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DEPARTMENT OF PUBLIC WORKS
COUNTY OF MAUI
200 SOUTH HIGH STREET, ROOM NO. 434
WAILUKU, MAUI, HAWAI`I 96793
www.mauicounty.gov/publicworks

June 19, 2025

Ms. Mary Alice Evans, Director
Office of Planning and Sustainable Development
Environmental Review Program
State of Hawai`i
Department of Business, Economic Development & Tourism
235 S. Beretania Street, Room 702
Honolulu, HI 96813

SUBJECT: DRAFT ENVIRONMENTAL ASSESSMENT – ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT (DEA-AFNSI)
HANA HIGHWAY AT KALEPA POINT ROAD REPAIRS AT VICINITY OF MILE POST 38.2
TMK: FRONTING (2) 1-6-010:999
KALEPA POINT, EAST MAUI, HAWAII

Dear Ms. Evans:

With this letter, the County of Maui Department of Public Works hereby transmits the Draft Environmental Assessment and Anticipated Finding of No Significant Impact (DEA-AFONSI) for the proposed Hana Highway at Kalepa Point Road Repairs for publication in the next available edition of The Environmental Notice. The DEA-AFONSI has been prepared pursuant to the Hawaii Revised Statutes, Chapter 343, and Hawaii Administrative Rules, Title 11, Chapter 200.1.

An electronic copy of this letter and a searchable PDF file of the DEA-AFONSI have been uploaded to the Environmental Review Program website.

If there are any questions, please contact Public Works Director, Jordan Molina, at (808) 270-7845 or email at public.works@mauicounty.gov. You may also contact our consultant, Mr. Gregory Wong of Sea Engineering, Inc., at (808) 536-3603 or email at gwong@seaengineering.com.

Sincerely,

for JORDAN MOLINA
Director of Public Works

RRR/JD(ED25-0399)
S:\ENG\PROJECTS\02 CIP\2019\19-31 Kalepa Revetment and Seawall\C Environmental\EA\DEA-AFNSI transmittal letter.doc

From: dbedt.opsd.erp@hawaii.gov
To: DBEDT OPSD Environmental Review Program
Subject: New online submission for The Environmental Notice
Date: Monday, June 30, 2025 3:43:37 PM

Action Name

Hana Highway at Kalepa Point Road Repairs

Type of Document/Determination

Draft environmental assessment and anticipated finding of no significant impact (DEA-AFNSI)

HRS §343-5(a) Trigger(s)

- (1) Propose the use of state or county lands or the use of state or county funds
- (2) Propose any use within any land classified as a conservation district
- (3) Propose any use within a shoreline area

Judicial district

Hāna, Maui

Tax Map Key(s) (TMK(s))

(2) 1-6-010:999A

Action type

Agency

Other required permits and approvals

Multiple (See Section 1.5)

Proposing/determining agency

County of Maui Department of Public Works

Agency jurisdiction

County of Maui

Agency contact name

John Datiles

Agency contact email (for info about the action)

johnedward.datiles@co.maui.hi.us

Email address for receiving comments

kalepa@seaengineering.com

Agency contact phone

(808) 270-7845

Agency address

200 S. High Street
Kalana O Maui Bldg. 4th Floor
Wailuku, Hawaii 96793

United States
Map It

Is there a consultant for this action?

Yes

Consultant

Sea Engineering Inc.

Consultant contact name

Gregory Wong

Consultant contact email

gwong@seaengineering.com

Consultant contact phone

(808) 536-3603

Consultant address

504 North Nimitz Hwy
Honolulu, HI. 96817
Honolulu, Hawaii 96782
United States
Map It

Action summary

The proposed project consists of: road protection and roadway improvements. The road protection consists of repairing 500 linear feet of rock rubblemound revetment and concrete rubble masonry wall with a hybrid rock rubblemound revetment and concrete retaining wall. The roadway improvements consist of repaving the roadway between the Kalepa Bridge and the Alelele Bridge and installing new concrete guardrails.

Reasons supporting determination

Please refer to Section 7 of the Draft EA for Findings Supporting The Anticipated Determination

Attached documents (signed agency letter & EA/EIS)

- 25721-Hana-Highway-at-Kalepa-Point-Road-Repairs-DRAFT-EA-20250630-OCR.pdf
- ED25-0399_OCR1.pdf

ADA Compliance certification (HRS §368-1.5):

The authorized individual listed below acknowledges that they retain the responsibility for ADA compliance and are knowingly submitting documents that are unlocked, searchable, and may not be in an ADA compliant format for publication. The project files will be published without further ADA compliance changes from ERP, with the following statement included below the project summary in The Environmental Notice: "If you are experiencing any ADA compliance issues with the above project, please contact (authorized individual submitting the project at phone and/or email)."

Action location map

- Hana-Highway-at-Kalepa-Point-Road-Repairs-Action-Location2.zip

Authorized individual

Gregory Wong
Authorized individual email
gwong@seaengineering.com
Authorized individual phone
(808) 536-3603
Authorization
• The above named authorized individual hereby certifies that he/she has the authority to make this submission.

Hana Highway at Kalepa Point Road Repairs
Draft Environmental Assessment

Kalepa Point, Maui, Hawaii

June 2025



Prepared for:
County of Maui
Department of Public Works
Engineering Division
200 S. High Street
Kalana O Maui Bldg. 4th Floor
Wailuku, Hawaii 96793

Prepared by:
Sea Engineering, Inc.
504 North Nimitz Hwy
Honolulu, Hawaii 96817

Job No. 25721

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TABLE OF CONTENTS

TABLE OF CONTENTS ..... **III**
LIST OF FIGURES ..... **VI**
LIST OF TABLES ..... **VIII**
LIST OF ACRONYMS AND ABBREVIATIONS ..... **IX**
PROPOSED PROJECT INFORMATION SUMMARY ..... **XII**
CONTENT CHECKLIST ..... **XIV**
1. INTRODUCTION **1**
1.1 PROPOSED PROJECT LOCATION AND GENERAL SITE DESCRIPTION 1
1.2 PROPOSED PROJECT HISTORY 2
1.3 SUMMARY DESCRIPTION OF THE PROPOSED PROJECT 8
1.4 ALTERNATIVES CONSIDERED 10
1.4.1 No Action Alternative *10*
1.4.2 Rock Rubblemound Revetment with Berm Toe Alternative *11*
1.4.3 Vehicular Tunnel Alternative *12*
1.5 REQUIRED FEDERAL, STATE, AND COUNTY APPROVALS, AND APPLICABLE REGULATORY REQUIREMENTS 14
1.6 COASTAL PROCESSES AND THE DESIGN OF COASTAL PROJECTS 15
2. DETAILED DESCRIPTION OF THE PROPOSED PROJECT **16**
2.1 GENERAL DESCRIPTION OF A HYBRID ROCK RUBBLEMOUND REVETMENT 16
2.2 OCEANOGRAPHIC DESIGN PARAMETERS 17
2.2.1 Design Offshore Wave Event *17*
2.2.2 Design Water Depth *21*
2.2.3 Design Wave Height *24*
2.3 REVETMENT DESIGN 26
2.3.1 Alternative Concrete Armor Unit Revetment Design *26*
2.4 CONCRETE RETAINING WALL 33
2.5 ROAD IMPROVEMENTS 34
2.5.1 Guardrails *34*
2.5.2 Paving *34*
2.6 CONSTRUCTION METHODOLOGY 35
2.7 SUMMARY OF CONSTRUCTION SCHEDULE 40
2.8 SUMMARY OF PROPOSED PROJECTED CONSTRUCTION COST 40
3. OVERVIEW OF THE EXISTING ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION MEASURES **41**
3.1 PHYSICAL ENVIRONMENT 41
3.1.1 Climate, Temperature, and Rainfall *41*
3.1.2 Wind *42*
3.1.3 Air Quality *44*
3.1.4 Noise *45*

3.1.5 Topography and Nearshore Bathymetry ... *47*
3.1.6 Nearshore Coastal Processes ... *48*
3.1.7 Streams and Wetlands ... *52*
3.1.8 Oceanographic Environment ... *52*
3.1.9 Flood and Tsunami Hazards ... *52*
3.1.10 Nearshore Water Quality ... *53*
3.1.11 Flora ... *58*
3.1.12 Fauna ... *59*
3.1.13 Marine Biological Environment ... *61*
3.1.14 Scenic and Open Space Resources ... *76*
3.1.15 Archaeological Resources ... *76*
3.1.16 Cultural Resources ... *78*
3.2 SOCIO-ECONOMIC ENVIRONMENT ... 80
3.2.1 Surrounding Land Use ... *80*
3.2.2 Population and Demography ... *82*
3.3 PUBLIC SERVICES ... 83
3.3.1 Police and Fire Protection ... *83*
3.3.2 Medical Facilities ... *84*
3.3.3 Educational Facilities ... *84*
3.3.4 Recreation ... *84*
3.4 INFRASTRUCTURE ... 85
3.4.1 Roadways ... *85*
3.4.2 Drainage System ... *85*
3.4.3 Electrical, Telephone and Cable Television Services ... *86*

4. POTENTIAL IMPACTS OF NO ACTION ... 87

5. RELATIONSHIP TO RELEVANT PLANS, POLICIES, AND CONTROLS ... 88

5.1 COUNTY OF MAUI ... 88
5.1.1 Countywide Policy Plan ... *88*
5.1.2 Maui Island Plan ... *89*
5.1.3 Hana Community Plan ... *90*
5.2 STATE OF HAWAII LAWS AND REGULATIONS ... 91
5.2.1 Hawaii State Planning Act ... *91*
5.2.2 State Land Use Laws ... *94*
5.3 FEDERAL ACTS AND LEGISLATION ... 96
5.3.1 Archaeological and Historic Preservation Acts ... *96*
5.3.2 Clean Air Act (42 U.S.C. § 7401 et seq.) ... *96*
5.3.3 Clean Water Act (CWA) of 1977, as Amended (33 USC §1251 et seq.) ... *96*
5.3.4 Rivers and Harbors Act (33 USC §403) ... *97*
5.3.5 Coastal Zone Management Act (16 U.S.C. § 1456 et seq.) ... *97*
5.3.6 Endangered Species Act (16 USC §1531 et seq.) ... *102*
5.3.7 Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §§661 et seq.) 103
5.3.8 Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.) 103

5.3.9 Migratory Bird Treaty Act of 1918, as Amended (16 USC §§703 et seq.) and EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds 103
5.3.10 National Historic Preservation Act (NHPA) of 1966 (16 USC §470 et seq.) 103
5.3.11 Other Federal Laws 104

6. MITIGATION MEASURES DURING CONSTRUCTION 105

6.1 BEST MANAGEMENT PRACTICES PLAN 105
6.2 PROTECTION OF ENDANGERED SPECIES 105
6.3 ARCHAEOLOGICAL MONITORING 105

7. FINDINGS SUPPORTING THE ANTICIPATED DETERMINATION 107

8. CONSULTATION 110

9. ENVIRONMENTAL ASSESSMENT DISTRIBUTION 111

10. REFERENCES 112

APPENDIX A – BASIS OF DESIGN REPORT (SEA ENGINEERING, INC.) 115

APPENDIX B – BASIS OF DESIGN REVISIONS MEMO (SEA ENGINEERING, INC.) 401

APPENDIX C – KALEPA POINT TUNNEL FEASIBILITY STUDY (GEOLABS, INC.) 411

APPENDIX D – FLORA AND FAUNA SURVEY (ROBERT W. HOBDY) 441

APPENDIX E – KALEPA POINT ROAD REPAIR PROJECT STAGING AREA FLORA AND FAUNA SURVEY (SWCA ENVIRONMENTAL CONSULTANTS) 456

APPENDIX F – MARINE BIOLOGICAL ASSESSMENT (MARINE RESEARCH CONSULTANTS, INC.) 477

APPENDIX G – A LITERATURE REVIEW AND FIELD INSPECTION FOR THE KALEPA REVETMENT AND SEAWALL REPAIRS PROPOSED PROJECT (SCIENTIFIC CONSULTANT SERVICES, INC.) 498

APPENDIX H – A CULTURAL IMPACT ASSESSMENT REPORT IN ADVANCE OF THE PROPOSED HANA HIGHWAY AT KALEPA POINT ROAD REPAIRS PROPOSED PROJECT (SCIENTIFIC CONSULTANT SERVICES, INC.) 604

LIST OF FIGURES

FIGURE 1-1. PROPOSED PROJECT LOCATION ON THE SOUTHEAST COAST OF MAUI 1
FIGURE 1-2. DETAILED VIEW OF PROPOSED PROJECT LOCATION 2
FIGURE 1-3. 1987 DESIGN DRAWINGS OF EXISTING CRM WALL TO REPAIR PREVIOUS WALL 3
FIGURE 1-4. 1987 DESIGN DRAWINGS OF EXISTING CRM WALL TO REPAIR BASE OF PREVIOUS WALL 4
FIGURE 1-5. 1987 DESIGN DRAWINGS OF EXISTING REVETMENT 5
FIGURE 1-6. ADDITIONAL 1987 DESIGN DRAWINGS OF EXISTING REVETMENT 5
FIGURE 1-7. AERIAL VIEW OF DAMAGE TO HANA HIGHWAY AND ROAD PROTECTION ON WEST SIDE OF KALEPA POINT 6
FIGURE 1-8. AERIAL VIEW OF DAMAGE TO HANA HIGHWAY AND ROAD PROTECTION ON EAST SIDE OF KALEPA POINT 7
FIGURE 1-9. LAND SIDE VIEW OF DAMAGED ROAD PROTECTION SEEN IN FIGURE 1-7 FROM HURRICANE ISELLE ON AUGUST 7, 2014 7
FIGURE 1-10. OVERVIEW OF THE PROPOSED PROJECT 9
FIGURE 1-11. PROPOSED PROJECT TYPICAL CROSS-SECTION 10
FIGURE 1-12. PRELIMINARY KALEPA POINT ROAD REPAIR ROCK RUBBLEMOUND REVETMENT WITH BERM TOE DESIGN SECTION 11
FIGURE 1-13. THE APPROXIMATE ALIGNMENT OF THE PROPOSED VEHICULAR TUNNEL SITE PLAN . 13
FIGURE 2-1. NOAA BEST TRACK POSITIONS FOR HURRICANE ISELLE, 31 JULY - 9 AUGUST 2014 (NOAA, 2018) 18
FIGURE 2-2. NOAA BEST TRACK POSITIONS FOR HURRICANE LANE, 15-28 AUGUST 2018 (NOAA, 2019) 18
FIGURE 2-3. STORM TRACKS FOR HURRICANE ISELLE (2014) AND HURRICANE LANE (2018) 19
FIGURE 2-4. SCENARIO HURRICANE TRACKS BASED ON HURRICANE ISELLE AND HURRICANE LANE 20
FIGURE 2-5. RELATIVE SEA LEVEL TREND, KAHULUI, HAWAII 1615680, 1947 TO 2023 (HTTPS://TIDESANDCURRENTS.NOAA.GOV/SLTRENDS/ NOAA, 2025) 23
FIGURE 2-6. PROPOSED PROJECTED SEA LEVEL CHANGE, KAHULUI HARBOR (NOAA, 2017). INTERMEDIATE RATE FOR 2080 CIRCLED IN RED 24
FIGURE 2-7. TYPICAL CROSS SECTION OF A TETRAPOD (SPM – 1984) 27
FIGURE 2-8. TYPICAL CROSS SECTION OF A TRIBAR (SPM – 1984) 28
FIGURE 2-9. TYPICAL CROSS SECTION OF A ACCROPODE (CLI 2019) 28
FIGURE 2-10. TYPICAL CROSS SECTION OF A XBLOC PLUSS (XBLOC) 29
FIGURE 2-11. EXAMPLE OF A TETRAPOD REVETMENT (PHOTO ALICE GORDENKER 2014) 29
FIGURE 2-12. EXAMPLE OF A TRIBAR REVETMENT IN SAIPAN (SEA ENGINEERING) 30
FIGURE 2-13. EXAMPLE OF AN ECOPODE REVETMENT (CLI) 30
FIGURE 2-14. CONCEPTUAL RENDERING OF PLAN AND PROFILE VIEW OF XBLOC PLUSS INSTALLATION AT KALEPA POINT (XBLOC) 31
FIGURE 2-15. PROPOSED CONSTRUCTION STAGING AREA 2.6 MILES WEST OF PROJECT AREA TMK (2)-1-7-003:001 37
FIGURE 2-16. PROPOSED CONSTRUCTION STAGING AREA WEST OF PROJECT AREA TMK (2)-1-7-003:001 (COUNTY OF MAUI) 37
FIGURE 2-17. PROPOSED CONSTRUCTION STAGING AREA 0.7 MILES WEST OF PROJECT AREA TMK (2)-1-7-001:006 38

FIGURE 2-18. PROPOSED CONSTRUCTION STAGING AREA WEST OF PROJECT AREA TMK (2)-1-7-001:006 (COUNTY OF MAUI) 38
FIGURE 2-19. PROPOSED CONSTRUCTION STAGING AREA NORTH OF PROJECT AREA 39
FIGURE 3-1. FREQUENCY OF OCCURRENCE OF WIND SPEED AND DIRECTION, KAHULUI AIRPORT .. 43
FIGURE 3-2. NEARSHORE BATHYMETRY FROM 2013 U.S. ARMY CORPS OF ENGINEERS LIDAR DATA (ELEVATIONS IN FEET MSL) 47
FIGURE 3-3. REPRESENTATIVE OFFSHORE PROFILE BASED ON SURVEY AND 2013 U.S. ARMY CORPS OF ENGINEERS LIDAR DATA (1V:9H) 48
FIGURE 3-4. VIEW OF KALEPA POINT HEADLAND SHOWING EXISTING BASALTIC BOULDER AND ROCK RUBBLE SHORELINE 49
FIGURE 3-5. BASALTIC BOULDER AND ROCK RUBBLE SHORELINE AT KALEPA POINT HEADLAND .. 50
FIGURE 3-6. BASALTIC BOULDERS AND ROCK RUBBLE SHORELINE 51
FIGURE 3-7. FIRM FOR KALEPA POINT 53
FIGURE 3-8. STATE OF HAWAII DEPARTMENT OF HEALTH WATER QUALITY STANDARDS MAP OF THE ISLAND OF MAUI 54
FIGURE 3-9. AERIAL VIEW OF KALEPA POINT HEADLAND SHOWING WATER SAMPLING TRANSECT LOCATIONS 55
FIGURE 3-10. TWO VIEWS OF UNCOLONIZED BARE BASALTIC BOULDERS IN THE NEARSHORE AREA OFF KALEPA POINT 63
FIGURE 3-11. TWO VIEWS OF BASALT REEF PLATFORM SEAWARD OF BOULDER ZONE. WATER DEPTH IS APPROXIMATELY 33 FEET 64
FIGURE 3-12. TWO VIEWS OF BASALTIC BOULDERS COLONIZED BY *POCILLOPORA MEANDRINA* IN THE NEARSHORE AREA OFF KALEPA POINT 66
FIGURE 3-13. TWO VIEWS OF COLONIES OF BRANCHING POCILLOPORA GRANDIS AND DOME-SHAPED PORITES LOBATA ON KALEPA POINT REEF PLATFORM. WATER DEPTH IS APPROXIMATELY 33 FEET 68
FIGURE 3-14. TWO VIEWS OF MATS OF COLONIAL *ZOANTHUS* SP. ON BOULDERS (TOP) AND REEF PLATFORM (BOTTOM) 70
FIGURE 3-15. TWO VIEWS OF BASALTIC PLATFORM COLONIZED BY A MIXED ASSEMBLAGE OF CORAL SPECIES INCLUDING *POCILLOPORA MEANDRINA*, *PORITES LOBATA* AND *PORITES COMPRESSA*. WATER DEPTH IS APPROXIMATELY 26 FEET 72
FIGURE 3-16. TWO VIEWS OF BASALTIC BOULDER ZONE INHABITED BY A VARIETY OF REEF FISH .. 74
FIGURE 3-17. A PORTION OF A 2017 USGS MAP SHOWING PREVIOUSLY IDENTIFIED ARCHAEOLOGY IN THE VICINITY OF THE PROPOSED PROJECT SITE AND THREE POTENTIAL STAGING AREAS 77
FIGURE 3-18. MAUI COUNTY REAL PROPERTY TAX ASSESSMENT WEBSITE MAP REAL PROPERTY TAX ASSESSMENT WEBSITE MAP OF TMK: (2)-1-6-010:006, ZONED AGRICULTURAL; CONSERVATION (COUNTY OF MAUI'S REAL PROPERTY TAX ASSESSMENT WEBSITE. 2021) 81
FIGURE 3-19. MAUI COUNTY MAUI ISLAND DIGITAL ZONING MAP 2, PAGE D4, GREEN IS ZONED AG AGRICULTURE, AND PINK IS ZONED INTERIM (COUNTY OF MAUI'S DEPARTMENT OF PLANNING) 82
FIGURE 3-20. ISLAND OF MAUI TOTAL POPULATION TOTAL POPULATION BY CENSUS TRACT 2007-2011. PROPOSED, PROPOSED PROJECT SITE IS IN CENSUS TRACT LOCATED IN CENSUS TRACT 301 (STATE OF HAWAII DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM RESEARCH AND ECONOMIC ANALYSIS DIVISION HAWAII STATE DATA CENTER, 2013) 83
FIGURE 5-1. KALEPA POINT CONSERVATION DISTRICT SUBZONES 95

LIST OF TABLES

TABLE 2-1. MODEL HURRICANE SCENARIOS 20
TABLE 2-2. DEEP-WATER DESIGN WAVE PARAMETERS, HURRICANE WAVES IN RED 21
TABLE 2-3. TIDAL DATUM VALUES FOR KAHULUI HARBOR 22
TABLE 2-4. PROPOSED PROJECTED 50-YEAR AND 90-YEAR SEA LEVEL CHANGE, KAHULUI HARBOR IN FEET (NOAA, 2017) 24
TABLE 2-5. SUMMARY OF NEARSHORE DEPTH LIMITED DESIGN WAVE HEIGHTS. SELECTED DESIGN WAVE HEIGHT OUTLINED IN RED 25
TABLE 3-1. AVERAGE MONTHLY TEMPERATURE FOR MAKENA GOLF COURSE AND RAINFALL FOR KIPAHULU, HAWAII 42
TABLE 3-2. MAXIMUM PERMISSIBLE SOUND LEVELS IN DBA 46
TABLE 3-3. RESULTS OF WATER CHEMISTRY ANALYSIS FROM THREE OCEAN SAMPLING TRANSECTS IN THE VICINITY OF THE KALEPA POINT REVETMENT REPAIRS. SAMPLES WERE COLLECTED ON NOVEMBER 1, 2021. 57

LIST OF ACRONYMS AND ABBREVIATIONS

‰, ppt	Parts Per Thousand
°C	Degree Celsius
µg	Microgram
BOD	Basis of Design
BMP	Best Management Practices
BMPP	Best Management Practices Plan
CDUP	Conservation District Use Permit
CEM	Coastal Engineering Manual
Chl a	Chlorophyll a
CIA	Cultural Impact Assessment
cm	Centimeter
cot $\boldsymbol{\theta}$	Cotangent of the revetment face slope
CRM	Concrete Rubble Masonry
CTD	Conductivity, Temperature, and Depth
CWA	Clean Water Act
CZM	Coastal Zone Management
DAR	Department of Aquatic Resources
DEA	Draft Environmental Assessment
Dir	Deep-water Wave Direction
DLNR	Department of Land and Natural Resources
DOH	Department of Health
DOH-CAB	Department of Health – Clean Air Branch
D_p	Peak wave direction
DPW	Maui County Department of Public Works
EA	Environmental Assessment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FIRM	Flood Insurance Rate Map
FONSI	Finding of No Significant Impact
ft	Foot/Feet
FWCA	Fish and Wildlife Coordination Act
H	Horizontal
H	Wave height
HAPC	Habitat Areas of Particular Concern
HAR	Hawaii Administrative Rules
HI-EMA	Hawaii Emergency Management Agency
H_o	Deep-water Significant Wave Height
HRS	Hawaii Revised Statutes
H_s	Significant Wave Height
HURDAT2	National Hurricane Center Hurricane Database
in	Inch
K_D	Armor stone stability coefficient
L	Liter
LiDAR	Light Detection And Ranging

MCAR	Marine Consulting and Analytical Resources LLC.
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
mm	Millimeter
mS/cm	milliSiemen per centimeter
MRCI	Marine Research Consultants Inc.
MSL	Mean Sea Level
NAAQS	National Ambient Air Quality Standards
NH_4^+	Ammonium Nitrogen
NHPA	National Historic Preservation Act
NO_2^-	Nitrate + Nitrogen
NO_3^-	Nitrate
NTU	Nephelometric Turbidity Units
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
OCCL	State Office of Conservation and Coastal Lands
pH	Potential of Hydrogen
PO_4^{-3}	Orthophosphate Phosphorus
$PM_{2.5}$	2.5-micron Particulate Mater
PM_{10}	10-micron Particulate Mater
RP	Revocable Permit
RSL	Relative Sea Level Rise
S	Still water level
S_a	Astronomical tied
S_p	Storm surge due to atmospheric pressure reduction
Sr	Specific gravity of the armor stone relative to seawater
S_x	Storm surge caused by wind stress in the x direction
S_y	Storm surge caused by wind stress in the y direction
S_w	Wave set up as a result of the breaking waves
SCS	Scientific Consultant Services, Inc.
SE	Sea Engineering, Inc.
SEM	Sequential Excavation Method
Si	Silica
SIHP	State Inventory of Historic Properties
SLC	Sea Level Change
SLR	Sea Level Rise
SM	Standard Methods
SMA	Special Management Area
SPM	Shore Protection Manual
SSV	Shoreline Setback Variance
T_p	Deep-Water Wave Period
TN, NO_3^-	Total Nitrogen
TON	Total Organic Nitrogen
TOP	Total Organic Phosphorus
TP	Total Phosphorus
TMK	Tax Map Key

USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
V	Vertical
W	Median weight in pounds of an individual armor stone
w_r	Unit weight of the stone
WPRFMC	Western Pacific Regional Fishery Management Council
WQC	Water Quality Certification
WQS	Water Quality Standards
w_r	unit weight of the stone
WWIII	WaveWatch III
yr	Year

PROPOSED PROJECT INFORMATION SUMMARY

This Environmental Assessment has been prepared in accordance with the requirements of Chapter 343, Hawaii Revised Statutes (HRS), and Title 11, Chapter 200.1, Hawaii Administrative Rules (HAR), Department of Health, which set forth the requirements for the preparation of environmental assessments.

Type of Document: Environmental Assessment

Proposed project Name: Hana Highway at Kalepa Point Road Repairs

Approving Authority: County of Maui
Department of Public Works
Jordan Molina, Director
200 South High Street,
Kalana O Maui Bldg. 4th Floor
Wailuku, HI 96793

Proposing Organization: County of Maui
Department of Public Works
Engineering Division
200 South High Street
Kalana O Maui Bldg. 4th Floor
Wailuku, HI 96793
Contact: John Datiles
Phone: (808) 270-7436
E-mail: johnedward.datiles@co.maui.hi.us

Consultant: Sea Engineering, Inc.
504 North Nimitz Highway
Honolulu, HI 96817
Phone: (808) 536-3603
E-mail : hi.engineering@seaengineering.com

EA Trigger: Use of State of Hawaii lands; Use of lands in the Conservation District; Use of land within a shoreline area

Proposed project Location: Kalepa Point, East Maui, Hawaii

Tax Map Keys: (2)-1-6-010:999

Proposed project Location: Approximately 500 linear feet of shoreline and 18,400 square feet of paved roadway

State Land Use District: Conservation (Resource Subzone)

County Zoning: Interim/Agriculture

Flood Zone:	X/VE
Proposed Action:	The proposed project consists of: road protection and roadway improvements. The road protection consists of repairing 500 linear feet of rock rubblemound revetment and concrete rubble masonry wall with a hybrid rock rubblemound revetment and concrete retaining wall. The roadway improvements consist of repaving the roadway between the Kalepa Bridge and the Alelele Bridge and installing new concrete guardrails.
Required Permits & Approvals:	Environmental Assessment and Finding of No Significant Impact (FONSI) (Chapter 343, HRS and 11-200.1 HAR) Department of the Army Permit (Section 10 and Section 404) Clean Water Act Section 401 Water Quality Certification Coastal Zone Management Act Consistency Determination Conservation District Use Permit (CDUP) Right of Entry National Pollutant Discharge Elimination System Coastal Zone Management Consistency Review Certified Shoreline Term, Non-Exclusive Easement County of Maui Special Management Area (SMA) Major Permit County of Maui Shoreline Setback Variance (SSV) County of Maui Special Flood Hazard Area Development Permit County of Maui Grading and Grubbing Permit County of Maui Building Permit
Anticipated Determination:	Finding of No Significant Impact (FONSI)
Estimated Cost:	$31,460,000
Time Frame:	Construction will begin when the necessary permits and approvals are obtained, and a construction contract is awarded, currently estimated for Fall 2026. Estimated construction duration is 20 months.

CONTENT CHECKLIST

The Draft Environmental Assessment, at a minimum, shall contain the following information required in this section (Hawaii Administrative Rules (HAR) 11-200.1-18)

Section	Requirement	Chapters / Sections
(d) (1)	Identification of the applicant.	Proposed Project Information Summary
(d) (2)	Identification of the approving agency.	Proposed Project Information Summary
(d) (3)	List of all required permits and approvals.	Proposed Project Information Summary Section 1.5
(d) (3)	Identification of which approval necessitates environmental review.	Proposed Project Information Summary Section 7
(d) (4)	Identification of agencies, citizen groups, and individuals consulted.	Section 8
(d) (5)	General description of the action's characteristics.	Section 1 Section 2
(d) (6)	Summary description of the affected environment.	Section 3
(d) (7)	Identification and analysis of impacts and alternatives considered.	Section 1.4
(d) (8)	Proposed mitigation measures.	Section 3
(d) (9)	Approving agency anticipated determination.	Proposed Project Information Summary Section 7

1. INTRODUCTION

The County of Maui, Department of Public Works (DPW), Highways Division proposes to repair and repave approximately 0.25 miles of damaged roadway, replace damaged steel guardrails with concrete guardrails, and repair approximately 500 feet of damaged road protection along Hana Highway at Kalepa Point. Kalepa Point is located at approximately mile post 38.2. The objective of the proposed project is to maintain vehicular access around the Kalepa Point headland and to ensure continued access to Hana district via the Hana Highway and Piilani Highway for daily vehicle traffic including, but not limited to, emergency vehicles, delivery trucks, construction and utility vehicles, public transportation, private residents of the area, and visitors. The Hana Highway is a critical transportation corridor as it is one of only two roads that provide access to the remote portions of east Maui.

1.1 Proposed Project Location and General Site Description

Kalepa Point is located on the southeast coast of Maui approximately 14 miles southwest of Hana Town, on the Hana Highway (State Route 360) near the transition to the Piilani Highway system (County Route 31), Kalepa Gulch, and Alelele Stream. The proposed project is located in the Kaaapahu Ahupuaa, Hana (Kipahulu) District of the Island of Maui. The Kalepa Bridge crosses the ephemeral stream at the base of Kalepa Gulch and the Alelele Bridge crosses the Alelele Stream. The proposed project location is Tax Map Key (TMK) (2)-1-6-010:999, a parcel owned by the County of Maui. The roadway fronts TMK (2)-1-6-010:006, a parcel owned by the United States of America and administered by the National Park Service. Lands seaward are owned by the County of Maui. The body of water fronting the roadway is the Alenuihaha Channel, which separates Maui and Hawaii Island. Figure 1-1 and Figure 1-2 show the proposed project location. The proposed project location is part of the Kipahulu Cliff and Valley physiographic division, composed of a series of cliffs and small valleys formed by streams.

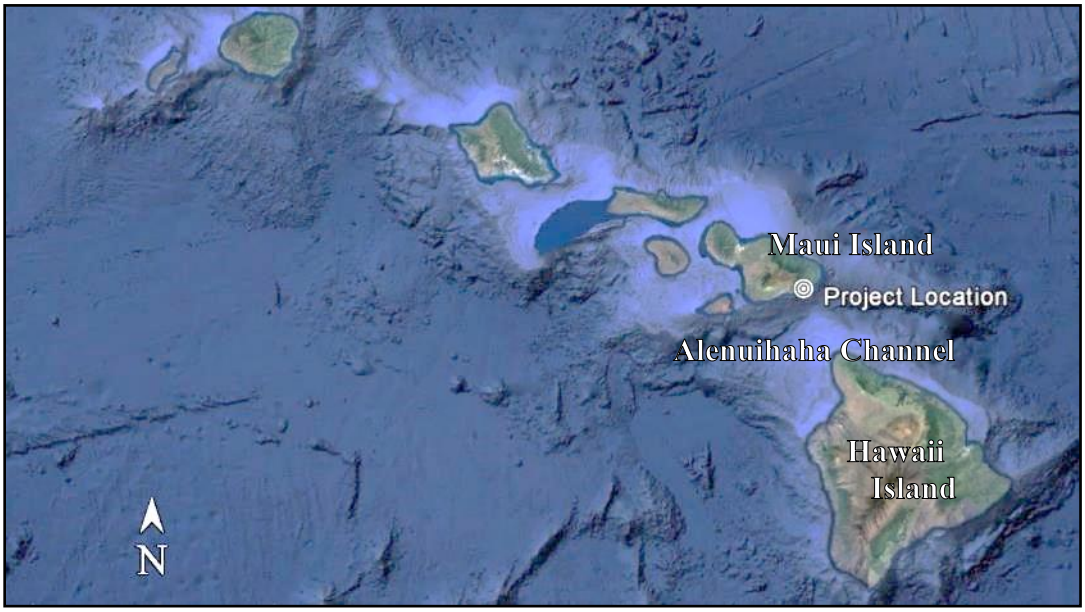


Figure 1-1. Proposed project location on the southeast coast of Maui



Figure 1-2. Detailed view of proposed project location

Although the highway is at an elevation of approximately 25 feet above sea level as it passes around the headland, this stretch of highway is particularly exposed to both terrestrial and oceanographic hazards. A vertical rock cliff is located on the landward side of the road, and a sloping rock embankment is on the ocean side. The road cut is draped in steel rock fall netting. In places the rock embankment has been modified with sections of concrete rubble masonry (CRM) and rock rubblemound road protection.

1.2 Proposed Project History

Initial construction of the roadway at Kalepa Point was completed around 1947 as part of the Hana Belt Road system. The original roadway was protected from oceanographic hazards by CRM walls. A rock rubblemound revetment was constructed fronting the CRM walls around 1987 (Figure 1-3, Figure 1-4, Figure 1-5, and Figure 1-6). The revetment structure was built on top of existing CRM walls in some areas; localized repairs of damaged areas were made in other areas of the CRM walls. The old CRM walls can be seen underneath more recent repairs and construction.

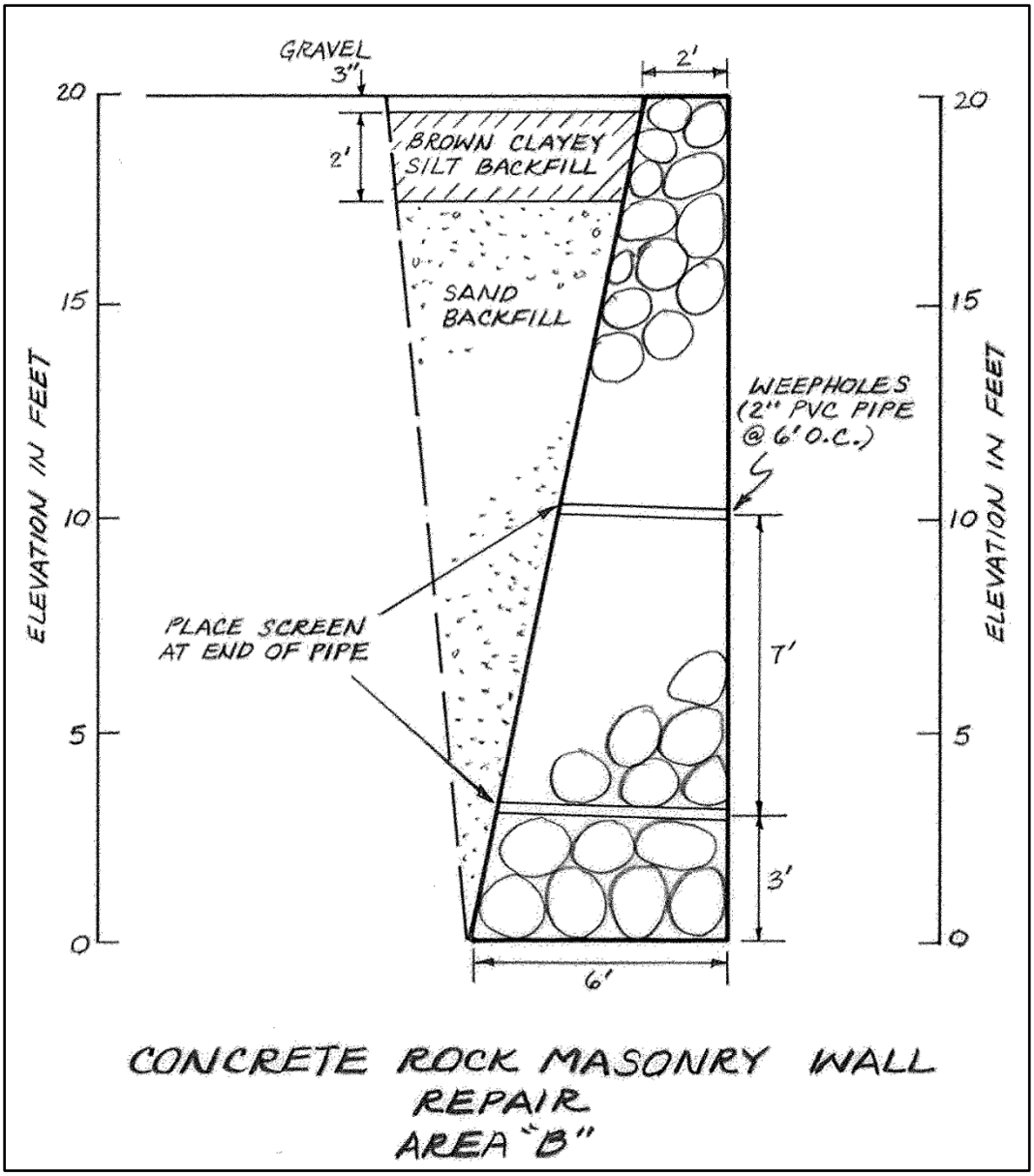


Figure 1-3. 1987 design drawings of existing CRM wall to repair previous wall

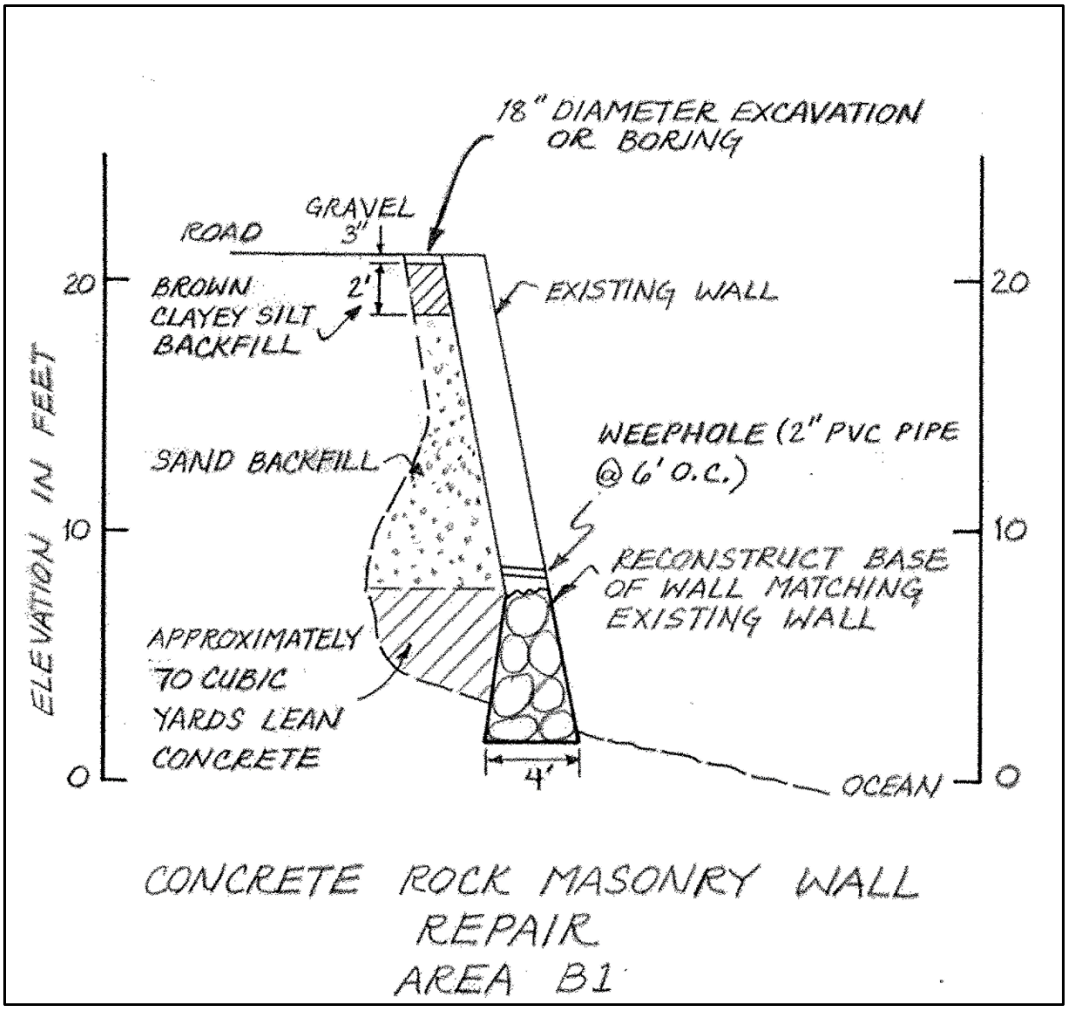


Figure 1-4. 1987 design drawings of existing CRM wall to repair base of previous wall

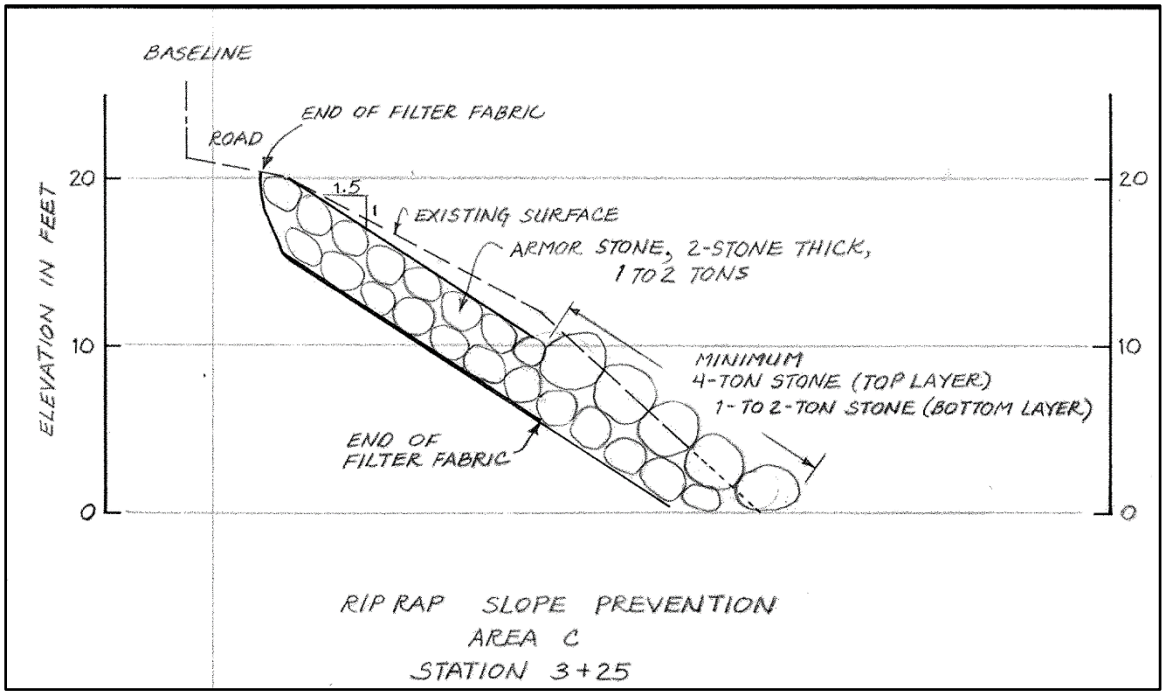


Figure 1-5. 1987 design drawings of existing revetment

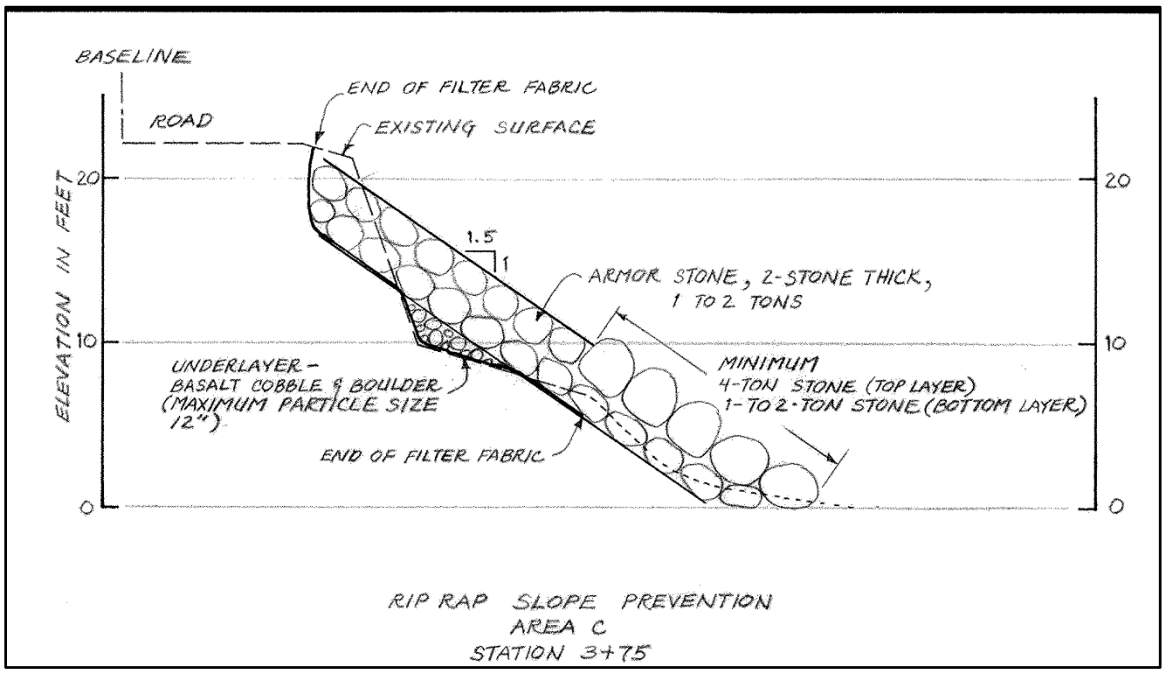


Figure 1-6. Additional 1987 design drawings of existing revetment

On August 7, 2014, Hurricane Iselle made landfall on the southeast coast of Hawaii Island. Although only a tropical storm at landfall, Iselle's strength peaked on August 4 as a Category 4 hurricane with maximum sustained winds of 140 mph (Figure 2-1). The storm brought large waves to the east-facing shores of Hawaii Island and Maui. The road protection structure at Kalepa Point was considerably damaged. Anecdotal information from eyewitnesses includes accounts of waves overtopping the road protection and inundating the roadway during the storm. Figure 1-7 and Figure 1-8 are aerial photographs showing the damage to the road protection, roadway, and guardrail. Figure 1-9 is a photo taken from shore of the damaged road protection seen in the aerial photograph in Figure 1-7. Holes in the road protection can be seen.

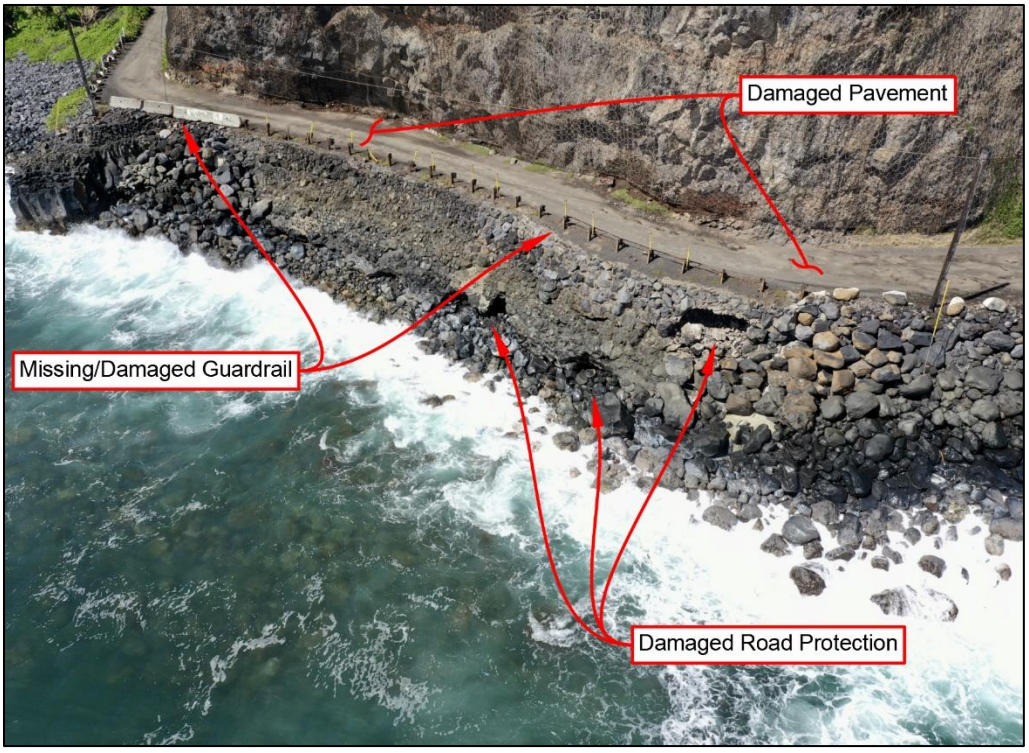


Figure 1-7. Aerial view of damage to Hana Highway and road protection on west side of Kalepa Point

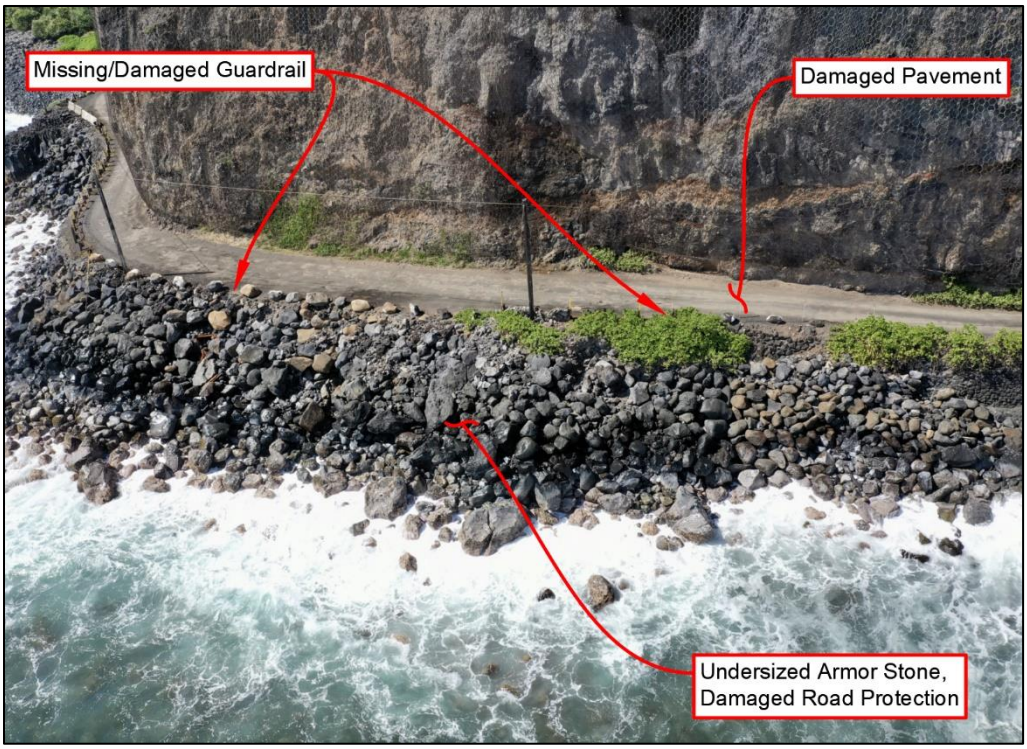


Figure 1-8. Aerial view of damage to Hana Highway and road protection on east side of Kalepa Point



Figure 1-9. Land side view of damaged road protection seen in Figure 1-7 from Hurricane Iselle on August 7, 2014

A site visit report by Geolabs, Inc, in October 2014 detailed much of the damage caused by Hurricane Iselle in an engineering field report. Subsequently, visits to the site were made by Sea Engineering, Inc. (SE) on June 30, 2015 with representatives of the DPW, Munekiyo Hiraga, Inc., and Austin, Tsutsumi & Associates, Inc. (ATA); on October 7, 2015 with Arnold Okubo & Associates, structural engineers; and on January 5, 2016 with representatives from DPW, Federal Emergency Management Agency (FEMA), the Hawaii State Civil Defense (now known as the Hawaii Emergency Management Agency (HI-EMA)), and Munekiyo Hiraga, Inc.

A preliminary coastal engineering report was completed by SE for DPW in February 2016. The report contained a discussion of the proposed project site conditions, the oceanographic setting, damage incurred by Hurricane Iselle, oceanographic design parameters derived from existing available information, and road protection concept plans. Following the January 5, 2016, site visit and submission of the coastal engineering report, it was recommended to complete a follow-on comprehensive basis of design study to examine different repair strategies for protection of the coastal road. A Basis of Design (BOD) report for the road protection and roadway repairs was produced by SE in June 2017 and revised in November 2020. The BOD report and the revision memo are included in this Draft Environmental Assessment (DEA) as Appendix A – Basis of Design Report (Sea Engineering, Inc.) and Appendix B – Basis of Design Revisions Memo (Sea Engineering, Inc.), respectively. The conclusion of the BOD was that the best option for road protection and constructability was to repair the low angle revetment and CRM wall.

1.3 Summary Description of the Proposed Project

The proposed project is to repair approximately 500 feet of CRM and undersized rock road protection. The probable cause of the existing revetment damage was the lack of a properly designed toe structure for the revetment. The intense wave attack from Hurricane Iselle very likely undermined the toe structure of the existing revetment, destabilizing the structure and causing down-slope movement of armor stone. Repairing the structure to the 1987 design would not comply with design standards in the United States Army Corps of Engineers (USACE) Shore Protection Manual (SPM – 1984) and the USACE Coastal Engineering Manual (CEM – 2008) (Appendix A – Basis of Design Report (Sea Engineering, Inc.)). The repair will consist of a hybrid rock rubblemound revetment and concrete retaining wall constructed to today's engineering design standards (design details are presented in Section 2).

The proposed revetment consists of a sloping, un-cemented structure constructed of wave resistant material. The revetment features include a two-stone thick layer of 4-ton to 6-ton armor stone, crest elevation of +12 ft MSL, and a 1V:3H slope. A reinforced-concrete retaining wall would be constructed between the revetment and the road to stabilize the side of the road.

In addition, approximately 0.25 miles of damaged roadway are to be repaved, and concrete guardrails will be used to replace the old guard rails on the seaward side of the road. This 0.25 miles of road is part of the Hana Highway between Kalepa Bridge and Alelele Bridge. Figure 1-10 shows an overview of the proposed project and Figure 1-11 shows a typical cross section of the road repairs and road protection.

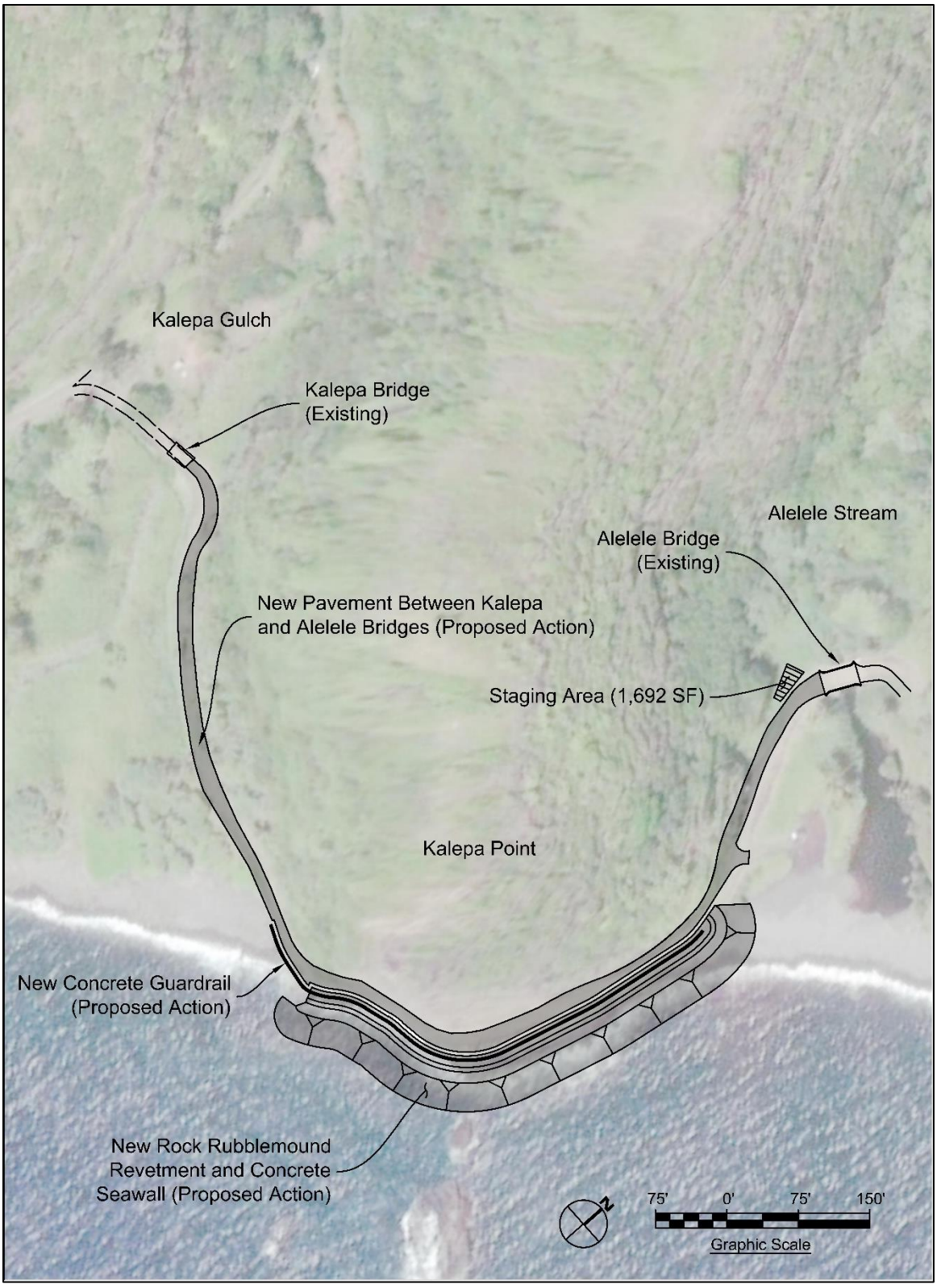


Figure 1-10. Overview of the proposed project

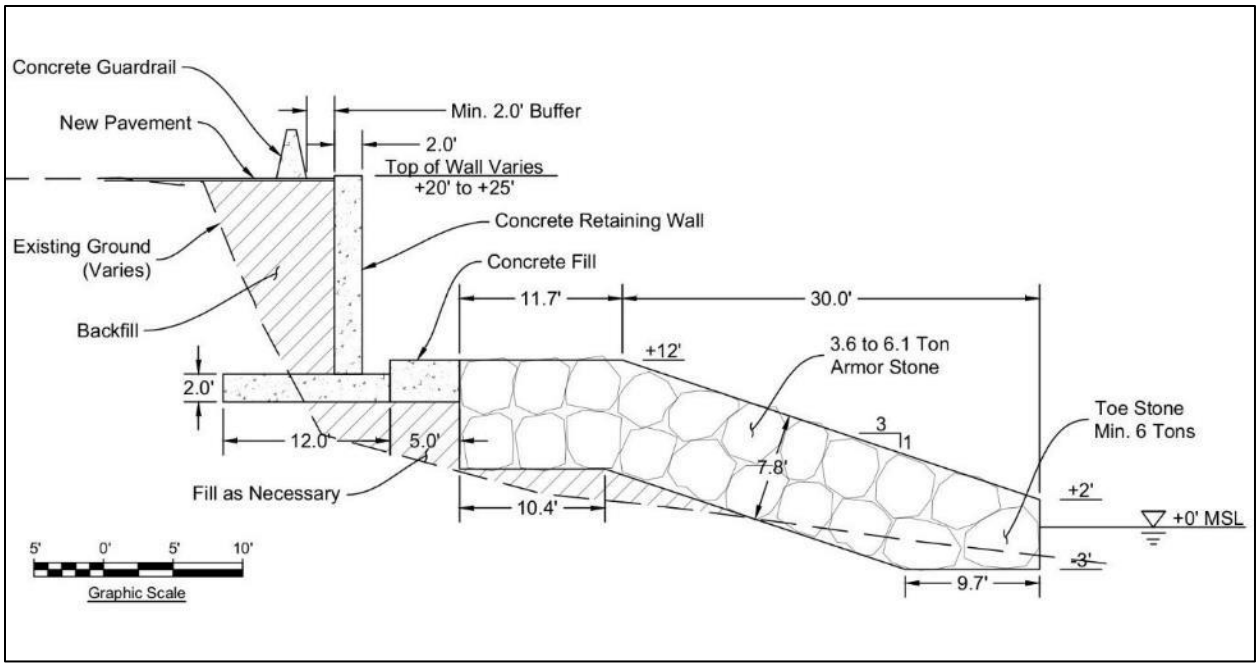


Figure 1-11. Proposed project typical cross-section

1.4 Alternatives Considered

Three alternatives were considered in addition to the proposed project: the No Action alternative; the rock rubblemound revetment with berm toe alternative; and a vehicular tunnel alternative through the Kalepa Point headland. The No Action and the vehicular tunnel alternatives include abandonment of the existing roadway alignment.

1.4.1 No Action Alternative

The No Action alternative includes forgoing maintenance to the roadway and existing road protection structure. The existing condition of Hana Highway at Kalepa Point is one of extreme disrepair in some areas. Much of the existing revetment has slid and exposed under-sized stones and previous CRM stonework. In some sections the edge of the highway has also begun to erode. If no action is taken, the condition of the highway will likely continue to degrade. The No Action alternative has a high probability of dead-ending Hana Highway at Kalepa Bridge and Alelele Bridge severely limiting access to the Hana district. This would result in the only access to the town of Hana being from the north via the Hana Highway, State Route 360. No alternate route would be constructed around Kalepa Point. This would result in significant disruption of a major transportation corridor, leaving residents and visitors without a primary accessway for critical services, and limit access to emergency services. The potential impacts of the No Action Alternative are further discussed in Section 4. The no action alternative would not satisfy the project objective of maintaining vehicular access around the Kalepa Point headland and is therefore not the preferred alternative.

1.4.2 Rock Rubblemound Revetment with Berm Toe Alternative

The rock rubblemound revetment alternative was explored as a road repair option. This alternative consisted of a sloping; un-cemented structure constructed of wave resistant material with crest even with the road elevation. The rock rubblemound revetment alternative features include a two-stone thick layer of 7-ton to 12-ton armor stone placed over underlayer consisting of 780-pound stone, crest elevation of +25 ft MSL, 1V:1.5H slope, and a toe berm to stabilize the revetment without the need for excavation.

An advantage of a revetment is that the rough, porous rock surface and sloping face of the structure will tend to absorb wave energy and reduce wave reflection. Properly designed and constructed rock rubblemound revetments are durable, flexible, and highly resistant to wave damage. Because of its durability, flexibility, and reduced wave reflection, a revetment is often considered the best erosion control/road protection measure for sites where shoreline hardening is considered appropriate.

A disadvantage of a revetment is that it would have a large structural footprint, which can be problematic in a coastal setting. Revetments are typically constructed in areas where the terrestrial area is already threatened by erosion, such as along roadways. In these locations, the erosion threat is typically so severe that there is little terrestrial area to accommodate a revetment so the structure can only be constructed seaward of the shoreline in the State's Conservation District. Construction of a revetment landward of the shoreline would be impractical as the Kalepa Point headland and existing roadway are currently directly landward of the shoreline. The rock rubblemound revetment design section is shown in Figure 1-12 (Appendix A – Basis of Design Report (Sea Engineering, Inc.)).

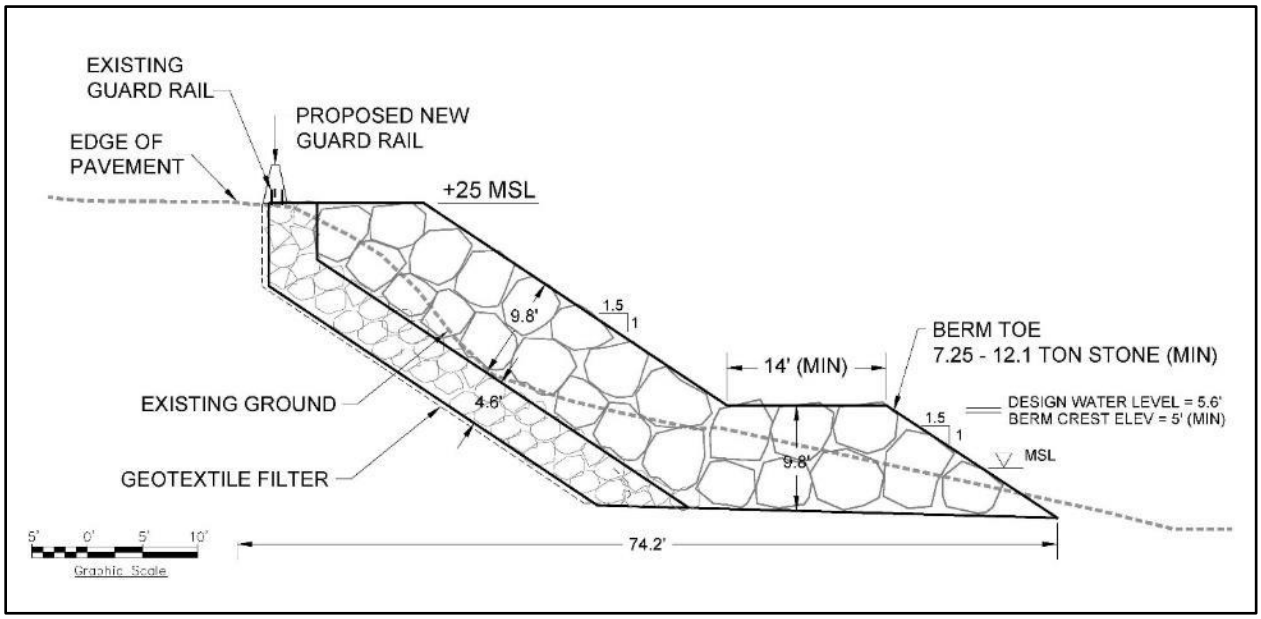


Figure 1-12. Preliminary Kalepa Point road repair rock rubblemound revetment with berm toe design section.

The Kalepa Point road repair site is a remote location with several load limited bridges that need to be crossed to access the site. The lowest load restriction is at the Kalepa bridge to the west of the proposed project site. The posted load rating of the Kalepa bridge is 9-tons. Transporting 7-ton to 12-ton armor stones could exceed bridge capacity and could result in additional impacts to the highway to allow for large loads such as this to be trucked to the proposed project site. In addition to the large armor stone size, a low angle revetment would extend further offshore. As shown in Figure 1-12 above, the rock revetment's berm toe would be 74 feet offshore of the edge of the existing guard rail and pavement. The proposed project's hybrid rock rubblemound revetment and concrete retaining wall would extend only 55 feet offshore of the existing guardrail, while also allowing for an addition of 10-feet of roadway width seaward of the guardrails. Due to the problematic armor stone size, and the larger structure footprint, the revetment with berm toe is not the preferred alternative.

1.4.3 Vehicular Tunnel Alternative

The slope above the roadway, originally built with near vertical and in some areas overhanging slopes, has a history of instability and rock falls. The slope stability was assessed in a 2007 report by Sato and Associates (2007), which recommended stabilization by flattening the slope and installing netting or possibly constructing a bypass tunnel. Due to ongoing concerns with slope stability above the roadway, a tunnel feasibility study was completed by Geolabs, Inc. (2021) for this project to be considered as a possible alternative to road protection. This tunnel alternative includes construction of a 600-foot-long, two-lane tunnel through the Kalepa headland. Hana Highway would be rerouted through the tunnel between Kalepa Bridge and Alelele Bridge. The existing road around Kalepa Point would be permanently closed. The tunnel alternative feasibility study is included as Appendix C – Kalepa Point Tunnel Feasibility Study (Geolabs, Inc.) in this DEA.

The Kalepa Point tunnel would have a horseshoe shaped cross-section, with approximate dimensions of 31 feet wide by 16 feet high (clear height). The tunnel cross section would contain two 12-foot travel lanes, one 2-foot shoulder on one side, and one 5-foot pedestrian walkway on the opposite side for a nominal total width of 31 feet. The tunnel would consist of one bore that would be constructed using the Sequential Excavation Method (SEM) designed to excavate and support the tunnel in sequential stages as twin top headings and a single bench. The concept tunnel alignment is shown on Figure 1-13.

