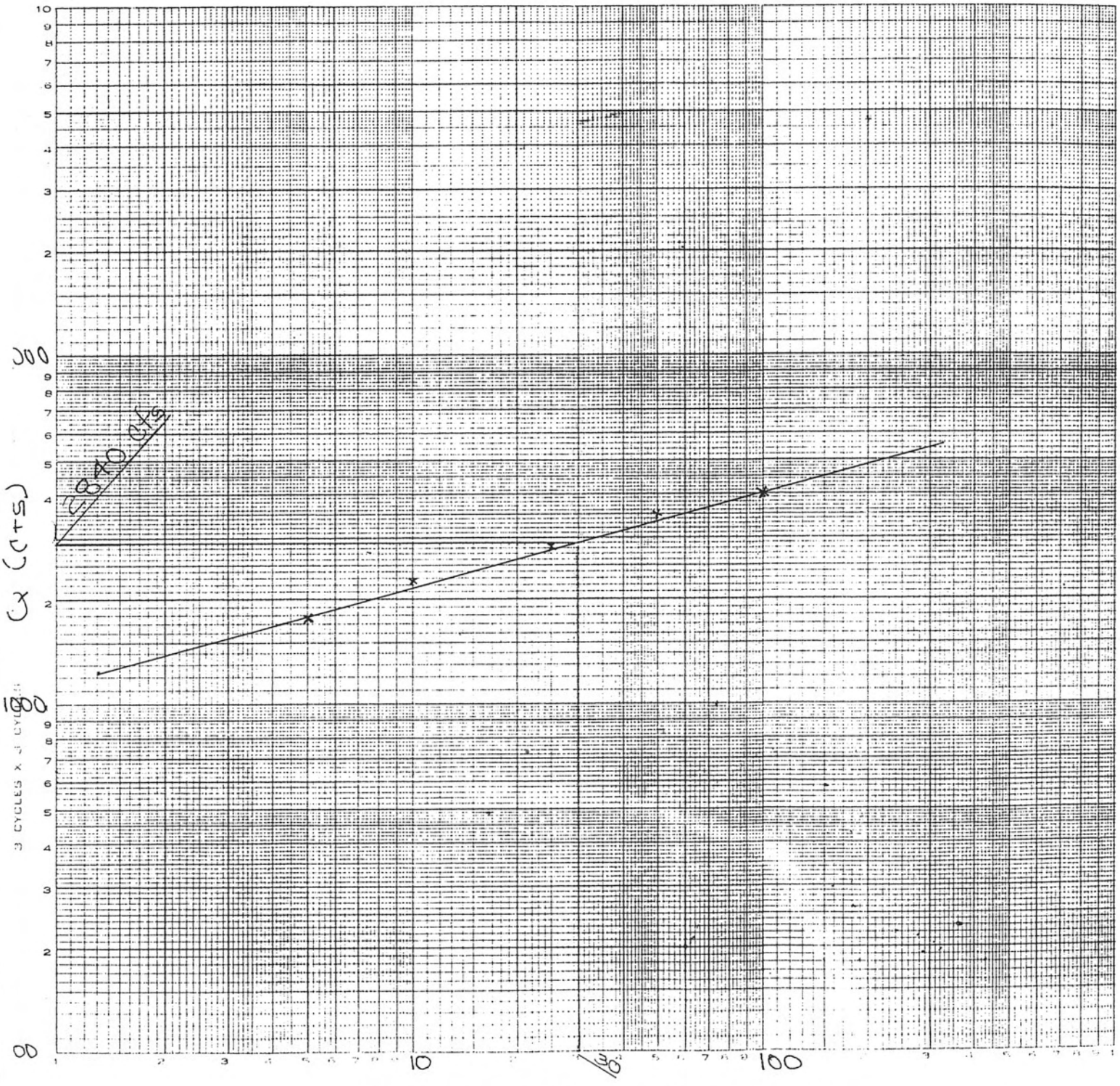
FIGURE 7

APPENDIX I

HYDROLOGY CALCULATIONS

IA. Summary of Soils Conservation Services Method

SOILS CONSERVATION SERVICES



50YR - 6 HR

HYDROGRAPH COMPUTATION

DATE 10-9-95
COMPUTED BY CMATSUDA
CHECKED BY

WATERSHED OR PROJECT KALANIANAOLE HWY INOAOLE STREAM BRIDGE REPLACEMENT

STATE WAIMANALO, OAHU

STRUCTURE SITE OR SUBAREA INOAOLE STREAM / KAL HWY CROSSING

DR. AREA 2.38 SQ. MI. STRUCTURE CLASS _____

T_c 1.71 HR. STORM DURATION 6 HR.

POINT RAINFALL 9.5 IN.

ADJUSTED RAINFALL:

AREAL : FACTOR 1.0 IN. 9.5

DURATION : FACTOR 1.0 IN. 6

RUNOFF CURVE NO. 82

Q 7.3 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 1.2 HR.

T_o 5.4 HR.

(T_o / T_p):

COMPUTED 4.51 ; USED 6

REVISED T_p 1.1

$q_p = \frac{484A}{\text{REV. } T_p} = 1047$ CFS.

$(Q \times q_p) = 7643$ CFS.

t (COLUMN) = (t / T_p) REV. T_p q (COLUMN) = $(q_c / q_p \times Q \times q_p)$

Q_t (COLUMN) = $(Q_t / Q) \times Q$

	$t = (t/T_p)$ Rev. T_p	$q = (q_c/q_p) \times Q \times q_p$	$Q_t = (Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2	0.4	8	0.01
3	0.7	38	0.02
4	1.1	115	0.02
5	1.5	283	0.1
6	1.9	749	0.2
7	2.2	1865	0.5
8	2.6	3110	1.1
9	3.0	3546	1.9
10	3.4	3279	2.7
11	3.7	2805	3.4
12	4.1	2362	4.1
13	4.5	1995	4.6
14	4.8	1712	5.0
15	5.2	1475	5.4
16	5.6	1292	5.7
17	5.9	1162	6.0
18	6.3	1062	6.3
19	6.7	986	6.6
20	7.1	864	6.8
21	7.4	650	7.0
22	7.9	420	7.1
23	8.2	267	7.2
24	8.6	153	7.2
25	9.0	92	7.2
26	9.3	61	7.3
27	9.7	38	7.3
28	10.1	31	7.3
29	10.5	23	7.3
30	10.8	15	7.3
31	11.2	8	7.3
32	11.6	0	7.3
33			
34			

100yr - 6 hr

HYDROGRAPH COMPUTATION

DATE 10/9/95
COMPUTED BY CNATEUDA
CHECKED BY

WATERSHED OR PROJECT KALANIANAOLE HWY INOAOLE STREAM BRIDGE REPLACEMENT

STATE WAIMANALO, OAHU

STRUCTURE SITE OR SUBAREA INOAOLE STREAM/ KAL HWY CROSSING

DR. AREA 2.38 SQ. MI. STRUCTURE CLASS _____

T_c 1.71 HR. STORM DURATION 6 HR.

POINT RAINFALL 10.5 IN.

ADJUSTED RAINFALL:

AREAL : FACTOR 1.0 IN. 10.5

DURATION : FACTOR 1.0 IN. 6

RUNOFF CURVE NO. 82

Q 8.2 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 1.2 HR.

T_o 5.4 HR.

(T_o / T_p):
COMPUTED 4.51 ; USED 6

REVISED T_p 1.1

$q_p = \frac{484A}{\text{REV. } T_p} = 1047$ CFS.

$(Q \times q_p)$ = 8585 CFS.

t (COLUMN) = (t / T_p) REV. T_p q (COLUMN) = $(q_c / q_p \times Q \times q_p)$

Q_t (COLUMN) = $(Q_t / Q) Q$

	$t = (t/T_p)$ Rev. T_p	$q = (q_c/q_p) \times Q \times q_p$	$Q_t = (Q_t/Q) Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2	0.4	8	0.01
3	0.7	43	0.02
4	1.1	129	0.1
5	1.5	318	0.2
6	1.9	341	0.2
7	2.2	2094	0.6
8	2.6	3494	1.2
9	3.0	3983	2.1
10	3.4	3683	3.1
11	3.7	3151	3.9
12	4.1	2653	4.6
13	4.5	2241	5.2
14	4.8	1923	5.6
15	5.2	1657	6.1
16	5.6	1451	6.4
17	5.9	1305	6.8
18	6.3	1193	7.1
19	6.7	1451	7.3
20	7.1	970	7.6
21	7.4	730	7.8
22	7.9	472	8.0
23	8.2	300	8.1
24	8.6	172	8.1
25	9.0	103	8.2
26	9.3	69	8.2
27	9.7	43	8.2
28	10.1	34	8.2
29	10.5	26	8.2
30	10.8	17	8.2
31	11.2	9	8.2
32	11.6	0	8.2
33			
34			

5yr- 6hr

SOIL CONSERVATION SERVICES METHOD
HYDROGRAPH COMPUTATION

DATE 10-12-95
COMPUTED BY CMATSUDA
CHECKED BY

PROJECT TITLE KALANIANAOLE HWY INOAOLE STREAM BRIDGE REPLACEMENT

PROJECT NO. _____

LOCATION INOAOLE STREAM/ KAL HWY, WAIMANALO

DR. AREA 2.38 SQ. MI.

T_c 1.71 HR. STORM DURATION 6 HR.

POINT RAINFALL 6 IN.

ADJUSTED RAINFALL:

AREAL: FACTOR 1.0 IN. 6

DURATION: FACTOR 1.0 IN. 6

RUNOFF CURVE NO. 82

Q 4 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 1.2 HR.

T_o 5.1 HR.

(T_o/T_p):
COMPUTED 4.25 ; USED 6

REVISED T_p 1.2

$q_p = \frac{484A}{REV.T_p} = 960$ CFS

$(Q)(a_p)$ = 3840 CFS

	$t=(t/T_p)$Rev.T_p	$q=(q_c/q_p)(Q)(a_p)$	$Q_t=(Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2			
3			
4			
5			
6			
7			
8			
9		1782	
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			

10 yr - 6 hr

SOIL CONSERVATION SERVICES METHOD
HYDROGRAPH COMPUTATION

DATE 10-12-95
COMPUTED BY LMATSUDA
CHECKED BY _____

PROJECT TITLE KALANIANAOLE HWY
INOAOLE STREAM BR REPAIR.

PROJECT NO. _____

LOCATION INOAOLE STREAM/
KAL HWY, WAIMANALO

DR. AREA 2.38 SQ. MI.

T_c 1.71 HR. STORM DURATION 6 HR.

POINT RAINFALL 7 IN.

ADJUSTED RAINFALL:

AREAL: FACTOR 1.0 IN. 7

DURATION: FACTOR 1.0 IN. 6

RUNOFF CURVE NO. 82

Q 4.9 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 1.2 HR.

T_o 5.2 HR.

(T_o/T_p):

COMPUTED 4.3 ; USED 6

REVISED T_p 1.15

$q_p = \frac{484A}{REV.T_p}$ = 1002 CFS

$(Q)(a_p)$ = 4908 CFS

	$t = (t/T_p)Rev.T_p$	$q = (q_c/q_p)(Q)(a_p)$	$Q_t = (Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2			
3			
4			
5			
6			
7			
8			
9		2270	
10			
11			
12			
13			
14			
15			
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30			
31			
32			
33			
34			

25 yr - 6 hr SOIL CONSERVATION SERVICES METHOD
HYDROGRAPH COMPUTATION

DATE 10-12-95
COMPUTED BY WATSUDA
CHECKED BY

PROJECT TITLE KALANIANAOLE HWY
INOAOLE STREAM BR REPLACE

PROJECT NO. _____

LOCATION INOAOLE STREAM/
KAL HWY. WAIMANALO

DR. AREA 2.38 SQ. MI.

T_c 1.71 HR. STORM DURATION 6 HR.

POINT RAINFALL 8 IN.

ADJUSTED RAINFALL:

AREAL: FACTOR 1.0 IN. 8

DURATION: FACTOR 1.0 IN. 6

RUNOFF CURVE NO. 82

Q 5.8 IN.

HYDROGRAPH FAMILY NO. 2

COMPUTED T_p 1.2 HR.

T_o 5.3 HR.

(T_o/T_p):
COMPUTED 4.41 ; USED 6

REVISED T_p 1.1

$q_p = \frac{484A}{REV.T_p}$ = 1047 CFS

$(Q)(a_p)$ = 6073 CFS

	$t=(t/T_p)Rev.T_p$	$q=(q_c/q_p)(Q)(a_p)$	$Q_t=(Q_t/Q)Q$
	t HOURS	q CFS	Q INCHES
1	0	0	0
2			
3			
4			
5			
6			
7			
8			
9		2717	
10			
11			
12			
13			
14			
15			
16			
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33			
34			

APPENDIX I

HYDROLOGY CALCULATIONS
IB. Regression Method

DOT 4-380

COMPUTATION SHEET

Project: INOAOLE STREAM BRIDGE Proj. No. _____

Computed by: J MATSUDA Date: 9/9/95 Checked by: _____ Date: _____

HYDROLOGY - REGRESSION METHOD

GIVEN: DA = 1523 acres = 2.38 mi^2

FIND: Q_{50}, Q_{100}

$Q_{50} = a(DA)^b = (3800)(2.38)^{0.72} = 7094$ cfs

$Q_{100} = a(DA)^b = (4800)(2.38)^{0.71} = 8984$ cfs

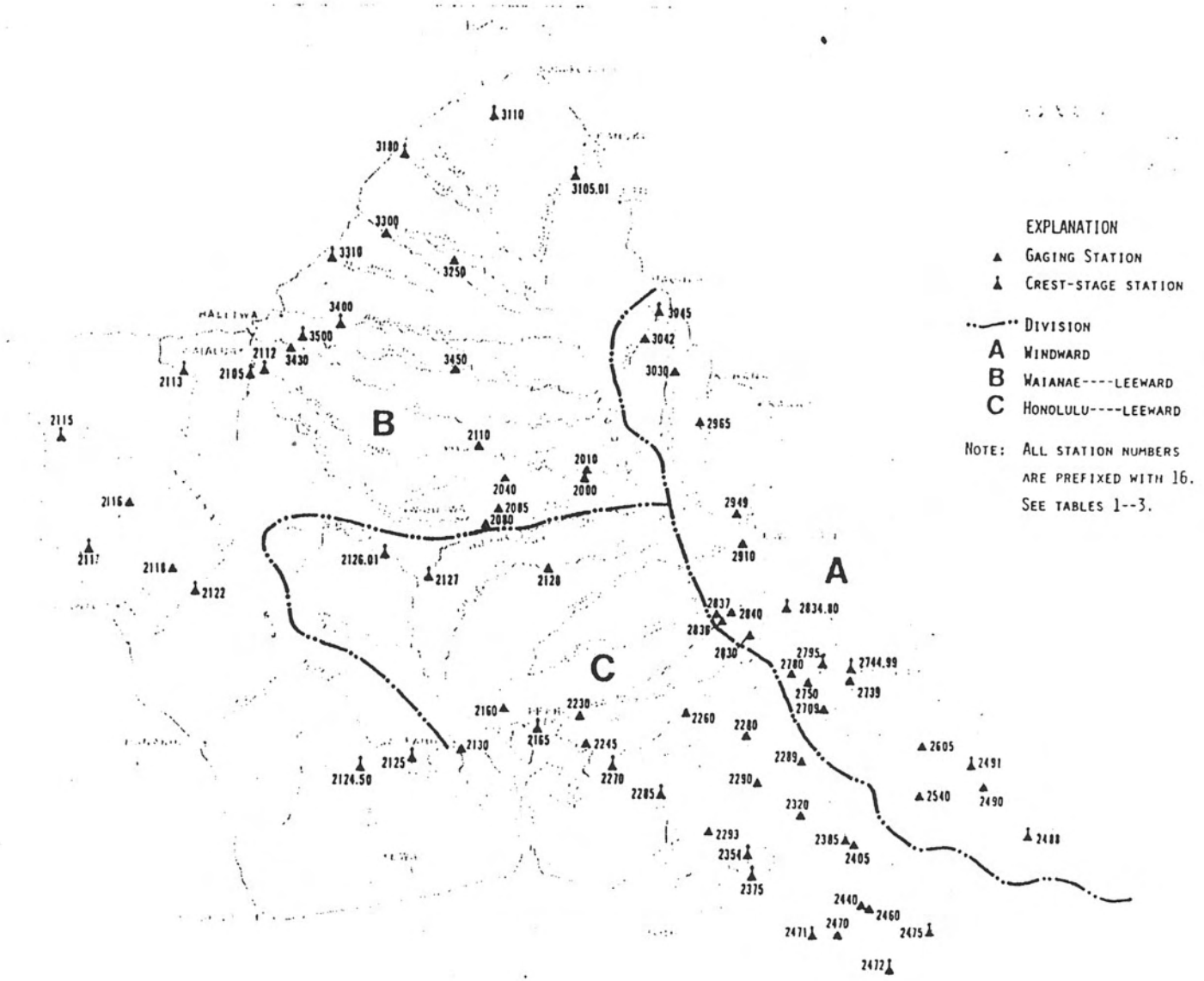


Figure 1. Location and grouping (A,B,C) of stations on Oahu.

APPENDIX I

HYDROLOGY CALCULATIONS
IC. Rational Formula

DOT 4-380

COMPUTATION SHEET

Project: KALANIANAOLE HWY INOAOLE STREAM BRIDGE REPLACEMENT Proj. No. _____

Computed by: CMATSUDA Date: 10/6/95 Checked by: _____ Date: _____

RATIONAL FORMULA -

GIVEN: $A = 1523$ ac, $C = 0.3$, $i_{50} = 8.5$, $i_{100} = 9.5$

FIND: Q_{50}, Q_{100}

$Q_{50} = (0.3)(9.5\ in/hr)(1523\ ac) = 4340$ cfs

$Q_{100} = (0.3)(10.5\ in/hr)(1523\ ac) = 4797$ cfs

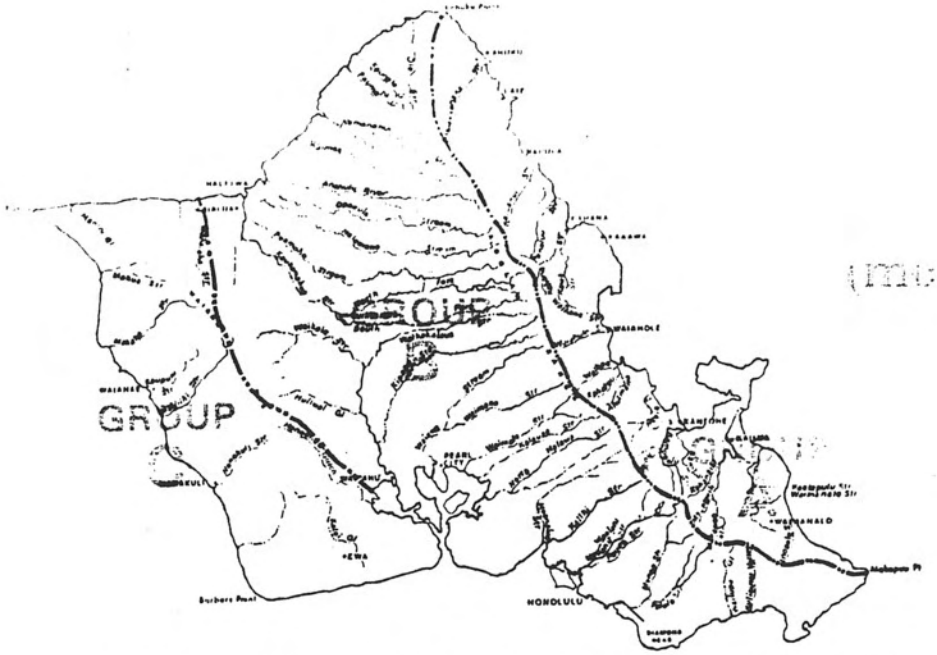
APPENDIX I

HYDROLOGY CALCULATIONS
ID. Log-Pearson Type III Method

```
            ********** HYDRO - Version 4.0 **********
            *  HEC19 / Design Event vs Return Period Program  *
            *              Date of Run: 09-18-95              *
                                                          PAGE NO   1
        HYDROLOGY - INOAOLE STREAM BRIDGE

      --- Input File: C:\HYDRO\INOAOLE.HDO

      JOBHYDROLOGY - INOAOLE STREAM BRIDGE
      FLW2

*** THE FLOW ANALYSIS OPTION HAS BEEN
*** SELECTED WITH THE USGS SUBOPTION.

      LPA* 3
      GFL665 480 138 155 487 542 108 557 908 959 1420 465 966 948 644 20
         29 252 282 363 100 400 630 1600 400 50 30 100 150 1420 280 980
         208 300 300

*** THE GAGE FLOWS ARE THE FOLLOWING:
     665.     480.     138.     155.     487.     542.     108.     557.
     908.     959.    1420.     465.     966.     948.     644.      20.
      29.     252.     282.     363.     100.     400.     630.    1600.
     400.      50.      30.     100.     150.    1420.     280.     980.
     208.     300.     300.

      RPD50

*** THE SELECTED RETURN PERIOD IS    50 YEARS

      END

*** END OF COMMAND FILE


*** THE MEAN OF THE LOG FLOW VALUES EQUALS   2.4904
*** THE STANDARD DEVIATION EQUALS   .49449
*** THE COMPUTED SKEW COEFFICIENT EQUALS  -.79040

                  -----------------------------------
                  PEAK FLOWS FOR COMMON RETURN PERIODS

                  -----------------------------------
                    RETURN PERIOD          PEAK FLOW
                       (YEARS)               (CFS)
                    ------------          ----------
              SELECTED    50.                1949.
                           2.                 358.
                           5.                 818.
                          10.                1167.
                          25.                1620.
                         100.                2264.
                         500.                2930.

      *** From System Shell, output CANNOT be written to Screen ***
                    **  Screen option TURNED OFF **

                              EXCEEDENCE PROBABILITY
     (99.865)  (97.73)   (84.13)   (50.00)   (15.87)   (2.27)    (0.135)
    4.37+.....|.....|.....|.....|.....|.....|.....+
        .                                          o.
        .  x - ACTUAL DATA                    o o   .
  F     .  o - CALCULATED                   xxo     .
  L  1.10+ * - BOTH                      xx o       +
  O     .                          x o x           .
  W     .                      xxx x               .
        .                     *x                   .
  1  .28+                  xx                     +
  0     .               x                         .
  0     .            xx                           .
  0     .          x                              .
     .07+                                         +
  C     .       x                                 .
  F     .     x                                   .
  S     .                                         .
    .02+.....x.....|.....|.....|.....|.....|.....+
                                2     5   10   25 50 100  500
     (3.0)     (2.0)     (1.0)     (0.0)     (-1.0)    (-2.0)    (-3.0)
                    RETURN PERIOD IN YEARS, (STAND. DEV.)
   FILE CREATED ON INTERMEDIATE DIRECTORY = INOAOLE.Q

                  ********************************************
                  * THE      50. YEAR FLOW IS        1949. CFS *
                  ********************************************


*** END OF RUN
```

APPENDIX I

HYDROLOGY CALCULATIONS
IE. Design Curve for Peak Discharge



(more than 100 acres)

● CURVES ARE FOR STREAM CHANNELS AND DRAINAGE STRUCTURES.

PEAK DISCHARGE IN 100 CFS

600
400
200
100
80
60
40
20
10
8
6
5

2000

2 4 6 8 10 20 40 60 80 100 200 400 600 800

DRAINAGE AREA IN 100 ACRES

SOURCE DATA FROM U S GEOLOGICAL SURVEY

APPENDIX II

HYDRAULIC CALCULATIONS
IA. Kalanianaole Highway-
Proposed Box Culvert Alternatives

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:01

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	4 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
5.06	370	370	0	0	0	0	0	0	1
6.20	740	740	0	0	0	0	0	0	1
7.17	1110	1110	0	0	0	0	0	0	1
8.03	1480	1480	0	0	0	0	0	0	1
8.88	1850	1850	0	0	0	0	0	0	1
9.38	2220	2039	0	0	0	0	0	177	4
9.69	2590	2149	0	0	0	0	0	433	3
9.90	2880	2227	0	0	0	0	0	648	3
10.20	3330	2330	0	0	0	0	0	995	3
10.43	3700	2402	0	0	0	0	0	1294	3
9.00	1893	1893	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
5.06	0.00	370	0	0.00
6.20	0.00	740	0	0.00
7.17	0.00	1110	0	0.00
8.03	0.00	1480	0	0.00
8.88	0.00	1850	0	0.00
9.38	-0.00	2220	3	0.15
9.69	-0.01	2590	8	0.32
9.90	-0.00	2880	6	0.19
10.20	-0.00	3330	4	0.13
10.43	-0.00	3700	4	0.10

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:01

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 4 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	5.06	1.96	1.96	2-M2c	1.31	1.23	6.27	1.23	3.07	-0.56
740	6.20	3.05	3.10	2-M2c	2.07	1.95	7.90	1.95	3.94	0.47
1110	7.17	3.97	4.07	2-M2c	2.73	2.56	9.04	2.56	4.53	1.30
1480	8.03	4.87	4.93	2-M2c	3.34	3.10	9.95	3.10	5.00	2.01
1850	8.88	5.78	5.72	2-M2c	3.91	3.59	10.72	3.59	5.39	2.64
2039	9.38	6.28	6.10	2-M2c	4.19	3.84	11.08	3.84	5.72	3.22
2149	9.68	6.58	6.45	6-FFn	4.75	3.97	9.42	4.75	6.02	3.76
2227	9.90	6.80	6.58	6-FFn	4.75	4.07	9.77	4.75	6.22	4.15
2330	10.20	7.10	6.76	6-FFn	4.75	4.19	10.22	4.75	6.52	4.73
2402	10.43	7.31	7.33	4-FFt	4.75	4.28	10.54	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL
INLET DEPRESSION	NONE

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:01

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ***********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:23:38

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	5 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.79	370	370	0	0	0	0	0	0	1
5.77	740	740	0	0	0	0	0	0	1
6.61	1110	1110	0	0	0	0	0	0	1
7.35	1480	1480	0	0	0	0	0	0	1
8.03	1850	1850	0	0	0	0	0	0	1
8.70	2220	2220	0	0	0	0	0	0	1
9.26	2590	2488	0	0	0	0	0	97	4
9.50	2880	2603	0	0	0	0	0	267	3
9.83	3330	2750	0	0	0	0	0	573	3
10.11	3700	2784	0	0	0	0	0	882	5
9.00	2365	2365	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.79	0.00	370	0	0.00
5.77	0.00	740	0	0.00
6.61	0.00	1110	0	0.00
7.35	0.00	1480	0	0.00
8.03	0.00	1850	0	0.00
8.70	0.00	2220	0	0.00
9.26	-0.00	2590	5	0.18
9.50	-0.01	2880	9	0.32
9.83	-0.00	3330	7	0.21
10.11	-0.00	3700	33	0.90

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:23:38

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 5 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.79	1.69	1.68	2-M2c	1.13	1.06	5.82	1.06	3.07	-0.56
740	5.77	2.65	2.67	2-M2c	1.79	1.68	7.33	1.68	3.94	0.47
1110	6.61	3.43	3.51	2-M2c	2.35	2.20	8.40	2.20	4.53	1.30
1480	7.35	4.15	4.25	2-M2c	2.86	2.67	9.24	2.67	5.00	2.01
1850	8.03	4.87	4.93	2-M2c	3.34	3.10	9.95	3.10	5.39	2.64
2220	8.70	5.60	5.56	2-M2c	3.80	3.50	10.58	3.50	5.72	3.22
2488	9.25	6.15	6.01	2-M2c	4.12	3.77	10.99	3.77	6.02	3.76
2603	9.50	6.40	6.19	3-M2t	4.26	3.89	10.45	4.15	6.22	4.15
2750	9.82	6.72	6.53	6-FFn	4.75	4.03	9.65	4.75	6.52	4.73
2784	10.11	6.80	7.01	4-FFt	4.75	4.07	9.77	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL
INLET DEPRESSION	NONE

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:23:38

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:32

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	6 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.59	370	370	0	0	0	0	0	0	1
5.47	740	740	0	0	0	0	0	0	1
6.20	1110	1110	0	0	0	0	0	0	1
6.86	1480	1480	0	0	0	0	0	0	1
7.46	1850	1850	0	0	0	0	0	0	1
8.03	2220	2220	0	0	0	0	0	0	1
8.57	2590	2590	0	0	0	0	0	0	1
9.04	2880	2868	0	0	0	0	0	7	5
9.45	3330	3091	0	0	0	0	0	226	3
9.84	3700	3104	0	0	0	0	0	582	3
9.00	2841	2841	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.59	0.00	370	0	0.00
5.47	0.00	740	0	0.00
6.20	0.00	1110	0	0.00
6.86	0.00	1480	0	0.00
7.46	0.00	1850	0	0.00
8.03	0.00	2220	0	0.00
8.57	0.00	2590	0	0.00
9.04	-0.00	2880	5	0.18
9.45	-0.01	3330	14	0.41
9.84	-0.01	3700	14	0.39

