Lualualei Flood Study
Executive Summary

(Contract Number DACA83-98-D-0018)

Waianae, Oahu, Hawaii

Submitted to:

U.S. Army Corps of Engineers

U.S. Department of Agriculture, Natural Resources Conservation Service

Submitted by:

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ABBREVIATIONS AND ACRONYMS

City	City and County of Honolulu
CLOMR	Conditional Letter of Map Revision
CWA	Clean Water Act
DOH	State of Hawaii Department of Health
FIRM	Flood Insurance Rate Map
ft	foot, feet
HEC-1	Software by the Hydrologic Engineering Center, U.S. Army Corps of Engineers
LOMR	Letter of Map Revision
mi^2	square miles
NFIP	National Flood Insurance Program
State	State of Hawaii
U.S.	United States
USACE	U.S. Army Corps of Engineers
WQC	Water Quality Certification

SECTION 1.0
INTRODUCTION

SECTION 1

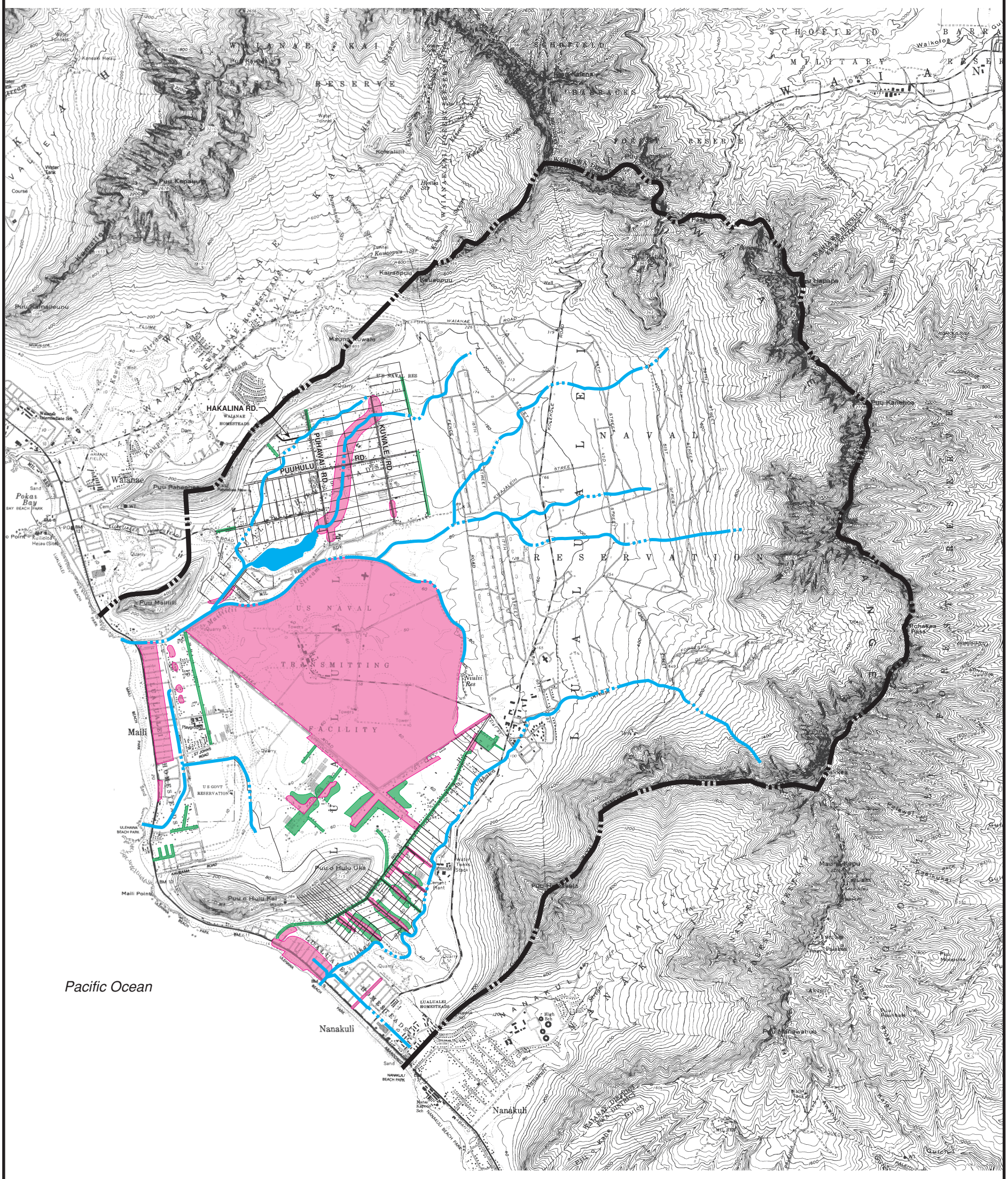
INTRODUCTION

Heavy rains on November 11, 13 and 14 of 1996 resulted in extensive flooding in Leeward and Central Oahu (Reference 1). The rainfall during the period was reported by the National Weather Service as being the heaviest in 50 to 100 years (Reference 2). Rainfall runoff, sheet flowing from the steep faces of the surrounding mountains and across the moderately sloping open lands in the upper portion of Lualualei Valley, collected on the valley floor. Homes and portions of area roadways were inundated for up to seven days (Reference 3). The areas reported to flood during the November 1996 rainfall event were typically located near drainage structures, such as open channels, culverts, and bridges, as shown in Figure 1.1 – Areas of November 1996 Flooding – 11/17/99 Public Hearing Comments.