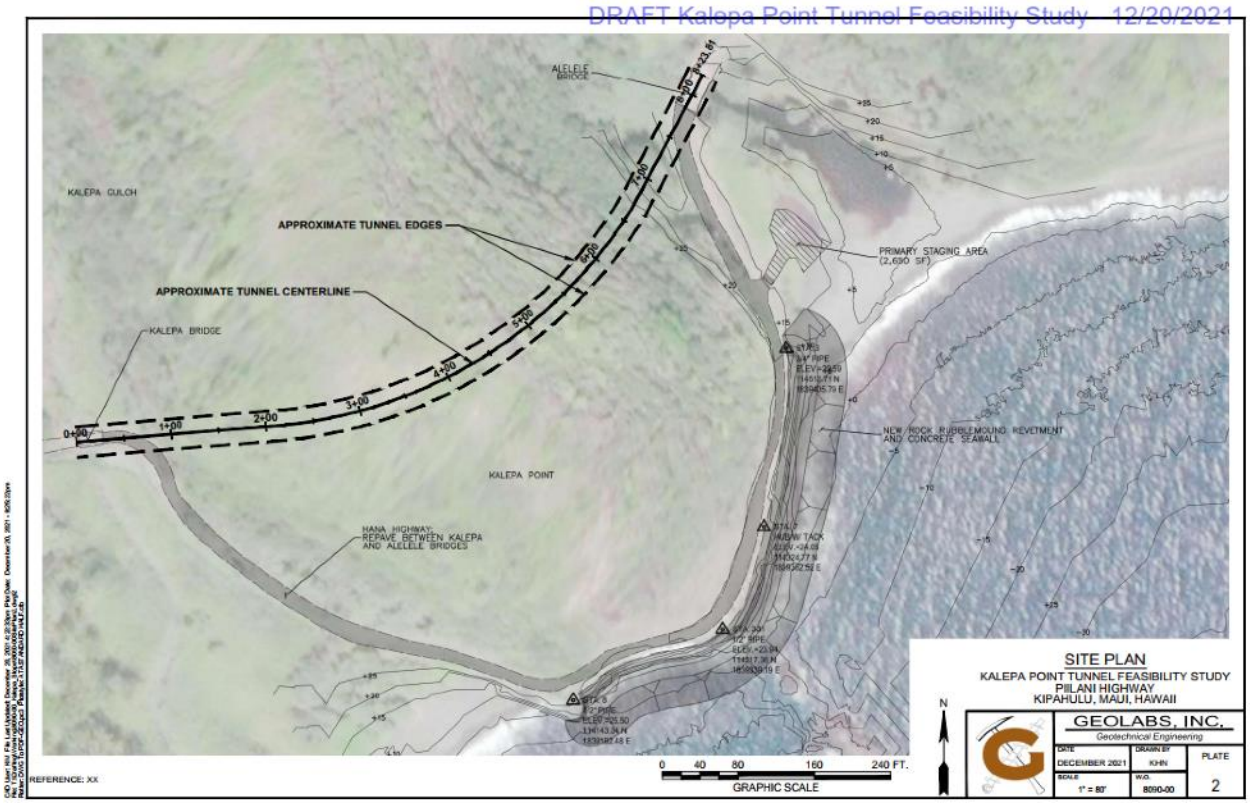


Figure 1-13. The approximate alignment of the proposed vehicular tunnel site plan

Both tunnel entrances would need to be prepared and levelled prior to excavation of the tunnel. Preparation of the tunnel entrances would likely require several tasks including coordination with local landowners for access, potentially locating utility lines in the subsurface, construction of a staging area, and clearing and grading of the land around the tunnel entrances to provide access to large construction equipment and drill rigs. Excavating into hillslopes would be conducted to construct the tunnel.

The feasibility study estimates the probable construction cost range to be $10,000,000 to $38,500,000. This estimated range was generally, but not strictly, conforming to the methods proposed by the Association for the Advancement of Cost Estimating (AACE). The probable construction cost estimate should be considered to have an approximate accuracy range of -50% to +100% relative to the specific cost estimate developed.

The tunnel alternative would require substantial additional geotechnical investigation (including borings), engineering design, impacts assessment, and cost estimation. Possible impacts include the required ground excavation, alteration and grading for the construction and staging: the effect of the drill and blast excavation method on the steep slope face above the existing roadway; and the likely progressive erosion damage to the roadway while the tunnel alternative is implemented. Additional potential impacts include project impacts to the pre contact State Site 50-50-16-3143, the King's Trail, a paved trail which encircles the Island of Maui. Construction was initiated by the alii Piilani and completed by his son, Kihaapiilani. The King's Trail in the vicinity of the Kapepa Bridge side of the tunnel alternative (Appendix H – A Cultural Impact Assessment Report

in Advance of the Proposed Hana Highway at Kalepa Point Road Repairs Proposed Project (Scientific Consultant Services, Inc.))

1.5 Required Federal, State, and County Approvals, and Applicable Regulatory Requirements

A summary of anticipated permitting and regulatory requirements for the proposed action includes the following:

County of Maui

- Special Management Area (SMA) Major Permit
- Shoreline Setback Variance (SSV)
- Special Flood Hazard Area Development Permit
- Grubbing and Grading Permit
- Building Permit

State of Hawaii

- Conservation District Use Permit (CDUP) - Department of Land and Natural Resources
- Revocable Permit (RP) - Department of Land and Natural Resources
- Shoreline Certification - Department of Land and Natural Resources
- Section 401 Water Quality Certification (WQC) - Department of Health
- National Pollutant Discharge Elimination System (NPDES) - Department of Health
- Coastal Zone Management Federal Consistency Review -DBEDT, Office of Planning and Sustainable Development, CZM Program
- Term, Non-Exclusive Easement - Hawaii State Legislature

Federal

- Section 10, Work in Navigable Waters of the U.S. - U.S. Army Corps of Engineers
- Section 404, Clean Water Act, for Fill in Waters of the U.S. - U.S. Army Corps of Engineers
- Other Federal laws that may affect the proposed project, including:
    a. Preservation of Historical and Archeological Data Act (54 USC 31250 et seq.);
    b. Historic Preservation Act (54 USC 300101 et seq.);
    c. Clean Air Act (42 USC § 7401 et seq.);
    d. Coastal Zone Management Act (16 USC § 1456 et seq.);
    e. Endangered Species Act (16 U.S.C. 1531 et seq.);
    f. Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC § 661 et seq.);
    g. Magnuson-Stevens Fishery Conservation and Management Act (16 USC § 1801 et seq.);
    h. Migratory Bird Treaty Act of 1918, as amended (16 USC § 703 et seq.)
    i. National Historic Preservation Act of 1966 (16 USC §470 et seq.)
    j. Marine Mammal Protection Act of 1972, as amended ((16 USC § 1361 et seq.)
    k. EO 13089, Coral Reef Protection (63 FR 32701 et seq.)
    l. EO 12898, Environmental Justice (59 FR 7629)(1994)

m. Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC § 3001)

1.6 Coastal Processes and the Design of Coastal Projects

The analyses and designs in this report have been done in accordance with industry standards contained in publications produced by the U.S. federal government and/or other industry experts, as referenced in the report. However, the prediction and assessment of natural hazards and their effects have an element of uncertainty that cannot be eliminated. Oceanographic conditions such as winds, waves, storms, and currents are highly variable, and the corresponding response of coastal systems and structures cannot always be predicted with absolute accuracy. Unforeseen changes to the seafloor or water depths resulting from the natural processes of sand transport and shoreline erosion may occur and may be attributed to coastal proposed projects. Other temporary or permanent changes may also occur to the natural environment that are not foreseen in this report.

2. DETAILED DESCRIPTION OF THE PROPOSED PROJECT

The proposed project consists of road protection and roadway repairs and improvements. The roadway repairs and improvements consist of repaving the roadway between the Kalepa Bridge and the Alelele Bridge and installing new corrosion resistant concrete guardrails. The road protection consists of repairing and improving 500 linear feet of rock rubblemound revetment and CRM with a rock rubblemound revetment and concrete retaining wall. The proposed project does not address the stability of the near vertical and in some areas overhanging slopes above the roadway. Slope stabilization was completed in 2008 with the installation of rockfall netting and is unrelated to this proposed road repair project.

2.1 General Description of a Hybrid Rock Rubblemound Revetment

A revetment is a sloping, uncemented structure built of wave-resistant material. The most common method of revetment construction is to place an armor layer of stone or concrete (unit), sized according to the design wave height, over a bed layer and filter. The bed layer and filter are designed to distribute the weight of the armor unit and to prevent loss of fine shoreline material through voids in the revetment. Properly designed and constructed revetments are durable, flexible, and highly resistant to wave damage. Should toe scour occur, the structure can settle and readjust without major failure. Damage from large waves is typically not catastrophic, and the revetment can still function effectively even if damage occurs.

The rough, porous surface along with the flatter slope of revetments absorb and dissipate more wave energy when compared to the smooth vertical wall structures. This absorption and dissipation of wave energy reduces wave reflection, runup, and overtopping. Sloping revetments do occupy more horizontal space and have a larger footprint than vertical walls. Because of their durability, flexibility, and reduced wave reflection, revetments are often considered the best solution for erosion control and road protection for sites where shoreline hardening is considered appropriate.

The footprint of a rock rubblemound revetment can be reduced by coupling the revetment with a vertical retaining wall set landward of the rock rubblemound revetment. This type of structure is referred to as a hybrid structure, containing components of both a rock rubblemound revetment and a vertical retaining wall. The rock rubblemound portion of the design has the same general function as described above, but with a lower crest elevation needed for the rock rubblemound, thereby reducing the seaward extent of the structure. The increased overtopping at higher wave conditions that would occur with this design would be limited by the vertical retaining wall coupled with the rock rubblemound revetment. See Figure 1-10 and Figure 1-11 for proposed project rock rubblemound revetment.

2.2 Oceanographic Design Parameters

2.2.1 Design Offshore Wave Event

The design wave event was determined using both historical deep-water wave data and numerically modeled waves for select hurricane events. Deep-water wave data was obtained for this proposed project from both measured data and a wave hindcast study. Wave hindcasting is a tool used to calculate past wave events based on historical wind data applied to wave growth and propagation models. WaveWatchIII (WWIII) is a numerical wave model used to both forecast and hindcast waves.

Numerical storm modeling was completed to quantify the proposed project site's vulnerability to hurricanes. Two recent hurricanes that had impacts on the proposed project site were selected as starting points for 7 hurricane scenarios to model. The first recent hurricane was Hurricane Iselle which occurred during August of 2014 and had peaked as a Category 4 hurricane before reaching the Hawaiian Islands. Hurricane Iselle, whose track is shown on Figure 2-1, was the first hurricane to make landfall in the State of Hawaii since 1992 (NOAA, 2018). Hurricane Iselle made landfall on August 8, 2014, at 2:30 a.m. on the Kau coast of Hawaii Island and caused the large surf that damaged the road protection at Kalepa Point.

The second was Hurricane Lane, which occurred in August 2018 and had peaked as a Category 5 hurricane. Hurricane Lane, whose track is shown on Figure 2-2, was only the fifth Category 5 hurricane on record in the central Pacific basin (NOAA, 2019). While Hurricane Lane's radius of maximum winds did not extend to any of the Hawaiian Islands, the hurricane was at one point on track to make landfall on the southern shores of the main Hawaiian Islands. Had the storm tracked approximately 3 degrees further north, Hurricane Lane likely would have made landfall with approximately 100 kt winds, large surf, and the attendant storm surge. Figure 2-3 shows Hurricane Iselle and Hurricane Lane's tracks near the Hawaiian Islands and the proposed project location.

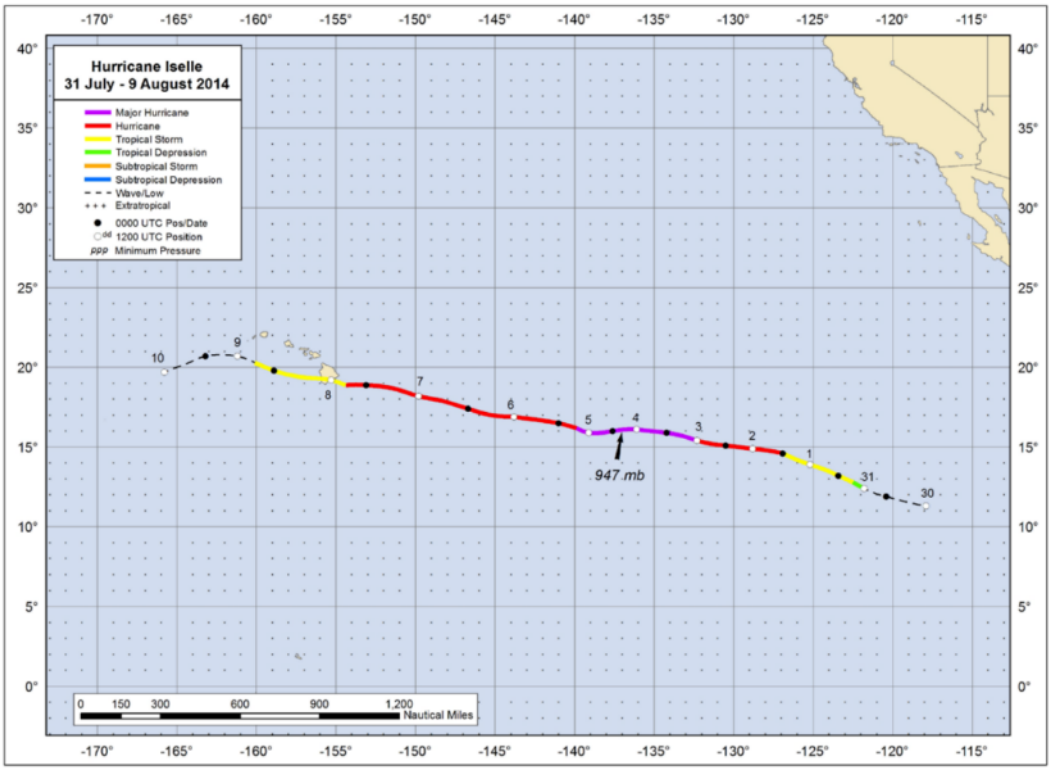


Figure 2-1. NOAA best track positions for Hurricane Iselle, 31 July - 9 August 2014 (NOAA, 2018)

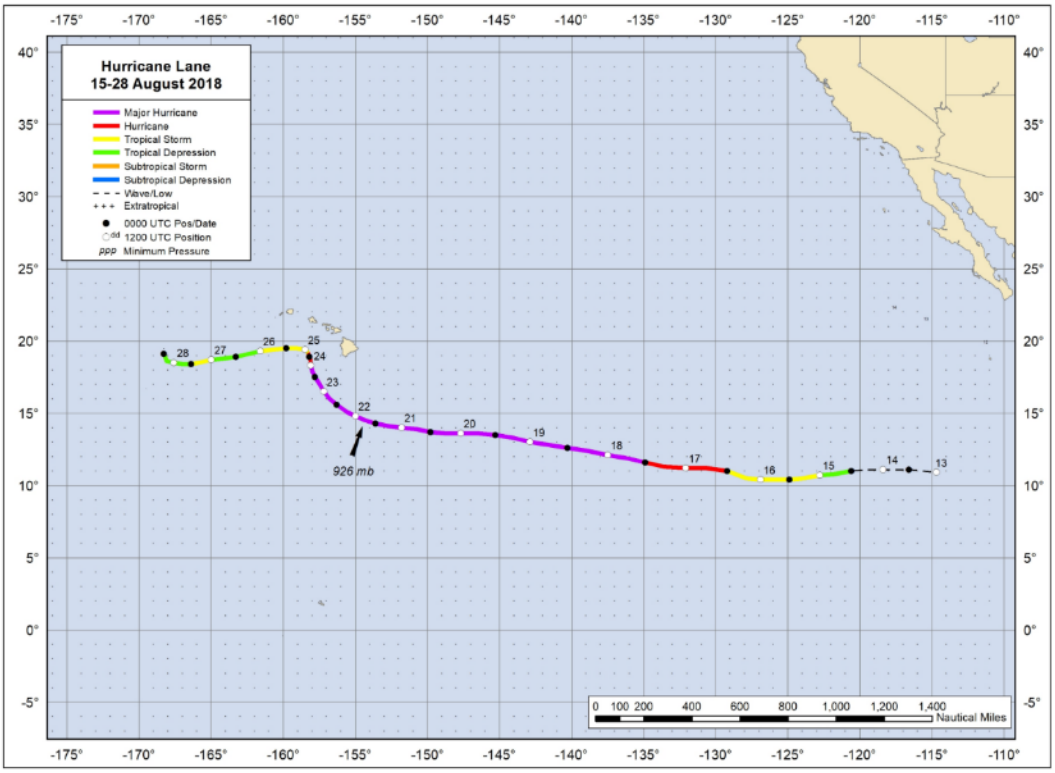


Figure 2-2. NOAA best track positions for Hurricane Lane, 15-28 August 2018 (NOAA, 2019)

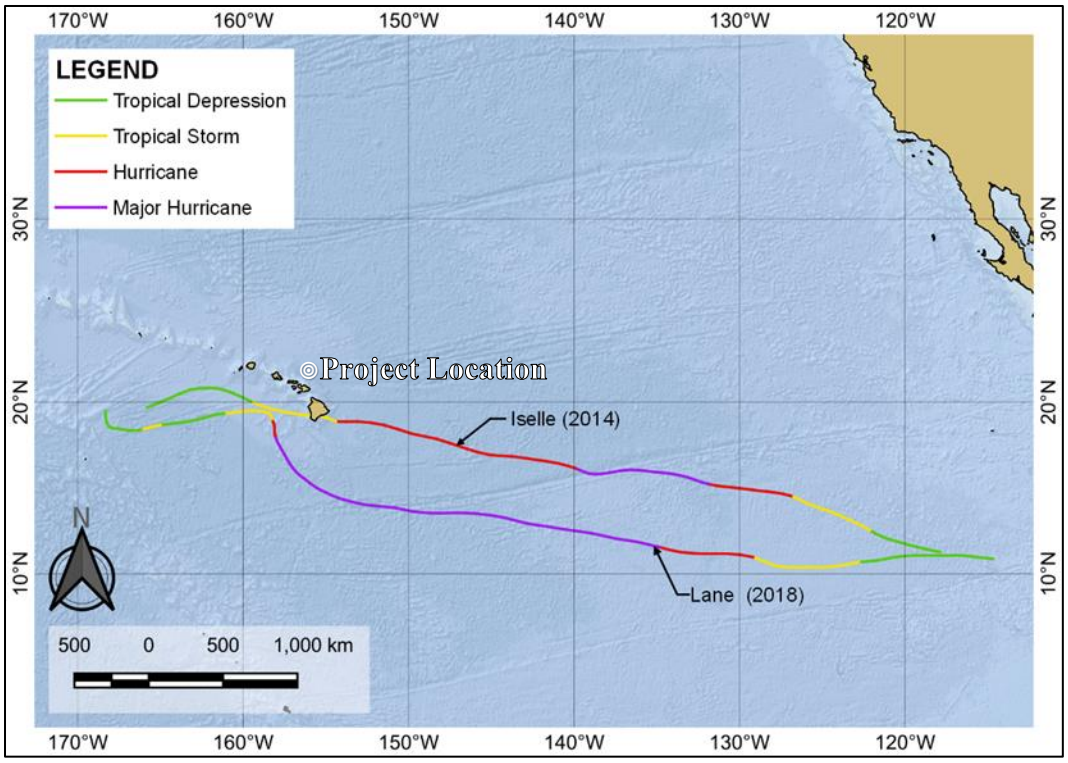


Figure 2-3. Storm tracks for Hurricane Iselle (2014) and Hurricane Lane (2018)

Hurricane Iselle represents a recorded hurricane whose waves directly impacted Kalepa Point and caused most of the current damage to the revetment and roadway. Hurricane Lane represents a recorded hurricane that had the potential to impact Kalepa Point revetment and roadway. Due to the infrequency of hurricanes in Hawaii, the tracks and intensities of Hurricane Iselle and Hurricane Lane were used to guide development of seven scenario hurricanes and assessment of their potential impacts on the proposed project site.

The storm track and parameters for Hurricane Iselle were obtained from National Hurricane Center Hurricane Database (HURDAT2). Hurricane Lane's track and parameters were obtained from the 2018 *Makani Pahili* study, a desktop exercise by the Hawaii Emergency Management Agency (HI-EMA) to study potential effects of a hurricane disaster. The storm tracks and intensities were modified to show the effects of hurricanes making landfall at Kalepa Point as well as the effects of Category 5 hurricanes on the proposed project site. The parametric wind fields for these storms were then used to calculate wind generated waves. The seven hurricane scenarios that were developed ranged in severity from "near-miss" to "worst case" and are described in Table 2-1. The storm tracks and intensities for the seven scenarios are shown in Figure 2-4. A comparison of the offshore wave conditions for the modeled hurricane waves and wave buoy data is presented in Table 2-2. See Appendix A – Basis of Design Report (Sea Engineering, Inc.) and Appendix B – Basis of Design Revisions Memo (Sea Engineering, Inc.) for a detailed discussion on the design offshore wave event analysis.

Table 2-1. Model hurricane scenarios

Number	*Scenario*	*Base Scenario*	*Track/Intensity Modification*
1	Iselle 1 and 2	Hurricane Iselle	None
2	Iselle Cat 5	Hurricane Iselle	Intensity increased to Category 5
3	Iselle Shifted	Hurricane Iselle	Track shifted north
4	Iselle Shifted Cat 2	Hurricane Iselle	Track shifted north, Category 2 landfall
5	Iselle Shifted Cat 5	Hurricane Iselle	Track shifted north, Category 5 landfall
6	Lane Shifted Cat 4	Hurricane Lane	Track continues through Maui, maintains intensity
7	Lane Shifted Cat 5	Hurricane Lane	Track continues through Maui, Category 5 landfall

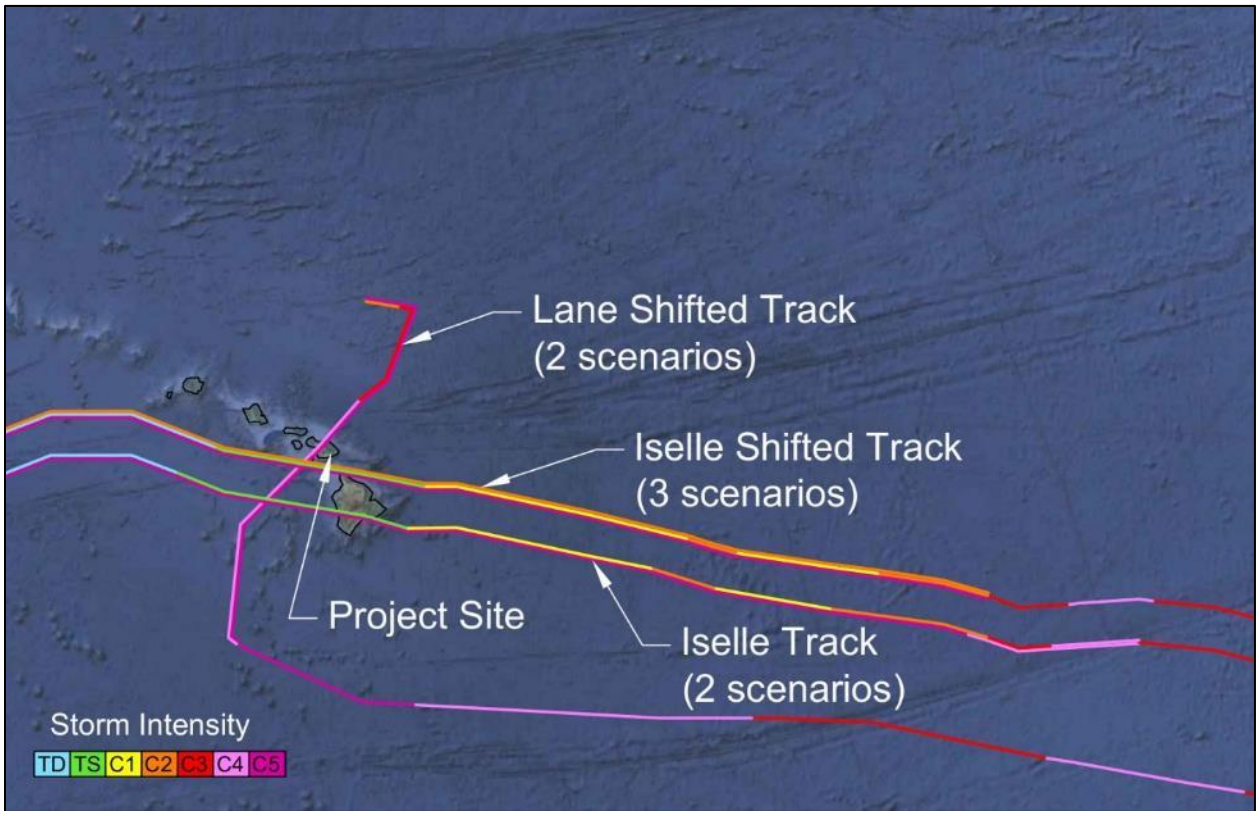


Figure 2-4. Scenario hurricane tracks based on Hurricane Iselle and Hurricane Lane

Table 2-2. Deep-water design wave parameters, hurricane waves in red

Wave Type	H_s (ft)	T_p (s)	D_p (deg)
Kona Storm (50-yr)	15.67	7	180
Southern Swell (50-yr)	7.6	17	190
East Swell (50-year)	25.2	12	85
Iselle 1	10.2	13	110
Iselle 2	14.3	9	110
Iselle Cat 5	16.9	15	120
Iselle Shifted	19.8	10	92
Iselle Shifted Cat 2	40.2	13	92
Iselle Shifted Cat 5	43.9	14	93
Lane Shifted	43.8	14	200
Lane Shifted Cat 5	44.0	14	200

2.2.2 Design Water Depth

Water depth at the shoreline is a critical element in coastal engineering design. Breaking waves are depth limited, meaning the maximum possible breaking wave height is related to the water depth. Deeper water allows higher wave heights to reach the shore, and coastal design must be adjusted accordingly. Water depths fluctuate over time and these fluctuations must be considered for design purposes. The most observable water depth fluctuations are the daily tides; however, other important phenomena occur that influence water depth fluctuations. These are wave setup and storm surge, long-term and short-term changes in water depth from sea level change (SLC). All these fluctuations were considered for the design of the proposed project.

Because the design wave event is produced from a hurricane storm. During a storm the rise in still water level is a combination of astronomical tide, the wave set-up, storm surge due to atmospheric pressure, and storm surge due to wind stress. These add in a linear fashion as shown in the following equation:

$$S = S_a + S_w + S_p + S_x + S_y$$

Where:

- Still water level (S)
- Astronomical tide (S_a)
- Wave set-up as a result of the breaking waves (S_w)
- Storm surge due to atmospheric pressure reduction (S_p)
- Storm surge caused by wind stress (S_x and S_y)

2.2.2.1 Astronomical Tie

The astronomical tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e., two tidal cycles each day with the range of high and low water levels being unequal). Tidal datum values for Kahului Harbor are shown in Table 2-3. An astronomical tide (S_a) of +1.13 feet MSL is used for design conditions. This is equivalent to the mean higher high water (MHHW) as measured at the Kahului Harbor tidal station.

Table 2-3. Tidal datum values for Kahului Harbor

Water level data for Kahului Harbor	Elevation (ft - MLLW)	Elevation (ft - MSL)
Mean Higher High Water	2.25	1.13
Mean High Water	1.9	0.78
Mean Sea Level	1.12	0.0
Mean Low Water	0.33	-0.79
Mean Lower Low Water	0.0	-1.12

2.2.2.2 Wave Setup

During high wave events, the water depth shoreward of the breaker zone may be increased above the normal tide level because of breaking waves. This increase in water depth is defined as wave setup (S_w). Wave setup may be as much as 10 to 12 percent of the initial breaking wave height. Wave setup is directly influenced by anything that affects breaking wave height, including refraction and shoaling effects. In a steep slope environment, such as the one found at the proposed project site, wave setup is less than the typical 10 to 12 percent. Wave setup is often a key parameter for coastal engineering design in Hawaii. Wave setup is computed in the wave transformation models (Appendix A – Basis of Design Report (Sea Engineering, Inc.)).

2.2.2.3 Storm Surge

During hurricane conditions, with high winds and very low pressures, an additional water level rise due to reduced atmospheric pressure (S_p) and wind stress (S_x and S_y) can occur. The combination of S_p, S_x and S_y is defined as storm surge. This water level rise can potentially add another 1 to 2 feet to the water depth. In the case of swells generated from distant storms and hurricanes, storm surge can be negligible while closely approaching hurricanes will have significant surge due to the combined low central pressure strong winds.

2.2.2.4 Sea Level Change

It is widely recognized that global warming has caused a world-wide acceleration in sea level rise. The present estimated rate of global mean sea-level change (SLC) is +3.4 mm/yr. (NASA, 2021). A positive number represents a rising sea level, increased water depth. The sea level trend for Kahului Harbor, station ID: 1615680, for the period of 1947 to 2020 is shown in Figure 2-5 (NOAA, 2021). The average rate of sea level change shown on Figure 2-5 is +2.21 ± 0.37 mm/yr. based on monthly data for the period 1947-2023, which is equivalent to a change of 0.75 feet in 100 years. Figure 2-5 shows interannual anomalies up to about 0.5 feet. (15 cm) in Kahului Harbor.

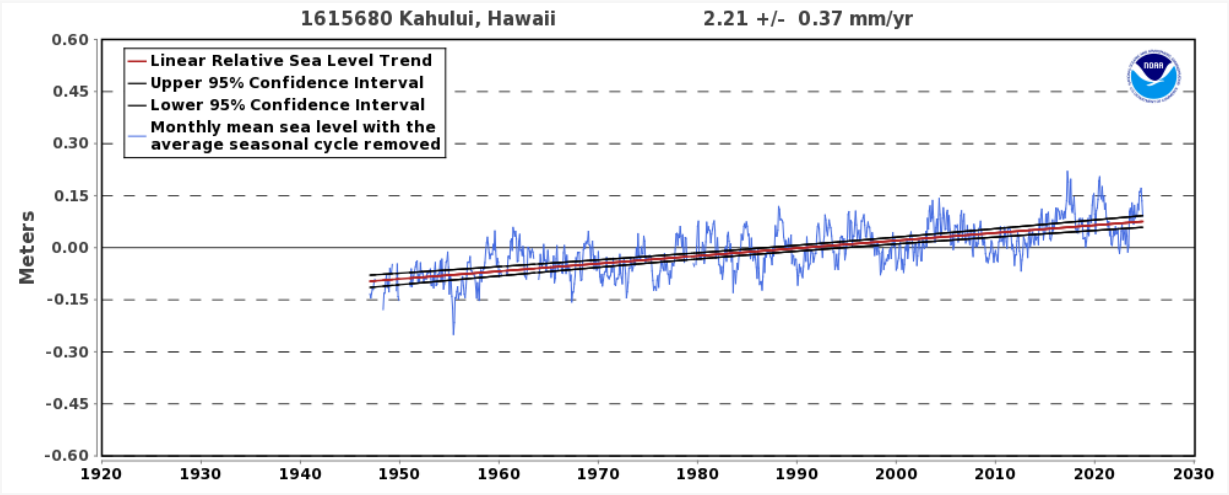


Figure 2-5. Relative sea level trend, Kahului, Hawaii 1615680, 1947 to 2023 (https://tidesandcurrents.noaa.gov/sltrends/ NOAA, 2025)

Regional sea level rise (RSL) values based on data from Kahului Harbor were calculated using the USACE website at: https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html. The site calculates scenarios for RSL based on National Oceanographic and Atmospheric Administration (NOAA) studies. Recent advances in the calculation of global and regional seal level rise have led coastal scientists and engineers to include the addition of sea level rise proposed projections to the more transient still water level rise phenomena.

Sea level rise for Maui using the NOAA scenarios developed from the U.S. Global Change Research Program 2017 are shown in Figure 2-6. The NOAA intermediate rate is used in the design for water depth at the proposed project site. For a proposed project design life of 50 years, in the year 2080 (approximately 50 years post-construction), the NOAA intermediate rate predicts a 2.85-foot increase of water depth above the year 2000 water depth. The 50-year and 90-year change in sea level is listed in Table 2-4.

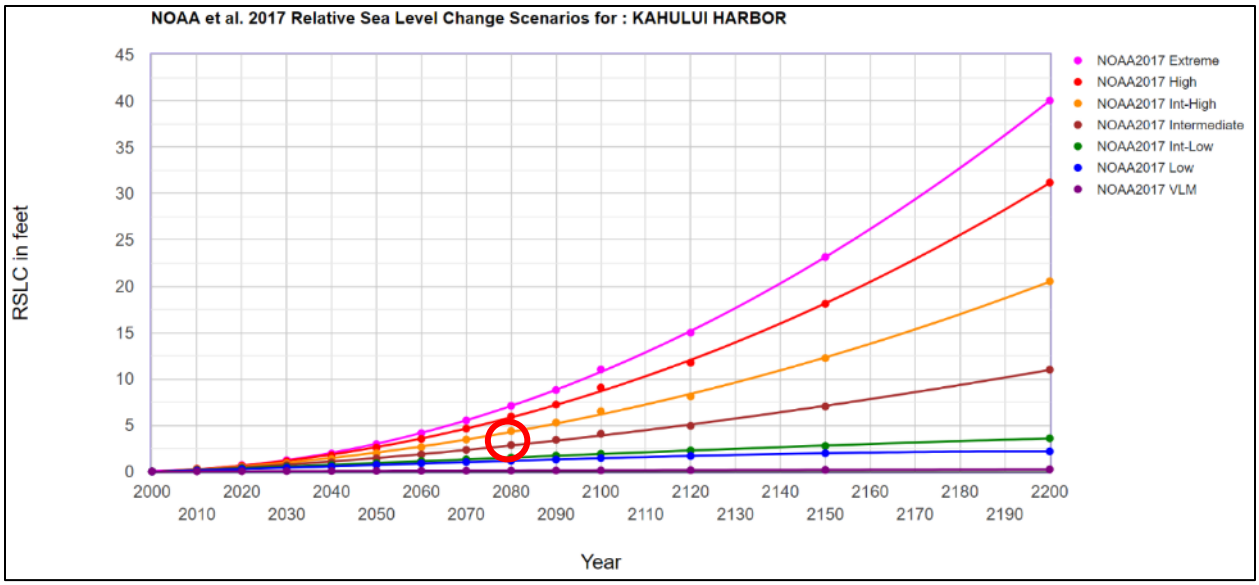


Figure 2-6. Proposed projected sea level change, Kahului Harbor (NOAA, 2017). Intermediate rate for 2080 circled in red

Table 2-4. Proposed projected 50-year and 90-year sea level change, Kahului Harbor in feet (NOAA, 2017)

Year	*Low (ft.)*	*Int-Low (ft.)*	*Int (ft.)*	*Int-High (ft.)*	*High (ft.)*	*Extreme (ft.)*
2080	1.15	1.51	**2.85**	4.36	5.94	7.09
2120	1.67	2.26	4.92	8.10	11.75	14.99

2.2.3 Design Wave Height

Wave refraction effects were calculated from the wave angle change between deep-water and nearshore depths shown in the numerical wave modeling. Shoaling effects were calculated using the wave model and the nearshore depth profile. Initial wave breaking height (H_b) was calculated using Rattanapitikon and Shibayama (2006) and occurs in water depths of approximately 15 to 20 feet.

Finally, a depth-limited criterion was used to calculate the design wave height. The design wave height is the nearshore breaking wave height that occurs in proximity of the toe of the proposed project road protection structure. Depth-limited waves are calculated by applying a breaker index to the nearshore water depths that have been adjusted for astronomical tide, wave setup, storm surge, and a 50-year sea level rise. The wave setup was calculated in the numerical wave model. The breaker index was calculated using Goda (2010). This empirical approach was used to determine the design wave height instead of numerical modeling because numerical models can potentially become unstable for large waves and steep irregular bathymetry, such as found at the proposed project site.

Using this methodology, the wave events that raise the local still water level the highest will generate the largest waves at the structure. Table 2-5 lists the total still water level rise (S), and wave height at the structure for the modeled hurricane scenarios. The nearshore nominal water depth of 4.5 feet. MSL was estimated from a USACE 2013 bathymetric LiDAR data set. LiDAR stands for Light Detection and Ranging and uses lasers, mounted in aircraft, to measure shallow nearshore bathymetry and topography.

The event selected for structural design of the wall and rock rubblemound revetment is the Iselle Shifted Category 2 model hurricane, with a design wave height of 10.7 feet and a total still-water elevation rise of +5.6 feet relative to MSL. This event was chosen because it has a reasonable chance of occurring during the design life of the proposed project (Table 2-5).

Table 2-5. Summary of nearshore depth limited design wave heights. Selected design wave height outlined in red

	Iselle 1	***Iselle 2***	***Iselle Cat 5***	***Iselle Shifted***	***Iselle Shifted Cat 2***	***Iselle Shifted Cat 5***	***Lane Shifted***	***Lane Shifted Cat 5***
H_o (ft)	10.2	14.3	16.9	19.8	40.2	43.9	43.8	44.0
T_p (s)	13	9	15	10	13	14	14	14
Dir (deg TN)	110	110	120	92	92	93	200	200
Nearshore slope ($cot\theta$)	9	9	9	9	9	9	9	9
Breaker Index	1.14	1.07	1.13	1.06	1.06	1.06	1.06	1.06
Tide (ft MHHW)(S_a)	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
Sea Level Rise (ft)	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Wave Setup (ft)(S_w)	0.0	0.0	0.2	0.1	0.7	0.8	1.5	1.4
Pressure Setup (ft)(S_p)	0.00	0.00	0.42	0.21	0.95	1.61	1.33	1.80
Nominal Depth (ft MSL)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Total Depth (ft MSL)	8.5	8.5	9.1	8.8	10.1	10.9	11.3	11.7
***H* design (ft)**	**9.7**	**9.1**	**10.3**	**9.3**	**10.7**	**11.5**	**12.0**	**12.4**

Note:
Ho: Deep-water Significant Wave Height
Tp: Deep-water Wave Period
Dir: Deep-water wave direction

2.3 Revetment Design

The revetment design follows the guidelines provided by the U.S. Army Corps of Engineers (USACE) *Coastal Engineering Manual* (2006) and EM 1110-2-1614, *Design of Coastal Revetments, Seawalls, and Bulkheads*.

A site-specific wave modeling analysis has shown a near-structure wave height of 10.7 feet at the shoreline resulting from a scenario Category 2 hurricane and a 5.6-foot water level rise (MHHW tide, +1.65 ft nearshore wave and pressure setup, and +2.85 ft future sea level rise).

Design wave height was determined in Section 2.2.3. The required revetment armor stone weight for stability under the design wave height is given by the Hudson Formula (Coastal Engineering Manual, 2006):

$$W = \frac{w_r H^3}{K_D (S_r - 1)^3 \, cot\, \theta}$$

were,

W = median weight in pounds of an individual armor stone
w_r = unit weight of the stone (160 lb/ft^3)
H = wave height (10.7 ft)
K_D = armor stone stability coefficient (2)
S_r = specific gravity of the stone relative to seawater (2.5)
cot θ = cotangent of the revetment face slope (3)

Lowering the revetment slope to 1V:3H increases the stability of the structure and allows reduction of stone weight to more buildable sizes. The resultant median armor stone weight is 4.8 tons. Utilizing a stone size range of +/-25% results in an armor stone of 3.6 to 6 tons.

Due to the rocky nature of the nearshore, the armor stones will be placed directly on the nearshore rocks and an underlayer will not be used.

The revetment plan layout and typical section are shown as Figure 1-10 and Figure 1-11 respectively.

2.3.1 Alternative Concrete Armor Unit Revetment Design

As an alternative to a rock rubblemound revetment the use of concrete armor units may be explored further. Concrete armor units typically have a higher stability coefficient value as compared to armor stone and thus lighter armor units can be used as compared to a similar revetment designed with armor stone (SPM – 1984). There are several benefits of exploring concrete armor units to construct the revetment as an alternative to armor stone as described above for the Kalepa Point Road Repairs. These are as follows:

1) Availability of materials
2) Reduction in size/weight of individual units
3) Lower total project cost
4) Shorter total project duration

Concrete armor units are available in different shapes, from different designers where some are a proprietary design, and some are not. Determining the best concrete armor unit for the Kalepa Point Road Repair project would need to be explored further should this alternative be chosen. Some examples of potential concrete armor units that could be evaluated are:

1) Tetrapod
2) Tribar
3) Accropode/Ecopode
4) Xbloc

Typical cross sections of those concrete armor units listed above:

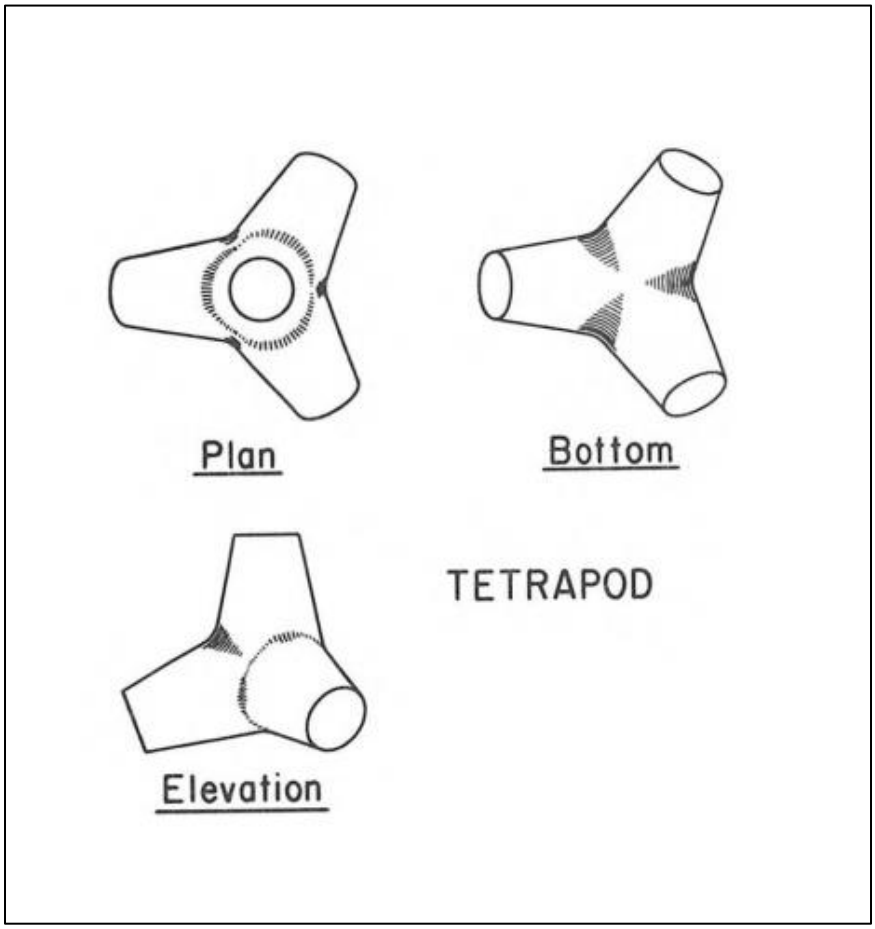


Figure 2-7. Typical cross section of a Tetrapod (SPM – 1984)

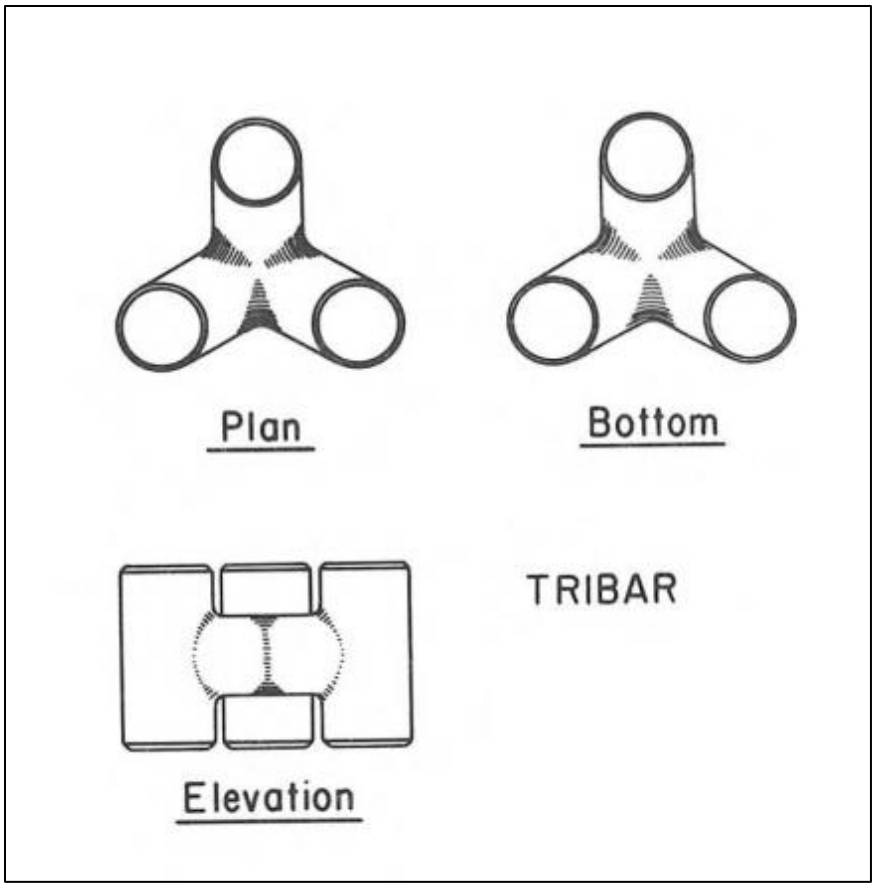


Figure 2-8. Typical cross section of a Tribar (SPM – 1984)

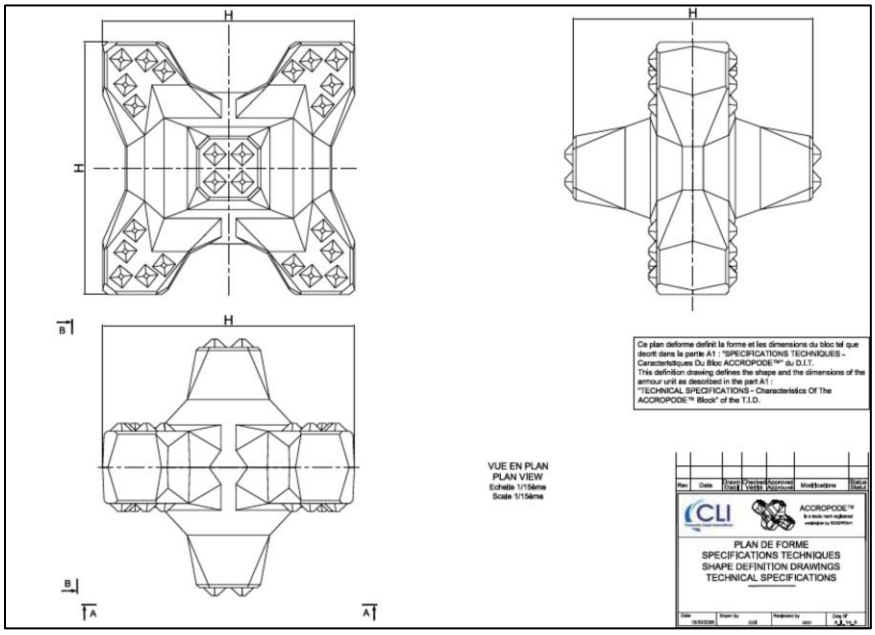


Figure 2-9. Typical cross section of a Accropode (CLI 2019)

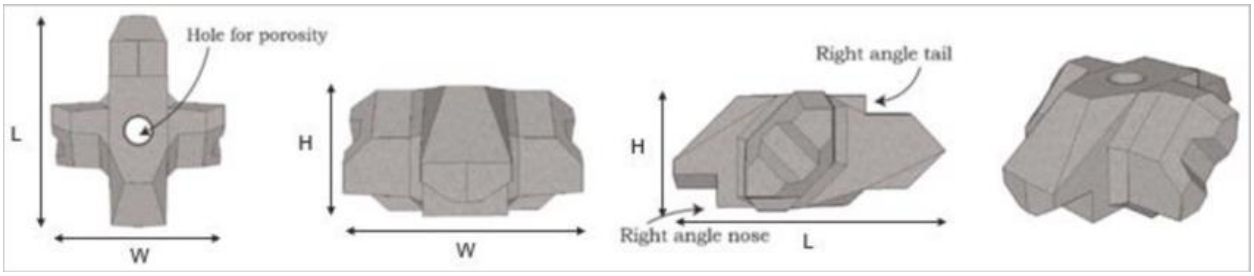


Figure 2-10. Typical cross section of a Xbloc Pluss (Xbloc)

Example revetment installations of those concrete armor units listed above.



Figure 2-11. Example of a Tetrapod revetment (photo Alice Gordenker 2014)



Figure 2-12. Example of a Tribar revetment in Saipan (Sea Engineering)



Figure 2-13. Example of an Ecopode revetment (CLI)

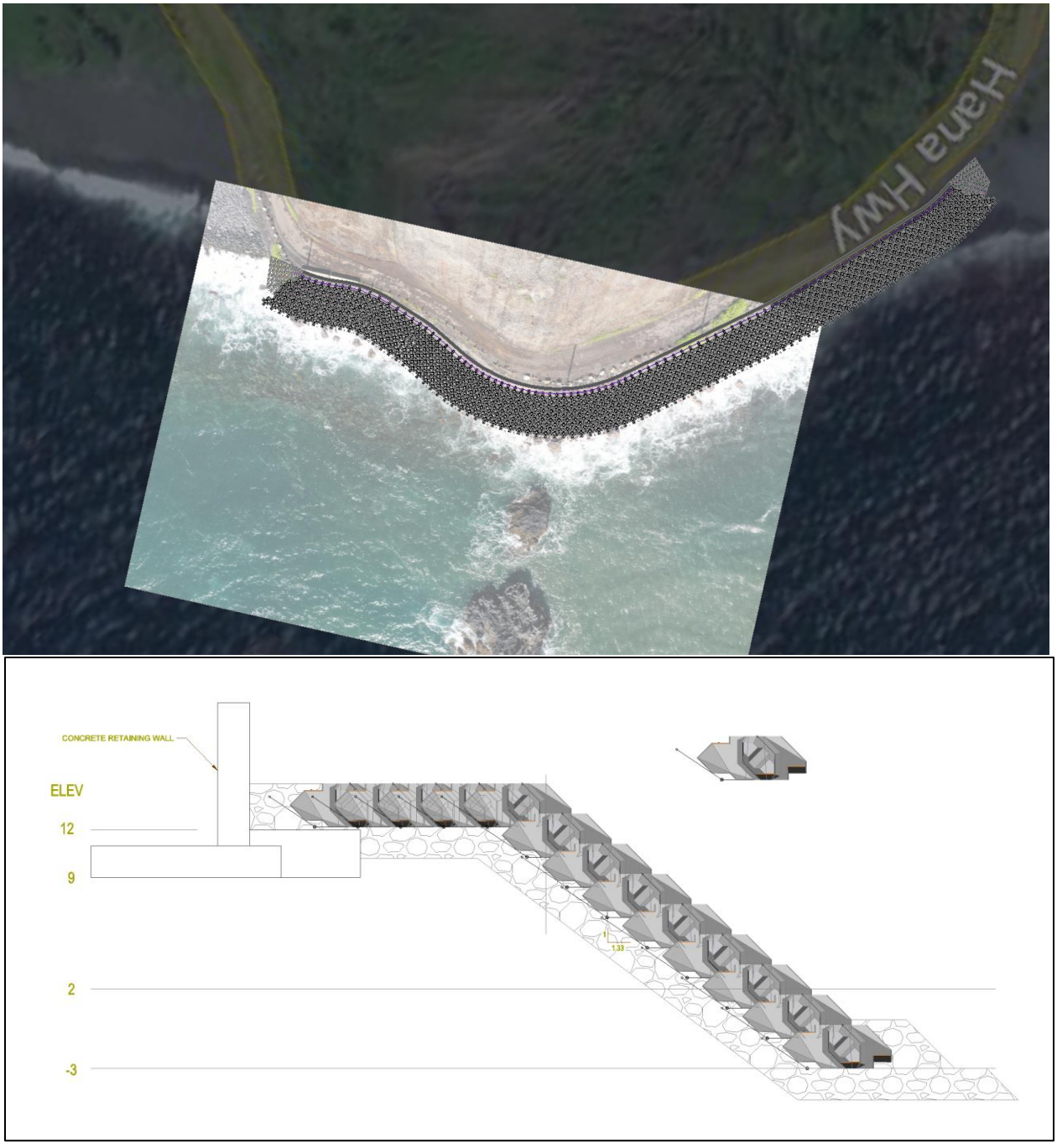


Figure 2-14. Conceptual rendering of plan and profile view of Xbloc Pluss installation at Kalepa Point (Xbloc)

As noted above, the benefits of exploring concrete armor units to construct the revetment are:

1) Availability of materials:
   Sea Engineering has observed in the past several years that contractors have had an increasingly difficult time sourcing the proper size, quantity, and quality of armor stone needed to construct rock revetments of this type. This difficulty in sourcing the rock

material has negatively affected projects budgets and schedules. Using concrete armor units can eliminate such risk as concrete is more readily available from reliable suppliers and manufacturing the concrete armor units can be completed on schedule and on budget with less risk to the project. Additionally, as the exact source of the 3.6 to 6 ton armor stone is at present unknown, uncertainties on how these stones would be transported to the project site are undefined. Given the limited road infrastructure to the project site such as narrow roads, limited weight ratings on the bridges leading to the project site, transporting these large stones may present a challenge to the contractor. In addition to transportation challenges and risks there is limited staging at the project location. Sea Engineering has observed that rock revetment projects such as this typically benefit from having a variety of rock at the project site to allow the contractor to select the proper shape and size stone for each rock placed into the revetment structure. Often several stones will need to be evaluated and even placed and then removed before the best fit stone is found for each stone placement. Not having easy access to the stones at the project site may lead to extended construction timelines to construct the rock revetment and/or improper placement of stones will degrade the structural integrity of the rock revetment. Concrete armor units are all uniform in size and placement can be completed on a schedule eliminating uncertainties in unit placement time and location. Units that are delivered to the project site can be installed as delivered, eliminating uncertainties that a particular unit can or cannot be used at the project site that day, eliminating the need for additional time and resources to transport it away from the project site and securing a replacement unit.

2) Reduction in size/weight of individual units:
   Due to the increased stability of concrete armor units the size and weight of the units can be reduced as compared to a comparably stable stone used in a rock revetment. A preliminary review of the design conditions at Kalepa Point indicates that concrete armor units would weigh approximately 2.4 tons each as compared to the 3.6 to 6 ton stone for the present design. These smaller and lighter units would be less complicated to transport to the project site. Bridge loading would be minimized and/or more units could be transported per vehicle to the project site as compared to the armor stone increasing transportation efficiency. Due to the remote location of the project transporting construction materials, particularly large heavy stones to the site will be a significant time and cost driver for the project.

3) Lower total project costs:
   Due to the above benefits of using concrete armor units a construction cost estimate was developed in parallel to the current project construction cost. The cost for the concrete armor unit alternative was 2% lower, $30,461,000 as compared to $31,460,000, a difference of $670,000.

4) Shorter total project duration:
   Due to the above benefits of using concrete armor units a construction schedule estimate was developed in parallel to the current project construction schedule. The schedule for the

concrete armor unit alternative was 10% faster than the rock revetment alternative, 17 months as compared to 20 months, a difference of 3 months.

Several concrete armor unit manufacturers in recent years have been developing units that are designed specifically to look more like natural materials. Using mold patterns and concrete colors concrete units can be made to match local geology and features. Eco-friendly concretes have also been used in the production of these units. These concrete structures are made to sequester carbon dioxide in their manufacturing process thus lowering the carbon footprint of projects. Concrete has also been developed to promote marine growth and habitat on the structures, thus improving the biological environment. Such construction techniques could be considered during concrete armor unit selection and design for Hana Highway at Kalepa Point Road Repairs project should this alternative be chosen. As the project continues through the final design and development phase consideration of concrete armor units in place of the stone will continue to be evaluated as an alternative design.

2.4 Concrete Retaining Wall

The existing rock masonry wall will be replaced by constructing a concrete cantilever retaining wall designed to AASHTO LRFD Bridge Design Specifications, Ninth Edition, dated 2020. The cantilever wall consists of a concrete stem and concrete base slab, both of which are relatively thin and fully reinforced to resist the moments and shears to which they are subjected. The cantilever retaining wall requires less concrete than a concrete gravity wall and utilizes the retained soil as dead load providing lateral resistance like a mechanically stabilized earth wall (Figure 1-11). The concrete cantilever retaining wall was selected due to the reduced amount of concrete compared to the concrete gravity wall while still taking advantage of mass and durability of concrete required to resist the extreme conditions. Minimizing materials used for construction was also seen as beneficial for the proposed project due to the remote location and difficulties transporting construction materials to the site.

Other options evaluated for the wall design were mechanically stabilized earth wall and a concrete gravity wall. The mechanically stabilized earth wall system considered was to utilize precast concrete panels mechanically connected to geogrid tensile reinforcement in the soil mass. Mechanically stabilized earth walls behave as gravity walls with lateral resistance provided through the dead weight of the reinforced soil mass behind the precast concrete panels. Construction of the mechanically stabilized earth wall system is relatively simple and is used throughout the state as earth retaining walls systems in non-coastal environments. This option was removed from consideration for the proposed project due to concerns with the wave heights, associated loads acting on the precast concrete panels, the potential weakness at panel joints, and the potential for washout of backfill material compromising the lateral resistance of the mechanically stabilized earth wall system.

Concrete gravity walls depend entirely on the mass of the concrete and any soil resting on the wall surface for its stability. The concrete gravity wall system considered was substantial due to the height and applied loads. The heavy concrete gravity wall construction is typical for retaining walls due to the mass and durability in the extreme loading conditions found on the coast. This option was removed from consideration for the proposed project due to the high volume of concrete

required for the entire length of the wall and the site restrictions that limit the weight of materials per vehicle delivery.

2.5 Road Improvements

The existing road and guardrails are deteriorated from decades of rock falls and salt spray. The proposed project includes repairing the road with new asphalt concrete paving and concrete guardrails that are appropriate for the harsh site conditions.

2.5.1 Guardrails

The existing steel guardrail needs replacement along this portion of the highway for safety reasons. Decisions to determine the requirement of guardrails and design were referenced from the American Association for State Highway and Transportation Officials (AASHTO), Roadside Design Guide, 4th Edition (2011). Multiple guardrail types were considered, including timber, galvanized steel, stone masonry, and concrete.

The proposed project includes 42-inch-tall constant slope concrete guardrails installed along the seaward side of 515 feet of Hana Highway (Figure 1-11). The concrete design will be constructed to withstand the salt air conditions through the use of epoxy-coated rebar and adequate concrete coverage. Relief holes at the base of the guardrails will allow drainage for rainwater runoff.

2.5.2 Paving

The road will be repaired with 2.5 inches of asphalt concrete pavement over 5 inches of asphalt treated base and 8 inches of base course. The new paving will have a 2% slope towards the ocean for drainage. In the areas of the repaired guardrail drainage will be through the relief holes in the concrete guardrail.

2.6 Construction Methodology

Construction of the proposed project is challenging due the remote location on a coast exposed to prevailing tradewind waves, narrow roads, low bridge weight ratings limits along Piilani Highway, limited access, and space for a staging area near the proposed project site. Establishing equipment and material access to the site that is both safe and minimally disruptive to local traffic will contribute to smooth construction of the proposed project.

The narrow roads and sharp turns will likely restrict the size and types of vehicles available to transport equipment and materials to the proposed project site. Sections of Piilani highway on the approach from Kula are rough gravel roads. The section of Hana highway from Kalepa to Hana is better maintained but contains more single lane bridges and is prone to more traffic. Twenty-three bridges along Piilani/Hana Highway between Kula and Hana were investigated for this project using the information provided in routine structural engineering inspection reports (Nagamine Okawa, 2015). There are five main bridges from Kula to the proposed project site. The smallest posted weight along this route is 9 tons at Kalepa Bridge #12. There are 18 bridges from Hana to the proposed project site. The smallest posted weight limit along this route is 3 tons at Lelekea Culvert Bridge. Thus, access to the site is anticipated to be from the west, from Kula. Repair and/or retrofit of Kalepa Bridge #12 may be necessary to bring materials and heavy equipment to the proposed project site.

There is limited space for construction staging near the proposed project site. The proposed project site is at the foot of steep mountainous terrain limiting access to the land side of the proposed project site. On the ocean side of the proposed project site space is limited by shoreline terrain with rough ocean conditions. The road at the proposed project site is narrow with limited to no shoulder, leaving space exclusively for vehicle traffic with no convenient turnaround or other maneuvering. Logistics for the project are therefore complex due to the limited space for construction activities and staging at the proposed project site, the remote location, and difficulty getting construction materials to the site. Due to the limited options for construction staging near the project site, several sites have been identified as options to be used to stage construction equipment and materials during construction. These sites vary in size and relative location to the project. They have been selected based upon availability of the land for the County of Maui to utilize, size, and proximity to the project site. Multiple staging areas have been identified as potential spaces to be used for the project to provide the contractor with opportunities to utilize the spaces that most benefit the project.

The largest area proposed for construction staging is a two-acre parcel owned by the State of Hawaii, TMK (2)-1-7-003:001. This staging area is the furthest from the project site and is located 2.6 miles to the west of the project site (Figure 2-15 and Figure 2-16). The site is accessible from Piilani Highway and is currently vacant and unused. This area has been identified as a staging area due to the limited current use of the site; it is accessible from Piilani Highway; it is relatively flat and large enough to allowing the ability to store larger construction equipment and materials. DPW has engaged with the State of Hawaii to secure usage of the property for the project.

An additional parcel owned by the State of Hawaii, TMK (2)-1-7-001:006, is closer to the project site and is located 0.7 miles to the west of the project site (Figure 2-17 and Figure 2-18). The areas of this parcel that may be available to the contractor are limited to the areas directly adjacent to Piilani Highway. This is due to the steep terrain of the parcel, there are no open or flat areas that

can be used for store construction equipment or materials other than the limited areas immediately adjacent to the road. Areas will need to be cleared of vegetation to facilitate the use as a suitable staging area.

A parcel owned by the National Parks Service north of the project site is the closest to the project site, just several hundred feet away, and is approximately 1,700 square feet. The site is located to the west of the start of Hāna Highway, near the Alelele Stream, along the steep slopes of Kālepa Point (Figure 2-19). The area will need to be cleared of vegetation to facilitate the use as a suitable staging area. This area may be used to locate a field office and/or construction equipment, store materials, handle materials, and park vehicles safely and conveniently during construction. Typically for construction projects of this scale one or more mobile offices trailers will be set up to support onsite management of the proposed project. These offices are typically housed in converted trailers; a 10-foot by 50-foot office trailer would use about one third of the available space of the primary staging area, or 500 square feet, space at the project site for staging is thus extremely limited.



Figure 2-15. Proposed construction staging area 2.6 miles west of project area TMK (2)-1-7-003:001



Figure 2-16. Proposed construction staging area west of project area TMK (2)-1-7-003:001 (County of Maui)



Figure 2-17. Proposed construction staging area 0.7 miles west of project area TMK (2)-1-7-001:006



Figure 2-18. Proposed construction staging area west of project area TMK (2)-1-7-001:006 (County of Maui)

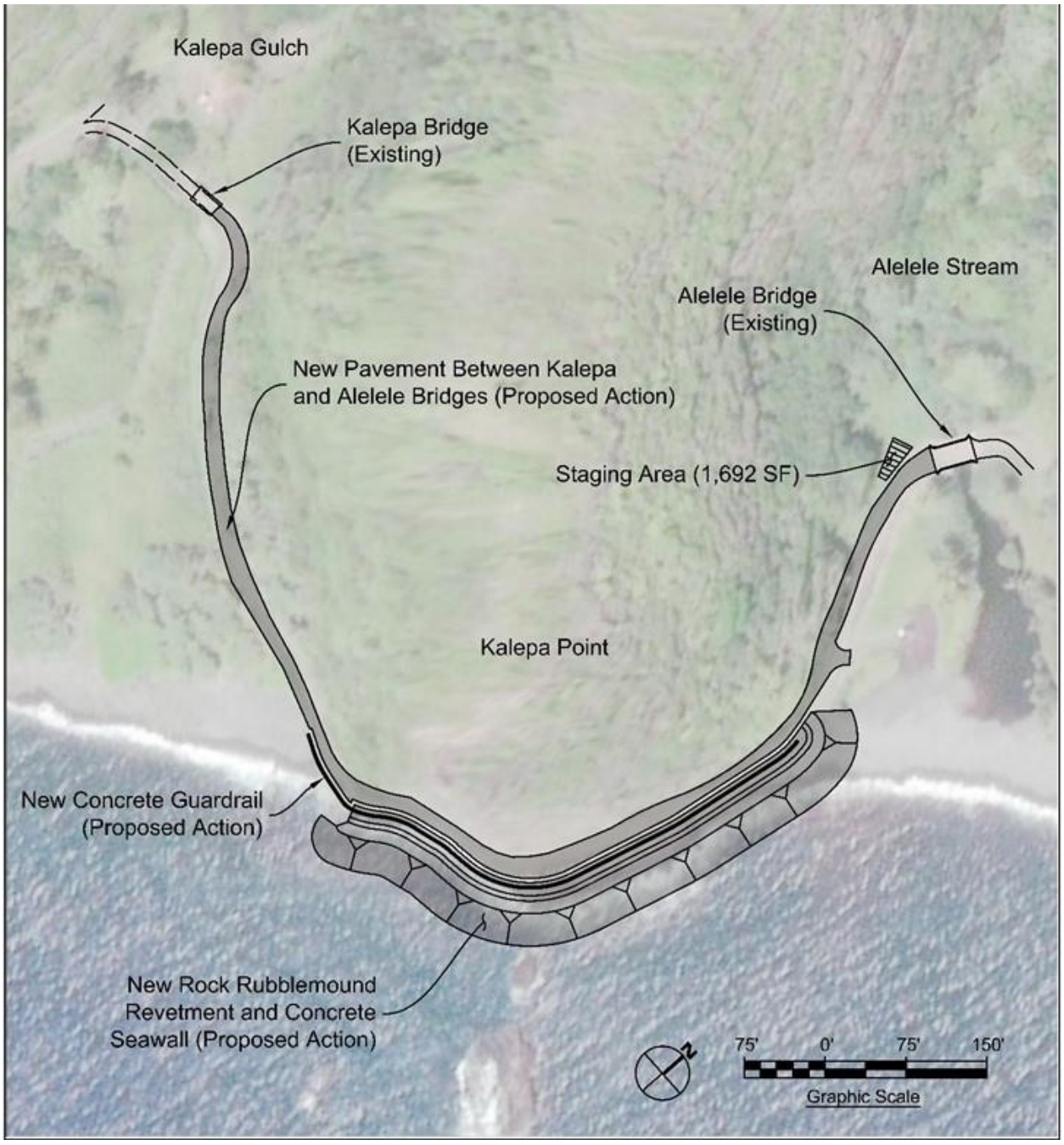


Figure 2-19. Proposed construction staging area north of project area

Best Management Practices (BMPs), including silt fences and stabilized construction entrances, will be installed around the staging areas for environmental protection. Weather and natural hazards will be monitored during the proposed project should there be a need to temporarily remove equipment or materials from the staging areas to avoid damage during a possible natural

hazard. For example, a large rain event may cause Alelele Stream's elevation to rise onto the banks of the estuary.

The construction will begin with repair and construction of the rock rubblemound revetment. Construction will proceed from one end of the project and progress to the opposite end, east to west or west to east. After the revetment has been repaired, the retaining wall will be constructed. Construction of the revetment and retaining wall will likely require periodic road closures. Daytime construction will require the road to be closed to traffic for approximately 7 hours a day during daylight hours, 8:30 am. To 3:30 pm, Monday through Friday. It is anticipated that the road will be re-opened to vehicle traffic during weeknights and 3:30 pm to 8:30 am. It is also anticipated that the road will be open on holidays and weekends. Due to the limited road width and limited access, there may be periods of time during the construction of the proposed project that the road will need to be closed for extended periods of time to allow for work to occur on the revetment, retaining wall, or road that will leave the road impassable to vehicles. These closures may be longer than the typical 8:30 am to 3:30 pm road closures. Closures may be required for several days during certain phases of construction. Should road closures be required overnight, there will not be repair work conducted during evening or nighttime hours as part of the proposed mitigation measures to avoid distracting endangered or threatened birds. Notice of road closure schedules will be provided to the public in advance of scheduled road closure schedules.

After the revetment and retaining wall have been repaired, the road will be graded and repaved. The replacement of the steel guardrails using concrete guardrails will take place after the road has been repaved. Once all elements of the proposed project have been constructed, all equipment and materials will be removed from the site and the staging area will be returned to pre-construction conditions.

2.7 Summary of Construction Schedule

The duration of the proposed project is estimated to be 20 months. One of the primary reasons for the length of the proposed project is the remoteness of the site and limited access. This will require transportation of materials, equipment, and labor to the proposed project site each day. An example is the transportation of large armor stones boulders for the rock rubblemound revetment. The rock rubblemound revetment will be constructed with large armor stone boulders weighing on average 4.85 tons (9,700 pounds). Kalepa bridge has a posted weight limit of 9 tons. With this weight limit only one armor stone boulder can be transported across the bridge at a time.

2.8 Summary of Proposed Projected Construction Cost

Construction cost estimates based upon the preliminary design of the proposed project is $31,460,000. This includes a $3,200,000 allowance for possible modifications to various bridges on the route to ensure safe material and equipment delivery.