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:32

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 6 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.59	1.49	1.49	2-M2c	1.01	0.94	5.48	0.94	3.07	-0.56
740	5.47	2.37	2.37	2-M2c	1.58	1.49	6.90	1.49	3.94	0.47
1110	6.20	3.05	3.10	2-M2c	2.07	1.95	7.90	1.95	4.53	1.30
1480	6.86	3.67	3.76	2-M2c	2.52	2.36	8.70	2.36	5.00	2.01
1850	7.46	4.27	4.36	2-M2c	2.94	2.74	9.37	2.74	5.39	2.64
2220	8.03	4.87	4.93	3-M2t	3.34	3.10	9.56	3.22	5.72	3.22
2590	8.57	5.47	5.47	3-M1t	3.72	3.43	9.57	3.76	6.02	3.76
2868	9.04	5.94	5.86	3-M1t	4.00	3.67	9.59	4.15	6.22	4.15
3091	9.44	6.34	6.25	3-M1t	4.22	3.86	9.07	4.73	6.52	4.73
3104	9.85	6.36	6.75	4-FFt	4.24	3.87	9.08	4.75	6.74	5.18

El. inlet face invert 3.10 ft El. outlet invert 3.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL
INLET DEPRESSION	NONE

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:32:32

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:24:40

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	7 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.45	370	370	0	0	0	0	0	0	1
5.24	740	740	0	0	0	0	0	0	1
5.90	1110	1110	0	0	0	0	0	0	1
6.49	1480	1480	0	0	0	0	0	0	1
7.04	1850	1850	0	0	0	0	0	0	1
7.57	2220	2220	0	0	0	0	0	0	1
8.10	2590	2590	0	0	0	0	0	0	1
8.50	2880	2880	0	0	0	0	0	0	1
9.10	3330	3316	0	0	0	0	0	24	5
9.61	3700	3363	0	0	0	0	0	361	4
9.00	3255	3255	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.45	0.00	370	0	0.00
5.24	0.00	740	0	0.00
5.90	0.00	1110	0	0.00
6.49	0.00	1480	0	0.00
7.04	0.00	1850	0	0.00
7.57	0.00	2220	0	0.00
8.10	0.00	2590	0	0.00
8.50	0.00	2880	0	0.00
9.10	0.00	3330	-10	-0.31
9.61	0.01	3700	-24	-0.65

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:24:40

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 7 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.45	1.35	1.35	2-M2c	0.92	0.85	5.20	0.85	3.07	-0.56
740	5.24	2.14	2.14	2-M2c	1.44	1.34	6.56	1.34	3.94	0.47
1110	5.90	2.77	2.80	2-M2c	1.88	1.76	7.51	1.76	4.53	1.30
1480	6.49	3.32	3.39	2-M2c	2.27	2.13	8.26	2.13	5.00	2.01
1850	7.04	3.85	3.94	3-M1t	2.64	2.47	8.33	2.64	5.39	2.64
2220	7.57	4.36	4.47	3-M1t	3.00	2.79	8.20	3.22	5.72	3.22
2590	8.10	4.87	5.00	3-M1t	3.34	3.10	8.21	3.76	6.02	3.76
2880	8.50	5.27	5.40	3-M1t	3.60	3.32	8.26	4.15	6.22	4.15
3316	9.10	5.90	6.00	3-M1t	3.98	3.65	8.34	4.73	6.52	4.73
3363	9.62	5.97	6.52	4-FFt	4.02	3.69	8.43	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL
INLET DEPRESSION	NONE

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:24:40

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:25:10

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	8 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.34	370	370	0	0	0	0	0	0	1
5.06	740	740	0	0	0	0	0	0	1
5.66	1110	1110	0	0	0	0	0	0	1
6.20	1480	1480	0	0	0	0	0	0	1
6.72	1850	1850	0	0	0	0	0	0	1
7.26	2220	2220	0	0	0	0	0	0	1
7.78	2590	2590	0	0	0	0	0	0	1
8.19	2880	2880	0	0	0	0	0	0	1
8.79	3330	3330	0	0	0	0	0	0	1
9.40	3700	3539	0	0	0	0	0	188	5
9.00	3334	3334	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.34	0.00	370	0	0.00
5.06	0.00	740	0	0.00
5.66	0.00	1110	0	0.00
6.20	0.00	1480	0	0.00
6.72	0.00	1850	0	0.00
7.26	0.00	2220	0	0.00
7.78	0.00	2590	0	0.00
8.19	0.00	2880	0	0.00
8.79	0.00	3330	0	0.00
9.40	0.01	3700	-27	-0.74

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:25:10

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 8 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.34	1.24	1.23	2-M2c	0.83	0.77	4.98	0.77	3.07	-0.56
740	5.06	1.96	1.96	2-M2c	1.31	1.23	6.27	1.23	3.94	0.47
1110	5.66	2.55	2.56	2-M2c	1.71	1.61	7.18	1.61	4.53	1.30
1480	6.20	3.05	3.10	3-M2t	2.07	1.95	7.68	2.01	5.00	2.01
1850	6.72	3.52	3.62	3-M1t	2.42	2.26	7.29	2.64	5.39	2.64
2220	7.26	3.97	4.16	3-M1t	2.73	2.56	7.17	3.22	5.72	3.22
2590	7.78	4.42	4.68	3-M1t	3.04	2.83	7.18	3.76	6.02	3.76
2880	8.19	4.77	5.09	3-M1t	3.28	3.04	7.22	4.15	6.22	4.15
3330	8.79	5.32	5.69	3-M1t	3.63	3.35	7.33	4.73	6.52	4.73
3539	9.40	5.58	6.30	4-FFt	3.79	3.49	7.76	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	1:1 BEVEL
INLET DEPRESSION	NONE

CURRENT DATE: 09-21-1995
CURRENT TIME: 10:25:10

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 10-05-1995
CURRENT TIME: 07:46:44

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	9 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.33	370	370	0	0	0	0	0	0	1
5.06	740	740	0	0	0	0	0	0	1
5.66	1110	1110	0	0	0	0	0	0	1
6.20	1480	1480	0	0	0	0	0	0	1
6.71	1850	1850	0	0	0	0	0	0	1
7.24	2220	2220	0	0	0	0	0	0	1
7.77	2590	2590	0	0	0	0	0	0	1
8.17	2880	2880	0	0	0	0	0	0	1
8.78	3330	3330	0	0	0	0	0	0	1
9.38	3700	3551	0	0	0	0	0	173	5
9.00	3359	3359	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.33	0.00	370	0	0.00
5.06	0.00	740	0	0.00
5.66	0.00	1110	0	0.00
6.20	0.00	1480	0	0.00
6.71	0.00	1850	0	0.00
7.24	0.00	2220	0	0.00
7.77	0.00	2590	0	0.00
8.17	0.00	2880	0	0.00
8.78	0.00	3330	0	0.00
9.38	0.01	3700	-24	-0.66

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 10-05-1995
CURRENT TIME: 07:46:44

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 9 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.33	1.23	1.23	2-M2c	0.77	0.72	4.79	0.72	3.07	-0.56
740	5.06	1.95	1.96	2-M2c	1.21	1.14	6.03	1.14	3.94	0.47
1110	5.66	2.54	2.56	2-M2c	1.58	1.49	6.90	1.49	4.53	1.30
1480	6.20	3.06	3.10	3-M1t	1.92	1.80	6.82	2.01	5.00	2.01
1850	6.71	3.54	3.61	3-M1t	2.23	2.09	6.48	2.64	5.39	2.64
2220	7.24	3.99	4.14	3-M1t	2.52	2.36	6.38	3.22	5.72	3.22
2590	7.77	4.42	4.67	3-M1t	2.80	2.62	6.38	3.76	6.02	3.76
2880	8.17	4.76	5.07	3-M1t	3.02	2.81	6.42	4.15	6.22	4.15
3330	8.78	5.29	5.68	3-M1t	3.34	3.10	6.51	4.73	6.52	4.73
3551	9.37	5.55	6.27	4-FFt	3.49	3.23	6.92	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 10-05-1995
CURRENT TIME: 07:46:44

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

CURRENT DATE: 10-04-1995
CURRENT TIME: 14:31:42

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	10 RCB	12.00	4.75	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE1 DATE: 09-21-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
4.25	370	370	0	0	0	0	0	0	1
4.92	740	740	0	0	0	0	0	0	1
5.52	1110	1110	0	0	0	0	0	0	1
5.98	1480	1480	0	0	0	0	0	0	1
6.51	1850	1850	0	0	0	0	0	0	1
7.05	2220	2220	0	0	0	0	0	0	1
7.58	2590	2590	0	0	0	0	0	0	1
7.98	2880	2880	0	0	0	0	0	0	1
8.58	3330	3330	0	0	0	0	0	0	1
9.20	3700	3647	0	0	0	0	0	67	5
9.00	3669	3669	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE1 DATE: 09-21-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
4.25	0.00	370	0	0.00
4.92	0.00	740	0	0.00
5.52	0.00	1110	0	0.00
5.98	0.00	1480	0	0.00
6.51	0.00	1850	0	0.00
7.05	0.00	2220	0	0.00
7.58	0.00	2590	0	0.00
7.98	0.00	2880	0	0.00
8.58	0.00	3330	0	0.00
9.20	0.00	3700	-15	-0.40

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 10-04-1995
CURRENT TIME: 14:31:42

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

PERFORMANCE CURVE FOR CULVERT # 1 - 10 (12 BY 4.75) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
370	4.25	1.15	1.15	2-M2c	0.71	0.67	4.62	0.67	3.07	-0.56
740	4.92	1.82	1.82	2-M2c	1.13	1.06	5.82	1.06	3.94	0.47
1110	5.52	2.38	2.42	2-M2c	1.48	1.39	6.66	1.39	4.53	1.30
1480	5.98	2.86	2.88	3-M1t	1.79	1.68	6.14	2.01	5.00	2.01
1850	6.51	3.30	3.41	3-M1t	2.07	1.95	5.83	2.64	5.39	2.64
2220	7.05	3.72	3.95	3-M1t	2.35	2.20	5.74	3.22	5.72	3.22
2590	7.58	4.12	4.48	3-M1t	2.61	2.44	5.74	3.76	6.02	3.76
2880	7.98	4.42	4.88	3-M1t	2.81	2.62	5.78	4.15	6.22	4.15
3330	8.58	4.89	5.48	3-M1t	3.10	2.89	5.86	4.73	6.52	4.73
3647	9.20	5.23	6.10	4-FFt	3.31	3.07	6.40	4.75	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	12.00 FT
BARREL RISE	4.75 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 10-04-1995
CURRENT TIME: 14:31:42

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

APPENDIX II

HYDRAULIC CALCULATIONS
IB. Kalanianaole Highway
Proposed Channel Upstream

DOT 4-380

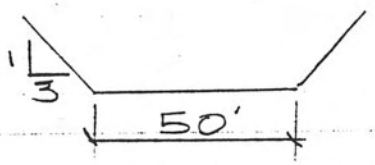
COMPUTATION SHEET

Project: KAL HWY - REPLACEMENT OF INOAOLE STREAM BRIDGE Proj. No. _____

Computed by: CMATSUOKA Date: 10/4/95 Checked by: _____ Date: _____

HYDRAULIC CALCULATIONS OF PROPOSED CHANNEL UPSTREAM OF KAL HWY

GIVEN: $Q_{50} = 3700$ cfs
$S = 0.002$
$n = 0.04$



FIND: d_n, V_n, Fr.

TRIAL & ERROR

FOR $d_n = 9'$ $Q = 4002$ cfs

$d_n = 8'$ $Q = 3206$ cfs

by interpolating

for $Q_{50} = 3700$ cfs $\underline{d_n = 8.6'}$

$$V_n = \frac{Q}{A} = \frac{3700}{(50 + (3)(8.6))8.6} = \underline{5.7 \text{ ft/s}}$$

$$Fr. = \frac{V}{\sqrt{(d)(g)}} = \frac{5.7}{\sqrt{(8.6)(32.2)}} = \underline{0.34}$$

APPENDIX II

HYDRAULIC CALCULATIONS
IC. Kalanianaole Highway
Existing Channel Downstream

RRENT DATE: 09-21-1995
RRENT TIME: 10:32:32

FILE DATE: 09-21-1995
FILE NAME: INOAOLE1

TAILWATER

****** REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

***** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
370.00	2.44	0.379	2.04	3.07	0.25
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.53	0.49
1480.00	5.01	0.411	4.61	5.00	0.57
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2880.00	7.15	0.422	6.75	6.22	0.84
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

APPENDIX II

HYDRAULIC CALCULATIONS
ID. Kalanianaole Highway
Existing Channel Upstream

DOT 4-380

COMPUTATION SHEET

Project: INOAOLE STREAM BRIDGE REPLACEMENT Proj. No. _____

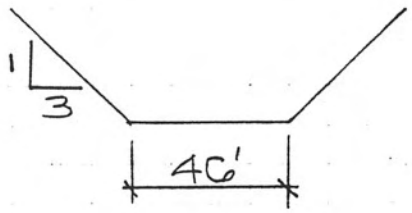
Computed by: CMATSUDA Date: 9/27/95 Checked by: _____ Date: _____

HYDRAULICS - EXISTING CHANNEL UPSTREAM OF KAL HWY

GIVEN: $Q_{50} = 3700$ cfs

$S = 0.002$

$n = 0.04$



FIND: d_n, V_n, F_r,

TRIAL & ERROR

For $d_n = 8.5'$, $Q = 3368$ cfs

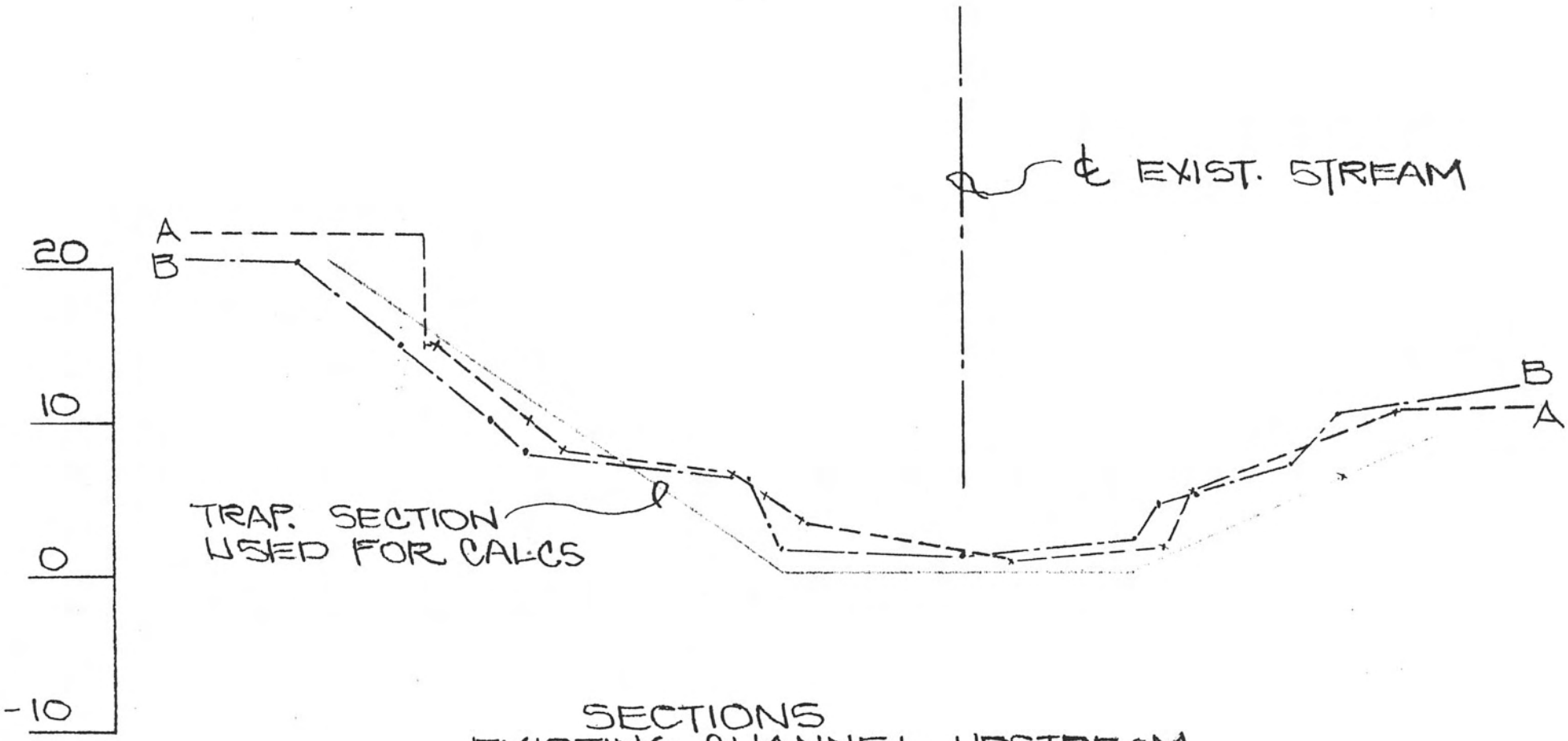
$d_n = 9.0'$, $Q = 3755$ cfs

by interpolating: $d_n = 8.9'$

$$V_n = \frac{Q_n}{A} = \frac{3700}{[(8.9)(3) + 46]8.9} = 5.7 \text{ ft/s}$$

$$F_r = \frac{V}{\sqrt{d_n g}} = \frac{5.7}{\sqrt{(8.9)(32.2)}} = 0.33 \text{ subcritical}$$

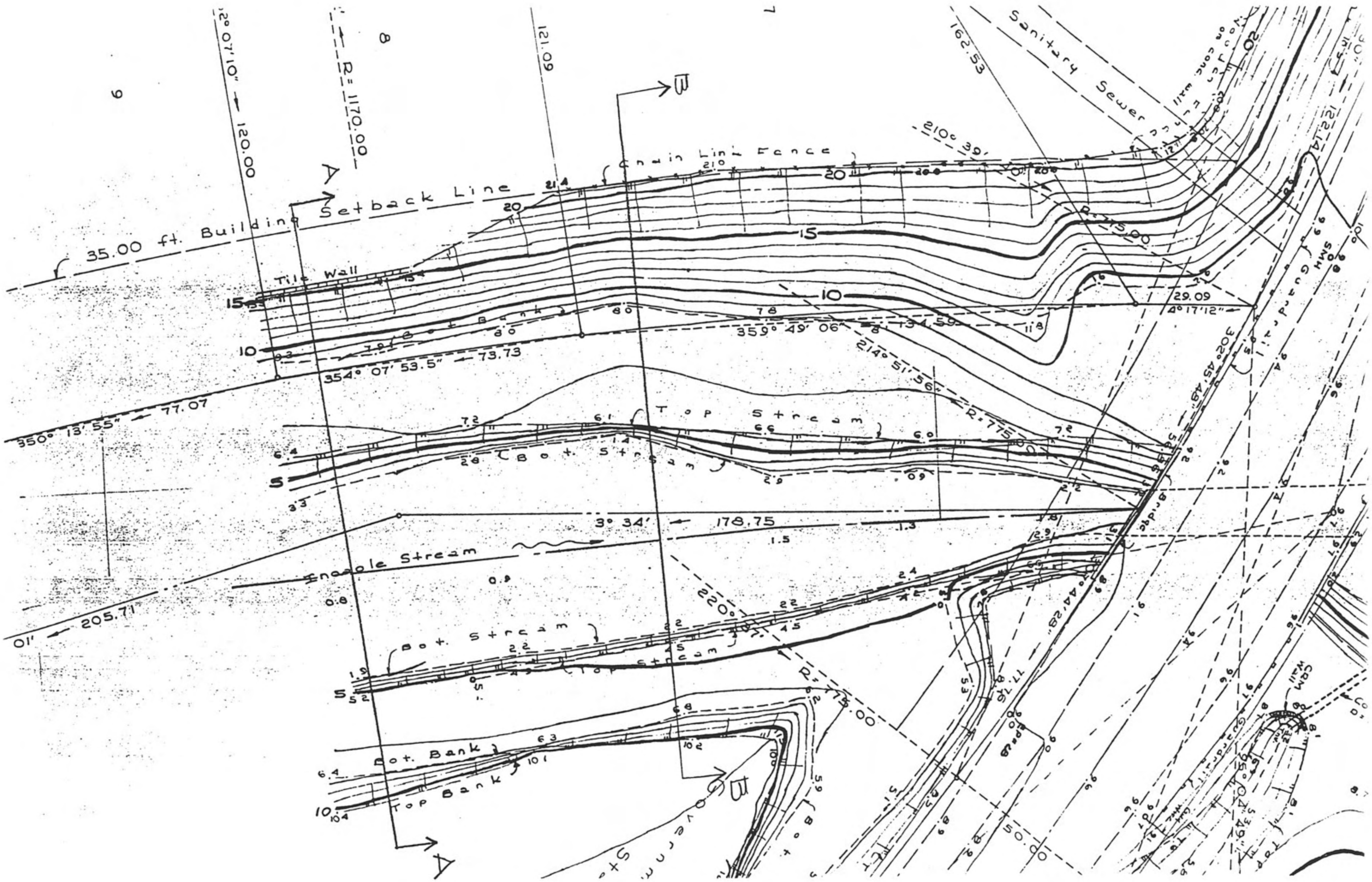
For $d_n = 8.9$, ELEV = 9.9 ← overtop hwy 6" ±



SECTIONS
EXISTING CHANNEL UPSTREAM

SCALE: HORIZ. 1" = 20'
VERT. 1" = 10'

C. MATSUDA
9-28-95


35.00 ft. Building Setback Line
Tile Wall
Chain Link Fence
Sanitary Sewer
Bot. Bank
Top Bank
Top Stream
Bot. Stream
Enoeple Stream
3° 34' 178.75
354° 07' 53.5" 73.73
350° 13' 55" 77.07
205.71
359° 49' 06" 134.59
214° 51' 56"
R=775.00
R=1170.00
120.00
121.09
162.53
210° 39'
302° 45' 48"
4° 17' 12"
29.09
125.14
Bridge
SMH
Guard rail
CRM Wall

APPENDIX II

HYDRAULIC CALCULATIONS
1E. Hughes Road
Existing Box Culvert

DESIGN ANALYSIS

TITLE OF PROJECT:

FY88 EMERGENCY MCP PROJECT PN BFMV85249,

EMERGENCY REPAIR FLOOD DAMAGED FACILITIES

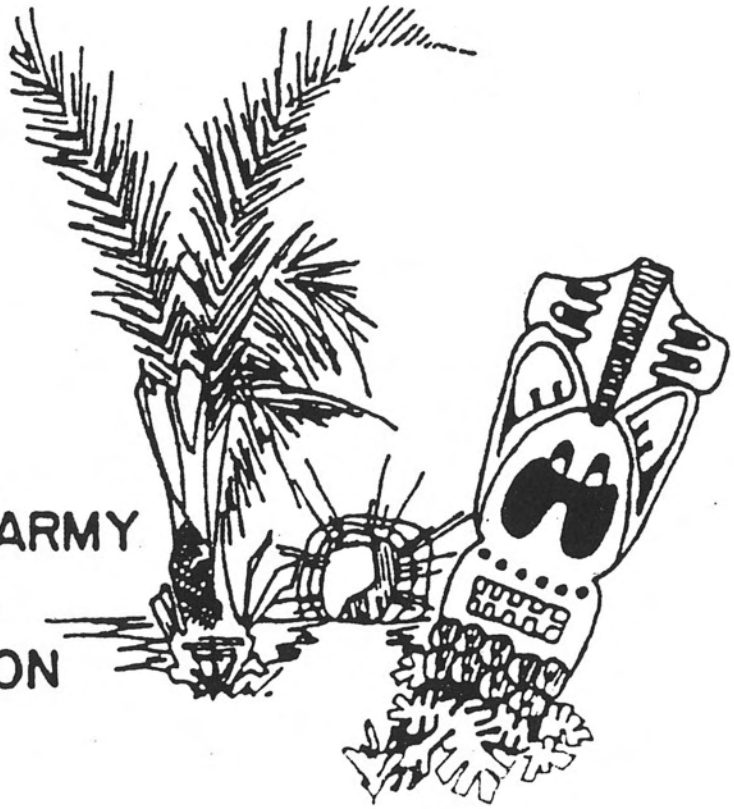
LOCATION:

BELLOWS AIR FORCE STATION,

WAIMANALO, OAHU, HAWAII

DATE:

APRIL 1988



DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
PACIFIC OCEAN DIVISION
HONOLULU HAWAII

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

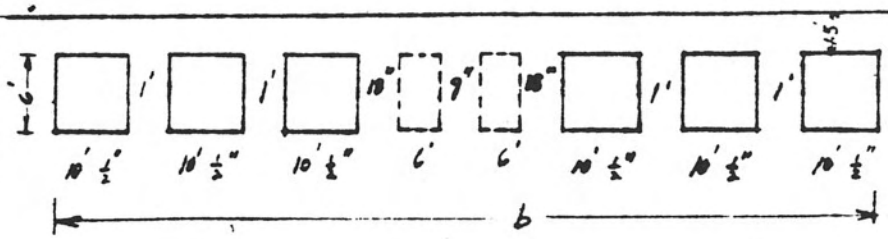
PROJECT TITLE INOAOLE STREAM SH NO. 9 OF 25 SHS
LOCATION ~~HUGHES~~ ROAD CROSSING SECTION
DRAWING (S) NO.
COMPUTED BY VC DATE 3/80 CHECKED BY DATE

DESIGN ANALYSIS

REQ'D: DETERMINE CAPACITY OF CULVERTS FOR IMPROVED CONDITION

EXISTING CULVERTS

PROPOSED NEW CULVERTS



b = 80'

PIERS & DEBRI ALLOWANCE (2' ON EACH SIDE OF PIER)
5' + 5' + 5.5 + 4.75 + 5.5 + 5 + 5 = 35.75'
NET EFFECTIVE WIDTH = 80 - 35.75 = 44.25'

ASSUME INLET CONTROL (REFER TO INLET CONTROL CHART)

$\frac{HW}{D} = \frac{7.5'}{6} = 1.25$

$\frac{Q}{b} = 55 \text{ CFS/FT}$

$Q = 55 (44.25) = \underline{2,430 \text{ CFS}}$ CAPACITY OF CULVERTS FOR IMPROVED CONDITIONS.

NOTE: BASED ON FIGURE 1, THE IMPROVED CAPACITY IS ABOUT A 3.3 - YEAR FLOOD.

POD Form 115
1 Jul 70

CURRENT DATE: 10-04-1995
CURRENT TIME: 11:21:00

FILE DATE: 10-04-1995
FILE NAME: TINKER

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	1.01	1.00	30.00	1 RCB	72.25	6.00	.012	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (CFS) FILE: TINKER DATE: 10-04-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
1.01	0	0	0	0	0	0	0	0	1
3.25	370	370	0	0	0	0	0	0	1
4.42	740	740	0	0	0	0	0	0	1
5.09	1000	1000	0	0	0	0	0	0	1
6.17	1480	1480	0	0	0	0	0	0	1
6.90	1850	1850	0	0	0	0	0	0	1
7.57	2220	2220	0	0	0	0	0	0	1
8.25	2590	2514	0	0	0	0	0	94	4
8.73	2960	2504	0	0	0	0	0	471	3
9.14	3330	2436	0	0	0	0	0	917	3
9.50	3700	2341	0	0	0	0	0	1392	4
8.00	2512	2512	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: TINKER DATE: 10-04-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
1.01	0.00	0	0	0.00
3.25	0.00	370	0	0.00
4.42	0.00	740	0	0.00
5.09	0.00	1000	0	0.00
6.17	0.00	1480	0	0.00
6.90	0.00	1850	0	0.00
7.57	0.00	2220	0	0.00
8.25	0.01	2590	-18	-0.69
8.73	0.01	2960	-15	-0.50
9.14	0.01	3330	-23	-0.68
9.50	0.01	3700	-33	-0.89

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

CURRENT DATE: 10-04-1995
CURRENT TIME: 11:21:00

FILE DATE: 10-04-1995
FILE NAME: TINKER

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (72.25 BY 6) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	1.01	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
370	3.25	1.60	2.24	3-M1t	1.65	0.94	2.45	2.09	2.89	2.09
740	4.42	2.53	3.41	3-M1t	2.53	1.49	3.27	3.13	3.67	3.13
1000	5.09	3.07	4.08	3-M1t	3.06	1.82	3.72	3.72	4.07	3.72
1480	6.17	3.94	5.16	3-M1t	3.90	2.36	4.41	4.65	4.62	4.65
1850	6.90	4.57	5.89	3-M1t	4.48	2.74	4.86	5.27	4.96	5.27
2220	7.57	5.18	6.56	3-M1t	5.03	3.09	5.27	5.83	5.25	5.83
2514	8.25	5.67	7.24	4-FFt	6.00	3.36	5.80	6.00	5.51	6.35
2504	8.73	5.65	7.72	4-FFt	6.00	3.35	5.78	6.00	5.74	6.83
2436	9.13	5.54	8.12	4-FFt	5.34	3.29	5.62	6.00	5.95	7.28
2341	9.50	5.38	8.49	4-FFt	5.20	3.20	5.40	6.00	6.14	7.71

El. inlet face invert 1.01 ft El. outlet invert 1.00 ft
El. inlet throat invert 0.00 ft El. inlet crest 0.00 ft

***** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	1.01
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	30.00
DOWNSTREAM ELEVATION (FT)	1.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

***** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	72.25 FT
BARREL RISE	6.00 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (0 DEG. FLARE)
INLET DEPRESSION	NONE

CURRENT DATE: 10-04-1995
CURRENT TIME: 11:21:00

FILE DATE: 10-04-1995
FILE NAME: TINKER

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.035
CHANNEL INVERT ELEVATION (FT)	1.00
CULVERT NO.1 OUTLET INVERT ELEVATION	1.00 FT

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	1.00	0.000	0.00	0.00	0.00
370.00	3.09	0.352	2.09	2.89	0.26
740.00	4.13	0.366	3.13	3.67	0.39
1000.00	4.72	0.372	3.72	4.07	0.46
1480.00	5.65	0.378	4.65	4.62	0.58
1850.00	6.27	0.381	5.27	4.96	0.66
2220.00	6.83	0.383	5.83	5.25	0.73
2590.00	7.35	0.385	6.35	5.51	0.79
2960.00	7.83	0.387	6.83	5.74	0.85
3330.00	8.28	0.388	7.28	5.95	0.91
3700.00	8.71	0.389	7.71	6.14	0.96

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	30.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	8.00

APPENDIX II

HYDRAULIC CALCULATIONS
1F. Hughes Road-
Existing Channel Downstream

DOT 4-380

COMPUTATION SHEET

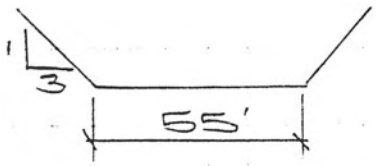
Project: INDIAOLE STREAM BRIDGE REPLACEMENT Proj. No. _____

Computed by: CMATSUDA Date: 10/4/95 Checked by: _____ Date: _____

HYDRAULICS - EXISTING CHANNEL DOWNSTREAM OF HUGHES ROAD

GIVEN: $Q_{50} = 3700$ cfs
$S = .002$
$n = 0.035$

FIND: d_n, V_n, Froude No.