Flooding problems were attributed to the absence of a storm drainage system within agricultural areas, and partially blocked existing culverts and other drainage structures in residential areas, due to their poor maintenance (Reference 4).

The Lualualei watershed consists of three drainage basins encompassing approximately 23.4 square miles (mi^2) of land located along the west coast of the island of Oahu. The ridgelines forming the upper limits of the watershed are the Waianae Mountain Range to the east, with the Pu‘u Mailiilii and Paheehee Ridge forming the limit to the north and Pu‘u Haleakala forming the limit to the south. The Pacific Ocean is the watershed’s western boundary. Primary access to the area is provided by Farrington Highway, as shown in Figure 1.2 – Lualualei Watershed.

Under this study, hydrologic and hydraulic investigations of flooding and drainage problems within the watershed were conducted. Recommendations to minimize or eliminate future flooding were then developed based on these investigations. The study also includes an environmental survey to identify constraints on implementation of the recommendations. The results of the study have been divided into four reports: environmental survey; hydrologic analysis; hydraulic analyses, mitigation alternatives, and construction cost estimates; and this executive summary. The executive summary summarizes major findings of the entire Lualualei Flood Study.


HAKALINA RD.
PUUHULU RD.
PUUHAWAI RD.
KUWALE RD.
Pacific Ocean
Nanakuli
Maili
Waianae
U.S. NAVAL TRANSMITTING FACILITY
U.S. NAVAL RESERVATION
LUALUALEI NAVAL RESERVATION
WAIANAE KAI FOREST RESERVE
SCHOFIELD BARRACKS MILITARY RESERVE
WAIANAE VALLEY
LUALUALEI VALLEY
NANAKULI VALLEY
Puu Kaala
Puu Kaimaipuuu
Puu Mailiili
Puu Hulu Oka
Puu Hulu Kai
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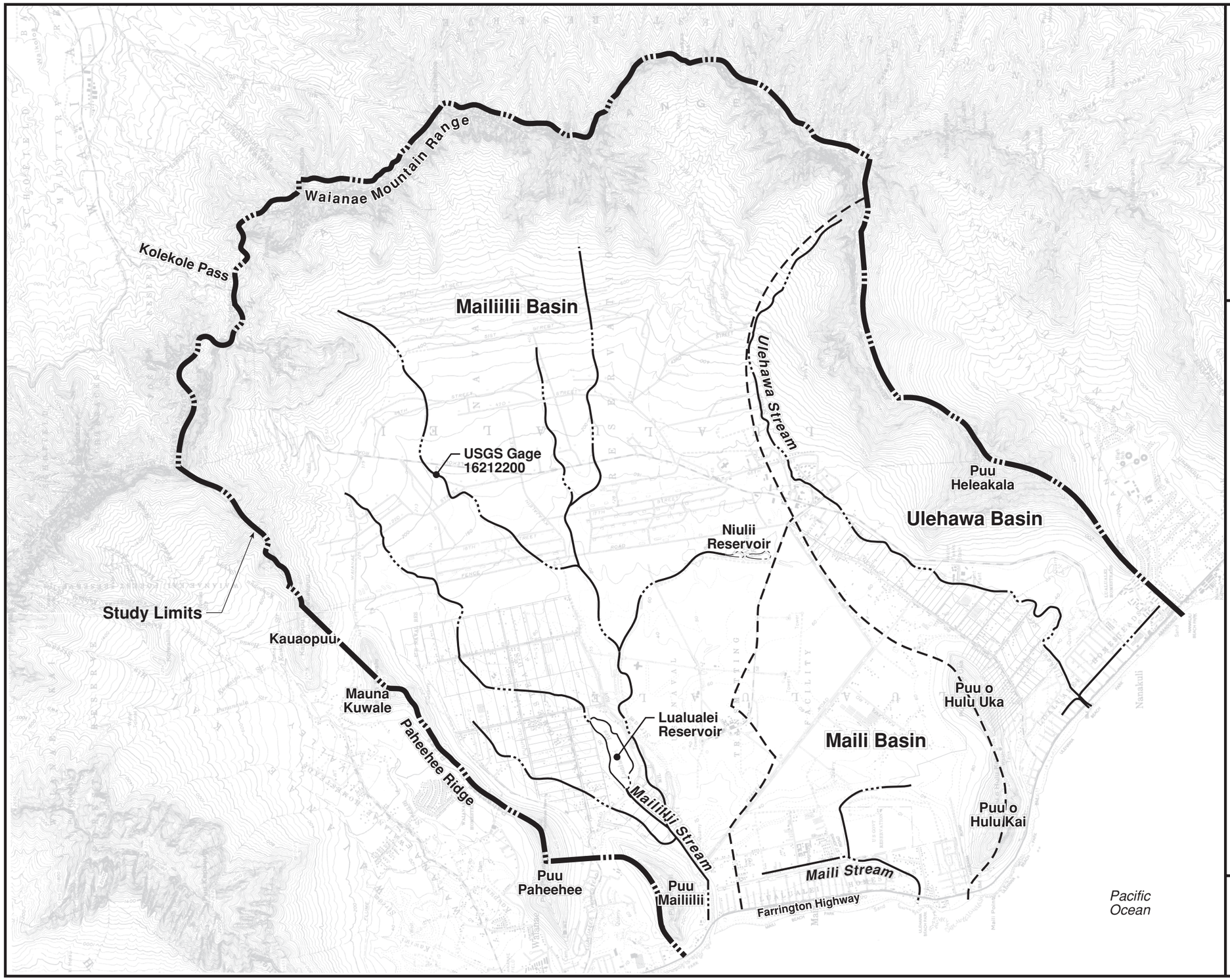