3. OVERVIEW OF THE EXISTING ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION MEASURES

3.1 Physical Environment

3.1.1 Climate, Temperature, and Rainfall

Existing Conditions

The Hawaiian Island chain is situated south of the large eastern Pacific, semi-permanent, high-pressure cell. This high-pressure cell is the dominant feature affecting air circulation and climate in the region. Over the Hawaiian Islands this high-pressure cell produces persistent northeasterly winds called trade winds. During the winter months cold fronts sweep across the north-central Pacific Ocean bringing rain to the Hawaiian Islands and intermittently modifying the trade wind regime. Thunderstorms, which are rare but most frequent in the mountains, also contribute to annual precipitation.

Due to the tempering influence of the Pacific Ocean and their low-latitude location, the Hawaiian Islands experience extremely small diurnal and seasonal variations in ambient temperature. The average winter high at Makena Golf Course, 23 miles from the proposed project site, is 81 degrees Fahrenheit, and the average winter low is 63 degrees Fahrenheit. The average summer high at Makena Golf Course is 87 degrees Fahrenheit, and the average summer low is 68 degrees Fahrenheit. These temperature variations are quite modest compared to those that occur at inland continental locations.

Topography and the dominant northeast trade winds are the two primary factors that influence the amount of rainfall on any given location on Maui. Near the peaks of the West Maui Mountains and the windward slope of Haleakala, which are fully exposed to the trade winds, rainfall averages nearly 250 inches per year. On the leeward side of Haleakala, where the proposed project site is located, the rainfall is lower with average annual rainfall of 85 inches per year. Average monthly rainfall varies between 5inches per month in September and 9 inches per month in January. Winter, Spring, Summer and Fall months receive similar total amounts of mean rainfall with winter being the wettest period receiving 24 inches for the period and summer being the drier period receiving 19 inches for the period (Table 3-1).

Table 3-1. Average monthly temperature for Makena Golf Course and rainfall for Kipahulu, Hawaii

Month	Normal Ambient Temperature, ºFahrenheit		Average Monthly Rainfall (inches)
	Average Daily Maximum	Average Daily Minimum	
January	80.4	63.2	8.86
February	80.5	62.7	7.90
March	81.8	63.4	7.92
April	83.2	64.1	7.43
May	84.1	65.6	6.49
June	86.3	67.3	5.77
July	87.3	68.4	7.30
August	87.8	68.8	6.17
September	87.3	68.7	5.04
October	86.6	68.0	7.02
November	84.1	66.7	8.04
December	81.8	64.2	7.07
Source: Western Regional Climate Center (Temperature Data From Station (515842) Makena Golf Course 249.1 1982 to 2016 Rainfall Data From Station: (514634) Kipahulu 258 1997 to 1981).			

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have an impact on local climate, temperature, and rainfall, and therefore no mitigation measures are required.

3.1.2 Wind

Existing Conditions

The prevailing wind throughout the year is the northeasterly trade wind. Its average frequency varies from more than 90% during the summer season to only 50% in January, with an overall annual frequency of 70%. Westerly, or Kona, winds occur primarily during the winter months, generated by low pressure or cold fronts that typically move from west to east past the islands. Figure 3-1 is a wind rose diagram applicable to the proposed project site based on wind data recorded at Kahului Airport on the island of Maui from 1945 to 2021. The wind rose shows the frequency of occurrence based on wind speed and direction and indicates the dominance of trade wind flow in the islands.

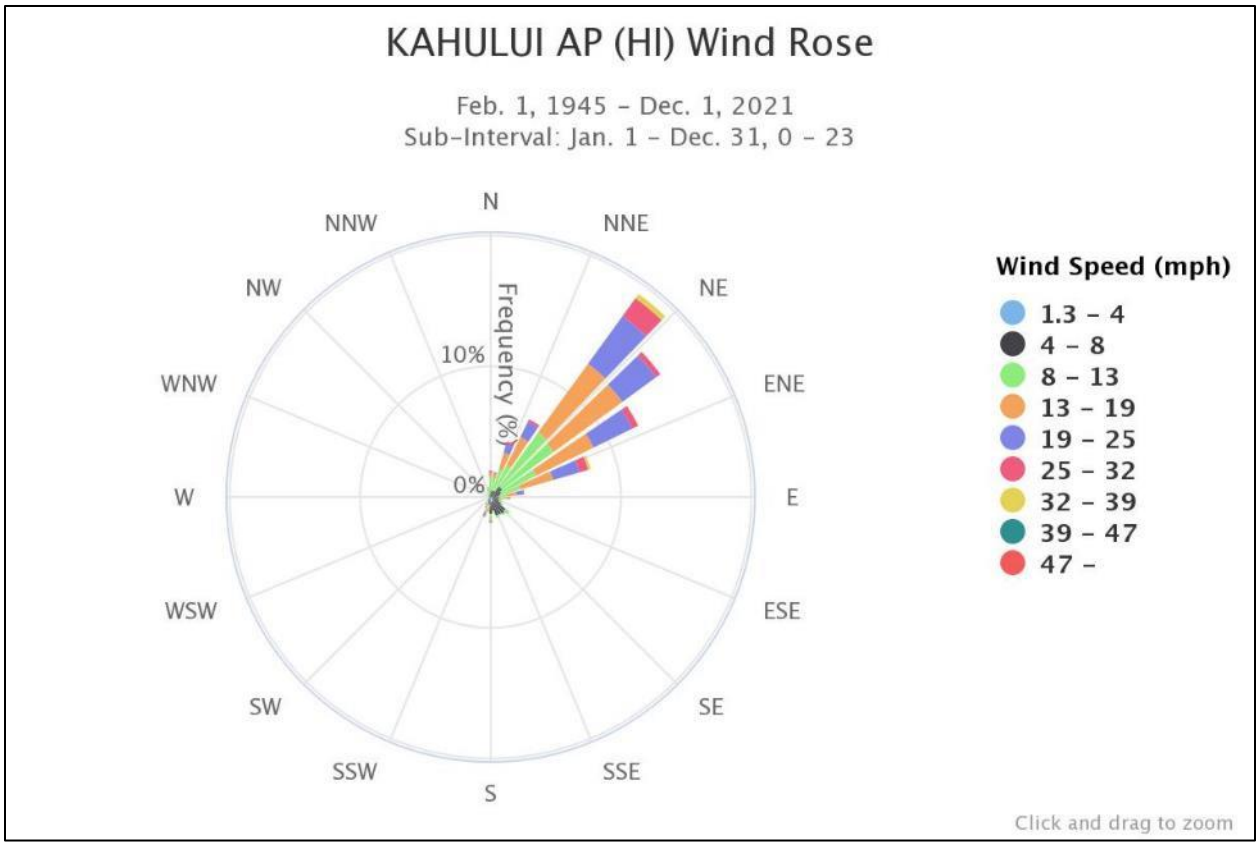


Figure 3-1. Frequency of occurrence of wind speed and direction, Kahului Airport

Tradewinds are produced by the outflow of air from the Pacific Anticyclone high-pressure system, also known as the Pacific High. The center of this system is located well north and east of the Hawaiian chain and moves to the north and south seasonally. In the summer months, the center moves to the north, causing the trade winds to be at their strongest from May through September. In the winter, the center moves to the south, resulting in decreasing trade wind frequency from October through April. During these months, the trade winds continue to blow; however, their average monthly frequency decreases to 50%.

Wind patterns of a more transient nature increase in prevalence during the winter months. Winds from extra-tropical storms can be very strong from almost any direction, depending on the strength and position of the storm. The low-pressure systems associated with these storms typically track west to east across the North Pacific north of the Hawaiian Islands. At Honolulu Airport, wind speeds resulting from these storms have on several occasions been measured to exceed 60 mph. Kona winds are generally from a southerly to a southwesterly direction, usually associated with slow-moving low-pressure systems known as Kona lows situated to the west of the island chain. These storms are often accompanied by heavy rain.

Trade winds can accelerate in the Alenuihaha Channel that lies between the island of Hawaii and Maui. The funneling effect in the channel can produce winds that are 15 knots higher than average trade winds found elsewhere in the island chain on the same day.

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have an impact on local wind conditions, and therefore no mitigation measures are required.

3.1.3 Air Quality

Existing Conditions

The U. S. Environmental Protection Agency has set national ambient air quality standards (NAAQS) for ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, 2.5-micron and 10-micron particulate matter (PM2.5 and PM10), and airborne lead. The NAAQS establishes the maximum concentrations of pollution considered acceptable, with an adequate margin of safety, to protect public health and welfare. The State of Hawaii has also adopted ambient air quality standards for certain pollutants, some of which are more stringent than the Federal standards. The State currently has set standards for five of the six pollutants (excluding PM2.5) in addition to hydrogen sulfide (DOH, 2003).

Generally, air quality in the area is excellent. The State of Hawaii Department of Health Clean Air Branch (DOH-CAB) monitors ambient air quality on Maui using a system of three monitoring sites. The DOH-CAB is responsible for pollution control in the state including reviewing air applications and issuing air permits for potential air pollution stationery sources, monitoring the activities of the stationary sources, and enforcing federal and state air pollution control laws and regulations. The primary purpose of the monitoring network is to measure ambient air concentrations of the six criteria NAAQS pollutants. DOH-CAB monitoring data for 2008 shows that at no time did air quality exceed the short-term or long-term State or National standards for the six pollutants measured [particulate matter (PM2.5 and PM10), nitrogen dioxide, sulfur dioxide, carbon monoxide, and hydrogen sulfide]. The State of Hawaii DOH-COB's only ozone monitoring station is located at Sand Island on Oahu. Existing ozone concentrations at that location also meet State and Federal ambient air quality standards.

Potential Impacts and Proposed Mitigation Measures

Because most of the work will take place on the rocky shoreline, the proposed project differs from many construction projects in that it involves little or no on-site soil disturbance that could result in particulate emissions such as dust or dirt. Potential sources of air pollution because of the proposed project are related to the construction phase.

During construction, machinery is expected to create temporary degradation in air quality in the immediate vicinity of the proposed project location. This negative impact on air quality will be limited to typical work hours and will end once the road repairs are completed. As part of the construction process, the contractor will be expected to observe all BMPs to keep construction-related emissions to the lowest practicable levels.

Short-term declines in air quality may occur due to emissions from construction equipment and would include carbon monoxide, nitrogen oxides, volatile organic compounds, directly emitted particulate matter (PM_{10} and $PM_{2.5}$), and toxic air contaminants such as diesel exhaust particulate matter. Sulfur dioxide is generated by oxidation during combustion of organic sulfur compounds contained in diesel fuel.

These effects on air quality are short-term in duration and, therefore, are not expected to result in adverse or long-term impacts. Implementation of the following measures is intended to reduce any air quality impacts resulting from construction activities:

- Silt fencing will be installed and maintained around the worksite and equipment/material staging areas.
- Apply water or dust palliative to the site and equipment as frequently as necessary to control fugitive dust emissions.
- Properly tune and maintain construction equipment and vehicles.
- Keep construction areas clean and orderly.

Once construction is completed and construction equipment leaves the site, the proposed project is anticipated to have no long-term air emissions or impact on air quality.

3.1.4 Noise

Existing Condition

Existing ambient noise levels vary within the proposed project location both spatially, from place to place, and temporarily, from one time to another. In general, existing background sound levels are the result of vehicle traffic, surf, and wind. Near significant construction activity, noise levels can intermittently reach 80 dBA. Sound levels associated with heavy construction equipment range from 80 to 120 dBA and power tools commonly used in construction produce sound levels up to 115 dBA.

Potential Impacts and Proposed Mitigation Measures

HAR §11-46, "Community Noise Control" establishes maximum permissible sound levels (see Table 3-2) and provides for the prevention, control, and abatement of noise pollution in the State of Hawaii from stationary noise sources and from equipment related to agricultural, construction, and industrial activities. The standards are also intended to protect public health and welfare and to prevent the significant degradation of the environment and quality of life. The limits are applicable at the property line rather than at some pre-determined distance from the sound source. Because of that, the Class C limits applicable to land zoned for agriculture use appear the most applicable. HAR §11-46-7 grants the Director of the State of Hawaii Department of Health the authority to issue permits to operate a noise source that emits sound more than the maximum permissible levels specified in Table 3-2 if it is in the public interest and subject to any reasonable conditions. Those conditions can include requirements to employ the best available noise control technology.

It may not be possible to mitigate construction noise to the extent that it does not at times exceed existing background noise levels or is inaudible to the public. Some reduction is practical, however, and the following measures would be implemented:

Equipment operation on the shoreline will be limited to the hours between 7:00 a.m. and 8:00 p.m.

- Broadband noise backup alarms in lieu of higher frequency beepers are recommended for construction vehicles and equipment. Broadband noise alarms tend to be less audible and intrusive with distance as they blend in with other background noise sources.
- The selected contractor will be encouraged to use the quietest locally available equipment, e.g., high insertion loss mufflers, fully enclosed engines, and rubber-tired equipment when possible.

A proposed project hotline will be provided at the job site to allow for noise feedback and other concerns from the community. The hotline could also be used to help develop modifications to construction operations whenever feasible.

Once construction is completed and construction equipment has left the site, the proposed project will have no long-term noise emissions.

Table 3-2. Maximum Permissible Sound Levels in dBA

Zoning Districts	Daytime (7 a.m. to 10 p.m.)	Nighttime (10 p.m. to 7 a.m.)
Class A	55	45
Class B	60	50
Class C	70	70

Table Notes:
(1) Class A zoning districts include all areas equivalent to lands zoned residential, conservation, preservation, public space, open space, or similar type.

(2) Class B zoning districts include all areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.

(3) Class C zoning districts include all areas equivalent lands zoned agriculture, country, industrial, or similar type.

(4) The maximum permissible sound levels apply to any excessive noise source emanating within the specified zoning district, and at any point at or beyond (past) the property line of the premises. Noise levels may exceed the limit up to 10% of the time within any 20-minute period. Higher noise levels are allowed only permit or variance issued under sections 11-46-7 and 11-46-8.

(5) For mixed zoning districts, the primary land use designation is used to determine the applicable zoning district class and the maximum permissible sound level.

(6) The maximum permissible sound level for impulsive noise is 10 dBA (as measured by the "Fast" meter response) above the maximum permissible sound levels shown.

Source: Hawaii Administrative Rules §11-46, "Community Noise Control"

3.1.5 Topography and Nearshore Bathymetry

Existing Conditions

The topography of the Kalepa headland is characterized by a steep and, in some areas, inverted cliff. The roadway rests on a narrow ledge (only 15 feet wide in some areas) at the base of the cliff. The cliff is approximately 570 feet long and 230 feet high at its highest point.

Offshore bathymetric information for the proposed project location is limited due to the difficulties with collecting data via traditional surveying and LiDAR on an exposed open coast. The bathymetric data that is available, from a 2013 U.S. Army Corps of Engineer's LiDAR survey, shows Kalepa Point promontory continuing offshore as a sub-marine ridge. The bathymetry in this area is highly variable, with multiple subaerial rock features and steep slopes. To the east and west of Kalepa Point, the bathymetry is characterized by a more gently sloping bottom (Figure 3-2). Areas of no data in Figure 3-2 are caused by wave breaking that causes air bubbles in the water column, with consequent interference with the LiDAR laser transmission. Figure 3-3 is a profile along the section line shown in the plan view. The nearshore bathymetric profile is at a 1Vertical to 9 Horizontal (1V:9H) slope.

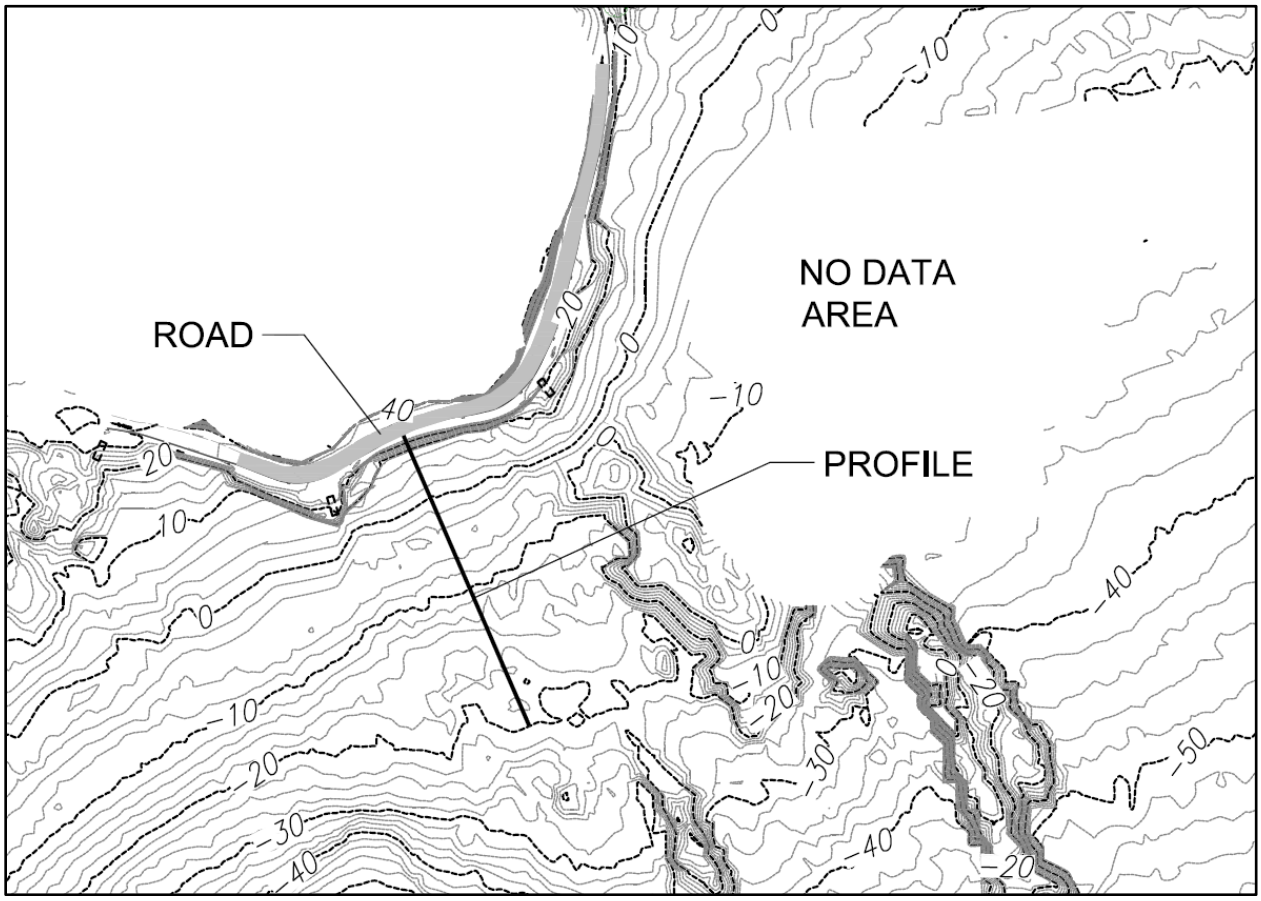


Figure 3-2. Nearshore bathymetry from 2013 U.S. Army Corps of Engineers LiDAR data (elevations in feet MSL)

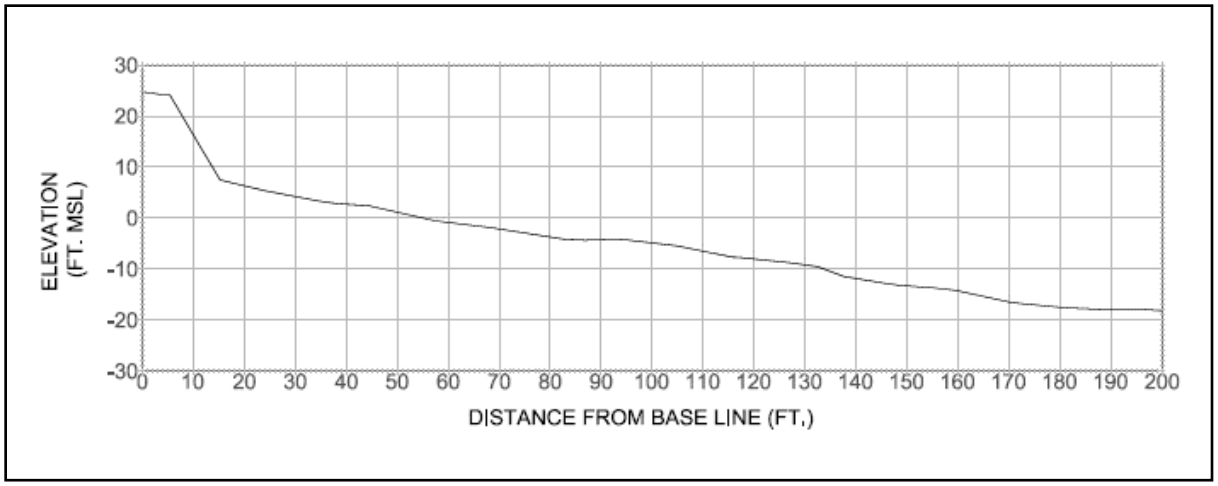


Figure 3-3. Representative offshore profile based on survey and 2013 U.S. Army Corps of Engineers LiDAR data (1V:9H)

Potential Impacts and Proposed Mitigation Measures

The proposed project is anticipated to have negligible impact on the topography and nearshore bathymetry around Kalepa Point outside of the areas directly altered by the road protection structure and road improvements. The area is a rocky basalt shoreline and the proposed rock structures utilize similar materials. Therefore, no mitigation measures are required.

3.1.6 Nearshore Coastal Processes

Existing Conditions

The existing coastline around Kalepa Point headland consists of basaltic boulders and rock rubble. The basaltic boulders extend through the intertidal zone and continue to cover the near-shore ocean floor for approximately 250 feet. Cobble stone beaches are located to either side of the headland where the Kalepa and Alelele streams exit to the ocean. The road is protected by a rock rubblemound revetment fronting a CRM wall (Figure 3-4, Figure 3-5, and Figure 3-6).



Figure 3-4. View of Kalepa Point headland showing existing basaltic boulder and rock rubble shoreline



Figure 3-5. Basaltic boulder and rock rubble shoreline at Kalepa Point headland



Figure 3-6. Basaltic boulders and rock rubble shoreline

Potential Impacts and Proposed Mitigation Measures

The proposed project is designed to repair the existing rock CRM and rubblemound revetment currently protecting the roadway from erosion and damage by large ocean waves. An advantage of a rock rubblemound revetment is that the rough, porous rock surface and sloping face of the structure absorbs wave energy and reduces wave reflection. Additional advantages of rock revetments are that materials are available on the island of Maui and localized damage can be repaired by placement of additional armor stone. Properly designed and constructed rock rubblemound revetments are durable, flexible, and highly resistant to wave damage. The proposed project, with its hybrid rock rubblemound revetment and concrete retaining wall have a smaller structural footprint than if only a rock rubblemound revetment were to be used to repair the existing structure.

The proposed project is not expected to negatively alter erosion or coastal processes as it is a repair of an existing rock rubblemound revetment structure. The surrounding area is composed of basaltic boulders, rock rubble, and cobble stone beaches in the region. There are no sandy beaches in the proposed project area, and thus there will be no impacts on sandy beaches. The proposed project will not change the existing shoreline elevation in the area.

3.1.7 Streams and Wetlands

Existing Conditions

The perennial Alelele Stream is located on the east side of Kalepa Point and is crossed by the Alelele Bridge. There is also an ephemeral stream in Kalepa Gulch, on the west side of Kalepa Point, that is crossed by the Kalepa Bridge.

Potential Impacts and Proposed Mitigation Measures

One of the potential construction staging areas is a 1,700 square foot area just to the west of the Alelele Bridge, just off the Hana Highway. The staging area will be set back from the stream banks, and the stream will be monitored during construction. Should the stream change direction or flood during construction, appropriate measures will be taken to minimize impact on the stream. The proposed project is anticipated to have negligible impact on existing streams.

3.1.8 Oceanographic Environment

Existing Conditions

Surrounded by the Pacific Ocean, the Hawaiian Islands are subject to wave approach from all directions. The wave climate in Hawaii is typically characterized by five general wave types. These include northeast tradewind waves, southeast tradewind swell, southern swell, North Pacific swell, and Kona wind waves. Tropical storms and hurricanes also generate waves that can approach the islands from virtually any direction. All these wave conditions may occur at the same time. Kalepa Point is located on the southeast corner of the island of Maui and is sheltered from North Pacific swell. The proposed project site has year-around exposed to trade wind waves, which are larger than other regions in the Hawaiian Islands due to funneling effect caused by the high mountains on either side of the Alenuihaha Channel.

Potential Impacts and Proposed Mitigation Measures

The proposed project is anticipated to have a negligible impact on the oceanographic environment around Kalepa Point.

3.1.9 Flood and Tsunami Hazards

Existing Conditions

Because of the site's remote location, historical tsunami observations have not been documented, and tsunami evacuation maps have not been produced for Kalepa Point. Runup from the 1946 tsunami was observed to be 10 feet at Huakini Bay, to the west of Kalepa Point, and 21 feet at Mokuia Point, to the east. The 1960 tsunami runup was observed to be 10 feet at Huakini Bay and Mokuia Point. *The Atlas of Natural Hazards in the Hawaiian Coastal Zone* (Fletcher et al., 2002) assigns a tsunami hazard rating of "Moderately High" to "High" for Kalepa Point due to the coastline's history of tsunami flooding and damage.

Flood hazards for Kalepa Point are shown on Flood Insurance Rate Map (FIRM) Flood Sheet 1500030735F, which indicates that there are no threats of flooding from streams at the proposed project site, but that the shoreline is exposed to flooding caused by storm waves and tsunami. The area immediately inland of the shoreline is in Zone VE with a base flood elevation of 36 feet. Figure 3-7 shows the FIRM for Kalepa Point.

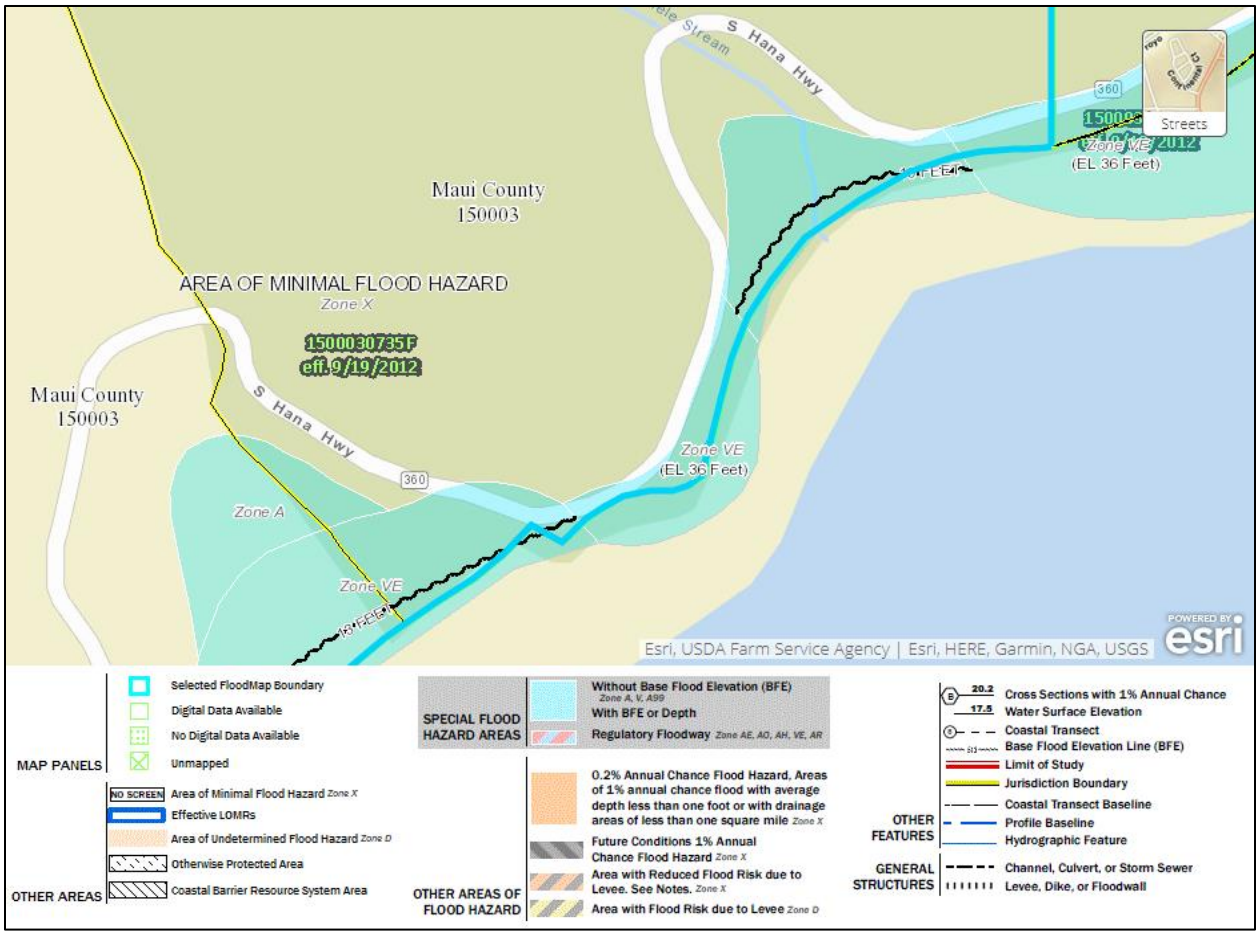


Figure 3-7. FIRM for Kalepa Point

Potential Impacts and Proposed Mitigation Measures

The proposed project is anticipated to have negligible impact on flooding or tsunami hazards.

3.1.10 Nearshore Water Quality

Existing Conditions

The waters surrounding the proposed project site are designated Class AA waters (Figure 3-8). It is the objective of class AA waters that these waters remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or actions. To the extent practicable, the wilderness character of these areas shall be protected (Department of Health 2014).

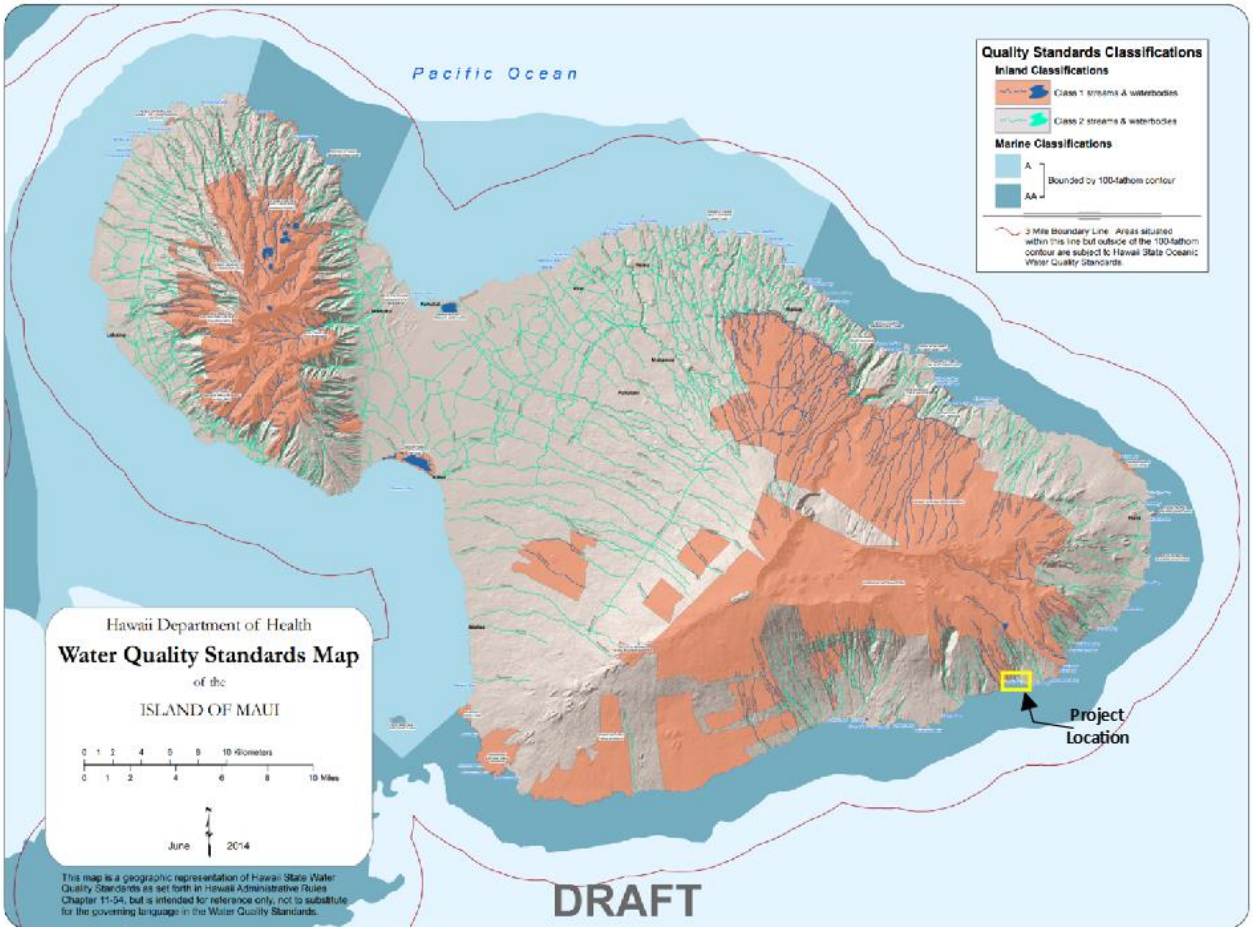


Figure 3-8. State of Hawaii Department of Health water quality standards map of the island of Maui

Water chemistry sampling was conducted on November 1, 2021, by Marine Research Consultants, Inc. (MRCI) investigators working from a small boat (Appendix F – Marine Biological Assessment (Marine Research Consultants, Inc.)). Water chemistry was assessed along three survey transects that spanned the shoreline length of the Kalepa Point road repairs proposed project site. Two sampling stations were established on each transect. The inner sampling stations were located at the most accessible area near the shoreline; the offshore stations were located approximately 75 m offshore (Figure 3-9). At each sampling station water was collected within 20 cm of the surface and 50 cm above the ocean floor. Such a sampling scheme is designed to span the area that could potentially experience impacts from the shoreline work.



Figure 3-9. Aerial view of Kalepa Point headland showing water sampling transect locations

Water quality constituents evaluated included all specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (b) (Open coastal waters) of the State of Hawaii Department of Health (DOH) Water Quality Standards. These criteria include total nitrogen (TN), nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium nitrogen (NH_4^+), total phosphorus (TP), Chlorophyll a (Chl a), turbidity, temperature, pH, and salinity. In addition, dissolved silica (Si) and orthophosphate phosphorus (PO_4^{-3}) were also reported as these constituents are sensitive indicators of biological activity and the degree of groundwater mixing.

Laboratory analyses were conducted by Marine Consulting and Analytical Resources LLC (MCAR) (Lab number HI 00928). Analyses for Si, NH_4^+, PO_4^{-3}, and NO_3^- were performed with a Seal Analytical AutoAnalyzer 3 HR using standard methods for seawater analysis. TN and TP were analyzed in a similar fashion following digestion. Total organic nitrogen (TON) was calculated as TN minus NH_4^+ and NO_3^-, and total organic phosphorus (TOP) was calculated as TP minus PO_4^{-3}.

Chl a was measured by filtering 150 ml through a GFF/F glass-fiber filters; pigments on filters were extracted in 90% acetone in the dark at -20 °C for 24 hours. Fluorescence of the extract was measured with a Turner Designs Trilogy Fluorometer model 7200-000 equipped with an extracted chlorophyll non-acidification module. Salinity was determined using a Mettler Toledo Seven Excellence Multi-parameter meter with an InLab 731-ISM conductivity probe, calibrated to a Hach Instruments traceable salinity standard of 35.00 parts per thousand (‰ or ppt), 53.0 mS/cm, with a readability of 0.01 ppt. Turbidity was determined using a Hanna Instruments Model #HI88703 Turbidimeter and reported in nephelometric turbidity units (NTU) (precision of 0.01 NTU). In situ

field measurements of water temperature, pH, dissolved oxygen, and salinity were acquired using RBR Concerto CTDs calibrated to factory specifications. The CTD has a readability of 0.001°C, 0.001pH units, 0.001% saturation, and 0.001 ppt (salinity). EPA and Standard Methods (SM) methods that were employed for chemical analyses, as well as detection limits, are listed in the Code of Federal Regulations Title 40, Chapter 1, Part 136, are as follows:

N_{H4}^{+}: EPA 350.1, Rev. 2.0 or SM4500-NH3 G, detection limit 0.042 µg/L.
NO_3^-+ NO_2^-: EPA 353.2, Rev. 2.0 or SM4500-NO3F, detection limit 0.084 µg/L.
PO_4^{-3}: EPA 365.5 or SM4500-P F, detection limit 0.28 µg/L.
Total P: EPA 365.1, Rev. 2.0 or SM4500-P E J, detection limit 0.93 µg/L.
Total N: SM 4500-N C., detection limit 1.96 µg/L.
Si: EPA 370.1 or SM 4500 SiO_2 E, detection limit 0.45 µg/L.
Chlorophyll *a*: SM 10200, detection limit 0.006 µg/L.
pH: EPA 150.1 or SM4500H+B, detection limit 0.002 pH units.
Turbidity: EPA 180.1, Rev. 2.0 or SM2130 B, detection limit 0.008 NTU.
Temperature: SM 2550 B, detection limit 0.01 degrees centigrade.
Salinity: SM 2520, detection limit 0.003 ppt.
Dissolved Oxygen: SM4500 O G, and detection limit 0.01% sat.

Table 3-3 shows results of all water chemistry analyses on samples collected along three transects off Kalepa Point road repair project site on November 1, 2021. Several patterns of distribution are evident in Table 3-3. The dissolved nutrients, Si and NO_3^-, are consistently elevated in shoreline surface samples relative to offshore surface samples. In addition, all surface values of Si, and most surface values of NO_3^- are elevated relative to deep samples. Salinity displays the opposite trend, with lower concentrations in the nearshore samples, and surface samples (Table 3-3). These patterns are most pronounced on Transect 3, and least pronounced on Transect 1. Over the entire sampling area, the range in NO_3^- is approximately 5 µg/L, while the range of salinity is approximately 1.25 ppt.

As there were no streams discharging to the ocean at the time of the sampling, the horizontal gradients of Si, NO_3^- and salinity likely represent input of groundwater to the ocean near the shoreline. Low salinity groundwater, which typically contains high concentrations of Si and NO_3^-, percolates to the ocean at the shoreline, resulting in a nearshore zone of mixing. In many areas of the Hawaiian Islands, such groundwater percolation results in steep horizontal gradients of increasing salinity and decreasing nutrients with increasing distance from shore. The gradients in the nearshore zone off the Kalepa Point road repair project site are substantially different, indicating a low volume groundwater discharge at the southwestern area (Transect 1) compared to the northeastern area (Transect 3).

Phosphate phosphorus (PO_4^{-3}) is also generally elevated in groundwater relative to ocean water. In the data set collected off the Kalepa Point road repair project site, there is a pattern of decreasing concentration of PO_4^{-3} at the inshore stations, particularly on Transect 3, indicating some groundwater flux from land to the ocean. Horizontal gradients of TN/TON and TP/TOP mirror the patterns of NO_3^- and PO_4^{-3}, respectively.

Ammonium nitrogen (NH_4^+) is usually not elevated in groundwater relative to ocean water. However, concentrations of NH_4^+ on the transects off the Kalepa Point road repair site show the

opposite pattern, with a consistent trend of elevated values at the offshore surface stations relative to the nearshore surface stations (Table 3-3). It is not evident if these gradients originate from groundwater discharge or biotic metabolic activity.

Except for Transect 1, the distributions of turbidity display highest values near the shoreline, with diminishing values moving seaward (Table 3-3). Overall, values of Chlorophyll a show no discernible pattern with respect to depth and distance from shore. All values are considered low for near-shore ocean settings with all values with all measurements below 0.23 µg/L. At all sites temperatures at the surface were slightly higher than near the bottom. Dissolved oxygen displayed no gradient of consistent change across the transects (Table 3-3).

Table 3-3. Results of water chemistry analysis from three ocean sampling transects in the vicinity of the Kalepa Point revetment repairs. Samples were collected on November 1, 2021.

SITE	DFS	DEPTH	PO_4^{3-}	$NO_3^-+NO_2^-$	NH_4^+	Si	TP	TN	TURB	SALT	pH	Chl-a	TEMP	Diss. O_2
	(m)	(m)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(NTU)	(o/oo)	(std. units)	(µg/L)	deg. C	% sat.
T-1	1-S	0.3	3.04	1.00	1.53	60.67	12.36	85.43	0.25	34.74	8.15	0.16	25.53	104.7
	1-D	9.5	2.82	1.19	1.34	59.11	11.94	82.70	0.61	34.82	8.15	0.18	25.51	109.5
	2-S	0.4	2.17	0.89	1.65	66.68	11.10	81.10	0.40	34.82	8.16	0.16	25.59	106.9
	2-D	14.8	3.41	1.00	1.55	61.02	12.61	81.80	0.38	34.78	8.16	0.17	25.51	111.5
T-2	3-S	0.3	3.97	2.62	1.43	99.79	11.69	83.03	0.45	34.55	8.17	0.16	25.69	111.2
	3-D	14.2	3.53	1.59	1.46	63.33	12.28	80.86	0.29	34.74	8.17	0.17	25.54	109.5
	4-S	0.0	4.34	1.31	5.70	77.89	12.61	79.30	0.41	34.74	8.16	0.16	25.63	108.5
	4-D	14.5	3.35	0.94	1.48	55.82	12.67	81.89	0.28	34.85	8.16	0.18	25.59	109.7
T-3	5-S	0.7	7.07	5.75	1.11	337.81	14.70	85.33	1.54	33.60	8.17	0.23	25.56	108.9
	5-D	10.0	3.22	1.34	1.43	79.86	11.87	80.82	0.49	34.74	8.16	0.18	25.52	109.5
	6-S	0.3	2.64	0.84	1.37	71.42	11.16	83.09	0.53	34.74	8.16	0.19	25.59	107.6
	6-D	14.8	3.13	0.65	1.27	58.83	11.92	81.23	0.32	34.74	8.16	0.18	25.59	106.5
DOH WQS	DRY	10%		10.00	5.00	-	30.00	180.00	0.50	*	**	0.50	***	****
		2%		20.00	9.00	-	45.00	250.00	1.00	*	**	1.00	***	****
	WET	10%		14.00	8.50	-	40.00	250.00	1.25	*	**	0.90	***	****
		2%		25.00	15.00	-	60.00	350.00	2.00	*	**	1.75	***	****

* = Salinity shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.
** = pH shall not deviate more than 0.5 units from a value of 8.1.
*** = Temperature shall not vary more than one degree C. from ambient conditions.
**** = Dissolved Oxygen not less than 75% saturation
DOH = Department of Health
BDL = below detection limit
NTU = nephelometric turbidity units
µg/L = micrograms per liter
WQS = water quality standards

Note: See Figure 3-9 for locations of sampling stations. Also shown are DOH WQS for "open coastal waters" under "wet" and "dry" conditions, "not to exceed more than 10% and 2% of the time" criteria. Grey shaded values indicate surface samples. Yellow shaded values exceed the "not to exceed more than 10% of the time under dry conditions" standards; blue shaded values exceeded the "not to exceed more than 2% of the time dry standards.

Results of analyses of water chemistry indicate a small component of groundwater entering the ocean near the shoreline. The groundwater input is rapidly mixed to background coastal oceanic values through wind, wave, and current action. The magnitude of effect from such terrestrial input is so low that it does not result in extensive elevation above State of Hawaii DOH water quality standards. The only constituent with values above DOH limits is turbidity, likely because of wave resuspension of naturally occurring bottom sediments. None of these factors are likely to be affected beyond the range of natural variability by employment of standard BMPs for construction in coastal waters.

Potential Impacts and Proposed Mitigation Measures

Construction will be accomplished using conventional heavy equipment and will proceed from one end of the project and progress to the opposite end, east to west or west to east. After the

revetment has been repaired, the retaining wall will be constructed from one end to the opposite end. A temporary increase in turbidity levels in the immediate area of construction is expected; however, this will be mitigated and isolated by the employment of BMPs and the requirements of the State Department of Health Water Quality Certification. These requirements by the State Department of Health Water Quality Certification for the proposed project. BMPs and environmental protection measures to be employed are summarized in Section 6.1. Water quality protection measures will include the following general requirements:

- The water area affected by construction shall be monitored as required by the project permitting and approvals. If monitoring indicates that turbidity standards are being exceeded, construction shall be suspended until the condition is corrected.
- The construction contractor shall be required to employ standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks; cleaning of equipment prior to operation near the water; proper location of storage, refueling, and servicing sites away from the water; implementation of adequate on-site spill response procedures; and stormy weather preparation plans.
- All construction activities shall be confined to the immediate area of construction, and no excess construction material shall be stockpiled in the water.
- Construction materials (e.g., stone and concrete) shall be inert and free of earthen and any other deleterious substances.

Following the completion of construction, the affected water body is expected to return to its pre-construction condition. No long-term effects on water quality or water circulation in the proposed project site are expected.

3.1.11 Flora

Existing Conditions

A walk-through botanical survey method was used to document flora in the project area. This survey was conducted by Robert Hobdy in January 2021. The survey covered all portions of the proposed project location following routes to ensure complete coverage of the area (Appendix D – Flora and Fauna Survey (Robert W. Hobdy)). Areas most likely to harbor native or rare plants were more intensively examined. Notes were made on plant species, distribution, and abundance as well as on terrain and substrate.

Much of the roadway, cliff face and shoreline were rocky and barren of vegetation. Areas more protected from salt and wind had increasingly diverse species representation. A total of 62 plant species were recorded during the survey.

Seven species were of common occurrence: hala (*Pandanus tectorius*), swollen fingergrass (*Chloris barbata*), tropical crabgrass (*Digitaria ciliaris*), akulikuli (*Sesuvium portulacastrum*), naupaka kahakai (*Scaevola taccada*), buttonweed (*Spermacoce capitata*) and napier grass (*Cenchrus purpureus*).

Eleven native plant species were found in the proposed project location. The akoko (*Euphorbia celastroides*) was the only endemic species (occurring only in Hawaii). Ten indigenous species (plants native in Hawaii but also native in other places as well) were recorded: ahuawa (*Cyperus*

javanicus), many-spiked sedge (*Cyperus polystachyos*), mauu akiaki (*Fimbristilis cymosa*), hala, akulikuli, naupaka kahakai, koali awa (*Ipomoea indica*), nanea (*Vigna marina*), aeae (*Bacopa monnieri*) and ulei (*Osteomeles anthyllidifolia*). Four Polynesian introductions were recorded: niu or coconut (*Cocos nucifera*), ki (*Cordyline fruticosa*), kukui (*Aleurites moluccana*) and noni (*Morinda citrifolia*).

Forty-seven species were non-native trees, shrubs, or herbaceous plants.

A terrestrial flora and fauna biological resources survey for two proposed construction staging areas for materials and equipment for the project was conducted by SWCA Environmental Consultants in February 2024. The survey covered all portions of the proposed projects staging areas discussed in Section 2.6 (Appendix E – Kalepa Point Road Repair Project Staging Area Flora and Fauna Survey (SWCA Environmental Consultants)).

The vegetation types and plant species identified during the survey are not considered unique. Two indigenous plants, naupaka (Scaevola taccada) and ulei (Osteomeles anthyllidifolia) were observed in the survey area. These species are not considered rare, nor are they federally or state-listed threatened or endangered species, species proposed for listing, or candidate species. No federally or state-listed endangered plant species were observed in or near the proposed construction staging areas survey areas. Therefore, the proposed project is not expected to have a significant, adverse effect on terrestrial vegetation.

Potential Impacts and Proposed Mitigation Measures

The vegetation in the proposed project location and in the proposed construction staging areas is predominantly non-native in character. While eleven native species were recorded, all are found throughout Hawaii and none are rare. The 47 non-native plant species are of no conservation concern.

No Endangered or threatened plant species were found to occur in the proposed project location (U.S.F.W.S., 2020). No special native plant habitats were found here.

The proposed roadway improvements project is not expected to have a significant negative impact on the native botanical resources in this part of Maui, and therefore no mitigation measures are proposed.

3.1.12 Fauna

Existing Conditions

A walk-through fauna survey was conducted in conjunction with the botanical survey by Robert Hobdy in January 2021. The survey covered all portions of the proposed project location following routes to ensure complete coverage of the area (Appendix D – Flora and Fauna Survey (Robert W. Hobdy)). Field observations were made with the aid of binoculars and by listening to vocalizations. Notes were made on species, abundance, activities, and location. observations and notes were made of trails, tracks, scat, and signs of feeding. An evening visit was made to the area to record crepuscular activities, vocalizations, and to see if there was any evidence of occurrence of the endangered Opeapea or Hawaiian hoary bat *(Lasiurus cinereus semotus)* in the area.

Two mammal species were recorded during the survey. Two wild goats (*Capra hircus*) were seen on the slope of Kalepa Gulch above the bridge. Goats roam on these forested mountains.

At least one Opeapea was identified during an evening survey with the use of a bat detector device which detects the echolocation signals bats are known to emit when hunting for nocturnal flying insects, mostly moths, upon which they feed. These endangered bats utilize a wide variety of habitats and move about seasonally following spikes in insect populations. Little is known of their population numbers as they are rarely seen because of their nocturnal lifestyle and because they cannot be heard due to their high-pitched calls which are undetectable to human hearing.

Other non-native animals likely to occur in the area but which were not seen include mongoose (*Herpestes auropunctatus*), rats (*Rattus* spp.), and mice (*Mus domesticus*).

Birdlife was sparse in this mostly barren and windy coastal habitat. Five species of non-native bird were observed during two site visits: common myna (*Acridotheres tristis*), nutmeg mannikin (*Lonchura punctulata*), cattle egret (*Bubulcus ibis*), zebra dove (*Geopelia striata*), and hwamei or Chinese laughing thrush (*Leucodioptron canorum*).

Some other non-native birds that are likely to occur here include Japanese white-eye (*Zosterops japonicus*) and northern cardinal (*Cardinalis cardinalis*). Other native species likely to occur here include the aukuu (*Nycticorax hoactli*) a water bird, migratory shorebirds kolea (*Pluvialis fulva*), akekeke (*Arenaria interpres*), and ulili (*Tringa incana*). Seabirds that would fly overhead but not land here include the uau (*Pterodroma sandwichensis*) and the ao (*Puffinus newelli*).

Insects were very uncommon in this windy, salty, and mostly barren habitat. Just three non-native insects were seen during two site visits: the southern house mosquito (*Culex quinquefasciatus*), the long-tailed blue butterfly (*Lampides boeticus*), and the Asian spiny-backed spider (*Gasteracantha mammosa*). No native insects were seen.

A terrestrial fauna biological resources survey for two proposed construction staging areas for materials and equipment for the project was conducted by SWCA Environmental Consultants in February 2024. The survey covered all portions of the proposed projects staging areas discussed in Section 2.6 (Appendix E – Kalepa Point Road Repair Project Staging Area Flora and Fauna Survey (SWCA Environmental Consultants)).

No federally or state-listed endangered birds were observed in the survey area. Three bird species in total were observed in the survey area, all of which are common, nonnative introduced bird species. No federally or state-listed endangered wildlife species were observed in or near the survey area; however, potential roosting trees for the Opeapea (Lasiurus cinereus semotus), a federally and state-listed endangered mammal, exist in the proposed construction staging areas survey area. The survey area does not overlap critical habitat of any listed terrestrial faunal species. For these reasons, the proposed project is not expected to have a significant, adverse effect on terrestrial wildlife at the proposed construction staging areas.

Potential Impacts and Proposed Mitigation Measures

The fauna species recorded during the survey were nearly all non-native mammals, birds, and insects that are of no special conservation concern. Only the Opeapea was a native species. This

endemic and endangered bat is highly mobile and able to avoid disturbances. It is mainly vulnerable during the summer months when it is breeding and raising pups which it places in trees. At these times, before the pups can fly, they may be harmed or killed by tree removal. This situation would have a higher chance of occurrence with alternative 2 option, construction of a tunnel, were selected. There are trees that would need to be removed within the scope of the construction of a vehicular tunnel.

While no endangered or threatened birds occur within the proposed project location, two seabird species, the uau and the ao, do fly over the area at dawn and dusk during their summer and fall breeding season to go to and from their nesting burrows high on the mountain slopes. At these times they are easily distracted by bright lights and can crash and be injured or killed. This can be avoided by not performing any proposed project work in the evening or at night.

Direct impacts to bats could occur during vegetation removal at the proposed construction staging areas if a juvenile bat that is too small to fly but too large to be carried by a parent is present in a tree or branch that is cut down. To prevent direct impacts to the Opeapea, the following measures are recommended:

- No trees taller than 15.0 feet (4.6 m) in the area should be trimmed or removed between June 1 and September 15 when flightless juvenile bats may be roosting in the trees.
- Any fences that are erected as part of the project should have a barbless, top-strand wire to prevent entanglements of the Opeapea on barbed wire.

Implementation of these measures, which have been promulgated by the USFWS, is expected to result in avoidance of all direct impacts to Opeapea. Because all impacts to the Opeapea will be discountable, the proposed project may affect, but is not likely to adversely affect, individuals or populations of the species.

With observance of the above recommendations, there are no further environmental issues of concern, and the proposed project is not anticipated to have a significant negative impact on the fauna resources in this part of Maui, and therefore no mitigation measures are proposed.

3.1.13 Marine Biological Environment

Existing Conditions

Physical and biotic composition of the survey area was assessed on November 1, 2021, by Marine Research Consultants Incorporated divers using self-contained underwater breathing apparatus (SCUBA) and working from a 42-foot boat (Appendix F – Marine Biological Assessment (Marine Research Consultants, Inc.)). Dive surveys were conducted by swimming in a zigzag pattern from the shoreline to approximately 250 feet offshore along the water quality sampling transects shown in Figure 3-9 During these underwater investigations, notes on species composition were recorded, and numerous digital photographs recorded the existing conditions of the area.

The section of the east Maui shoreline at Kalepa Point where shoreline mitigation is planned abuts a steep eroded soil and rock escarpment that terminates in a basaltic boulder field that extends from the roadway to the waterline. The boulders extend through the intertidal zone and continue to cover the nearshore ocean floor for approximately 250 feet, and to a water depth of approximately 50 feet (Figure 3-10). At the seaward edge of the boulder zone, bottom composition

grades into a flat basaltic platform interspersed with pockets of rubble (Figure 3-11). The basaltic platform extends seaward for the entire offshore range of the study area.

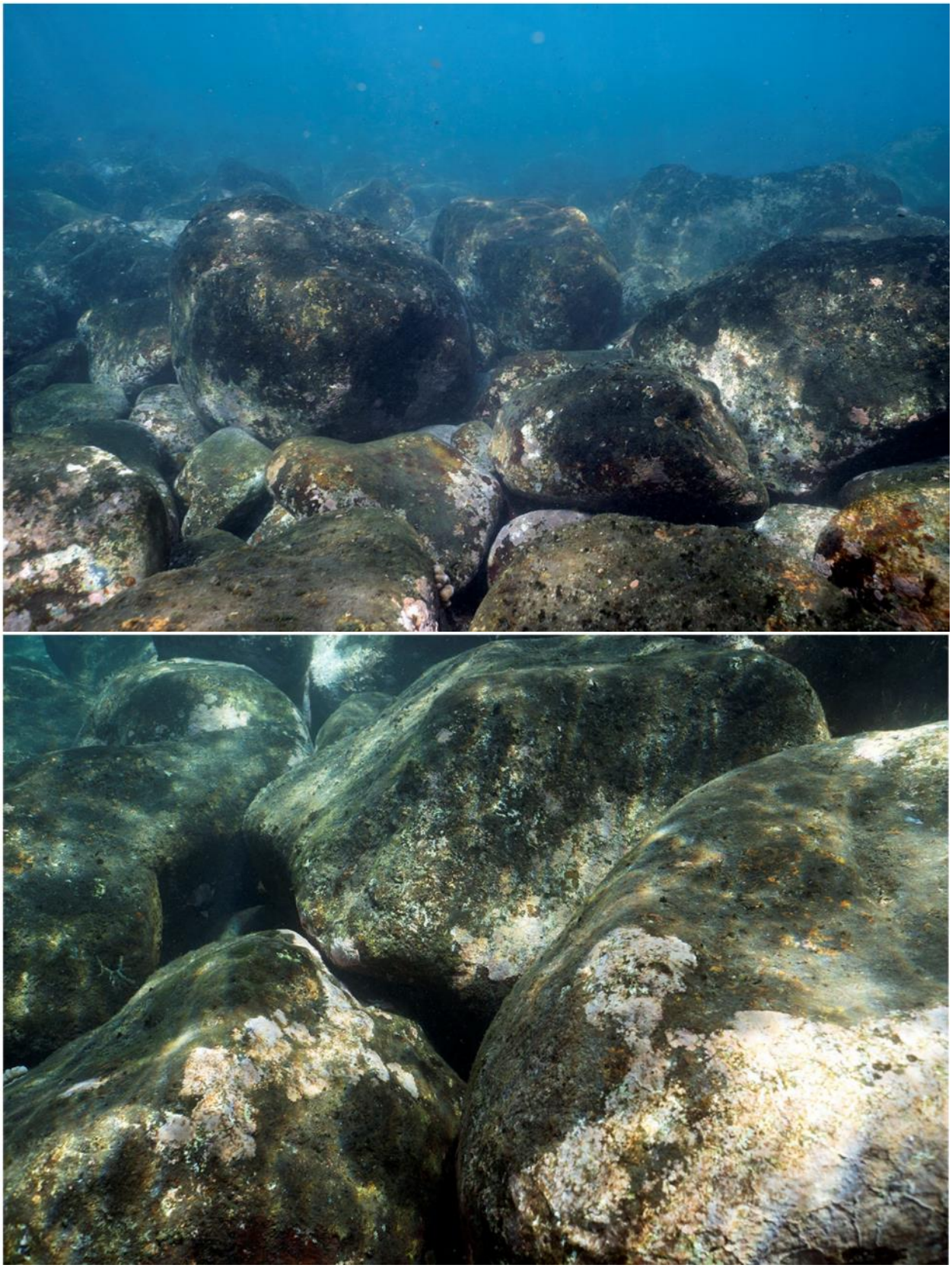


Figure 3-10. Two views of uncolonized bare basaltic boulders in the nearshore area off Kalepa Point

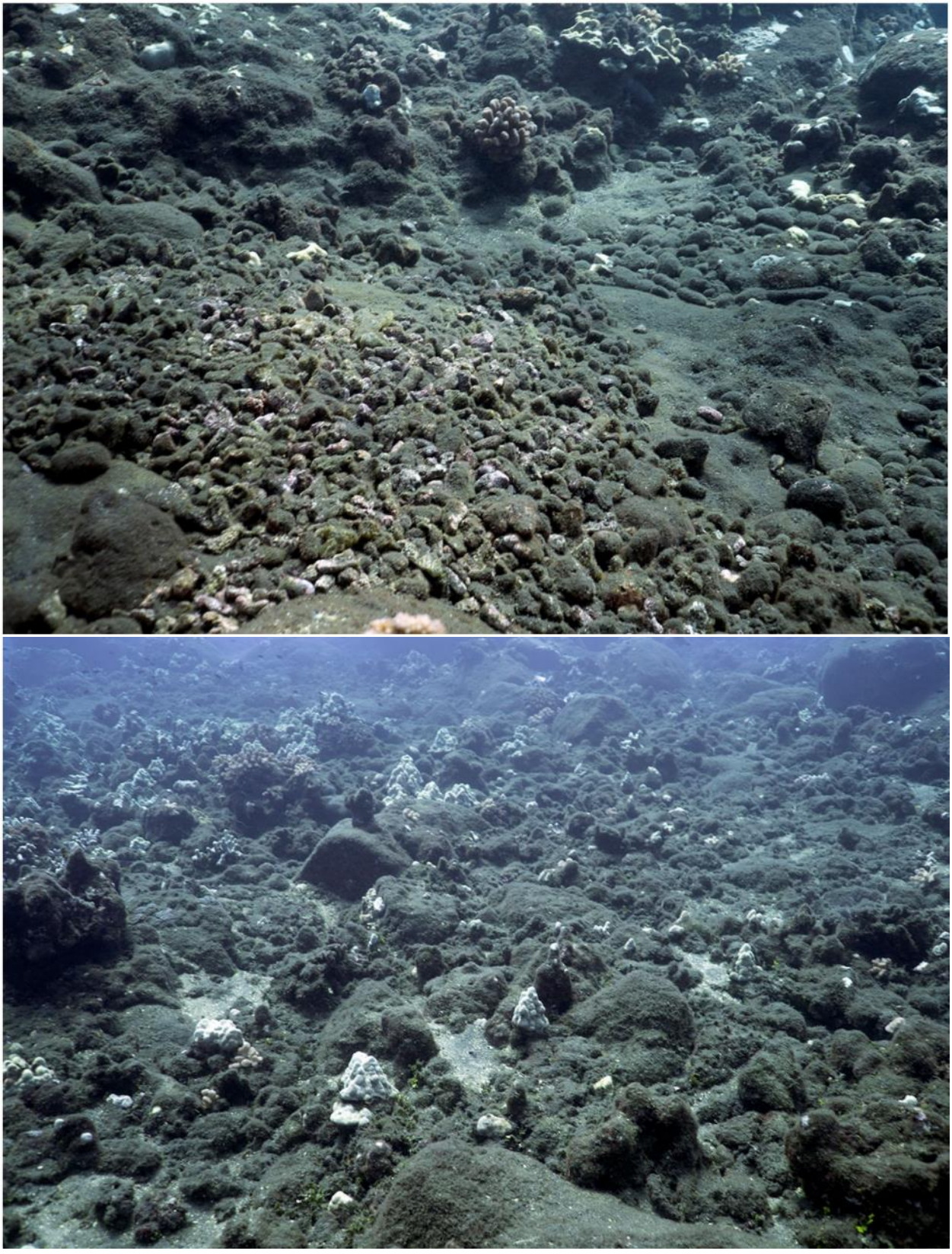


Figure 3-11. Two views of basalt reef platform seaward of boulder zone. Water depth is approximately 33 feet

Biotic composition of the reef communities fronting the survey section of Kalepa Point fits well into the classification of a "*Pocillopora meandrina* – boulder zone" that has been described as part of the typical zonation pattern of reef on the West Coast of the Island of Hawaii (Dollar1982, Dollar and Tribble 1993). Such communities typify Hawaiian reefs that are in open coastal areas that receive substantial impact from breaking waves. At the Kalepa Point road repair site such wave stress is sufficient to prevent all coral growth from the shoreline to approximately 50 feet offshore. The only colonization of boulders in this area is by calcareous algae (Figure 3-11).

With increasing distance and depth offshore, coral, predominantly of the species *Pocillopora meandrina*, begin to colonize the surfaces of the basalt boulders (Figure 3-12). The predominance of *Pocillopora meandrina* is not surprising as this species is considered a "pioneer species". That is, it is the first species to inhabit newly cleared substratum and can persist in areas that are too harsh for other species. *Pocillopora meandrina* is typically the most common coral on a wave impacted shallow reefs in Hawaii (Dollar, 1982; Dollar and Tribble, 1993).



Figure 3-12. Two views of basaltic boulders colonized by *Pocillopora meandrina* in the nearshore area off Kalepa Point

With increasing distance from shore, other species of coral colonize the boulder surfaces. These include *Porites lobata*, which is the overall most abundant coral on Hawaiian reefs. *Porites lobata* occurs in a variety of growth forms, ranging from flat encrustations to dome-shaped structures. Other species observed on the mid-reef were *Pocillopora grandis* and several species of *Montipora* (*M. flabellata*, *M. patula*, and *M. capitata*). All the species of *Montipora* occurred as flat encrusting growth forms (Figure 3-13).

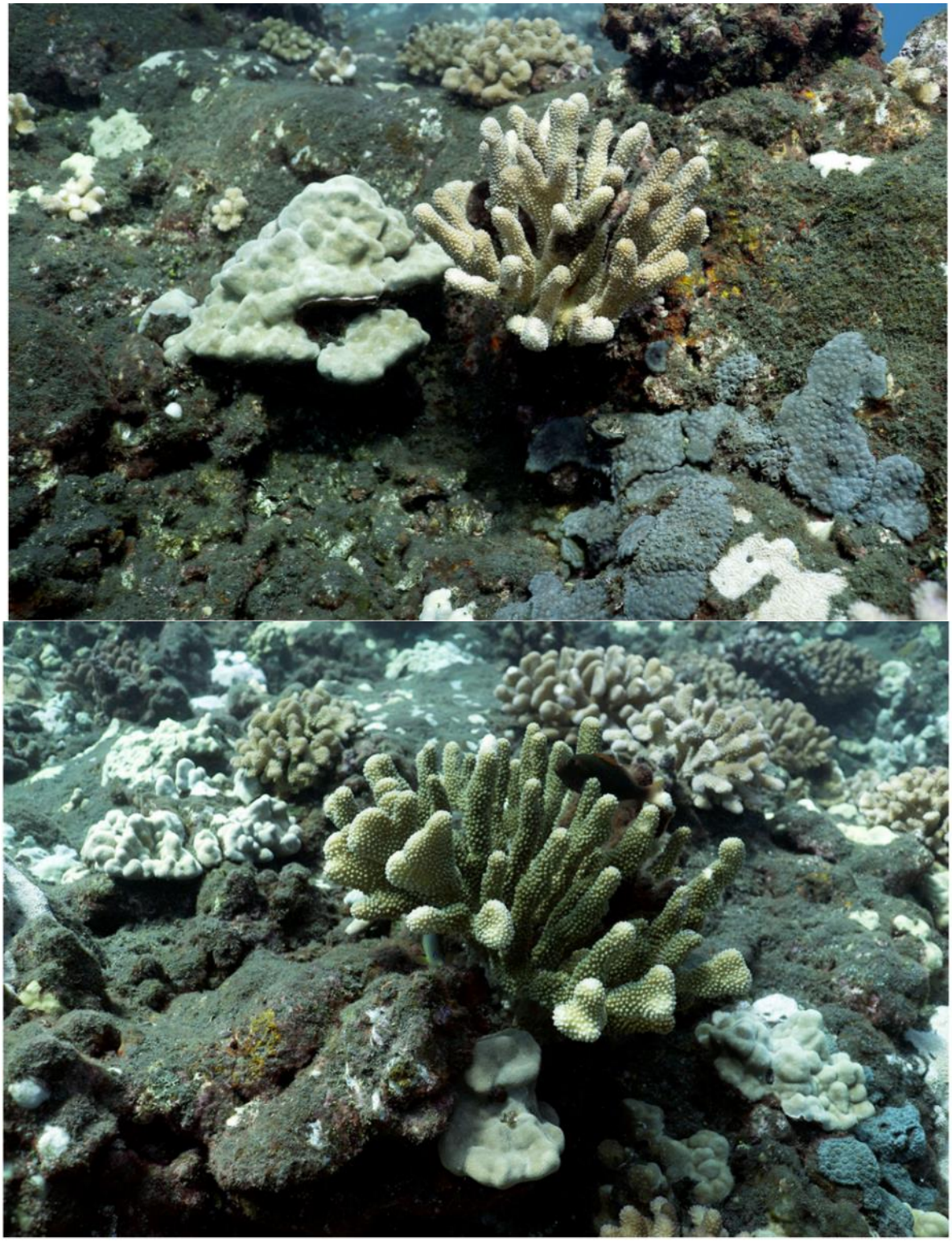


Figure 3-13. Two views of colonies of branching Pocillopora grandis and dome-shaped Porites lobata on Kalepa Point reef platform. Water depth is approximately 33 feet

In terms of benthic community structure off Kalepa Point is the predominance of a species of colonial *Zoanthus* that occurs as mats growing on the boulder and platform surfaces. While this species is often seen on Hawaiian reefs, it generally occurs as small, isolated colonies. In contrast, at Kalepa Point it was observed as extensive expanses that sometimes covered the entirety of boulder surfaces (Figure 3-14).