TRIAL & ERROR

For $d_n = 7'$ $Q = 3095$ cfs

$d_n = 8'$ $Q = 3955$ cfs

Thru interpolation:

For $Q_{50} = 3700$ cfs $\underline{d_n = 7.7'}$

$$V_n = \frac{Q}{A} = \frac{3700}{(55 + (3)(7.7))7.7} = \underline{6.2 \text{ ft/s}}$$

$$\text{Froude No.} = \frac{V}{\sqrt{dg}} = \frac{6.2}{\sqrt{(7.7)(32.2}} = \underline{0.39}$$

APPENDIX II

HYDRAULIC CALCULATIONS
IG. Hihimanu Street
Existing Box Culvert

DOT 4-380

COMPUTATION SHEET

Project: KALANIANAOLE HWY INOAOLE STREAM BRIDGE Proj. No. _____

Computed by: CMATSUDA Date: 10/4/95 Checked by: _____ Date: _____

CAPACITY OF EXISTING BOX CULVERT @ HIHIMANU STREET

GIVEN: 13.5' x 2.75' RCB opening
HW depth = 3.75' ±
45° WINGWALLS
ASSUME INLET CONTROL.

FIND: CAPACITY OF CULVERT

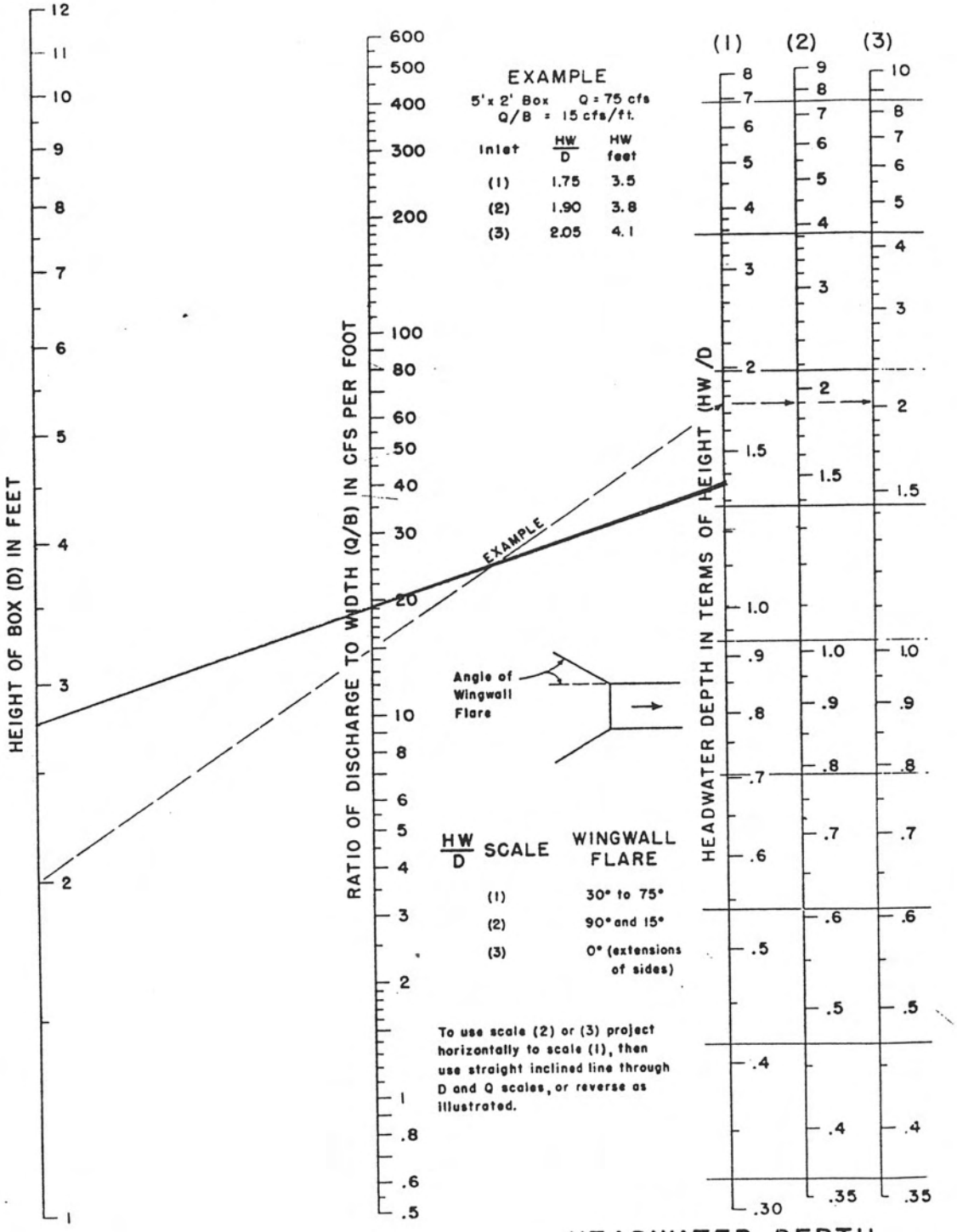
ASSUMING NO FREEBOARD;

FOR D = 2.75 & $\frac{HW}{D} = \frac{3.75}{2.75} = 1.36$ USING CHART 8

Q/B = 19 cfs/ft

Q capacity = (19')(13.5') = 256.5 ↳ 260 cfs

CHART 8



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

APPENDIX II

HYDRAULIC CALCULATIONS
1H. Kalanianaole Highway-
Existing Box Culvert

URRENT DATE: 09-22-1995
URRENT TIME: 07:16:53

FILE DATE: 09-22-1995
FILE NAME: INOAOLE2

FHWA CULVERT ANALYSIS
HY-8, VERSION 4.3

CULV	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (FT)	OUTLET ELEV. (FT)	CULVERT LENGTH (FT)	BARRELS SHAPE MATERIAL	SPAN (FT)	RISE (FT)	MANNING n	INLET TYPE
1	3.10	3.00	50.00	1 RCB	13.50	4.50	.012	CONVENTIONAL
2								
3								
4								
5								
6								

UMMARY OF CULVERT FLOWS (CFS) FILE: INOAOLE2 DATE: 09-22-1995

ELEV (FT)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
3.10	0	0	0	0	0	0	0	0	1
6.42	200	200	0	0	0	0	0	0	1
9.45	740	511	0	0	0	0	0	227	6
9.82	1110	543	0	0	0	0	0	558	3
10.13	1480	568	0	0	0	0	0	906	3
10.40	1850	589	0	0	0	0	0	1256	3
10.65	2220	609	0	0	0	0	0	1608	3
10.88	2590	626	0	0	0	0	0	1961	3
11.10	2960	642	0	0	0	0	0	2315	3
11.31	3330	657	0	0	0	0	0	2671	3
11.52	3700	671	0	0	0	0	0	3027	3
9.00	471	471	0	0	0	0	0	OVERTOPPING	

SUMMARY OF ITERATIVE SOLUTION ERRORS FILE: INOAOLE2 DATE: 09-22-1995

HEAD ELEV(FT)	HEAD ERROR(FT)	TOTAL FLOW(CFS)	FLOW ERROR(CFS)	% FLOW ERROR
3.10	0.00	0	0	0.00
6.42	0.00	200	0	0.00
9.45	-0.01	740	2	0.29
9.82	-0.01	1110	9	0.83
10.13	-0.00	1480	7	0.45
10.40	-0.00	1850	5	0.26
10.65	-0.00	2220	4	0.17
10.88	-0.00	2590	3	0.11
11.10	-0.00	2960	2	0.08
11.31	-0.00	3330	2	0.06
11.52	-0.00	3700	2	0.05

<1> TOLERANCE (FT) = 0.010 <2> TOLERANCE (%) = 1.000

URRENT DATE: 09-22-1995
URRENT TIME: 07:16:53

FILE DATE: 09-22-1995
FILE NAME: INOAOLE2

PERFORMANCE CURVE FOR CULVERT # 1 - 1 (13.5 BY 4.5) RCB

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRITICAL DEPTH (ft)	OUTLET VEL. (fps)	OUTLET DEPTH (ft)	TAILWATER VEL. (fps)	TAILWATER DEPTH (ft)
0	3.10	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	-2.60
200	6.42	3.21	3.32	2-M2c	1.99	1.90	7.80	1.90	2.44	-1.18
511	9.45	6.35	6.14	2-M2c	3.78	3.55	10.66	3.55	3.94	0.47
543	9.81	6.71	6.39	2-M2c	3.94	3.70	10.87	3.70	4.54	1.30
568	10.12	7.02	6.57	6-FFn	4.50	3.81	9.34	4.50	5.00	2.01
589	10.39	7.29	6.74	6-FFn	4.50	3.91	9.70	4.50	5.39	2.64
609	10.65	7.55	6.90	6-FFn	4.50	3.99	10.02	4.50	5.72	3.22
626	10.88	7.78	7.05	6-FFn	4.50	4.07	10.31	4.50	6.02	3.76
642	11.10	8.00	7.18	6-FFn	4.50	4.14	10.57	4.50	6.28	4.26
657	11.31	8.21	7.55	4-FFt	4.50	4.20	10.81	4.50	6.52	4.73
671	11.51	8.41	8.12	4-FFt	4.50	4.26	11.04	4.50	6.74	5.18

El. inlet face invert 3.10 ft
El. inlet throat invert 0.00 ft
El. outlet invert 3.00 ft
El. inlet crest 0.00 ft

**** SITE DATA ***** EMBANKMENT TOE **********

UPSTREAM STATION (FT)	0.00
UPSTREAM ELEVATION (FT)	3.10
UPSTREAM EMBANKMENT SLOPE (X:1)	0.00
DOWMSTREAM STATION (FT)	50.00
DOWNSTREAM ELEVATION (FT)	3.00
DOWNSTREAM EMBANKMENT SLOPE (X:1)	0.00

**** CULVERT DATA SUMMARY **********

BARREL SHAPE	BOX
BARREL SPAN	13.50 FT
BARREL RISE	4.50 FT
BARREL MATERIAL	CONCRETE
BARREL MANNING'S N	0.012
INLET TYPE	CONVENTIONAL
INLET EDGE AND WALL	SQUARE EDGE (90-45 DEG.)
INLET DEPRESSION	NONE

CURRENT DATE: 09-22-1995
CURRENT TIME: 07:16:53

FILE DATE: 09-22-1995
FILE NAME: INOAOLE2

TAILWATER

******* REGULAR CHANNEL CROSS SECTION **********

BOTTOM WIDTH (FT)	55.00
SIDE SLOPE H/V (X:1)	2.0
CHANNEL SLOPE V/H (FT/FT)	0.002
MANNING'S N (.01-0.1)	0.033
CHANNEL INVERT ELEVATION (FT)	0.40
CULVERT NO.1 OUTLET INVERT ELEVATION	3.00 FT

****** UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

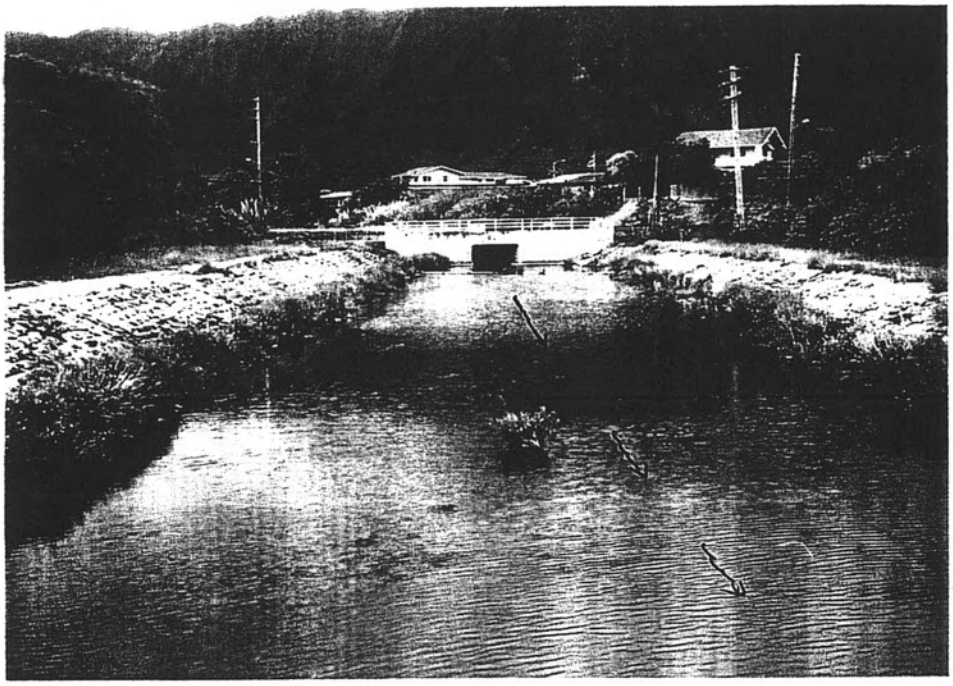
FLOW (CFS)	W.S.E. (FT)	FROUDE NUMBER	DEPTH (FT)	VEL. (FPS)	SHEAR (PSF)
0.00	0.40	0.000	0.00	0.00	0.00
200.00	1.82	0.362	1.42	2.44	0.18
740.00	3.47	0.396	3.07	3.94	0.38
1110.00	4.30	0.405	3.90	4.54	0.49
1480.00	5.01	0.411	4.61	5.00	0.58
1850.00	5.64	0.415	5.24	5.39	0.65
2220.00	6.22	0.418	5.82	5.72	0.73
2590.00	6.76	0.421	6.36	6.02	0.79
2960.00	7.26	0.423	6.86	6.28	0.86
3330.00	7.73	0.424	7.33	6.52	0.92
3700.00	8.18	0.426	7.78	6.74	0.97

ROADWAY OVERTOPPING DATA

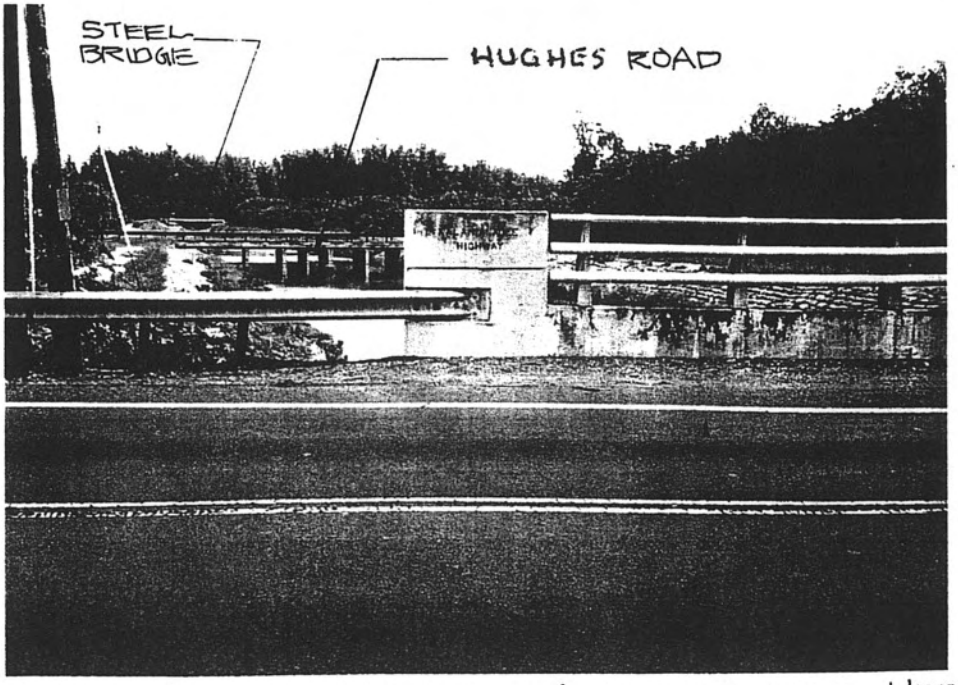
ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH (FT)	50.00
CREST LENGTH (FT)	250.00
OVERTOPPING CREST ELEVATION (FT)	9.00

APPENDIX III

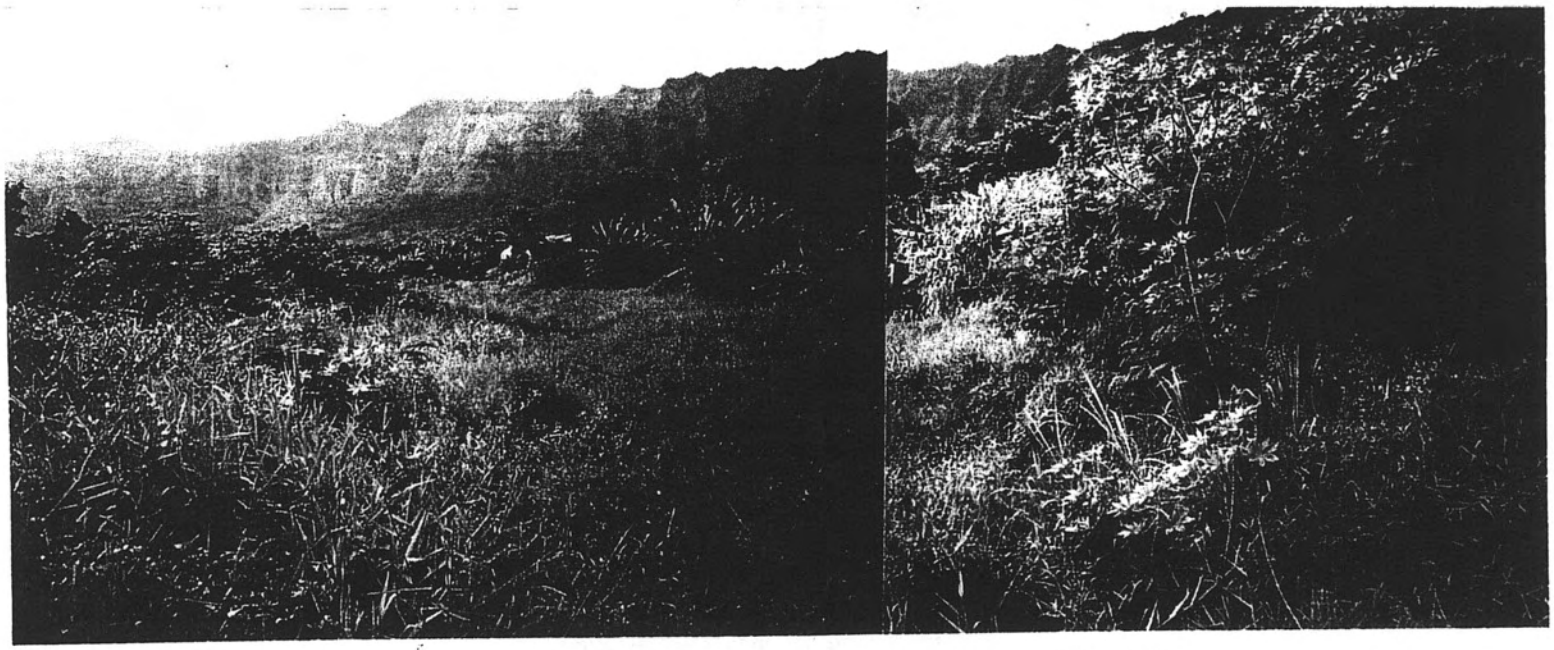
PHOTOGRAPHS OF SITE



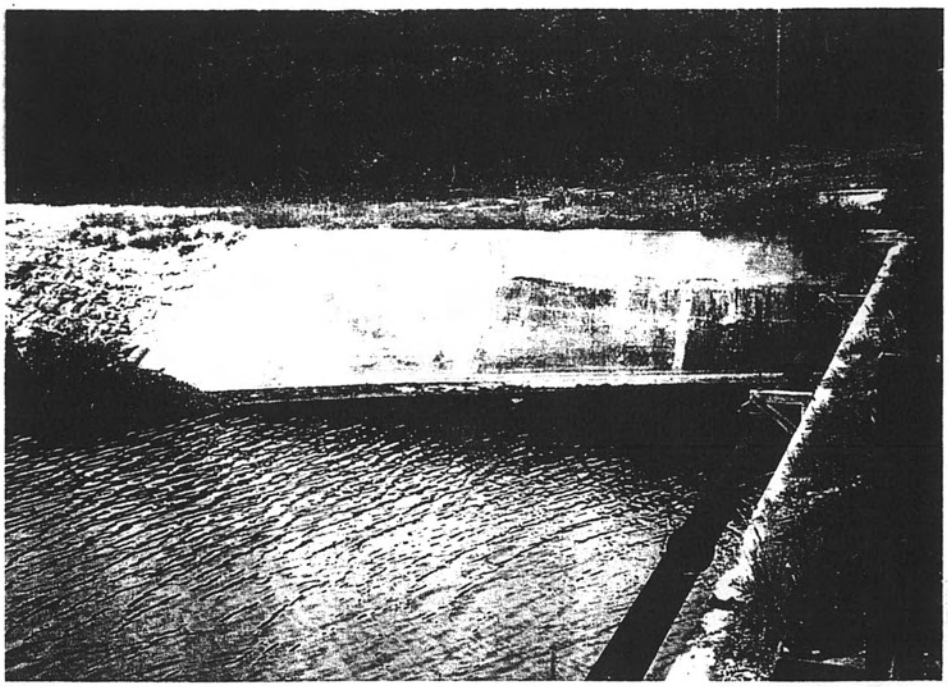
13.5' x 4.5' CONCRETE BOX CULVERT
@ KAL HWY - LOOKING UPSTREAM



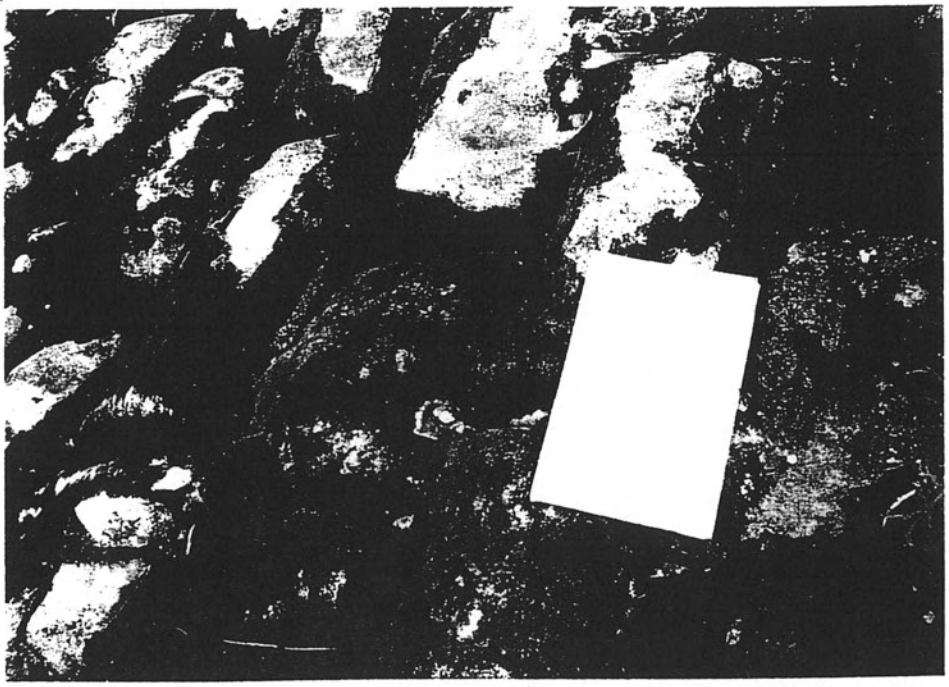
LOOKING DOWNSTREAM FROM KAL HWY.



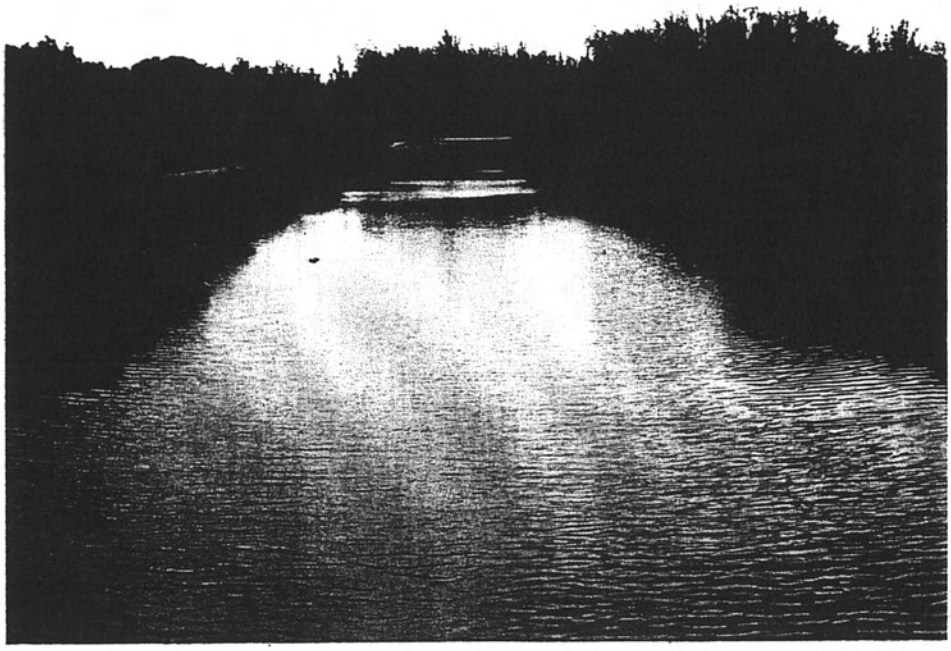
CHANNEL UPSTREAM FROM KAL HWY.