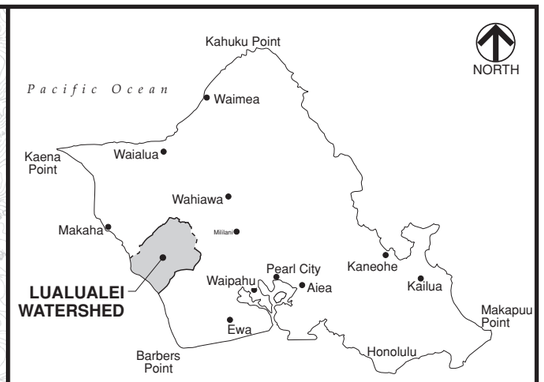

ISLAND OF OAHU

LEGEND:

- Drainage Basin Limits
- Study Limits
- Stream Centerline

Source: U.S. Geological Survey (1983) Schofield Barracks, Hawaii and Waianae, Hawaii Quadrangles. 7.5 minute series (topographic).

NORTH

0 3500 7000

SCALE IN FEET

Figure 1.2
LUALUALEI WATERSHED

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SECTION 2.0
HYDROLOGIC AND HYDRAULIC ANALYSES

SECTION 2

HYDROLOGIC AND HYDRAULIC ANALYSES

The three drainage basins of the Lualualei Watershed are fed by three streams: the Mailiilii Stream (15.9 mi^2 basin), Maili Stream (3.1 mi^2 basin), and the Ulehawa Stream (4.4 mi^2 basin). All three streams were subject to flood control projects in the 1960s and 1970s, consisting primarily of the concrete lining of portions of the streams and the construction of several bridges (Reference 5).

Under this study, these flood control improvements were generally determined to be adequate to convey the design flows, with a few exceptions. However, it was found that these flood control projects did not provide for a means of effective runoff conveyance to the improved portions of the three streams. This absence of drainage infrastructure or inadequacy of existing drainage infrastructure, and sump conditions were all identified in the study as contributing to the extensive watershed flooding. Some of the major infrastructure improvements are highlighted below. The Hydraulic Analysis, Mitigative Alternatives, and Construction Cost Estimates report presents a detailed discussion of these and all other improvements.

The majority of the roads in the study area lack drainage infrastructure and many have low points where runoff accumulates causing shallow flooding. This condition is particularly prevalent along and within Paakea Road, Iliili Road and Hakimo Road, and less severe along Farrington Highway. Flood mitigation for these roadways generally consists of reconstructing roads to have curbs and catch basins to collect runoff, and drain lines to convey runoff to the streams or the ocean, providing drainage relief for sump conditions.

Many of the reported flood areas are near drainage structures. In most cases, drainage structures servicing these areas were found to be undersized. This condition was observed in the upper portions of Mailiilii Basin above the Lualualei Reservoir. All the bridges constructed as part of the flood control projects in the 1960s and 1970s were found to be adequate. However, four major culverts and two bridges, not part of the flood control projects in the 1960s and 1970s, were found to be inadequate in reported flood prone areas.