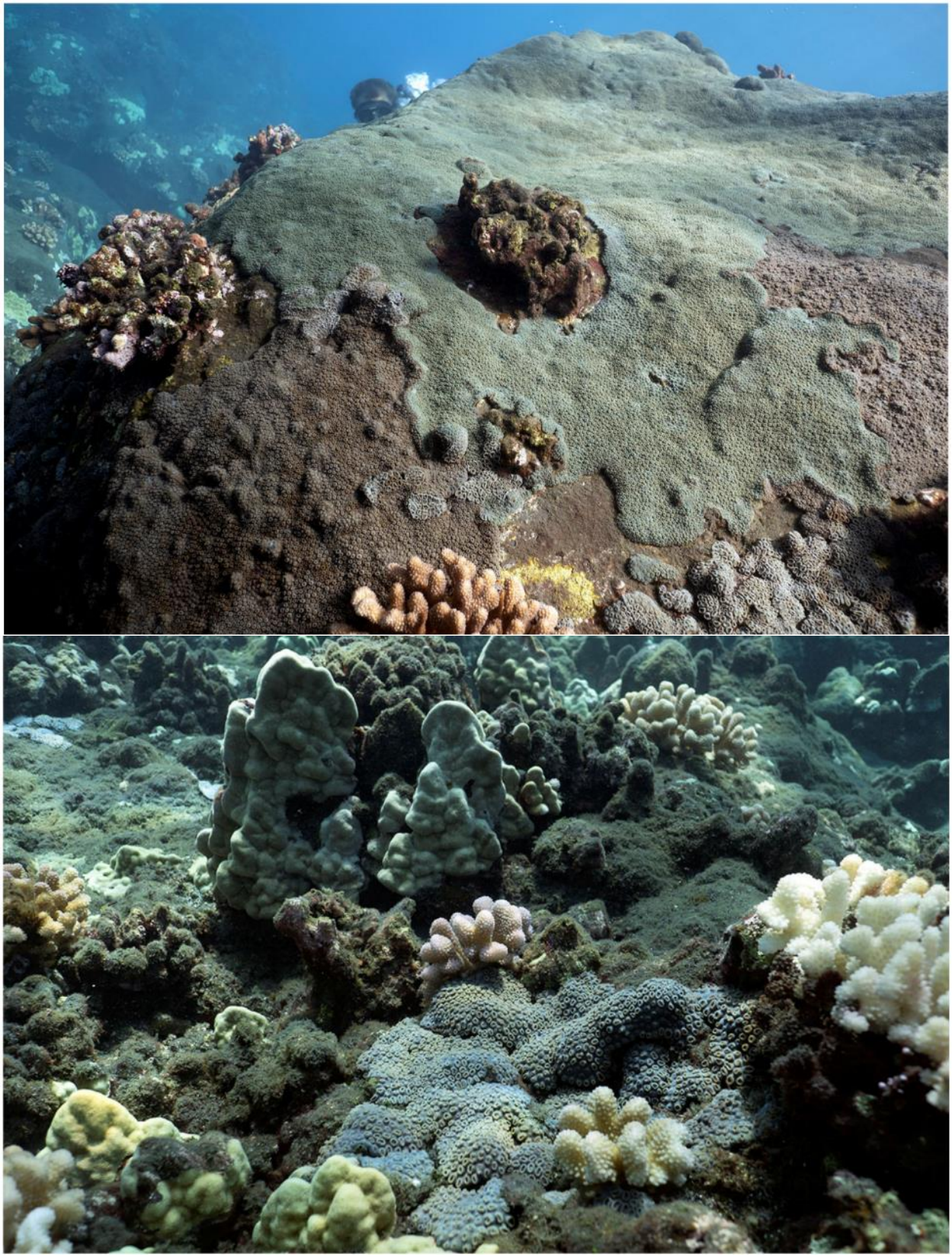


Figure 3-14. Two views of mats of colonial *Zoanthus* sp. on boulders (top) and reef platform (bottom)

At approximately 150 feet from shore, where bottom structure grades from boulders to a flat platform, coral species included clumps of *Porites compressa*, often referred to as "finger coral" (Figure 3-15). As the growth form of this species is very susceptible to breakage from wave impact, it is restricted to the flatter bottom and deeper water habitats on the reef.

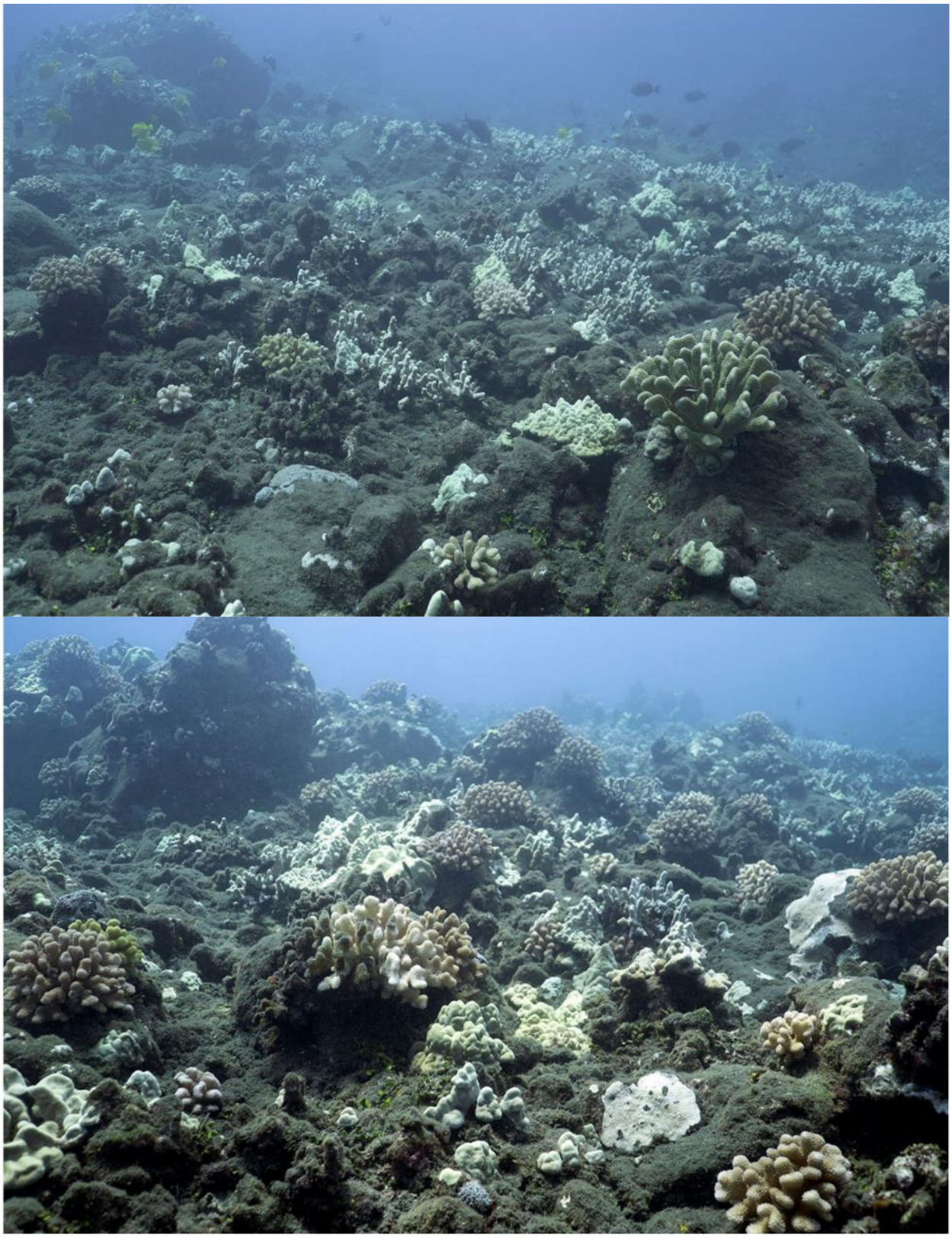


Figure 3-15. Two views of basaltic platform colonized by a mixed assemblage of coral species including *Pocillopora meandrina*, *Porites lobata* and *Porites compressa*. Water depth is approximately 26 feet

Motile macro-invertebrates, or invertebrates that are capable of motion and are large enough to be seen, were essentially absent from the survey area. Particularly conspicuous by their absence were sea urchins, which are generally common in nearshore reef areas throughout the Hawaiian Islands. Typically, the most common urchin on Hawaiian reefs, *Echinometra matheai* burrow into the limestone reef platform, and are thus somewhat protected from wave stress. As the reef surface at Kalepa is entirely basalt, with essentially no limestone, no urchins of the species *Echinometra matheai* were observed. Larger urchins that typically occur on the surface of the reef such as *Heteroxenous mammilatus*, *Echinothrix diadema*, and *Diadema paucispinum* were not observed in the survey area. No sea cucumbers (e.g., *Actinopyga spp*., *Holothuria spp*.) were observed. The lack of motile benthic invertebrates is consistent with surveys of areas that are subjected to constant wave forces and/or shifting sediment which result in physical conditions too harsh for these species.

Frondose, or leafy, benthic algae were uncommon throughout the study area. The high wave energy and continual scouring action of moving water appear to be a limiting factor for many species of fleshy frondose algae on the reef platforms.

Reef fish were abundant throughout the entire survey area. The most common and conspicuous fish were the surgeonfish (*Acanthuridea*), wrasses (*Labridae*), butterfly fish (*Chaetodontidae*), and dameselfish (*Pomacentridae*). Particularly abundant were several species of goatfish (*Mullidae*) that occurred in schools throughout the survey area (Figure 3-16). The abundance of fish is likely a response to abundant habitat space and low fishing pressure in the area.



Figure 3-16. Two views of basaltic boulder zone inhabited by a variety of reef fish

Green sea turtles (*Chelonia mydas*) are commonly found within the nearshore areas of Maui. However, no turtles were observed during the present survey, although they undoubtedly occur on the reefs off the Kalepa Point site.

Results of this baseline study reveal that the composition of the nearshore area consists of a boulder field that extends from the shoreline through the nearshore ocean and terminates in a basalt platform that extends seaward beyond the limits of the survey. The predominant biotic composition of the area is a coral community consisting of relatively few species, based on the physiological and growth form tolerance to high levels of water movement in the form of breaking waves. Fish community structure was rich with typical reef species, likely in response to low fishing pressure at the remote location.

Potential Impacts and Proposed Mitigation Measures

Construction will be accomplished using conventional heavy equipment and will proceed from one end of the project and progress to the opposite end, east to west or west to east. After the revetment has been repaired, the retaining wall will be constructed. A temporary increase in turbidity levels in the immediate area of construction is expected; however, this will be mitigated by the employment of BMPs to restrict or eliminate any transfer of terrigenous material to the marine environment. BMPs and environmental protection measures to be employed are summarized in Section 6.1 and will include the flowing general requirements.

- The water area affected by construction shall be monitored. If monitoring indicates that turbidity standards are being exceeded, construction shall be suspended until the condition is corrected.
- The construction contractor shall be required to employ standard BMPs for construction in coastal waters, such as daily inspection of equipment for conditions that could cause spills or leaks; cleaning of equipment prior to operation near the water; proper location of storage, refueling, and servicing sites away from the water; implementation of adequate on-site spill response procedures; and stormy weather preparation plans.
- All construction activities shall be confined to the immediate area of construction, and no excess construction material shall be stockpiled in the water.
- Construction materials (e.g., stone and concrete) shall be inert and free of earthen and any other terrigenous substances.

It is not likely that the proposed action to repair the road at Kalepa Point would have any negative effect on existing biotic communities. The boulder zone extends seaward to a distance that is likely beyond the limit of influence of any shoreline activities. As the area is essentially an open coastline subjected to wind, waves, and tides, normal currents flush the area on a regular basis, preventing the buildup of any input of materials from land. In addition, biota inhabiting the area appears to be pre-adapted to substantial wave stress that would facilitate rapid removal of any terrigenous input to the marine environment.

Following the completion of construction, the affected water body is expected to return to its pre-construction condition. No long-term effects on water quality or water circulation in the proposed project site are expected. Negligible impacts on the marine environment in the proposed project site are anticipated, and any impacts will be mitigated and isolated through best management practices.

3.1.14 Scenic and Open Space Resources

Existing Conditions

The roadway at Kalepa Point offers views and scenery of the ocean and south Maui coastline. Many small rocky islands and sea stacks fringe this coast and are visible from the elevated roadway. On clear days, motorists and pedestrians can view the volcanoes of Hawaii Island from the roadway at Kalepa Point. The dirt area by the Alelele Bridge is a popular spot for people to stop and take photos.

Potential Impacts and Proposed Mitigation Measures

During construction there will be construction equipment and construction materials at the site and staging areas. There will be ongoing construction adjacent to and on the roadway during this time. As construction is temporary, the proposed project will have negligible long-term impacts to scenic and open space resources once construction equipment and materials are removed at the end of the proposed project. All staging materials and environmental controls, such as silt fences, will be removed and staging areas will be restored to their pre-construction condition. The final views after the proposed action will be the same as the pre-project conditions along the roadway.

3.1.15 Archaeological Resources

Existing Conditions

Archaeological resources were assessed by Scientific Consultant Services Inc. (SCS) through a literature review of previous archaeological surveys of the Kaaapahu Ahupuaa, Kipahulu District on the island of Maui. SCS also completed an archaeological field inspection on September 9, 2021 at the project area and on April 7, 2024 at the proposed construction staging areas west of the project site (Appendix G – A Literature Review And Field Inspection For The Kalepa Revetment And Seawall Repairs Proposed Project (Scientific Consultant Services, Inc.) and Appendix H – A Cultural Impact Assessment Report in Advance of the Proposed Hana Highway at Kalepa Point Road Repairs Proposed Project (Scientific Consultant Services, Inc.)). The literature review and field inspection identified potential archeological resources in the proposed project site and its vicinity, as well as provided a brief cultural history of the proposed project site.

The historical research included the study of archival sources, historical maps, land commission awards, secondary historical sources, and previous archaeological reports. This research was conducted to construct a history of land use and to determine if archaeological sites have been recorded on or are likely to be recorded on the proposed project site and the terrain adjacent to the proposed project site.

The field work entailed a 100% pedestrian survey of the proposed construction area, as well as the adjacent beach south of Kalepa Point and Alelele Stream. The survey was conducted to identify any surface archaeological features and to investigate and assess the potential for impacts on such archaeological sites. The assessment also identified any sensitive areas that may require further investigation or mitigation before work on the proposed project proceeds.

The Kipahulu District is rich in archaeological resources with a wide variety of recorded site types and occurrences. Rock shelters and other exposed bedrock features, such as overhangs, with evidence of human occupation are common in Kipahulu. In some parts of Kipahulu, these exposed bedrock features extend all the way down to the seashore, making them attractive locations for

habitation and planting features. Burials were also suspected to be present in such caves. Previous archaeology in the area has identified agricultural features, such as walls, terraces, and mounds, as well as habitation features, including "C" shaped structures. Several heiau have also been identified in the area. Unlike other parts of Maui, Kipahulu has not been subject to extensive urbanization or development. Available physiographic, archaeological, and historical evidence suggests a high probability for finding pre-contact archaeological sites and features in the survey area, particularly as those that had been previously recorded remained intact through time.

The archival research and literature search identified several previous archaeological studies that have been conducted in the vicinity of the proposed project site and multiple archaeological sites that have been identified around the proposed project site. Research suggests limited potential for archaeological sites within the proposed project site (Figure 3-17).

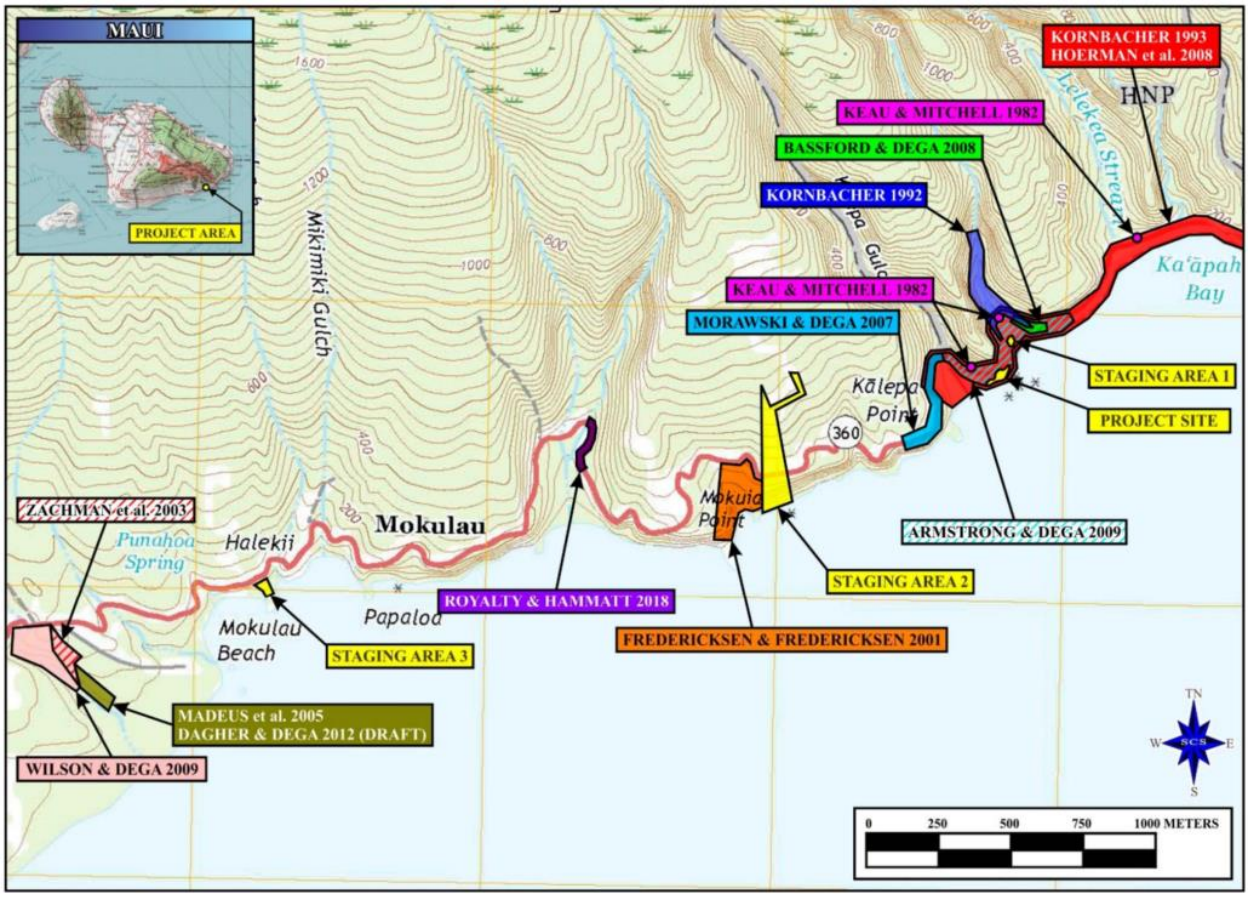


Figure 3-17. A portion of a 2017 USGS map showing previously identified archaeology in the vicinity of the proposed project site and three potential staging areas

The pedestrian survey of the immediate proposed project site and proposed construction staging areas did not lead to the identification of any new surface archaeological sites of any non-modern temporal period. The proposed project site has seen significant damage to a previously present guardrail, which is no longer intact. No Pre-Contact surface features were observed during the pedestrian survey of the stone shoreline and nearby beach to the east and west of the proposed project site, which is an area primarily accessed by tourists during the late summer and early fall.

The construction staging areas were also assessed to have no identified historic properties or archaeological resources present. They were identified to be low risk for containing archaeological resources or cultural resources. The proposed project site is associated with a roadway and accordingly is a previously utilized environment. While the field investigation did not include subsurface testing, the likelihood of disturbing any subterranean cultural deposits during the proposed project is extremely unlikely. SCS does note that there is potential to observe terraces on the landward portion of the proposed construction staging area TMK (2)-1-7-001:006. As staging at this location will be limited to the adjacent road shoulder area the landward portion of the site will be limited, thus the potential to observe such terraces during the project is limited.

The accessible archaeological sites adjacent to the proposed project site are those along a now prohibited hiking trail along Alelele Stream, Kalepa Fishing Shrine (SIHP Site 50-50-16-01130), and the King's Trail (SIHP Site 50-50-16-03143) a cobbled-based conduit used by Hawaiians to facilitate travel around the island. All other archaeological sites that had previously been accessible routes have since been overgrown and hidden by thick growth of razor grass (*Paspalum virgatum L.*) and hala (*Pandanus tectorius*). A previously identified trail in the area, State Inventory of Historic Properties (SIHP site # 50-50-16-06577), is no longer easily accessible and is likewise overgrown and eroded.

Potential Impacts and Proposed Mitigation Measures

No archeological sites were observed in the immediate proposed project site and sites identified during the literature review are not easily accessible and not likely to be disturbed by permitted actions. While any ground altering or subsurface activities associated with the proposed project is not expected to negatively impact any archaeologically significant sites or structures, SHPD will be consulted regarding any ground disturbance.

3.1.16 Cultural Resources

Existing Conditions

Scientific Consultants Services Inc. (SCS) completed a Cultural Impact Assessment (CIA) in accordance with the Guidelines for Assessing Cultural Impacts (Office of Environmental Quality Control 1997:11-13)(Appendix H – A Cultural Impact Assessment Report in Advance of the Proposed Hana Highway at Kalepa Point Road Repairs Proposed Project (Scientific Consultant Services, Inc.). The purpose of a CIA is to identify the possibility of on-going cultural activities and resources within a proposed project site, or its vicinity, and then assess the potential for impacts on these cultural resources. The guidelines recommend that a CIA consult relevant individuals/organizations, conduct ethnographic interviews and archival and historical research, identify cultural resources and practices located within the proposed project area or in proximity, and finally, assess the impact of the proposed action and its mitigation measures on the cultural practices or resources identified.

SCS sent letters of inquiry to forty-six individuals and organizations that may have knowledge or information pertaining to the collection of cultural resources and/or practices currently in Kaaapahu Ahupuaa of Kipahulu District via the U.S. Postal Service and e-mail. Written responses

received from fifteen individuals and two interviews identified valued cultural, historical, or natural resources near the proposed project area and adjacent environments.

Background and supporting information were obtained from historical and cultural source materials provided by scholars such as Samuel Kamakau, Martha Bechwith, Jon J. Chinen, Lilikala Kameeleihiwa, R. S. Kuykendall, Marion Kelly, E. S. C. Handy, E. G. Handy, Elspeth P. Sterling, Mary Kawena Pukui, and Samuel H. Elbert. The works of these and other authors were consulted and incorporated into the report where appropriate. Land use document research was supplied by the Waihona Aina Database (2021) and the Office of Hawaiian Affairs Kipua Database (2021) (Appendix H – A Cultural Impact Assessment Report in Advance of the Proposed Hana Highway at Kalepa Point Road Repairs Proposed Project (Scientific Consultant Services, Inc.)).

As the geographical extent of the CIA study should be greater than the area over which the proposed project extends to ensure that cultural practices that occur outside of the proposed project site, but which may still be affected, are included in the assessment. Thus, for the proposes of the CIA, completed by SCS, the entire Kaaapahu Ahupuaa was assessed.

During the consultation process, the cultural practices and cultural resources identified included burials, flora and fauna, freshwater resources, coastal resources, marine environments resources, trails, and historic properties.

Hawaii mortuary practices include interring the dead in pits, coffins, crypts, cairns, cists, or other structural monuments. Structural monuments include lava tubes, blisters, and caves which are known to be in the cliff face immediately above the proposed project site. Some of which have been documented including SIHP site #50-50-16-6486. Three individuals who participated in the consultation process mentioned these burials. Stakeholders involved with this proposed project should remain aware of their presence. One individual with generational ties to the area stated that her grandmother knew the names of the individuals who were buried in the cliffs and never shared that information with anyone because that information was too sacred.

The flora and fauna in and near the proposed project site provide a wide variety of natural resources that were previously and continue to be used in cultural practices. Numerous native plants grow in the surrounding area, many of which continue to be used for traditional purposes including medicinal, ceremonial, and as food sources. The koae kea (white-tailed tropic bird/*Phaethon rubricauda* and *P. lepturus*) is a cultural resource associated with the cliffs above Kalepa Point area, as pointed out by Dr. Scott Fisher in his interview. These birds have long tailed feathers which are used to make kahili, a feather standard symbolic of royalty, and a source of food. At one time koa trees (*Acacia Koa*) were abundant throughout the area. Traditional uses of this tree include using the wood to make canoes, ceremonial purposes, and to make surfboards.

The coastal area historically and presently provides cultural resources for subsistence and ceremonial purposes. Families continue to supplement their diet with a variety of freshwater and coastal fish, snails, mollusks, and algae found in Alelele Stream, Kaaapahu, and Lelekēa Bay.

Overland trails form an important component of traditional settlement landscapes forming linkages between individual communities, particularly along the leeward coasts of the Hawaiian Islands. Trails in Kipahulu extend parallel to the coastline or landward – seaward between the upland and

the coast. The Hana Belt highway follows an earlier trail, the Alanui o Piilani, which was a foot trail. These trails continue to be used for travel in the area, to access cultural resources, and ceremonial areas, including burials.

No additional cultural resources or cultural practices were identified within the Kalepa Point road repair segment of the Hana Belt Highway. However, valued cultural and natural resources have been identified in the surrounding environment. These include the human burials, including the rockshelter and human burial designated as SIHP site # 50-50-16-6486, and those human burials reported to be in the cliff face above the proposed project area by the cultural contacts during the current consultation process. Also, freshwater, near coastal/marine resources, native flora, and fauna used for food, medicine, and ceremonial purposes are traditional cultural practices which were identified during the consultation process.

Potential Impacts and Proposed Mitigation Measures

Due to the proximity of cultural resources, consultation with the State Historic Preservation Division is to be conducted prior to the commencement of ground altering activities to determine appropriate mitigation measures to protect historic properties from impacts throughout the duration of the proposed project. Additional mitigation measures will be part of the BMPs to protect cultural resources identified through the consultation process and to allow native Hawaiians to continue to conduct cultural activities by providing alternative access to identified cultural resources throughout the duration of the proposed project.

3.2 Socio-Economic Environment

3.2.1 Surrounding Land Use

Existing Conditions

Maui Island is in the County of Maui. Maui County is the second largest county in the State of Hawaii. It includes four major islands with a land area of 1,173.5 square miles. Maui Island is the economic center and seat of county government. Maui Island has a land area of 772 square miles. (State of Hawaii Department of Business, Economic Development & Tourism, 2021) The land adjacent to the roadway is zoned as Agricultural, Conservation, or Interim. The parcels inland of the roadway are owned by the United States Government National Parks Service and are within the boundaries of the Haleakala National Park (Figure 3-18 and Figure 3-19).

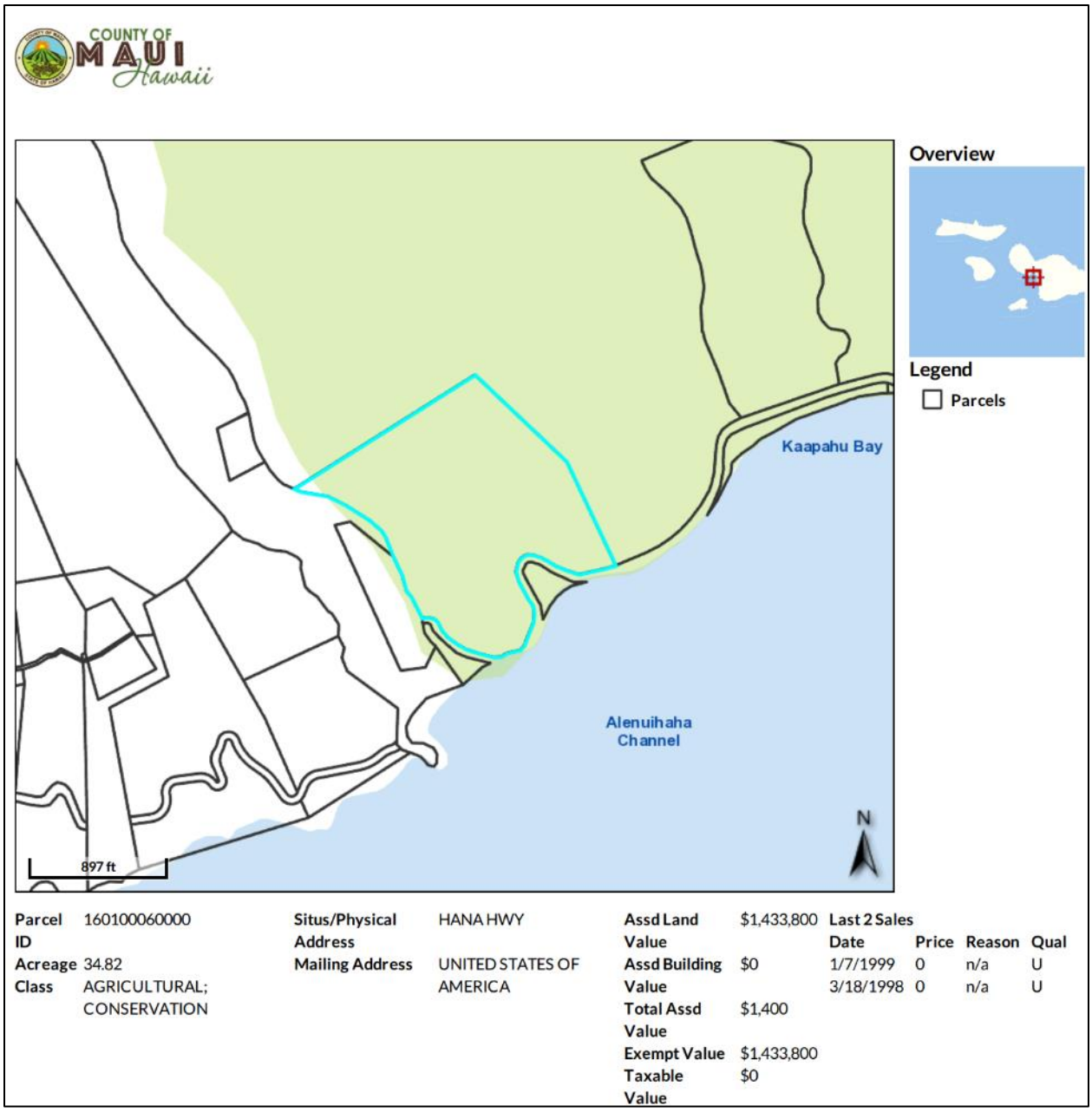


Figure 3-18. Maui County real property tax assessment website map real property tax assessment website map of TMK: (2)-1-6-010:006, zoned agricultural; conservation (County of Maui's real property tax assessment website. 2021)

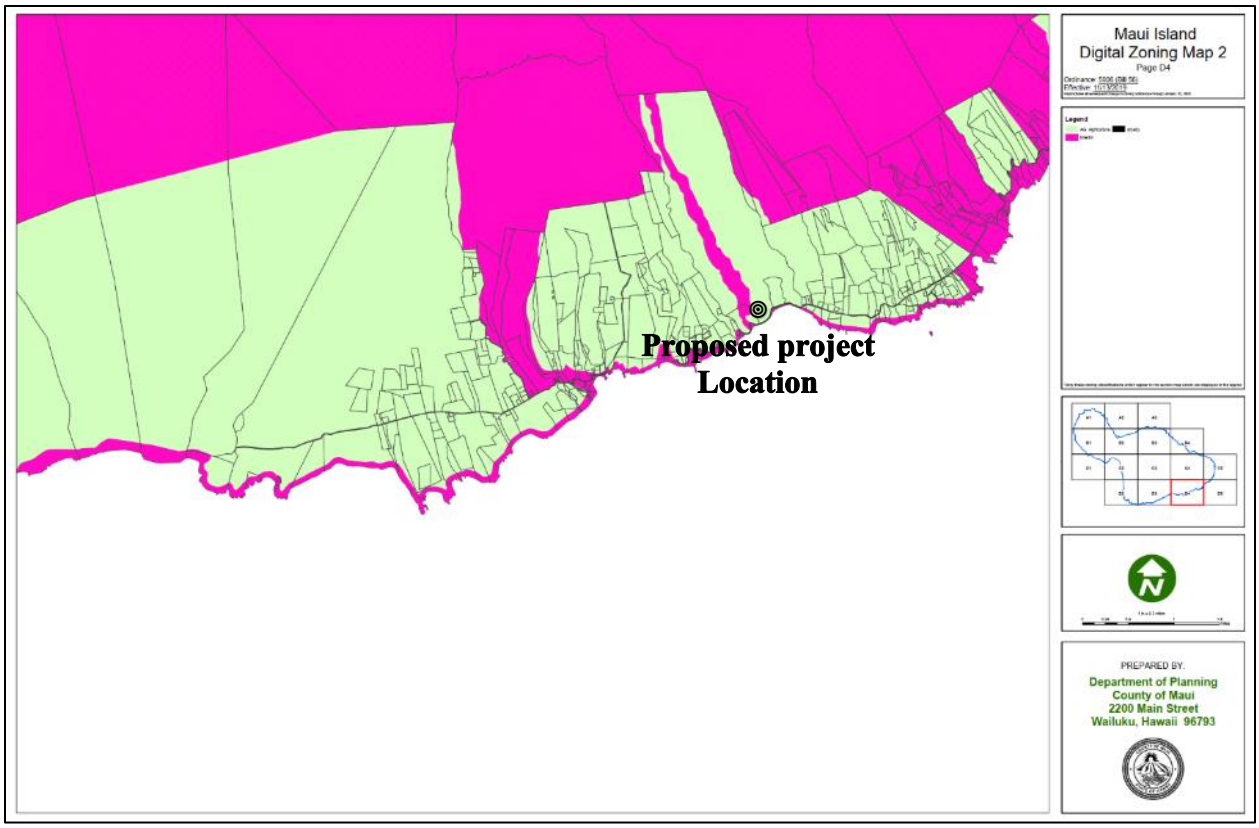


Figure 3-19. Maui County Maui Island digital zoning map 2, page D4, green is zoned AG agriculture, and pink is zoned interim (County of Maui's Department of Planning)

Potential Impacts and Proposed Mitigation Measures

The proposed project is anticipated to have negligible impact on the surrounding land use, and therefore no mitigation measures are required.

3.2.2 Population and Demography

Existing Conditions

The area around Kalepa Point is sparsely populated. Kaupo, a remote ranching community, is located to the west of the proposed project site. There is no population information available for this community. The proposed project site is in the Hana Census Tract and in the 2020 Census Redistricting Data, the total population of this large area of Maui was 1,526 people. The total population of Maui County was 164,754 people. In the 2007 – 2011 American Community Survey 5-year Estimate, the total population of this large area of Maui was between 1 – 2,500 people. (Figure 3-20) (State of Hawaii Department of Business, Economic Development & Tourism Research and Economic Analysis Division Hawaii State Data Center, 2013).

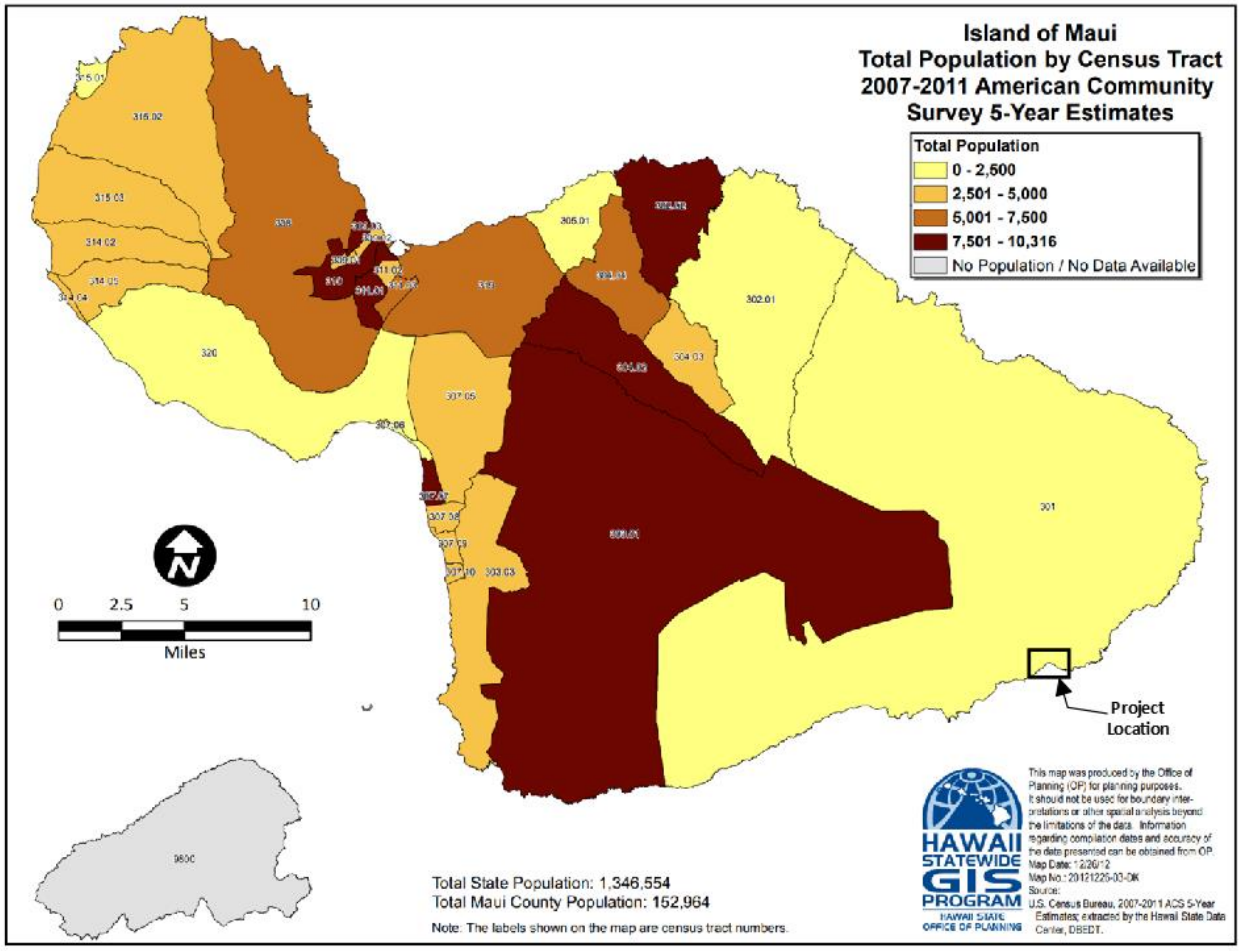


Figure 3-20. Island of Maui total population total population by census tract 2007-2011. Proposed, proposed project site is in census tract located in census tract 301 (State of Hawaii Department of Business, Economic Development & Tourism Research and Economic Analysis Division Hawaii State Data Center, 2013)

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have an impact on local population and demography, and therefore no mitigation measures are required.

3.3 Public Services

3.3.1 Police and Fire Protection

Existing Conditions

The nearest police station to the proposed project site is in Hana, 14 miles northeast of Kalepa Point via the Hana Highway, State Route 360. The next closest police station to the proposed project site is the Maui Police Department in Wailuku, 51 miles northwest of Kalepa Point via the Piilani Highway, County Route 31.

The nearest fire station to the proposed project site is in Hana 14 miles northeast of Kalepa Point via the Hana Highway, State Route 360. The next closest fire station to the proposed project site is in Kula, 34 miles west of Kalepa Point via the Piilani Highway, County Route 31. During

construction of the project the Contractor will coordinate with county and state emergency agencies to maximize access for emergency vehicles servicing the residents of the surrounding areas to minimize disruptions to emergency services.

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have a long-term impact on police or fire protection. During the proposed project Contractor coordination with county and state emergency agencies will aid in minimizing potential impacts to emergency vehicle access to the residents of the surrounding areas. Once completed the proposed project will improve access for police and fire protection due to the improvements to this critical transportation artery that services the region.

3.3.2 Medical Facilities

Existing Conditions

The nearest hospital to the proposed project site is in Kula, 30 miles northwest of Kalepa Point via the Piilani Highway, County Route 31. This facility services much of southeast Maui, including communities that are located east of Kalepa Point.

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have an impact on medical facilities, and therefore no mitigation measures are required.

3.3.3 Educational Facilities

Existing Conditions

The nearest K-12 schools to the proposed project site are in Kula and Hana. School buses must pass through the proposed project site to and from school each day with the students from the surrounding communities. Because of this road closures for construction will occur from 8:30 to 3:30 during the weekdays to allow school buses and vehicles taking students to and from school each day to pass through the project site.

Potential Impacts and Proposed Mitigation Measures

The proposed project is not anticipated to have an impact on educational facilities. The project is anticipated to have a temporary impact on transportation to and from school for students in the community that must transit through the proposed project site. This impact will be mitigated through the coordination of the Contractor with State and private schools and residents in the proposed project area that utilize the road to access educational facilities. Therefore, the mitigation measures are required.

3.3.4 Recreation

Existing Conditions

Alelele cove if used by locals and visitors to access the shoreline and as a place to recreate. Due to the remote location and rough and unpredictable ocean conditions along the proposed project shoreline, the area around Kalepa Point is not as popular for ocean recreation as other beaches found on Maui. However, locals and visitors alike do stop at the small pullout area. Additionally, people do access the shoreline for fishing and diving at other locations near the proposed project site.

Potential Impacts and Proposed Mitigation Measures

During the construction of the proposed project access to the areas surrounding the proposed project site will be limited. The Contractor shall, to the best of their ability, maintain access to these areas for recreation. It is anticipated that during the course of the proposed project there will need to be some limitations placed on access to ensure the safety of the public. Such limitation shall be determined by the Contractor based on construction of the proposed project. The proposed project is not anticipated to have a long-term impact on recreation, and therefore no long-term mitigation measures are required.

3.4 Infrastructure

3.4.1 Roadways

Existing Conditions

Hana Highway (State Route 360) is the only route around Kalepa Point for vehicular traffic. Hana Highway transitions to Piilani Highway (County Route 31) at Kalepa Bridge to the west of the proposed project site.

Potential Impacts and Proposed Mitigation Measures

The proposed project would provide critically needed repairs and improvement to the Hana Highway at Kalepa Point: repair approximately 500 feet of damaged road protection, repave approximately 0.25 miles of damaged roadway, and replace damaged steel guardrails with concrete guardrails. Improvements include increasing roadway width. The proposed project is expected to have important beneficial impacts to the community by maintaining passage along the roadway. During construction, intermittent disruptions to through traffic are anticipated. During the repairs of the rock rubblemound revetment and road. Closures of the road will be required during weekday daytime working hours. Daytime construction will require the road to be closed to traffic for approximately 7 hours a day during daylight hours, 8:30 am. To 3:30 pm, Monday through Friday. It is anticipated that the road will be re-opened to vehicle traffic during nights and weekends, 3:30 pm to 8:30 am. Due to the limited road width and limited access, there may be periods of time during the construction of the proposed project that the road will need to be closed for extended periods of time for safety reasons, longer than the anticipated 8:30 am to 3:30 pm. Closures may be required for several days during certain phases of construction. Road closures will be kept, as much as feasibility possible, to a minimum to ensure a working environment clear from vehicle traffic. Public notices of scheduled road closures will be made to the community to advise when road closures will be required for the proposed project. After construction, the proposed project is anticipated to positively impact this section of roadway due to its increased width, mitigation of shoreline erosion, and new concrete guard rails. The proposed project is anticipated to have negligible impact on other local roadways.

3.4.2 Drainage System

Existing Conditions

There is no drainage infrastructure in the proposed project vicinity. Presently, rainwater that falls on the road collects in depressions or runs off the roadway into the ocean.

Potential Impacts and Proposed Mitigation Measures

The proposed project will improve roadway drainage along this stretch of Hana Highway. The new pavement would be sloped towards the ocean to allow rainwater to runoff the roadway and the concrete barriers and retaining wall will have weep holes to allow for drainage off the road and from behind the retaining wall.

3.4.3 Electrical, Telephone and Cable Television Services

Existing Conditions

Utility poles and overhead lines are located on the seaward side of the roadway at Kalepa Point.

Potential Impacts and Proposed Mitigation Measures

Utility poles along Hana Highway at Kalepa Point will be relocated as necessary. The proposed project is anticipated to have negligible impact on electrical, telephone, and cable television services, and therefore no mitigation measures are required.

4. POTENTIAL IMPACTS OF NO ACTION

No action would consist of not implementing the proposed action and allowing the road and road protection to continue to degrade and fall further into disrepair. This will at some point lead to failure of the road requiring condemnation and closure of Hana Highway at Kalepa Point. The highways on either side of the point would dead-end at Kalepa Point.

The existing condition of Hana Highway at Kalepa Point is one of severe disrepair in some areas. Much of the existing road protection has failed, exposing under-sized stones and previous CRM stonework. In some sections the edge of the highway has also begun to erode. Without protection, the condition of the highway is expected to further degrade, and the road will eventually need to be condemned and closed to vehicle traffic due to inadequate road width for vehicle access.

The socioeconomic effects of condemning Hana Highway at Kalepa Point would be significant. Impacts on the local community due to limited access would include access to emergency services, medical facilities, education facilities, recreational facilities, and access to other various services. There is no alternate route around Kalepa Point, thus a road closure would result in a 95-mile (approximately 4 hours driving time) detour around Haleakala. The road closure would delay the response time of emergency services including police, ambulance, and fire department, causing a negative impact to public health and welfare.

5. RELATIONSHIP TO RELEVANT PLANS, POLICIES, AND CONTROLS

The county, state, and federal governments all have different policies and rules to guide the direction of the future of these entities. The following sections discuss the proposed project's relationships to various county, state, and federal policies.

5.1 County of Maui

Coastal lands landward of the shoreline are classified as Special Management Areas (SMA), and County of Maui rules and regulations apply.

5.1.1 Countywide Policy Plan

The Countywide Policy Plan provides broad goals, objectives, policies, and implementing actions that portray the desired direction of the future of the County of Maui (County of Maui 2030 General Plan, 2010). The Countywide Policy Plan provides these to the year 2030. Improving physical infrastructure is one of the eleven core themes of the plan. The Countywide Policy Plan notes that the County's transportation system is vital to the health of the economy, the island's communities, and the daily lives of County residents. Part of this transportation system is the roads of the County, of which conditions, capacity and current volumes vary tremendously. The plan notes that some of the County roads are narrow, winding, and incredibly scenic. While the capacity of these roads is relatively low, the experience of traveling these roads in their current state is more valuable than increasing capacity. Piilani Highway at Kalepa Point is one such narrow, winding and incredibly scenic road where the experience of traveling the road is valuable.

The goals, objectives, policies, and actions of the Countywide Policy Plan include the following key strategies, H) Diversify Transportation Options, and I) Improve Physical Infrastructure.

Strategy H, Diversify Transportation Options, has the following goal:

> *"Goal: Maui County will have an efficient, economical, and environmentally sensitive means of moving people and goods."*

Part of this goal includes ensuring that roadway systems are safe, efficient, and maintained in good condition. It also includes preserving roadway corridors that have historic, scenic, or unique physical attributes that enhance the character and scenic resources of communities.

The Kalepa Point road repairs will ensure that this scenic and unique roadway remains protected from existing shoreline erosion, into the future.

Strategy I, Improve Physical Infrastructure, has the following goal:

> *"Goal: Maui County's physical infrastructure will be maintained in optimum condition and will provide for and effectively serve the needs of the County through clean and sustainable technologies"*

The Kalepa Point road repairs project involves maintenance and improvement of County of Maui's physical infrastructure and is therefore well aligned with Countywide Policy Plan.

5.1.2 Maui Island Plan

The Maui Island Plan is a blueprint that provides direction for future growth, the economy, and social and environmental decisions on the island through 2030 (Maui Island Plan General Plan 2030).

Chapter 2, Heritage Resources of the Maui Island Plan discusses Scenic Resources including how the East Maui portion of the Hana Highway, like the Kalepa Point road, is famous for its legendary cliff, ocean, rainforest, waterfall, and valley views. Goal 2.5 of the Heritage Resources of the Maui Island Plan states that:

> *"Goal 2.5: Maui will continue to be a beautiful island steeped in coastal, mountain, open space, and historically significant views that are preserved to enrich the residents' quality of life, attract visitors, provide a connection to the past, and promote a sense of place."*

Objective 2.5.1 of this goal is:

> *"Objective 2.5.1: A greater level of protection for scenic resources."*

Policies 2.5.1.e to meet these goals is:

> *"Policy 2.5.1.e: Protect scenic resources along Maui's scenic roadway corridors."*

The proposed Kalepa Point Road Repair proposed project is well aligned with these goals, objectives, and policies by protecting the scenic resource along Kalepa Point road from future damage due to large ocean waves.

Chapter 3, Natural Hazards of the Maui Island Plan discusses mitigation, risk, and vulnerability that should be addressed for specific natural hazards. Of the natural hazards listed, tropical cyclones and sea level rise were specifically addressed in the design of the Kalepa Point Road Repairs.

The specific risks outlined in Table 3-1 of the Maui County General Plan 2030 (2010) are:

> *Tropical Cyclones:*
> *"Tropical Cyclone" is a general term that can describe tropical depressions, tropical storms, and hurricanes. The systems are classified according to maximum sustained wind speeds. These storms generally affect Maui from June through November. In addition to high wind damage, tropical cyclones impart riverine (non-coastal) flooding, freshwater coastal flooding, high surf damage, highly destructive storm surge, and severe flooding in low-elevation areas with insufficient drainage. Maui's unique topography concentrates torrential rains on mountain slopes, resulting in destructive flash floods and landslides. Even a relatively weak tropical system can have the potential to result in considerable property damage and loss of life. Major tropical cyclones on average occur once every 10 years.*

> *Sea Level Rise:*
> *The University of Hawaii Coastal Geology Center has predicted that the sea level will rise in the coming decades. This would impact all coastlines, and would most severely affect Maui's developed, low-lying communities: Maalaea, North Kihei, Lahaina, Kaanapali, and Kahului. Prudent land use planning will consider possible sea-level rise as a variable in the future.*

The goal from Chapter 3, Natural Hazards of the Maui Island Plan, is that Maui will be disaster resilient, through the objective of greater protection of life and property. The Kalepa Point Road Repair proposed project is well aligned with policy 3.1.2.d which states:

> *"Policy: 3.1.2.d Encourage the use of construction techniques that reduce the potential for damage from natural hazards."*

The proposed Kalepa Point Road Repair project accounts for both tropical cyclones and sea level rise in the design of the road repairs and will use construction techniques that will reduce the potential damage from the future natural hazards identified.

The Maui Island Plan also discusses infrastructure and public facilities in Chapter 6:

> *"Streets and highways are currently the primary infrastructure supporting Maui's transportation system and play a major role in shaping settlement patterns. The quality of the roadway system affects various modes of travel including automobile, transit, bicycle, and pedestrian. The condition of Maui's roadway system also impacts the safety of all roadway users, the movement of goods and products, efficiency of emergency public services, and quality of life. This system experiences increasing demand associated with island growth and development. A key outcome, therefore, is to maintain, improve, and expand where necessary the existing roadway system, and expand multimodal transportation to improve traffic flow, safety, and efficiency."*

The proposed project is intended to maintain and improve the County of Maui Route 31 and is therefore well aligned with the Maui Island Plan.

5.1.3 Hana Community Plan

The Hana Community Plan develop in 1994 is one of nine community plans for the County of Maui. It reflects current and anticipated conditions in the Hana region, advances planning goals, objectives, policies, and implementation considerations to guide decision making in the region through the year 2010. The Hana Community Plan provides specific recommendations to guide government action and decision making in the Hana community (Hana Community Plan, 1994).

In Part II -Description of the Region and its Problems and Opportunities, Section B.1. Problems, Infrastructure is identified as one of the problems identified. Infrastructure needs to be in balance with environmental and cultural sensitivities of the region. Roadways are listed as an example, where improvements to Hana Highway need to be balanced with the character of the community it serves, namely its rural character. Improvements to the Hana Highway are needed to protect the roadway from existing shoreline erosion.

Part III - Policy Recommendations, Implementing Actions and Standards for the Hana Region - discusses physical infrastructure with the goal of timely, environmentally sensitive development and maintenance of infrastructure systems which protect and preserve the safety and health of the Hana region's residents and visitors. Effective transportation systems are part of this goal. Objectives and policies include improving road conditions through more frequent resurfacing and repair and encouraging a program of roadway safety improvements including installation of guardrails. Implementation of these objectives and policies include improving Hana Highway to allow safe passage of two-way traffic. Currently two-way traffic is not possible around Kalepa Point due to the damaged and narrow road. The Kalepa Point road repairs will repair the road surface and widen the road with which will allow for two-way traffic around Kalepa Point once completed. Another implementing action of the community plan is the improvement of Piilani Highway as an alternative route to Hana. The Kalepa Point road repairs are critical for maintaining this alternate route to Hana.

Part III - Policy Recommendations, Implementing Actions and Standards for the Hana Region - also discusses a planning standard where, to help maintain the intent of the land use and urban design objectives and policies, roadways, including highways, shall not exceed 20 feet in pavement width, except in residential areas where on-street parking is desired. The Kalepa Point Road repairs will maintain the road width under the 20-foot limit discussed.

5.2 State of Hawaii Laws and Regulations

5.2.1 Hawaii State Planning Act

The Hawaii State Planning Act (Chapter 226 HRS), which was signed into law in 1978, was established to "improve the planning process in this state, to increase the effectiveness of government and private actions, to improve coordination among different agencies and levels of government, to provide the wise use of Hawaii's resources and to guide the future development of the state". Specific objectives and policies of the Hawaii State Planning Act that are relevant to the proposed project include Section 226-11, 226-12, 226-13, and 226-17.

Section 226-11 Objectives and policies for the physical environment – land-based, shoreline, and marine resources.

- *(a) Planning for the State's physical environment with regard to land-based, shoreline, and marine resources shall be directed towards achievement of the following objectives:*
  - *(1) Prudent use of Hawaii's land-based, shoreline, and marine resources.*
  - *(2) Effective protection of Hawaii's unique and fragile environmental resources.*
- *(b) To achieve the land-based, shoreline, and marine resources objectives, it shall be the policy of this State to:*
  - *(1) Exercise an overall conservation ethic in the use of Hawaii's natural resources.*
  - *(2) Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.*
  - *(3) Take into account the physical attributes of areas when planning and designing activities and facilities.*
  - *(4) Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.*

(5) Consider multiple uses in watershed areas, provided such uses do not detrimentally affect water quality and recharge functions.
(6) Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii.
(7) Provide public incentives that encourage private actions to protect significant natural resources from degradation or unnecessary depletion.
(8) Pursue compatible relationships among activities, facilities, and natural resources.
(9) Promote increased accessibility and prudent use of inland and shoreline areas for public recreational, educational, and scientific purposes.

The proposed project's use of the area is consistent with State and County land use districts and zoning designations. No endangered plant species, animal species, or habitats are found in the proposed project area. The proposed project is not anticipated to pose threats to Native Hawaiian endangered plant or animal species or habitats (Sections 3.1.10, 3.1.11, and 3.1.12). The federally listed threatened green sea turtle may be found in the proposed project area (Section 3.1.12). National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NOAA-NMFS) recommended turtle avoidance procedures will be utilized during construction to avoid potential impacts.

Construction activities will be limited to daylight hours and will not use construction work lights to avoid attracting seabirds or disorienting sea turtles. The proposed project has minimal intrusion into the marine environment and is not anticipated to have significant or substantial impacts on environmental and marine resources.

Section 226-12 Objectives and policies for the physical environment – scenic, natural beauty, and historic resources.

(a) Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawaii's scenic assets, natural beauty, and multi-cultural/historical resources.
(b) To achieve the scenic, natural beauty, and historic resources objectives, it shall be the policy of the State to:
(1) Promote the preservation and restoration of significant natural and historic resources.
(2) Provide incentives to maintain and enhance historic, cultural, and scenic amenities.
(3) Promote the preservation of views and vistas to enhance the landscapes, and other natural features.
(4) Protect those special areas, structures, and elements that are an integral and functional part of Hawaii's ethnic and cultural heritage.
(5) *Encourage the design of developments and activities that complement the natural beauty of the islands.*

The proposed project will not result in adverse impacts to existing scenic vistas or archaeological/historical resources at the proposed project site. The proposed revetment crest elevation is eight to thirteen feet below the roadway elevation. The concrete retaining wall will extend above this to the existing grade of the roadway. The new concrete guard rails will be 42 inches tall per code requirement. The rock rubblemound portion of the structure will be similar in appearance to the present shoreline. A historical/archaeological review was conducted for the

proposed project, and no effects on historical or archaeological resources are anticipated. The Kalepa Point Road repairs has been designed to minimize the need for road closures of Hana Highway due to damage from natural hazards, ensuring access to the scenic coastline with its natural features and historic resources on the east side of Maui for the public. The current roadway is currently at risk of additional damage and possible closure due to large waves and other natural hazards and disasters.

Section 226-13 Objectives and policies for the physical environment – land, air, and water quality.

(a) Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:
  (1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.
  (2) Greater public awareness and appreciation of Hawaii's environmental resources.

(b) To achieve the land, air, and water quality objectives, it shall be the policy of the State to:
  (1) Foster educational activities that promote a better understanding of Hawaii's limited environmental resources.
  (2) Promote the proper management of Hawaii's land and water resources.
  (3) Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters.
  (4) Encourage actions to maintain or improve aural and air quality levels to enhance the health and well-being of Hawaii's people.
  (5) Reduce the threat to life and property from erosion, flooding, tsunamis, hurricanes, earthquakes, volcanic eruptions, and other natural or man-induced hazards and disasters.
  (6) Encourage design and construction practices that enhance the physical qualities of Hawaii's communities.
  (7) Encourage urban developments in close proximity to existing services and facilities.
  (8) Foster recognition of the importance and value of the land, air, and water resources to Hawaii's people, their cultures, and visitors.

The proposed project will reduce the threat to life and property from erosion, tsunamis, and hurricane by protecting the Kalepa Point Road from these natural hazards. The Kalepa Point roadway provides primary access for east Maui communities via the Piilani and Hana Highways. The proposed project is appropriately scaled and will not adversely affect coastal resources. Use of construction BMPs will minimize adverse effects on land, air, and water quality.

Section 226-17 Objectives and policies for facility systems -- Transportation.

(a) Planning for the State's facility systems with regard to transportation shall be directed towards the achievement of the following objectives:
  (1) An integrated multi-modal transportation system that services statewide needs and promotes the efficient, economical, safe, and convenient movement of people and goods.
  (2) A statewide transportation system that is consistent with and will accommodate planned growth objectives throughout the State.

(b) To achieve the transportation objectives, it shall be the policy of this State to:

(1) Design, program, and develop a multi-modal system in conformance with desired growth and physical development as stated in this chapter;
(2) Coordinate state, county, federal, and private transportation activities, and programs toward the achievement of statewide objectives;
(3) Encourage a reasonable distribution of financial responsibilities for transportation among participating governmental and private parties;
(4) Provide for improved accessibility to shipping, docking, and storage facilities;
(5) Promote a reasonable level and variety of mass transportation services that adequately meet statewide and community needs;
(6) Encourage transportation systems that serve to accommodate present and future development needs of communities;
(7) Encourage a variety of carriers to offer increased opportunities and advantages to interisland movement of people and goods;
(8) Increase the capacities of airport and harbor systems and support facilities to effectively accommodate transshipment and storage needs;
(9) Encourage the development of transportation systems and programs which would assist statewide economic growth and diversification;
(10) Encourage the design and development of transportation systems sensitive to the needs of affected communities and the quality of Hawaii's natural environment;
(11) Encourage safe and convenient use of low-cost, energy-efficient, non-polluting means of transportation;
(12) Coordinate intergovernmental land use and transportation planning activities to ensure the timely delivery of supporting transportation infrastructure in order to accommodate planned growth objectives; and
(13) Encourage diversification of transportation modes and infrastructure to promote alternate fuels and energy efficiency.

The proposed project will enable the continued efficient, economical, and convenient movement of people and goods through this area of Maui. Loss of this roadway would have significant detrimental impacts to both the supply of basic services to the community and possible future growth opportunities.

5.2.2 State Land Use Laws

Pursuant to Chapter 205A, Hawaii Revised Statutes, all lands in the State have been divided and placed into one of four land use districts by the State Land Use Commission. These land use districts have been designated "Urban", "Rural", "Agricultural", and "Conservation". Conservation District lands are further broken down into four (4) subzones that dictate what types of development can and cannot take place. These subzones, from most restrictive to least restrictive, are (1) Protective, (2) Limited, (3) Resource, and (4) General. The Conservation District has an additional subzone – Special, which is unique for each location it is applied to.

Coastal Lands include beaches, dunes, and rocky shorelines that are seaward of County jurisdictions. The Coastal Lands in the location of the proposed project are considered part of the Conservation District, Protective, Limited, and General Subzones (Figure 5-1). The DLNR Office

of Conservation and Coastal Lands (OCCL) is responsible for the management of these coastal resources. The Hawaii Board of Land and Natural Resources (BLNR) regulates the use of the State Conservation District by issuing Conservation District Use Permits (CDUP) for approved activities. Statutes governing the use of and the administration procedures of the Conservation District are written in Hawaii Revised Statutes, Chapter 183C (HRS Chapter 183C Conservation District). The administration is further clarified by the Hawaii Administration Rules, Title 13, Chapter 5 (HAR §13-5 Conservation District).

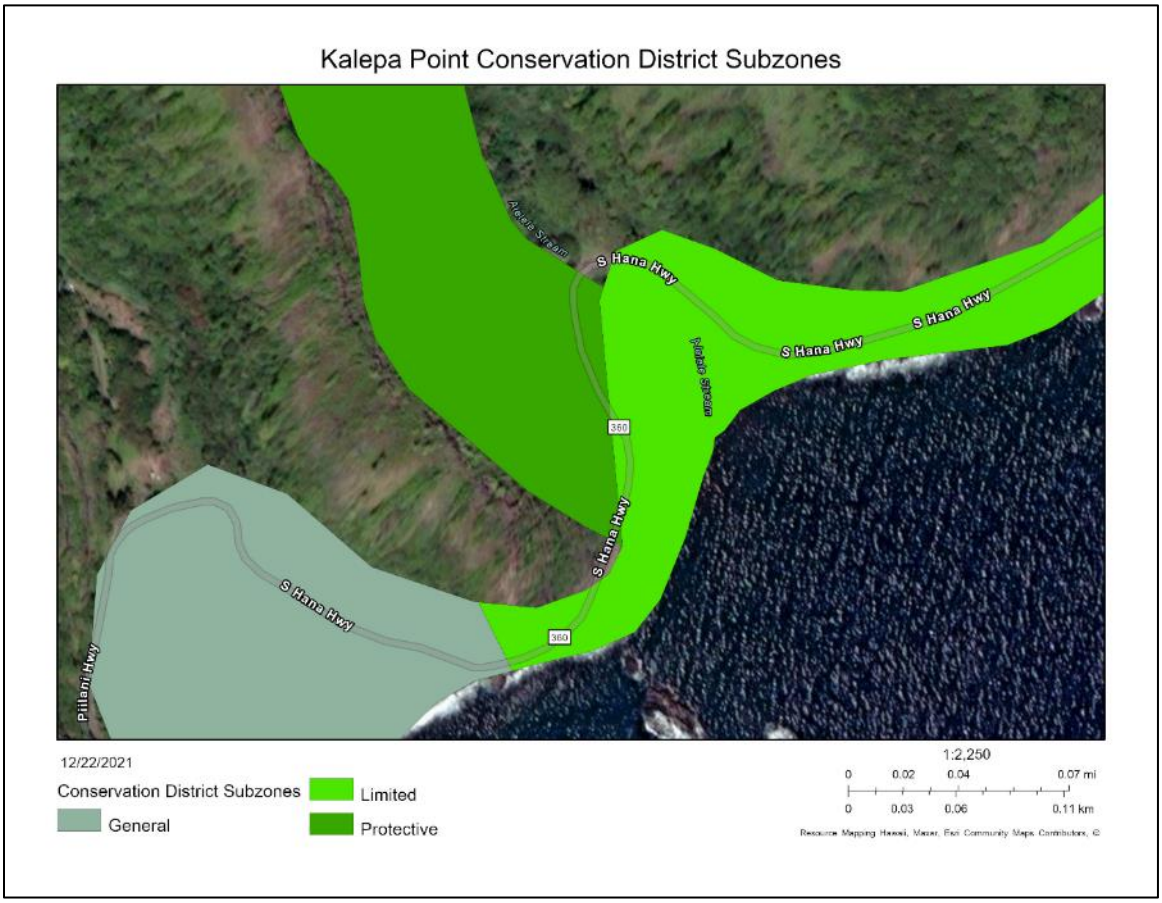


Figure 5-1. Kalepa Point conservation district subzones

Subchapter 3 Section §13-5-22 of the Hawaii Administration Rules, Title 13, Chapter 5 lists the identified land uses in the protective subzone. The identified land use for the proposed actions are P-6 Public Purpose Uses and P-15 Shoreline Erosion Control.

As specified in HAR §13-5-22 Land Use P-6 Public Purpose Uses D-1:

> *"(D-1) Not for profit land uses undertaken in support of a public service by an agency of the county, state, or federal government, or by an independent non-governmental entity, except that an independent non-governmental regulated public utility may be considered to be engaged in a public purpose use. Examples of public purpose uses may include but are not limited to public roads, marinas, harbors, airports, trails, water systems and other utilities, energy generation from renewable sources, communication systems, flood or*

> *erosion control projects, recreational facilities, community centers, and other public purpose uses, intended to benefit the public in accordance with public policy and the purpose of the conservation district."*

The proposed project is a not-for-profit land use undertaken in support of a public service by the County of Maui. The proposed project is the repair of a public road intended to benefit the public.

As specified in HAR §13-5-22 Land Use P-15 Shoreline Erosion Control D-1:

> *"(D-1) Seawall, revetment, groin, or other coastal erosion control structure or device, including sand placement, to control erosion of land or inland area by coastal waters, provided that the applicant shows that (1) the applicant would be deprived of all reasonable use of the land or building without the permit;(2) the use would not adversely affect beach processes or lateral public access along the shoreline, without adequately compensating the State for its loss; or (3) public facilities (e.g., public roads) critical to public health, safety, and welfare would be severely damaged or destroyed without a shoreline erosion control structure, and there are no reasonable alternatives (e.g., relocation). Requires a shoreline certification."*

Presently, revetment and CRM wall structures protect the roadway at Kalepa Point but are in a substantially deteriorated condition due to damage from storm waves. The proposed project is to repair existing shoreline erosion control by installing a hybrid revetment/wall designed to current codes and accounting for hurricane waves and future sea level rise. Erosion control repair is critical to public health and welfare. The roadway may be severely damaged or destroyed without the proposed project in the future. Relocating the road is not trivial due to the natural rock headland located at Kalepa Point. The relocation alternatives have not been fully studied or engineered though they are expected to be an order of magnitude that is more costly and time consuming than the proposed road repair project.

5.3 Federal Acts and Legislation

5.3.1 Archaeological and Historic Preservation Acts

Consultation with the State Historic Preservation Division (SHPD) will be accomplished to ensure that the proposed project complies with the provisions of the Preservation of Historical and Archeological Data Act, as amended (54 USC 312501 et seq.) and the Historic Preservation Act, as amended (NHPA) (54 USC 300101 et seq.). If necessary, an NHPA Section 106 review will be accomplished during federal, Department of the Army, permit processing for work in the water.

5.3.2 Clean Air Act (42 U.S.C. § 7401 et seq.)

The only emissions associated with the proposed project would be during construction. Once construction is completed the proposed project is not expected to produce any emissions. The proposed project is consistent with the provisions of the Clean Air Act.

5.3.3 Clean Water Act (CWA) of 1977, as Amended (33 USC §1251 et seq.)

The Clean Water Act (CWA) is the key legislation governing surface water quality protection in the United States. Sections 401, 402, and 404 of the Act require permits for actions that involve wastewater discharges or discharge of dredged or fill material into waters of the United States. The

placement of stone into nearshore marine waters constitutes fill as defined in the CWA and is subject to regulations implementing the CWA. An application will be made to the Department of the Army for authorization to construct the proposed project under Section 404 of the CWA. Should the Department of the Army determine that an Individual Permit is required, a Section 401 Water Quality Certification application will be submitted to the State of Hawaii Department of Health Clean Water Branch.

5.3.4 Rivers and Harbors Act (33 USC §403)

Section 10 of the Rivers and Harbors Act, 33 USC §403, requires a Department of the Army permit for any activity that obstructs or alters navigable waters of the U.S., or the course, location, condition, or capacity of any port, harbor, refuge, or enclosure within the limits of any breakwater, or of the channel of any navigable water.

The revetment stones will be placed seaward of the mean high-water line, which is in the navigable waters of the U.S. An application will be made to the Department of the Army for authorization to construct the proposed project under Section 10 of the River and Harbors Act.

5.3.5 Coastal Zone Management Act (16 U.S.C. § 1456 et seq.)

The Federal Coastal Zone Management Act of 1972 (16 USC §§1451-1464) was established as a United States National policy to preserve, protect, develop, and where possible, restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations. The Act encourages coastal states to develop and implement coastal zone management plans.

Enacted as Chapter 205A, HRS, the Hawaii Coastal Zone Management (CZM) Program was developed in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses the entire state, including all marine waters seaward to the extent of the state's police power and management authority, as well as the 12-mile U.S. territorial sea and all archipelagic waters. Application will be made to the State Office of Planning, CZM Program, for CZM Federal Consistency Determination.

The relationship of the project to the objectives and policies of the CZM program listed in 205A-2, HRS, are as follows:

1. Recreational Resources

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

- Improve coordination and funding of coastal recreational planning and management;
- Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area;
- Protect coastal resources uniquely suited for recreational activities that cannot be provided in other areas;
- Require replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be

unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;
- Provide and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;
- Provide an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;
- Ensure public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;
- Adopt water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;
- Develop new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and
- Encourage reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the Land Use Commission, Board of Land and Natural Resources, and county authorities.

Discussion: The proposed project includes repair of the existing roadway and shoreline protection. The proposed project is anticipated to have negligible long-term effects on coastal recreation opportunities or accessibility at the proposed project or in the region.

2. Historic Resources

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.

Policies:
- Identify and analyze significant archaeological resources;
- Maximize information retention through preservation of remains and artifacts or salvage operations; and
- Support state goals for protection, restoration, interpretation, and display of historic resources.

Discussion: The State Historic Preservation Division (SHPD) will be consulted to determine requirements for the proposed project to comply with Section 106 of the National Historic Preservation Act and Hawaii Revised Statutes (HRS) §6E-8. The construction specifications will contain provisions to protect any historic resources and alert the proper agencies should any be found during the construction activities.

3. Scenic and Open Space Resources

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

Policies:

- Identify valued scenic resources in the coastal zone management area;
- Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;
- Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and
- Encourage those developments that are not coastal dependent to locate in inland areas.

Discussion: The proposed project is the protection and improvement of a scenic roadway. Construction of the proposed project is temporary and will have negligible long-term impacts on the scenic and open space resources once construction equipment and materials are removed at the end of the proposed project. All staging materials and environmental controls, such as silt fences, will be removed and staging areas will be restored to their pre-construction condition. The final visa, after the proposed project, will be like the pre-project conditions along the roadway. The proposed project is anticipated to have negligible effects on scenic and open space resources.

4. Coastal Ecosystems

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

Policies:

- Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;
- Improve the technical basis for natural resource management;
- Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;
- Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and
- Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.

Discussion: The proposed project is not anticipated to have any significant long-term impacts on coastal ecosystems. The proposed project construction specifications will include requirements which will reduce, minimize, and avoid the potential for adverse impacts during construction to the maximum extent practicable. Marine biota surveys have shown that much of the affected area to be loose rock or other mobile substrate. The creation of a hard, stable habitat for shelter and colonization on the proposed revetment may increase marine species abundance.