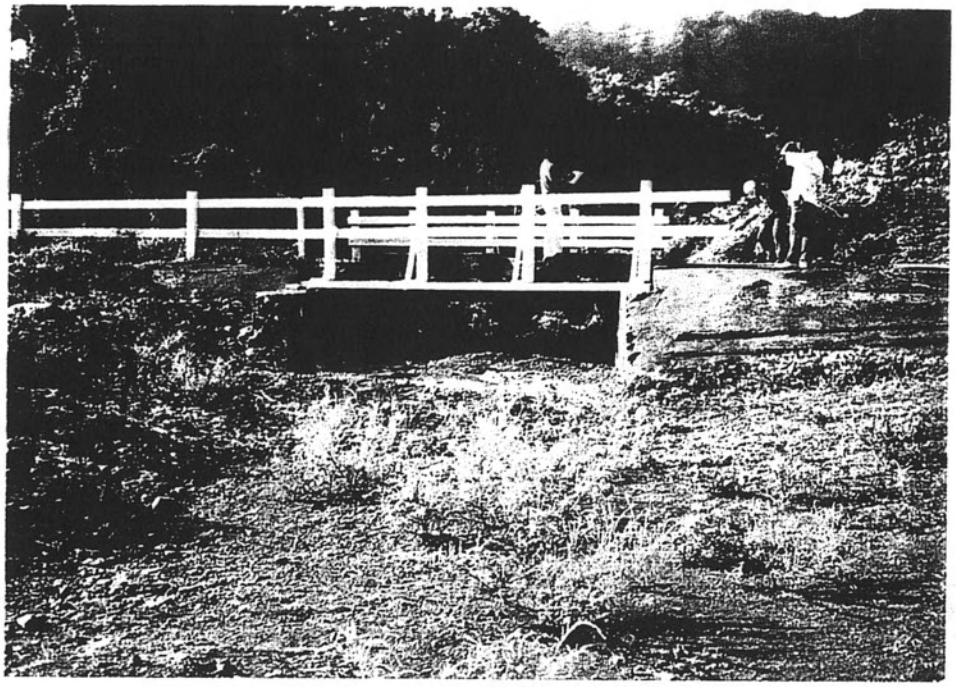
CONCRETE WINGWALL TRANSITION @ HUGHES ROAD BOX CULVERTS



"CONCRETE SACK" ALONG EMBANKMENT

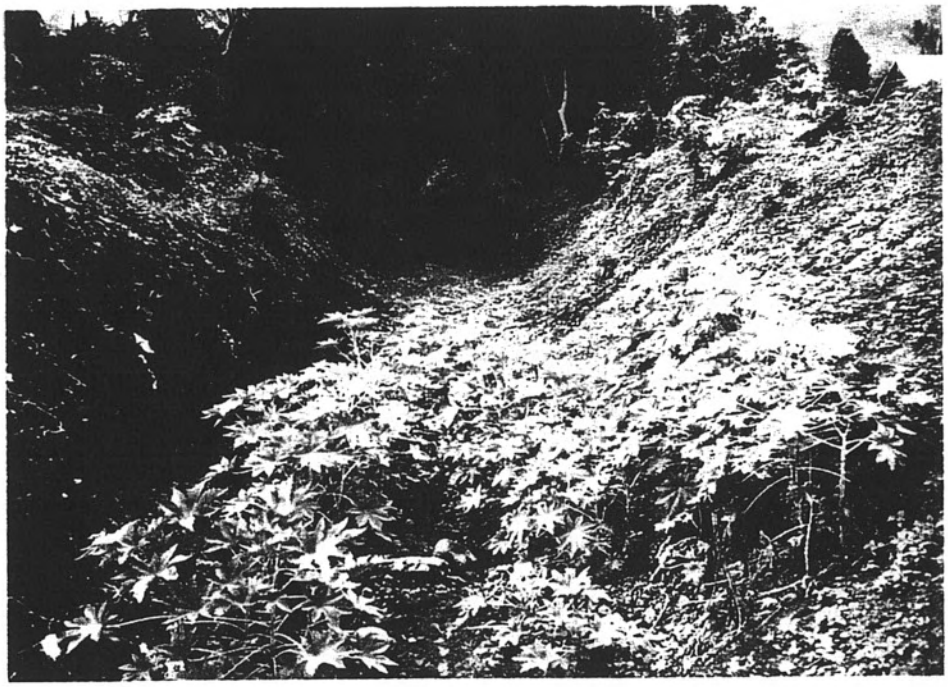


STEEL BRIDGE - LOOKING DOWNSTREAM FROM HUGHES ROAD



13.5' x 2.75' BOX CULVERT @ HIHIMANU STREET - LOOKING UPSTREAM

INLET @ BOX CULVERT - HIHIMANU STREET - LOOKING DOWNSTREAM



CHANNEL UPSTREAM FROM HIHIMANU STREET BOX CULVERT

CHANNEL DOWNSTREAM FROM HIHIMANU STREET BOX CULVERT

APPENDIX B

Aquatic Resources Survey for Kalanianaole Highway Bridge Improvements at Inoaole Stream in Waimanalo, Oahu, AECOS, Inc., September 2000

Aquatic resources survey for Kalaniana`ole Highway Bridge improvements at Inoa`ole Stream in Waimänalo, O`ahu[1]

December 20, 2002 *AECOS* No. 953

Eric Guinther
AECOS, Inc.
45-939 Kamehameha Highway, Room 104
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Introduction

Inoa`ole Stream is one of three stream systems that drain Waimanalo Ahupua`a (Figure 1). The largest of these three systems is Waimanalo Stream (State ID No. 3-2-15) located in the northern half of the ahupua`a, discharging along Waimanalo Beach within Marine Corps Training Area at Bellows (MCTAB). East of Waimanalo Stream is Inoa`ole (the name means "no name" or "without a name"), the mouth of which also is within MCTAB, a distance of 1.6 km (1 mi) southeast along Waimanalo Beach from Waimanalo Stream. A third much smaller, unnamed drainage occurs at the east end of Waimanalo, discharging between Waimanalo Beach Park and Kaiona Beach Park.

Although Inoa`ole Stream has a drainage area nearly as large as that of Waimanalo Stream, Inoa`ole is not listed as a perennial stream (Hawaii Cooperative Park Service Unit. 1990) and its watershed is often combined with that of Waimanalo Stream (Geographic Decision Systems International and E. P. Dashiell. 1994). Classifying the stream as intermittent may satisfy certain State resource inventory requirements, but is not a satisfactory approach for environmental assessment purposes because a number of functional attributes of a stream within a watershed are not dependent upon constant or uninterrupted flow. Many natural drainages in the Hawaiian Islands are, or have significant portions thereof, intermittently flowing. These would be defined as "interrupted" streams (Timbol and Maciolek, 1978) if water flow is perennial in the upper reach and the stream bed seasonally dry in the lower reach. Most Hawaiian streams are intermittent and flashy in the very uppermost reaches.

[1] Report prepared for Sato and Associates, Inc. for an environmental assessment. This report will become part of the public record.

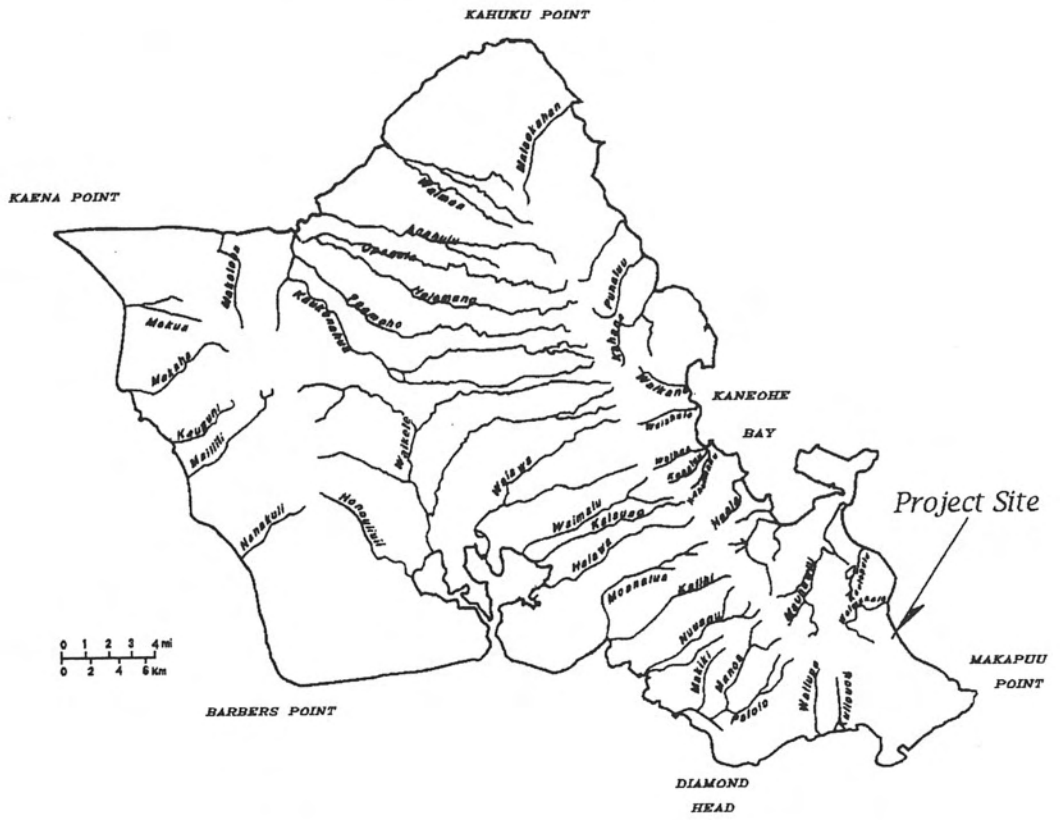


Figure 1. Location of Inoa`ole Stream and Kalaniana`ole Highway Bridge Project on a map of O`ahu streams.

Because Inoa`ole drains the Ko`olau ridgeline at the eastern end of the Island of O`ahu where the maximum elevation is mostly under 730 m (2400 ft), Tradewind-generated (orographic) rainfall is minimal. Above the project area (above Kalaniana`ole Highway), this stream appears intermittent, although some isolated pools may not dry up completely except during prolonged drought periods. Below Kalaniana`ole Highway, the stream likely always contains water, although flow (turnover) is very minimal in dry periods. We suggest Inoa`ole Stream should be assigned State ID No. 3-2-16, since it is a completely separate watershed from that of Waimanalo Stream, although the upper and middle reaches of Inoa`ole Stream are intermittent.

This report presents results of a brief survey of Inoa`ole Stream in the vicinity of Kalaniana`ole Highway undertaken in order to assess potential impacts from a proposed highway bridge construction project.

Methods

The survey of Inoa`ole Stream was limited to the vicinity of the proposed bridge replacement project and a distance of approximately 60 m (200 ft) upstream and downstream of the existing highway bridge. The site survey was conducted on August 31, 2000. Aquatic biota was sampled by direct observation and by using hand-nets. In general, conditions were moderately poor for this approach, because of extensive coverage on the water surface by floating plants and plant debris. More intrusive sampling methods downstream or north of the highway bridge (snorkeling, fish poison, electric shocker) would likely reveal additional species not observed by us. Also, because this body of water appears to be subject to saline influence, conditions might be different at other times of the year. For example, many rocks in this part of the stream have calcareous tubes on them made by serpulid worms (*Ficopomatus enigmaticus*). These tubes were not occupied in August and the worms probably require an environment that is a bit more saline. Their presence indicates conditions can be considerably different in this body of water from what they were at the time of our survey, and at least some elements of the flora and fauna will be different if conditions change.

Water Quality — Water quality measurements were made in several locations, primarily to characterize the aquatic environments present. All measurements represent conditions at a single point in time and may not be representative of average conditions. Three stations were sampled. Station 1 was located along the right bank approximately 10 m upstream of the highway bridge. At Station 1, the water depth was only a few centimeters and collecting a water sample without incorporating large amounts of sediment and plant debris was not possible. Consequently, only selected analyses were undertaken on this sample. Stations 2 and 3 were both located on the large pool north of the highway bridge: Station 2 directly off the box culvert under Kalaniana`ole Highway, and Station 3 off the left bank just upstream from the Tinker Road bridge.

Methods pertaining to the water quality analyses for this report are given in Table 1. All water samples were taken to *AECOS* laboratory (assigned laboratory Log No. 13371) in Kailua[2] immediately after collection and either preserved or analyzed immediately as required by standard methodology for each analysis. Temperature, pH, and dissolved oxygen were measured with *in situ* probes.

[2] AECOS Inc. has since moved the laboratory to Kane`ohe.

Table 1. Analytical methods and instruments used for the August 31, 2000 sampling in Inoa`ole Stream, Waimanalo.

Analyses List	Method	Reference	Instrument
Ammonia	alkaline phenol	Koroleff in Grasshoff et al. (1986)	Technicon AutoAnalyzer II
Conductivity	Method 2510B (EPA 120.1)	Standard Methods 18th Edition (1992)	Hydach pH/conductivity meter
Dissolved Oxygen	EPA 360.1	EPA (1979)	YSI Model 55 DO meter
Nitrate + Nitrite	EPA 353.2	EPA (1993)	Technicon AutoAnalyzer II
pH	EPA 150.1	EPA (1979)	pHep 3
Temperature	thermister calibrated to NBS cert. Thermometer (EPA 170.1)	EPA (1979)	YSI Model 55 DO meter
Total Nitrogen	persulfate digestion /EPA 353.2	D'Elia et al. (1977) / EPA (1993)	Technicon AutoAnalyzer II
Total Phosphorus	persulfate digestion /EPA 365.1	Koroleff in Grasshoff et al. (1986) / EPA (1993)	Technicon AutoAnalyzer II
Total Suspended Solids (TSS)	Method 2540D (EPA 160.2)	Standard Methods 18th Edition (1992); EPA (1979)	Mettler H31 balance
Turbidity	Method 2130B (EPA 180.1)	Standard Methods 18th Edition (1992); EPA (1993)	Hach 2100P Turbidimeter

D'Elia, C.F., P.A. Stendler, & N. Corwin. 1977. *Limnol. Oceanogr.* 22(4): 760-764.
EPA. 1979. Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency, EPA 600/4-79-020.
EPA. 1993. Methods for the Determination of Inorganic Substances in Environmental Samples. EPA 600/R-93/100.
EPA. 1994. Methods for Determination of Metals in Environmental Samples, Supplement 1. EPA/600/R-94/111. May 1994.
Grasshoff, K., M. Ehrhardt, & K. Kremling (eds). 1986. Methods of Seawater Analysis (2nd ed). Verlag Chemie, GmbH, Weinheim.
Standard Methods. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition. 1992. (Greenberg, Clesceri, and Eaton, eds.). APHA, AWWA, & WEF. 1100 p.

Stream Description

Inoa`ole Stream is normally confined behind an extensive barrier of sand at Waimanalo Beach, forming what is known as a muliwai: an estuarine, stream mouth pond. Presumably, this barrier is only breached during significant flooding events. The seaward end of the muliwai is located in a forest of ironwood trees (*Casuarina equisetifolium*). The channel extending inland is confined to a straight, steep-sided cut that is man-made through the coastal plain. This cut widens somewhat towards Kalaniana`ole Highway, becoming a channel lined with concrete poured into geotextile fabric sacks that give the appearance of stacked canvas sand bags (Figure 2).

Geologically, this part of Waimanalo is Recent Era beach and dune sand deposits fronting remnants of Waimanalo Stand (Pleistocene Era) emergent reef partly buried by alluvium (Macdonald and Abbott, 1970). It is possible, given this geology, that the stream or streams now feeding Inoa`ole Stream did not always have a mouth at the

shore. Instead, intermittent stream flows reached only to the porous limestone plain where the water either soaked into the ground or caused localized flooding as is the case at both Kahuku and Ewa where the coastal plain is very similar. Thus, the present day Inoa`ole Stream is actually a man-made drainage channel whose purpose is to reduce flood hazards in the central part of Waimanalo. It appears that the muliwai of Inoa`ole Stream extends inland all of the way along this channel to Kalaniana`ole Highway, and further inland during wetter times, although at the time of our survey water level in the muliwai was at least 30 cm (1 ft) below the floor of the box culvert under the highway bridge.

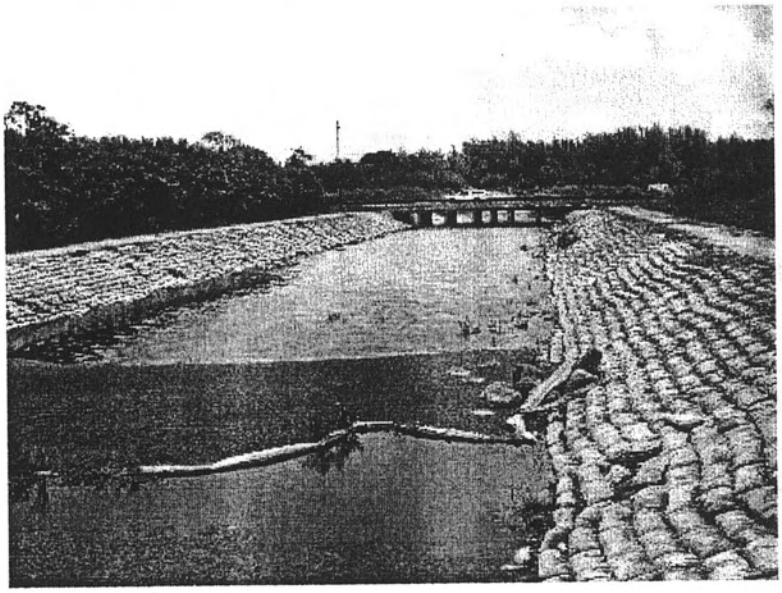


Figure 2. The muliwai of Inoa`ole Stream looking *makai* from Kalaniana`ole Highway bridge on Aug. 31, 2000.

Because this large pond in the drainage channel is open (not shaded) in the upper part, it is usually (at least in recent years) covered by giant salvinia fern (*Salvinia molesta;* a small, floating plant). Apparently the area was sprayed sometime in the weeks before our visit, because giant salvinia, which previously had been observed to cover all of the water surface well into the Marine Corps Training Area at Bellows (MCTAB), was limited to a patch approximately 10 m by 12 m close to the bridge on August 31 (Figure 2). Other obligate or facultative aquatic plants observed in this area growing on rocks, concrete, or the canvas float (soil, *per se*, is very limited here) were primrose willow (*Ludwigia octovalvis*), `ae`ae (*Bacopa monnieri*), sessile joy weed (*Alternanthera sessiles*), California grass (*Brachiaria mutica*), barnyard grass (*Echinochloa crus-galli*), and Mexican sprangle-top (*Leptochloa uninerva*). Several species of algae were also present in the water.

Upstream from the Kalanianaole Highway bridge, Inoa`ole Stream is not perennially flowing, although some standing water may be always present for at least 100 m (~ 100 yds) up from the bridge. The channel here, confined by graded soil banks, is heavily overgrown with California grass or covered with dead grass and stubble following application of herbicide (as was the case during our field survey). Dense stands of elephant grass (*Pennisetum purpureum*) are present along parts of the stream bank. On August 31, water depth was generally under 20 cm and the water surface almost completely covered by duckweeds (*Spirodela polyrrhiza* and *Wolffia globosa*). Although only a few small fishes were observed here, there were few places where one could look down into the water or, because of the straw from California grass plants killed by spraying, effectively utilize a hand net for sampling. However, the large diversity of invertebrates, especially mollusks and arthropods, would suggest fish populations are quite small. Poor water quality, in addition to limitations on movement imposed by grass stubble, would further indicate very poor habitat for fishes in this part of Inoa`ole Stream.

Water Quality

As noted under methods above, water quality measurements and samples were made at three locations: one (Station 1) representing water upstream of the Kalaniana`ole Highway bridge, two (Stations 2 and 3) representing the *muliwai* downstream of the bridge. Because of the very shallow water upstream, only some of the analyses anticipated could actually be completed. In all cases, although the water is fresh, it must be considered that this is standing water, and not flowing water. The stagnant nature of the water upstream is immediately apparent in the very low dissolved oxygen (DO) value recorded. Despite the shallow depth (which might encourage diffusion of oxygen from the air), the solid covering of duckweed and rich organic material on the bottom work against retention of oxygen in this water. The invertebrates captured here must have the ability to survive at such low oxygen tension by living at the water surface.

The higher pH values in the muliwai probably reflect the local geology or influence of slightly saline water. Stream waters typically have a pH around 7 or a little less; brackish and saline waters are more likely to have a pH closer to 8.0. The conductivity values are commensurate with very slightly brackish water (< 1 ppt salt). Turbidity and TSS (total suspended solids) are moderately high, and may reflect phytoplankton in the standing water of the muliwai as well as small, inert particulates.

Nitrates and, especially in the shallow water upstream of the highway bridge, phosphates are elevated, indicating nutrient inputs to the stream from somewhere. This could be from agricultural activities upstream or more locally. The stream parallels the Waimanalo polo field above our Station 1. The nutrients present

encourage weedy growth in the stream bed as well as the extensive growth of floating plants as observed in this area in the past. Nutrients encourage phytoplankton development in the muliwai where floating plants do not completely cover the water surface. This eutrophication of the water body leads to wide swings in DO content, from possibly very high in the daylight, to anoxic (lacking oxygen) at night, with adverse impacts on aquatic animals. Eventually high nutrient content or the organic material generated by the high nutrient content is swept out into Waimanalo Bay whenever rains cause discharge flows from Inoa`ole Stream.

Table 2. Water quality characteristics of the lower reach of Inoa`ole Stream from samples obtained August 31, 2000.

		Time	Temp. (°C)	pH	DO (mg/l)	DO Sat. (%)	Cond. (µmhos)	Turbidity (ntu)
Sta. 1	08-31-00	1100	26.5	6.8	0.77	10	--	--
Sta. 2	08-31-00	1115	26.8	7.9	7.2	91	748	5.84
Sta. 3	08-31-00	1125	27.5	8.1	7.9	100	761	12.8

			TSS (mg/l)	Ammonia (µg N/l)	Nitrate + nitrite (µg N/l)	Total N (µg N/l)	Ortho-P (µg P/l)	Total P (µg P/l)
Sta. 1	08-31-00	1100	--	2	1	--	411	--
Sta. 2	08-31-00	1115	5.1	40	3370	3920	124	129
Sta. 3	08-31-00	1125	12.2	20	3050	3760	124	154

Stream Biota

Table 3 provides a checklist if the biota observed or reported from Inoa`ole Stream. The two parts of this stream surveyed: the large muliwai or coastal pond downstream from the highway and the shallow, vegetation-choked pool upstream of the bridge contained generally different plants and animals. The upstream pool was covered by *Spirodella* and *Wolffia* duckweeds and dominated by small snails, mostly ramshorn (*Planorbella duryi*) and physid snails (*Physa virgata*). Amphipods and insect larvae were also present. No fishes were observed in this pool.

The downstream body of water was inhabited by poecilid fishes (mosquitofish and mollies) and tilapia (indet.). Snails were also numerous, particularly large-numbers of small ramshorn and melanid (*Melanoides tuberculata*) snails. It is assumed the

ramshorn snails, mostly under 0.5 cm across, are the same species as collected above the bridge (individuals mostly at least 1 cm across). The smaller size downstream from the bridge may simply reflect a recent surge in the population, with large numbers of subadults representing a single cohort, or some unknown environmental factor below the bridge that stunts the growth of this species. Two species of "pond" snails (*Pseudosuccinea columella* and *Physa virgata*) are found here, but neither was very abundant in August.

Table 3. Checklist of aquatic fauna observed or previously reported from the lower reach of Inoa`ole Stream, Waimanalo.

Species	Common name	Status	QC Code	Abundance
INVERTEBRATES				
ANNELIDA, POLYCHAETA				
Ficopomatus enigmaticus (Fauvel)	tube worm, tubes only	nat.	10	†
MOLLUSCA, GASTROPODA	(mollusks)			
LYMNAEIDAE				
Pseudosuccinea columella Say	pond snail	nat.	20	R
PHYSIDAE				
Physa virgata	pond snail	nat.	20	C
PLANORBIDAE				
Planorbella duryi Wetherby	ramshorn snail	nat.	20	A
THIARIDAE				
Melanoides tuberculata (Müller)	melanid snail	nat	10	A
ARTHROPODA, CRUSTACEA	(crustaceans)			
AMPHIPODA			10	C
ARTHROPODA, INSECTA	(insects)			
TIPULIDAE	(crane flies)			
indet.	larva		20	P
ODONATA, COENAGRIONIDAE	(damaselflies)			
Ischnura ramburi (Selys-Longchamps)	adults & naiads	nat.	20	C
ODONATA, LIBULELLIDAE	(dragonflies)			
Crocothemis servilia Drury	asiatic, adult	nat.	10	C
VERTEBRATES				
VERTEBRATA, PISCES	(fishes)			
CICHLIDAE				
indet.	tilapia	nat.	10	P
ELEOTRIDAE				
Eleotris sandwicensis (Vaillant & Sauvage)	*`o`opu `akupa*	**end.**	01	P
POECILIIDAE				
Gambusia affinis (Baird & Girard)	mosquitofish	nat.	20	U
Poecilia mexicana (Steindachner)	Mexican mollie	nat	10	C
VERTEBRATA, AMPHIBIA	(frogs & toads)			
BUFONIDAE				
Bufo marinus	marine toad, dead adult	nat.	10	

KEY TO SYMBOLS AND ABBREVIATIONS USED:

Status:

nat. - naturalized. An introduced or exotic species.

Table 3 (continued).

ind. - indigenous. A native species also found elsewhere in the Pacific.
end. - endemic - A native species found only in the Hawaiian Islands.

QC Code:
01 - Observed previously in this stream; not necessarily at this location.
10 - Observed in the field by aquatic biologist on August 31, 2000.
20 - Collected; identified in the laboratory; specimen(s) not saved.

Abundance categories:
U - Uncommon - several to a dozen individuals observed.
C - Common - Seen everywhere, although generally not in large numbers.
A - Abundant - found in large numbers and widely distributed.
P – Present - noted as occurring, but quantitative information lacking.
†- Tubes or shells only; not alive at time of observation.

The presence of `o`opu akupa (*Eleotris sandwicensis*) noted in Table 3 is known from observations made by the author previously near the mouth of Inoa`ole Stream. It is very likely that this native fish also occurs in the project area, but was not observed during our field survey on August 31.

Conclusions

Inoa`ole Stream at the project site is essentially a large pond that only flows occasionally, although there certainly may be a slow exchange of water between the local groundwater and the coastal waters through the beach that results in some slight movement of water in this part of the stream. Seemingly isolated coastal ponds are also subject to small changes in water level from ocean tidal action transmitted through the a basal aquifer. Aquatic environments upstream of the highway bridge are generally quite poor and water quality is indicative of stagnant water. Overall, there are no aquatic resources in the project area that would be adversely impacted by the proposed construction of a new bridge or any temporary structures associated with the construction process. No aquatic species listed as threatened or endangered were observed in the project area (DLNR, 1996; Federal Register, 1999). While certain listed waterbirds (such as Hawaiian stilt; *Himantopus mexicanus knudseni*) and the State protected black-crowned night heron (*Nycticorax nycticorax hoactli*) are potential visitors to the muliwai (heron have been observed on lower Inoa`ole Stream by the author), the project area is not critical habitat for these species and likely is used only incidentally if at all in the immediate project vicinity. Given the highly modified nature of the stream channel as it presently exists upstream, but especially downstream, of the highway bridge, replacement of the bridge structure will not result in further degradation of aquatic habitat once the project is completed. Construction activities may require implementation of best management practices (BMPs) to minimize adverse water quality impacts.

Literature Cited

Code of Federal Regulations (CFR). 1999. Title 50 - Wildlife and Fisheries, Part 17 - Endangered and Threatened Wildlife and Plants, Subpart B - Lists. 50 CFR §17.11 and §17.12. U.S. Government Printing Office. 37 pp. (Also URL: `http://endangered.fws.gov`).

Federal Register. 1999. Department of the Interior, Fish and Wildlife Service, 50 CFR 17. Endangered and Threatened Wildlife and Plants. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Recycled Petitions, and Annual Description of Progress on Listing Actions. *Federal Register*, **64** (205 (Monday, October 25, 1999)): 57534-57547.

Geographic Decision Systems International and E. P. Dashiell. 1994. State definition and delineation of watersheds. Prep. for State of Hawaii, Office of State Planning, Coastal Zone Management Program. Geographic Decision Systems International.

Hawaii Cooperative Park Service Unit. 1990. Hawaii stream assessment. A preliminary appraisal of Hawaii's stream resources. Prep. for State of Hawaii, Commission on Water Resource Management. National Park Service, Hawaii Cooperative Park Service Unit, Rept. No. R84: 294 pp.

Macdonald, G. A., and A. T. Abbott. 1970. *Volcanoes in the Sea. The Geology of Hawaii.* University of Hawaii Press. 441 pp.

State of Hawaii - Department of Health (DOH). 1992. Hawaii Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards. State of Hawaii, Department of Health.

State of Hawaii, Department of Land and Natural Resources (DLNR). 1996. Hawaii Administrative Rules. Title 13, Department of Land and Natural Resources, Subtitle 5, Forestry and Wildlife, Part 2 Wildlife, Chapter 124. 11 p.

Timbol, A. S., and J. A. Maciolek. 1978. *Stream Channel Modification in Hawaii. Part A. Statewide Inventory of Streams, Habitat Factors and Associated Biota.* Vol. Part A. Stream Channel Modification in Hawaii. Stream Alteration Project, Office of Biological Services, Fish & Wildlife Service. 157 pp.

APPENDIX C

Inoaole Stream Bridge Replacement Wetland Survey, Char & Associates, September 2000

CHAR & ASSOCIATES
Botanical/Environmental Consultants
4471 Puu Panini Ave.
Honolulu, Hawaii 96816
(808) 734-7828

05 September 2000

Sato & Associates, Inc.
2046 South King Street
Honolulu, Hawaii 96826

Attention: Loren G.S. Lau

SUBJECT Inoa'ole Stream Bridge Replacement
Kalaniana'ole Highway, Waimanalo, O'ahu

Dear Mr. Lau:

An inspection was made of the Inoa'ole Stream Bridge site for the presence of wetlands and wetland vegetation on 09 August 2000.