Sumps with no drainage relief are prevalent throughout the study area. These areas are generally small. However, large sumps have resulted in extensive flooding along Maipalaoa and Meaaulu Roads adjacent to the Maili Stream, and along Paakea Road, as shown in Figure 2.1 – Lualualei Watershed Sump Locations. The sump located along Paakea Road is approximately 90 acres in size and as reported was the site of most extensive flooding during the 1996 flood. The flat grades in the area make draining the Paakea Road sump infeasible. Therefore, corrective measures to reduce flooding in this area include diverting runoff from 188.1 acres, of the open grassed area above Paakea Road, away from the sump. A 113-acre-foot (ft) detention basin is recommended for this upslope area to attenuate the peak design flows and to minimize the size of downstream drainage infrastructure, consisting of a proposed 84-inch culvert, and 25-ft-wide rectangular channel to convey runoff to the Maili Stream. In similar fashion, a 7-ft-high, 2,730-ft-long berm can be constructed in Federal Reserve land to divert runoff from 118.2 acres flows into the sump inundating Maipalaoa and Meaaulu Roads. With the construction of the proposed diversion berm and a new 48-inch drain line to service Meaaulu Road, the existing drainage infrastructure along Maipalaoa Road is anticipated to be adequate to drain the area.

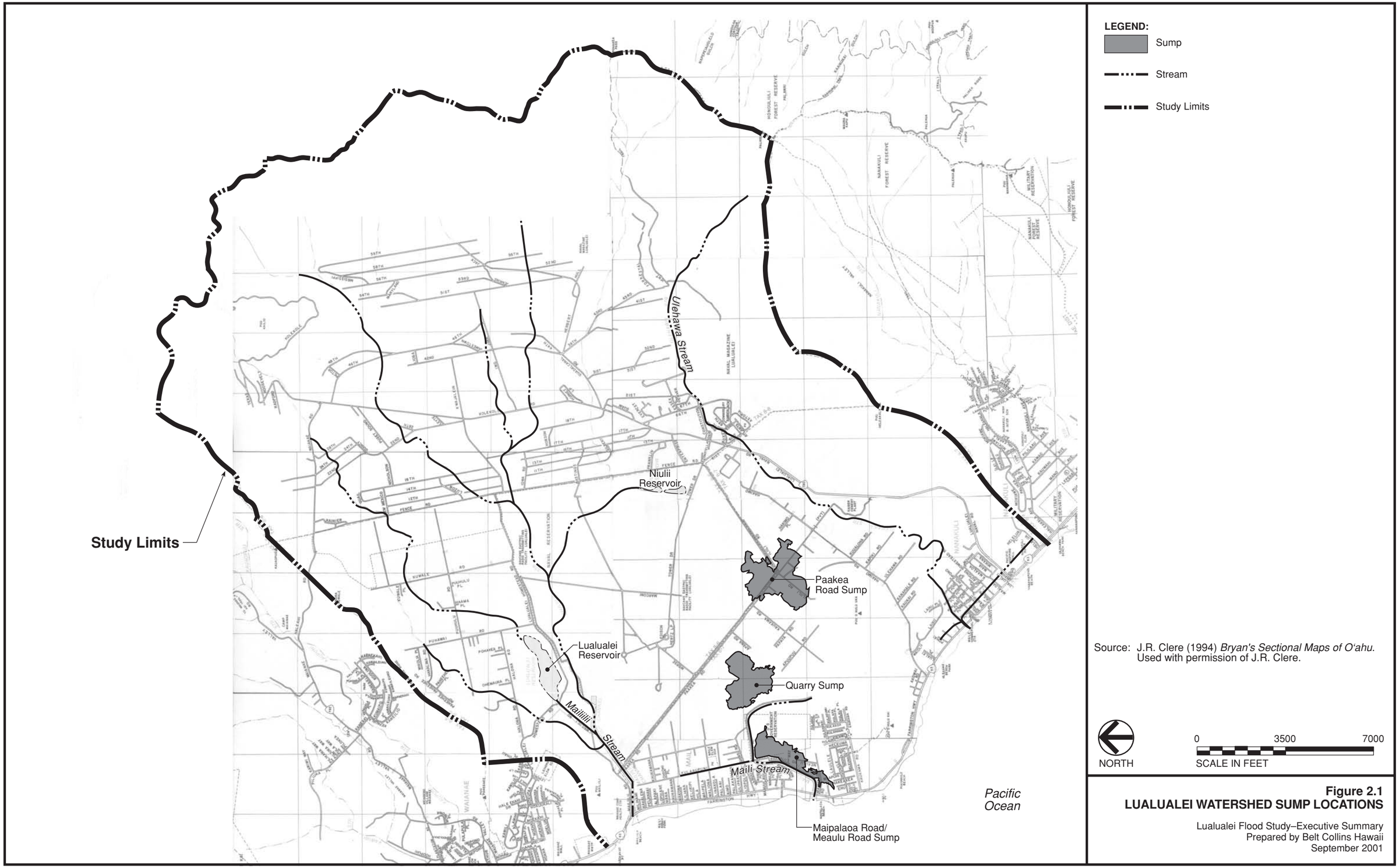

Figure 2.1
LUALUALEI WATERSHED SUMP LOCATIONS

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SECTION 3.0
RECOMMENDED FLOOD IMPROVEMENTS AND ESTIMATED COST

SECTION 3

RECOMMENDED FLOOD IMPROVEMENTS AND ESTIMATED COST

The estimated construction costs for the recommended flood mitigation improvements for the Mailiilii Basin, Maili Basin, and Ulehawa Basin are $3.5 million, $18.9 million, and $13.0 million, respectively. Locations of flood mitigation improvements are shown in Figure 3.1 – Mitigation Alternative Locations.

A summary of specific flood mitigation improvements for the three drainage basins and their estimated cost are provided in Tables 3.1 through 3.3.

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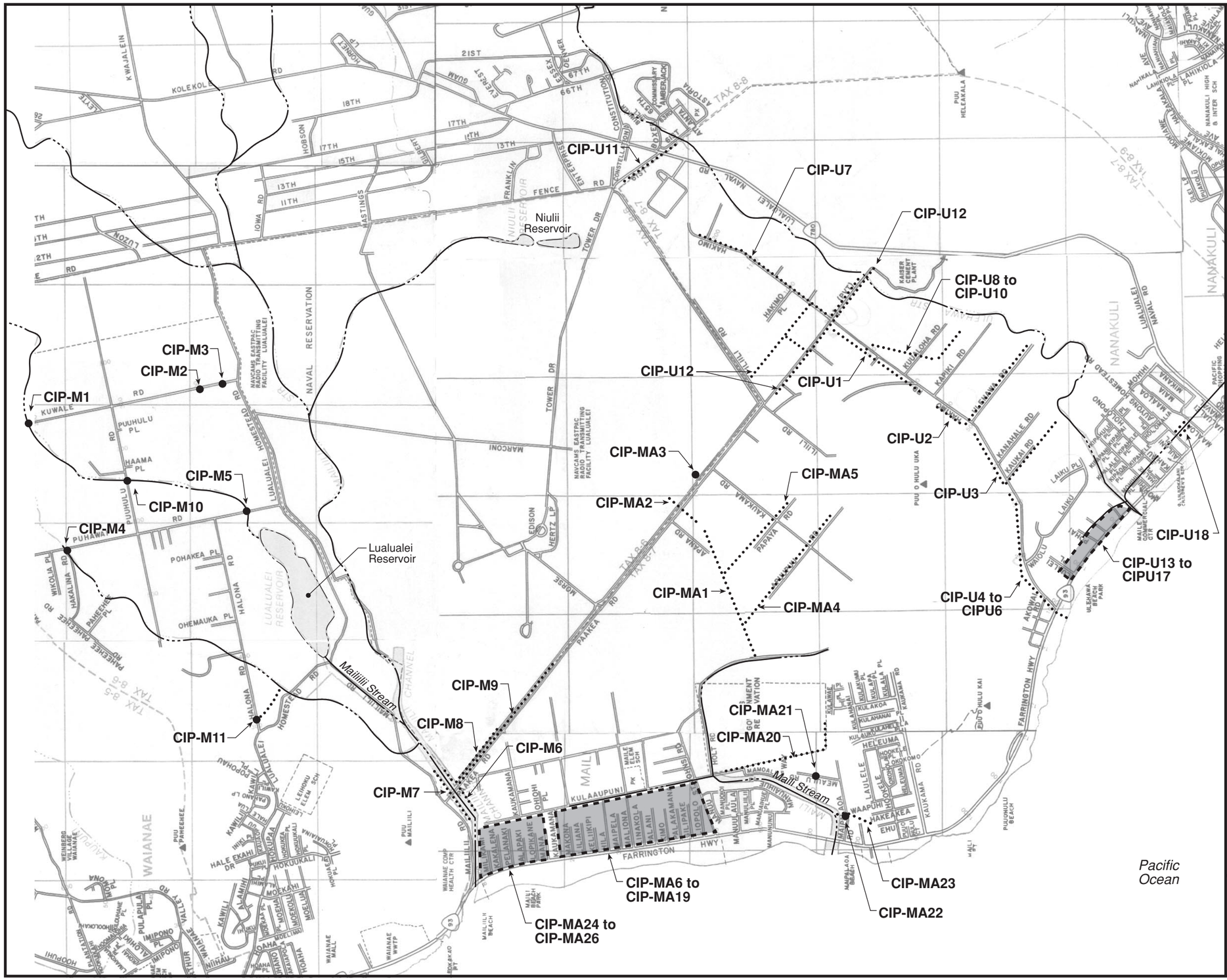

LEGEND:

·····	CIP-U1	Capital Improvement–Linear (e.g., Berm, Drainline)
●	CIP-M1	Capital Improvement–Structure (e.g. Bridge, Culvert, Detention Basin)
▒	CIP-MA24 to CIP-MA26	Area with Multiple Capital Improvements
—·—·—	Stream	

Source: J.R. Clere (1994) *Bryan's Sectional Maps of O'ahu.* Used with permission of J.R. Clere.