5. Economic Uses

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

Policies:

- Concentrate coastal dependent development in appropriate areas;
- Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and
- Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:
- Use of presently designated locations is not feasible;
- Adverse environmental effects are minimized; and
- The development is important to the State's economy.

Discussion: The proposed project is anticipated to have negligible effects on economic uses.

6. Coastal Hazards

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

Policies:

- Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;
- Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;
- Ensure that developments comply with requirements of the Federal Flood Insurance Program; and
- Prevent coastal flooding from inland proposed projects.

Discussion: The proposed project is anticipated to reduce hazard to life and property from storm waves such as those that originally damaged the roadway in 2014 from Hurricane Iselle. The existing rock rubblemound revetment is in disrepair and at risk of failure. Should the road be compromised further there will be risks to life and property along this stretch of the highway.

7. Managing Development

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

Policies:

- Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;
- Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and
- Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

Discussion: All anticipated impacts of the proposed project will be communicated to the public and concerned agencies. The permitting and approval process will provide an opportunity for public participation and discussion in the plan formulation process.

8. Public Participation

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

Policies:

- Promote public involvement in coastal zone management processes;
- Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and
- Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

Discussion: The public is given an opportunity to review and comment on the proposed project through the DEA as part of the public review process. Further opportunities for public involvement will be available during the permitting process.

9. Beach Protection

Objective: Protect beaches for public use and recreation.

Policies:

- Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;
- Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and
- Minimize the construction of public erosion-protection structures seaward of the shoreline.

Discussion: The proposed project shoreline is a rocky headland, presently protected by revetment and CRM wall structures that are in a substantially deteriorated condition due to damage from

storm waves. There are no sandy beaches in the proposed project area. Therefore, the proposed project is anticipated to have negligible effects on beaches. There are several cobble stone beaches in the region, however, they are outside the proposed project area and are not anticipated to be impacted by the proposed project during construction or after construction.

10. Marine Resources

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

Policies:

- Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;
- Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;
- Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;
- Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and
- Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.

Discussion: The proposed project is anticipated to have negligible effects on marine and coastal resources. The proposed project plan will be fully coordinated with federal and state marine resource agencies, including NOAA/NMFS, USFWS, USEPA and DLNR-DAR.

5.3.6 Endangered Species Act (16 USC §1531 et seq.)

The Endangered Species Act (16 U.S.C. §§ 1531et seq., December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contain exceptions and exemptions.

Endangered turtles and monk seals have been observed in the nearshore waters near the proposed project site. The Best Management Practices Plan will outline a plan for avoiding impacts to endangered species in the work area, including utilization of the appropriate Pac-SLOPES guidelines provided by the National Marine Fisheries Service. Additional requirements to avoid impacts on endangered species may be imposed by marine resource agencies during the permitting and review process.

5.3.7 Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 USC §§661 et seq.)

The FWCA provides for consultation with the USFWS and other relevant Federal and State agencies when a federal action proposes to modify or control U.S. waters for any purpose. This consultation will be initiated during the Federal permitting process.

5.3.8 Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.)

The Magnuson-Stevens Act (16 USC §1801 et seq.), as amended by the Sustainable Fisheries Act, PL 104-297, calls for action to stop or reverse the loss of marine fish habitat. The waters out to 200 nautical miles around the Hawaiian Islands are under the jurisdiction of the Western Pacific Regional Fishery Management Council (WPRFMC). The WPRFMC has approved a Fisheries Management Plans for Hawaii that designates all the ocean waters surrounding Oahu, from the shore to depths of over 100 feet, including the area that would be affected by the proposed project as Essential Fish Habitat (EFH).

The WPRFMC has also identified Habitat Areas of Particular Concern (HAPC). As defined in the 1996 amendments to the Act, these habitats are a subset of EFH that are “rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area".

The proposed project site is in the intertidal and very shallow waters. The area is in the EFH Habitat Mapper, thus further investigation was completed by MRCI. This investigation resulted in the finding that the proposed project area does not appear to have the listed organisms. In addition, the area is not withing an HAPC. AS such, good engineering and design practices will be utilized to eliminate, minimize, or mitigate any potential but unforeseen impacts to EFH. These actions are summarized in the BMPP and include the pertinent guides within the Pac-SLOPES documents.

5.3.9 Migratory Bird Treaty Act of 1918, as Amended (16 USC §§703 et seq.) and EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds

The Migratory Bird Treaty Act is a bilateral migratory bird treaty with Canada, Mexico, Japan, and Russia. Sections 703 to 712 of the Act prohibit the taking of migratory birds in the absence of a permit.

Under Executive Order 13186, dated January 10, 2001, all Federal agencies taking actions that have, or are likely to have, a measurable negative impact on migratory bird populations are directed to develop and implement a Memorandum of Understanding with USFWS that promotes the conservation of migratory bird populations.

The Best Management Practices Plan will include methods of reducing impacts on birds within the proposed project location. Additional requirements may be imposed by resource agencies during the permit review process to minimize impacts to migratory birds.

5.3.10 National Historic Preservation Act (NHPA) of 1966 (16 USC §470 et seq.)

Section 106 of the NHPA of 1966, 16 USC §470 et seq., as amended, requires federal agencies having direct or indirect jurisdiction over a federal undertaking to take into account effects on any district, site, building, structure, or object that is included or is eligible for inclusion in the National

Register of Historic Places prior to the approval of expenditure of any funds or issuance of any license or permit.

If necessary, a NHPA Section 106 review will be accomplished during the federal Department of the Army, permit processing for the work in the water.

5.3.11 Other Federal Laws

Other federal laws that may affect the proposed project:

Marine Mammal Protection Act of 1972, as amended ((16 USC §§ 1361 et seq.)
EO 13089, Coral Reef Protection (63 FR 32701 et seq.)(1998)
EO 12898, Environmental Justice (59 FR 7629)(1994)
Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC § 3001)

6. MITIGATION MEASURES DURING CONSTRUCTION

6.1 Best Management Practices Plan

Although no significant adverse environmental impacts are anticipated to arise from the proposed project, a Best Management Practices Plan (BMPP) will be developed as a mitigation measure to ensure that adequate protective measures are in place during construction of the road repairs. The plan will be designed to prevent or minimize adverse impacts on the environment during construction. The proposed project specifications will require the contractor to adhere to environmental protection measures detailed in the plan.

6.2 Protection of Endangered Species

To protect endangered species that may approach the proposed project location during construction of the proposed project, the following rules, as recommended by the National Marine Fisheries Service (NMFS), shall be adhered to during construction of the proposed project:

- Contractor shall establish a safety zone around the proposed project location whereby a designated person shall visually monitor this zone for marine protected species 30 minutes prior to, during, and 30 minutes post daily proposed project activity. Contractor shall record information on the species, numbers, behavior, time of observation, location, start and end times of proposed project activity, sex, or age class (when possible), and any other disturbances (visual or acoustic).
- If a marine protected species is in the area, either hauled out onshore or in the nearshore waters, a 150-foot buffer must be observed with no humans approaching it. If a monk seal/pup pair is seen, a minimum 300-foot buffer must be observed.
- In the event a marine protected species enters the safety zone, and the proposed project activity cannot be halted, contractor shall conduct observations and immediately contact NMFS staff in Honolulu to facilitate agency assessment of collected data. For monk seals contact the NOAA Marine Wildlife Hotline: (888) 256-9840, as well as the monk seal hotline at (808) 220-7802. For turtles, contact the turtle hotline at (808) 983-5730.
- For on-site proposed project personnel that may interact with a listed species potentially present in the action area, contractor shall provide education on the status of any listed species and the protections afforded to those species under federal laws. NMFS may be contacted for scheduling educational briefings to convey information on marine mammal behavior and explain why and when to call NMFS and other resource agencies.

Additionally, the Effects of Implementing Standard Local Operating Procedures for Endangered Species in Central and Western Pacific Region on Endangered Species Act (ESA) Listed Sea Turtles and Marine Mammals will be used to ensure that the proposed project actions meet requirements of the ESA with procedures that are simple to use, efficient, and accountable for all parties (Pac-SLOPES 2010).

6.3 Archaeological Monitoring

Should any unanticipated archaeological sites, such as walls, platforms, pavements and mounds, or remains such as artifacts, burials, concentrations of charcoal or shells be uncovered during construction of the proposed project, all work shall cease in the immediate area and the contractor

shall notify the State Historic Preservation Office. No work shall resume until the owner/contractor obtains clearance from the State Historic Preservation Office.

7. FINDINGS SUPPORTING THE ANTICIPATED DETERMINATION

Chapter 343, Hawaii Revised Statutes (HRS), and Hawaii Administrative rules (HAR) §11-200.1, establish certain categories of action that require the agency processing an applicant's request for approval to prepare an Environmental Assessment. HAR §11-200.1-14 established procedures for determining if an Environmental Assessment (EA) is sufficient or if an Environmental Impact Statement (EIS) should be prepared for actions that may have a significant effect on the environment. Based on analysis presented in this document, a Finding of No Significant Impact (FONSI) is anticipated for the proposed project, and an EIS will therefore not be required. HAR §11-200.1-13 lists the following criteria to be used in making such a determination:

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource.*

The natural, archaeological, and cultural landscapes have been documented in studies conducted specifically for the proposed project. As detailed in *Section 3.1.13, 3.1.15, and 3.1.16* of this DEA, the proposed project does not involve any known loss or destruction of existing natural, cultural, archaeological, or historical resources. Due to the existing roadway and high-energy rocky shoreline at the proposed project site, there is a very low expectation for the occurrence of historic properties. If any cultural or archaeological resources are unearthed or ancestral remains are inadvertently discovered during construction, the DLNR, SHPD, the Maui Lanai Island Burial Council representative and participating interests from lineal descendants and individuals will be notified. The treatment of these resources will be conducted in strict compliance with the applicable historic preservation and burial laws.

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

Permeable rock rubblemound revetment structures are intrinsically designed to absorb a significant fraction of incoming wave energy and thereby reduce the level of potentially harmful reflected waves, which tend to energize nearfield erosional processes. The rock rubblemound revetment is designed to protect the existing shoreline and adjacent roadway from further damage, particularly to large storm wave events, like the one that damaged it in 2014. No negative impact on public lateral access to the shoreline is expected. The lateral shoreline access in this area is dangerous and difficult due to the exposure to rough seas and natural steep and rocky shorelines. There are no expected impacts to fishing or other cultural activities on the areas surrounding the proposed project site.

3. *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 343, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders.*

The proposed project is consistent with, and does not conflict with, the Hawaii's State Environmental Policy as established in HRS Chapter 343, and any revisions thereof and amendment thereto, court decisions, or executive orders. See Section 5.1 for discussion of the proposed project's consistency with plans, policies, and controls of the County of Maui. See

Section 5.2 for discussion of the proposed project's consistency with plans, policies, and controls of the State of Hawaii.

As required by §343-5(1), (2), (3), Applicability and Requirements, an Environmental Assessment is required for actions that (1) Propose the use of county lands or the use of county funds. The proposed project is on county lands and will use county funds. (2) Use within land classified as conservation district. The proposed project will be within lands classified as conservation district. And (3) Use within a shoreline area. The proposed project is within a shoreline area.

4. *Substantially affects the economic welfare, social welfare, and cultural practices of the community or State.*

The proposed project will not have any substantial affects on the economic welfare, social welfare, or cultural practices of the community or state. The proposed project is intended to repair the existing roadway allowing continued access to East Maui for residents and visitors.

5. *Substantially affects public health.*

The proposed project will not have any affects on public health. There will be limited air quality impacts and increases to noise levels during construction due to the use of construction equipment and vehicles. The construction contractor will coordinate with the County of Maui to mitigate access to the road for emergency vehicles should the road be impassable during construction periods. There will be long term public health benefit from having a road to travel for emergency vehicles and residents around Kalepa Point.

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

The proposed project will not have any substantial secondary impacts, such as population changes or effects on public facilities. The road repair will restore the existing roadway to pre-storm damage conditions and improve the protection of the road at Kalepa Point from existing shoreline erosion. The shoreline erosion improvements and repair of the roadway will not have any secondary impacts on public facilities in the area.

7. *Involves a substantial degradation of environmental quality.*

The proposed project will not involve a substantial degradation of environmental quality. Long-term impacts on air quality, noise, flora, fauna, the marine environment, water quality, cultural resources, or archaeological resources are not anticipated. Standard construction and erosion control BMPs will be implemented to minimize the anticipated construction-related short-term impacts. The proposed project has a long-term goal of protecting the Kalepa Point road from eroding into the ocean during large wave events.

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

The proposed project will not have cumulative effects upon the environment. The proposed project does not involve a commitment for larger actions and is a standalone project limited to the repair of the Kalepa Point roadway. The repair of the roadway will prevent the critically important public roadway from eroding to the point of permanent closure.

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

The proposed project will not have effects on rare, threatened, or endangered species, or habitats. As noted in Sections 3.1.11, 3.1.12, and 3.1.13 there were no rare, threatened, or endangered species, or habitats observed in the proposed project area. During construction standard BMPs and other guidelines will be used to observe for rare, threatened, or endangered species to mitigate any impacts during construction. There is not anticipated to be any long-term affects to rare, threatened, or endangered species, or their habitat from the proposed project.

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

The proposed project will not have long-term detrimental effects on air or water quality or ambient noise levels. The short-term effects on air quality, water quality, and ambient noise levels associated with construction are discussed in Sections 3.1.3, 3.1.10, and 3.1.4 respectively. Short term effects during construction will be mitigate through implementation of BMPs during construction.

11. Have a substantial adverse effect on or be likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, freshwater, or coastal waters.

The proposed project is in flood zone X and VE. There are no threats of flooding from streams, but the shoreline is exposed to potential flooding caused by storm waves or tsunami. The proposed project is designed to repair the rock rubblemound revetment protecting the road from these hazards, particularly flooding and erosion due to storm waves. The road repairs have incorporated future sea level rise into the design of the repairs of the rock rubblemound revetment which will impact the breaking waves at in the proposed project area. There will be no long-term adverse effects on flood plain, tsunami zone, sea level rise exposure area, beach, erosion-prone area, geologically hazardous land, estuary, freshwater, or coastal waters due to the proposed project.

12. Have a substantial adverse effect on scenic vistas and view planes, during day or night, identified in county or state plans or studies.

Scenic vistas and view planes are not expected to be negatively impacted by the proposed project.

13. Require substantial energy consumption or emit substantial greenhouse gases.

The proposed project is a passive structure and will require no additional energy consumption. There will be short-term energy consumption and greenhouse gases emissions during construction produced by construction equipment.

8. CONSULTATION

The names of organizations that may be contacted to provide pre-consultation for the proposed project are summarized below:

Federal

- U.S. Army Corps of Engineers, Honolulu District, Regulatory Branch
- U.S. Fish and Wildlife Service, Pacific Islands Fish and Wildlife Office
- NOAA, National Marine Fisheries Service, Pacific Islands Regional Office
- U.S. Environmental Protection Agency, Region IX, Pacific Islands Contact Office

State of Hawaii

- Department of Land and Natural Resources, Historic Preservation Division
- Department of Land and Natural Resources, Office of Conservation and Coastal Lands
- Department of Land and Natural Resources, Land Division
- Department of Education, Student Transportation
- Department of Health, Clean Water Branch
- Department of Business, Development, Economics and Tourism, Office of Planning
- Department of Transportation, Highways Division
- Office of Hawaiian Affairs

County of Maui

- Department of Planning
- Department of Public Works
- Department of Water Supply
- Police Department
- Fire Department
- Ambulance

Other

- Aha Moku Council
- Na Kupuna O Maui
- Maui Tomorrow Foundation
- Association of Hawaiian Civic Clubs

9. ENVIRONMENTAL ASSESSMENT DISTRIBUTION

The following agencies, organizations, and individuals will be directly notified of the publication of the Highway at Kalepa Point Road Repairs Draft Environmental Assessment (DEA).

FEDERAL AGENCIES
Department of the Army, U.S. Army Corps of Engineers
Department of Commerce, National Marine Fisheries Service
Department of the Interior, National Parks Service
Department of the Interior, U.S. Fish and Wildlife Service

STATE OF HAWAII
Department of Accounting and General Services
Department of Business, Economic Development and Tourism, Office of Planning
Department of Health,
Department of Land and Natural Resources, Division of Aquatic Resources
Department of Land and Natural Resources, Land Division
Department of Land and Natural Resources, Office of Conservation and Coastal Lands
Department of Land and Natural Resources, State Historic Preservation Division
Department of Transportation
Office of Hawaiian Affairs
Office of Planning and Sustainable Development – Environmental Review Program

COUNTY OF MAUI
Department of Planning

OTHER
State Senator Lynn DeCoite
State Representative Mahina Poepoe
Maui County Council Representative Shane Sinenci
Hana Advisory Committee to Maui Planning Commission
Hana Community Association

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APPENDIX A – BASIS OF DESIGN REPORT (SEA ENGINEERING, INC.)

KALEPA REPAIRS PROJECT

BASIS OF DESIGN REPORT

JUNE, 2017



Prepared for:

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
Contract No. C5999
Job No. 16-37

FEMA No. PW-27, DR 4194

Prepared by:
Sea Engineering, Inc.
Makai Research Pier
Waimanalo, HI 96795

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TABLE OF CONTENTS

`

1. INTRODUCTION 1
1.1 DAMAGE FROM HURRICANE ISELLE 1
1.2 PROJECT LOCATION 1
1.3 PROJECT HISTORY 4
1.4 PREVIOUS WORK 5
2. SITE CONDITIONS 8
2.1 TOPOGRAPHIC SURVEY AND DAMAGE AREAS 8
2.1.1 Damage Area "A" 8
2.1.2 Damage Area "B" 8
2.1.3 CRM Reach 8
2.1.4 Damage Area "C" 15
2.2 REVISED TOPOGRAPHIC SURVEY BY AUSTIN TSUTSUMI & ASSOCIATES, INC. 17
2.3 GEOTECHNICAL SITE INVESTIGATIONS BY GEOLABS, INC. 17
2.3.1 Subsurface Conditions 18
2.3.2 Rock Rubblemound Revetment Recommendations 19
2.3.3 Concrete Rubble Masonry (CRM) Retaining Wall 19
2.3.4 Reinforced concrete wall with tie-backs 21
3. OCEANOGRAPHIC SETTING 29
3.1 INTRODUCTION 29
3.2 BATHYMETRY 29
3.3 WINDS 31
3.4 ASTRONOMICAL TIDES 33
3.5 WAVES IN HAWAII 33
3.5.1 General Wave Climate 33
3.5.2 Statistical Wave Analysis 37
3.5.3 Extreme Wave Heights 41
4. NUMERICAL HURRICANE AND WAVE MODELING 46
4.1 INTRODUCTION 46
4.2 NUMERICAL MODELING OF HURRICANE ISELLE 46
4.3 NUMERICAL MODELING OF WAVE APPROACH 51
4.3.1 Wave Transformation In Shallow Water 51
4.3.2 Offshore Wave Transformation 52

5. DESIGN WAVE ANALYSIS 55
5.1 INTRODUCTION 55
5.2 DEEPWATER DESIGN WAVES 55
5.3 TIDE AND WATER LEVEL RISE 55
5.3.1 Astronomical Tide 56
5.3.2 Storm Surge 57
5.3.3 Wave Setup 57
5.3.4 Global Sea Level Change 57
5.4 NEARSHORE WAVE TRANSFORMATIONS – DESIGN WAVE HEIGHT 59
6. SHORE PROTECTION ALTERNATIVES 61
6.1 NO ACTION ALTERNATIVE 61
6.2 ABANDONMENT OF THE EXISTING ROADWAY ALIGNMENT 62
6.3 ENGINEERED SHORE PROTECTION 62
6.3.1 Introduction 62
6.3.2 Rock Rubble Mound Revetment 62
6.3.3 Tribar Revetment 63
6.3.4 Seawall 63
7. PROJECT CONCEPT DESIGNS 64
7.1 INTRODUCTION 64
7.2 EXISTING DESIGN CONDITION 64
7.3 PRELIMINARY DESIGNS (SEI 2016) 66
7.4 UPDATED ARMOR STONE SIZE 71
7.4.1 Concrete Armor Units: Tribar Revetment Design 72
7.5 COMBINED LOW ANGLE REVETMENT AND SEAWALL (PREFERRED DESIGN) 76
7.5.1 Combined Low Angle Revetment and CRM Wall (Preferred Option) 76
DESIGN LAYOUT 79
7.5.2 Combined Low Angle Revetment and Reinforced Concrete Wall with Tie-Backs. 79
8. ROADWAY DESIGN 82
8.1 INTRODUCTION 82
8.2 GUARDRAIL REPORT 82
8.3 ROAD AND PAVING 84
9. STONE SOURCE 85
9.1 STONE SOURCE INVESTIGATION 85
10. SITE ACCESS – BRIDGE STUDY 87

11. COST ESTIMATE OF ALTERNATIVES 89
12. PERMITTING REQUIREMENTS AND CONCERNS 90
13. DISCUSSION AND RECOMMENDATIONS 94
14. REFERENCES 96

LIST OF FIGURES

FIGURE 1-1. STORM TRACK OF HURRICANE ISELLE 2
FIGURE 1-2. PROJECT LOCATION ON THE SOUTHEAST COAST OF MAUI 2
FIGURE 1-3. THE KALEPA PROJECT SITE LOCATION BETWEEN KAUPO AND KIPAHULU 3
FIGURE 1-4. AERIAL PHOTOGRAPH OF PROJECT REACH 3
FIGURE 1-5. 1987 REVETMENT DESIGN DRAWINGS 5
FIGURE 1-6. 1987 CRM WALL DESIGN 6
FIGURE 2-1. ATA TOPOGRAPHIC SURVEY (1 OF 2) SHOWING "AREA A", AREA "B", AND THE "CRM REACH" 9
FIGURE 2-2. ATA TOPOGRAPHIC SURVEY (2 OF 2) SHOWING "AREA B" 10
FIGURE 2-3. LARGE SCALE TOPOGRAPHIC DRAWING OF AREA "A" (STA. 1+00 TO STA. 1+65) 11
FIGURE 2-4. DAMAGE AREA "A"; VIEW EAST FROM KALEPA BEACH 12
FIGURE 2-5. SUBSTRATE DAMAGE AT AREA "A" 12
FIGURE 2-6. LARGE SCALE DRAWING OF DAMAGE AREA "B" (STA. 1+75 TO STA. 2+25) 13
FIGURE 2-7. DAMAGE AREA "B" SHOWING SLOPE CHANGE, EXPOSED UNDERLAYER, EXPOSED RELICT CRM 13
FIGURE 2-8. CRM REACH (STA. 2+25 TO STA. 3+40) 14
FIGURE 2-9. PHOTOGRAPH OF CRM REACH 14
FIGURE 2-10. HOLE IN CRM WALL 15
FIGURE 2-11. DAMAGE AREA "C", STA. 3+35 TO STA. 5+00 16
FIGURE 2-12. DAMAGE FEATURES, DAMAGE AREA "C" 16
FIGURE 2-13. EXPOSED CRM UNDER DAMAGED STRUCTURE, DAMAGE AREA "C" 17
FIGURE 2-14. LOCATIONS OF BORINGS B-1 AND B-2 AT AREA "B" AND THE CRM REACH 23
FIGURE 2-15. LOCATION OF BORING B-3 AT AREA "C" 24
FIGURE 2-16. LOG OF BORING B-1 25
FIGURE 2-17. LOG OF BORING B-2 26
FIGURE 2-18. LOG OF BORING B-3 27
FIGURE 2-19. PLATE 3 FROM GEOLABS, INC (2016) SHOWING SINGLE LEVEL TIEBACK 28
FIGURE 3-1. NEARSHORE BATHYMETRY. ELEVATIONS IN MSL. 30
FIGURE 3-2. REPRESENTATIVE OFFSHORE PROFILE BASED ON SURVEY AND LIDAR DATA (1V:9H) 30
FIGURE 3-3. FREQUENCY OF OCCURRENCE OF WIND SPEED AND DIRECTION, HONOLULU AIRPORT SHOWING THE DOMINANCE OF NORTHEAST TRADEWINDS 32
FIGURE 3-4. COMMON WAVE TYPES AND APPROACH DIRECTIONS IN HAWAII 34

FIGURE 3-5. WEATHER MAP SHOWING LOW PRESSURE SYSTEM NE OF HAWAII (11-20-03) 36
FIGURE 3-6. SEA-STATE ANALYSIS SHOWING WAVES UP TO 10 M (33 FT) IN HEIGHT NE OF HAWAII (11-20-03) 36
FIGURE 3-7. HISTORICAL HURRICANE TRACKS 37
FIGURE 3-8. VIRTUAL BUOY LOCATIONS 38
FIGURE 3-9. DEEPWATER WAVE HEIGHT ROSE FROM VIRTUAL BUOY 81103 FROM 1979 TO 2007 . 39
FIGURE 3-10. DEEPWATER WAVE PERIOD ROSE FROM VIRTUAL BUOY 81103 FROM 1979 TO 2007 40
FIGURE 3-11. DEEPWATER WAVE HEIGHT ROSE FROM VIRTUAL BUOY 81113 FROM 1979 TO 2007 40
FIGURE 3-12. DEEPWATER WAVE PERIOD ROSE FROM VIRTUAL BUOY 81113 FROM 1979 TO 2007 41
FIGURE 3-13. EXTREME VALUE DISTRIBUTION FOR KONA STORM TYPE WAVE EVENTS 42
FIGURE 4-1 HURRICANE ISELLE WIND FIELD AT 24-HR INTERVALS: (A) 08/03/2014 THROUGH (F) 08/08/2014 48
FIGURE 4-2. HURRICANE ISELLE WAVE FIELD AT 24-HR INTERVALS: (A) 08/03/2014 THROUGH (F) 08/08/2014 49
FIGURE 4-3. HURRICANE ISELLE VIRTUAL BUOY WAVE HEIGHT TIME SERIES. PEAK WAVE HEIGHTS ISELLE 1 AND ISELLE 2 ARE CONSIDERED FOR DESIGN WAVE CONDITIONS. 50
FIGURE 4-4. HURRICANE ISELLE VIRTUAL BUOY WAVE PERIOD TIME SERIES. 50
FIGURE 4-5. NESTED SWAN GRID BOUNDARIES 52
FIGURE 4-6. WAVE HEIGHT AND APPROACH VECTORS FOR WAVES FROM THE EAST; 500M GRID 53
FIGURE 4-7. WAVE HEIGHT AND APPROACH VECTORS FOR WAVES FROM THE EAST; 50M GRID 53
FIGURE 4-8. WAVE HEIGHT AND APPROACH VECTORS FOR WAVES FROM THE SOUTHWEST, 500M GRID 54
FIGURE 4-9. WAVE HEIGHT AND APPROACH VECTORS FOR WAVES FROM THE SOUTHWEST, 50M GRID. 54
FIGURE 5-1. MEAN SEA LEVEL TREND, HONOLULU HARBOR, 1905 TO PRESENT (NOAA, 2015) .. 58
FIGURE 5-2. PROJECTED SEA LEVEL CHANGE, KAHULUI HARBOR (USACE, 2016) 58
FIGURE 6-1. DETERIORATION OF THE HIGHWAY DUE TO EROSION 61
FIGURE 7-1 . 1987 REVETMENT DESIGN DRAWINGS 65
FIGURE 7-2. 1987 CRM WALL DESIGN 66
FIGURE 7-3. PRELIMINARY REVETMENT DESIGN SECTION FROM SEI (2016) 68
FIGURE 7-4. PRELIMINARY HYBRID CRM WALL / ROCK RUBBLEMOUND REVETMENT WITH BERM TOE FROM SEI (2016) 69
FIGURE 7-5. HYBRID CONCRETE WALL / ROCK RUBBLEMOUND REVETMENT WITH BERM TOE ADAPTED FROM SEI (2016) 70
FIGURE 7-6. ROCK RUBBLE MOUND REVETMENT WITH BERM TOE AND REVISED ARMOR STONE SIZE (DESIGN WAVE HEIGHT = 10.4 FT) 73
FIGURE 7-7. TRIBAR REVETMENT IN AMERICAN SAMOA 74
FIGURE 7-8. TRIBAR REVETMENT WITH ROCK RUBBLE TOE AT AREA C 75

FIGURE 7-9. HYBRID CRM WALL WITH ROCK RUBBLE MOUND REVETMENT TOE PROTECTION AT AREA C 77
FIGURE 7-10. HYBRID CRM WALL WITH ROCK RUBBLE MOUND REVETMENT TOE PROTECTION AT CRM REACH. 78
FIGURE 7-11. LAYOUT OF CRM WALL WITH RUBBLE MOUND TOE PROTECTION 80
FIGURE 7-12. LAYOUT OF CONCRETE WALL WITH RUBBLE MOUND TOE PROTECTION 81
FIGURE 8-1. DETERIORATION OF GUARDRAILS AT KALEPA HEADLAND 82
FIGURE 8-2. CONSTANT-SLOPE CONCRETE GUARDRAIL (FROM ATA REPORT, APPENDIX D) 83
FIGURE 8-3. ROAD SURFACE CONDITION AT KALEPA 84
FIGURE 8-4. SCHEMATIC OF ROADWAY REPAIRS 84

LIST OF TABLES

TABLE 3-1. WATER LEVEL DATA FOR KAHULUI HARBOR 33
TABLE 3-2. TEN LARGEST KONA STORM EVENTS 42
TABLE 3-3. RETURN PERIOD FOR KONA STORM WAVES 43
TABLE 3-4. TEN LARGEST SOUTHERN SWELL EVENTS 43
TABLE 3-5. RETURN PERIOD FOR SOUTHERN SWELL WAVE EVENTS 44
TABLE 3-6. TEN LARGEST EAST WAVE EVENTS 44
TABLE 3-7. RETURN PERIOD FOR EAST WAVE EVENTS 45
TABLE 5-1. DEEPWATER DESIGN WAVE PARAMETERS (50-YEAR RECURRENCE) 56
TABLE 5-2. PROJECTED SEA LEVEL CHANGE FROM 2017 59
TABLE 5-3. SUMMARY OF NEARSHORE DEPTH LIMITED DESIGN WAVE HEIGHTS 60
TABLE 7-1. DEEPWATER WAVE HEIGHT AND RETURN PERIOD FOR 8 FT DESIGN WAVE HEIGHT 67
TABLE 7-2. ROCK REVETMENT ARMOR STONE WEIGHT AND NOMINAL DIAMETER 71
TABLE 7-3. TRIBAR REVETMENT ARMOR UNIT WEIGHT AND SIZE 72
TABLE 7-4. ROCK RUBBLE MOUND TO PROTECTION UNIT WEIGHT AND NOMINAL DIAMETER 76

APPENDICES

APPENDIX A: ENGINEERING FIELD REPORT, GEOLABS, INC., OCTOBER 27, 2014

APPENDIX B: GEOTECHNICAL ENGINEERING EXPLORATION, KALEPA POINT SHORELINE DAMAGE REPAIRS,KIPAHULU, MAUI, HAWAII, OCTOBER, 2016; GEOLABS, INC.

APPENDIX C: STRUCTURAL CALCULATIONS, ARNOLD OKUBO & ASSOCIATES, INC., STRUCTURAL ENGINEERS

APPENDIX D: GUARDRAIL REPORT, AUSTIN TSUTSUMI AND ASSOCIATES, INC.

APPENDIX E: BRIDGE ASSESSMENT, SEA ENGINEERING, INC.
APPENDIX F: COST ESTIMATE, PACIFIC COST ENGINEERING, INC.
APPENDIX G: PERMITTING ANALYSIS, MUNEKIYO & HIRAGA, INC.

1. INTRODUCTION

1.1 Damage from Hurricane Iselle

On August 7, 2014, Hurricane Iselle made landfall on the southeast coast of the island of Hawaii (Figure 1-1). Although a tropical storm at landfall, Iselle's strength peaked on August 4 as a Category 4 storm, with maximum sustained winds of 140 mph. Estimated damages in Hawaii were $79.2 M. The storm brought large waves to the east side of Hawaii, as well as to the east shore of Maui. Road protection structures for the Hana Highway were considerably damaged in the area of Kalepa gulch southwest of the town of Hana. Anecdotal information from eyewitnesses include accounts of waves overtopping the roadway at an elevation of 25 ft above Mean Sea Level (MSL).

Maintaining the highway around the Kalepa Headland is a difficult engineering problem due to the road elevation, terrain steepness, and wave exposure. The existing protection consists of reaches containing both cemented rock walls (concrete rubble masonry, or CRM) and uncemented rubble mound protection. The existing rubble mound revetment was designed and built circa 1987. Underneath the structures damaged by the hurricane are layers of past road protection efforts, extending back to original construction in the 1930's and 1940's.

1.2 Project Location

The Kalepa headland is located on the southeast coast of Maui approximately 14 miles southwest of Hana Town, on the Hana Highway (State Route 360) near the transition to the Piilani Highway (County Route 31) at Kalepa Bridge. The Tax Map Key is TMK (2)-1-6-010:999. Figure 1-2 shows the general location relative to the main Hawaiian Islands. The site is a headland between two drainage systems, Kalepa Gulch and Alelele Stream, and is a particularly exposed reach of the highway. Figure 1-3 is an aerial photograph showing the route of the highway in the vicinity of the site. The highway is at an elevation of approximately 25 ft above sea level as it passes around the headland, with a shear rock road cut on the landward side of the road and a sloping rock embankment on the ocean side. The road cut is draped in steel rock fall netting. In places the rock embankment has been modified with sections of Concrete Rubble Masonry (CRM) and rock rubble mound shore protection. Figure 1-4 is a closer view that shows three initial areas of interest (Area "A", Area "B", and Area "C") that were targeted for repair by the County of Maui, Department of Public Works (DPW).

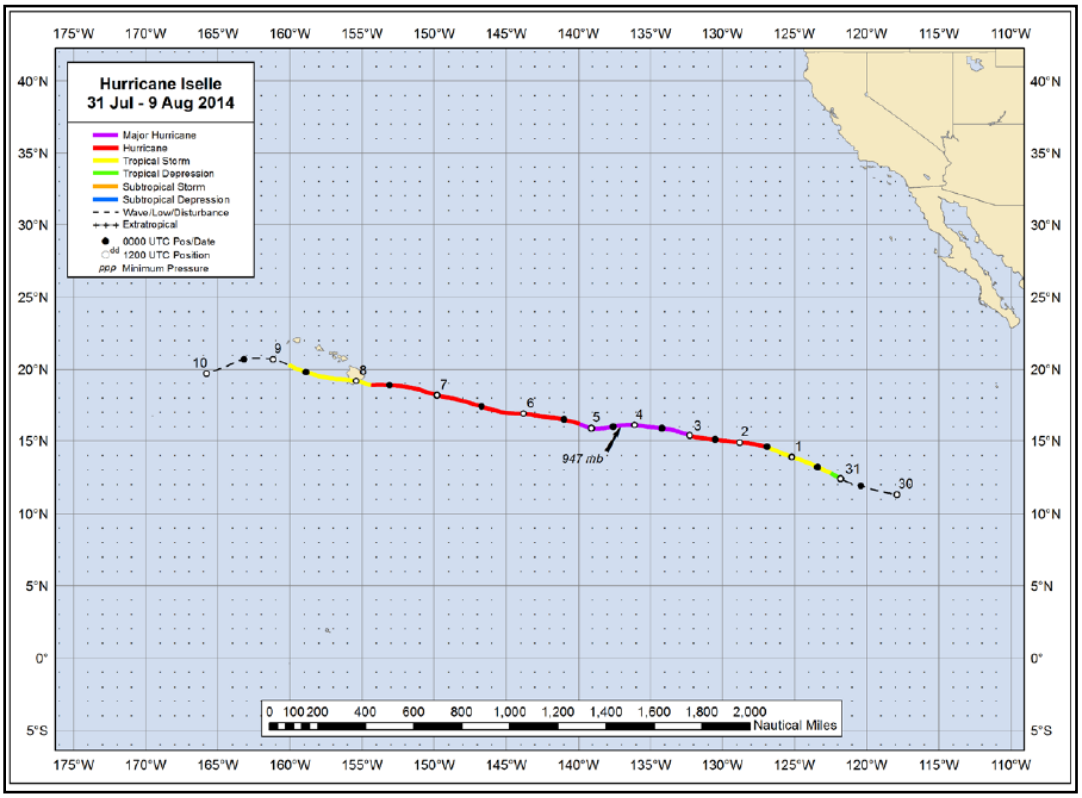


Figure 1-1. Storm track of Hurricane Iselle

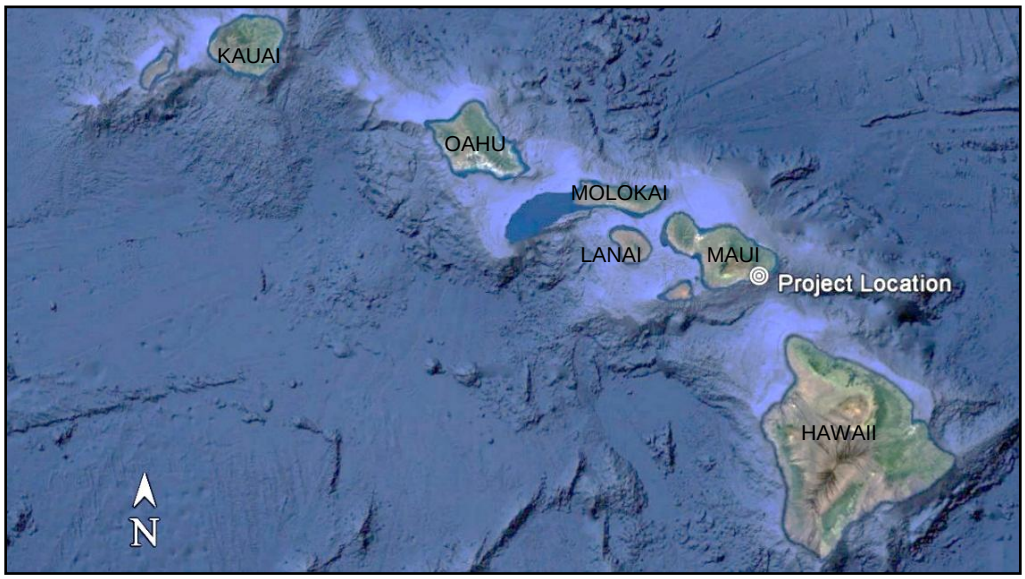


Figure 1-2. Project location on the southeast coast of Maui

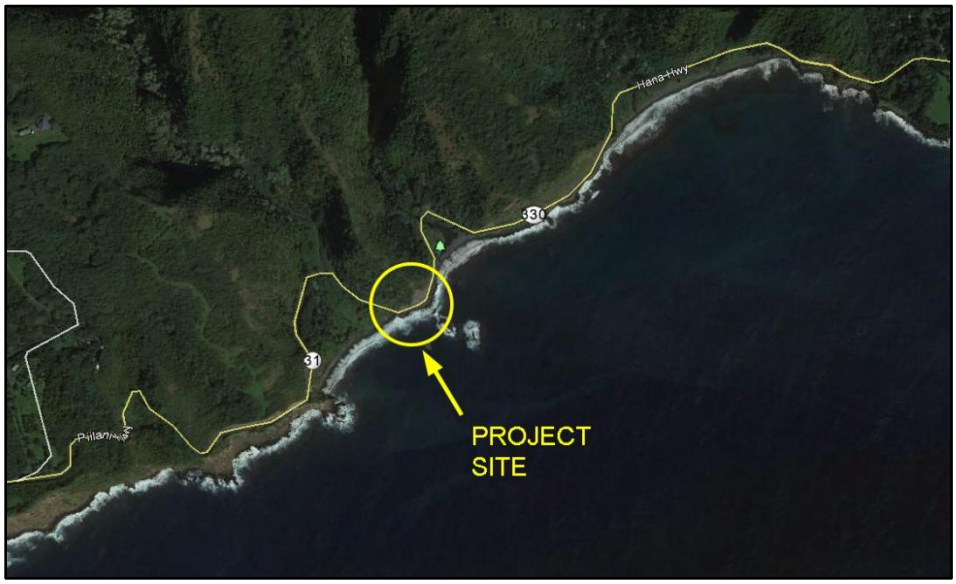


Figure 1-3. The Kalepa project site location between Kaupo and Kipahulu (Google Earth image)

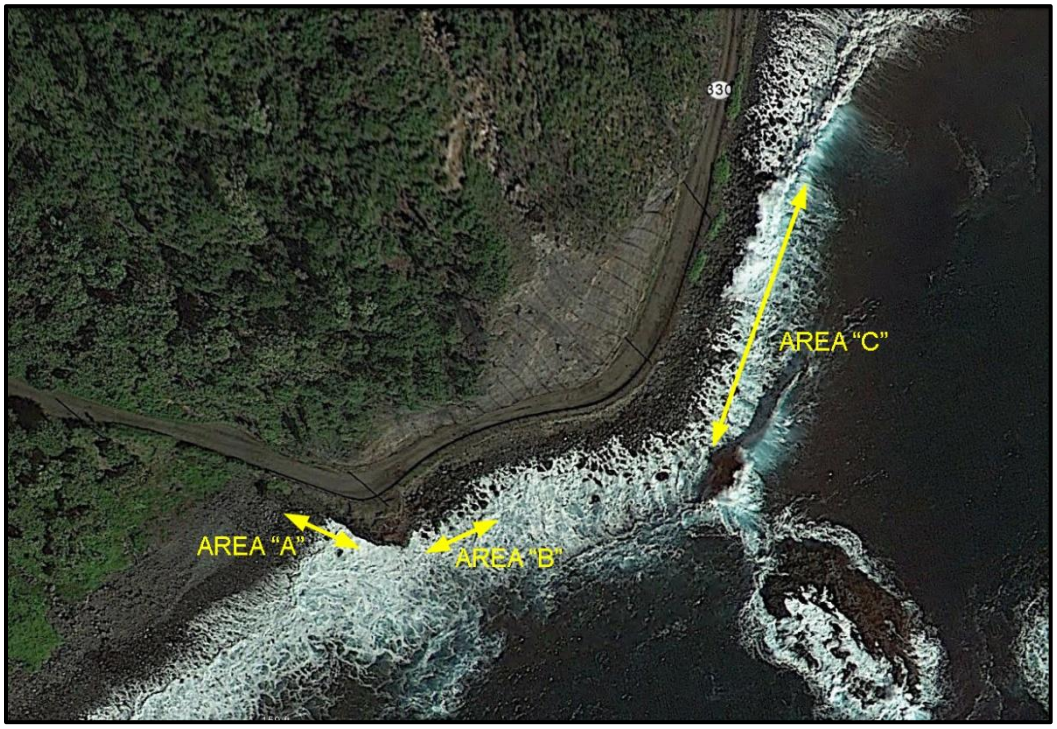


Figure 1-4. Aerial photograph of project reach (Google Earth image)

1.3 Project History

Initial construction of the roadway at Kalepa was done as part of the Hana Belt Road system that was completed around 1947. Old CRM walls can be seen underneath existing more recent repairs and construction. A single layer rock rubble mound revetment was constructed at the project site in approximately 1987. In places the revetment structure was built on top of existing CRM walls; localized repairs of damaged areas were made in other areas of the CRM.

A site visit by Geolabs, Inc, in October 2014 detailed much of the damage caused by Hurricane Iselle in an Engineering Field Report (October 27, 2014 – see Appendix A). Subsequently, visits to the site were made by Sea Engineering, Inc. (SEI) on June 30, 2015 with representatives of the DPW, Munekiyo & Hiraga, Inc., and Austin, Tsutsumi & Associates, Inc. (ATA); on October 7, 2015, with Arnold Okubo & Associates, structural engineers; and on January 5, 2016 with representatives from DPW, Federal Emergency Management Agency (FEMA), the Hawaii State Civil Defense (now known as the Hawaii Emergency Management Agency), and Munekiyo & Hiraga, Inc. A preliminary coastal engineering report was completed by SEI for DPW in February, 2016 (SEI, 2016). The report contained a discussion of the project site conditions, the oceanographic setting, damage incurred by Hurricane Iselle, oceanographic design parameters derived from existing available information, and shore protection concept plans. Following submission of the coastal engineering report and the January 5, 2016 site visit, it was recommended to complete a follow-on comprehensive basis of design study to examine different repair strategies for protection of the coastal road.

The present study has been conceived to thoroughly examine the coastal engineering options available for protection of the Hana Highway at the Kalepa headland where it was damaged by Hurricane Iselle. The project scope includes:

- Review and update of oceanographic design parameters: nearshore bathymetry, wind and wave hindcasts, water level calculations, and hindcasts of Hurricane Iselle.
- Revetment and seawall design concepts: concept designs with joint input from coastal and structural engineers.
- Update of topographic information;
- Additional Geotechnical information, including borings;
- Permitting requirements;
- Cost of alternatives.

The project team includes:

- Sea Engineering, Inc. (SEI) – project management, coastal engineering;

- Arnold Okubo & Associates (AOA) – structural engineering;
- Geolabs, Inc. – geotechnical engineering;
- Austin, Tsutsumi & Associates, Inc. (ATA) – topographic information, roadway engineering;
- Munekiyo & Hiraga, Inc. (MHI) – permit requirements;
- Pacific Cost Engineering (PCI) – cost estimates;

1.4 Previous Work

Previous available work includes:

1. Dames & Moore, 1987, *Plans for the Repair of a Portion of Hana Highway Between Kipahulu and Kaupo*;

The 1987 plans are presumed to show the existing design that was damaged by Hurricane Iselle. Figure 1-5 shows a revetment section, and Figure 1-6 shows a CRM wall section.

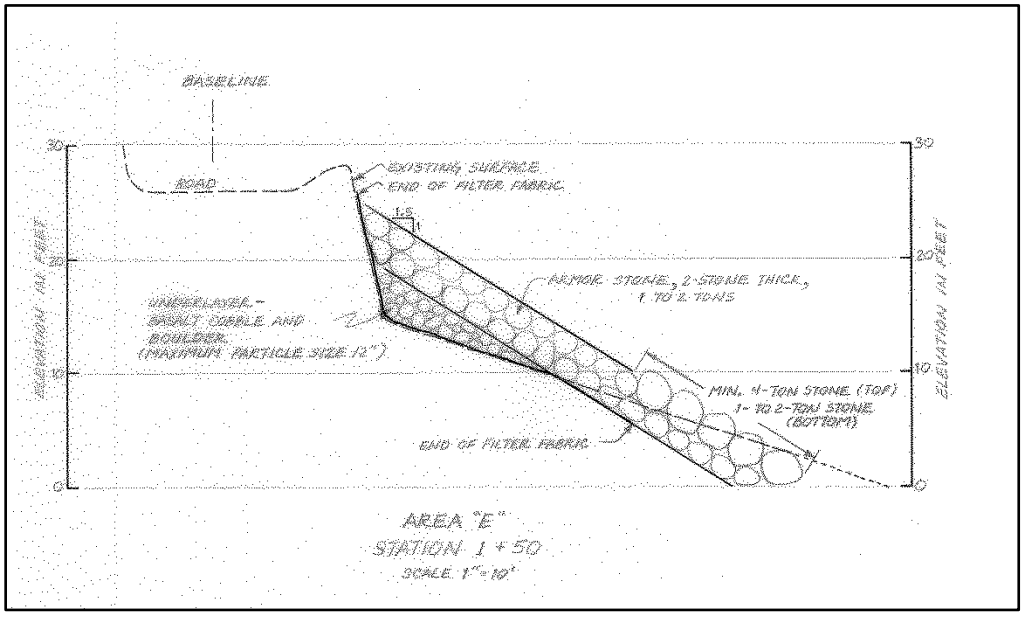


Figure 1-5. 1987 revetment design drawings

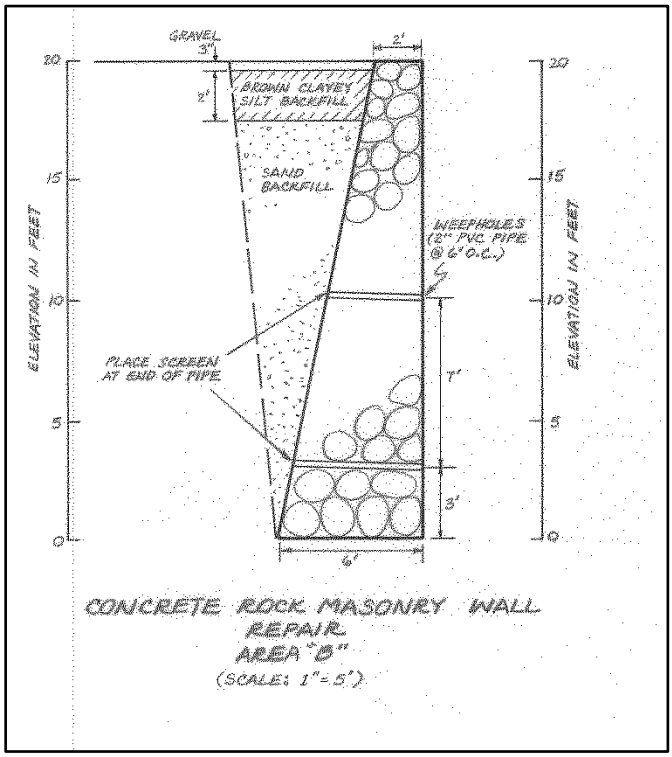


Figure 1-6. 1987 CRM Wall design

2. Sato & Associates, 2007, *Kaupo Kipahulu Rockfall Protection , Kalepa and Alelele Slopes; Earthquake Damage Assessment and Mitigation Option*s;

The Sato & Associates report was concerned with the hazards caused by the steep rock cliffs at Kalepa, not with shore protection. The report included mitigation options after the October 15, 2006 earthquake caused rock falls at Kalepa and nearby Alelele. Three options were presented, including 1) cutting back the rock slopes to a 65° angle and installing netting, 2) trimming and scaling slopes to an approximately 80° angle and installing a substantial rock containment and braking system consisting of heavy ring nets and bolt anchors, and 3) a 700-ft by-pass tunnel. The by-pass tunnel, estimated to cost between $10,500,000 and $14,000,000, is a potential option that would circumvent concerns for both rock fall and shore protection. Rock fall netting was added to the headland subsequent to the 2007 report.

3. Geolabs, Inc., 2014, *Kalepa Point Shoreline Erosion Damage*, Field Report for County of Maui DPW.

The Geolabs report detailed the post-Iselle damage to the shore protection (rubble mound revetment and CRM wall), and to the rock fall netting and roadway features seen in the October 27, 2014 site visit.

4. Austin Tsutsumi & Associates, Inc., 2014, *Topographic Survey of a Portion of Roadway Lot 4 (Hana Highway) of the Kaapahu Subdivision*.

ATA completed topographic surveys of the project site area. These have been revised and updated for the present report.

5. Sea Engineering, Inc. 2016, *Kalepa Emergency Repairs Coastal Engineering Report*.

The SEI preliminary report described the project site and oceanographic setting and presented three shore protection concept designs. These are further detailed in Section 7.3, and include:

- Rock revetment (see Figure 7-3)
- Hybrid CRM wall and rock revetment (see Figure 7-4)
- Hybrid anchored concrete wall and rock revetment (see Figure 7-5)

These three designs incorporated an emergent berm toe configuration (see figures) that is a key design feature. The berm toe is robust due to the amount of material used, and eliminates the need for excavation in a difficult environment (see Herrera and Meinga, 2015). These concept designs have been revised in the present report with updated oceanographic design parameters.

2. SITE CONDITIONS

2.1 Topographic Survey and Damage Areas

ATA completed a topographic survey of the site, shown in Figure 2-1and Figure 2-2. The survey includes a baseline used to locate repair areas. Damage area labels (Damage Area "A", Damage Area "B", Damage Area "C") are taken from the October, 2014 Geolabs report (Geolabs, 2014); however; a long reach of Damage Area "B" was re-termed "CRM Reach" due to the CRM wall along its length.

2.1.1 Damage Area "A"

A large-scale view of the topographic drawing for Area "A is shown in Figure 2-3, and Figure 2-4 is a panoramic photograph taken from the west, at Kalepa Beach. The reach extends for approximately 65 ft. from Sta 1+00 to Sta 1+65 and appears to be founded on a hard rock outcrop. The damage incurred along this reach is to the substrate that holds the guardrail in place on the road shoulder (Figure 2-5). The rock that underlies the loose material appears to be in good condition. The road shoulder will likely need to be re-graded, filled, and compacted. No additional shore protection structures are planned for Area "A".

2.1.2 Damage Area "B"

In the 2014 Geolabs' report, Area "B" is a 185-ft reach. In this report, damage Area "B" is approximately 50 ft. in length, from Sta 1+75 to Sta 2+25 (Figure 2-6). The adjacent 115-ft section is termed the "CRM Reach" because it defines the length of a long CRM wall (see next section). The remaining 20 ft of the Geolabs' reach is included in the next section (Area "C"), because it is consistent with revetment shore protection. The damage to Area "B" consists of down-slope movement of rock shore protection. Figure 2-7 is a photograph showing the damage area from the east side. Graphic overlays in the figure indicate the difference in slope from the near-water portion (less steep) to the near road portion (very steep). The change in slope is indicative of toe failure, and down-slope movement of rock, with the upper portions left in an unstable, hanging condition. The photograph also shows an exposed CRM section that had likely been previously covered by rock shore protection.

2.1.3 CRM Reach

Adjacent to Damage Area "B", the road embankment consists of a reach of CRM approximately 115 ft. in length, from Sta 2+25 to Sta 3+40 shown in Figure 2-8 and Figure 2-9. While much of the CRM is in reasonable condition, there are at least two sections where the CRM has been breached - the rock has fallen away leaving holes in the rock wall. Figure 2-10 is a photograph of one of the breached areas.

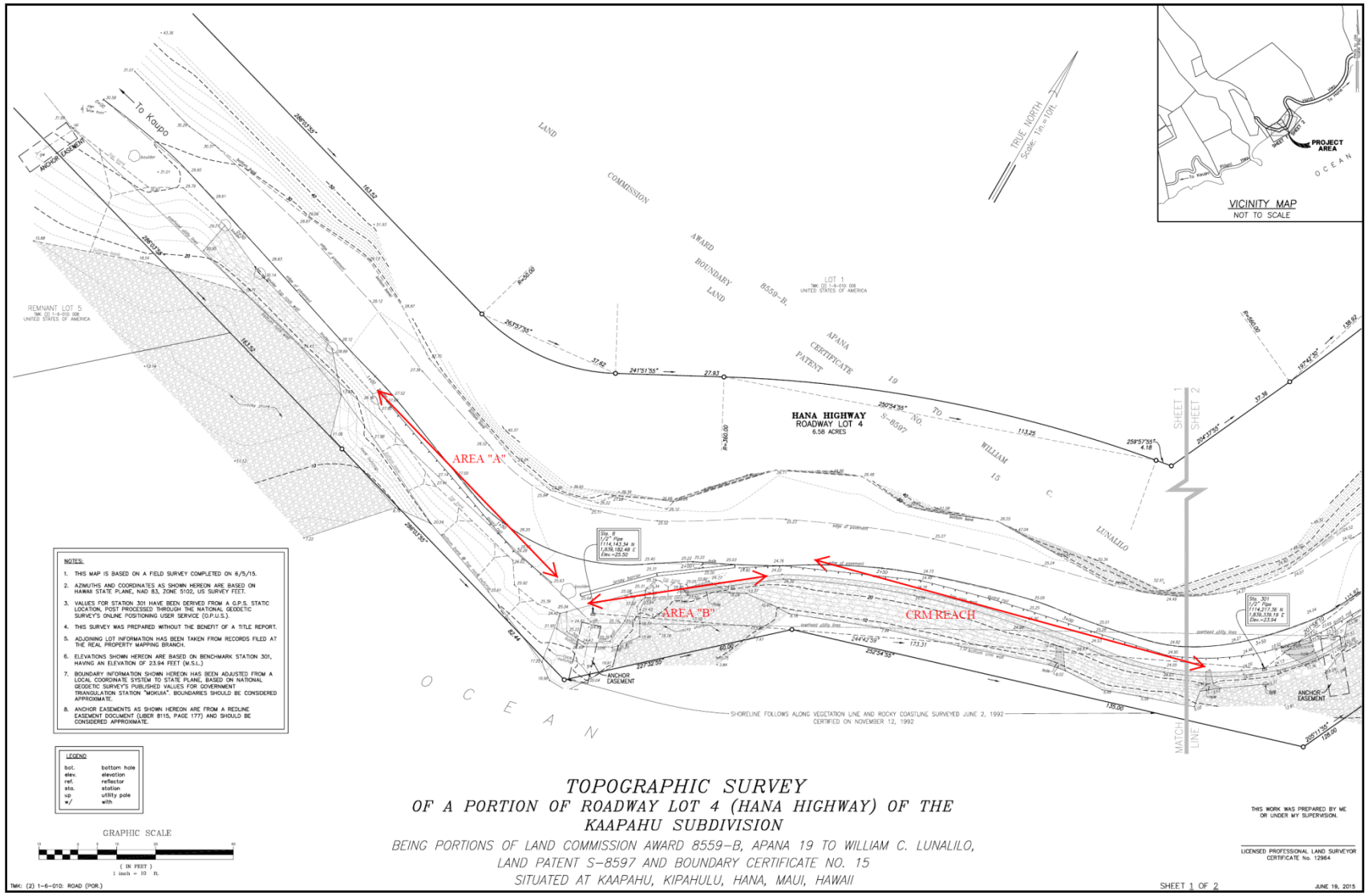


Figure 2-1. ATA topographic survey (1 of 2) showing "Area A", Area "B", and the "CRM Reach"

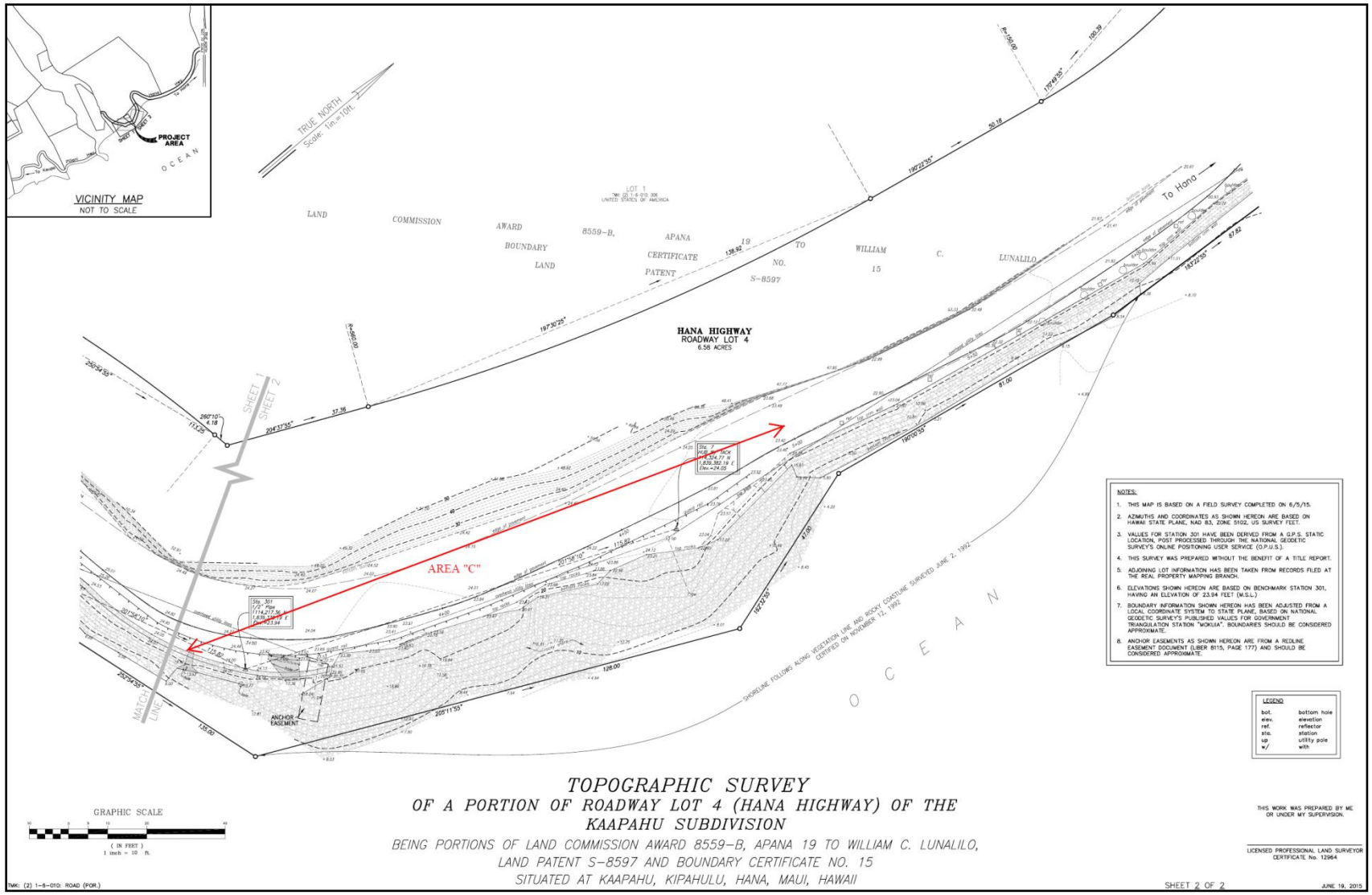


Figure 2-2. ATA topographic survey (2 of 2) Showing "Area B"

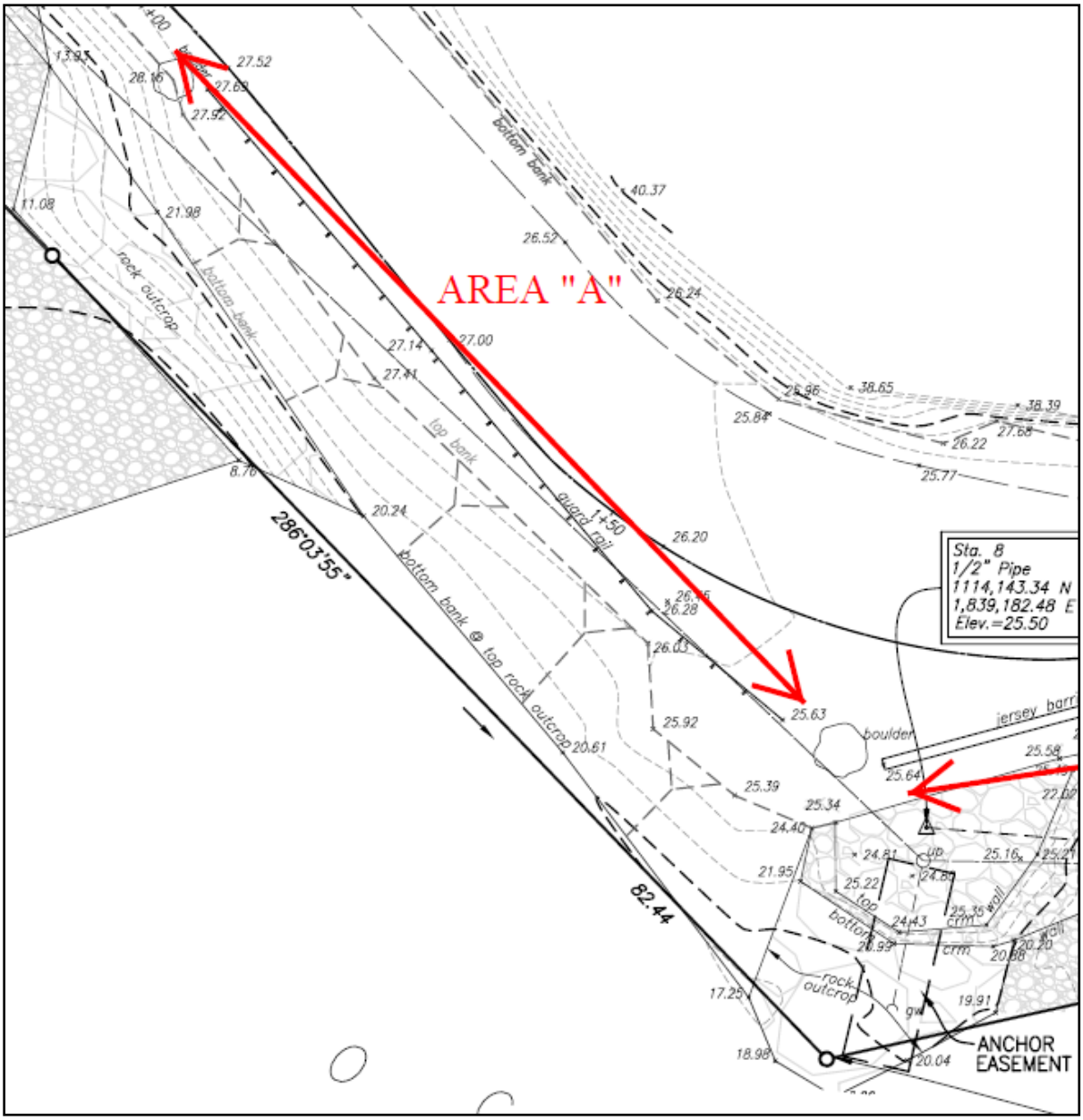


Figure 2-3. Large scale topographic drawing of Area "A" (Sta. 1+00 to Sta. 1+65)



Figure 2-4. Damage Area "A"; view east from Kalepa Beach



Figure 2-5. Substrate damage at Area "A"

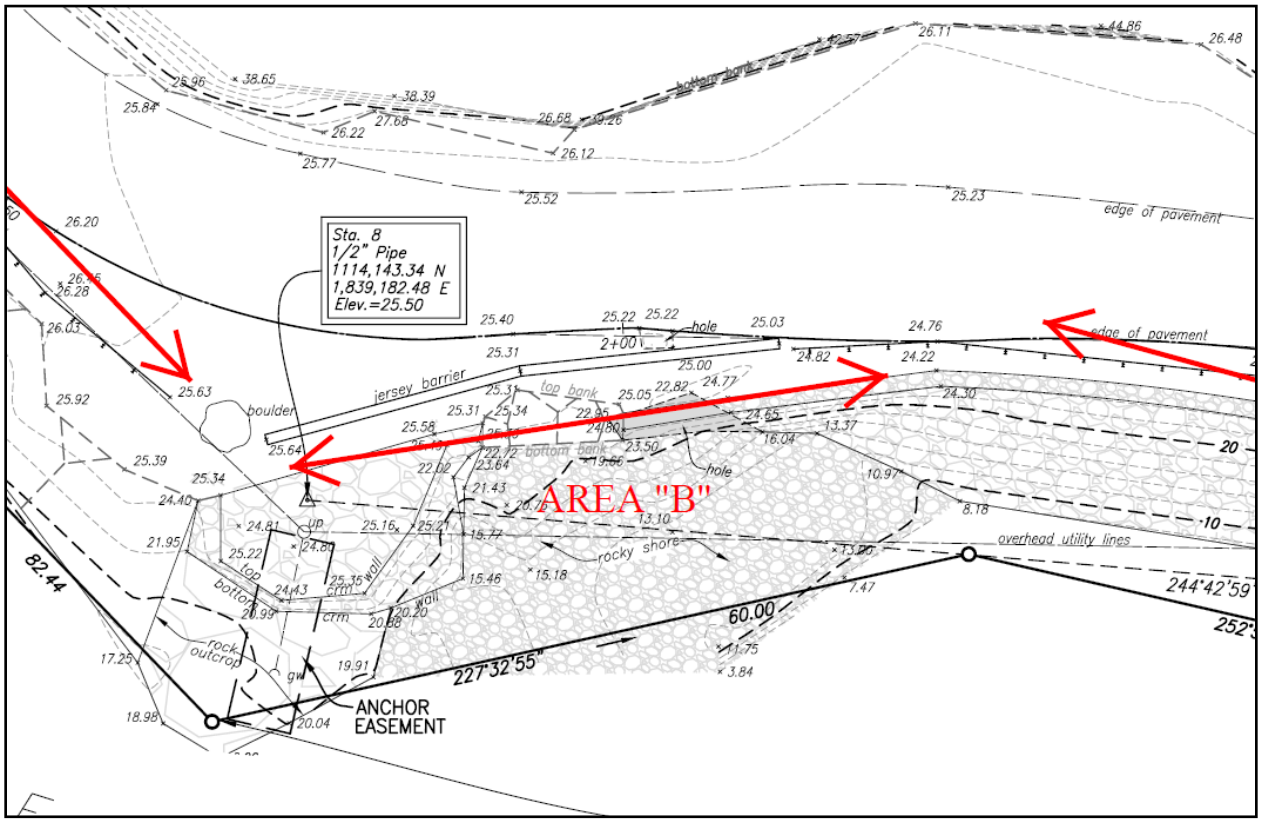


Figure 2-6. Large scale drawing of Damage Area "B" (Sta. 1+75 to Sta. 2+25)



Figure 2-7. Damage Area "B" showing slope change, exposed underlayer, exposed relict CRM

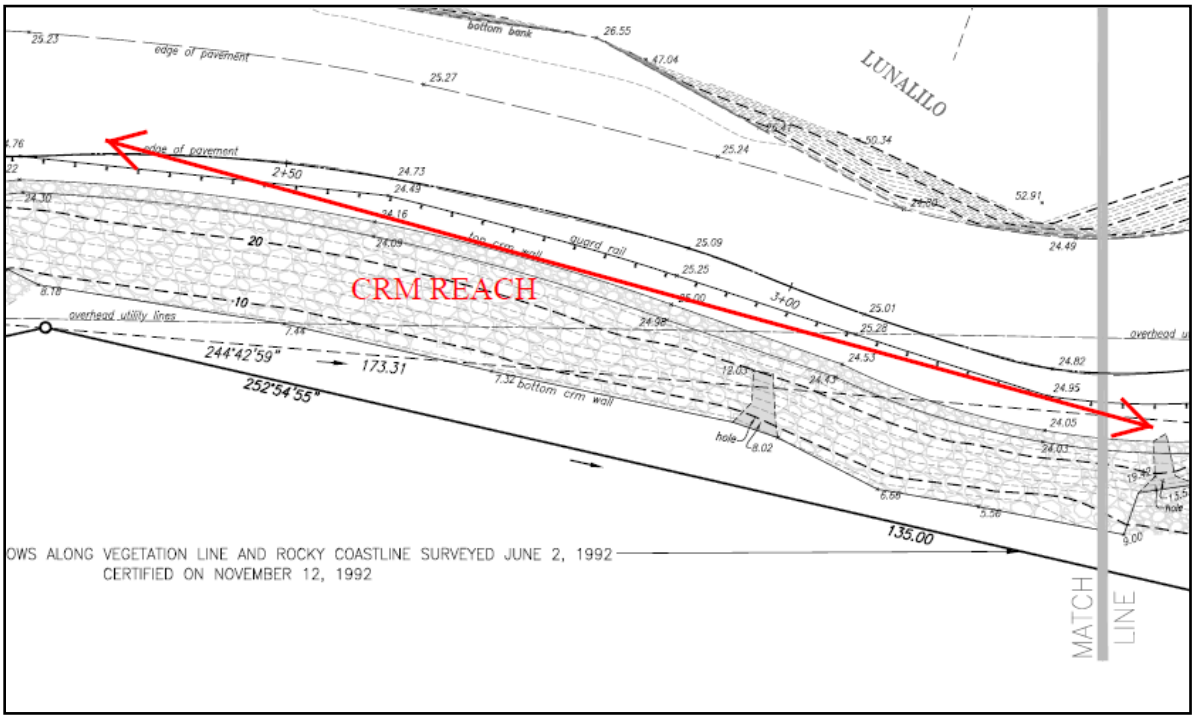


Figure 2-8. CRM Reach (Sta. 2+25 to Sta. 3+40)



Figure 2-9. Photograph of CRM Reach



Figure 2-10. Hole in CRM wall

2.1.4 Damage Area "C"

Damage Area "C" is an approximate 165-ft reach from Sta. 3+35 to Sta. 5+00 (Figure 2-11). Similar to Damage Area "B", the reach consists of a loose rock rubble mound revetment that had moved down slope. The damage was likely due to the lower part (the toe) of the structure being moved offshore due to high wave conditions. Movement of the toe will typically cause slides to form further up-slope. The result is a slope with intermittently exposed underlayer stone and sub-grade, large armor stones hanging on the slope with little or no support from surrounding stones, and a mass of stone at the base of the slope. It is probably the most critically damaged reach on the headland area. Figure 2-12 illustrates some of the damage features. The damage also exposed previously existing CRM walls that had likely been covered by the damaged structure (Figure 2-13).