A small wetland is found along the stream channel on the mauka side of the highway and bridge. The wetland boundary is well-defined by the banks of the stream (see map attached).

The stream bank area was recently mowed with the vegetation 6 inches to 1 foot tall. California grass (Brachiaria mutica) is the most abundant plant along the banks of the stream and also occurs within the stream on muddy areas. There are pools of shallow water within the stream. These contain duckweed (Lemna minor) and abundant green algae (unicellular forms). Other wetland indicator species found along the water's edge are honohono (Commelina diffusa) and false daisy (Eclipta alba). These plants make up more than 50% of the plant cover. The wetland indicator categories (Reed 1988) for these species are as follows:

Species	Category
Lemna minor	Obligate wetland (OBL). Occur almost always (estimated probability greater than 99%) under natural conditions in wetlands.
Commelina diffusa	Facultative wetland (FACW). Usually occur in wetlands (estimated probability 67% to 99%), but occasionally found in nonwetlands.

Eclipta alba	FACW
Brachiaria mutica	FACW

The soils are mapped as "HeA", Haleiwa silty clay, 0 to 2 percent slopes (Foote et al. 1972). These soils occur on alluvial fans or as long narrow areas in drainageways. Small areas with poorly drained clayey soils in depressions are associated with this soil type. Within the stream/wetland area, the soil contains abundant organic material and is anaerobic.

The wetland area is probably flushed during periods of heavy rainfall, but most of the time standing pools of stagnant water is the typical condition.

If you have any questions regarding the findings, please do not hesitate to contact me.

Sincerely,

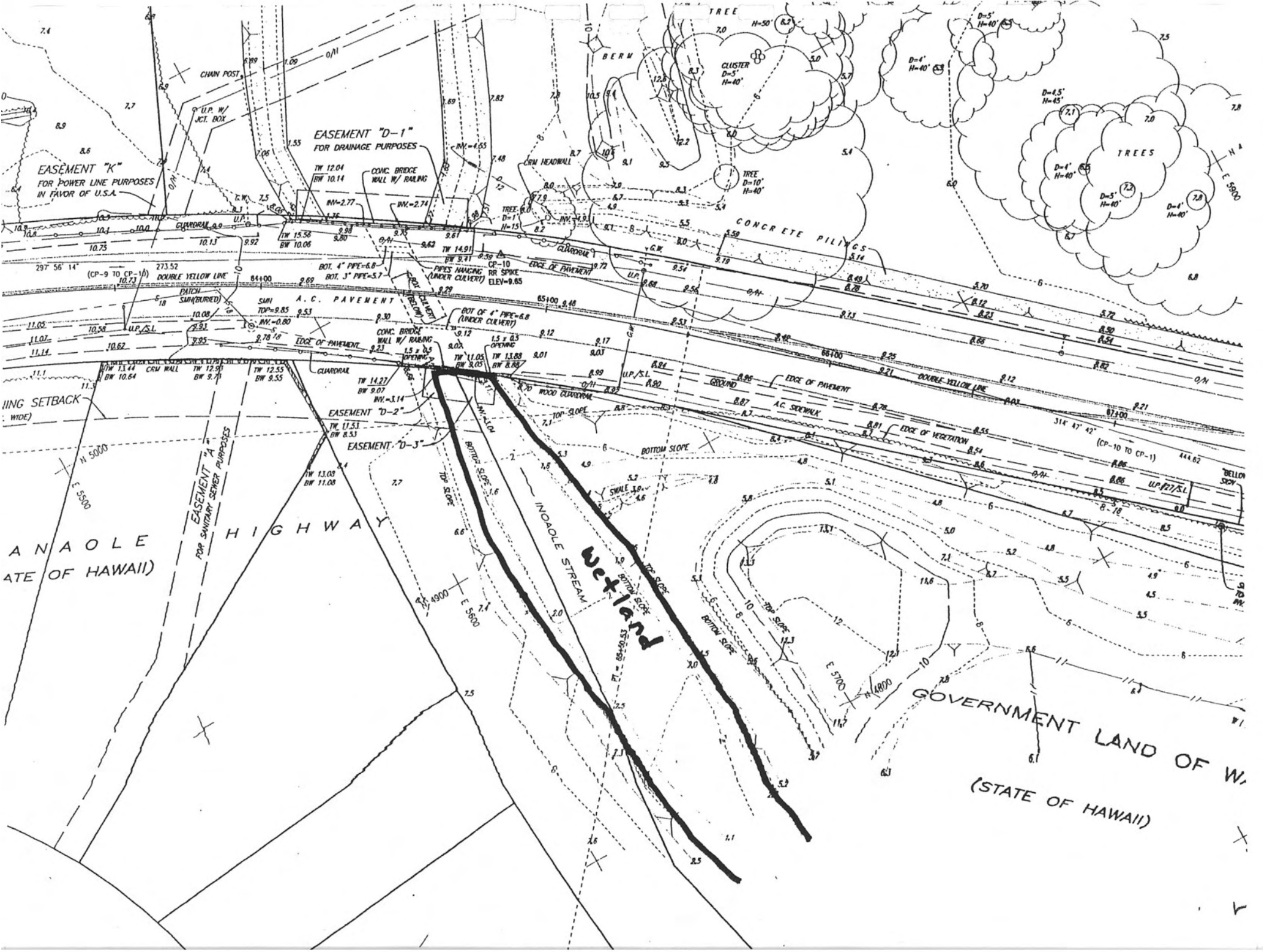
Winona P. Char

Winona P. Char

References

Reed, P.B., Jr. 1988. National list of plant species that occur in wetlands: Hawaii (Region H). U.S. Fish and Wildlife Service Biological Report 88(26.13).

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens. 1972. Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.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FOR DRAINAGE PURPOSES
EASEMENT "D-2"
EASEMENT "D-3"
EASEMENT "A"
FOR SANITARY SEWER PURPOSES
CHAIN POST
U.P. W/ JCT. BOX
CONC. BRIDGE WALL W/ RAILING
CRM HEADWALL
BERM
CLUSTER
TREE
TREES
CONCRETE PILINGS
GUARDRAIL
EDGE OF PAVEMENT
DOUBLE YELLOW LINE
A.C. SIDEWALK
EDGE OF VEGETATION
WOOD GUARDRAIL
A.C. PAVEMENT
PATCH
SAWCUT(BURIED)
BOT. 4" PIPE=6.8
BOT. 3" PIPE=5.7
PIPES HANGING (UNDER CULVERT)
CP-10
RR SPIKE
ELEV=9.65
1.5 x 0.5 OPENING
TOP SLOPE
BOTTOM SLOPE
SWALE
INOAOLE STREAM
wetland
ANAOLE HIGHWAY
(STATE OF HAWAII)
GOVERNMENT LAND OF W
(STATE OF HAWAII)
BUILDING SETBACK
(CP-9 TO CP-10)
(CP-10 TO CP-1)
297° 56' 14"
273.52
314° 47' 42"
444.62
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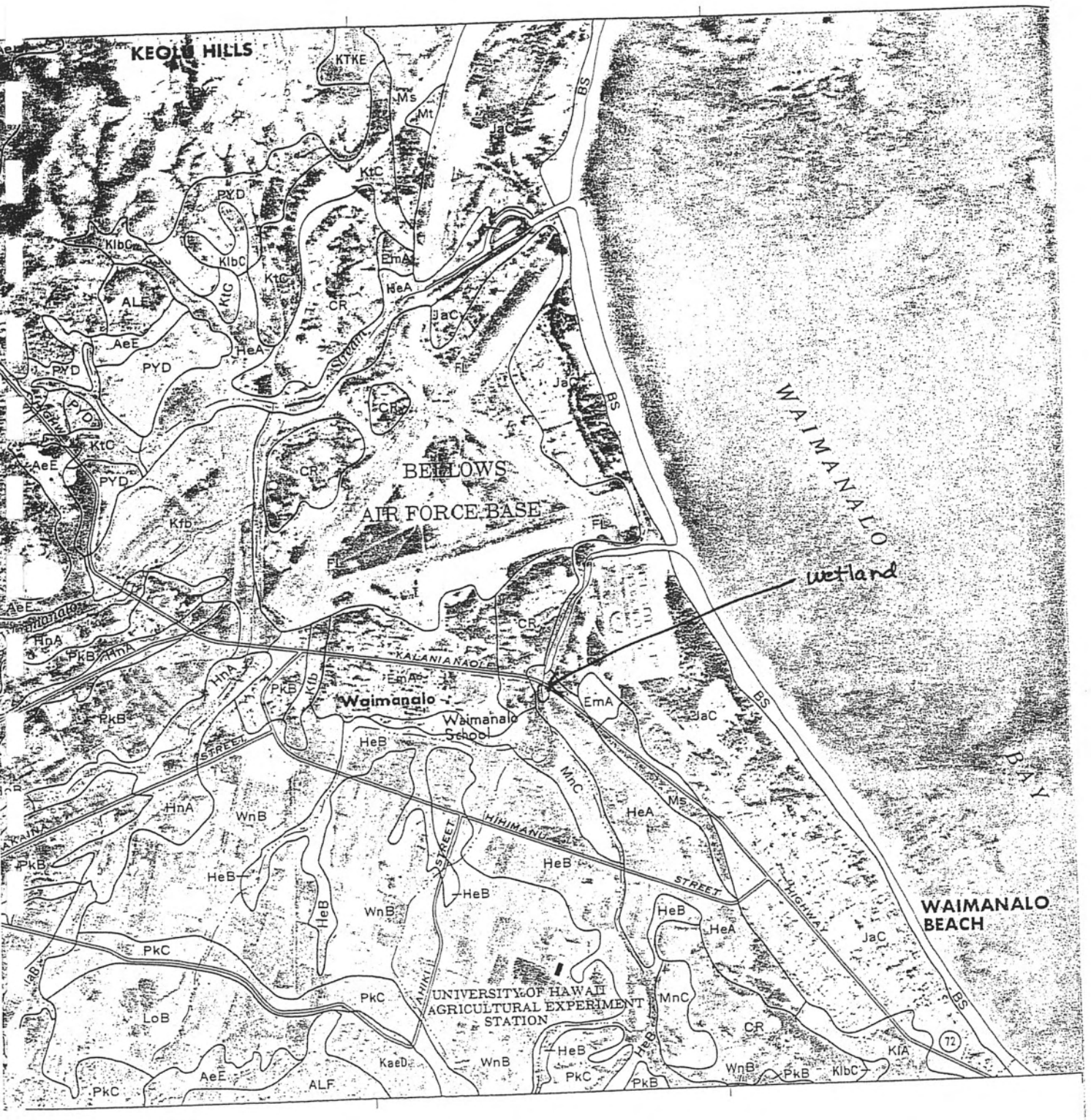
E 5500
N 4900
E 5600
E 5700
N 4800
E 5900

OAHU ISLAND, HAWAII — SHEET NUMBER 66



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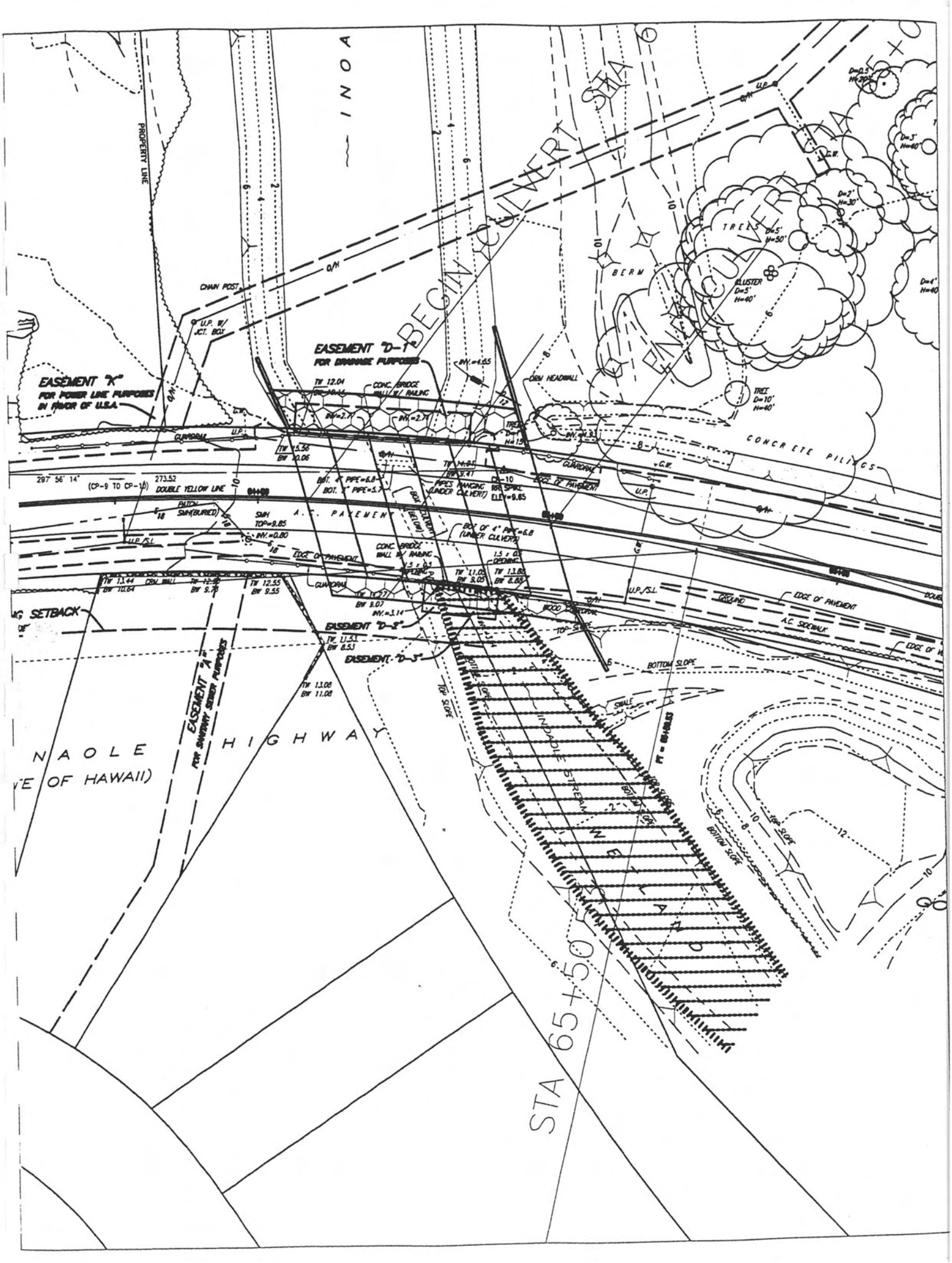
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FOR POWER LINE PURPOSES
IN FAVOR OF U.S.A.
EASEMENT "D-1"
FOR DRAINAGE PURPOSES
EASEMENT "A"
FOR SANITARY SEWER PURPOSES
EASEMENT "D-2"
EASEMENT "D-3"
BEGIN CULVERT STA
END CULVERT STA
PROPERTY LINE
CHAIN POST
U.P. W/ JCT. BOX
GUARDRAIL
CONC. BRIDGE WALL W/ RAILING
CBM HEADWALL
CONCRETE PILINGS
BERM
TREES D=5' H=50'
CLUSTER D=5' H=40'
TREE D=10' H=40'
297° 56' 14"
273.52
(CP-9 TO CP-10)
DOUBLE YELLOW LINE
A.C. PAVEMENT
EDGE OF PAVEMENT
SMH TOP=9.85 INV.=0.80
PATCH SMH(BURIED)
BOX CULVERT (BELOW)
BOT. 4" PIPE=6.8
BOT. 3" PIPE=5.7
PIPES HANGING UNDER CULVERT
BOT. OF 4" PIPE=6.8 (UNDER CULVERT)
1.5 x 0.5 OPENING
U.P./S.L.
GROUND
A.C. SIDEWALK
SETBACK
TOP SLOPE
BOTTOM SLOPE
SWALE
INDABLE STREAM
WETLAMP
STA 65+50
NAOLE
HIGHWAY
E OF HAWAII)

Project No.	Project Name	Type	SAI Box#	Bar Code	
92001-00	OSAKI RESIDENCE	PROJECT	343	237779	
92001-00	OSAKI RESIDENCE	CON	364	237800	
92002-A0	ROYAL KUNIA HONOLULU COUNTRY CLUB GOLF COURSE CLUBHOUSE	PROJECT	481	237837	
92002-A0	ROYAL KUNIA HONOLULU COUNTRY CLUB GOLF COURSE CLUBHOUSE CALCS (ENVELOPE)	PROJECT	481	237837	
92002-A0 to -E0	ROYAL KUNIA COUNTRY CLUB GC CLUBHOUSE	CON	309		
92002-A1	ROYAL KUNIA HONOLULU COUNTRY CLUB GOLF COURSE CLUBHOUSE - CART STORAGE	PROJECT	481	237837	
92002-B0	ROYAL KUNIA HCC GC MAINT BLG	PROJECT	343	237779	
92002-B1	ROYAL KUNIA HCC GC MAINT BLDG SPEC INSPECT	PROJECT	63		
92002-C0	ROYAL KUNIA HONOLULU COUNTRY CLUB - PUMP HOUSE	PROJECT	481	237837	
92002-D0	ROYAL KUNIA HCC GC 1/2WY HSE	PROJECT	343	237779	
92002-E0	ROYAL KUNIA HCC GC TEMPORARY CLUBHOUSE	PROJECT	343	237779	
92002-F0	ROYAL KUNIA HCC GC CART STORAGE SPECIAL INSP.	PROJECT	343	237779	
92002-G0	ROYAL KUNIA HONOLULU COUNTRY CLUB - MAINT. BLDG. SP. INSPECTION	PROJECT	481	237837	
92003-00	WAILUKU COURTHOUSE (OLD)	PROJECT	357	237793	
92003-00	WAILUKU COURTHOUSE (OLD)	CON	364	237800	Missing/Not in box
92004-00	SEVENTEENTH (17TH) STREET BUILDING	PROJECT	481	237837	
92005-00	HONPA HONGWANJI CLASSROOM	PROJECT	357	237793	
92005-00	HONPA HONGWANJI CLASSROOM	CON	364	237800	
92006-00	SUBARU TELESCOPE	CON	364	237800	
92006-00, 01, 02	SUBARU TELESCOPE	PROJECT	349	237785	
92007-00	WAIMANO HOME ROAD & KAMEHAMEHA HIGHWAY - WATERMAINS	CON	475	237818	
92007-00	WAIMANO HOME ROAD & KAMEHAMEHA HIGHWAY - WATERMAINS (3)	PROJECT	482	237838	
92007-01	WAIMANO HOME ROAD & KAMEHAMEHA HIGHWAY - EXTRA WORK	PROJECT	482	237838	
92008-00, 01	K-MART RENOVATIONS	PROJECT	357	237793	
92009-00	WAIALAE GOLF COURSE	CON	364	237800	
92009-00	WAIALAE GOLF COURSE	PROJECT	481	237837	
92010-00	WINDWARD PARK DRIVING RANGE	CON	325	237756	
92010-00	WINDWARD PARK DRIVING RANGE	PROJECT	482	237838	
92011-00	ARITA-POULSON BASE	PROJECT	482	237838	
92012-00	HALE LAVA RESTAURANT	PROJECT	357	237793	
92013-00	FURUTANI RESIDENCE	PROJECT	357	237793	
92014-00	SIMMONS WAREHOUSE	PROJECT	36		
92014-00	SIMMONS WAREHOUSE	CON	364	237800	
92014-00	SIMMONS WAREHOUSE	PROJECT	482	237838	
92015-00	KEAHOLE - ASSISTANCE/DESIGN ASSISTANCE	PROJECT	357	237793	
92016-00	GIBSON RENOVATION	PROJECT	343	237779	
92016-00	GIBSON RENOVATION	CON	364	237800	
92016-00	GIBSONS RENOV. (SERVCO)	PLAN	P-19	040609	
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92016-01	GIBSON RENOVATION - INSPECT	PROJECT	343	237779	
92017-00	WAIEHU TERRACE - INCREMENT C	CON	364	237800	
92017-00, 01	WAIEHU TERRACE - INCREMENT C	PROJECT	357	237793	
92018-00	KAHALUU FISH POND	PROJECT	357	237793	
92020-00	HECO WAIAU / MAKALAPA - SPECIAL INSPECTION	CON	475	237818	

Note: Box #61 #73 not used. Box P-4 Box 28 destroyed.

APPENDIX D

General Best Management Practices Plan

GENERAL BEST MANAGEMENT PRACTICE PLAN
KALANIANAOLE HIGHWAY
REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
WAIMANALO, OAHU

Background: The State of Hawaii Department of Transportation (DOT) Highways Division proposes to replace the existing single cell concrete box culvert bridge structure with a multi-cell concrete box culvert bridge structure to improve stream drainage below the bridge. The wider opening would prevent flooding of the adjacent properties and roadway during heavy storm conditions.

General Notes: The following special conditions apply to all land disturbance work conducted under this General Best Management Practice Plan:

A. Construction Management Techniques.

1. Clearing and grubbing shall be held to the minimum necessary for grading and equipment operation.

2. Construction shall be sequenced to minimize the exposure time of the cleared surface area.

3. Construction shall be staged or phased for large projects. Areas of one phase shall be stabilized before another phase is initiated. Stabilization shall be accomplished by temporarily or permanently protecting the disturbed soil surface from rainfall impacts and runoff.

4. Erosion and sediment control measures shall be in place and functional before earth moving operations begin. These measures shall be properly constructed and maintained throughout the construction period.

5. All control measures shall be checked and repaired as necessary, for example, weekly in dry periods and within twenty-four hours after any rainfall of 0.5 inches or greater within a 24-hour period. During prolonged rainfall, daily checking is necessary. The Contractor shall maintain records of checks and repairs.

6. The Contractor shall maintain records of the duration and estimated volume of storm water discharge(s).

7. A specific individual shall be designated to be responsible for erosion and sediment controls on each project site.

8. Construction related equipment and vehicles shall be in proper operating condition. Equipment with lubricant or fuel leakage, or malfunctioning or missing required emissions control devices shall be removed from the project site. The Contractor shall inspect equipment and staging area once during each working day to prevent petroleum based products from leaking on the construction site. Contractor shall keep absorption pads on-site to soak up any accidental spills.

9. No discharge of any treated effluent from any point sources (such as dewatering or hydrotesting effluent) into State water without first obtaining a permit issued by the Department of Health under the authorization of National Pollutant Discharge Elimination System of the Section 402 of the Clean Water Act.

10. The Contractor shall notify the State Department of Health Oahu District Health Office at (808) 586-4304 and the Clean Water Branch at (808) 586-4309 at least three (3) days prior to construction activity begins.

11. Contractor shall submit and provide updated timetable for major construction activities, including the date when the Contractor will begin site disturbance, to the State of Hawaii DOH Clean Water Branch and to the State of Hawaii Department of Transportation - Highways Division before the commencement of the construction.

12. Washdown of concrete trucks and/or drums will be done at the Contractor's staging area. Staging area shall have berms to contain runoff.

13. No surplus concrete will be allowed to be discharged within the project site.

14. Contractor shall coordinate rerouted utilities with roadway/culvert construction in order to maintain continuous service.

B. Vegetation Controls.

1. Pre-construction vegetative ground cover shall not be destroyed, removed, or disturbed more than twenty calendar days prior to land disturbance.

2. Temporary soil stabilization with appropriate vegetation shall be applied on areas that will remain unfinished for more than thirty calendar days.

3. Permanent soil stabilization with perennial vegetation or pavement shall be applied as soon as practical after final grading. Irrigation and maintenance of the perennial vegetation shall be provided for thirty calendar days or until the vegetation takes root, whichever is shorter.

C. Structural Controls.

1. Storm water flowing toward the construction area shall be diverted by using appropriate control measures, as practical.

2. Erosion control measures shall be designed according to the size of disturbed or drainage areas to detain runoff and trap sediment.

3. Water must be discharged in a manner that the discharge shall not cause or contribute to a violation of the basic water quality criteria as specified in Section 11-54-04.

D. Fugitive Dust: Construction activities shall comply with provisions of Hawaii Administrative Rules, Chapter 11-60.1, "Air Pollution Control," Section 11-60.1-33 on Fugitive Dust. The contractor shall control dust from road areas and during the various phases of construction activities and include:

1. Minimizing amounts of dust-generating materials and activities, centralizing material transfer points and on-site vehicular traffic routes, and locating potentially dusty equipment in areas of least impact.

2. Providing or having access to adequate water source for dust control at the site prior to start up of construction activities.

3. Landscaping and/or rapid covering of bare areas, including slopes, starting from the initial grading phase.

4. Controlling of dust from shoulders, project entrances, and access roads.

5. Providing adequate dust control measures during weekends, after hours, and prior to daily start up of construction activities.

6. Install dust screen(s) in areas where fugitive dust could impact residential land areas.

7. Frequent watering during grading to maintain dust control.

E. Noise Control: Construction activities shall comply with provisions of Hawaii Administrative Rules, Chapter 11-46, "Community Noise Control".

1. The contractor shall obtain a noise permit if anticipated construction activities are expected to exceed the maximum permissible sound levels of the regulations as stated in Section 11-46-6(a).
2. Construction equipment and on-site vehicles requiring an exhaust of gas or air shall be equipped with mufflers as stated in Section 11-46-6(b)(1)(A).

3. Contractor shall comply with the conditional use of the permit as specified in the regulations and the conditions issued with the permit as stated in Section 11-46-7(d)(4).

Although the above construction is anticipated, the contractor shall ultimately be responsible for all means and methods of construction and erosion, dust, noise and water pollution control.

SITE SPECIFIC BEST MANAGEMENT PRACTICE PLAN

Contractor shall submit a Site Specific Best Management Practice Plan(s), and sediment and erosion control plan(s) to the State of Hawaii DOH Clean Water Branch and to the State of Hawaii Department of Transportation - Highways Division at for review, comment, and approval, since the Contractor is responsible for the project construction methodology, sequence, and compliance with all governmental regulatory environmental and building related codes, conditions, and mandates. Documents shall be submitted for review, comment and approval 30 days prior to commencement of construction. All related concern(s) and comment(s) shall be properly addressed to the Department of Health Director's satisfaction before any discharge occurs.

APPENDIX E

Detour Road Study, Sato & Associates, Inc., November 2000

INOAOLE BRIDGE REPLACEMENT PROJECT NO. : STP-072-1(43)

DETOUR ROAD STUDY

Prepared for:

State of Hawaii
Department of Transportation
Highways Division

Prepared by:

Sato & Associates, Inc.
2046 South King Street
Honolulu, Hawaii

7 November 2000

TABLE OF CONTENTS

CHAPTER 1

1.1 Introduction

The Inoaole Bridge is located on Kalanianaole Highway on the Windward side of Oahu, in the District of Waimanalo. The bridge is north of Tinker Road (main entrance road to Bellows Air Force Station) and Kalanianaole Highway intersection. Refer to Figures 1-1 and 1-2.

Inoaole Bridge provides a stream crossing over Inoaole Stream and is a single cell concrete box culvert which accommodates the 2-lane highway. The highway is comprised of 2-lanes with shoulders and an asphaltic concrete sidewalk on the mauka side. The posted speed limit is 25 mph. Refer to Figure 1-3.

During periods of heavy rains, the area adjacent to the bridge experiences flooding due to the inadequate drainage opening within the single cell box culvert. This project proposes to replace the existing single cell concrete box culvert with a new multi-cell concrete box culvert in order to improve storm drainage capacity and avoid future flooding of the adjacent area.

The new multi-cell concrete box culvert will be located at the existing single cell concrete box culvert location to minimize impact to Kalanianaole Highway roadway approaches to the bridge. Therefore, a detour road will be required to facilitate construction of the new multi-cell concrete box culvert structure.