NORTH

0 1000 2000 4000

SCALE IN FEET

Figure 3.1
MITIGATION ALTERNATIVE LOCATIONS

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Table 3.1
Mitigation Alternatives and Cost Estimate
Mailiilii Basin

Improvement Identification	*Severity Rating*	*Proposed Capital Improvement*	*Drainage Area (acres)*	*Return Interval (years)*	*Item Cost*
A. Kuwale Road					
CIP-M1	2	57-ft-span bridge to replace 27-ft-span bridge	1,380	100[C]	$201,000
CIP-M2	3	Replace single 22-inch culvert with triple 30-inch culvert	45	50[H]	$22,000
CIP-M3	2	Replace single 22-inch culvert with 7-ft x 17-ft box culvert	179	100[C]	$49,000
B. Puhawai Road					
CIP-M4	2	Construct new 7-ft x 17-ft box culvert	186	100[C]	$49,000
CIP-M5	2	Construct 69-ft-span, 10.5-ft-high bridge to replace triple 36-inch culvert	1,920	100[H]	$220,000
C. Mailiilii Channel					
CIP-M6	2	Raise 950 ft of left bank by 3.8 ft	10,180	100[H]	$70,000
CIP-M7	2	Raise 2,720 ft of right bank by 3.8 ft	10,180	100[H]	$190,000
D. Paakea Road					
CIP-M8	1	Construct berm to divert runoff into the Mailiilii Stream	12	10[C]	$60,000
CIP-M9	1	Construct 48-inch drain line	57	10[C]	$1,880,000
E. Puuhulu Road					
CIP-M10	2	56-ft-span bridge to replace 23-ft-span bridge	1,464	100[H]	$199,000
F. Halona Road					
CIP-M11	1	36-inch-diameter drain line (280H), manholes, and inlet structure	16.1	50[C]	
		7-ft x 6.5-ft rectangular channel (1,120 ft)	112.6	100[C]	$583,000
				Rounded Mailiilii Basin Total =	$3,520,000

[C] = City and County of Honolulu (City) Drainage Standards were used for sizing.
[H] = HEC-1 results were used for sizing.

Table 3.2
Mitigation Alternatives and Cost Estimate
Maili Basin

Improvement Identification	*Severity Rating*	*Proposed Capital Improvement*	*Drainage Area (acres)*	*Return Interval (years)*	*Item Cost*
A. Paakea Road					
CIP-MA1	1	25-ft-wide rectangular concrete channel	581	100[C]	$2,800,000
CIP-MA2	1	84-inch drain line	444	100[C]	$1,610,000
CIP-MA3	1	113-acre-ft detention basin	444	100[C]	$8,090,000
B. Apuupuu Road CIP-MA4	1	42-inch drain line, road, curb, manholes, and catch basins	65	10[C]	$880,000
C. Papaya Road CIP-MA5	1	30-inch drain line, road, curb, manholes, and catch basins	26	10[C]	$490,000
D. St. Johns Road CIP-MA6	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$251,000
E. Lipolo Road CIP-MA7	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$200,000
F. Gilipake Road CIP-MA8	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$197,000
G. Palakamana Street CIP-MA9	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$199,000
H. Kimo Street CIP-MA10	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$197,000
I. Palani Street CIP-MA11	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$152,000
J. Linakola Street CIP-MA12	3	24-inch drain line, road, curb, manholes, and catch basins	4	50[C]	$176,000
K. Maliona Street CIP-MA13	3	24-inch drain line, road, curb, manholes, and catch basins	4	50[C]	$197,000
L. Maipela Street CIP-MA14	3	24-inch drain line, road, curb, manholes, and catch basins	3	50[C]	$171,000
M. Hila Street CIP-MA15	3	24-inch drain line, road, curb, manholes, and catch basins	4	50[C]	$184,000