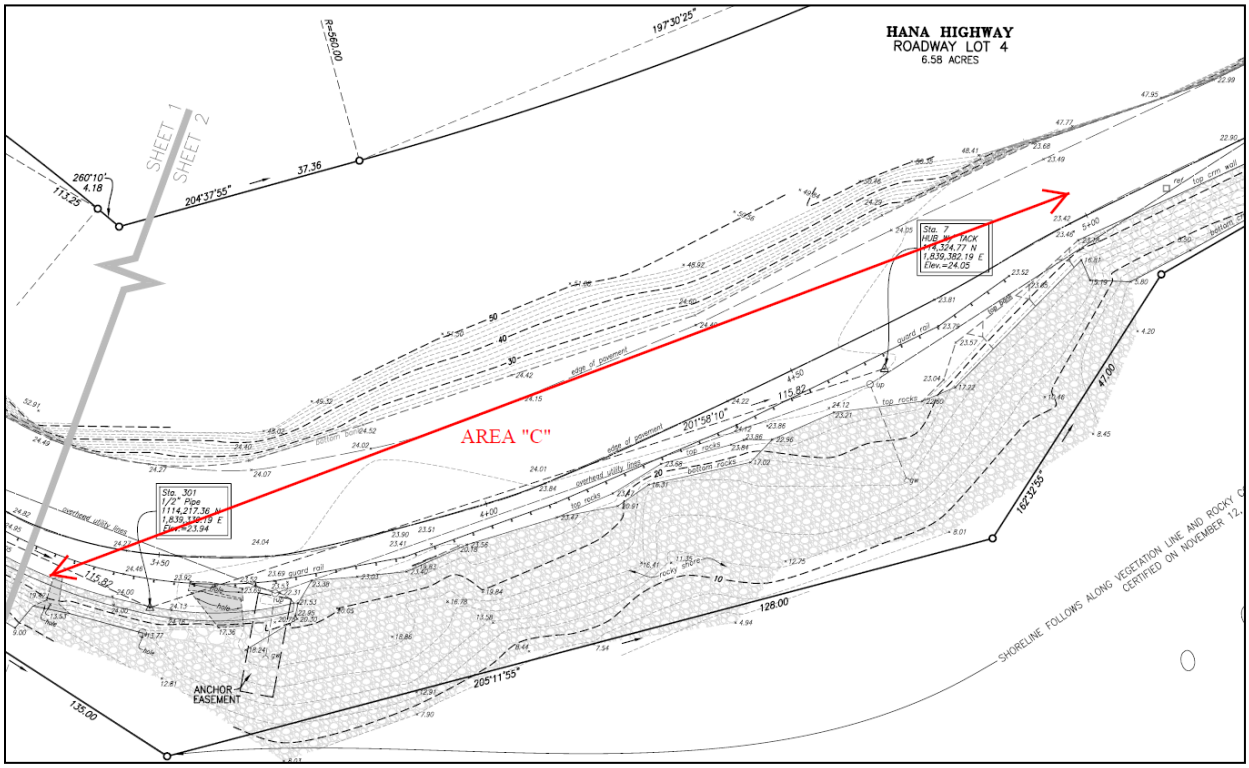


Figure 2-11. Damage Area "C", Sta. 3+35 to Sta. 5+00

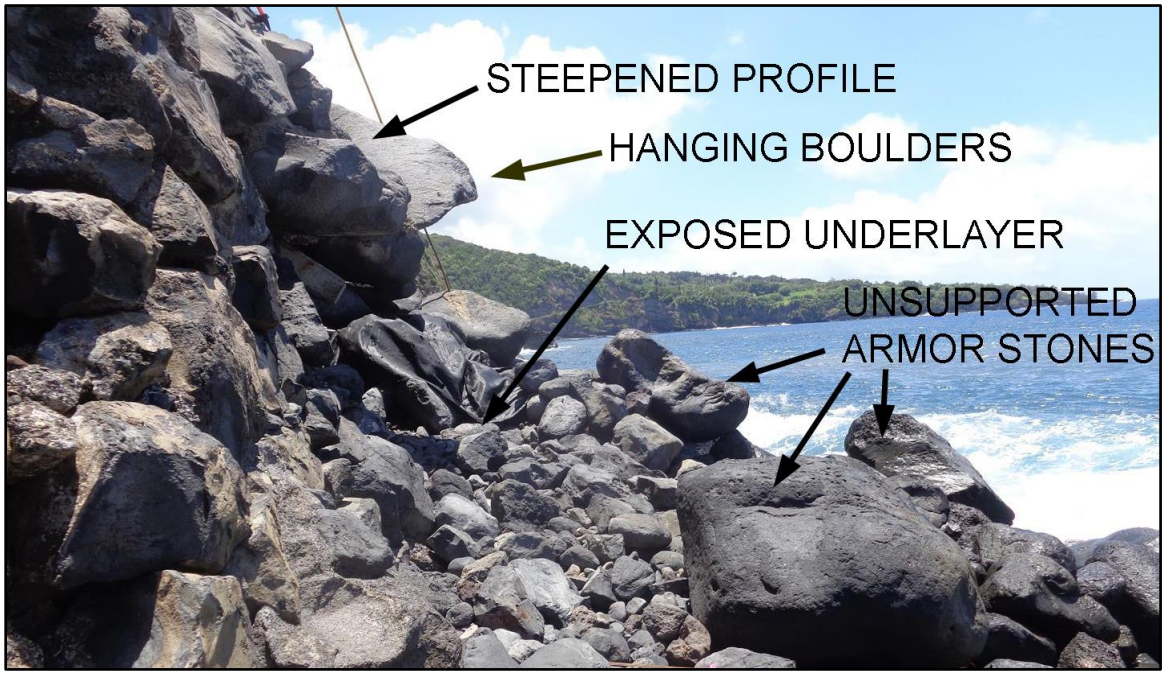


Figure 2-12. Damage features, Damage Area "C"



Figure 2-13. Exposed CRM under damaged structure, Damage Area "C"

2.2 Revised Topographic Survey by Austin Tsutsumi & Associates, Inc.

The topographic survey used for the preliminary concept designs (see Figures 7-3 through 7-5) had sparse topographic information at elevations less than approximately +6 ft MSL. The lack of information is due to the open coast exposure of the site, and the sheer difficulty and danger of traditional surveying in those conditions.

As part of this project, ATA produced additional topographic information by using "reflectorless" laser surveying, whereby the laser beam is bounced off of an object (a stone, in this case) rather than a survey reflector. Although less accurate than standard techniques, it allows surveying in difficult to access or dangerous areas such as a the project site.

2.3 Geotechnical Site Investigations by Geolabs, Inc.

Geotechnical site investigations were conducted by Geolabs, Inc. on July 25 through July 27, 2016. Three borings were drilled to depths of 35 to 37.8 ft below the highway pavement. Figures 2-14 and 2-15 show the location of the borings relative to the project reaches, Area "B",

the CRM Reach, and Area "C". Boring logs are shown in Figures 2-16 through 2-18. The complete Geolabs report (Geolabs, Inc., 2016) is included as Appendix B.

2.3.1 Subsurface Conditions

Following are descriptions of the subsurface from the report:

> *The subsurface conditions at the site were explored by drilling and sampling three borings, designated as Borings Nos. 1 through 3, extending down to depths of about 35 to 37.8 feet below the existing pavement surface. The approximate boring locations are shown on the Site Plan, Plate 2* (note: see Figures 2-14 and 2-15).
>
> *In general our borings encountered 1 inch of asphaltic concrete underlain by fill consisting of medium dense to dense silty sand with varying amounts of cobbles and stiff to very stiff clayey silt extending to depths of about 2 to 5 feet below the existing pavement surface.*
>
> *Below the fill, talus deposits consisting of medium dense to dense basaltic boulders and cobbles with gravel were encountered in Boring Nos. 1 and 2 extending to depths of about 30 and 9 feet below the existing pavement surface, respectively. Very stiff clayey silt (residual soil) and dense silty gravel (weathered clinker) were encountered below the talus deposits in Boring No. 1 extending to the maximum depth explored of about 37.8 feet below the existing pavement surface. In Boring No.2, the talus deposits were underlain by medium hard to hard basalt rock interbedded with clinker consisting of medium dense gravelly cobbles.*
>
> *In Boring No. 3, the fill was underlain by medium hard to very hard basalt rock interbedded with clinker extending to the maximum depth explored of about 35 feet below the existing ground surface. The clinker was generally weathered (stiff clayey silt) near the surface.*
>
> *We encountered groundwater in the borings at depths ranging from about 17 to 21.1 feet below the existing pavement surface, which corresponds to about +3.9 to +8 feet Mean Sea Level (MSL), at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to tidal fluctuations, rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.*

The report also contained recommendations with respect to the three concept designs presented in Section 1.4, and shown in Figures 7-3, 7-4, and 7-5:

- Rock rubblemound revetment,

- Concrete rubble masonry (CRM) retaining wall, and
- Reinforced concrete wall with tie-backs.

2.3.2 Rock Rubblemound Revetment Recommendations

The Geolab's report suggests a rock revetment as a possible option for Area "C":

> *Based on the existing topography at the site, we believe that the rock rubblemound revetment is a viable option for Area "C." The existing ground surface along the shoreline at Area "B" and the CRM reach generally have very steep slope inclinations; therefore, constructing a revetment along the shoreline in these areas is likely not viable.*

2.3.3 Concrete Rubble Masonry (CRM) Retaining Wall

A CRM retaining wall is seen as an option for the steeper reaches:

> *In areas with a steep slope inclination, such as Area "B" and the CRM Reach, the rock revetment in conjunction with a CRM gravity retaining wall may be a viable option. The CRM gravity retaining wall will need to be designed to resist the static lateral earth pressures acting on the wall. Since the wall will be located along a sloping shoreline that is subjected to wave action, resistance from passive earth pressures should be neglected. This would require a larger and heavier CRM wall to resist lateral earth pressures acting on the wall.*

General guidelines for the wall are as follows:

<u>Retaining Wall Foundations:</u>

> *For design of the gravity retaining wall foundation, an allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used for the design of shallow foundations bearing on the boulders/cobbles (talus deposits or stone underlayer) or basalt rock formation. This bearing value is for supporting dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as those caused by wind or seismic forces.* [note: the allowable bearing pressure was increased to 4,500 psf on review, see Section 7.5.1]

It should be noted that the stone underlayer below the revetment would likely move over time due to erosion from wave action. If the wall bears on the stone underlayer, movement of the stone underlayer could result in structural distress to the wall. To reduce potential for structural distress to the wall from movement of the stone underlayer, we recommend placing a minimum 2-foot thick layer of reinforced concrete below the full width of the wall to evenly distribute the load over the stone underlayer and to act as a "bridging" layer if movement of the stone underlayer occurs.

Generally, wall footings should have a minimum width of 18 inches. In addition, wall footings should be embedded a minimum depth of 24 inches below the lowest adjacent finished grade of the new revetment.

Lateral loads may be resisted by friction developed between the bottom of the foundation and the bearing soil. A coefficient of friction of 0.5 may be used for footings bearing on the 2-foot thick layer of reinforced concrete. Resistance due to passive earth pressure acting against the near-vertical faces of the foundation should be neglected since the wall is located in an area that is prone to erosion by wave action.

Static lateral earth pressures:

For design of the retaining wall, we recommend using equivalent fluid pressures of 34 pcf and 53 pcf for the active and at-rest conditions, respectively. Surcharge and hydrostatic pressures are not accounted for in the above values. Surcharge stresses due to areal surcharges, live loads, and point loads should be considered in the wall design.

For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution with uniform pressure equal to 28 and 44 percent of the vertical surcharge pressure acting on the entire height of the wall may be used for the active and at-rest conditions, respectively. Additional analyses during design may be needed to valuate the surcharge effects of point loads and line loads.

Dynamic lateral earth pressures:

Dynamic lateral earth forces due to seismic loading will need to be considered in the design of the retaining wall. Forces caused by dynamic lateral earth pressures due to seismic loading (amax = 0.26g) within the upper soil layer above the basalt rock formation may be estimated using $5.0H^2$ pounds per linear foot of wall length for

level backfill conditions, where H is the height of the wall within the upper soil layer in feet. The resultant force should be assumed to act through the mid-height of the wall within the upper soil layer. An appropriately reduced factor of safety may be used when dynamic lateral earth forces are accounted for in the design of the retaining wall.

It should be noted that the forces due to dynamic lateral earth pressures provided above assume that the wall will be allowed to move laterally by about 2 to 3 inches in the event of an earthquake. For restrained condition (less than 0.5 inches of lateral movement), forces caused by dynamic lateral earth pressures due to seismic loading may be estimated using $16.1H^2$ per linear foot of the wall length for level backfill conditions.

Drainage:

Retaining walls should be well drained to reduce the build-up of hydrostatic pressures. A typical drainage system for the retaining walls should consist of about 1 cubic foot of permeable material, such as open-graded gravel (ASTM C 33, No. 67 gradation), wrapped with non-woven filter fabric (Mirafi 180N or equivalent) at each of the weep hole locations. The weep holes should be spaced no more than 6 feet apart.

Alternatively, a 1 to 2-foot wide strip of geocomposite drainage material extending the full height of the retaining wall may be used. The geocomposite drainage material should be connected hydraulically to a weep hole or drainage outlet. Unless covered by concrete, the upper 12 inches of backfill should consist of impervious material to reduce the potential for excessive water infiltration behind the walls.

2.3.4 Reinforced concrete wall with tie-backs

As mentioned previously, resistance from passive earth pressures should be neglected for the design of the retaining wall since the wall will be located along a sloping shoreline that is subjected to wave action. A larger and heavier gravity retaining wall may be required to resist the lateral earth pressures. However, it may not be feasible to use a larger and heavier gravity retaining wall; therefore, a reinforced concrete wall with a permanent tieback anchor system may be used in lieu of a gravity retaining wall to provide the lateral support.

In general, the permanent tieback anchor system is constructed by drilling a borehole, installing a reinforcing bar into the borehole, and grouting the borehole.

The basic components of a grouted permanent tieback anchor consist of the anchorage and the bonded and unbonded lengths of the reinforcing bar. In general, the unbonded length of the tieback anchor is the portion of the reinforcing bar that does not have direct contact with the grout, allowing the reinforcing bar to elongate elastically and transfer the resisting force from the structure to the bonded length. The bonded length of the tieback anchor is the portion of the reinforcing bar that is directly bonded to the grout allowing it to transfer the applied load into the ground. Based on the depths of the boulders and cobbles encountered in the borings, we recommend that the unbonded length of the tieback anchor extend at least 25 feet behind the new concrete retaining wall so that the bonded length extends beyond the boulder and cobble layer and into the basalt rock formation. Due to the presence of boulders and cobbles at the site, there is a high potential for caving in of the borehole in the boulder and cobble layer. To reduce the potential for caving in of the borehole, we recommend using a permanent steel casing for the unbonded length of the tieback anchor. The permanent steel casing would also reduce the potential grout loss that could occur in the boulder and cobble layer if not cased.

We envision that the permanent tieback anchors would derive support principally from the bond between the grout and the basalt rock anticipated at the project site. The bond stress, which is the pullout resistance per unit area of the grout/soil interface contact, is variable depending on the type of soil/rock and grout, the overburden stress, and the construction procedures used in installing the permanent tieback anchors. An average bond stress of 2,000 pounds per square foot (psf) may be used for the basalt rock. The bond stress used in the design will need to be confirmed during construction by load testing.

In general, we believe the reinforced concrete retaining wall foundations may be designed in accordance with the recommendations and parameters presented in the "Concrete Rubble Masonry (CRM) Retaining Wall" section herein. The permanent tieback anchor system will be designed to provide resistance to the lateral earth pressures and lateral loads imposed from the traffic loading on the roadway. Details for the earth pressure diagram for one level of tieback anchors are presented on Plate 3 (see Figure 2-19).

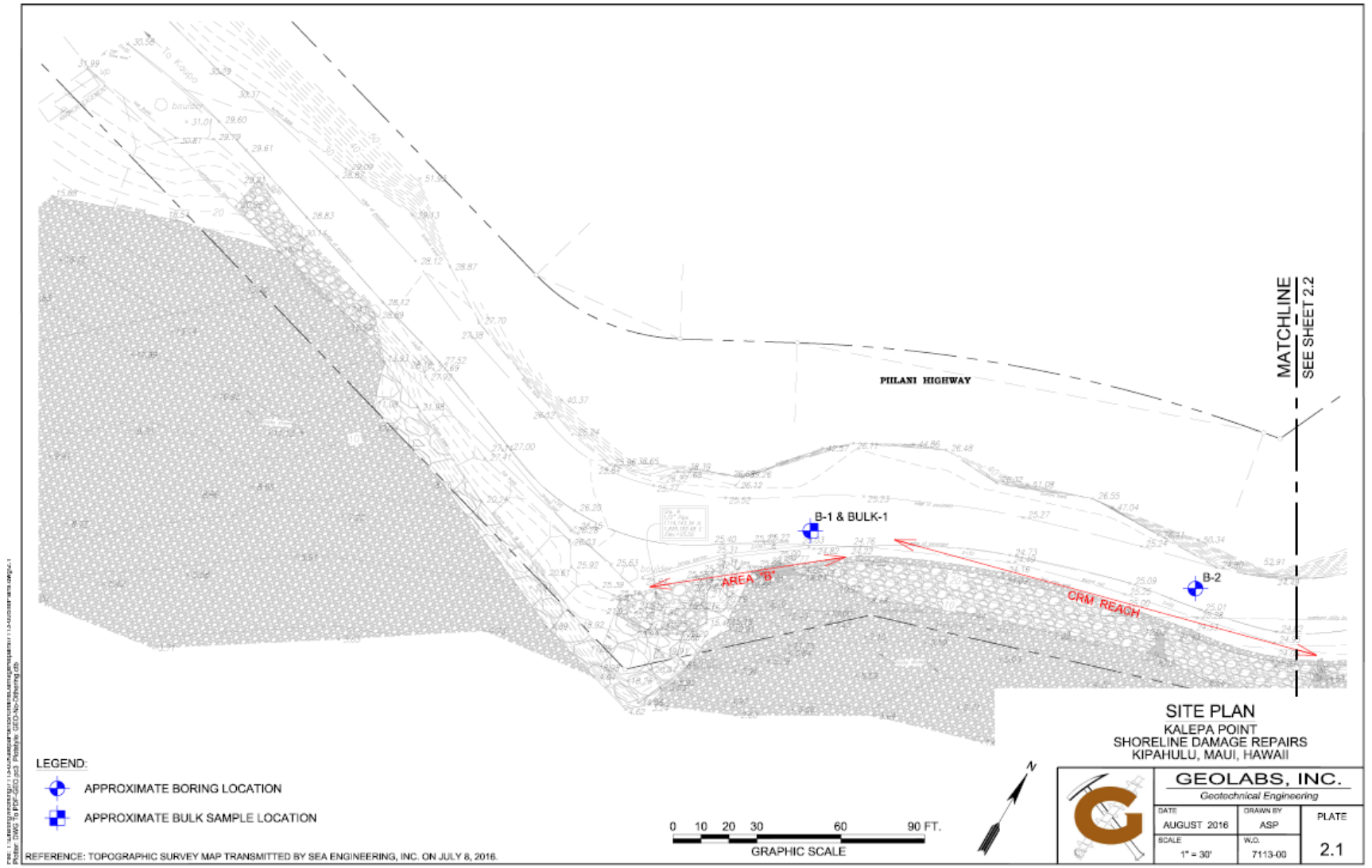


Figure 2-14. Locations of borings B-1 and B-2 at Area "B" and the CRM Reach

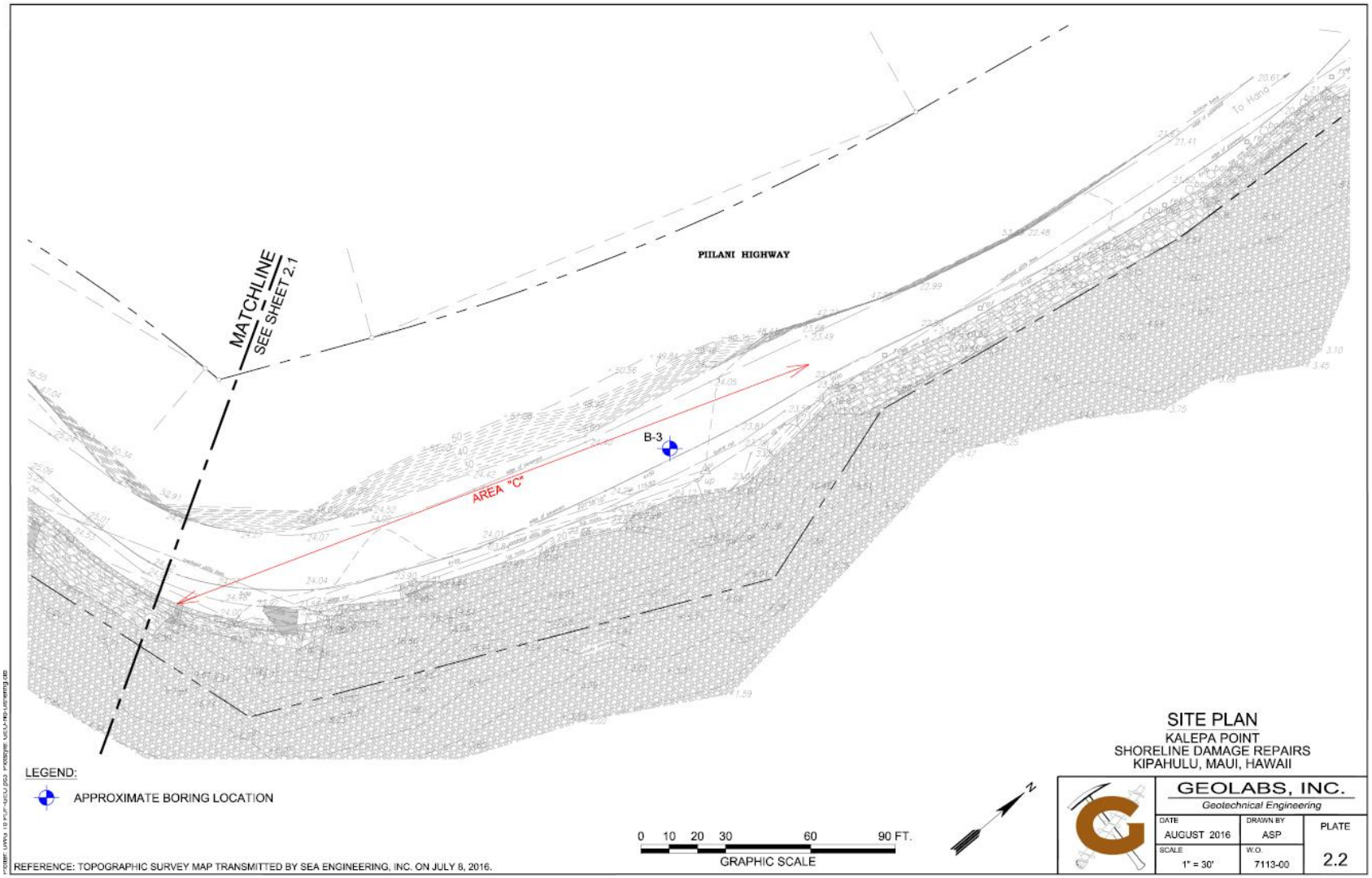


Figure 2-15. Location of boring B-3 at Area "C"

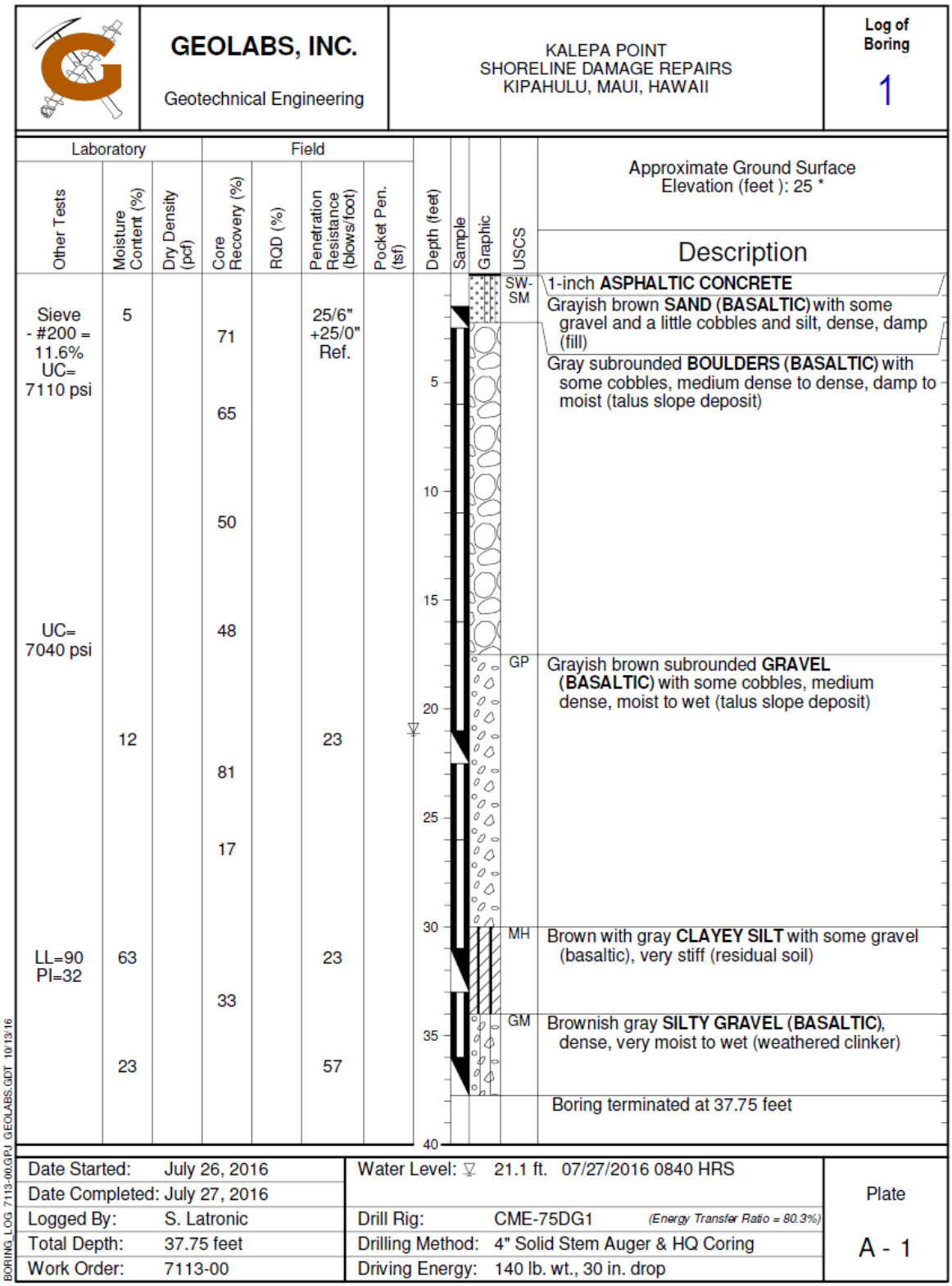


Figure 2-16. Log of boring B-1

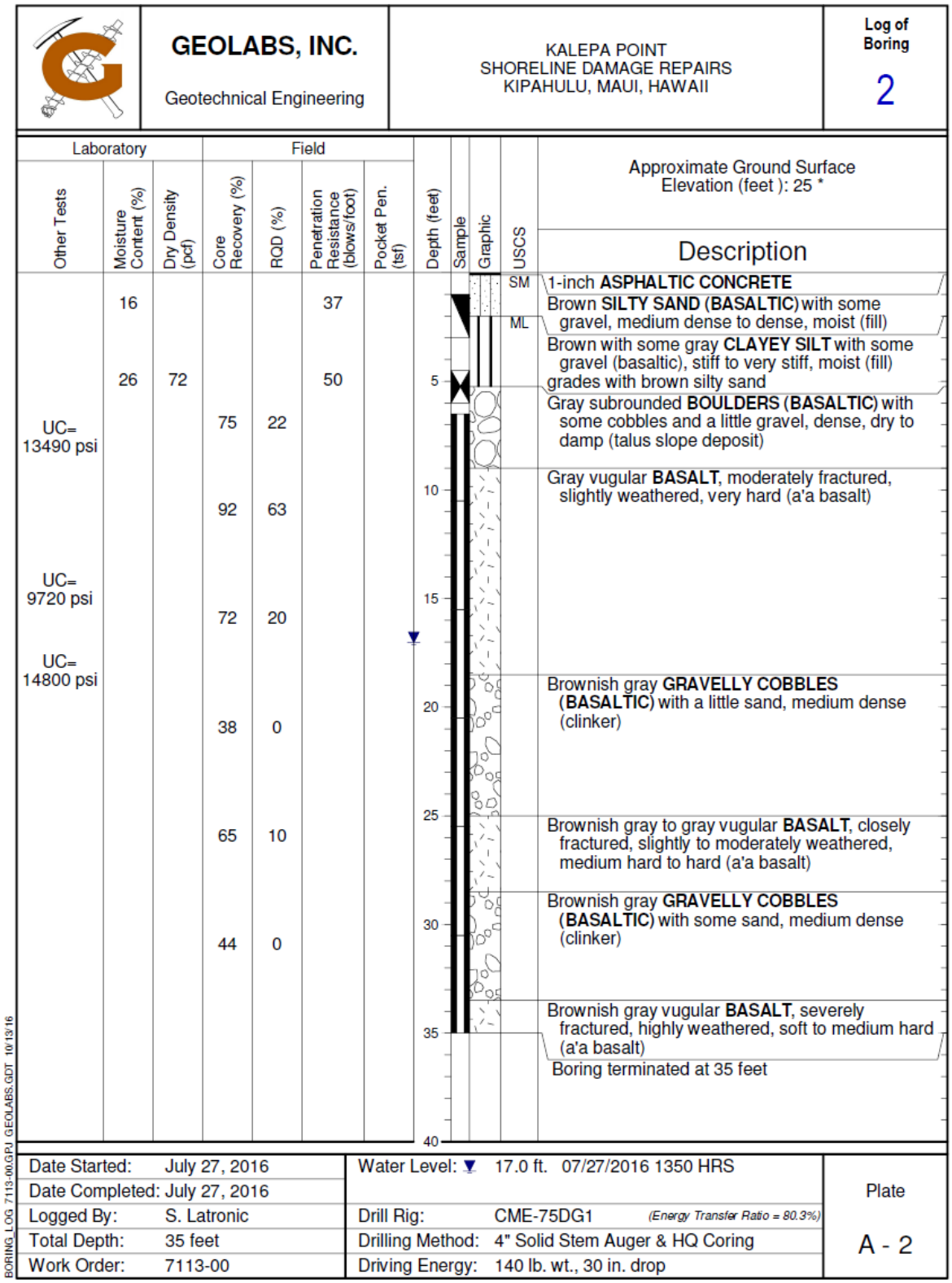


Figure 2-17. Log of boring B-2

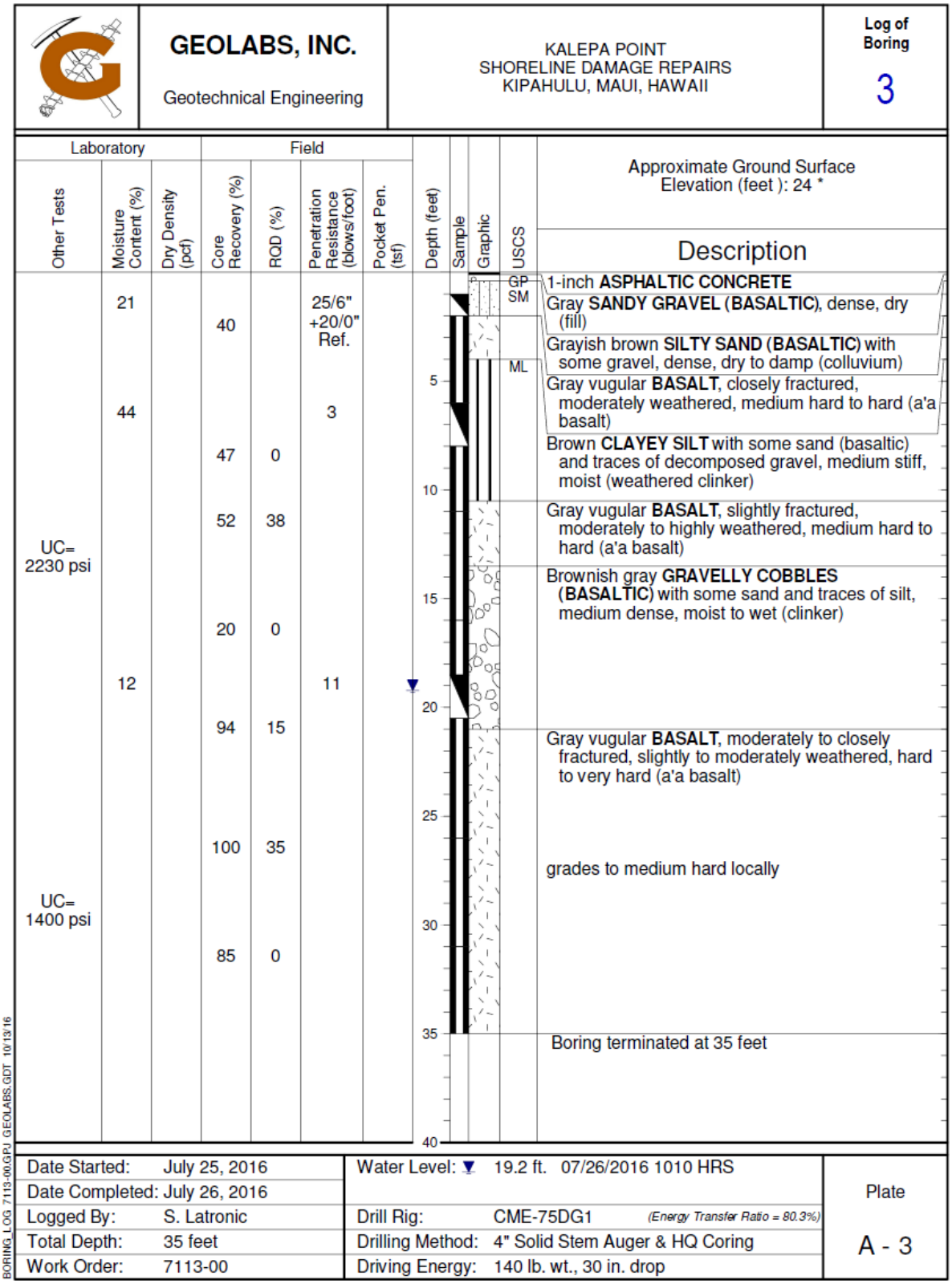


Figure 2-18. Log of boring B-3

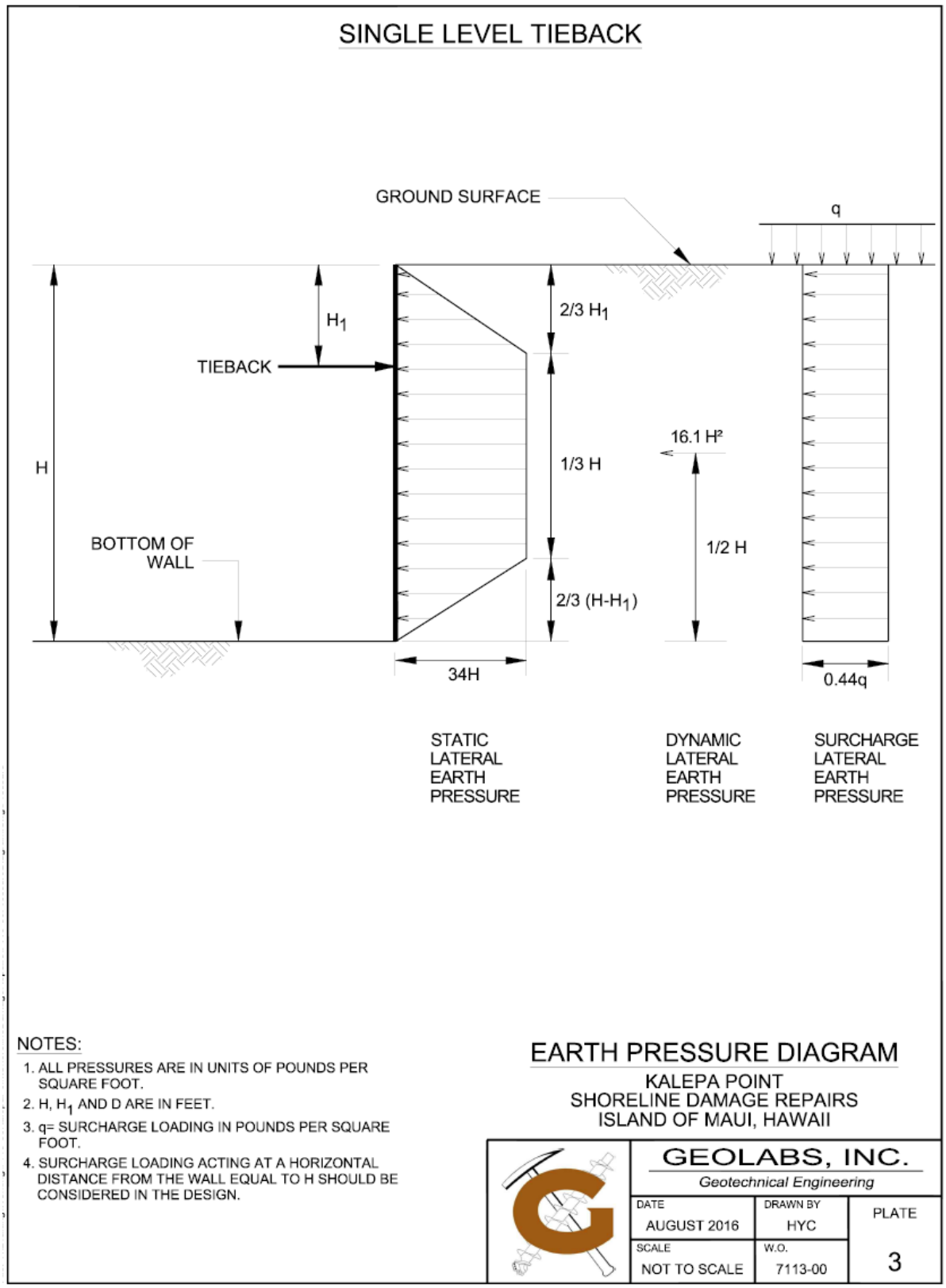


Figure 2-19. Plate 3 from Geolabs, Inc (2016) showing single level tieback

3. OCEANOGRAPHIC SETTING

3.1 Introduction

The Kalepa project site borders the Alenuihaha channel between the islands of Maui and Hawaii. Due to the high mountains on both islands, the prevailing trade winds in the channel are stronger than other channels and open waters in the Hawaiian Islands. Trade wind generated waves similarly tend to be larger, and the channel is known by mariners for its roughness. Island shadowing shelters the site from winds and waves from the west and northwest, but there is open exposure to the east, a common direction for Hawaiian hurricanes.

3.2 Bathymetry

Accurate nearshore bathymetric data are a critical element for calculating wave size and behavior for purposes of design. The remote location and open coast exposure of the project site make data collection difficult and generally unsafe. However, lidar data were available from the U.S. Army Corps of Engineers (USACE). Lidar stands for Light Detection and Ranging, and uses airborne lasers to measure shallow nearshore bathymetry and topography. The depth limit for the lidar methodology is about 150 to 200 ft in clear water.

Lidar data from 2013 (USACE, 2013) were used to develop nearshore bathymetry for the project (Figure 3-1). Areas of no data in Figure 3-1 are caused by wave breaking that causes air bubbles in the water column, with consequent interference with the laser transmission. The combined nearshore bathymetry and additional topographic information provided by ATA (see Section 2.2) were used in further design analysis. Figure 3-2 is a profile along the section line shown in the plan view. This section was used to calculate wave breaking parameters and for structure design. The nearshore design bathymetric profile is at a 1Vertical to 9 Horizontal (1V:9H) slope.

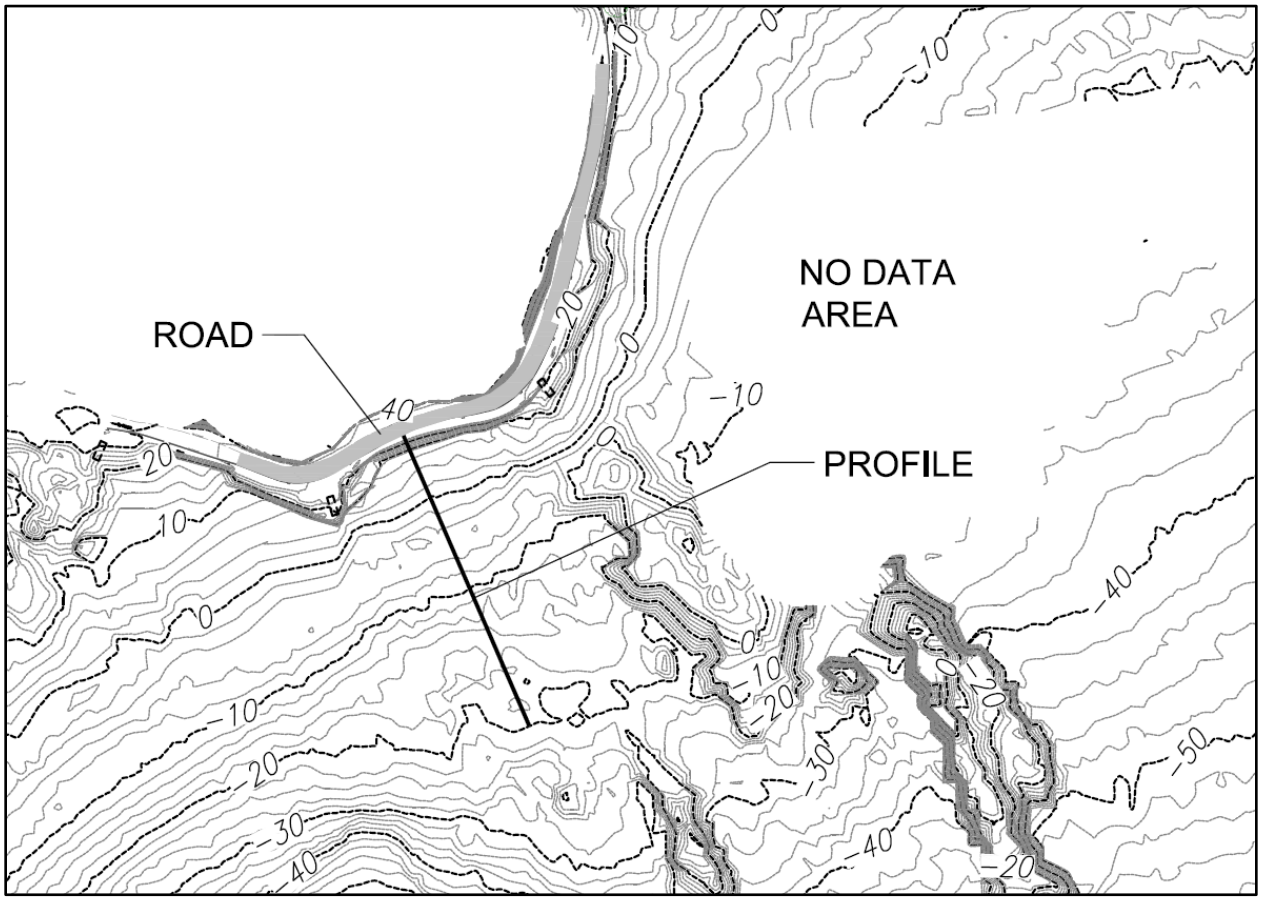


Figure 3-1. Nearshore bathymetry. Elevations in MSL.

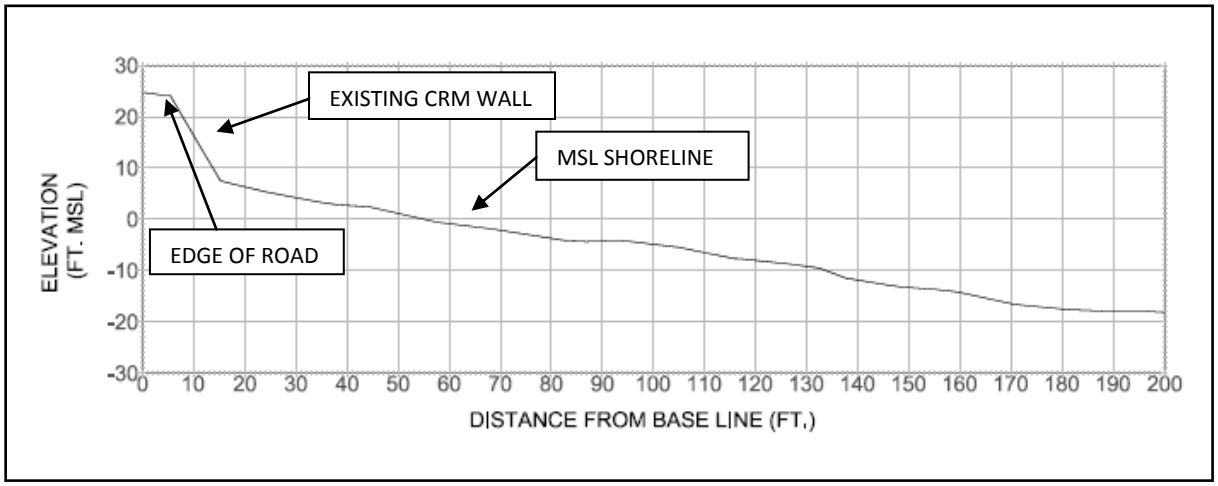


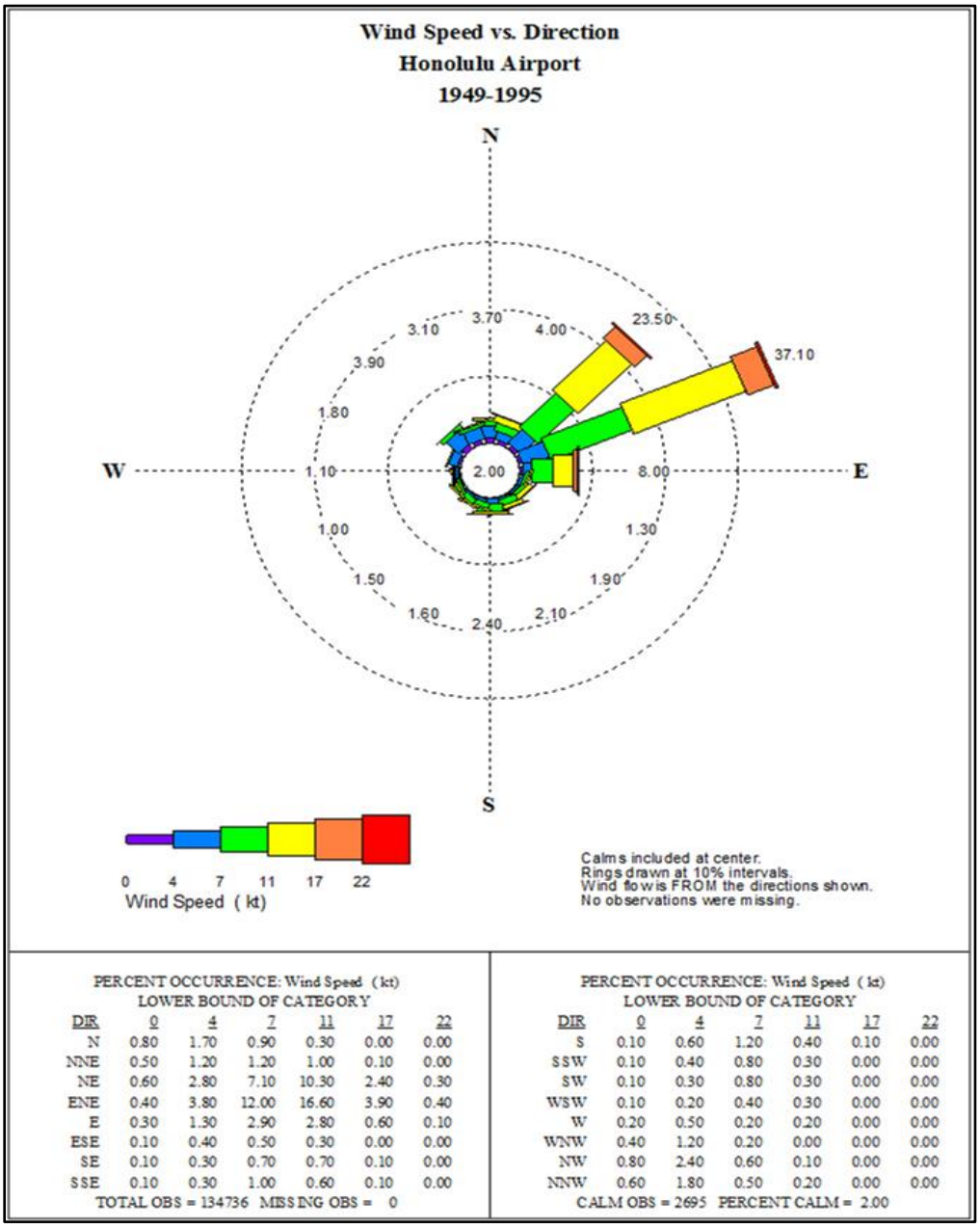
Figure 3-2. Representative offshore profile based on survey and LIDAR data (1V:9H)

3.3 Winds

The prevailing winds throughout the year in Hawaii are the northeasterly trade winds. Trade wind frequency varies from more than 90% during the summer season to only 50% in January, with an overall annual frequency of about 70%. Winds from the south and west, termed Kona winds, occur primarily during the winter months and are generated by low pressure systems near the islands. Figure 3-3 is a wind rose diagram based on wind data recorded at the Daniel K. Inouye Airport (formerly the Honolulu International Airport) between 1949 and 1995 that is generally applicable to the Hawaiian Islands. The wind rose shows the frequency of occurrence based on wind speed and direction and indicates the dominance of trade wind flow in the islands.

Trade winds are produced by the outflow of air from the Pacific Anticyclone high pressure system, also known as the Pacific High. The center of this system is located well north and east of the Hawaiian chain and moves to the north and south seasonally. In the summer months, the center moves to the north, causing the tradewinds to be at their strongest from May through September. In the winter, the center moves to the south, resulting in decreasing trade wind frequency from October through April.

Wind patterns of a more transient nature increase during the winter months. Winds from extra-tropical storms can be strong from almost any direction, depending on the strength and position of the storm. The low-pressure systems associated with these storms typically track west to east across the North Pacific, north of the Hawaiian Islands. At the Daniel K. Inouye (Honolulu) Airport, gusts resulting from these storms have on several occasions exceeded 60 mph. Kona winds generally come from a southerly to southwesterly direction, and are sometimes associated with slow moving low pressure systems known as Kona lows situated near the island chain. These storms are often accompanied by heavy rains.



PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
N	0.80	1.70	0.90	0.30	0.00	0.00
NNE	0.50	1.20	1.20	1.00	0.10	0.00
NE	0.60	2.80	7.10	10.30	2.40	0.30
ENE	0.40	3.80	12.00	16.60	3.90	0.40
E	0.30	1.30	2.90	2.80	0.60	0.10
ESE	0.10	0.40	0.50	0.30	0.00	0.00
SE	0.10	0.30	0.70	0.70	0.10	0.00
SSE	0.10	0.30	1.00	0.60	0.10	0.00

TOTAL OBS = 134736 MISSING OBS = 0

PERCENT OCCURRENCE: Wind Speed (kt)
LOWER BOUND OF CATEGORY

DIR	0	4	7	11	17	22
S	0.10	0.60	1.20	0.40	0.10	0.00
SSW	0.10	0.40	0.80	0.30	0.00	0.00
SW	0.10	0.30	0.80	0.30	0.00	0.00
WSW	0.10	0.20	0.40	0.30	0.00	0.00
W	0.20	0.50	0.20	0.20	0.00	0.00
WNW	0.40	1.20	0.20	0.00	0.00	0.00
NW	0.80	2.40	0.60	0.10	0.00	0.00
NNW	0.60	1.80	0.50	0.20	0.00	0.00

CALM OBS = 2695 PERCENT CALM = 2.00

Figure 3-3. Frequency of occurrence of wind speed and direction, Honolulu Airport showing the dominance of northeast tradewinds

The Kalepa area is exposed to the prevailing northeasterly trade winds, and to occasional winds from the south and southeast. Winds from the southwest clockwise to the north directions are mostly blocked by the island of Maui. No wind data are available from direct measurements in the vicinity of the project site, and speed and direction values will differ from the general

Honolulu values. The presence of Haleakala volcano and the volcanoes on the island of Hawaii will tend to increase the speeds of the prevailing trade winds.

3.4 Astronomical Tides

The tides in Hawaiian waters are semi-diurnal, with pronounced diurnal inequalities (i.e. two tidal cycles each day with the range of high and low water levels being unequal). Tidal datum values for Kahului Harbor are shown in Table 3-1.

Table 3-1. Water level data for Kahului Harbor

Datum	Elevation (ft - MLLW)	Elevation (ft - MSL)
Mean Higher High Water	2.25	1.13
Mean High Water	1.9	0.78
Mean Sea Level	1.12	0.0
Mean Low Water	0.33	-0.79
Mean Lower Low Water	0.0	-1.12

3.5 Waves in Hawaii

Ocean waves are the most important oceanographic phenomena for both coastal structure design and understanding coastal processes. The following sections present the general wave climate and site specific wave conditions that influence the design of shore protection.

3.5.1 General Wave Climate

The wave climate in Hawaii is typically characterized by four general wave types. These include northeast tradewind waves, southern swell, North Pacific swell, and Kona wind waves (Figure 3-4). Tropical storms and hurricanes also generate waves that can approach the islands from virtually any direction. On occasion, large waves from the northeast can impact the east shores of the islands. Unlike winds, any and all of these wave conditions may occur at the same time.

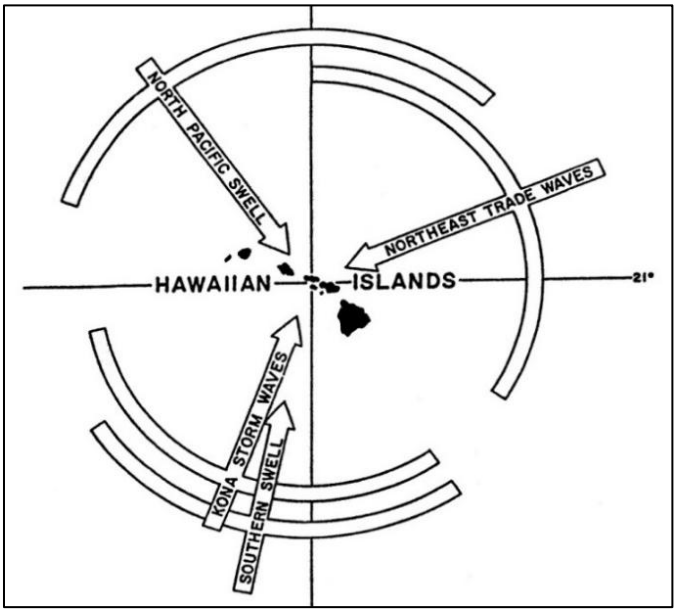


Figure 3-4. Common wave types and approach directions in Hawaii

Northeast Tradewind Waves

Tradewind waves occur throughout the year and are the most persistent in April through September when they usually dominate the local wave climate. They result from the strong and steady tradewinds blowing from the northeast quadrant over long fetches of open ocean. Tradewind deepwater waves are typically between 3 to 8 ft in height with periods of 5 to 10 seconds, depending upon the strength of the tradewinds and how far the fetch extends east of the Hawaiian Islands. The direction of approach, like the tradewinds themselves, varies between north-northeast and east-southeast and is centered on the east-northeast direction. The project site is exposed to trade wind waves, which are generally larger than other regions in the Hawaiian Islands due to funneling effect caused by the high mountains on either side of the Alenuihaha Channel.

Southern Swell

Southern swell is generated by storms in the southern hemisphere and is most prevalent during the summer months of April through September. Traveling distances of up to 5,000 miles, these waves arrive with relatively low deepwater wave heights of 1 to 4 ft and long periods of 14 to 20 seconds. Depending on the positions and tracks of the southern hemisphere storms, southern swell approaches from southeasterly through southwesterly directions. Kalepa is exposed to swell from the southeast through south directions, but is sheltered from the southwest exposure.

North Pacific Swell

During the winter months in the northern hemisphere, strong storms are frequent in the North Pacific in the mid latitudes and near the Aleutian Islands. These storms generate large waves that range in direction from west-northwest to northeast and arrive at the northern Hawaiian shores with little attenuation of wave energy. Deepwater wave heights often reach 15 ft and in extreme cases can reach 30 ft. Wave periods vary between 12 and 20 seconds, depending on the location of the storm. Kalepa is well sheltered from swell approach from the north and northwest by island shadowing.

Kona Storm Waves

Kona storm waves also directly approach the south and southwest; these waves are fairly infrequent, occurring only about 10 percent of the time during a typical year. Kona waves typically range in period from 6 to 10 seconds with heights of 5 to 10 ft, and approach from the southwest. However, deepwater wave heights during the severe Kona storm of January 1980 were about 24 ft. The waves during this event had a significant impact on the south and west shores of Maui.

Northeast Wave Events

Occasionally (and predominately in the Fall months) the winter storm systems become oriented in such a way that strong winds blow toward the Hawaiian Islands from the northeast and directly impact the east shores of the islands.

The wave event of November 21, 2003 was a particularly severe high wave condition that impacted the east side of all the Hawaiian Islands, and apparently resulted in damage to the breakwater and boat ramp at Hana Wharf. Figure 3-5 shows the North Pacific weather conditions that existed on November 20, 2003. A strong low pressure system lay to the east of a high-pressure system in the North Pacific, resulting in a strong pressure gradient and high winds and waves directed at the Hawaiian Islands from the northeast. Figure 3-6 shows the corresponding wave height analysis, with 10-meter (33-ft) waves in the storm region, and 5-meter (16.5-ft) waves reaching the Hawaiian Islands. Breaking wave heights up to 40 feet were reported during this event (Honolulu Advertiser, Nov. 22, 2003).

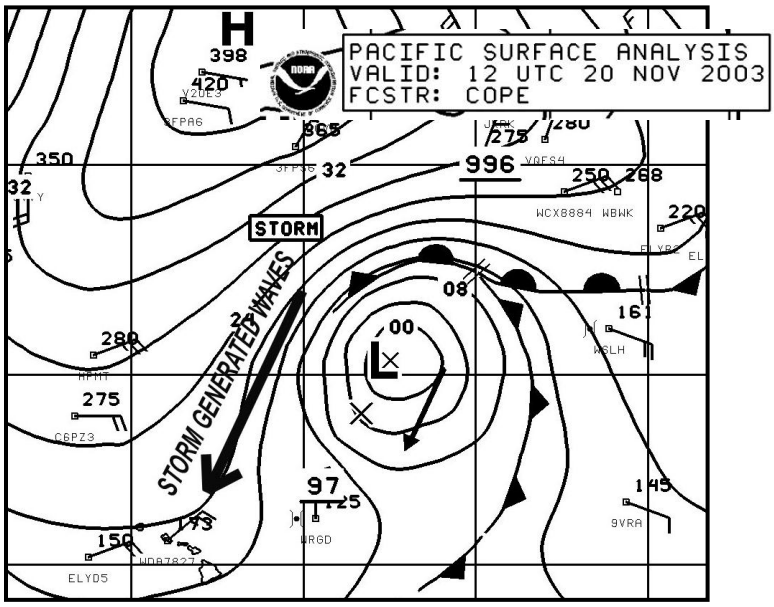


Figure 3-5. Weather map showing low pressure system NE of Hawaii (11-20-03)

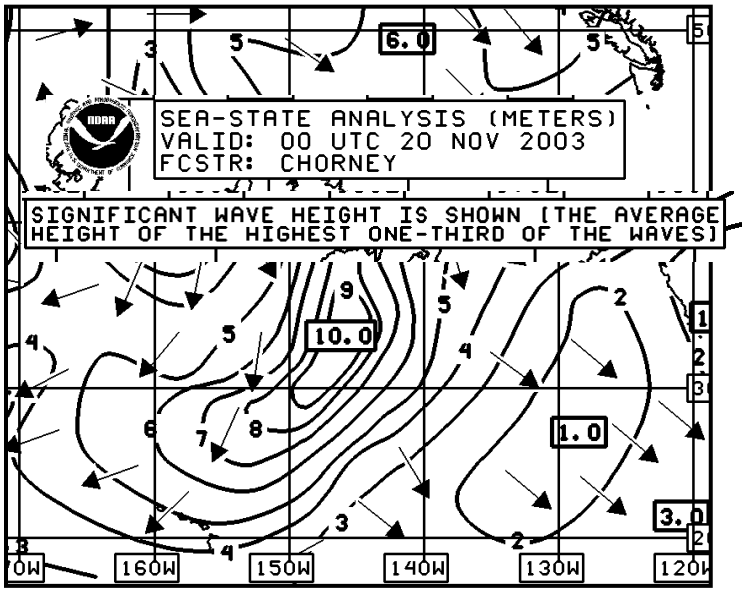


Figure 3-6. Sea-state analysis showing waves up to 10 m (33 ft) in height NE of Hawaii (11-20-03)

Tropical Storm and Hurricane Waves

Severe tropical storms and hurricanes have the potential to generate extremely large waves, which in turn could potentially affect the project site. Historical storm tracks from 1950 to 2015 are shown in Figure 3-7. Recent major hurricanes impacting the Hawaiian Islands with high

damage levels include Hurricane Iwa in 1982 and Hurricane Iniki in 1992. Iniki directly hit the island of Kauai and resulted in large waves along the southern shores of all the Hawaiian Islands. Damage from these hurricanes was extensive. Although not frequent or even likely events, they are often considered for project design conditions, particularly with regard to shoreline structures. Hurricane Iselle (2014) was down-graded to a tropical storm just before making landfall at Kapoho on the island of Hawaii; however; waves generated by the hurricane before landfall caused severe damage at the project site.

Even though damage resulting from hurricanes is rare in Hawaii, when damage occurs, it is significant. For this reason, hurricane generated waves from Iniki and Iselle are considered for design purposes. Waves from Hurricane Iniki are recorded in previous hindcast records; however, there is no recorded data available to quantify the size of the waves generated by Hurricane Iselle.

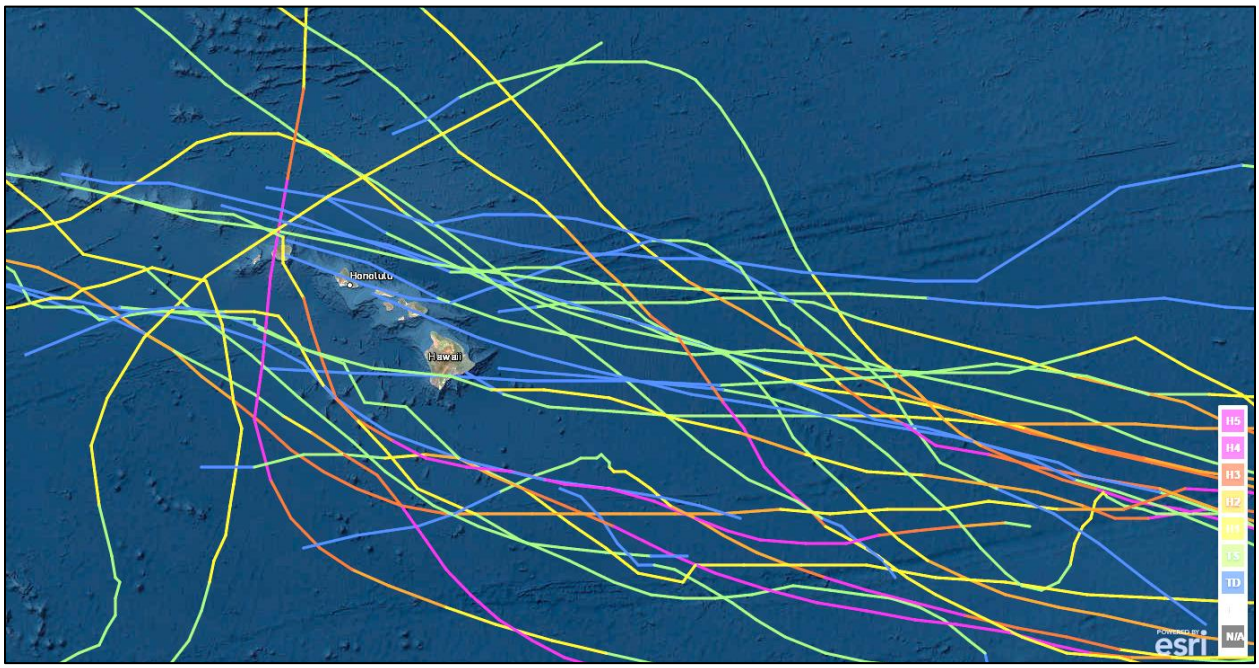


Figure 3-7. Historical hurricane tracks

3.5.2 Statistical Wave Analysis

Deepwater wave data were obtained for this project from both measured data and a wave hindcast study. Wave hindcasting is a tool used to calculate past wave events based on historical wind data applied to wave growth and propagation models. With the proper inputs, wave hindcast models can calculate historical wave climates anywhere in the world. Hindcast model

outputs are often recorded at a single location, known as a "virtual buoy". Waves generated by tropical storms and hurricanes will show as discrete events in the wave hindcasts, but are more accurately represented by using computer models specifically designed for that purpose. Waves generated by Hurricane Iselle are modeled in Section 4.2 using a specific hurricane model.

WaveWatchIII (WWIII) is a numerical wave model used to both forecast and hindcast waves. Data for a 28-year period (1979-2007) are available for a wide range of locations through NOAA/NCEP. For this study, hindcast wave data were obtained from virtual buoys (VB) 81103, located 25 miles north-northeast of the project site, and VB 81113 located 50 miles southwest of the site (Figure 3-8). VB 81103 was used to provide data for waves from the north and east sector (North Pacific swell and trade wind waves), while VB 81113 was used to provided data for waves from the south (southern swell, Kona storm waves).