1.2 Study Criteria

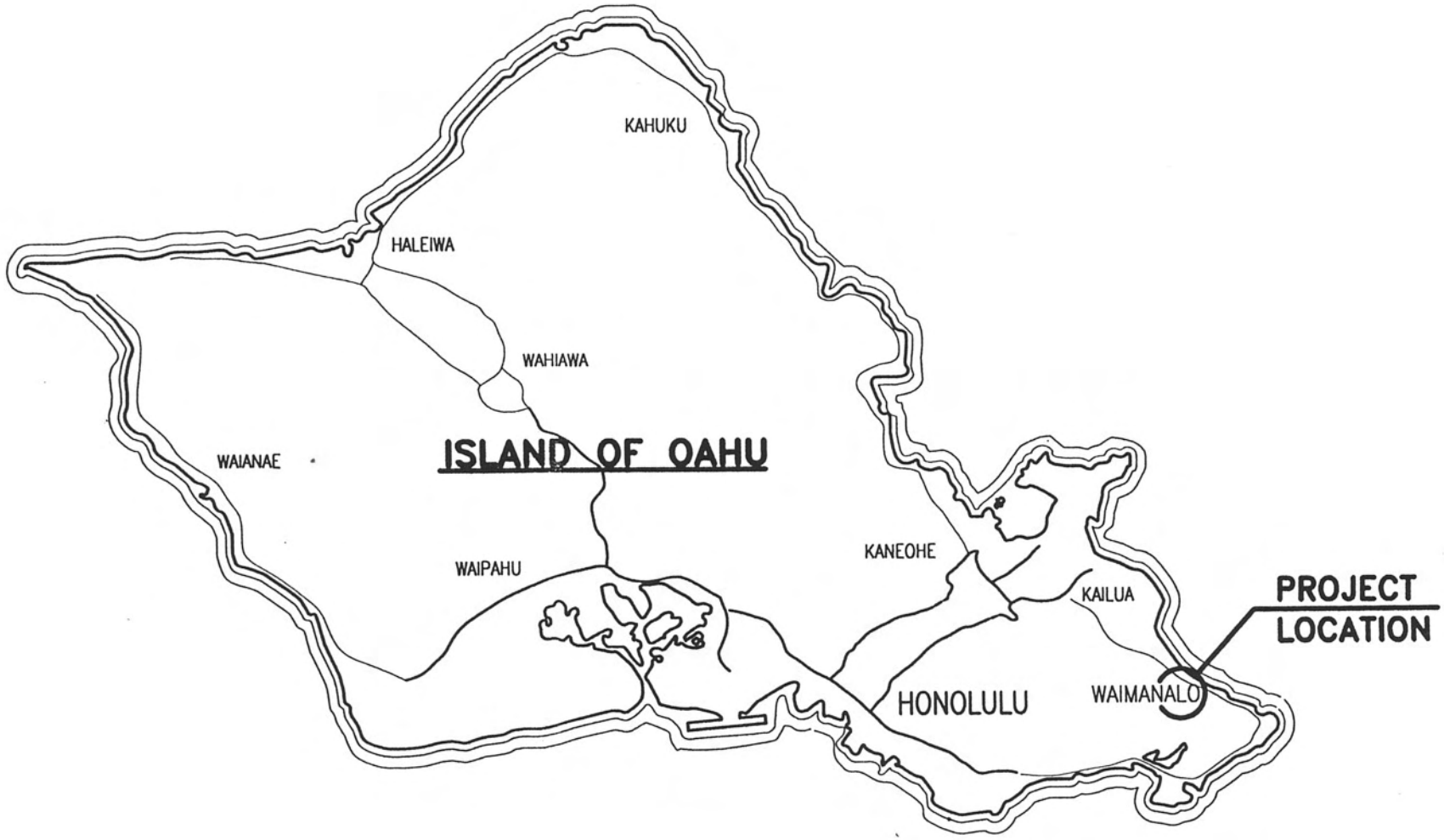
In order to minimize project impact to the community and adjacent property, the following criteria was established:

- Roadway shall be open to traffic at all times. This shall be accomplished by a detour road. The detour road speed limit may be reduced to 15 mph.
- New culvert structure shall be located at the existing culvert structure location to maintain current roadway alignment.

1.3 Detour Road Options

Several detour roadway alternatives were investigated on a conceptual design level and are discussed below. Scenarios include utilizing:

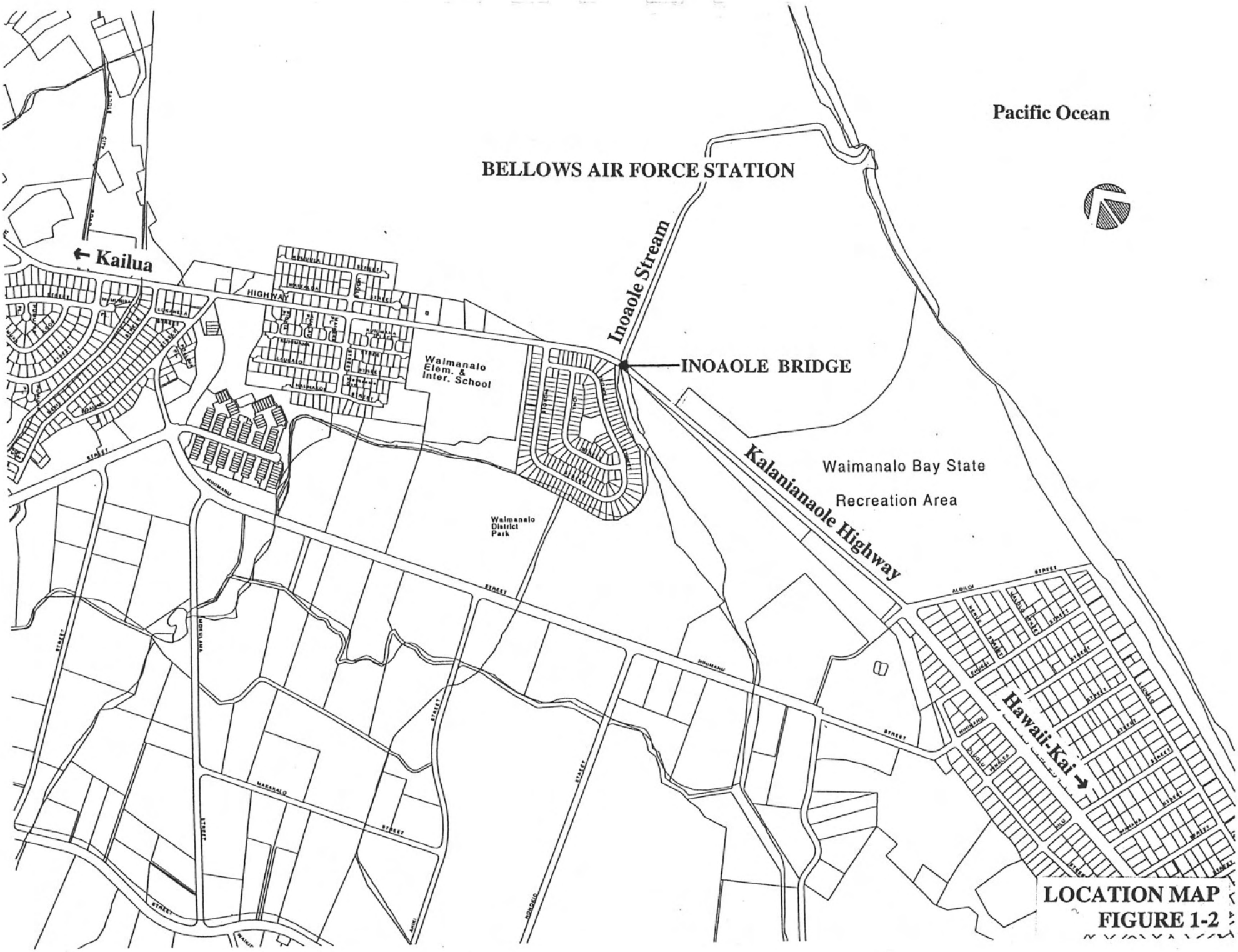
- Existing roadway entrance to Bellows Air Force Station (BAFS) with minor roadway improvements and/or temporary bridge structure over Inoaole Stream;
- Existing roadways within the Waimanalo community; and
- Phased construction of the new culvert structure.



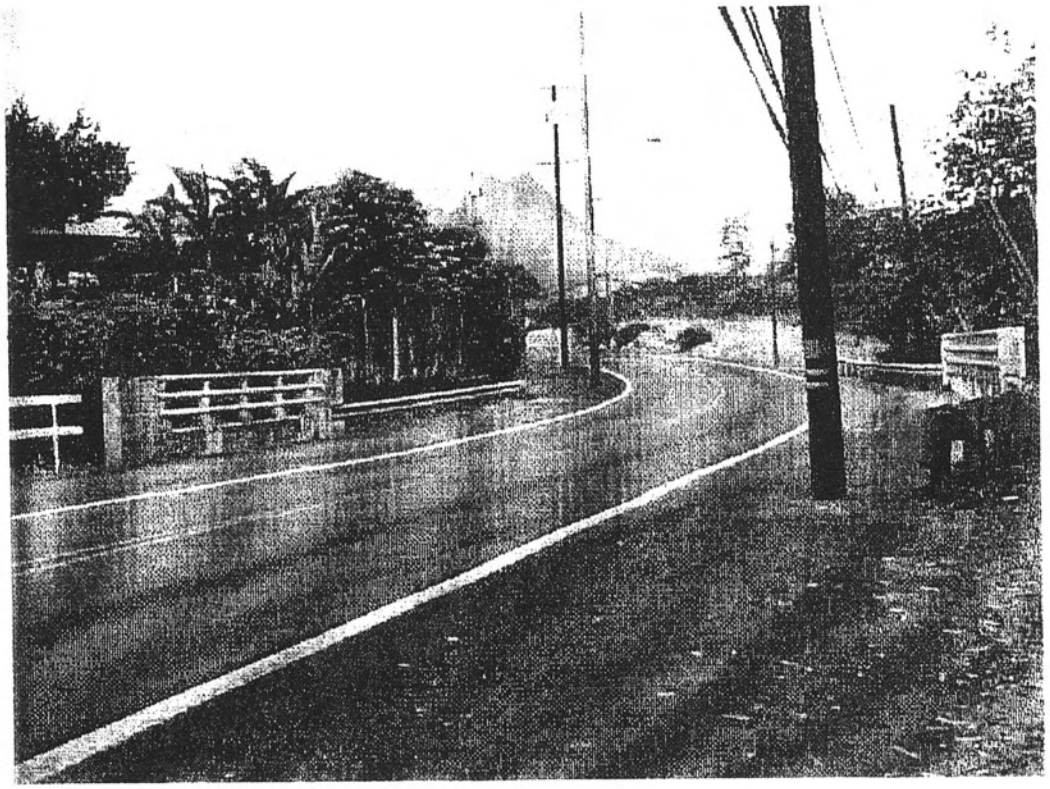
VICINITY MAP

NO SCALE

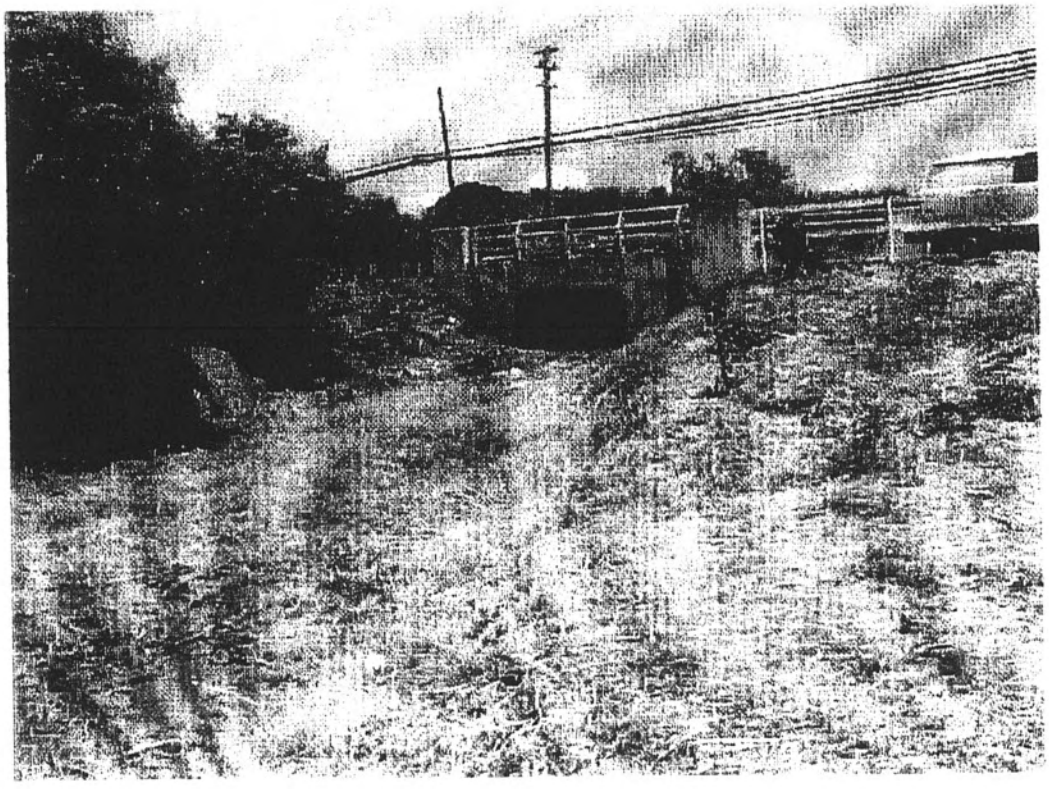
VICINITY MAP
FIGURE 1-1



LOCATION MAP
FIGURE 1-2



INOAOLE BRIDGE : VIEW TOWARDS KAILUA



INOAOLE BRIDGE : MAUKA/UPSTREAM SIDE VIEW

INOAOLE BRIDGE
PHOTOS
FIGURE 1-3

CHAPTER 2

2.1 Alternate 1 *Detour Route Through Bellows Air Force Station*

This alternate considers closing Kalanianaole Highway immediately north of the Bellows Air Force Station (BAFS) entry at Tinker Road and south of the Kalanianaole Highway/Inoaole Street intersection. A detour road would be created on Tinker Road approximately 200 feet from the Kalanianaole Highway intersection, approximately midway between the BAFS entry and guard house. Tinker Road is a 2-lane road with shoulders, without sidewalks and serves as the primary entrance to BAFS. Refer to Figure 2-1.

This alternative requires:

- Grading and paving;
- A temporary bridge structure over Inoaole Stream;
- Detour road signage and temporary lighting; and
- Removal of detour road and repair of Tinker Road to original condition upon completion and activation of the new Inoaole Bridge.

Construction of the detour road and temporary bridge structure over Inoaole Stream is estimated to be approximately 4 to 6 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 13 to 18 months.

The temporary bridge structure over Inoaole Stream is estimated to cost approximately $800,000. Other detour route improvements is estimated to cost approximately $220,000. Repair of Tinker Road and removal of the detour road is estimated to cost approximately $75,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $2,595,000 to $2,795,000.

Advantages:

- Detour road does not intrude into existing residential areas.
- Detour road avoids large group of trees on the makai side of Kalanianaole Highway, just south of Inoaole Bridge.
- Traffic flow pass the commercial business at the southern end of the Waimanalo Bay State Recreation Area is not diverted.
- Impact to traffic along Kalanianaole Highway is minimized during construction of the detour road.

Disadvantages:

- Detour road impacts the existing BAFS entry to Kalanianaole Highway.
- Vehicle queue space before BAFS guard house is reduced.

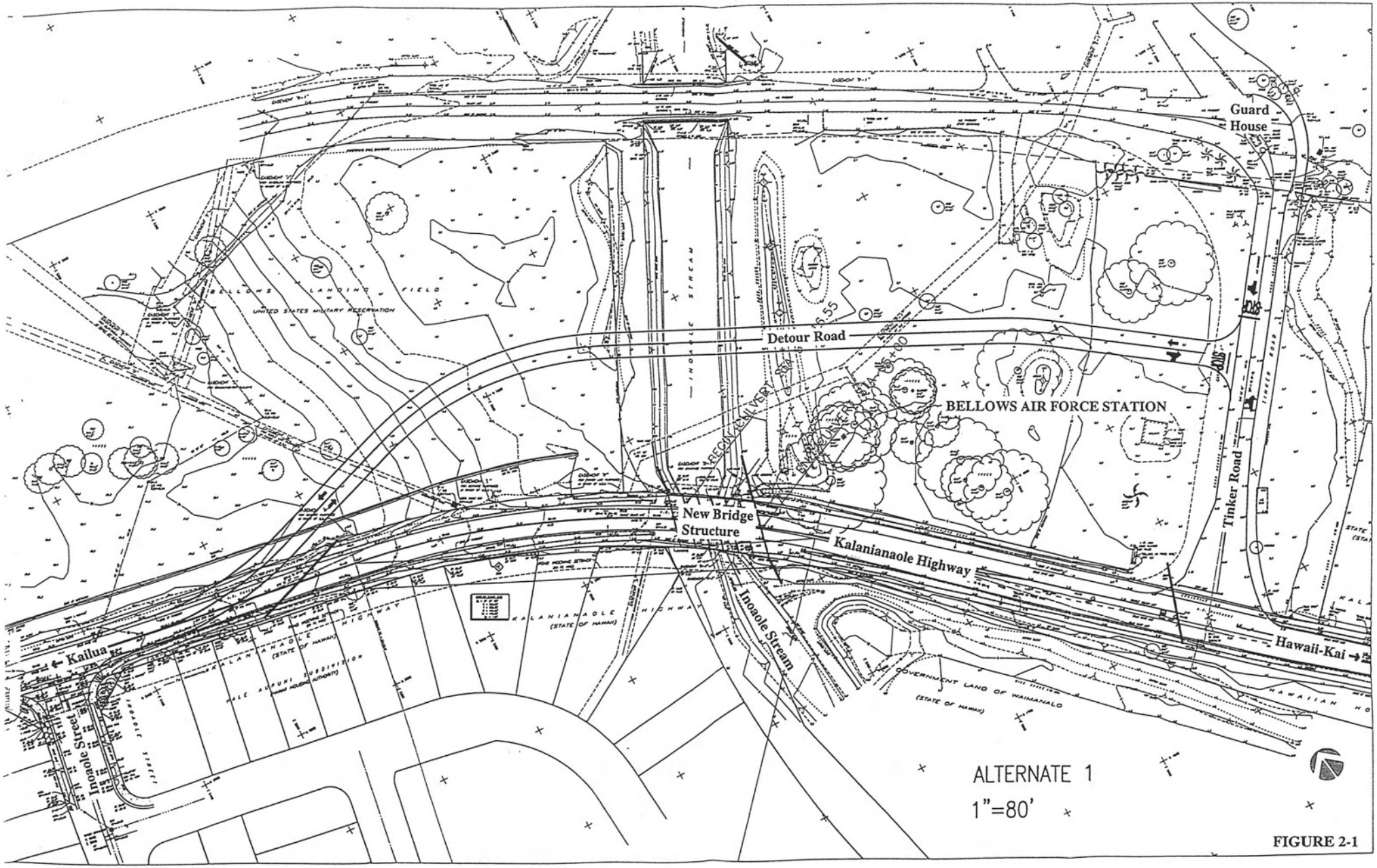

Guard House
Detour Road
BELLOWS AIR FORCE STATION
Tinker Road
New Bridge Structure
Kalanianaole Highway
Inoaole Stream
Inoaole Street
Kailua
Hawaii-Kai
ALTERNATE 1
1"=80'

FIGURE 2-1

2.2 Alternate 1A *Detour Route Through Bellows Air Force Station*

This alternate is similar to Alternative 1 except for relocation of BAFS guard house and a portion of the entry road. Refer to Figure 2-2.

This alternative requires:

- Grading and paving;
- A temporary bridge structure over Inoaole Stream;
- Detour road signage and temporary lighting;
- Relocation of BAFS guard house entry road; and
- Removal of detour road, relocation of BAFS guardhouse to original location, and repair of Tinker Road to original condition upon completion and activation of the new Inoaole Bridge.

Construction of the detour road and temporary bridge structure over Inoaole Stream is estimated to be approximately 4 to 6 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 13 to 18 months.

The temporary bridge structure over Inoaole Stream is estimated to cost approximately $800,000. Other detour route improvements is estimated to cost approximately $250,000. The existing BAFS guard house would remain inactive and a temporary BAFS guard house would be used and is estimated to cost approximately $30,000. Repair of Tinker Road, removal of the detour road and temporary guard house, and reactivation of the existing guard house is estimated to cost approximately $100,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $2,680,000 to $2,880,000.

Advantages: Identical to Alternative 1 plus:

- Kalanianaole Highway traffic movement along the detour road is a through movement with BAFS traffic controlled by stop signs, which reflect the existing BAFS access/egress to Kalanianaole Highway.

Disadvantages: Identical to Alternative 1.

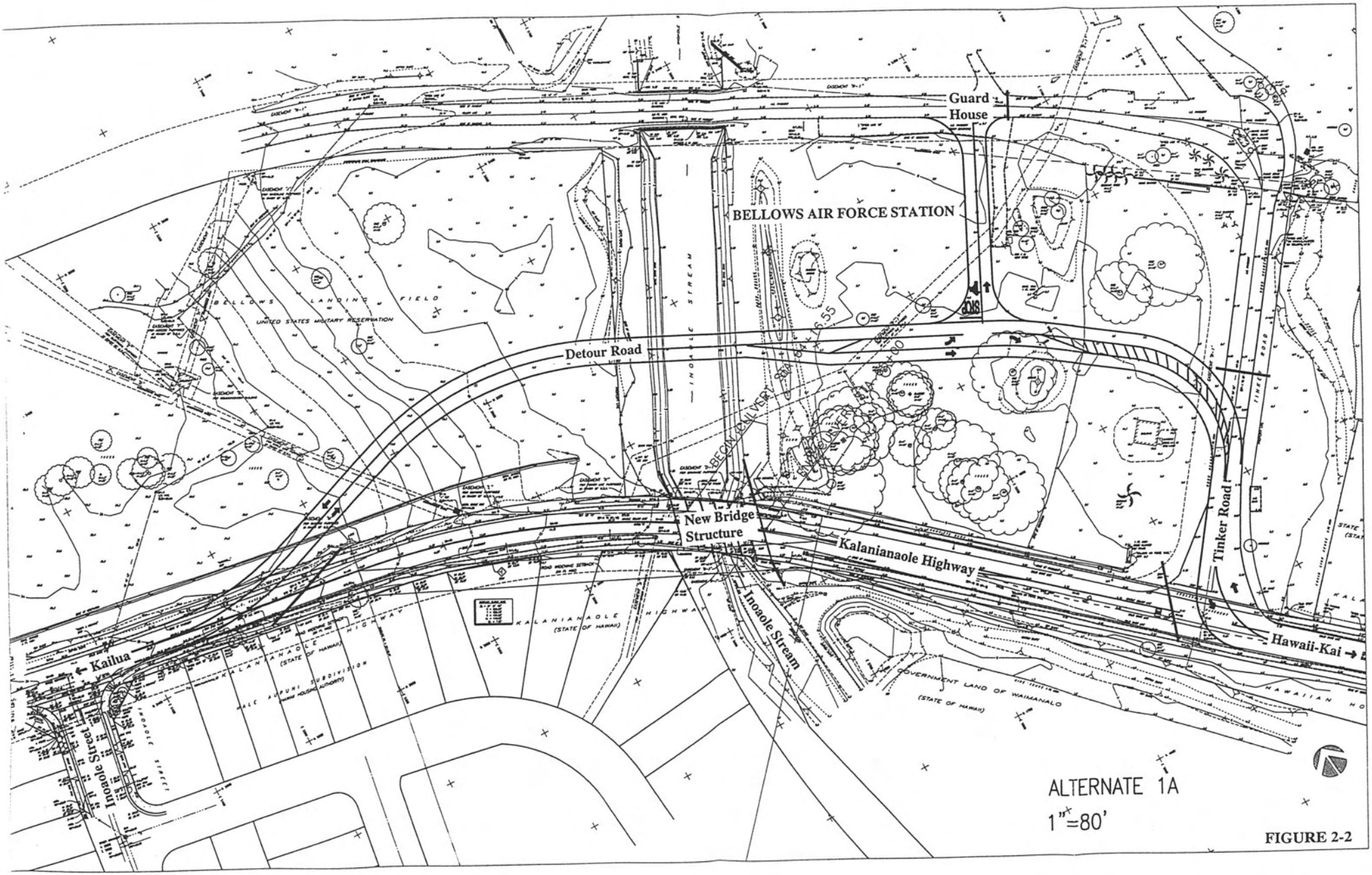

Guard
House
BELLOWS AIR FORCE STATION
Detour Road
New Bridge
Structure
Kalanianaole Highway
Tinker Road
Inoaole Stream
Kailua
Inoole Street
Hawaii-Kai
ALTERNATE 1A
1"=80'

FIGURE 2-2

2.3 Alternate 2 *Detour Route Through Bellows Air Force Station*

This alternate is similar to Alternate 1 except that a detour road would connect to Tinker Road approximately 200 feet north of the existing multi-cell concrete box culvert structure. The existing BAFS guard house would be relocated approximately 200 feet north of the detour road Tinker Road intersection. The southern portion of Tinker Road would serve as the balance of the detour road. Refer to Figure 2-3.

This alternative requires:

- Grading and paving;
- Detour road signage and temporary lighting;
- Relocation of BAFS guard house; and
- Removal of detour road, relocation of BAFS guardhouse to original location, and repair of Tinker Road to original condition upon completion and activation of the new Inoaole Bridge.

Construction of the detour road and relocation of BAFS guard house is estimated to be approximately 3 to 4 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 12 to 16 months.

Detour road improvements is estimated to cost approximately $120,000. The existing BAFS guard house would remain inactive and a temporary BAFS guard house would be used and is estimated to cost approximately $30,000. Repair of Tinker Road, removal of the detour road and temporary guard house, and reactivation of the existing guard house is estimated to cost approximately $150,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $1,800,000 to $2,000,000.

Advantages:

- Detour road does not intrude into existing residential areas.
- Detour road avoids large group of trees on the makai side of Kalanianaole Highway, just south of Inoaole Bridge.
- Traffic flow pass the commercial business at the southern end of the Waimanalo Bay State Recreation Area is not diverted.
- Impact to traffic along Kalanianaole Highway is minimized during construction of the detour road.

Disadvantages:

- Detour road impacts the existing BAFS entry to Kalanianaole Highway.
- Vehicle queue space before BAFS guard house is reduced.

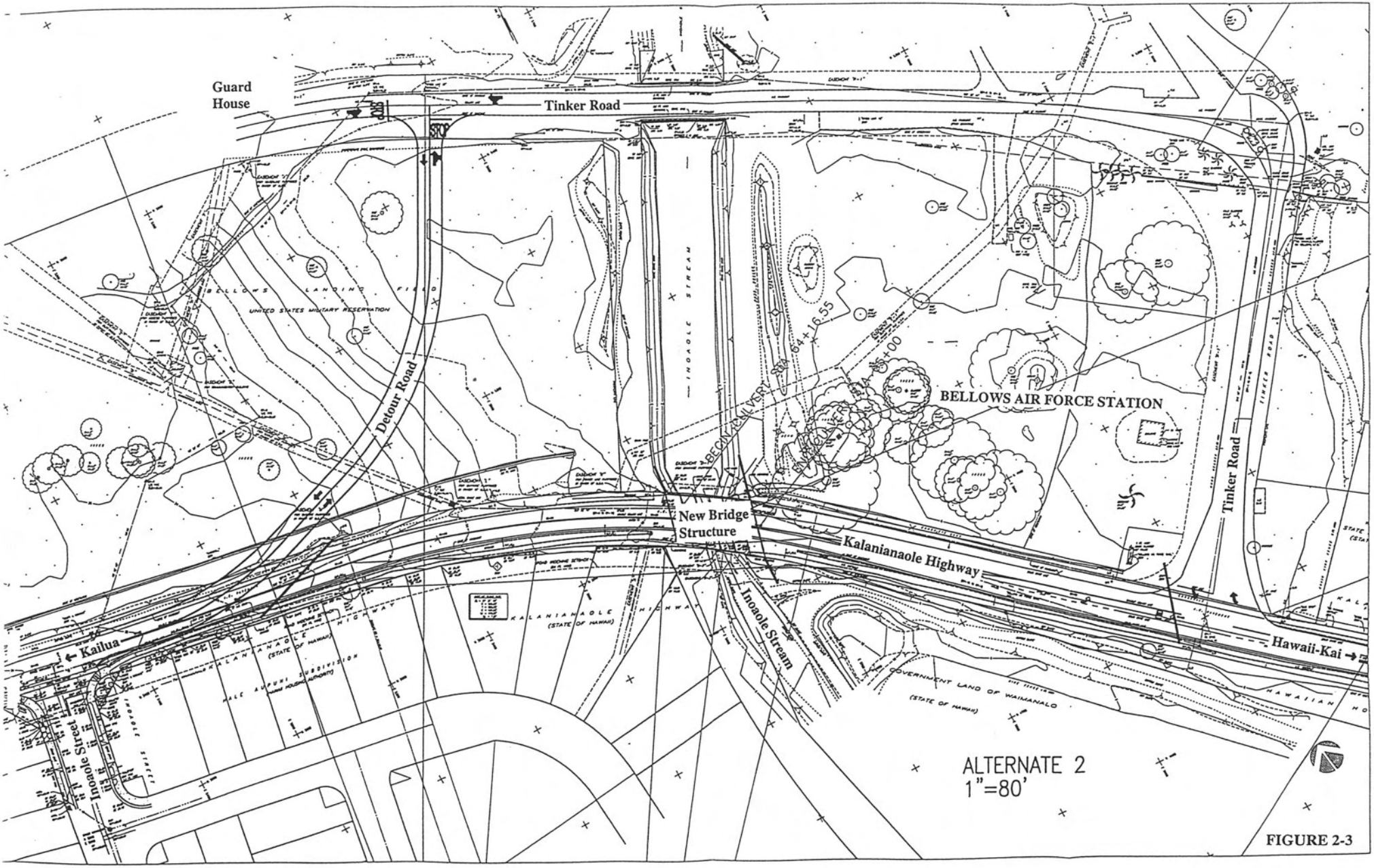

Guard House
Tinker Road
Detour Road
BELLOWS AIR FORCE STATION
Tinker Road
New Bridge Structure
Kalanianaole Highway
Inoaole Stream
Kailua
Inoaole Street
Hawaii-Kai
ALTERNATE 2
1"=80'

FIGURE 2-3

2.4 Alternate 2A *Detour Route Through Bellows Air Force Station*

This alternate is similar to Alternative 2, with the entry road into BAFS has been modified to provide Kalanianaole Highway traffic a through movement with BAFS traffic controlled by a stop sign. Refer to Figure 2-4.