Table 3.2 (cont.)
Mitigation Alternatives and Cost Estimate
Maili Basin

Improvement Identification	*Severity Rating*	*Proposed Capital Improvement*	*Drainage Area (acres)*	*Return Interval (years)*	*Item Cost*
N. Keliikipi Street CIP-MA16	3	24-inch drain line, road, curb, manholes, and catch basins	2	50[C]	$156,000
O. Lilianana Street CIP-MA17	3	24-inch drain line, road, curb, manholes, and catch basins	2	50[C]	$161,000
P. Makona/ Kaukamana Street CIP-MA18	3	36/24-inch drain line, road, curb, manholes, and catch basins	8	50[C]	$472,000
Q. Kulaaupuni Street CIP-MA19	3	24-inch drain line, road, curb, manholes, and catch basins	NA	NA	$234,000
R. Maipalaoa/ Meaaulu Road					
CIP-MA20	1	7-ft-high berm	14	50[C]	$191,000
CIP-MA21	1	48-inch drain line, road, curbs, and catch basins	14	50[C]	$480,000
S. Ehu/Hakeakea Rd					
CIP-MA22	1	Widen existing concr. channel by 2 ft	6	10[C]	$65,000
CIP-MA23	1	24-inch drain line, road, curb, manholes, and catch basins	6	10[C]	$286,000
T. Milikami, Kakalena, Pelanaki, Alapaki, Lopikane, Mana Roads CIP-MA24	3	36-inch drain line, manholes, and outlet structure	12	50[C]	$70,000
U. Milikami, Kakalena, Pelanaki Roads CIP-MA25	3	24/30-inch drain line, road, curb, manholes, and catch basins	6	50[C]	$447,000
V. Alapaki, Lopikane, Mana Roads CIP-MA26	3	24/30-inch drain line, road, curb, manholes, and catch basins	6	50[C]	$506,000
				Rounded Maili Basin Total =	$18,900,000

[C] = City Drainage Standards were used for sizing.
[H] = HEC-1 results were used for sizing.

Table 3.3
Mitigation Alternatives and Cost Estimate
Ulehawa Basin

Improvement Identification	*Severity Rating*	*Proposed Capital Improvement*	*Drainage Area (acres)*	*Return Interval (years)*	*Item Cost*
A. Hakimo Road					
CIP-U1	1	36-inch drain line, road, curb, manholes, and catch basins	20	10[C]	$1,000,000
CIP-U2	1	42-inch drain line, road, curb, manholes, and catch basins	21	10[C]	$1,000,000
CIP-U3	1	42-inch drain line, road, curb, manholes, and catch basins	33	10[C]	$984,000
CIP-U4	1	36-inch drain line, road, curb, manholes, and catch basins	20	10[C]	$366,000
CIP-U5	1	42-inch drain line, road, curb, manholes, and catch basins	42	10[C]	$622,000
CIP-U6	1	42-inch drain line, road, curb, manholes, and catch basins	58	10[C]	$682,000
CIP-U7	1	24-inch drain line, road, curb, manholes, and catch basins	4	10[C]	$1,140,000
CIP-U8	1	15-ft x 7-ft rectangular channel	120	100[C]	$1,100,000
CIP-U9	1	15-ft x 7-ft box culvert	120	100[C]	$36,000
CIP-U10	1	Clear 20-ft x 6-ft box culvert	70	50[H]	$15,000
CIP-U11	1	Cutoff ditch above 87-1245 Hakimo Road, culvert, headwalls	12	50[H]	$56,000
B. Paakea Road					
CIP-U12	1	Paakea Road 8-ft x 12-ft box culvert, manholes, and headwalls	172	100[C]	$2,450,000
	1	7-ft x 5.5-ft rectangular channel and 8-ft x 6.75-ft rectangular channel	156	100[C]	$1,650,000
	1	48-inch drain line in Paakea Road, catch basins, curb, and road	24	50[H]	$610,000
C. Unnamed Roads Between Princess Kahanu Avenue and Ulehawa Stream					
CIP-U13	3	24-inch drain line, road, curb, manholes, and catch basins	3	10[C]	$166,000
D. Unnamed Road Between Poahi Road and Kahanu Avenue					
CIP-U14	3	24-inch drain line, road, curb, manholes, and catch basins	2	10[C]	$170,000

Table 3.3 (cont.)
Mitigation Alternatives and Cost Estimate
Ulehawa Basin

Improvement Identification	*Severity Rating*	*Proposed Capital Improvement*	*Drainage Area (acres)*	*Return Interval (years)*	*Item Cost*
E. Pohai Road CIP-U15	3	24-inch drain line, road, curb, manholes, and catch basins	4	10[C]	$285,000
F. Lualei Place and Road Between Lualei Place and Pohai Road CIP-U16	3	24-inch drain line, road, curb, manholes, and catch basins	8	10[C]	$347,000
G. Collector Line Serving Roads Between Lualei Place and Princess Kahanu Avenue CIP-U17	3	36-inch drain line and manholes	15	10[C]	$285,000
H. Ulehawa Stream Channel U3 CIP-U18	3	Raise channel sides by 2.4 ft	134	100[C]	$25,000
				Rounded Ulehawa Basin Total =	$13,000,000

[C] = City Drainage Standards were used for sizing.
[H] = HEC-1 results were used for sizing.