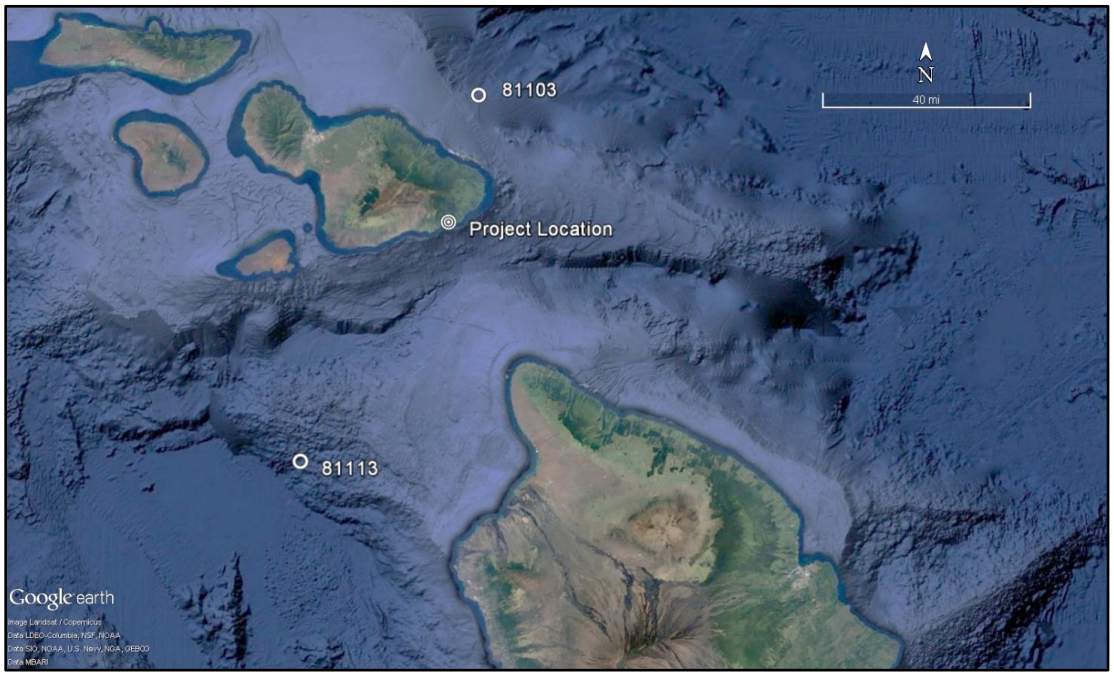


Figure 3-8. Virtual buoy locations

The technique of wave hindcasting allows the reconstruction of previous wave events, in this case over a 28-year period, to provide a large database from which wave statistics can be derived. Figure 3-9 is a wave height rose diagram that shows the percent occurrence of wave height and direction for waves as measured at VB 81103. Figure 3-10 is a wave period rose for waves measured at VB 81103. The roses show that the wave climate is dominated by tradewind waves from the east-northeast. The roses show that tradewind waves typically range between 6 and 8 feet in height, with heights rarely larger 10 ft. Tradewind wave periods typically range

from 6 to 10 seconds. The rose diagram also shows a range of north pacific swell coming from the northwest and north. While less frequent than trade wind waves, the north pacific swell tends to have larger wave heights and longer wave periods. However, this wave type is blocked at the project site by island shadowing.

Figure 3- and Figure 3-122 are the respective wave height and wave period roses for VB 81113. The buoy is sheltered from direct trade wind wave exposure, and shows increase exposure to waves from the west, south and southeast. Southern swell approaches from 180° to 210° and has a peak period between 10 and 18 seconds. Waves approaching from 135° to 160° are southeast tradewind waves and typically have smaller wave heights.

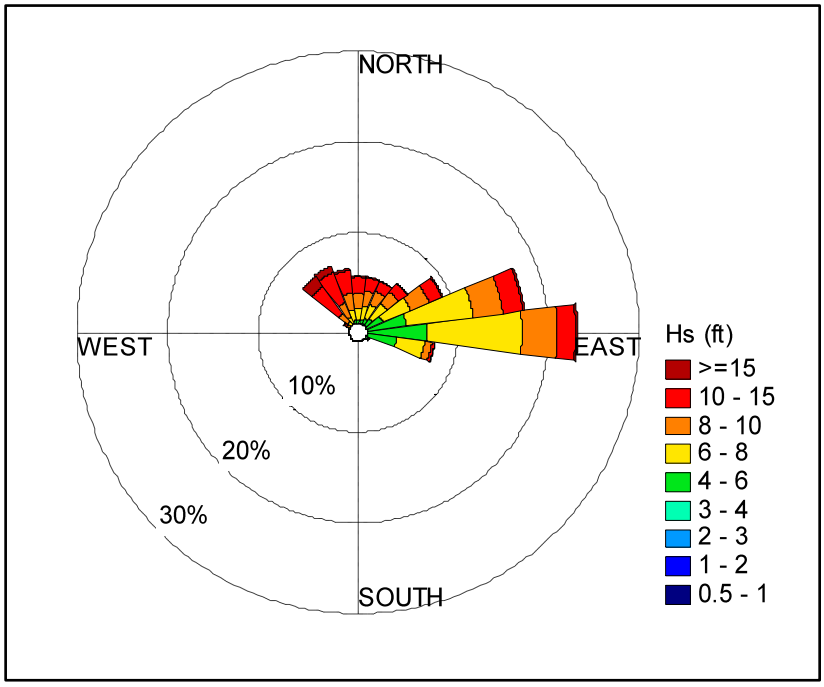


Figure 3-9. Deepwater wave height rose from virtual buoy 81103 from 1979 to 2007

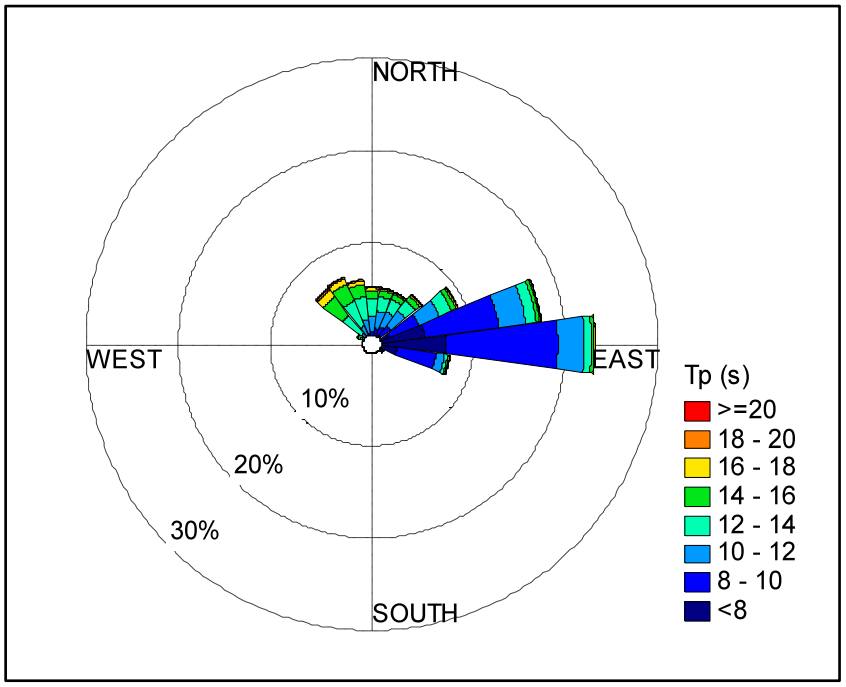


Figure 3-10. Deepwater wave period rose from virtual buoy 81103 from 1979 to 2007

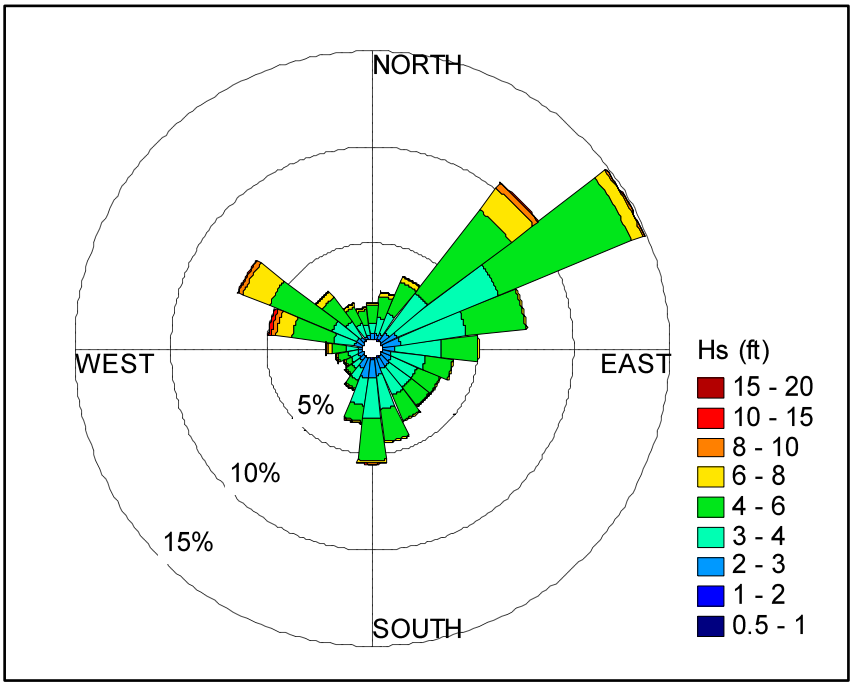


Figure 3-11. Deepwater wave height rose from virtual buoy 81113 from 1979 to 2007

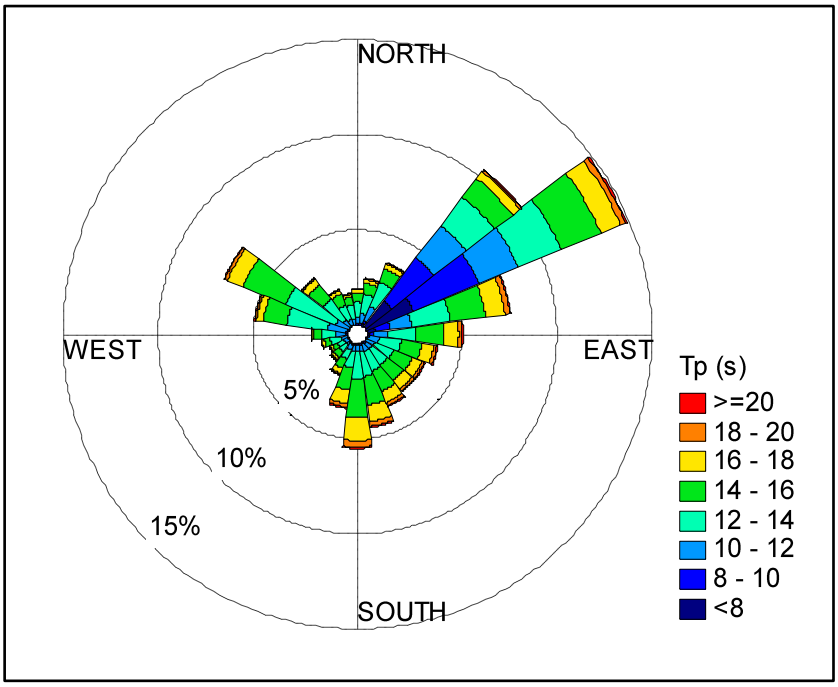


Figure 3-12. Deepwater wave period rose from virtual buoy 81113 from 1979 to 2007

3.5.3 Extreme Wave Heights

The robust data set provided by wave hindcasting also allows the prediction of extreme wave events. These are infrequent, low probability events that are typically used for design purposes. For example, a 50-year return period wave is an extreme event with a probability of occurrence once every 50 years. Extreme wave heights were investigated by filtering virtual buoy data by direction and period, and collecting the annual extreme events for 1) Kona storm waves, 2) southern swell, and 3) waves from the northeast and east. Hurricane waves are investigated in Section 4.

Table 3-2 is a list of the ten largest Kona storm type events from the virtual buoy data. The maxima data were used to generate a Weibull extreme value distribution (Figure 3-), and return period wave heights (Table 3-3). Similarly, Table 3-4 is a list of the largest ten southern swell events over the data period, with return period events listed in Table 3-5. Table 3-6 and Table 3-7 are for northeast and east wave events. The extreme value distribution shown in Figure 3- for Kona storm events is illustrative of the similar treatment of southern swell and northeast/east wave events.

Extreme wave heights are further discussed for design in Section 4.

Table 3-2. Ten largest Kona storm events

Date (yyyy-mm-dd hh)	Hs (ft.)	Tp (sec)	Dp (deg)
1980-01-09 13	13.12	11	242
2007-12-06 00	12.50	10	248
1996-03-04 16	11.55	8	241
1996-03-03 23	11.05	7	184
1987-12-13 12	10.59	7	182
2004-02-28 11	10.10	7	216
2001-11-27 21	10.04	7	190
1985-01-14 23	9.94	7	247
1982-02-12 02	9.77	7	243
1989-03-03 18	9.35	10	246

Note:
Hs – Significant Wave Height (the average of the highest 1/3 wave heights)
Tp – Peak Wave Period
Dp – Peak Wave Direction

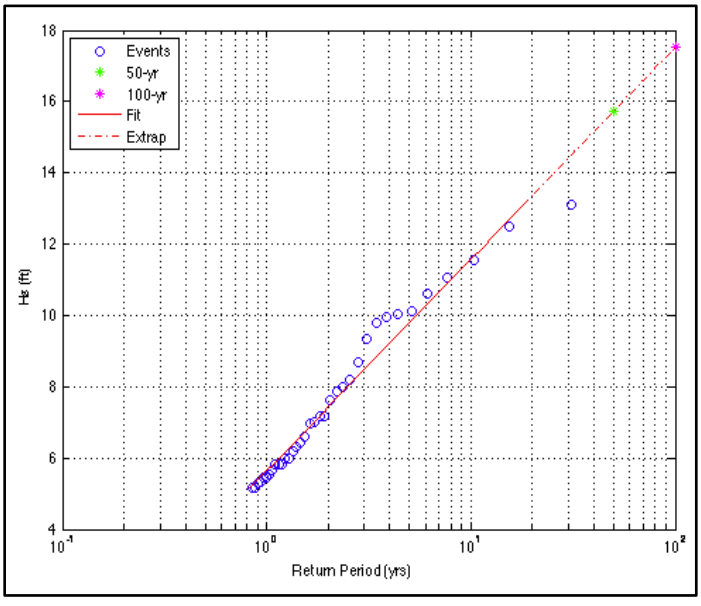


Figure 3-13. Extreme value distribution for Kona storm type wave events

Table 3-3. Return period for Kona storm waves

Return Period (yrs.)	Hs (ft.)
1	5.6
2	7.4
5	9.8
10	11.6
25	13.9
50	15.7
100	17.5

Table 3-4. Ten largest southern swell events

Date (yyyy-mm-dd hh)	Hs (ft.)	Tp (sec)	Dp (deg)
1993-10-26 01	7.25	14	181
1980-05-11 21	6.40	18	192
1980-05-12 00	6.36	18	192
1992-05-05 13	6.04	17	193
1998-06-12 23	6.00	17	188
1995-06-13 16	5.94	17	194
1992-02-19 21	5.90	17	187
1981-02-11 17	5.84	13	185
1987-10-03 11	5.74	17	191
1987-08-06 17	5.64	16	188

Table 3-5. Return period for southern swell wave events

Return Period (yrs.)	Hs (ft.)
1	4.8
2	5.3
5	6.0
10	6.5
25	7.1
50	7.6
100	8.1

Table 3-6. Ten largest east wave events

Date (yyyy-mm-dd hh)	Hs (ft.)	Tp (sec)	Dp (deg)
1988-12-31 12	22.50	12	89
2001-12-13 23	22.34	11	88
1985-03-06 10	21.42	12	69
1998-12-05 09	20.89	11	85
1986-04-10 19	19.78	10	64
1989-01-10 14	19.65	13	86
1980-03-31 04	18.99	13	84
2002-01-19 10	18.56	11	70
1994-11-19 18	18.27	11	88
1984-12-09 18	18.17	10	67

Table 3-7. Return period for east wave events

Return Period (years)	Hs (ft)
1	15.4
2	17.2
5	19.4
10	21.2
25	23.5
50	25.2
100	26.9

4. NUMERICAL HURRICANE AND WAVE MODELING

4.1 Introduction

In addition to wave hindcast modeling (see Section 3), numerical computer modeling was used to generate the wind and wave field of Hurricane Iselle, and to propagate deepwater waves into shallow water.

4.2 Numerical Modeling of Hurricane Iselle

Tropical storm and hurricane waves are modeled by using measured or assumed pressure gradients to reproduce the cyclonic wind field. The gradients are based on a vortex model that uses the central pressure and radius of the hurricane as the major parameters. The *cyclostrophic wind* is the theoretical wind speed based on the pressure gradient, and is the balance between the centrifugal force of the wind, and the force due to the pressure gradient. Phadke (2003) used a parametric, Rankine vortex wind model to hindcast waves generated by Hurricane Iniki. The modified Rankine vortex model defines the wind speed distribution in the radial direction as

$$V(r) = V_{max}\left(\frac{r}{R}\right)^{0.5}, \quad r < R$$

$$V(r) = V_{max}\left(\frac{R}{r}\right)^{0.5}, \quad r \geq R$$

where

V = cyclostrophic wind
V_{max} = maximum cyclostrophic wind $= K_1\sqrt{\Delta P}$
K_1 = an empirical coefficient
ΔP = pressure drop from the center of the storm to typical atmospheric pressure
r = radial distance from the hurricane center
R = radius of maximum cyclostrophic winds

The above example equations result in a more or less symmetrical wind field around the center of the hurricane. Applying a forward velocity (Jelesnianski *et al*, 1992) and inflow angle correction (Bretschneider, 1984) to the hurricane skews the wind velocity field to have greater wind speeds in the forward direction of the hurricane - resulting in the *dangerous semicircle* of the hurricane. And, finally, a correction from Powell and Black (1990) is applied to convert the cyclostrophic wind speeds (V) to surface winds speeds at 10 m above ground (V_{10}).

$$V_{10} = 0.8\,V$$

The parametric inputs for Hurricane Iselle, including the storm track and pressure gradients were obtained from National Hurricane Center Hurricane Database (HURDAT2) best-track archive. The concept of a constant circle of maximum winds is a simplifying assumption of the model that does not exist in a real hurricane; therefore, the radius of maximum winds (R) is the most difficult variable to measure and define. It is common practice to apply one constant R throughout the entire storm analysis to reduce the uncertainty of a time varying radius of maximum winds (Phadke et al, 2003). At the storm's peak intensity on August 4, 2014, the National Hurricane Center measured the radius of the hurricane eyewall as 25 nautical miles (~45 km). In well-developed hurricanes, the radius of maximum winds is generally found at the inner edge of the eyewall (National Hurricane Center). With no measured data from reconnaissance aircraft available, a constant radius of maximum wind of 45 km was applied to the hurricane wind model.

The formulas and parameters described above were used to generate a parametric wind field to model Hurricane Iselle winds from August 2 to August 9, 2014. The parametric wind field was then used to calculate wind generated waves in a nested SWAN model.

Figure 4-1 shows the modeled hurricane wind field as Iselle traveled west toward Hawaii from August 3 to August 7. Figure 4-2 shows the resulting wave field. The model results show the that the largest waves are on the north side of the storm near the radius of maximum winds. After August 5, the storm travels on a relatively straight path, creating what is known as a *captured fetch*. In a captured fetch scenario, the hurricane travels in the same direction and with the same speed as the waves being generated, adding energy to the waves and increasing their height.

A time series of wave height (Hs) and peak wave period (Tp) in Figure 4-3 and Figure 4-4, respectively, show the model results from a virtual buoy in deep water offshore of the project site. The time series shows long period swell persisting over a few days with two discrete wave height peaks. This result could be explained by the captured fetch of the storm. The wave parameters from the two peaks of the wave height time series are termed Iselle 1 and Iselle 2. The first peak, Iselle 1, has a deepwater wave height of 8.6 ft. and a peak period of 16 seconds. The second peak, Iselle 2, has a deepwater wave height of 12.5 ft. and a peak period of 14 seconds. Iselle 1 is considered for design purposes despite have a smaller wave height as it has a longer wave period. It will experience greater wave height increase due to shoaling as it moves into shallow water.

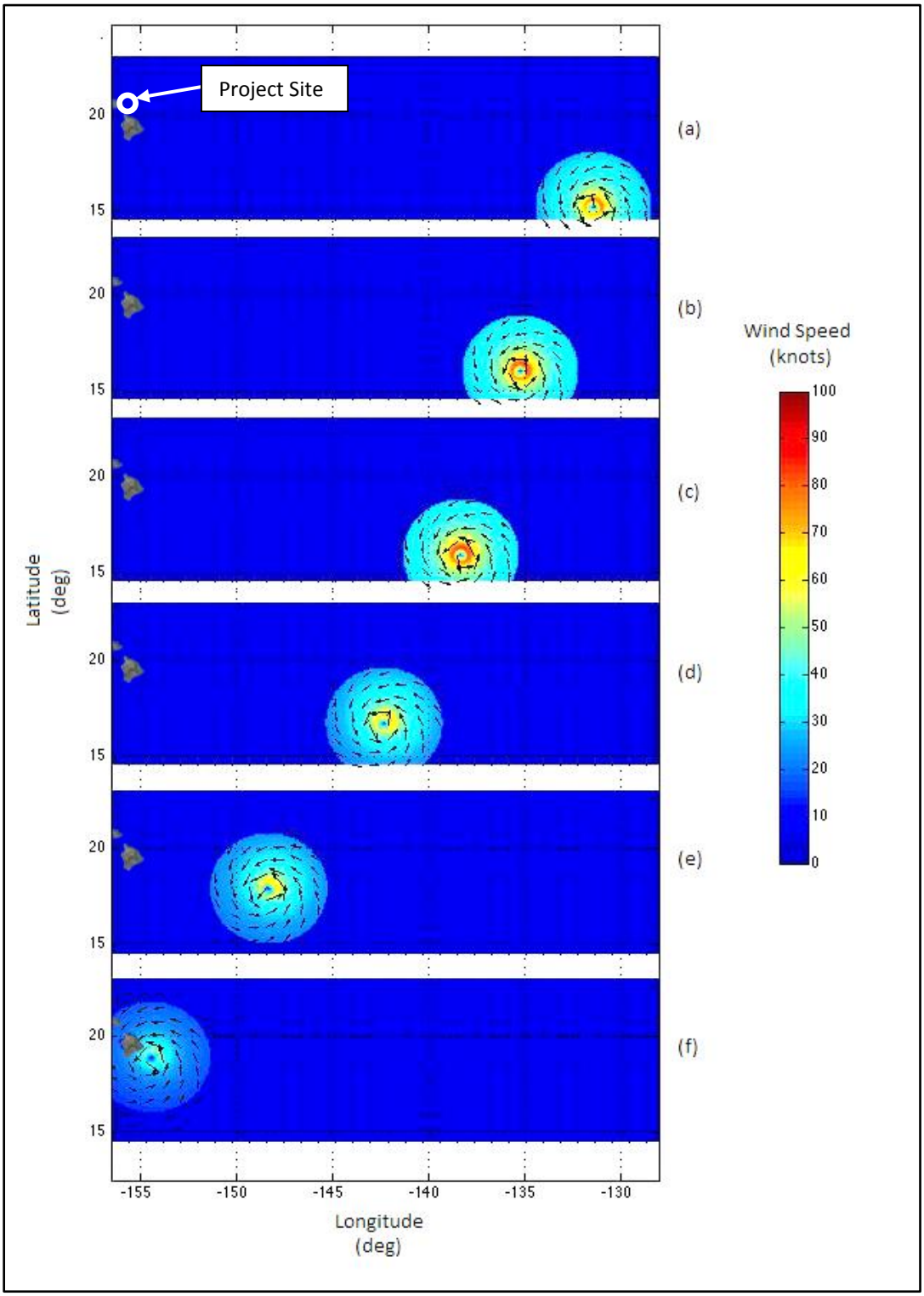


Figure 4-1 Hurricane Iselle wind field at 24-hr intervals: (a) 08/03/2014 through (f) 08/08/2014

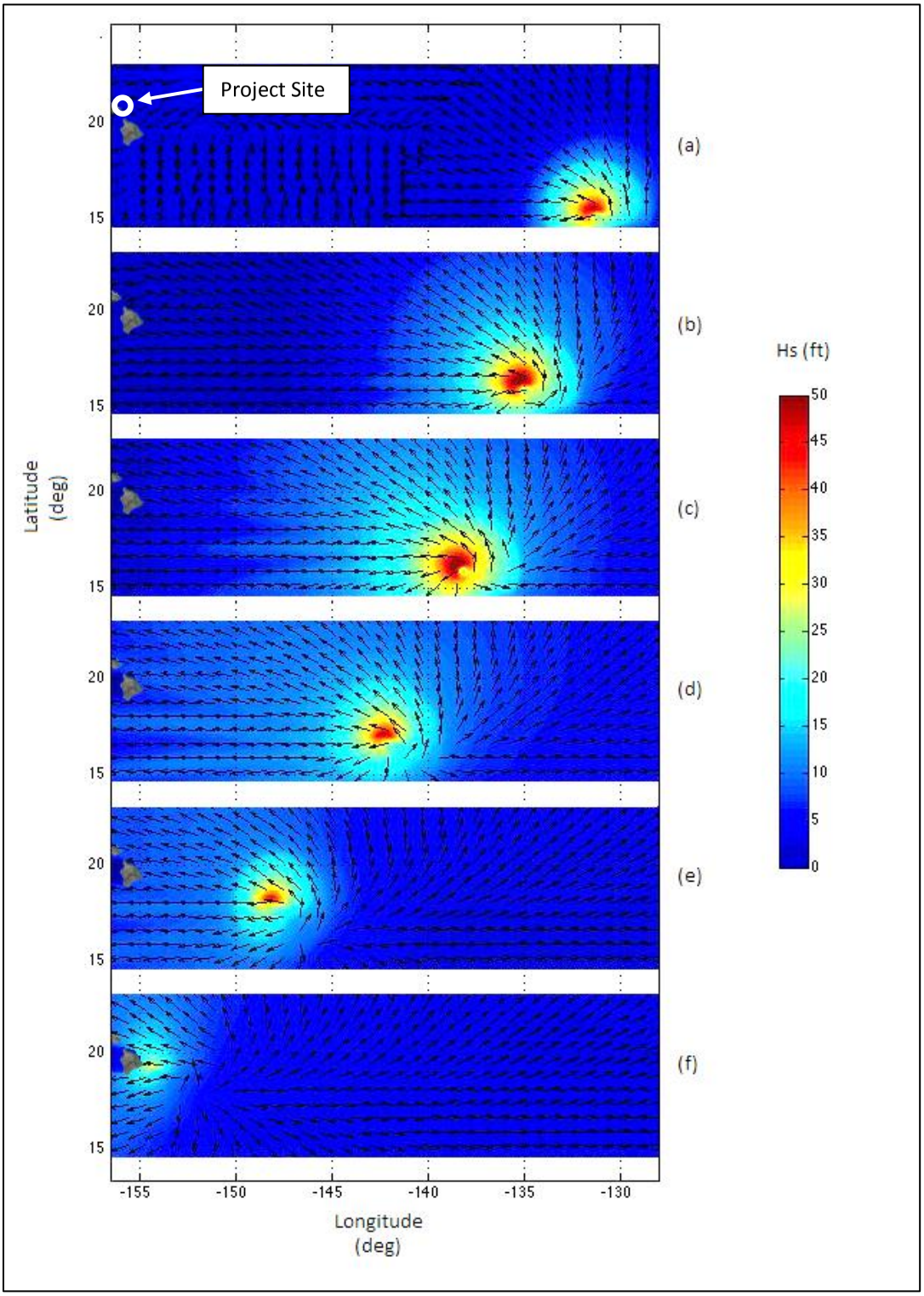


Figure 4-2. Hurricane Iselle wave field at 24-hr intervals: (a) 08/03/2014 through (f) 08/08/2014

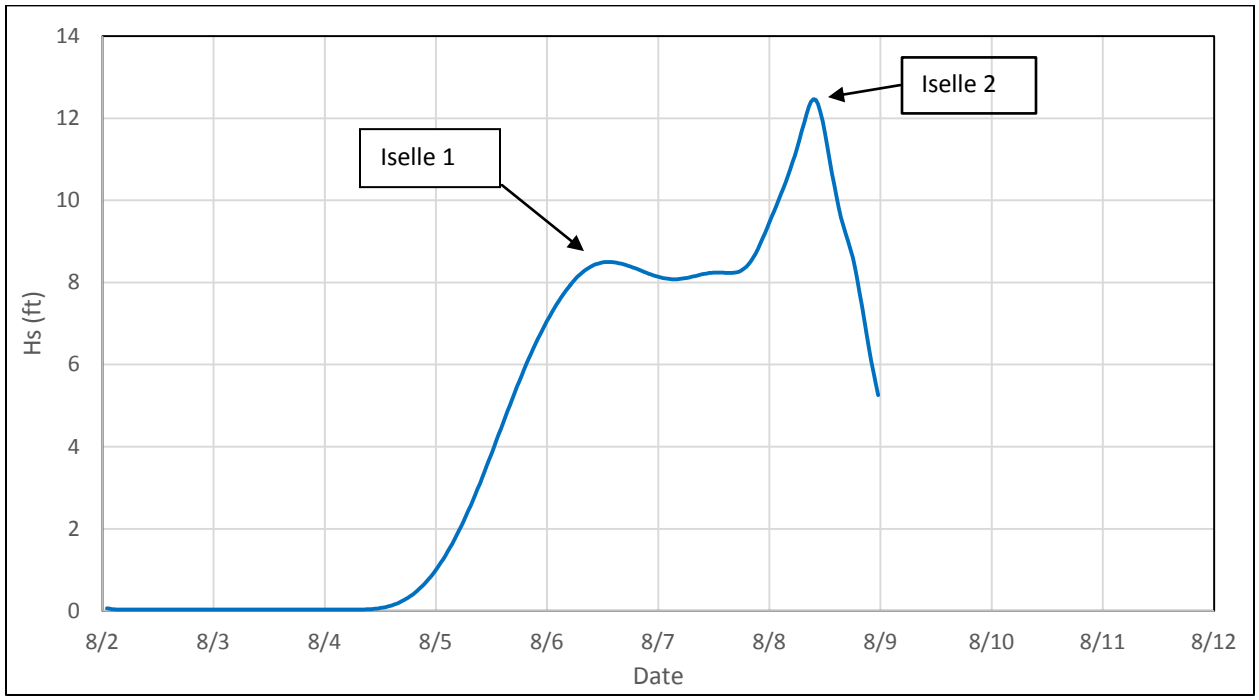


Figure 4-3. Hurricane Iselle virtual buoy wave height time series. Peak wave heights Iselle 1 and Iselle 2 are considered for design wave conditions.

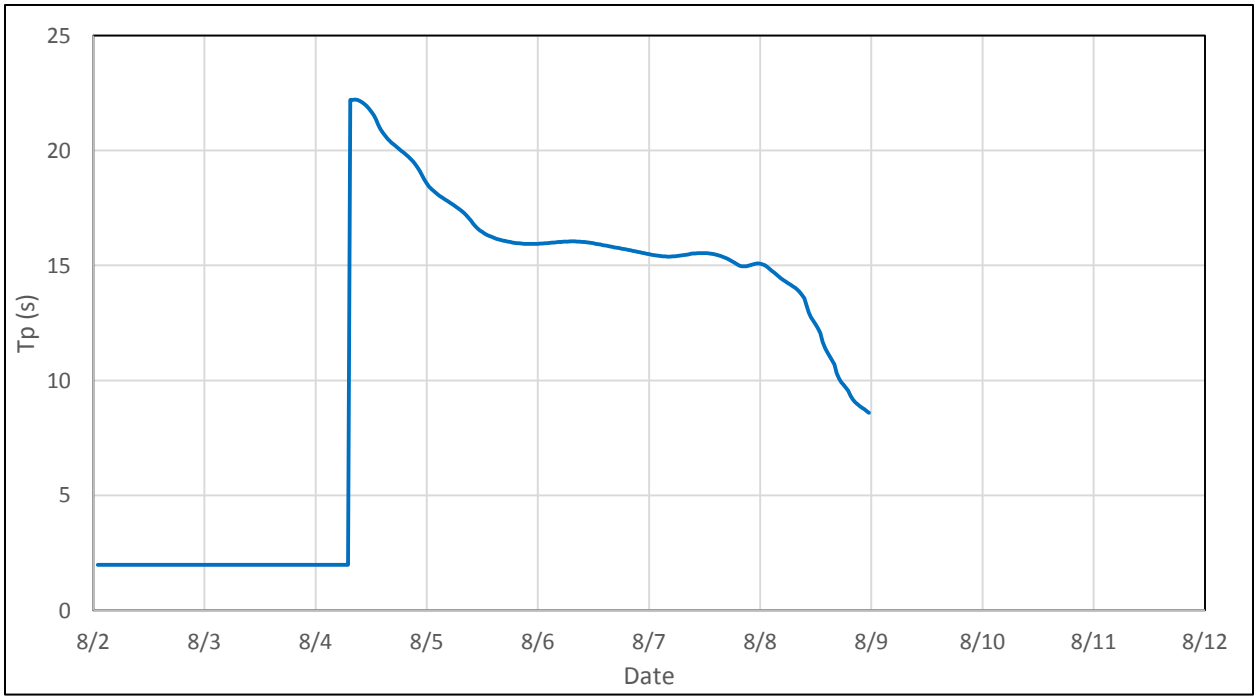


Figure 4-4. Hurricane Iselle virtual buoy wave period time series.

4.3 Numerical Modeling of Wave Approach

4.3.1 Wave Transformation In Shallow Water

The design of coastal structures requires determination of the design wave conditions at the project site. Wave behavior is complex, with deepwater waves determined by growth and decay factors in generating regions such as mid-latitude storms and tropical hurricanes, and shallow water behavior dramatically influenced by approach direction and bathymetry.

There are a number of phenomena that apply to the behavior of water waves in shallow nearshore water that are important for understanding fundamental coastal processes. As deepwater waves propagate toward shore, they begin to encounter and be transformed by the ocean bottom. Wave speed is governed by the wavelength in deep water, but in shallow water the wave speed becomes directly related to the water depth. As waves decelerate with decreasing depth, the process of *wave shoaling* generally steepens the wave by increasing the wave height and decreasing the wavelength. *Wave breaking* occurs when the wave profile shape becomes too steep to be maintained, and is a mechanism for dissipating the wave energy. Wave breaking typically occurs when the ratio of wave height to water depth, exceeds the *breaker depth index*. The breaker index is dependent on the deepwater wave height, wave period, and near shore slope, although a theoretical value of 0.78 based on solitary wave theory is often used. Due to the steep slope of the sea floor off the project site, the breaker index is on the order of 1.3. Wave energy is also dissipated due to bottom friction. The process of wave breaking causes a rise in nearshore water level termed *wave setup*. The difference in wave setup at adjacent nearshore areas is the hydraulic mechanism responsible for driving wave-derived longshore and cross-shore ("rip") currents. The phenomenon of *wave refraction* is caused by differential wave speed along a wave crest due to depth variations, and will cause wave crests to converge or diverge and may locally increase or decrease wave heights. Although not a shallow water phenomenon, *wave diffraction* is the lateral transmission of wave energy along the wave crest, and will cause the spreading of waves in a shadow zone, such as occurs behind a breakwater or other barrier. *Wave reflection* will occur along vertical or steep shorelines or submerged features, including steep beaches, rock formations, reefs, or man-made structure such as breakwaters or seawalls.

Simulating WAves Nearshore (SWAN) is a third-generation wave model developed by Delft University of Technology that computes random, short-crested wind-generated waves in coastal regions and inland waters. The SWAN model can be applied as a steady state or non-steady state model, and is fully spectral, meaning that it covers the total range of wave frequencies. Wave propagation is based on linear wave theory, including the effect of wave generated currents. SWAN provides many output quantities including two-dimensional spectra, significant wave height and mean wave period, and average wave direction and directional spreading. For this

project, the SWAN model was used to transform waves from deepwater to the project site (Section 4.4) and to model the waves generated by Hurricane Iselle (Section 4.2).

4.3.2 Offshore Wave Transformation

A nested three-grid setup in the SWAN wave model was used to propagate the deepwater design waves to the project area (Figure 4-5). The wave conditions are applied along all boundaries of the largest grid, which has a resolution of 500 m (1,640 ft) and nests an intermediate grid with a resolution of 250 m (820 ft), and then a nearshore grid with a resolution of 50 m (164 ft).

Figure 4-6 is an example of the SWAN output, and shows the large scale (500 m) transformation of a deepwater swell from the east as it approaches the project site. Figure 4-7 shows east waves at the project site at a closer scale (50 m grid), with pronounced refraction, or bending of the wave paths near to the shore.

Figure 4-7 and Figure 4-8 shows the approach of waves from the south southwest, representative of waves that occurred during Hurricane Iniki in 1992.

The wave modeling shown in Figure 4-5 through Figure 4-9 allows the calculation of the effects of refraction and shoaling as the deepwater wave progresses into shallow water. Final calculation of wave transformation into a breaking wave in shallow water is used to generate a design wave height.

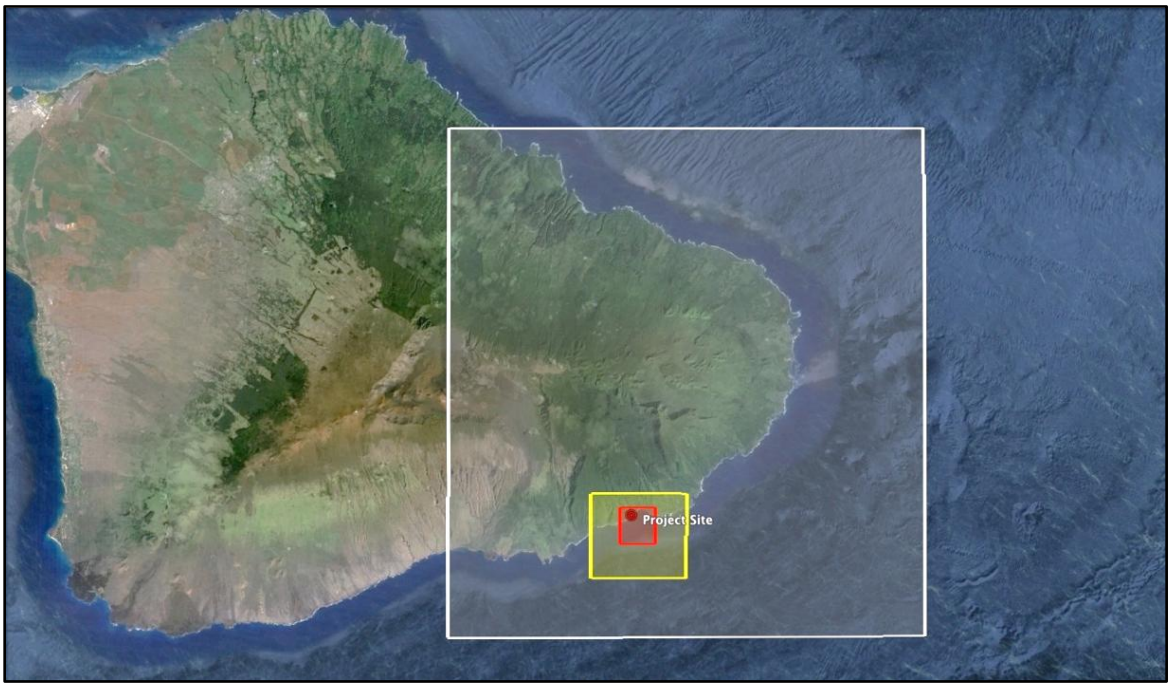


Figure 4-5. Nested SWAN grid boundaries

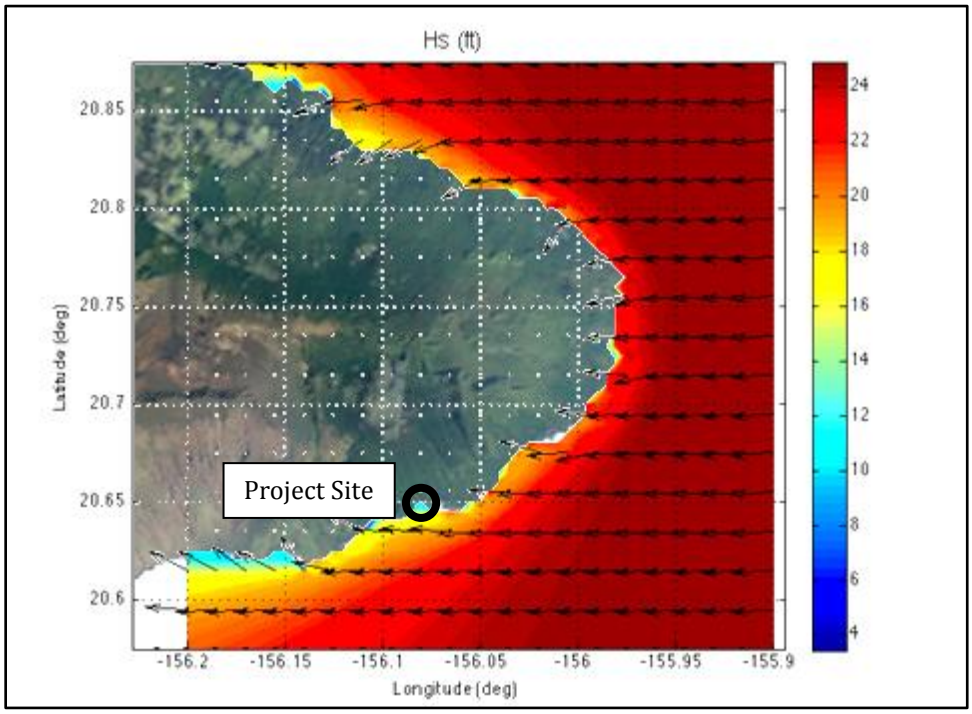


Figure 4-6. Wave height and approach vectors for waves from the east; 500m grid

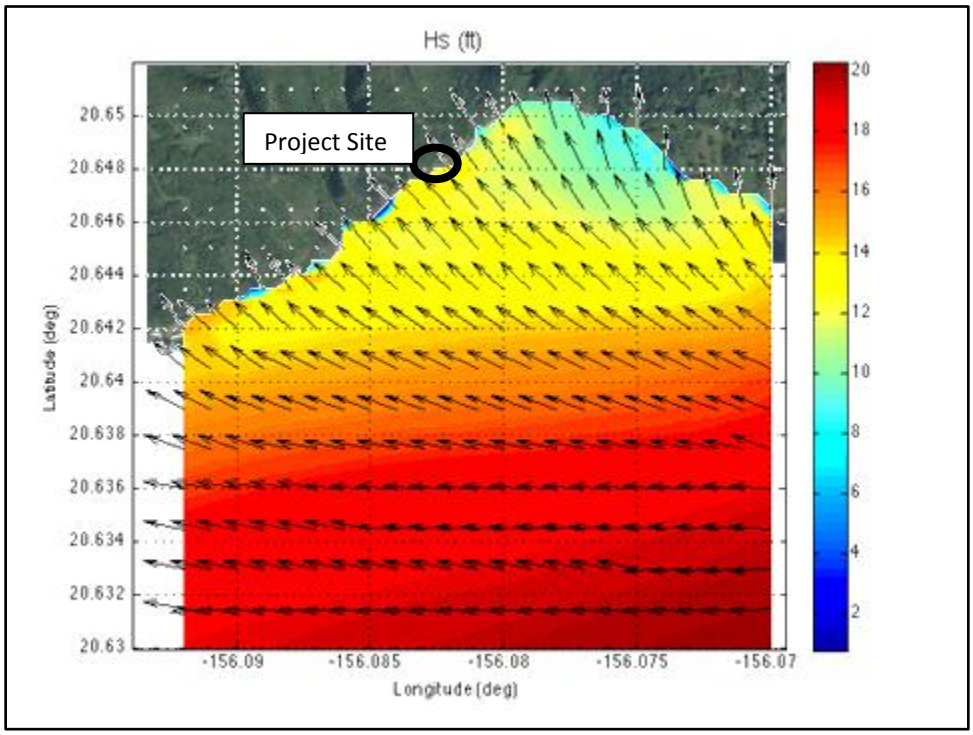


Figure 4-7. Wave height and approach vectors for waves from the east; 50m grid

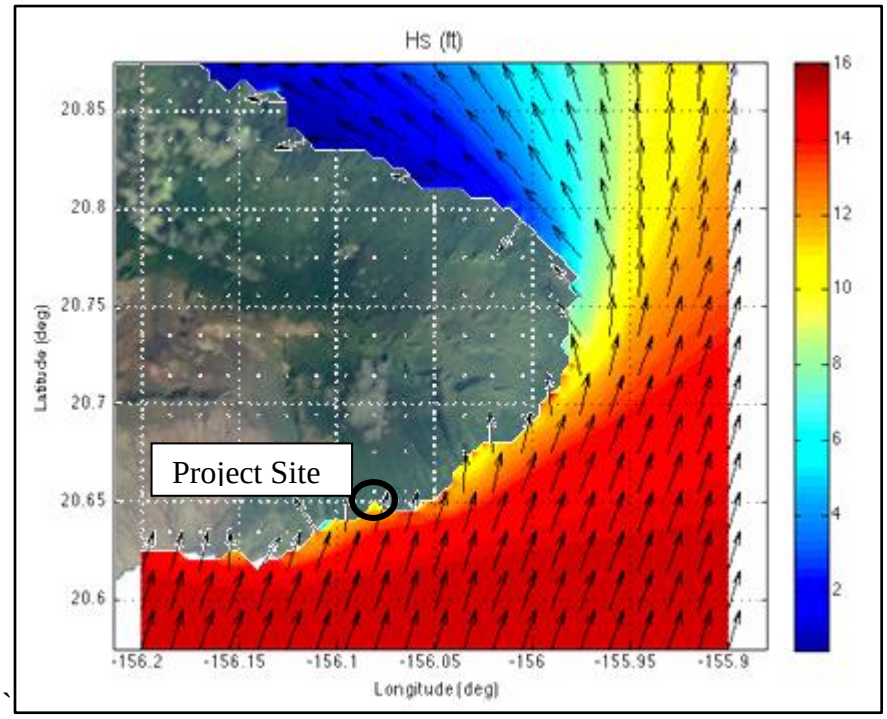


Figure 4-8. Wave height and approach vectors for waves from the southwest, 500m grid

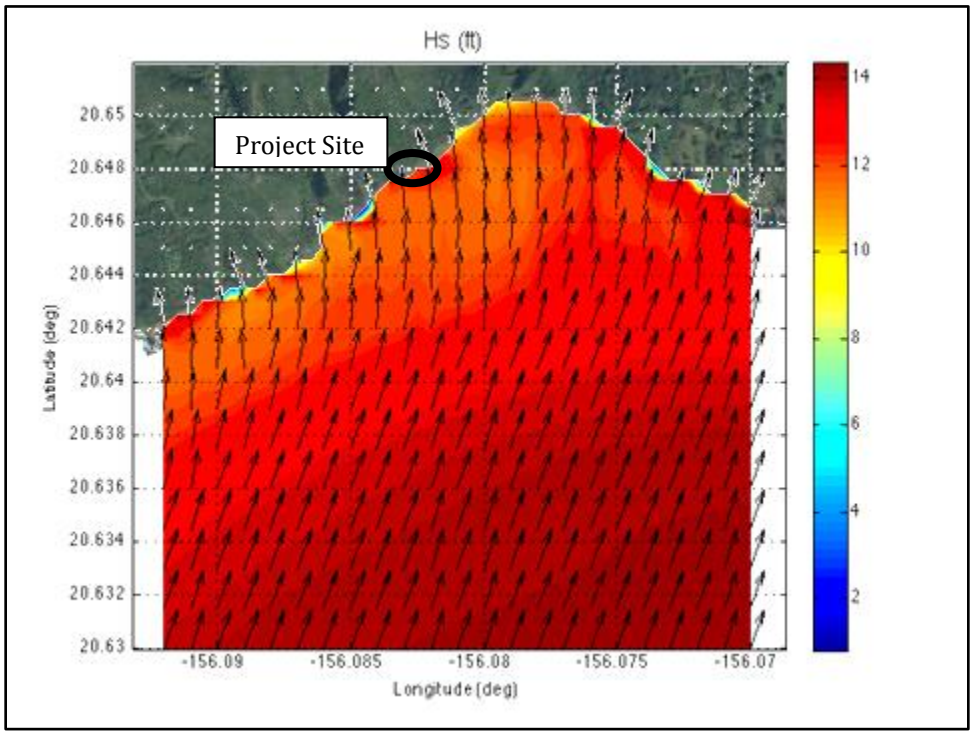


Figure 4-9. Wave height and approach vectors for waves from the southwest, 50m grid.

5. DESIGN WAVE ANALYSIS

5.1 Introduction

Extreme waves from different sources were compiled in their deepwater form in Section 3.5.2 and 3.5.3 for statistical waves, and Section 4.2 for Hurricane Iselle. However, the wave heights at or near the shoreline are the parameter of importance for coastal structure design. The combination of bathymetry and water depth at breaking greatly affect the breaking wave behavior and the design wave height. Waves in shallow water are depth limited, meaning that they are unstable and will break after a particular ratio of water depth to wave height is reached (the breaker depth index – a value of 0.78 is commonly used in the absence of detailed information). Steep bathymetry can dramatically increase this ratio. The breaker height index at the project site was found to be 1.3 (see Section 5.5).

The nearshore water level is, therefore, a major parameter of concern for the estimation of a design wave. High astronomical tides, storm surge, global sea level rise, and wave setup are all factors that can greatly influence the breaking wave height of the design wave. Sections 5.3 and 5.4 explain the various water level rise parameters, and a calculation for the design stillwater level. Section 4.3.1 (above) discusses the behavior of waves in shallow water, including the wave transformation phenomena of shoaling and refraction, and wave setup - the rise in water level due to wave breaking. Wave setup and wave shoaling are further discussed in Section 5.3.1 and Section 5.5, respectively.

5.2 Deepwater Design Waves

Potential design waves are listed in Table 5-1. These include the 50-year recurrence wave parameters from Table 3-3, Table 3-5, and Table 3-7 for Kona storm waves, southern swell, and east swell, respectively, as well as deepwater hurricane wave parameters from Hurricane Iniki (1992) obtained from the hindcast record at virtual buoy 81113. Waves generated by Hurricane Iselle as calculated in Section 4.2 are included as *Iselle 1* and *Iselle 2* from the two maxima shown in Figure 4-3.

5.3 Tide and Water Level Rise

Water depth at the shoreline is a critical element in coastal engineering design. Breaking waves are “depth limited,” meaning the maximum possible breaking wave height is related to the water depth. Deeper water allows higher wave heights to reach the shore, and coastal design must be adjusted accordingly. The most obvious water depth fluctuations are the daily tides; however, other important phenomena occur, including storm surge during hurricanes and Kona storms, wave setup during high wave events, and both long and short term changes in ocean elevation from sea level change (SLC).

Table 5-1. Deepwater design wave parameters (50-year recurrence)

Wave Type	Hs (ft.)	Tp (s)	Dp (deg)
Kona Storm (50-yr)	15.67	7	180
Southern Swell (50-yr)	7.6	17	190
East Swell (50-year)	25.2	12	85
Hurricane Iniki	15.6	12	200
Hurricane Iselle 1	8.6	16	115
Hurricane Iselle 2	12.5	14	110

During severe storm events a "super elevation" of the water level at the shore may occur. The rise in still water level is a combination of the astronomical tide, wave setup, and storm surge due to reduced atmospheric pressure and wind stress:

- Astronomical tide (Sa),
- Wave set-up as a result of the breaking waves (Sw).
- Storm surge due to atmospheric pressure reduction (Sp),
- Storm surge caused by wind stress (Sx and Sy),

These add in a linear fashion:

$$S = Sa + Sp + Sx + Sy + Sw$$

Recent advances in the calculation of global and regional seal level rise have led coastal scientists and engineers to include the addition of sea level rise projections to the more transient still water level rise phenomena.

5.3.1 Astronomical Tide

An astronomical tide (Sa) of +2.25 feet MLLW is used for design conditions. This is equivalent to the mean higher high water (MHHW) level as measured at the Kahului Harbor tidal station (see Section 3.4).

5.3.2 Storm Surge

During hurricane conditions, with high winds and very low pressures, an additional water level rise due to reduced atmospheric pressure (Sp) and wind stress (Sx and Sy) can occur. The combination of Sp, Sx and Sy is defined as storm surge, and this rise can potentially add another 1 to 2 feet to the stillwater level. However, in the case of a distant storms and hurricanes, storm surge can negligible. There is no storm surge component to southern swell or tradewind waves. For the hurricane cases, storm surge is also considered negligible as both Hurricane Iniki and Hurricane Iselle were distant from the project site. However, closely approaching hurricanes will have significant surge due to the combined low central pressure strong winds.

5.3.3 Wave Setup

During high wave events, the water level shoreward of the breaker zone may be elevated above the normal tide level as a result of breaking waves. This water level rise, termed *wave setup* (Sw), may be as much as 10 to 12 percent of the initial breaking wave height. Wave setup is directly influenced by anything that affects breaking wave height, including refraction and shoaling effects. In a steep slope environment, such as the one found at the project site, wave setup is less than the typical 10 to 12 percent. Wave setup is often a major parameter for coastal engineering design in Hawaii.

5.3.4 Global Sea Level Change

It is widely recognized that global warming has caused a world-wide acceleration in sea level rise. The present estimated rate of global mean sea-level change (SLC) is +3.20 mm/yr. (NASA, 2014), where a positive number represents a rising sea level.

The sea level trend for Honolulu Harbor for the period of 1905 to present is shown in Figure 5-1 (NOAA, 2015). The average rate of sea level change (RSLC) shown in the figure is +1.41 ± 0.22 mm/yr based on monthly data for the period 1905-2013. Figure 5-1 shows interannual anomalies up to about 0.5 ft. (15 cm) in Honolulu Harbor.

Regional sea level rise (RSL) values based on data from Kahului Harbor were calculated using the USACE website at: http://www.corpsclimate.us/ccaceslcurves.cfm . The site calculates five different scenarios for RSL based on both USACE and NOAA (National Oceanographic and Atmospheric Administration) studies.

Sea level rise for Maui using the five USACE/NOAA scenarios is shown in Figure 5-2. The NOAA *intermediate high* rate is used as a prediction for future sea level at the project site based on recent discussions with University of Hawaii and other scientists. For a project design life of

50 years, the calculations predict an increase of 1.81 ft. from 2017 to 2067. The 50-year and 100-year change in sea level are listed in Table 5-2.

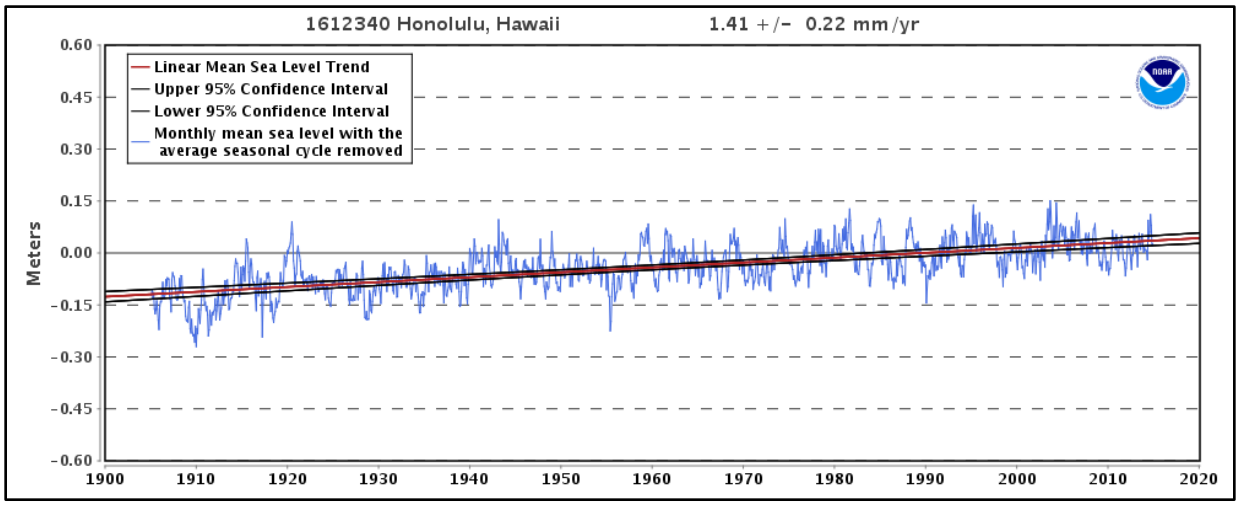


Figure 5-1. Mean sea level trend, Honolulu Harbor, 1905 to present (NOAA, 2015)

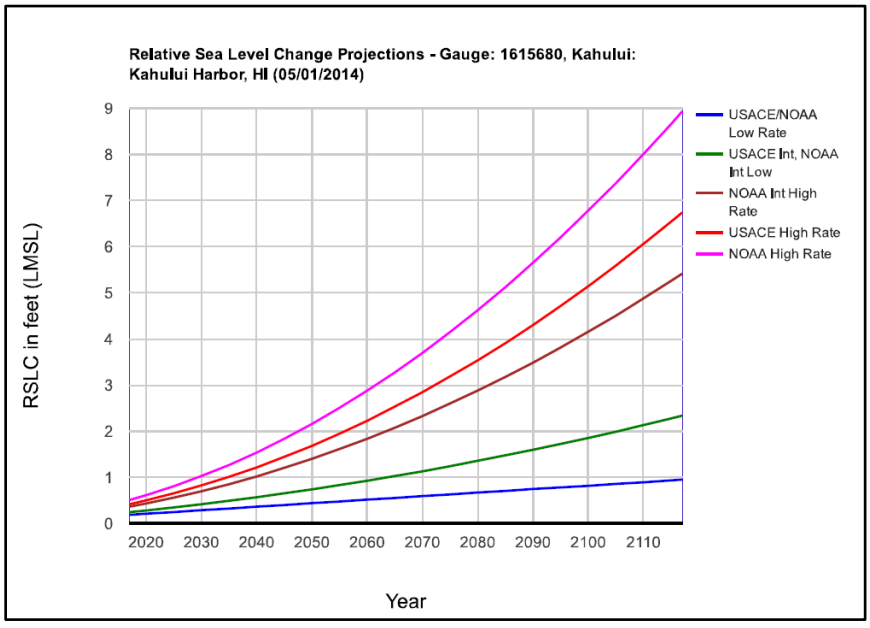


Figure 5-2. Projected Sea Level Change, Kahului Harbor (USACE, 2016)

Table 5-2. Projected Sea Level Change from 2017

Year	USACE Low NOAA Low	USACE Int NOAA Int Low	NOAA Int High	USACE High	NOAA High
2067	0.38	0.82	**1.81**	2.24	2.93
2117	0.74	2.06	4.98	6.24	8.32

5.4 Nearshore Wave Transformations – Design Wave Height

As waves move into shallow water, bathymetry has greater influence on wave behavior. Waves interact with the bottom, dissipating more energy through depth induced breaking and bottom friction. The processes of shoaling and refraction (see Section 4-1) directly influence wave height.

Wave refraction effects were calculated from the wave angle change between deepwater and nearshore depths shown in the numerical wave modeling. Shoaling effects were calculated using the wave model and the nearshore depth profile (see Figure 3-2). Initial wave breaking height (Hb) occurs in water depths of approximately 15 to 20 ft, and this wave height is used to calculate wave setup (Sw).

Finally, a depth limited criteria can be used for the design wave height (Hd). The design wave height is the nearshore breaking wave height that occurs in proximity of the toe of the proposed structure. Depth limited waves are calculated by applying a breaker index to the nearshore water depths that have been adjusted for tide, wave setup and a 50-year sea level rise. The breaker index and wave setup calculations were completed using the Automated Coastal Engineering System (ACES). This empirical approach was used to determine the design wave height instead of numerical modeling because numerical models can potentially become unstable for large waves and steep irregular bathymetry.

Table 5-3 lists the wave transformation results, and nearshore wave breaking height for the six design wave conditions. Deepwater wave heights were calculated from generalized extreme value distributions, extracted from the WIS wave buoy data (Hurricane Iniki case), or calculated using hurricane wind and wave modeling (Hurricane Iselle case) . The nearshore nominal water depth of 3.5 ft. MLLW was estimated from the 2013 Lidar data set (Figure 3-1). Breaking wave heights and wave setup values were calculated using ACES.

Due to different refraction and shoaling effects for each wave types, the final nearshore design wave heights were similar, with a convergence around 10 ft. The design wave height selected is

for the largest Hurricane Iselle wave of with a wave height of 10.4 ft. and a total stillwater elevation rise of 5.5 ft. relative to MLLW (4.35 ft relative to MSL). The design wave height used for preliminary designs (SEI, 2016) was 7.9 ft.

Table 5-3. Summary of nearshore depth limited design wave heights

	East	South Swell	Kona Storm	Iniki	Iselle 1	Iselle 2
Ho (ft)	25	7.6	15.6	15.4	8.6	12.5
Tp (s)	12	17	7	12	16	14
Nearshore slope	0.1	0.1	0.1	0.1	0.1	0.1
H/Db	1.19	1.30	0.98	1.19	1.30	1.27
Hb (ft)	22.4	15.5	16.3	18.5	16.4	17.26
Sw (ft)	0.5	0.1	0.3	0.6	0.4	0.4
Tide (MHHW)	2.3	2.3	2.3	2.3	2.3	2.3
Sea Level Rise (ft)	1.8	1.8	1.8	1.8	1.8	1.8
Nominal Depth (ft MLLW)	3.5	3.5	3.5	3.5	3.5	3.5
Total Depth (ft MLLW)	8.1	7.7	7.9	8.2	8.0	8.0
H design (ft)	**9.6**	**10**	**7.7**	**9.7**	**10.4**	**10.1**

Note:

Ho: Design Deepwater Significant Wave Height
Tp: Wave Period
Hb/Db: Wave Breaker Depth Index
Hb: Breaking Wave Height
Db: Breaking Wave Depth
Sw : Wave Setup

6. SHORE PROTECTION ALTERNATIVES

Due to the extreme topography, a strategy of retreat is not feasible for the Kalepa site. Options for the site are:

- No action,
- Abandonment of the existing roadway alignment,
- Engineered rock or concrete structures: seawalls and revetments.

6.1 No Action Alternative

The existing condition at the Kalepa site is one of extreme disrepair in some areas. Much of the existing revetment has slid and exposed under-sized stones and previous CRM stonework. In some sections the edge of the highway has also begun to erode (Figure 6-1). Without protection, the condition of the highway will likely continue to degrade. The no-action alternative will ultimately result in long-term road closure.



Figure 6-1. Deterioration of the highway due to erosion

6.2 Abandonment of the Existing Roadway Alignment

The Kalepa reach is remote, exposed and difficult terrain with high relief. While abandonment of the Kalepa reach by dead-ending the highway is not likely to be acceptable, Sato & Associates (2007) proposed a 700-ft by-pass tunnel as an option. Although expensive, at projected costs between $10,500,000 and $14,000,000, the option offers potential advantages in terms of safety and removal of the highway from open coast exposure.

6.3 Engineered Shore Protection

6.3.1 Introduction

Shore protection alternatives for the high energy open coast environment include uncemented sloping revetments made from rock or concrete armor units, seawalls, or a hybrid combination of structures.

6.3.2 Rock Rubble Mound Revetment

A rock rubble mound revetment is a sloping uncemented structure built using boulder size rock. The most common method of revetment construction is to place an armor layer of stone, sized according to the design wave height, over an underlayer and filter designed to distribute the weight of the armor layer and to prevent loss of fine shoreline material through voids in the revetment. The armor layer and underlayer are typically two stone diameters in thickness.

One major advantage of revetments is that the rough porous rock surface and relatively flat slope of the structure will tend to absorb wave energy, reduce wave reflection, and help to promote accretion of sand on a sandy beach. Revetments in Hawaii are typically built on a 1 vertical to 1.5 to 2 horizontal slope to ensure stability.

Toe scour protection can be provided by excavating to place the toe on solid substrate where possible, constructing the foundation as much as practical below the maximum depth of anticipated scour, or extending the toe to provide a scour apron of excess stone.

Properly designed and constructed rock revetments are durable, flexible, and highly resistant to wave damage. Should toe scour occur, the structure can settle and readjust without major failure. Damage from large waves is typically not catastrophic, and the revetment can still function effectively even if damage occurs.

For large wave heights, a typical revetment will be constructed with a two-stone thickness armor layer that uses a uniform stone size stable under the design wave conditions. Because of its durability, flexibility, and reduced wave reflection, a rock revetment is often considered the best

erosion control/shore protection measure for sites where shoreline hardening is considered appropriate.

6.3.3 Tribar Revetment

Man-made concrete armor units have been developed for use when stone of large enough size is not available to meet the design requirements. These concrete units have larger stability coefficients, i.e., greater interlocking and ability to withstand wave attack, than does stone, thus the concrete units can be smaller than the required stone size for a given wave height. Tribar concrete armor units have been used with considerable success for projects with design conditions similar to the project site, and are recommended as an alternative to stone armor.

Tribar armor units are implemented as a single layer but like the rubble mound revetment the armor units are places over an underlayer and filter designed to distribute the weight of the armor layer and to prevent loss of fine shoreline material through voids in the revetment. The underlayer is two stone diameters in thickness.

Because Tribar units depend on interlocking for stability, the sides, toe, and crest of the revetment must be securely tied in and fixed to the surrounding environment. Typically, the toe of the structure is entrenched and grouted into the seafloor.

6.3.4 Seawall

A seawall is a vertical or sloping concrete, CRM, or cement-masonry-unit (CMU) wall used to protect the land from wave damage and erosion. A seawall, if properly designed and constructed, is a proven, long lasting, and relatively low maintenance shore protection method. Seawalls also have the advantage of having a relatively small "footprint" on the shore.

The impervious and vertical face of a seawall results in very little wave energy dissipation. Hence, wave energy is deflected both upward and downward, and also a large amount of wave energy is reflected seaward.

The downward energy component can cause scour at the base of the wall, and thus the foundation of a seawall is critical for its stability, particularly on a sandy and eroding shoreline. Ideally, a seawall should be constructed on solid, non-erodible substrate. Seawalls are not flexible structures, and their structural stability is dependent on the stability of their foundations. A rubble mound rock revetment can be used to protection the seawall foundation from wave induced erosion.

Much of the project reach is still composed of CRM, and there is evidence of relict CRM walls at the project site that have been covered by more recent construction (see Figure 2.13).

7. PROJECT CONCEPT DESIGNS

7.1 Introduction

Several seawall and revetment design options were initially considered for the project site in the preliminary coastal engineering assessment (SEI 2016):

- Repair and rebuild to match the existing revetment and wall design.
- Upgrade the revetment and wall design to incorporate design improvements.
- Combine upgraded revetment and wall designs for a hybrid structure.

7.2 Existing design condition

Figure 7-1 is from as-built drawings for the 1987 repair and shows some of the original design elements of the revetment construction, including:

- The design uses two armor stone weight classes, 4-ton and 2-ton.
- Underlayer stone is used as fill, and is not specified for the entire revetment.
- The revetment is designed without a proper toe section to keep the revetment slope stable.

Localized repairs were also done to discrete portions of the CRM wall. Figure 7-2 shows a repair section. [*note: Figures 7-1 and 7-2 are identical to Figures 1-5 and 1-6, and are reproduced here for convenience*]

The probable cause of the existing revetment damage was the lack of a properly designed toe. Modern coastal engineering design is continually evolving, but is most often referenced in U.S. government publications: the U.S. Army Corps of Engineers (USACE) *Shore Protection Manual* (SPM - 1984), and the USACE *Coasal Engineering Manual* (CEM - 2008). The design section shown in Figure 7-2 does not conform to design standards shown in either of the manuals. Departures include:

- There is no explicit toe design, the lower level stones are keyed into existing ground on an existing slope that has no stability criterion. Design manuals typically require the slope to be keyed into hard bottom, keyed by an over sized toe stone, or protected by an apron toe that can compensate for scouring. A more recent innovation, the berm toe, can be used in environments like Kalepa where the substrate conditions are not well known and poorly accessible (see next section).
- Revetments designed for wave heights over 5 ft are typically constructed of armor stone with a limited size range, usually between multipliers of 1.25 and 0.75 times the median armor stone weight. In the existing design, two median weights are specified, 4 tons and

2 tons. The 2-ton portion is placed on existing ground, or an undersized underlayer. The 4-ton stone is placed as a single layer overlying a single layer of 2-ton stone. These stone sizings do not comply with standard sections shown in the SPM or the CEM.

The Kalepa site is an extremely challenging place for revetment design and construction. The intense wave attack from Hurricane Iselle very likely undermined the toe area of the existing structure, destabilizing the structure and causing down-slope movement of armor stone. Repairing the structure in-kind, i.e., according to the 1987 design, would not comply with design standards in the USACE manuals.