This alternative requires:

- Grading and paving;
- Detour road signage and temporary lighting;
- Relocation of BAFS guard house; and
- Removal of detour road, relocation of BAFS guardhouse to original location, and repair of Tinker Road to original condition.

Construction of the detour road and relocation of BAFS guard house is estimated to be approximately 3 to 4 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 12 to 16 months.

Detour road improvements is estimated to cost approximately $160,000. The existing BAFS guard house would remain inactive and a temporary BAFS guard house would be used and is estimated to cost approximately $30,000. Repair of Tinker Road, removal of the detour road and temporary guard house, and reactivation of the existing guard house is estimated to cost approximately $180,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $1,870,000 to $2,070,000.

Advantages: Identical to Alternative 2 plus:

- Kalanianaole Highway traffic movement along the detour road is a through movement with BAFS traffic controlled by stop signs.

Disadvantages: Identical to Alternative 2.

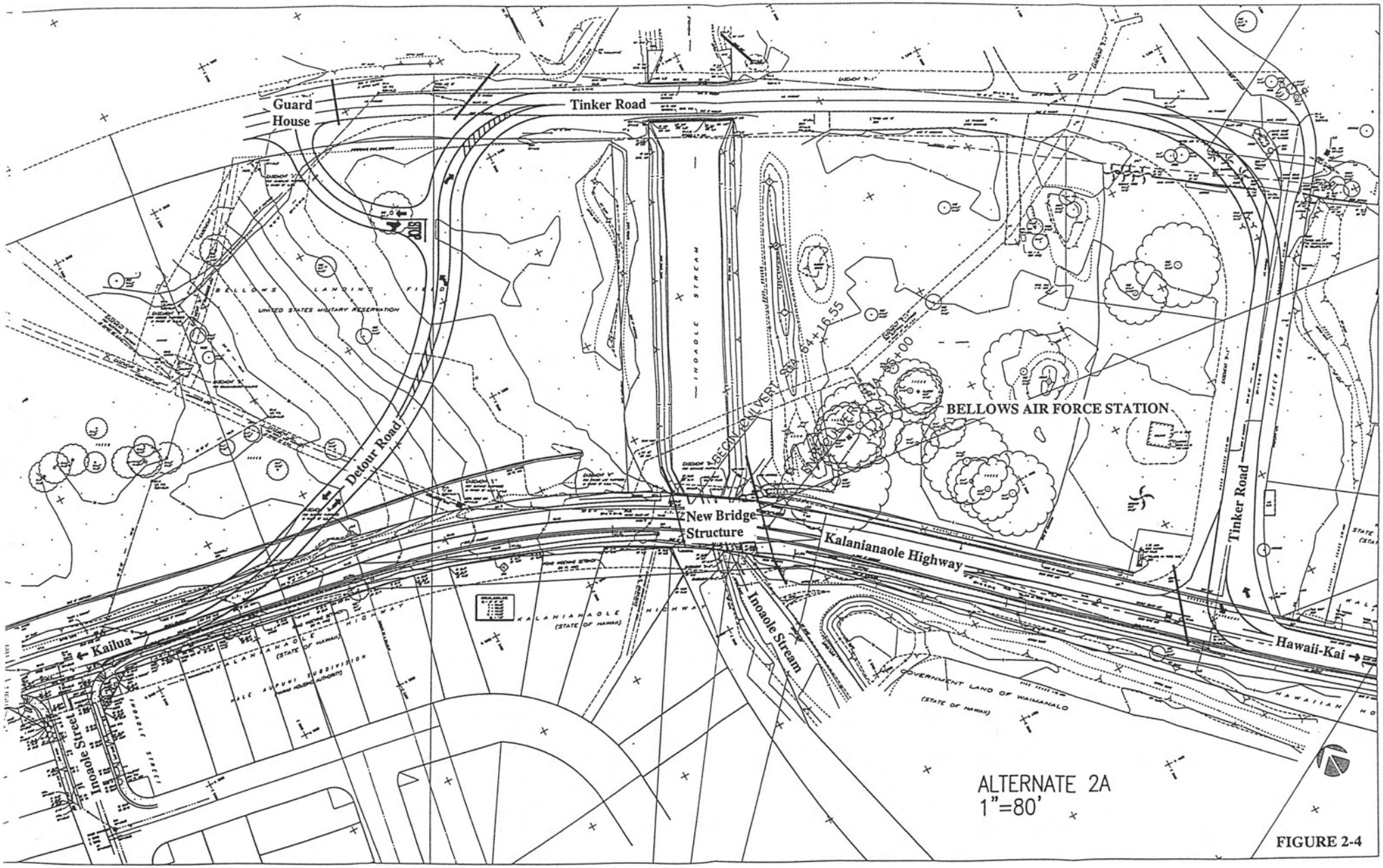

Guard House
Tinker Road
Detour Road
New Bridge Structure
Kalanianaole Highway
Inoaole Stream
BELLOWS AIR FORCE STATION
Tinker Road
Kailua
Inoaole Street
Hawaii-Kai
ALTERNATE 2A
1"=80'

FIGURE 2-4

2.5 Alternate 3 *Detour Route Makai of Existing Inoaole Bridge*

This alternate considers closing Kalanianaole Highway prior to the south approach to Inoaole Bridge and south of the Kalanianaole Highway/Inoaole Street intersection. A detour road would be created makai of the existing Inoaole Bridge. Refer to Figure 2-5.

This alternative requires:

- Grading and paving;
- A temporary bridge structure over Inoaole Stream;
- Detour road signage and temporary lighting.

Construction of the detour road and temporary bridge structure over Inoaole Stream is estimated to be approximately 4 to 6 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 13 to 18 months.

The temporary bridge structure over Inoaole Stream is estimated to cost approximately$800,000. Other detour route improvements is estimated to cost approximately $180,000. Removal of the detour road is estimated to cost approximately $50,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $2,530,000 to $2,730,000.

Advantages:

- Detour road does has minimal impact to existing residential area and BAFS entry.
- Traffic flow pass the commercial business at the southern end of the Waimanalo Bay State Recreation Area is not diverted.
- Impact to traffic along Kalanianaole Highway is minimized during construction of the detour road.

Disadvantages:

- Detour road impacts large group of trees on the makai side of Kalanianaole Highway, just south of Inoaole Bridge.

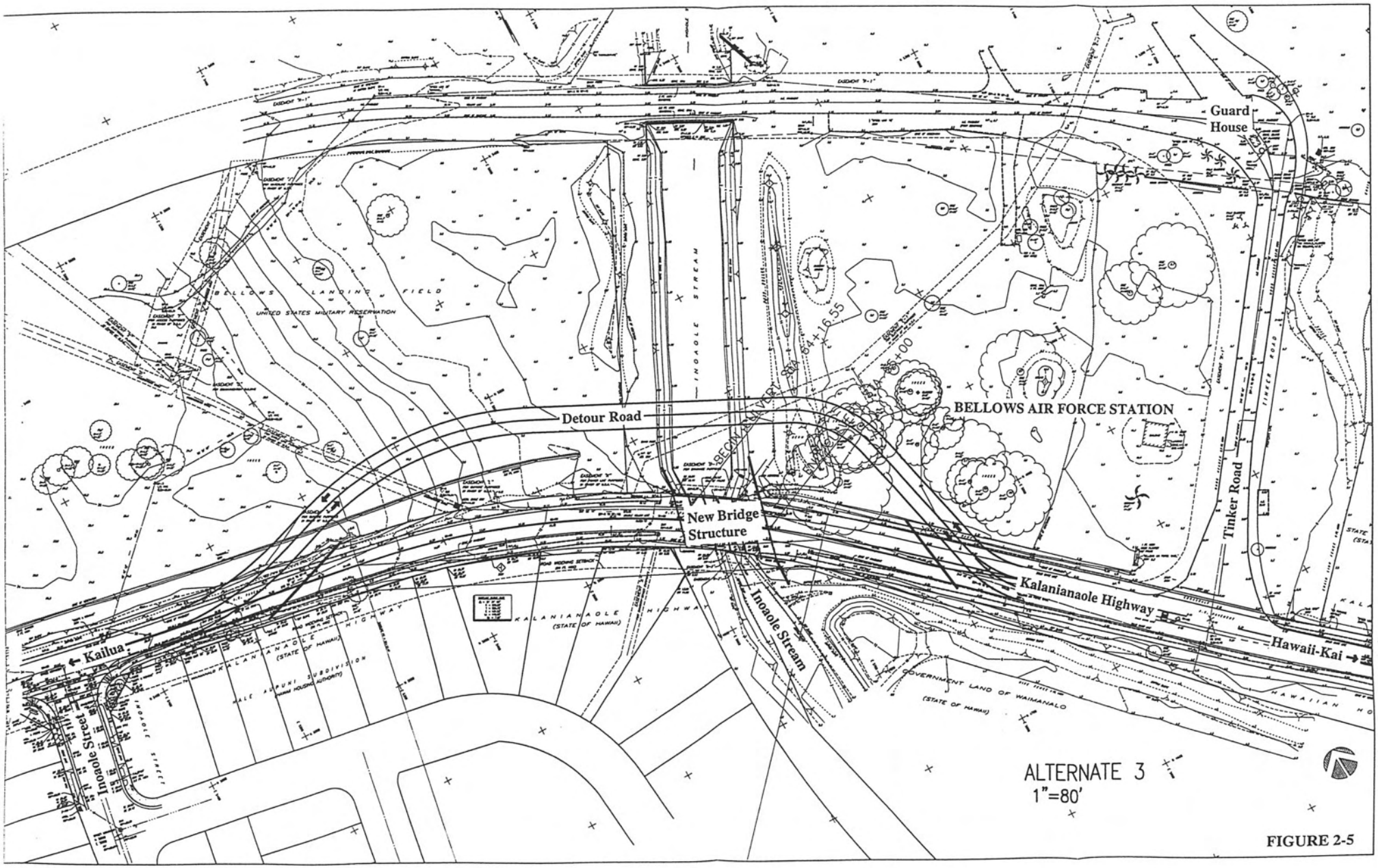

Guard House
Detour Road
BELLOWS AIR FORCE STATION
Tinker Road
New Bridge Structure
Inoaole Stream
Kalanianaole Highway
Hawaii-Kai
← Kailua
Inoaole Street
ALTERNATE 3
1"=80'

FIGURE 2-5

2.6 Alternate 4 *Phased Bridge Construction*

This alternate considers phasing the new bridge construction to allow continued vehicular access over portions of the existing bridge and new bridge. This alternative does not require a detour road.

This alternative requires:

- Phased construction to allow two open traffic lanes at all times;
- Reduced speed within construction zone of 10 mph;
- Temporary lighting; and
- Temporary barriers for worker safety.

Phased construction would involve numerous phases to allow continuous vehicular traffic while providing for stream flow. These phases would include:

- **Phase 1**: Realigning the existing 2-lanes to the mauka side of the existing bridge. This would allow the makai portion of the bridge to be removed and reconstructed. Refer to Figure 2-6.
- **Phase 2**: Upon completion of Phase 1, 1-lane would be realigned to the makai side of the newly finished portion of the new bridge and 1-lane would remain on the mauka side of the existing bridge. The center portion of the existing bridge would then be removed and reconstructed. Refer to Figure 2-7.
- **Phase 3**: Upon completion of Phase 2, the 1-lane on the mauka side of the existing bridge would be realigned to parallel the 1-lane on the makai side of the newly finished portion of the new bridge. The mauka portion of the existing bridge would then be removed and reconstructed. Refer to Figure 2-8.
- **Phase 4**: Upon completion of Phase 3, the roadway would be realigned to the original alignment.

Construction of the bridge is estimated to be between 18 to 24 months. Estimated cost of the bridge is estimated to be between $2,300,000 to $2,500,000.

Advantages:

- Detour road is not required.
- Modification to BAFS entrance is not required.
- Large group of trees on the makai side is not effected.
- Traffic flow pass the commercial business at the southern end of the Waimanalo Bay State Recreation Area is not diverted.

Disadvantages:

- Longer construction time.
- Increase risk of accident between vehicles and construction activities.

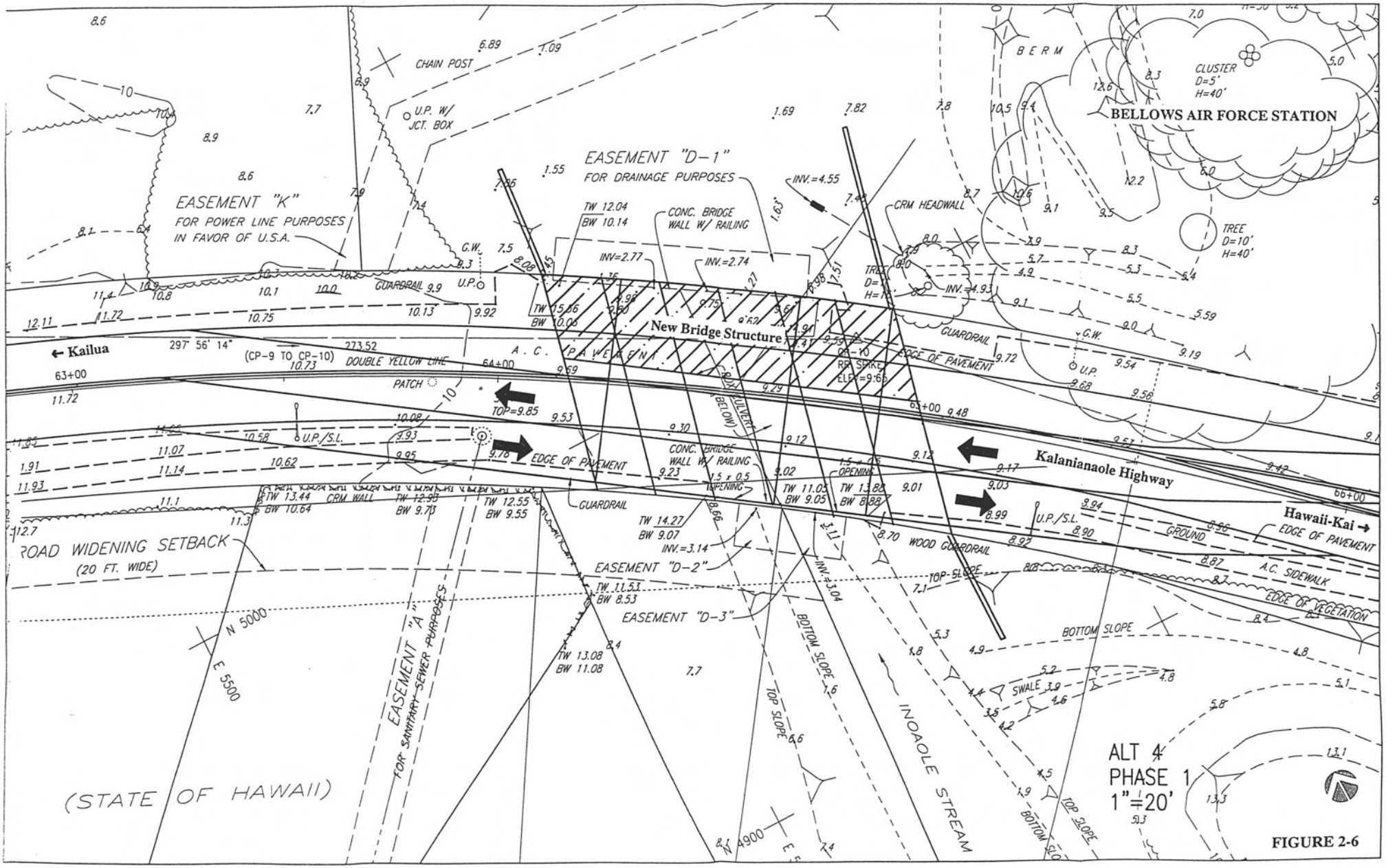

BELLOWS AIR FORCE STATION
EASEMENT "K"
FOR POWER LINE PURPOSES
IN FAVOR OF U.S.A.
EASEMENT "D-1"
FOR DRAINAGE PURPOSES
New Bridge Structure
A. C. PAVEMENT
Kailua
Kalanianaole Highway
Hawaii-Kai
EASEMENT "D-2"
EASEMENT "D-3"
EASEMENT "A"
FOR SANITARY SEWER PURPOSES
ROAD WIDENING SETBACK
(20 FT. WIDE)
(STATE OF HAWAII)
INOAOLE STREAM
CHAIN POST
U.P. W/ JCT. BOX
CONC. BRIDGE WALL W/ RAILING
CRM HEADWALL
GUARDRAIL
EDGE OF PAVEMENT
WOOD GUARDRAIL
A.C. SIDEWALK
EDGE OF VEGETATION
BOTTOM SLOPE
TOP SLOPE
SWALE
GROUND
BERM
CLUSTER D=5' H=40'
TREE D=10' H=40'
ALT 4
PHASE 1
1"=20'

FIGURE 2-6

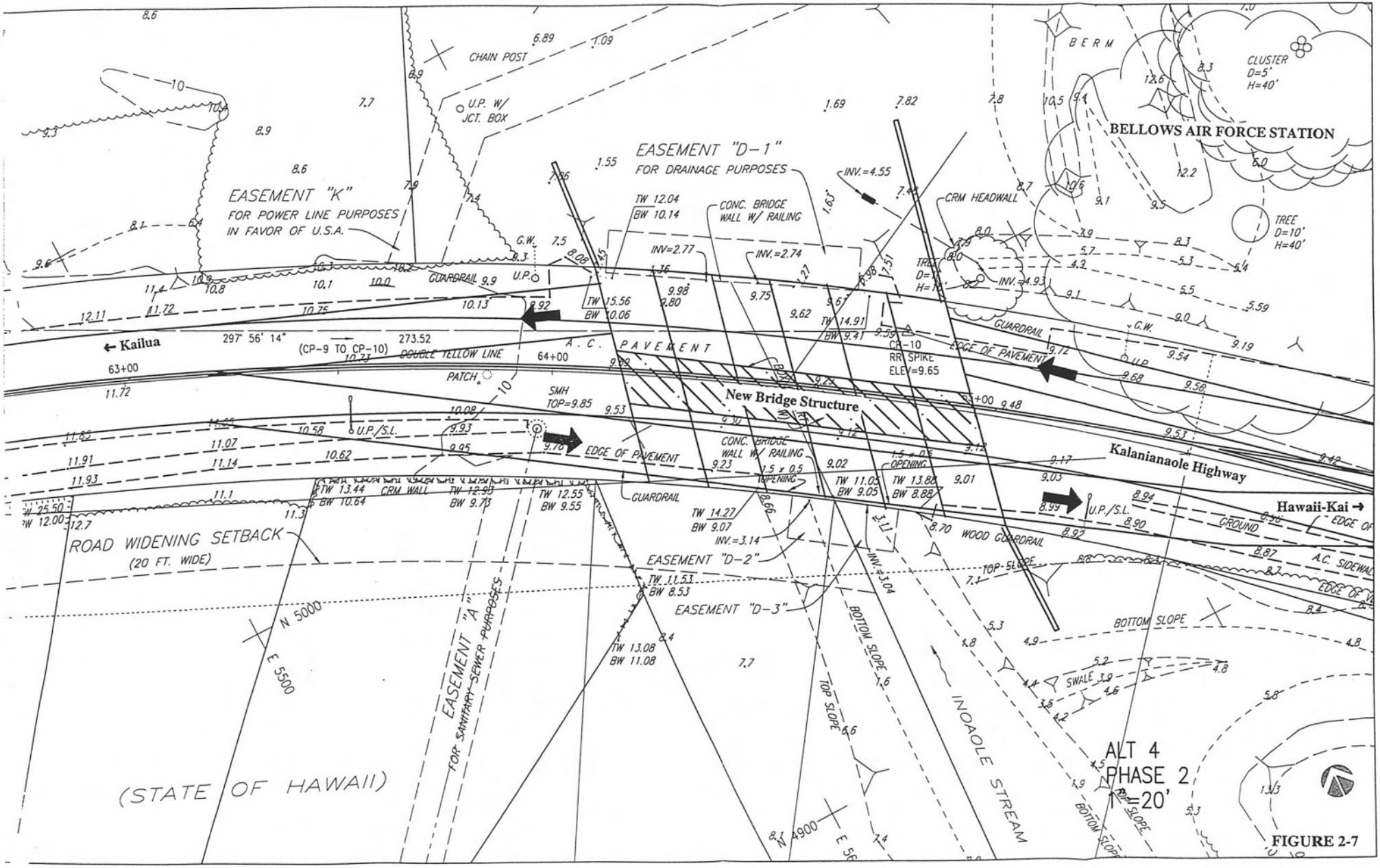

BELLOWS AIR FORCE STATION
EASEMENT "K"
FOR POWER LINE PURPOSES
IN FAVOR OF U.S.A.
EASEMENT "D-1"
FOR DRAINAGE PURPOSES
EASEMENT "D-2"
EASEMENT "D-3"
EASEMENT "A"
FOR SANITARY SEWER PURPOSES
ROAD WIDENING SETBACK
(20 FT. WIDE)
(STATE OF HAWAII)
New Bridge Structure
Kalanianaole Highway
Hawaii-Kai
← Kailua
CHAIN POST
U.P. W/
JCT. BOX
CONC. BRIDGE
WALL W/ RAILING
CRM HEADWALL
CRM WALL
GUARDRAIL
WOOD GUARDRAIL
EDGE OF PAVEMENT
A.C. PAVEMENT
DOUBLE YELLOW LINE
PATCH
SMH
TOP=9.85
U.P./S.L.
GROUND
BERM
CLUSTER
D=5'
H=40'
TREE
D=10'
H=40'
CP-10
RR SPIKE
ELEV=9.65
297° 56' 14"
273.52
(CP-9 TO CP-10)
63+00
64+00
TOP SLOPE
BOTTOM SLOPE
SWALE
INOAOLE STREAM
N 5000
E 5500
N 4900
E 56
ALT 4
PHASE 2
1"=20'

FIGURE 2-7

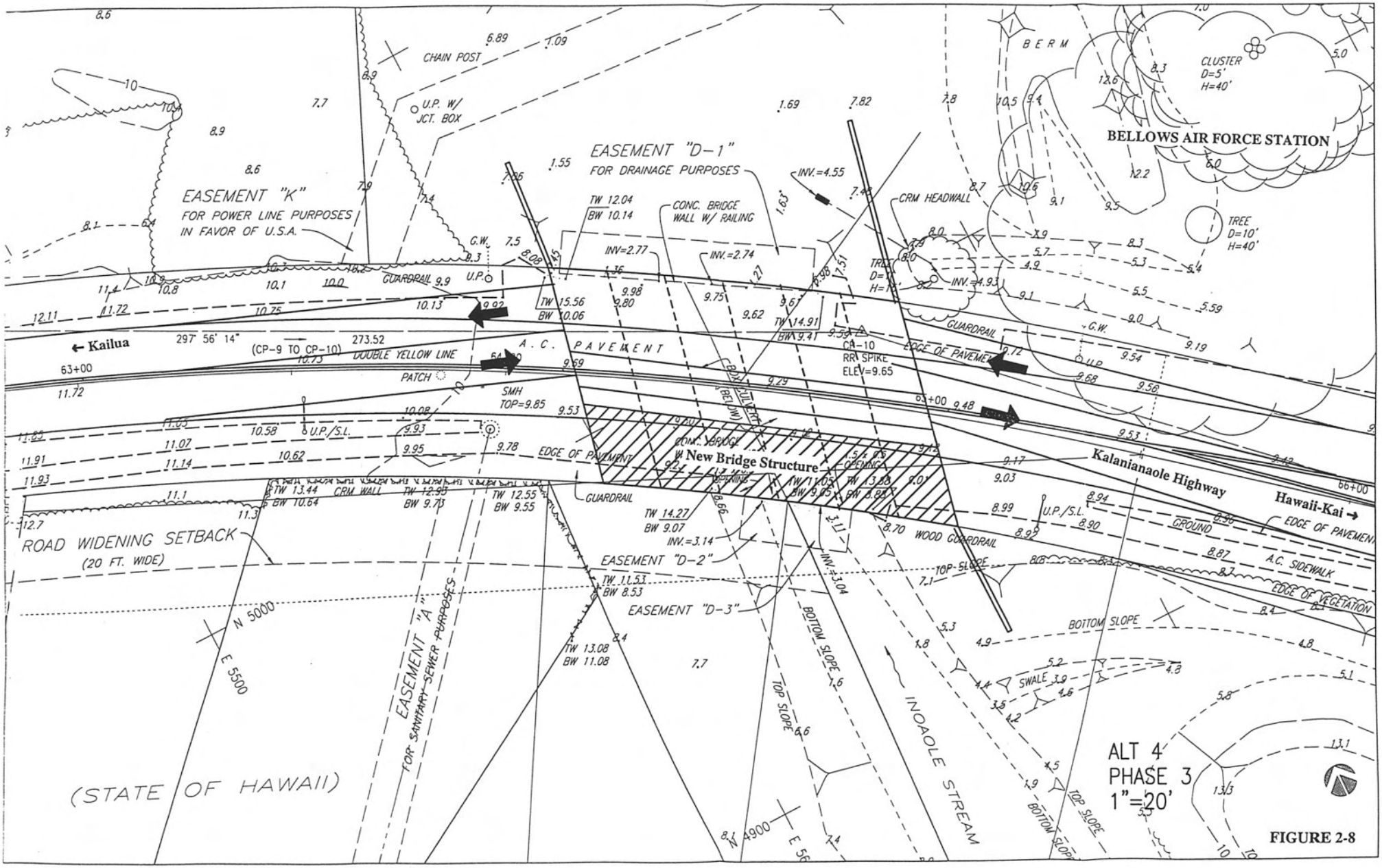

BELLOWS AIR FORCE STATION
BERM
CLUSTER D=5' H=40'
TREE D=10' H=40'
CHAIN POST
U.P. W/ JCT. BOX
EASEMENT "K"
FOR POWER LINE PURPOSES IN FAVOR OF U.S.A.
EASEMENT "D-1"
FOR DRAINAGE PURPOSES
CONC. BRIDGE WALL W/ RAILING
CRM HEADWALL
GUARDRAIL
Kailua
297° 56' 14"
273.52
(CP-9 TO CP-10)
DOUBLE YELLOW LINE
A.C. PAVEMENT
PATCH
SMH TOP=9.85
U.P./S.L.
EDGE OF PAVEMENT
CONC. BRIDGE W/ New Bridge Structure
OPENING
CULVERT (BELOW)
CA-10 RR SPIKE ELEV=9.65
Kalanianaole Highway
Hawaii-Kai
WOOD GUARDRAIL
GROUND
A.C. SIDEWALK
EDGE OF VEGETATION
ROAD WIDENING SETBACK (20 FT. WIDE)
EASEMENT "D-2"
EASEMENT "D-3"
EASEMENT "A" FOR SANITARY SEWER PURPOSES
BOTTOM SLOPE
TOP SLOPE
SWALE
INOAOLE STREAM
N 5000
E 5500
N 4900
(STATE OF HAWAII)
ALT 4
PHASE 3
1"=20'

FIGURE 2-8

2.7 Alternate 5 *Utilize Existing Roadways*

This alternate considers utilizing existing roadways within the area to serve as a detour road during construction and creates a road closure at Inoaole Bridge. Traffic along Kalanianaole Highway would be routed mauka of the highway along Hihimanu and Poalima Streets. Hihimanu and Poalima Streets are 2-lane roadways without sidewalks. This alternative detour route requires crossing an unnamed bridge over an unnamed gulch, and travel through small residential areas and large agricultural areas. Refer to Figure 2-9.

This alternative requires:

- Road closure and detour road signage;
- Minor roadway improvements;
- Replacement of the unnamed bridge structure to accommodate the detour road traffic. Refer to Figure 2-10. The design would be required to meet Federal Highways Administration (FHWA) criteria since the project utilizes federal funds; and
- Coordination with the City and County of Honolulu since the detour road usage and improvements are within County jurisdiction.

Construction of the detour road and bridge over the unnamed gulch is estimated to be approximately 9 to 12 months. Construction of the new Inoaole Bridge is estimated to be approximately 9 to 12 months. The total project construction time is estimated to be 18 to 24 months.