SECTION 4.0
ENVIRONMENTAL CONSTRAINTS

SECTION 4

ENVIRONMENTAL CONSTRAINTS

Some of the capital improvements proposed for the Lualualei watershed are located in areas with sensitive environments. Improvements have been proposed in areas where illegal waste disposal sites, significant flora and fauna, important archaeological sites, and potential wetlands are known to exist. The potential implications of locating improvements in these areas are briefly discussed below.

Capital improvement structures proposed for Kuwale and Puhawai Roads in the Mailiilii Basin and below Paakea Road in the Maili Basin are located in the vicinity of State Department of Health (DOH) documented illegal waste disposal sites. Illegal waste disposal sites are prevalent throughout the valley, and are not all DOH-documented. These illegal waste disposal activities may have resulted in the contamination of soil and/or water in the area. Thus, there is potential to encounter contaminated materials during construction of the proposed drainage improvements.

Species of significant flora and fauna have been observed in areas proposed for capital improvements. The *Lipochaeta lobata var lobata*, or Nehe, was observed in the vicinity of residential areas located along Farrington Highway, located to the north of the Ulehawa Stream Bridge. Although the Nehe was last observed in 1914, it is possible that it still exists in the area. The *Monachus schauinslandi*, or Hawaiian Monk Seal, was seen in 1994 along the coastline across Farrington Highway from residential areas in the Maili Basin, below Kulaapuni Road. Road reconstruction and the construction of drain lines are proposed for this area. Based on the available information, a biological survey should be conducted prior to construction of the proposed improvements to ensure that endangered or significant flora and fauna will not be impacted.

Most of the valley's archaeological sites are located on the coastline along the west side of Farrington Highway, while capital improvements are proposed for areas located on the east side of Farrington Highway. There are, however, some capital improvements that may be affected by archaeological sites. These improvements are at Paakea Road near Mailiilii Stream and along Lipolo Street in the Maili Basin. Both locations will require further investigation and data collection prior to construction.

There is no inventory of historic buildings for Lualualei Valley other than those located in the Lualualei Naval Magazine and the Naval Radio Transmitter Facility. Based on the information regarding the location of the historic structures on these naval reservations, no historic structures are known to exist in the areas proposed for improvements.

There is no current inventory of culturally significant sites for the Lualualei watershed. The Waianae/Lualualei region has one of the oldest communities, as well as one of the largest Native Hawaiian communities on Oahu. Therefore, the areas proposed for capital improvements should be further investigated to determine if they are in culturally significant areas or contain sites of cultural significance.

Wetland areas identified by the U.S. Department of the Interior Fish and Wildlife Service are present in the vicinity of several capital improvements. Although these areas may be mapped as

wetlands, they may not possess the characteristics that the U.S. Army Corps of Engineers (USACE) requires for a wetlands designation. Therefore, additional investigation will be required to determine if these areas meet the USACE requirements for a wetlands designation. The Clean Water Act (CWA) Section 404 defines requirements for discharges in navigable waters of the U.S. and sets limits on the discharge of dredged or fill materials into navigable waters. Permit approval is through USACE. Proposed improvements involving wetland, stream or bank excavation and fill will require a Section 404 permit.

If a capital improvement project requires a CWA Section 404 permit, it will also then require a CWA Section 401, Water Quality Certification (WQC). The DOH enforces Section 401 of the CWA, which will be required for activities that propose construction or operations that result in discharges to State waters.

The 1968 National Flood Insurance Act created the National Flood Insurance Program (NFIP), which provides flood insurance for participating flood-prone communities. Insurance rates are based on flood hazard-area zone designations. These designations indicate the flood risk associated with each participating flood-prone community, as identified on NFIP Flood Insurance Rate Maps (FIRMs). Revisions are obtained through the Conditional Letter of Map Revision (CLOMR) and Letter of Map Revision (LOMR) process. A project may require submittal of a CLOMR/LOMR prior to construction to assure impacts on designated flood hazard districts are identified.

Other permits and approvals that may be required under Federal and State laws are discussed in detail in the Environmental Survey report. Along with a detailed regulatory review for implementation of the proposed capital improvement, additional investigations will be required to determine if significant environmental resources are actually present in the vicinity of the proposed projects. Based on the available information, it seems likely that specific environmental documentation, such as an environmental assessment in addition to regulatory permits, will also be required. Site-specific investigations and subsequent environmental documentation or permits will help ensure that the construction and operation of the proposed improvements do not adversely impact significant environmental, archaeological, or cultural resources.

SECTION 5.0
REFERENCES

SECTION 5

REFERENCES

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