The new bridge structure over the unnamed gulch is estimated to cost approximately $1,500,000 to $1,700,000. Other improvements to the detour route is estimated to cost approximately $500,000. The new Inoaole Bridge replacement cost is estimated to be approximately $1,500,000 to $1,700,000. The total project cost is estimated to be approximately $3,500,000 to $3,900,000.

Advantages:

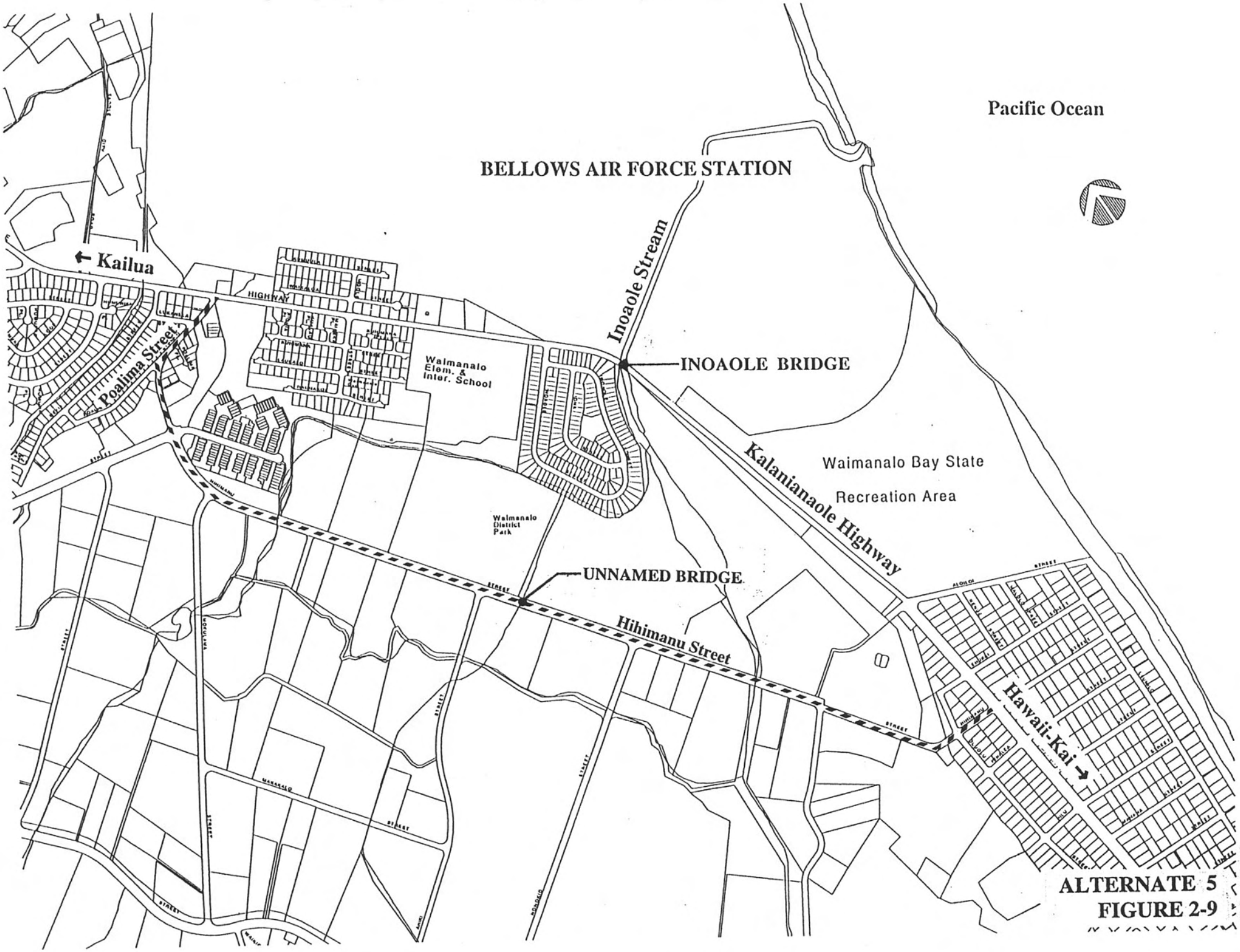
- Improvements to the detour road would be permanent, including the new bridge structure over the unnamed gulch.
- The detour road could serve as a future by-pass road.

Disadvantages:

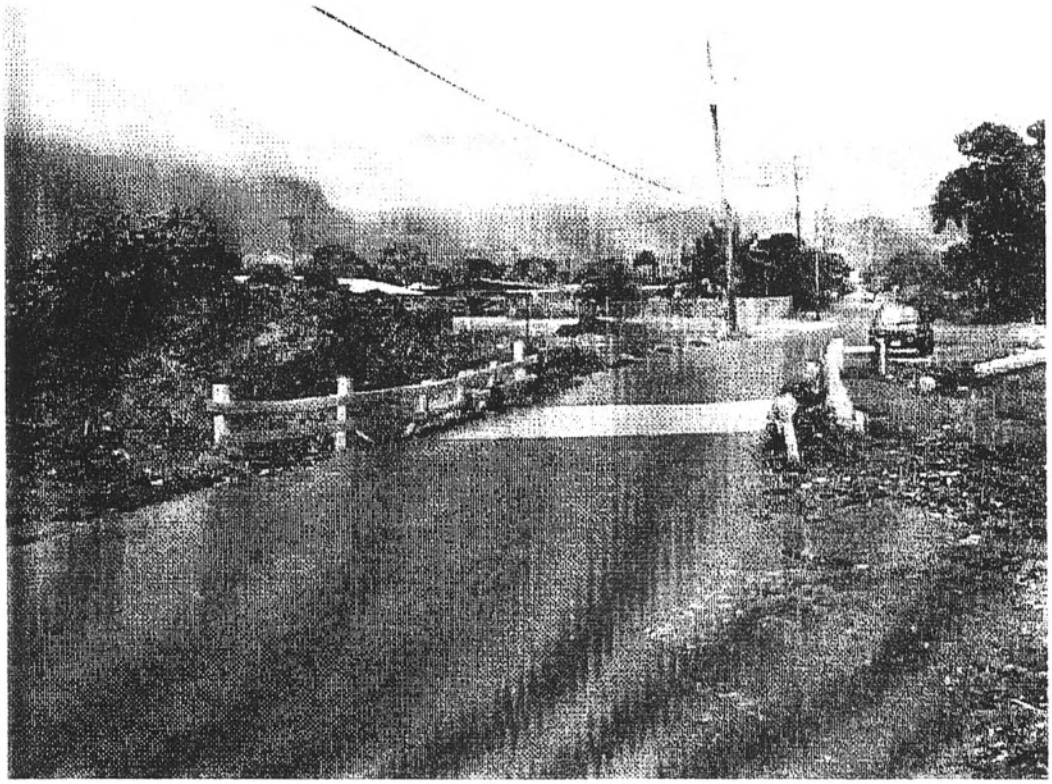
- Increase traffic movement through residential areas may adversely impact the community.
- Commercial business at the southern end of the Waimanalo Bay State Recreation Area would experience temporary reduced vehicular traffic, except for local traffic and traffic going to and from Bellows Air Force Station, Waimanalo Bay State Recreation Area, and the Honolulu Polo Field.

2.7 Alternate 5 (Cont.)

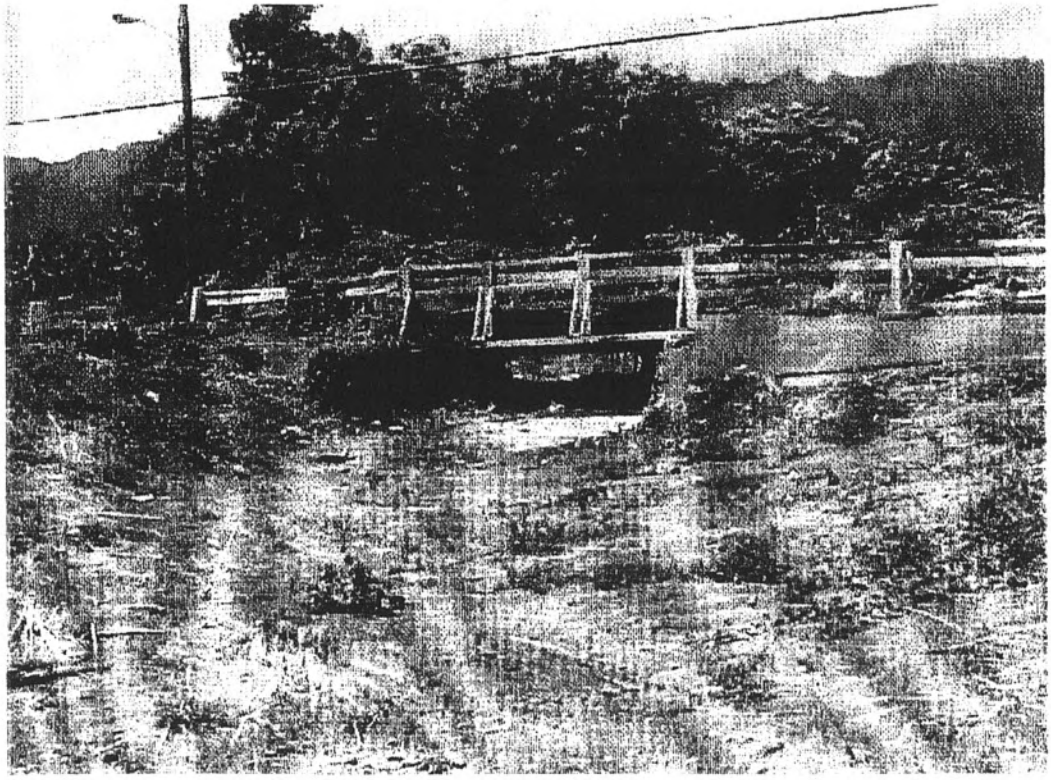
- During improvements to the detour route, local traffic would be temporarily detoured to Kalanianaole Highway or other adjacent streets.



ALTERNATE 5
FIGURE 2-9



UNNAMED BRIDGE ON HIHIMANU STREET : VIEW TOWARDS KAILUA



UNNAMED BRIDGE ON HIHIMANU STREET : DOWNSTREAM

UNNAMED BRIDGE
PHOTOS
FIGURE 2-10

CHAPTER 3

3.1 Summary

A matrix of the various Alternatives with Advantages/Disadvantages, Schedule, and Cost Estimate is included in Table 3-1. The matrix indicates that Alternative 2 is the least costly with the shortest construction schedule and minimal adverse impact to the community, but impacts BAFS.

3.2 Coordination

Since the majority of the detour road alternatives were proposed on BAFS property, coordination meetings were held with BAFS representatives to determine if Alternatives 1, 1A, 2, 2A, or 3 were possible options. Meetings with Ms. Ann Rodrigue-Bailey - Deputy Commander of Bellows Air Force Station, Mr. Henry Kennedy - State Department of Transportation Highways (SDOT), and Sato & Associates, Inc. representatives were conducted on 17 August 2000 and 14 September 2000 at Bellows Air Force Station.

During the 14 September 2000 meeting, Ms. Rodrigue-Bailey indicated that Alternate 2 Detour Road was preferred. A confirmation letter documenting the meeting is included in Appendix A.

We understand that SDOT is currently requesting formal approval for temporary detour road use from Ms. Janice Goo - Civil Engineering Real Estate Office Hickam Air Force Base.

3.3 Recommendation

Alternative 2 is recommended because:

- Least estimated project cost;
- Shortest projected construction schedule;
- Least adverse impact to the community; and
- Acceptable to BAFS.

3.4 Pedestrian Sidewalk

A pedestrian sidewalk is located on the mauka side of the existing bridge. The preferred detour roadway alternative will integrate a pedestrian route which will connect back to the existing pedestrian sidewalk. However, design of the sidewalk will occur after selection and approval of the detour roadway alternative by the State of Hawaii, Department of Transportation. Also, costs associated with the detour roadway pedestrian route has not been included.

INOAOLE BRIDGE REPLECMENT - DETOUR ROAD STUDY

ALTERNATIVES	ADVANTAGES/DISADVANTAGES										SCHEDULE				COST ESTIMATE									
	Detour Road Required	Detour Traffic In Residential Areas	Avoid Large Trees	Divert Traffic From Businesses	BAFS Entry Impacted	BAFS Vehicle Queue Space Reduced	Permanent Roadway Improvement	Temporary Bridge Over Inoaole Stream	New Bridge over Unnamed Gulch	Increased Accident Risk	Estimated Detour Road Construction Time (Months)	Estimated New Bridge Construction Time (Months)	Estimated New Unnamed Bridge Constrcution Time (Months)	Estimated Total Project Time (Months)	Estimated Cost Of Temporary Bridge Over Inoaole Stream ($1,000)	Estimated Detour Road Cost ($1,000)	BAFS Guard House Relocation ($1,000)	Repair Tinker Road and/or Detour Road Removal ($1,000)	Estimated New Inoaole Bridge	Cost ($1,000)	New Bridge Over Unnamed Gulch	Cost ($1,000)	Estimated Project	Cost ($1,000)
ALT. 1	Y	N	Y	N	Y	Y	N	Y	N	N	4 - 6	9 - 12	-	13 - 18	800	220	-	75	1,500	1,700	-	-	2,595	2,795
ALT. 1A	Y	N	Y	N	Y	Y	N	Y	N	N	4 - 6	9 - 12	-	13 - 18	800	250	30	100	1,500	1,700	-	-	2,680	2,880
ALT. 2	Y	N	Y	N	Y	Y	N	N	N	N	3 - 4	9 - 12	-	12 - 16	-	120	30	150	1,500	1,700	-	-	1,800	2,000
ALT. 2A	Y	N	Y	N	Y	Y	N	N	N	N	3 - 4	9 - 12	-	12 - 16	-	160	30	180	1,500	1,700	-	-	1,870	2,070
ALT. 3	Y	N	N	N	N	N	N	Y	N	N	4 - 6	9 - 12	-	13 - 18	800	180	-	50	1,500	1,700	-	-	2,530	2,730
ALT. 4	N	N	Y	N	N	N	N	N	N	Y	-	18 - 24	-	18 - 24	-	-	-	-	2,300	2,500	-	-	2,300	2,500
ALT. 5	Y	Y	Y	Y	N	N	Y	N	Y	Y	-	9 - 12	9 - 12	18 - 24	-	500	-	-	1,500	1,700	1,500	1,700	3,500	3,900

TABLE 3-1

APPENDIX A

Sato & Associates, Inc.
Consulting Engineers
2046 S. King Street, Honolulu, Hawaii 96826
OFFICES IN HONOLULU AND MAUI
Tel: (808) 955-4441
Fax:(808) 942-2027

15 September 2000

Bellows Air Force Station
DET 1, 15 SPTG/CD
515 Tinker Road
Waimanalo, HI 96795

Attn: Ms. Ann Rodrigue-Bailey
Deputy Commander

Re: Replacement of Inoaole Bridge, Kalanianaole Highway
Project No.: STP-072-1(43),Waimanalo, Oahu

Dear Ms. Rodrigue-Bailey;

This is a letter of confirmation regarding your detour road alternative preference for the above project. You may recall that the project is a State of Hawaii Department of Transportation Highways Division action to replace the existing Inoaole Bridge with a new multi-cell culvert bridge structure. The new bridge is located at the same location as the existing bridge and requires a detour road to facilitate traffic during the construction process.

We met on 17 August 2000 to review the project and several detour road alternatives. We met again on 14 September 2000 to review your preference of the various alternatives. During that meeting, you informed us that Alternative 2 was preferred. A copy of Detour Road Alternative 2 is attached. Please review the above to confirm my understanding.

One original and one copy of this document is attached. Should you concur with the above, please sign the original and return it to us. The copy should be retained for your record. Should your understanding differ from the above, please contact me.

Thank you for your assistance on this project. Please contact us should you have any questions.

Very truly yours,
SATO & ASSOCIATES, INC.

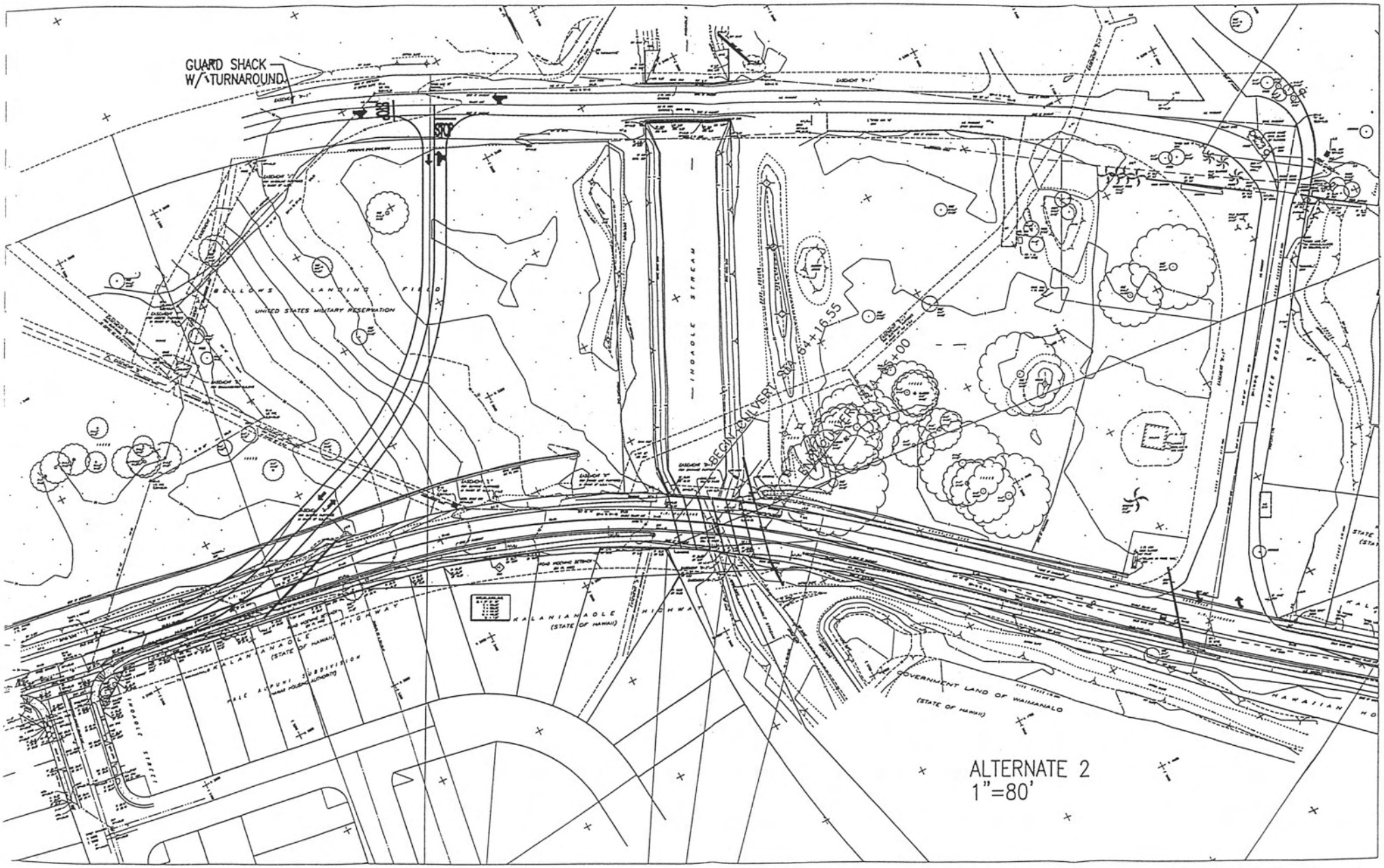
Loren G.S. Lau, A.I.A.
Project Manager

cc: Henry Kennedy - SDOT-HWY

I concur with the above and our
preference for Alternative 2 Detour Road.

9/20/00

Ms. Ann Rodrigue-Bailey
Deputy Commander
Bellows Air Force Station


GUARD SHACK
W/ TURNAROUND
STOP
BEGIN DELIVERY SYS. 6+16.55
END DELIVERY SYS. 45+00
INDIVIDUAL SYSTEM
BELLOWS LANDING FIELD
UNITED STATES MILITARY RESERVATION
KALANIANAOLE HIGHWAY
(STATE OF HAWAII)
GOVERNMENT LAND OF WAIMANALO
(STATE OF HAWAII)
HAWAIIAN
ALTERNATE 2
1"=80'

APPENDIX F

Historic Preservation Review, State Historic Preservation Division

LL

United States Department of the Interior

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

In Reply Refer To: GCS

SEP 22 2000

Loren G.S. Lau, Project Manager
Sato and Associates, Inc.
2046 King St.
Honolulu HI 96826

Re: Inoa'ole Bridge Replacement Project, Waimanalo, Oahu

Dear Ms. Lau:

The U.S. Fish and Wildlife Service (Service) received your August 9, 2000 letter requesting technical assistance on the Inoa'ole Bridge Replacement Project, located on the island of Oahu. The project involves replacement of the existing single cell box culvert with a multi-cell box culvert. Your letter requested information on the presence of any federally listed threatened or endangered species in the project area.

Our records do not indicate the presence of any threatened or endangered species in the immediate project area. However, we are not aware of any detailed biological surveys from that area and it is possible that such species are present but not recorded.

Please note that downstream of the project area, the lower reaches of Inoa'ole Stream provides wetland habitat suitable for endangered waterbirds and migratory shorebirds. The Service recommends that the following measures be incorporated into the project to minimize impacts to aquatic and riparian resources:

1) all project-related materials should be placed or stored in ways to avoid or minimize disturbance to the aquatic environment;

2) all project-related material should be free of pollutants;

3) no contamination of the aquatic environment (trash, debris disposal, etc.) should result from project activities;

4) a contingency plan to control accidental spills of petroleum products should be developed. Absorbent and containment booms should be stored on-site to facilitate the clean-up of petroleum spills;

5) turbidity and siltation from excavation activities should be minimized and contained to the immediate vicinity of excavation through the use of silt containment devices and the curtailment of excavation during adverse weather conditions; and

6) removal of riparian vegetation should not occur.

Also, the Service is cooperating in a riparian restoration effort that involves planting native vegetation along several sections of Inoa'ole Stream bank. One of these riparian restoration sites is adjacent to the project area in the upstream direction. We recommend that you consult with Ms. Lisa Ferentinos, Waimanalo Health Center Water Quality Project Coordinator to avoid impacting streambank restoration efforts.

The Service appreciates your concern for threatened and endangered species and we thank you for requesting our technical assistance at this early stage of project planning. If you have any questions, please contact Gordon Smith, of my staff, at 541-3441.

Sincerely,

Paul Henson
Field Supervisor
Ecological Services

HWY-DS 2.5647

Mr. Paul Henson, Field Supervisor
U. S. Fish and Wildlife Service
Pacific Islands Ecoregion
United States Department of the Interior
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

Dear Mr. Henson:

Subject: Kalanianaole Highway, Replacement of Inoaole Stream Bridge
Federal-Aid Project No. STP-072-1(43)
Response to Pre-consultation Letter for Draft Environmental Assessment (EA) Comments

Thank you for your letter dated September 22, 2000, concerning the subject project.

We acknowledge that your records do not indicate the presence of any threatened or endangered species in the immediate project area.

We also offer the following responses in the respective order of the comments:

1. The Draft EA will discuss a general best management practice plan that briefly discusses comments 1-6.
2. Please see the attached memo for the initial consultation with Ms. Lisa Ferentinos. As you requested, she will be kept appraised of the details and impacts of the proposed project.

We appreciate your interest and participation in the EA review process. Your letter along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)

00030 FAXED

Sato & Associates, Inc.
Consulting Engineers
2046 S. King Street, Honolulu, Hawaii 96826 Tel: (808) 955-4441
OFFICES IN HONOLULU AND MAUI Fax: (808) 942-2027

MEMORANDUM

Date: 20 September 2000

To: Henry Kennedy SDOT-HWY

From: Loren Lau

Re: Inoaole Stream Bridge

I received a phone call from Ms. Lisa Ferentinos. She is a resident of Waimanalo, a member of the Neighborhood Board for 1.5 years, and is involved with a project on the mauka side of Inoaole Bridge.

Her project involves demonstrating methods of restoring stream banks utilizing native plants. The project receives funds from the U.S. Fish and Wildlife Service. We had forwarded a letter to the U.S. Fish and Wildlife Service on 9 August 2000 requesting a review of the site for any information relative to presence of any federally listed (or proposed for listing) endangered or threatened flora/fauna species or critical habitat in the project area. The U.S. Fish and Wildlife Service then informed Ms. Ferentinos of the project.

Ms. Ferentinos requested plans which would indicate the project construction in order to determine impact to her project. I informed her that those documents were not yet available. She expressed a strong desire to participate in the project planning.

I informed her that we are in process of completing a Detour Road Study, then will proceed with a Draft Environmental Assessment (DEA) and Final Environmental Assessment (FEA) with the project design progressing concurrently with the DEA and FEA. I also informed her that the DEA requires pre-consultation with the community and governmental agencies/representatives. I informed her that she and the neighborhood board would participate during the EA process.

Ms. Ferentinos mentioned that the Waimanalo Neighborhood Board did not have a favorable experience with a previous EA about a year ago. I suggested that they contact the Office of Environmental Quality Control (OEQC) and obtain a copy of the EA & EIS Guidelines to become informed on the environmental permitting process.

She requested the SDOT-HWY contact so we informed her of you position as the Project Manager. Should you wish to contact her, she can be reached at:

Ms. Lisa Ferentinos	Ph: 783-7890
41-041 Hinalea Street	Fax: 259-5376
Waimanalo, HI 96795	e:mail lf@lava.net

Please contact me should you have any questions.

APPENDIX G

Technical Assistance Consultation, U.S. Fish & Wildlife Service

HWY 231

LINDA LINGLE
GOVERNOR OF HAWAII

DIRECTOR'S OFFICE
DEPT. OF
TRANSPORTATION
2003 FEB 27 P 3:43

PETER T. YOUNG, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCES MANAGEMENT

DEPUTY
ERNEST Y. W. LAU

STATE OF HAWAII
03 MAR 5 P1:36
DEPARTMENT OF LAND AND NATURAL RESOURCES

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

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND
STATE PARKS

February 25, 2003

Rodney K. Haraga
Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813-5097

LOG NO: 31740
DOC NO: 0302EJ26

Dear Mr. Haraga:

SUBJECT: **Chapter 6E-8 Historic Preservation Review – Pre-Draft Environmental Assessment for Replacement of Inoaole Stream Bridge, Kalanianaole Highway HWY-DS 2.8871**
Waimanalo, Ko`olaupoko, O`ahu
TMK (1) 4-1-33

Thank you for the opportunity to provide comment for the Environmental Assessment for the proposed bridge replacement at Inoaole Stream in Waimanalo. Our review is based on historic reports, maps, and aerial photographs maintained at the State Historic Preservation Division. Staff also made a brief inspection of the bridge area on February 20, 2003. We received notification of this undertaking from your office on January 23, 2003, and provide the following comment.

A review of our records shows that there are no known historic sites within the "stream" at this location. Archival records indicate that this drainage was constructed as a result of sugarcane cultivation in the area. Although subsurface cultural deposits (temporary habitation, traditional agricultural) have been found in the Inoaole Stream segment on the Bellows Air Force Station parcel the portion along the stream at the project location has been extensively modified with rip rap revetments on the *makai* side of the bridge. The upstream (*mauka)* although not previously installed with revetments has been previously cleared and modified making it unlikely that significant subsurface deposits still exist in the area proposed for improvements. Therefore, we believe that the proposed bridge replacement improvements will have "no effect" on significant historic sites.

If you have any questions please call Sara Collins at 692-8026 or Elaine Jourdane at 692-8027.

Aloha,

P. Holly McEldowney

P. Holly McEldowney, Acting Administrator
State Historic Preservation Division

EJ:jk

RECEIVED
MAR 3 8 40 AM '03
DEPT. OF TRANSPORTATION
HIGHWAYS DIVISION

HWY-DS 2.5648

TO: MS. P. HOLLY McELDOWNEY, ACTING ADMINISTRATOR
STATE HISTORIC PRESERVATION DIVISION
DEPARTMENT OF LAND AND NATURAL RESOURCES

FROM: RODNEY K. HARAGA
DIRECTOR OF TRANSPORTATION

SUBJECT: KALANIANAOLE HIGHWAY, REPLACEMENT OF INOAOLE STREAM BRIDGE
FEDERAL-AID PROJECT NO. STP-072-1(43)
RESPONSE TO PRE-CONSULTATION LETTER FOR DRAFT ENVIRONMENTAL ASSESSMENT (EA) COMMENTS

Thank you for your letter dated February 25, 2003, concerning the subject project.

We acknowledge that based on your records, the proposed bridge replacement improvements will have "no effect" on significant historic sites.

We appreciate your interest and participation in the EA review process. Your letter, along with this response, will be included in the forthcoming Draft EA. If you have any questions, please call Emilio Barroga, Project Manager at 692-7546, or Misako Oshiro at 692-7553, Technical Design Services Office, Design Branch, Highways Division.

MKO:kny

bc: HWY-DS (EB, MKO)
Sato & Associates, Inc. (Clifford Arakawa)