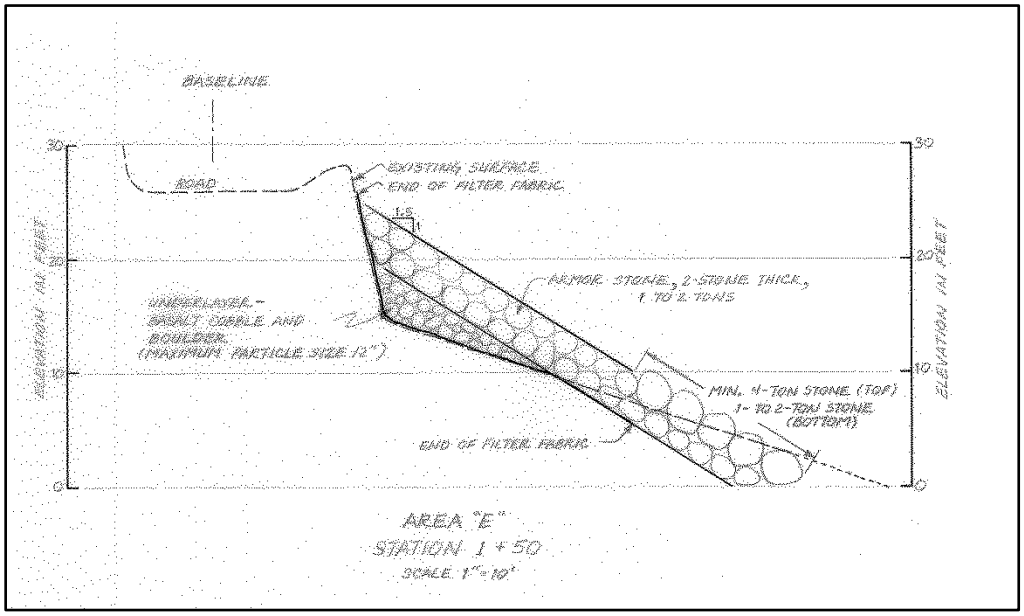


Figure 7-1 . 1987 revetment design drawings

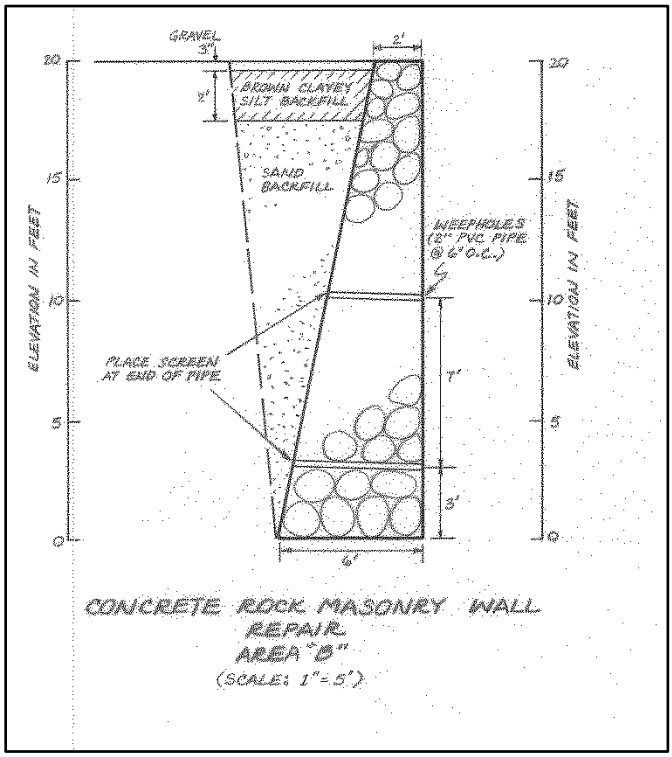


Figure 7-2. 1987 CRM Wall design

7.3 Preliminary Designs (SEI 2016)

The SEI preliminary report described the project site and oceanographic setting and presented three shore protection concept designs. These preliminary designs were used as a template to proceed with the present report, including the need for additional geotechnical and topographic information. The preliminary designs include:

- Rock revetment (Figure 7-3)
- Hybrid CRM wall and rock revetment (Figure 7-4)
- Hybrid anchored concrete wall and rock revetment (Figure 7-5)

The rock rubble mound revetment structure is a uniform armor stone design, using a relatively limited size range of armor stone. The two-stone thickness will promote interlocking, strengthen the structure and give resilience from minor damage.

These three designs incorporated an emergent berm toe configuration (see figures) that is a key design feature (Herrera and Medina, 2015). The berm toe is robust due to the amount of material used, and eliminates the need for toe excavation in a difficult environment. Although the bottom conditions are not well known, it appears that some of the existing revetment armor stones have

slid down and collected at the base of the slope, underwater. Toe design for rock rubble mound structures typically uses an extended apron for scour protection on erodible substrates, or uses toe embedment for a hard bottom condition. Extensive work in the water at this project site is not seen as feasible due to the exposure and difficult access.

The toe berm is not difficult to construct as long as heavy equipment can access the site, and in fact the berm can be used for access, as the berm is emergent with a minimum crest elevation of 5 ft. (MSL). Design water elevation during the design event is 3.4 ft. (MSL) and includes the estimated 50-yr sea level rise. Once in place, the emergent berm toe will help reduce wave inundation and facilitate construction of the revetment slope.

These concept designs were used as a basis for the present report. However, updated bathymetry and oceanographic design analysis have resulted in an increase in the design wave height from 7.9 ft to 10.4 ft, with a resulting increase in armor stone size from 4 tons to 9 tons. The increased wave height is due to updated deepwater wave information from modeling of Hurricane Iselle, as well as improved nearshore bathymetry.

The 4-ton revetment design shown in Figure 7-3 is considered an improved version of the original design because it uses the armor stone size of 4 tons that is used for the lower stones in the existing design (see previous section). While not an in-kind repair, it does comply with published design guidelines. The level of protection for the revetment using 4-ton stone was found by calculating the return period of the design wave height that results in that stone sizing.

A design wave height of 8 ft was un-refracted to find the equivalent deep water wave height and then the return period from data in Section 3.5.3 for Kona waves, southern swell, and East swell (see Tables 3-3, 3-5, and 3-7). Table 7-1 shows the wave heights and return periods for an equivalent deepwater wave for the three wave types. The data show that the level of protection has a maximum of a 1.9 year return period.

Table 7-1. Deepwater wave height and return period for 8 ft design wave height

	Ho (ft)	T (s)	Dp (deg)	Return Period (yrs)
Kona	7.3	7	85	1.9
South	5.1	17	190	1.5
East	9.1	12	180	<1

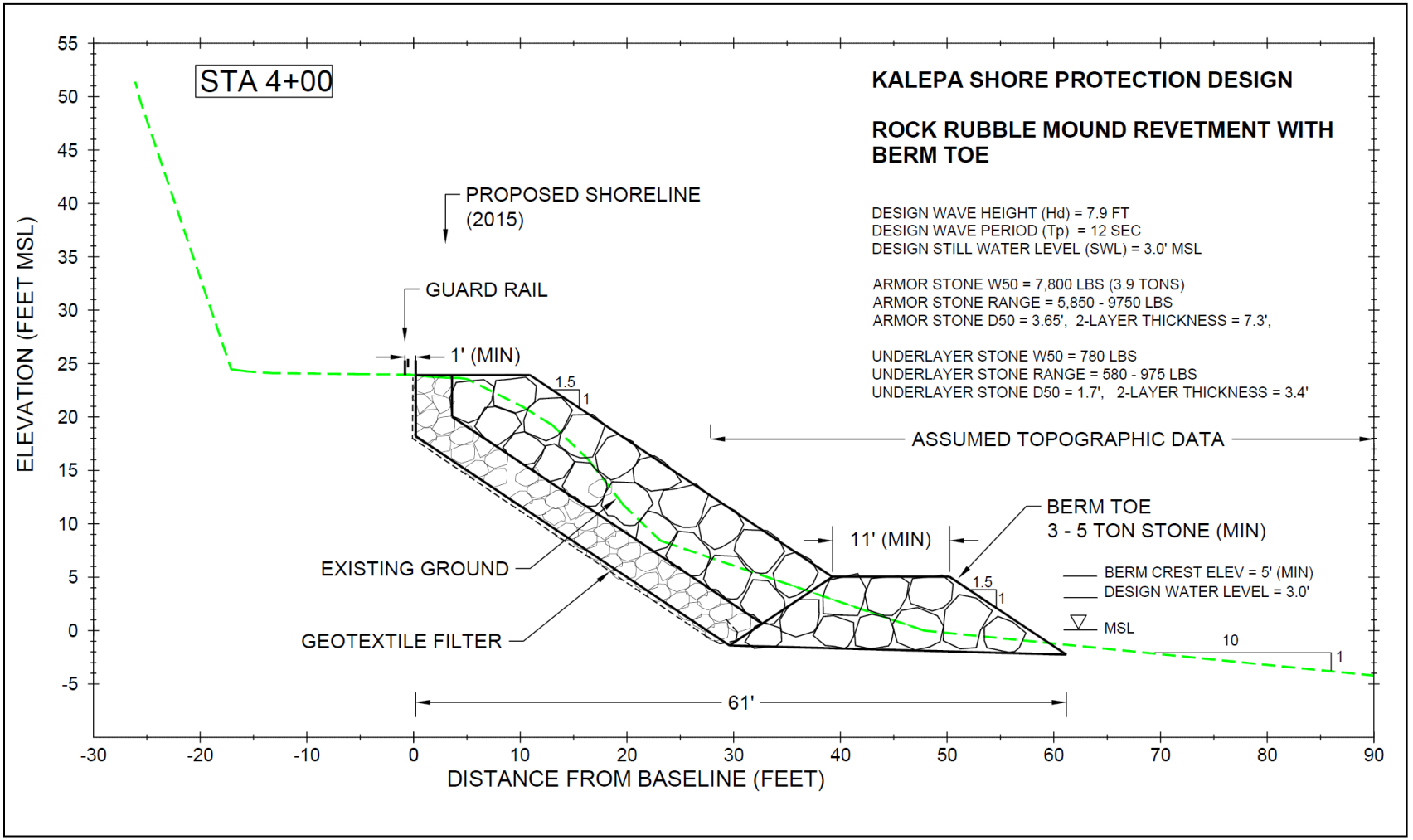


Figure 7-3. Preliminary revetment design section from SEI (2016)

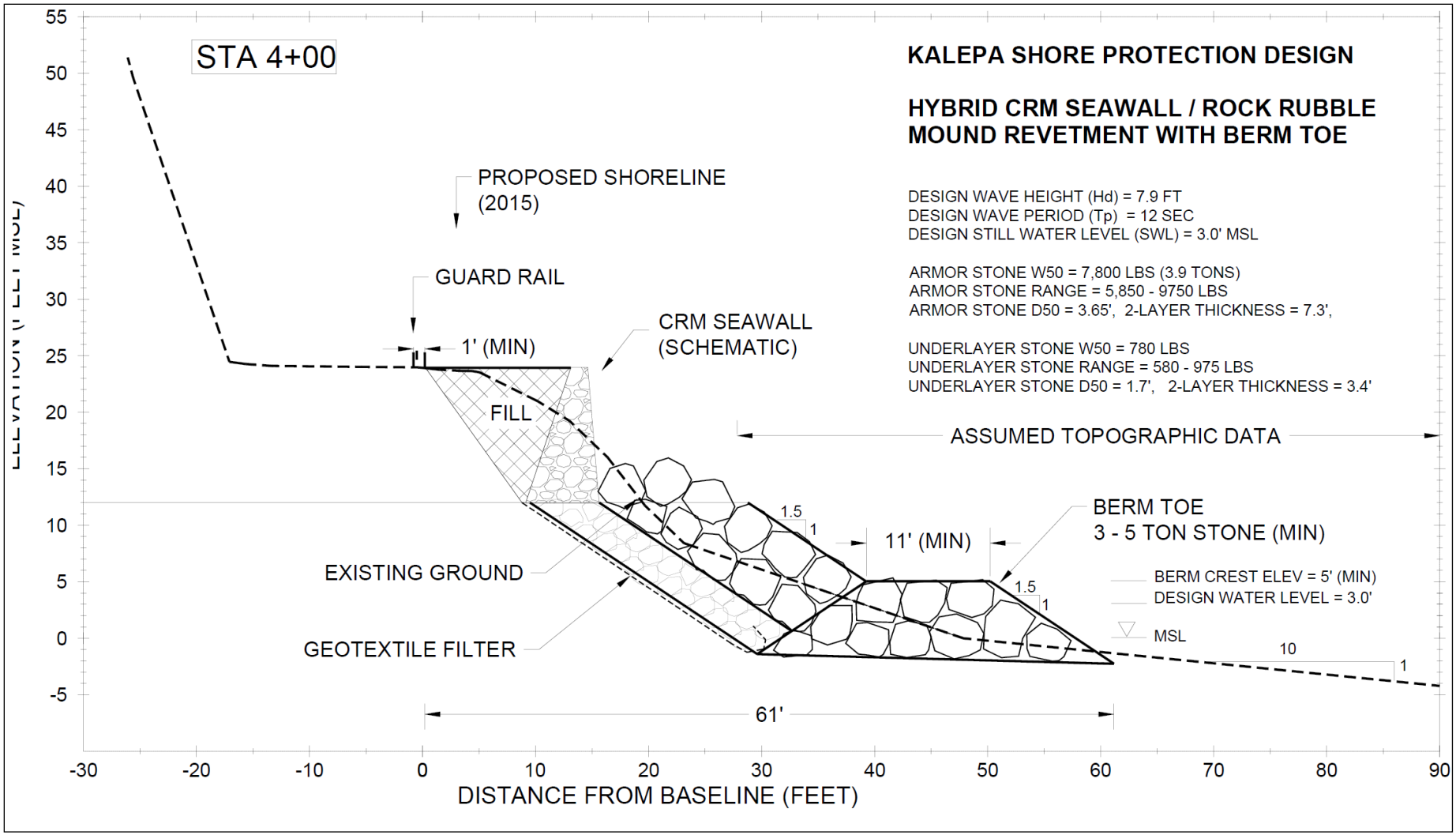


Figure 7-4. Preliminary hybrid CRM wall / rock rubblemound revetment with berm toe from SEI (2016)

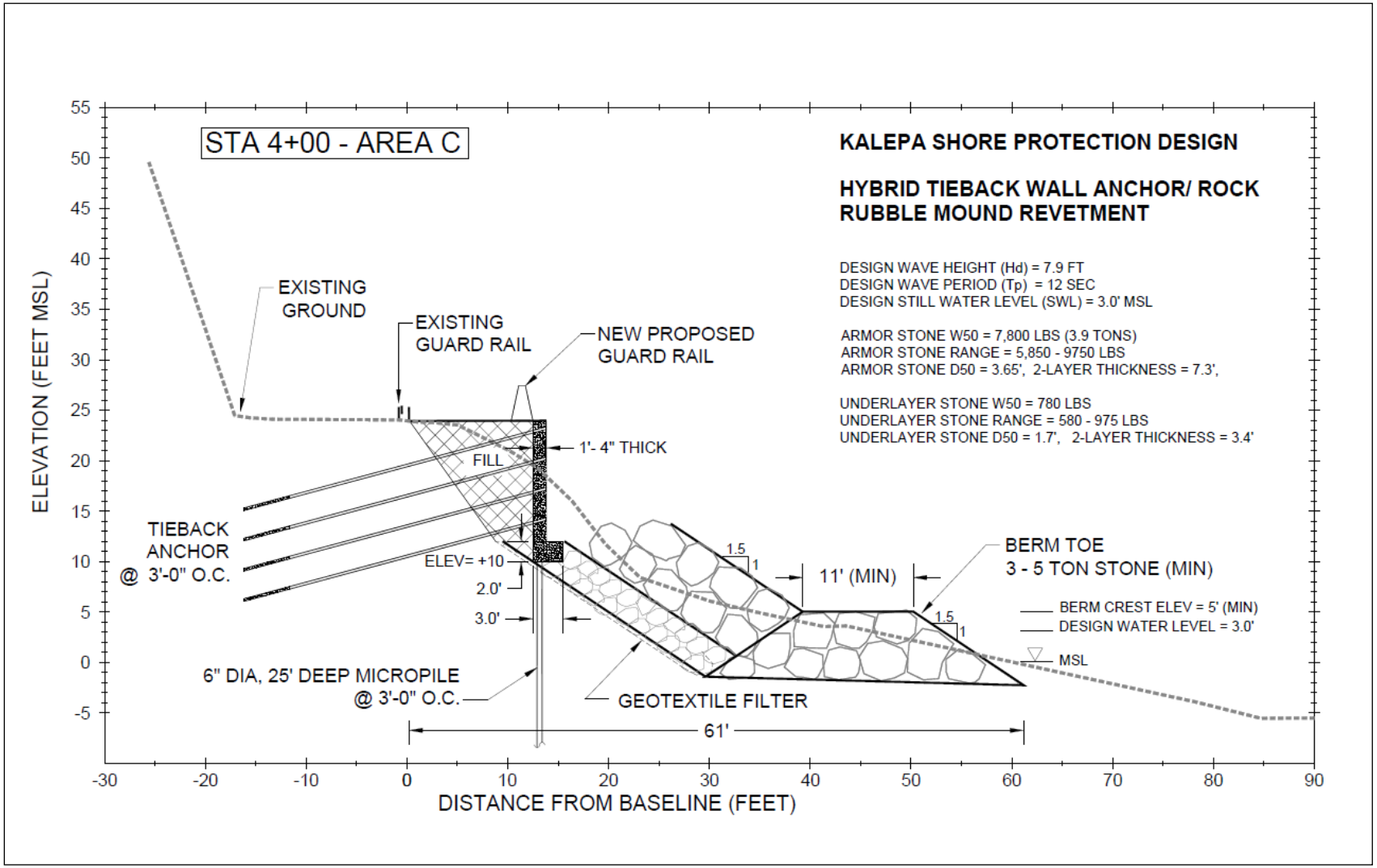


Figure 7-5. Hybrid concrete wall / rock rubblemound revetment with berm toe adapted from SEI (2016)

7.4 Updated Armor Stone Size

Shore protection design relies on matching protective armor stone size to the design wave height (Hd). The median weight (W_{50}) of armor stone required is determined by Hudson's stability formula (*Shore Protection Manual*, 1984):

$$W_{50} = w_r H^3 / K(S_r - 1)^3 \cot\theta$$

Where,

w_r = unit weight of stone (use 160 lbs/cu ft for basalt stone)
H = design wave height (H = 10.4 ft.)
K = stability coefficient (= 2 for quarrystone)
S_r = specific gravity of the stone (2.5)
θ = structure slope

The armor unit nominal diameter is determined by:

$$D = (W_{50} / w_r)^{1/3}$$

Armor layer thickness is twice the nominal diameter. Resulting armor unit weight and diameter are listed in Table 7-2.

Table 7-2. Rock revetment armor stone weight and nominal diameter

Design Wave Height Hd (ft.)	K	cot(θ)	Armor		Underlayer	
			W_{50} (lb.)	D_{50} (ft)	W_{50} (lbs)	D_{50} (ft)
10.4	2	1.5	18,000	4.8	1,800	2.2

The median armor stone weight (W_{50}) is 9 tons (18,000 lbs); allowable armor stone weight range is from 0.75 x W_{50} to 1.25 x W_{50}, or 13,500 lb. to 22,500 lb (approximately 6 to 11 tons).

The underlayer stone is nominally 10 percent of the armor stone range, or a W50 of 1,800 lbs. The underlayer stone range is 1,350 to 2,250 lbs., with a 2-stone layer thickness of 4.4 ft.

Discussion

Figure 7-6 shows a rock revement section with the 9-ton armor stone specification listed in Table 7-1. The section includes a berm toe design as in the preliminary revetment design (Figure 7-3). The unit weight is over twice that of the preliminary design calculation of 3.9 tons, and has a footprint 13 ft wider (74 ft versus 61 ft). Given the difficulties of transportation and site access, as well as the need for a larger crane, the 9-ton armor stone is likely not a practical size for construction at the Kalepa site.

Two alternative design methods are explored: 1) the use of concrete armor units, and 2) decreasing the structure slope (low-angle revetment).

7.4.1 Concrete Armor Units: Tribar Revetment Design

Concrete armor units are cast concrete shapes that are man-made substitutes for armor stone. The units are made to interlock, which gives them a higher net stability and allows a lighter unit to be used. They are often used where armor stone of sufficient size or quantity is not available. Many different unit types have been invented, including Dolos, Tetrapods, Core-Loc, and Tribar units. Problems with the units include breakage of under-sized units, and this can lead to the formation of projectiles that can increase the damage. Two unit types that have been used successfully in Hawaii are Core-Loc and Tri-bar units. Core-Loc designs require precise unit placement, which could be problematical at the Kalepa site.

As with armor stone, the weight of Tribar units is calculated using the Hudson stability formula. Table 7-3 lists the Tribar unit and underlayer sizes for the 10.4-ft design wave. The 2-ton armor unit weight is much less than the stone weight (Table 7-2) because of the higher stability coefficient (K).

Table 7-3. Tribar revetment armor unit weight and size

Design Wave Height (ft.)	K	cot(θ)	Armor		Underlayer	
			W (lb.)	Unit Height (ft.)	W_{50} (lb.)	D_{50} (ft.)
10.4	12	1.5	4,000	3.2	800	1.7

Figure 7-7 is a photograph of a Tribar revetment shore protection structure in American Samoa, and Figure 7-8 is a design section for the Kalepa headland. The design section shows that, similar to the rock rubble mound structure, the toe berm is a key feature for the Tribar design. The toe berm plays the critical role of locking the Tribar armor units in place. However, the armor stones of the toe berm are the same 9-ton size as the rock rubble mound armor.

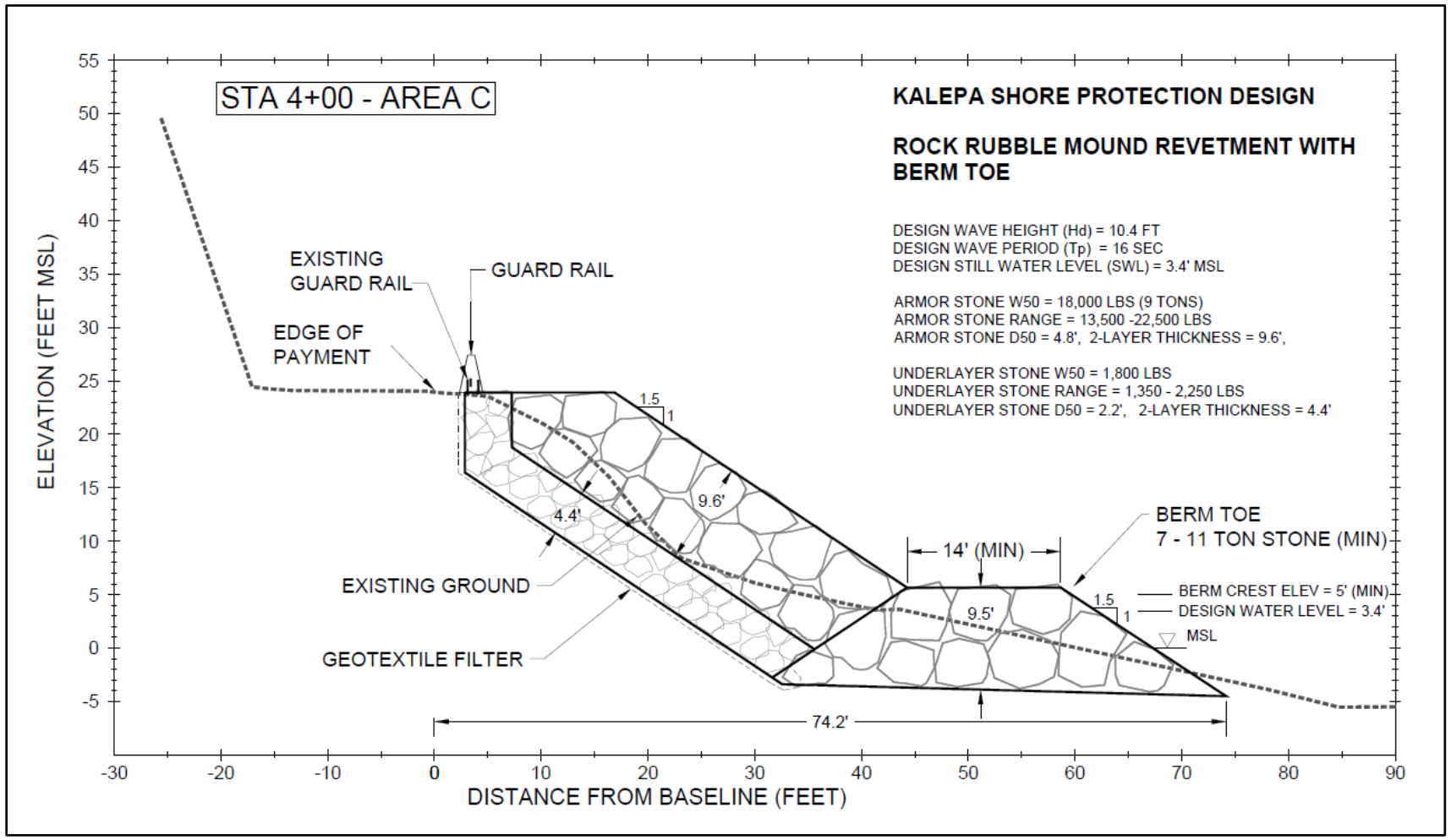


Figure 7-6. Rock rubble mound revetment with berm toe and revised armor stone size (design wave height = 10.4 ft)

Discussion

Tribar concrete armor units offer an alternative revetment construction methodology with lighter weight concrete units. These can be cast and transported to the site, or a batch plant can be set up on location. The units are much lighter than stone units. Tribar construction requires precise underlayer placement to form a uniform slope, and both the toe units and crest units must be firmly locked in place. The toe units will require 9-ton stone for stability in design conditions.

Tribars, and concrete armor units in general, have a man-made, engineered look that can seem out of place in a scenic corridor.



Figure 7-7. Tribar revetment in American Samoa

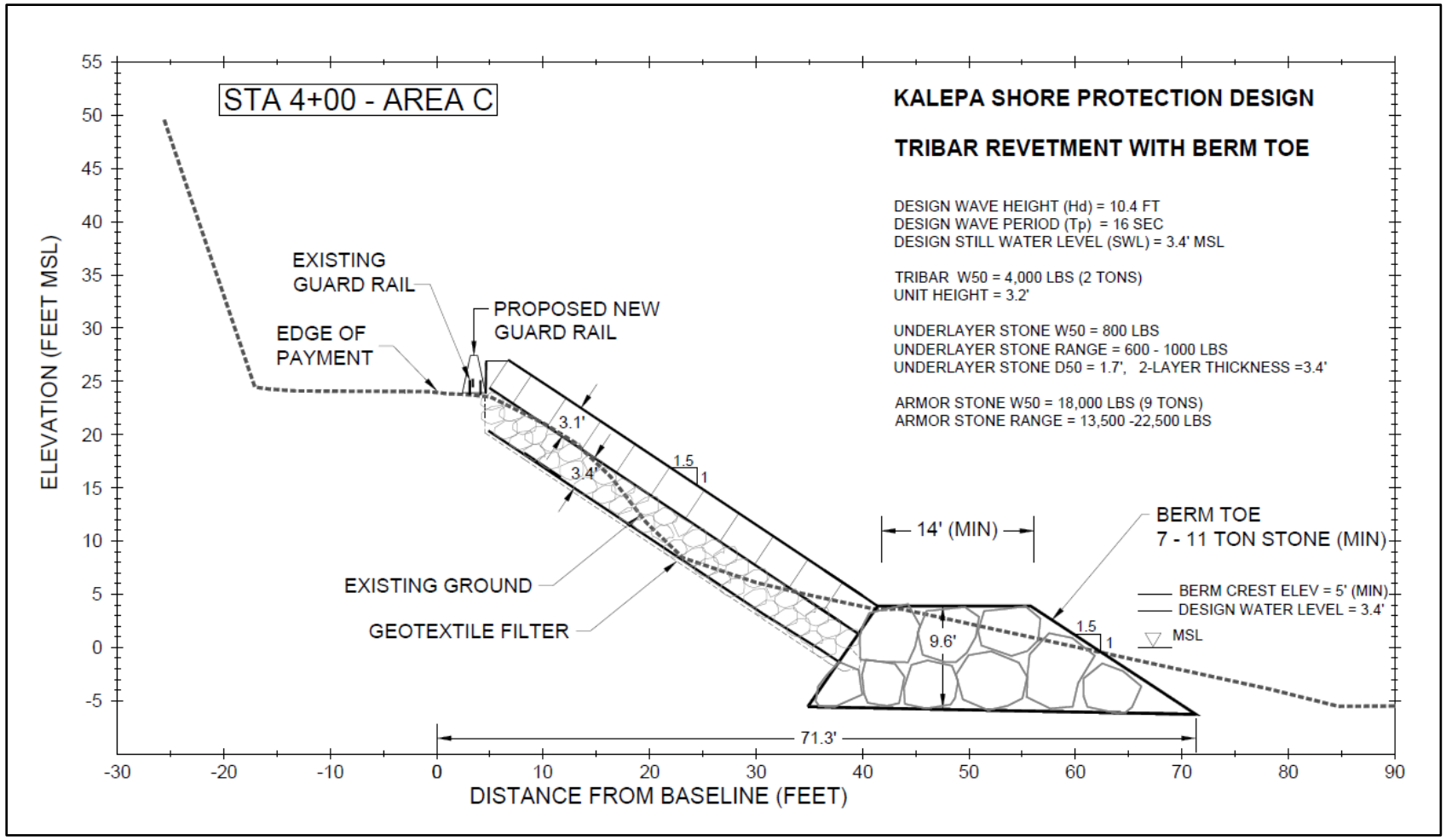


Figure 7-8. Tribar revetment with rock rubble toe at Area C

7.5 Combined Low Angle Revetment and Seawall (Preferred Design)

As the design steepness of a structure is decreased, the stability increases (see the Hudson stability formula, Section 7.4). However, decreasing the slope will generally increase the structure footprint. Table 7-4 lists the armor stone sized for a 10.4 ft design wave for a structure of 1Vertical to 3 Horizontal (1V:3H). The 4-ton (8,000 lb) stone is roughly equivalent to the existing stone size (see Section 7.2), and the stone sized to a 7.9-ft design wave in the preliminary designs (SEI, 2016).

Table 7-4. Rock rubble mound to protection unit weight and nominal diameter

Design Wave Height (ft.)	K	cot(θ)	Armor		Underlayer	
			W_{50} (lb.)	D_{50} (ft.)	W_{50} (lb.)	D_{50} (ft.)
10.4	2	3	8,000	3.8	-	-

The low angle of a 1V:3H design broadens the footprint of the structure to the extent that it will no longer fit the topography. To fit a shore protection structure using the reduced slope, the low angle revetment is paired with a wall to form a hybrid combination of seawall and revetment, similar to the structure shown in Figures 7-4 and 7-5.

7.5.1 Combined Low Angle Revetment and CRM Wall (Preferred Option)

Figures 7-9 and 7-10 are sections showing a combined low angle revetment and a free-standing CRM wall at Area "C" and the CRM Reach, respectively. The two sections show that the design can be applied along the entire Kalepa headland. A free-standing CRM gravity wall with a rock rubble mound toe protection will allow upgraded erosion protection as well as the potential for road widening.

The combined structure has the following characteristics:

The revetment portion of the structure has a low angle at 1V:3H. Because it approaches the low angle of repose of the existing rock on the lower reaches of the site, the structure will require a minimum of excavation or displacement of existing stone. The new stone is meant to overlie the existing stone, and will not require an underlayer, although some slope preparation will be required. The stability generated by the low angle will not require a particular toe treatment like the berm toe necessary for stability of the steeper revetment structure. However, excess stone from the slope preparation can be moved downslope to buttress the toe area for added protection. The two-layer rock rubble mound structure will protect the foundation of the wall from the energetic wave climate near the shoreline. The nominal weight for the armor stones is 8,000 lbs. with an allowable weight range is from 6,000 lbs. to 10,000 lbs.

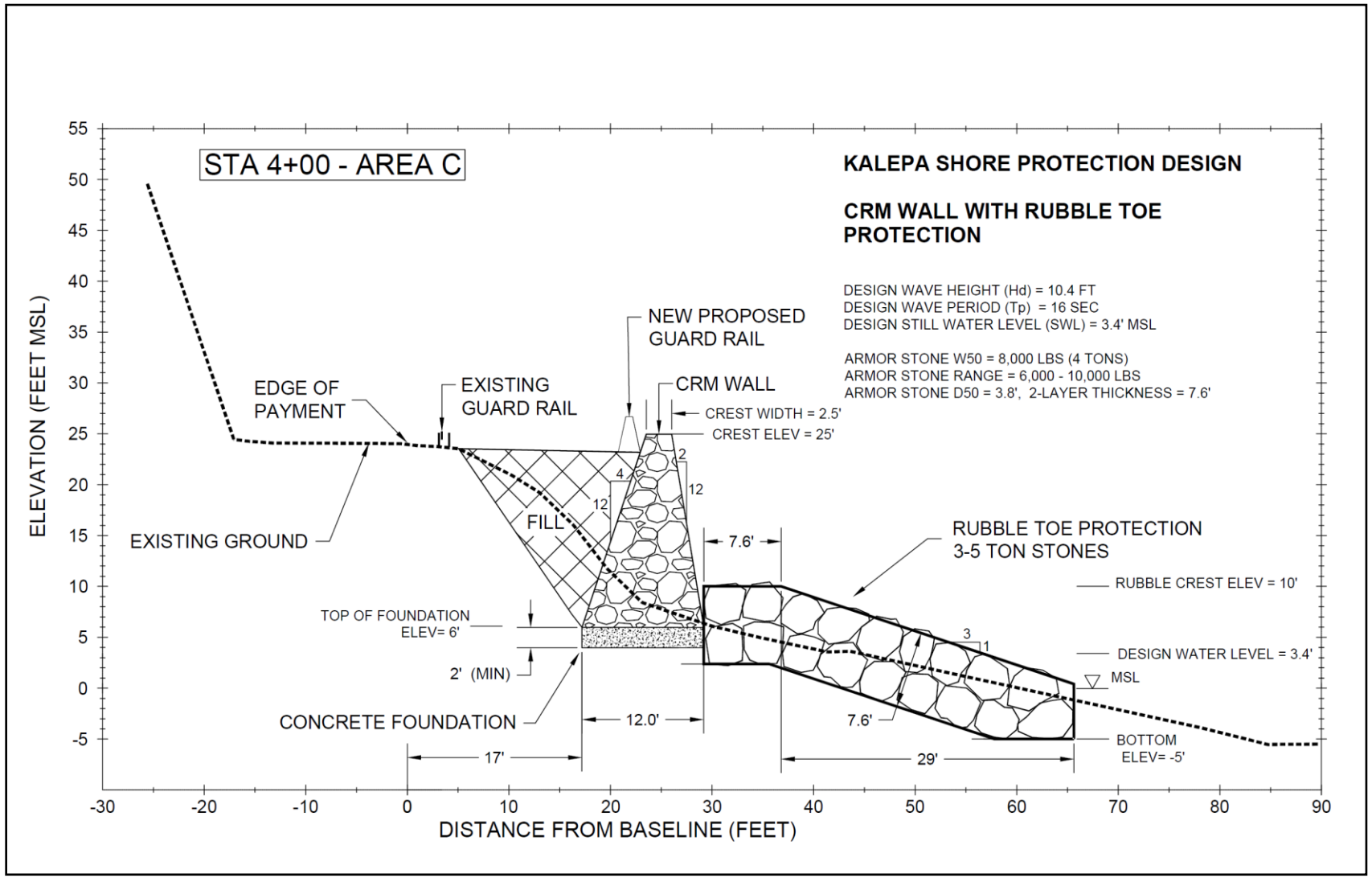


Figure 7-9. Hybrid CRM wall with rock rubble mound revetment toe protection at Area C.

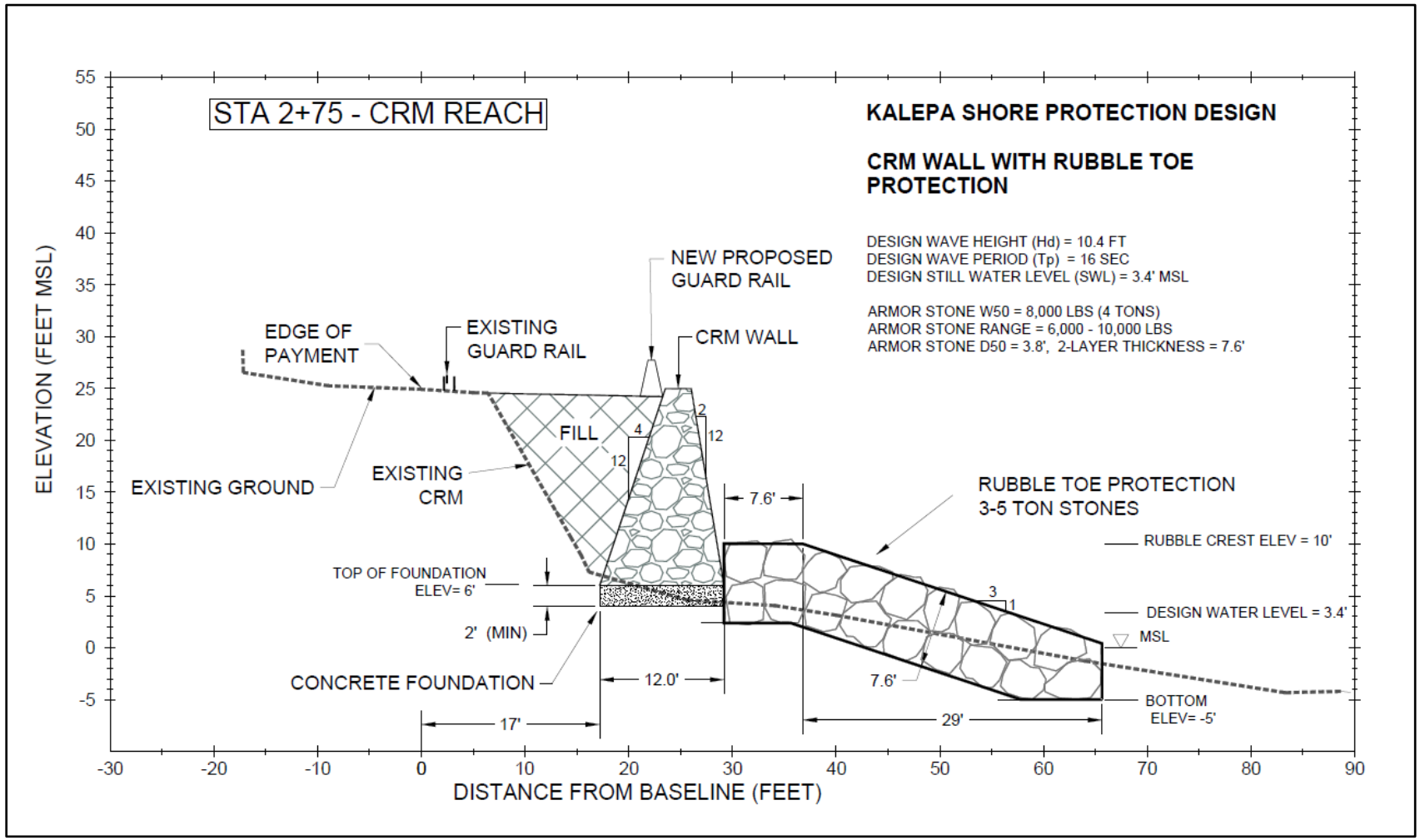


Figure 7-10. Hybrid CRM wall with rock rubble mound revetment toe protection at CRM Reach.

The crest of the revetment is set at +10 ft MSL, with a horizontal crest two armor stones in width in front of the CRM wall for additional stability.

Following recommendations in the Geolabs geotechnical report, the CRM wall is set on a concrete foundation 2 ft in thickness. The base of the wall is set at +6 ft, and the wall crest is at +25 ft, for a wall height of 19 ft. The wall has a minimum crest width of 2.5 ft, and a base width of 12 ft. Placing the wall at the nominal base of the existing scarp allows approximately 20 ft of additional width to the roadway area due to the wall batter.

Geotechnical and Structural Engineering Design Considerations

The combined or hybrid option was arrived at after multiple iterations to satisfy the constraints of the geotechnical information. In particular, the allowable bearing pressure of 3,000 psf (lbs per square foot) was not sufficient. After review of their data, Geolabs increased the allowable bearing pressure to 4,500 psf.

Structural calculations are contained in Appendix C.

Design Layout

Figure 7-11 shows the plan view of the proposed upgraded CRM wall with a rubble mound toe protection spanning over Area "B" through the CRM Reach and Area "C". The structure is approximately 430 ft. long on the crest, from Sta. 1+96 to 6+25. The south end of the revetment at Sta. 1+96 is butted into a pronounced rock headland, and the north end is similarly "returned" into an opportunistic bend in the shoreline alignment.

7.5.2 Combined Low Angle Revetment and Reinforced Concrete Wall with Tie-Backs

Figure 7-12 is a section showing the low angle revetment design used with a reinforced concrete wall. The concrete wall will require tie-back anchors for stability. The Geolabs report (Appendix B) recommends that the tieback anchor borehole extends at least 25 ft behind the new concrete retaining wall in order to extend past the boulders and cobbles into basalt rock. The borehole should include a permanent steel casing to prevent collapse of the borehole. Grout should be injected into the borehole, past the 25-ft distance, to bind the anchor to the basalt rock. The anchoring support would mainly be due to the bond between the grout and the basalt. The allowable bond stress for design is 2,000 psf, but should be confirmed by load testing during construction. The estimate for the anchor density is 3 ft on-center, or approximately 570 anchors over the 430-ft distance of the protected reach. Micropiles may also be necessary to support the wall (see Figure 7-12).

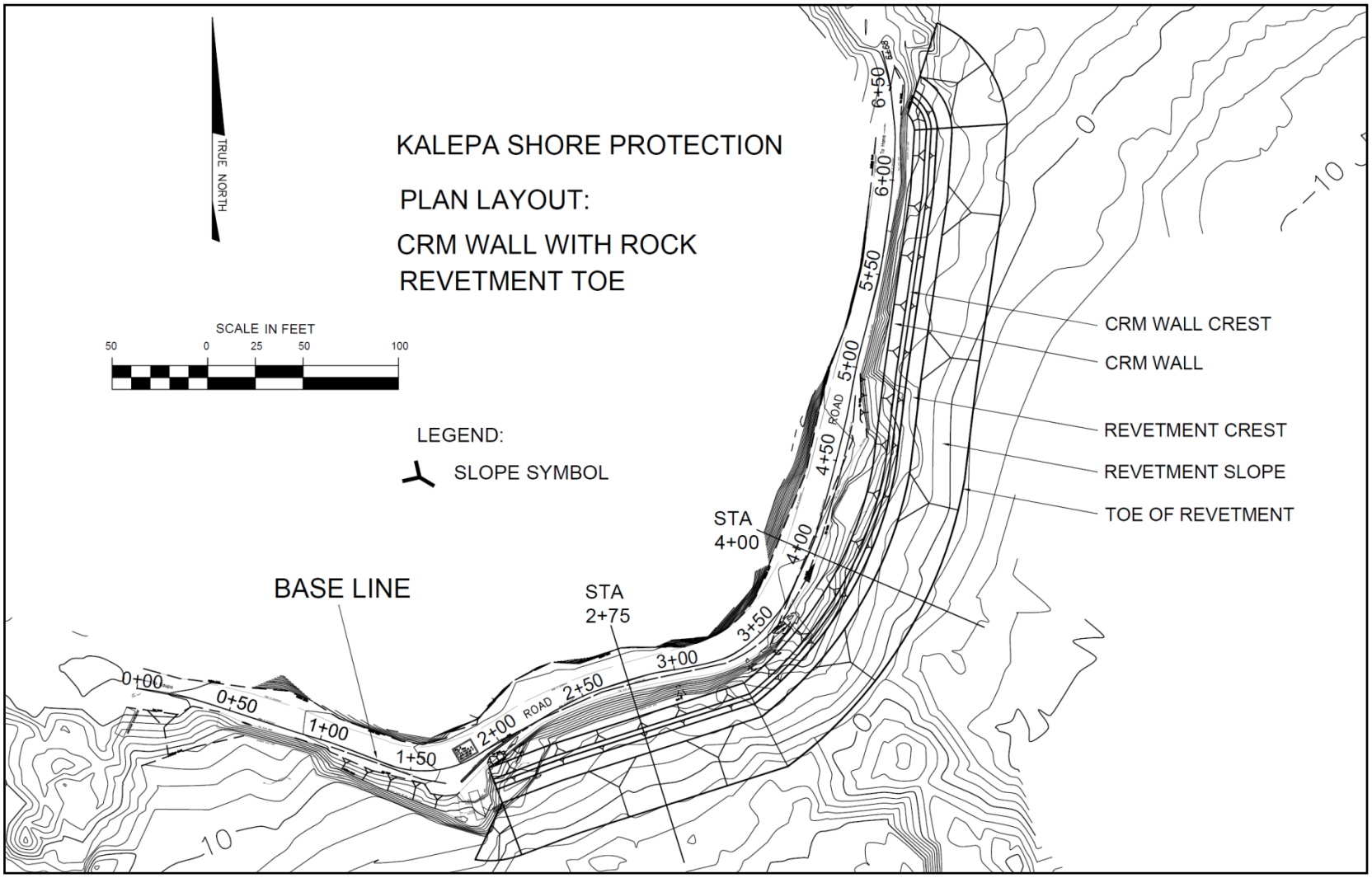


Figure 7-11. Layout of CRM wall with rubble mound toe protection

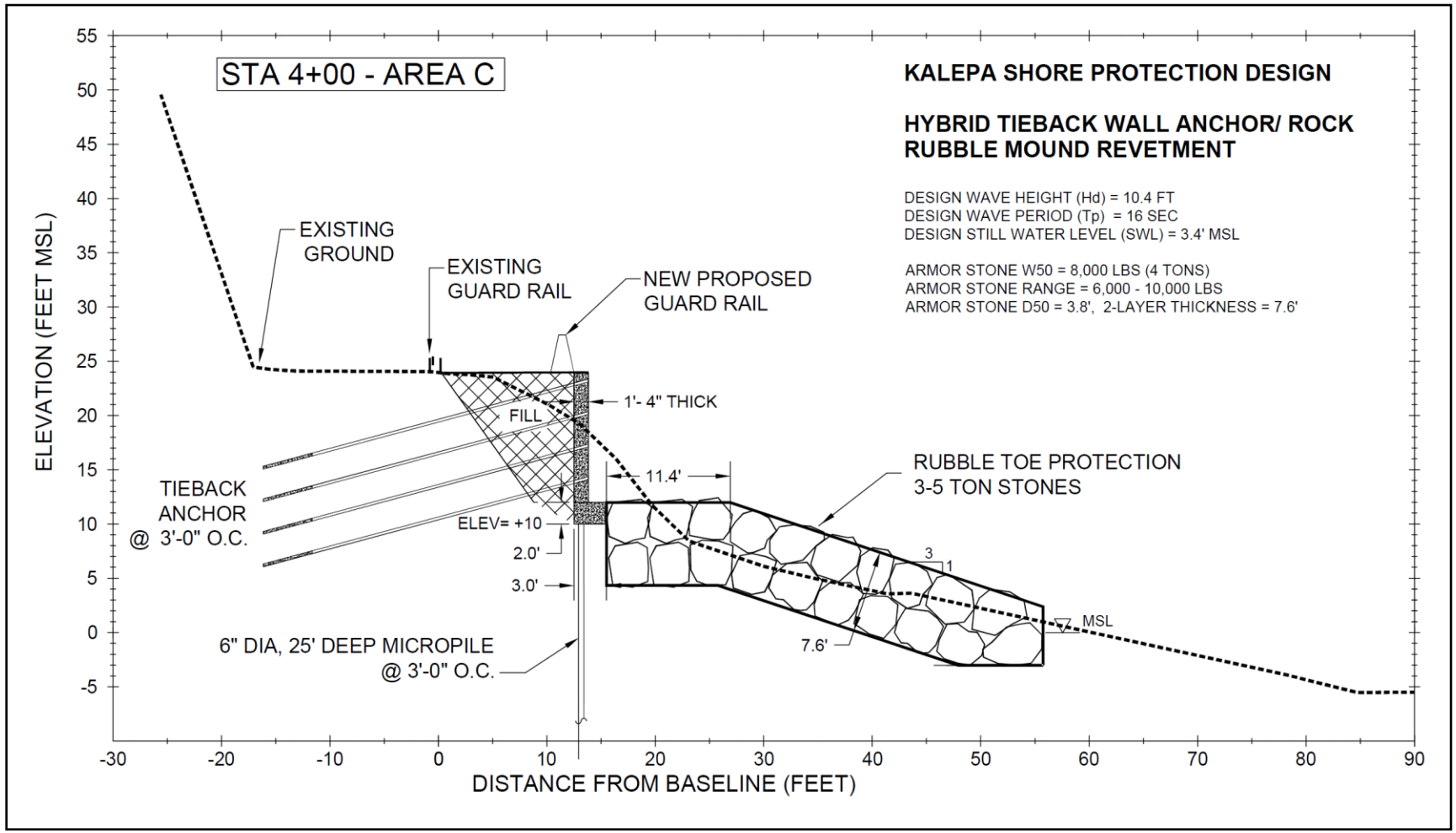


Figure 7-12. Layout of concrete wall with rubble mound toe protection

8. ROADWAY DESIGN

8.1 Introduction

The guardrails around the Kalepa headland are in a particularly corroded condition (Figure 8-1). Austin Tsutsumi & Associates, Inc. (ATA) conducted a study of potential guardrail alternatives that might stand up better to the harsh site conditions. The ATA study is included as Appendix D.



Figure 8-1. Deterioration of guardrails at Kalepa headland

8.2 Guardrail Report

The ATA guardrail report detailed the criteria necessary to justify a guardrail installation, and four guardrail alternatives:

- Timber guardrail,
- Steel galvanized guardrail,
- Stone masonry guardrail, and,
- Concrete guardrail.

Alternative materials, such as GRP (glass-reinforced plastic) laminates were considered, but do not have Federal Highways Administration (FHA) approval. Galvanized steel guardrails and steel elements of the timber guardrails are subject to the corrosive conditions at the project site.

Stone masonry guardrails are also not approved by the FHA, but are addressed in the report because many reaches of the Hana highway are protected in that manner.

The ATA report recommends the use of concrete guardwalls at the site. There are several guardwall types, including:

- Jersey barriers,
- F-shape barriers (note: these are not shaped like an "F", but are named after a list of options)
- 9.1 degree single-slope barrier, and,
- 10.8 degree constant-slope barrier.

The study recommends the 10.8 degree constant-slope barrier. The concrete design can be constructed to withstand the salt air conditions with the use of epoxy-coated rebar and adequate concrete coverage. Figure 8.2 shows a constant slope barrier at the Maui International Airport. The design has an aesthetically pleasing appearance and low maintenance costs. Relief holes at the base of the guardwalls will allow drainage for rainwater runoff.



Figure 8-2. Constant-slope concrete guardrail (from ATA report, Appendix D)

8.3 Road and Paving

The roadway surface around the Kalepa headland is paved, but is seriously damaged (Figure 8-3). An option for new light paving consists of a 6-inch base course and 2-inch asphalt concrete (Figure 8-3).



Figure 8-3. Road surface condition at Kalepa

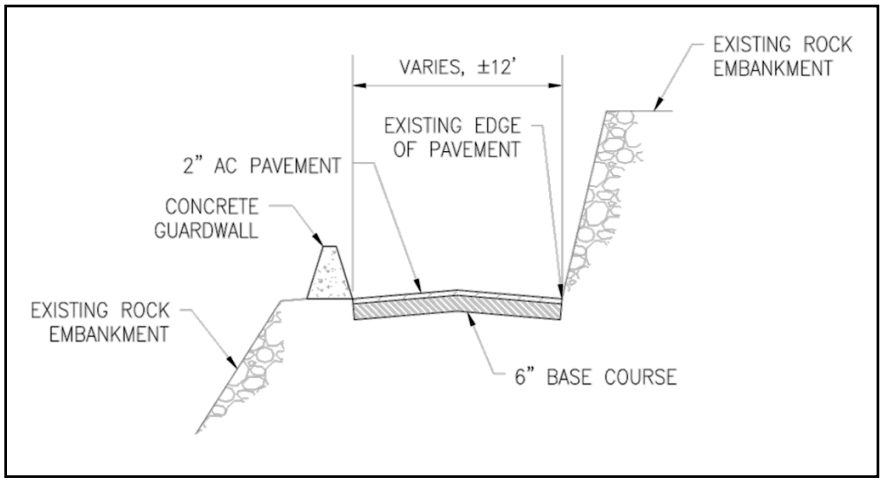


Figure 8-4. Schematic of roadway repairs

9. STONE SOURCE

9.1 Stone Source Investigation

Four stone sources were investigated to check on stone availability:

- HC&D, LLC, Kahului (quarry stone)
- Kiewet Corporation Waiohuli Development (field stone, angular)
- Hana Quarry (field stone)
- GS Excavations, Inc. Kahului (field stone)

Both the HC&D quarry and GS Excavations have the potential for providing the 4-ton stone necessary for the revetment armor. The Hana Quarry field stone appeared to be lesser quality stone.



Figure 8-5. HC&D quarry pit



Figure 8-6. Sample stone stockpile from GS Excavation

10. SITE ACCESS – BRIDGE STUDY

Construction of the proposed structure will be difficult. The area is remote, the road is narrow, and there a several small bridges with restrictive maximum load ratings along the road to the project site. As part of this study, 23 bridges between Kula and Hana were investigated using the information provided in routine structural engineering inspection reports (Nagamine Okawa, 2015). The bridge report is included as Appendix E. There are five main bridges from Kula to the project site. The smallest posted weight limit along this route is 9 tons at Kalepa Bridge #12. There are 18 bridges from Hana to the project site. The smallest posted weight limit along this route is 3 tons at Lelekea Culvert Bridge. The specific load rating and descriptions for all bridges from Kula to Hana are listed in the bridge report. The narrow roads and sharp turns will likely restrict the size and types of trucks available to transport equipment and materials to the project site. Sections of Piilani highway on the approach from Kula are rough gravel roads. The section of Hana highway from Kalepa to Hana is better maintained but contains more single lane bridges and is prone to more traffic. Figure and Figure are photographs illustrating the conditions of the road from Kula and Hana respectively.

Repair of Kalepa Bridge #12 will be necessary to bring materials and heavy equipment to the project site.



Figure 10-1. Section of road from Kula to Kalepa.

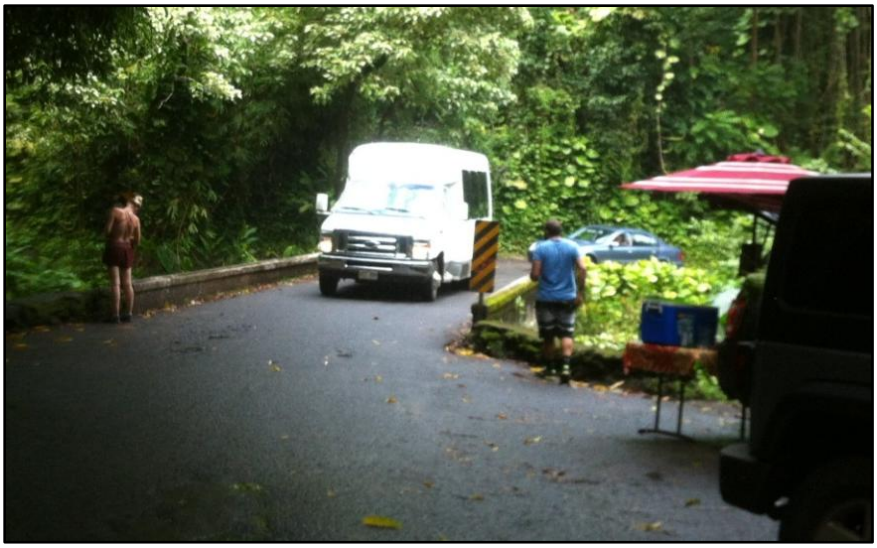


Figure 10-2. Typical one lane bridge crossing from Kalepa to Hana

11. COST ESTIMATE OF ALTERNATIVES

Estimates of various repair alternatives were calculated by Pacific Cost Engineering, LLC. The full cost estimate is included as Appendix F. All costs included a $2.5M lump sum cost to retrofit Kalepa Bridge No. 12 in order to gain access to the site with heavy equipment and materials.

A total of four options were considered for cost estimation:

1. Repair to As-Built Conditions ($11,805,914)

The as-built condition was discussed in Section 7.2 and includes the 4-ton and 2-ton stone revetment shown in Figure 7-1 and the CRM design in Figure 7-2.

2. Rock rubble mound revetment with Berm Toe (4-ton stone - $15,357,802)

The 4-ton stone revetment was first presented in SEI (2016), is discussed in Section 7.3 with a cross section shown in Figure 7-3. It is an upgraded repair due to a more robust design that includeds a berm toe and two armor stone layers.

3. Hybrid Low Angle Revetment with CRM Wall (preferred alternative - $15,822,442)

The preferred alternative is discussed in Section 7.5.1, and consists of a low angle revetment abutting a CRM sea wall. The design section is shown in Figure 7-9 and 7-10. The low armor stone angle allows the use of 4-ton stone without the need for extensive toe excavation or buttressing.

4. Hybrid Low Angle Revetment with Concrete Wall ($25,414,408)

This alternative is an extension of the preferred alternative, but using a cast-in-place concrete wall instead of CRM. The design is discussed in Section 7.5.2, and a design section is shown in Figure 7-12. The high cost of this alternative is due in part to extensive anchoring requirements (570 tie-back anchors).

12. PERMITTING REQUIREMENTS AND CONCERNS

A permitting analysis was prepared by Munekiyo & Hiraga, Inc., and is included as Appendix G.

Table 12-1 (Table 1 from the report) summarizes land use designations at the projet site. Table 12-2 (Table 2 from the report) is a permitting analysis summarizing the potential required permits and actions under Federal, State, and County regulations. The estimated cost of all actions is $460,000.

Based on a consultation meeting on June 9, 2017 with the Regulatory Branch of the USACE, and because the project consists of repairs to a previously authorized structure, the project will likely qualify for a Department of the Army (DA) Nationwide Permit (NWP) for maintenance (NWP 3). A project Environmental Assessment or Environmental Impact Statement will therefore not be required by federal regulations, however, it will likely be required by state and county policy (Hawaii Environmental Policy Act - HRS Chapter 343).

The DA permit will likely trigger the need for a Section 401 Water Quality Certification (401WQC) administered by the State of Hawaii Department of Health, Clean Water Branch. The compliance requirements for the 401WQC typically require substantial in-water sampling by qualified technicians. However, the nature of the Kalepa site is such that typical sampling and testing will not be possible because of safety issues. Entering the water from shore is extremely dangerous at most locations due to the heavy shore break on a rock cobble beach. Boat access is highly problematical because the sea state is often rough, and because the Kalepa site is far from the nearest boat launching sites at Hana and Kihei. Although excavation to -5 ft MSL will be required, actual in-water work will be minimal as the excavation for the preferred alternative will occur on the rock beach shoreface (see Figures 7-9 and 7-10). With adequate Best Management Practices (BMP's) in place, these factors may allow an exemption from water quality monitoring to be pursued.

Table 1. Land Use Designations

State Land Use Commission	Conservation District Subzones: Limited and General
Maui Island Plan	Area mauka of Piʻilani Highway in the vicinity of the proposed project area is classified as Sensitive Lands as depicted on Protected Areas Diagram E-1 in the Maui Island Plan
Hana Community Plan	Conservation District
Maui County Zoning	Interim on either side of the headland makai of Piʻilani Highway, and Agricultural and Interim mauka of Piʻilani Highway
Special Management Area	Located within the Special Management Area (SMA) for the County of Maui
Flood Hazard Zone	VE

Table 2. Preliminary Discretionary Permitting Analysis for Preferred Alternative

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
FEDERAL					
1.	National Environmental Policy Act (NEPA)	U.S. Army Corps of Engineers (USACE)	A stand-alone NEPA EA is not anticipated to be required based on indication from the USACE that proposed action may qualify for a Department of Army (DA) Nationwide Permit (NWP) – see below.	NEPA is triggered by use of federal funding and requirement for federal permit (DA permit) Assumes that USACE (following consultation with FEMA) is determined to be the lead federal agency for the project due to NWP requirement. Assumes that a NWP is issued for the project. Should an Individual (DA) permit be required, a NEPA Environmental Assessment (EA) /Environmental Impact Statement (EIS) (or Categorical Exclusion) would need to be prepared in support of the DA permit application. This permitting analysis matrix does not include an estimated cost for preparation/processing a NEPA EA/EIS document.	N/A
2.	Section 10 (Rivers and Harbors Act)/Section 404 (Clean Water Act) Department of Army (DA) Permit	USACE	Based on feedback received at meeting held with the USACE Regulatory Branch on June 9, 2017, the proposed action could be considered to qualify for a NWP under NWP 3 (Maintenance). A meeting memorandum from the June 9, 2017 is enclosed herein as **Exhibit A**. *3. Maintenance. (a) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. Minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement are authorized. This NWP also authorizes the removal of previously authorized structures or fills. Any stream channel modification is limited to the minimum necessary for the repair, rehabilitation, or replacement of the structure or fill; such modifications, including the removal of material from the stream channel, must be immediately adjacent to the project. This NWP also authorizes the removal of accumulated sediment and debris within, and in the immediate vicinity of, the structure or fill. This NWP also authorizes the repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events, provided the repair, rehabilitation, or replacement is commenced, or is under contract to commence, within two years of the date of their destruction or damage. In cases of catastrophic events, such as hurricanes or tornadoes, this two-year limit may be waived by the district engineer, provided the permittee can demonstrate funding, contract, or other similar delays.*	Assumes current structure is determined to meet 'previously authorized structure' provision. Assumes that USACE would agree to issue a waiver of two-year time limit. NWP 3 would be subject to Honolulu District (Regional) conditions. If NWP cannot be granted, an Individual Permit would be required. This permitting analysis matrix does not include an estimated cost for preparation/processing an Individual Permit. The (State) Final EA would act as the primary technical supporting document for the DA application process (see below).	$30,000.00

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
3.	Section 106, National Historic Preservation Act	USACE	A consultation process pursuant to Section 106, Historic Preservation Act requirements would need to be completed for the project.	Consultation process would be initiated (during State EA process) following completion of baseline archaeological and cultural studies.	$15,000.00
4.	Section 7, Endangered Species Act (ESA) and Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)	U.S. Fish and Wildlife Service (USFWS) / National Oceanic and Atmospheric Administration (NOAA)	Consultation with USFWS /NOAA would need to be undertaken pursuant to applicable ESA and Essential Fish Habitat (EFH) requirements.	Consultation process would be initiated (during State EA process) following completion of baseline flora/fauna and marine biological studies.	$15,000.00
STATE OF HAWAIʻI					
5.	Hawai'i Environmental Policy Act - Chapter 343, Hawai'i Revised Statutes (HRS)	County of Maui, Department of Public Works (DPW)	Preparation and processing of a State EA document pursuant to requirements set forth in Chapter 343, HRS. The following technical studies /documents would need to be prepared in support of the EA: • Conceptual plans/elevations/sections • Preliminary Engineering/Drainage Report • Archaeological Inventory Survey • Cultural Impact Assessment • Flora/Fauna Survey • Marine Biological Survey • Traffic Assessment & Control Plan	Triggered due to use of Conservation District lands, shoreline area and County funds/lands. Assumes that proposed action would not qualify for an EA exemption determination due to expansion of use. Assumes that DPW would be determined to be appropriate approving agency for EA following consultation with the State of Hawaii, Department of Land and Natural Resources (DLNR) and the County of Maui, Department of Planning. Compliance with related Federal Consultation processes would need to be addressed during environmental review process (i.e. Section 106 National Historic Preservation Act; Section 7 Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act). If significant impacts are anticipated by findings of EA process, then a State EIS would need to be prepared and processed.	$250,000.00
6.	Conservation District Use Permit	Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL)	Preparation and processing of a Conservation District Use Application (CDUA) based on following land use provisions in the State Conservation District Rules: *§13-5-22 Identified land uses in the protective subzone.* *P-8 Structures And Land Uses, Existing* *<u>If classified as a Moderate Alteration:</u>* *(C-1) Moderate alteration of existing structures, facilities, uses, and equipment.* *Identified land uses beginning with letter (C) require a departmental permit.* *<u>If classified as a Major Alteration:</u>* *(D-1) Major alteration of existing structures, facilities, uses, and equipment, or topographical features which are different from the original use or different from what was allowed under the original permit. When county permit(s) are required for the associated plan(s), the department's approval shall also be required.* *P-15 Shoreline Erosion Control* *<u>If classified as a "Shoreline Erosion Control action:</u>*	Project area is located in both the (L) Limited and (G) General Conservation District Subzones. In addition to the land uses identified in the respective sections of the OCCL's administrative rules pertaining to the L and G Subzones, all identified land uses and their associated permit or site plan approval requirements listed for the Protective Subzone also apply, unless otherwise noted. The proposed action may be classified as either a "Moderate Alteration", "Major Alteration". • *A Moderate Alteration is defined as: work done to an existing structure, facility, or use that results in more than a ten per cent increase, but no more than a fifty per cent increase, in the size of the structure, facility, or use.* • *A Major Alteration is defined as: work done to an existing structure, facility, or use that results in more than fifty per cent increase in the size of the structure, facility, or use.* The (State) Final EA would act as the primary technical supporting document for the CDUA application process.	$30,000.00

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
			(D-1) Seawall, revetment, groin, or other coastal erosion control structure or device, including sand placement, to control erosion of land or inland area by coastal waters, provided that the applicant shows that (1) the applicant would be deprived of all reasonable use of the land or building without the permit;(2) the use would not adversely affect beach processes or lateral public access along the shoreline, without adequately compensating the State for its loss; or (3) public facilities (e.g., public roads) critical to public health, safety, and welfare would be severely damaged or destroyed without a shoreline erosion control structure, and there are no reasonable alternatives (e.g., relocation). Requires a shoreline certification. *Identified land uses beginning with letter (D) require a board permit, and where indicated, a management plan.*	Pre-consultation with the OCCL will be necessary to determine classification of project and confirm permitting requirements.	
7.	Section 401 Water Quality Certification (WQC)	Department of Health, Clean Water Branch	Preparation and processing of a Section 401 Water Quality Certification Approval. The following additional technical study would need to be prepared in support of the application: • Applicable Monitoring and Assessment Plan (AMAP)	The (State) Final EA would act as the primary technical supporting document for the Section 401 WQC application process.	$40,000
8.	Coastal Zone Management Consistency (CZM) Determination	Office of Planning	Preparation and processing of a CZM Consistency Determination Application		$20,000
COUNTY OF MAUI					
9.	Special Management Area (SMA) Use Permit	County of Maui, Department of Planning	Preparation and Processing of SMA Use Permit application.	A SMA Use Permit is anticipated to be required based on the expansion in use and project valuation being in excess of $500,000.00. The (State) Final EA would act as the primary technical supporting document for the SMA application process. Pre-consultation with the Department of Planning will be necessary to confirm SMA permitting requirements.	$30,000.00
10.	Shoreline Setback Variance (SSV)	County of Maui, Department of Planning	Preparation and processing of SSV application.	Action is not a regularly permitting action within the shoreline setback area as it involves hardening the shoreline and an expansion of existing use. The (State) Final EA would act as the primary technical supporting document for the SSV application process. The need for a SSV also triggers the requirement for preparation of a Chapter 343, HRS EA. Pre-consultation with the Department of Planning will be necessary to confirm SSV permitting requirements.	$30,000.00
				TOTAL	**$460,000.00**

13. DISCUSSION AND RECOMMENDATIONS

The remote location and the open coast exposure of the project site, as well as the limited capacity of the approach roadways present numerous difficulties for the design and construction of repairs or upgrades to the road protection at Kalepa. Based on the work presented in this study, the following design alternatives have been considered for initial repair consideration:

1. Repair to as-built condition using existing design (Section 7.2); 4-ton and 2-ton stone

Cost: $11.8M

Pros: existing (1987) design is conceptually simple, with relatively low cost.

Cons: the design does not conform to coastal engineering practice as shown in the USACE manuals (SPM, 1984, and CEM, 2008), and is not adequate for the site conditions. The structure will continue to degrade and fail during design conditions.

Conclusions: the existing design will not provide protection for the site.

2. Preliminary SEI concept design: design upgrade using a rock rubble mound revetment with a berm toe (Section 7.3, Figures 7-3 and 7-4); 4-ton stone

Cost: $15.4M

Pros: these are design improvements using in-kind stone size as the existing design - i.e. 4-ton nominal stone in a two layer configuration, with the addition of a stabilizing berm toe.

Cons: revised oceanographic design parameters done for this study show that the 4-ton stone size will only protect the site for an event with a maximum return period of 1.9 years. The structure will degrade and fail during design conditions.

Conclusions: the design will not provide adequate protection for the site.

3. Rock rubble mound revetment with a berm toe and upgraded oceanographic parameters; (9-ton stone – Section 7.4)

Pros: robust structure designed with upgraded oceanographic parameters

Cons: needs very large 9-ton stone; difficult to transport on-site, difficult to build

Conclusions: the stone size is too big for construction at the site.

4. Tribar revetment with a berm toe (Section 7.4.1)

Pros: a proven design using cast concrete armor units that are of modest size and potentially less cost; these can be fabricated on-site or off-site.

Cons: requires berm toe with 9-ton stone for stability; non-natural appearance

Conclusions: berm toe stone size is too big, aesthetics are not likely to be acceptable.

5. Low angle revetment with CRM wall (preferred option – Section 7.5) 4-ton stone

Cost: $15.8M

Pros: use of a low angle construction (3 horizontal to 1 vertical) adds stability to a 4-ton stone design that is in-kind with the existing armor stone. However, the increased footprint means the rock revetment must be used as toe and scour protection for a seawall. A free-standing CRM wall is preferred. The hybrid design will add approximately 20 ft of available width to the roadway. The revetment can be built using existing stone as an underlayer. Stability is achieved using relatively modest rock sizes.

Cons: The footprint of the revetment is still fairly wide. Access may require building a temporary crane or large excavator road.

Conclusion: best option for shore protection and constructability.

6. Low angle revetment with concrete wall; 4-ton stone

Cost: $25.4M

Pros: similar to (5) except the CRM is replaced with a concrete wall anchored with tie-backs.

Cons: tiebacks will require sophisticated geotechnical engineering and construction techniques, include horizontal borings, casing placement, and grouting of the tieback anchors.

Conclusion: anchoring is too difficult and expensive for the project site constraints.

14. REFERENCES

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APPENDIX A:

ENGINEERING FIELD REPORT,

GEOLABS, INC

OCTOBER 27, 2014

GEOLABS, INC.

Geotechnical Engineering and Drilling Services

ENGINEERING FIELD REPORT

TO: Mr. John Smith
County of Maui, DPW
200 S. High St.
Wailuku HI 96793

DATE: October 27, 2014
W.O.: 7113-00

SUBJECT: Kalepa Point Shoreline Erosion Damage
Piilani Hwy Mile Post 38.2
Kipahulu, Maui Hawaii

PRESENT AT SITE: Nick Mitchell (Geolabs, Inc.)
John Smith (County of Maui, DPW)

Observations/Description:

A visit to the site was made to observe the conditions of the of the storm damages, which occurred from the recent passing of Tropical Storm Iselle. The location along the Piilani Highway which was reported experiencing damages was at approximately mile post at mile post 38.2. We understand that a storm surge occurred with wave heights of 20 feet impacted directly on the Kalepa Point area.

Kalepa Point Mile Post 38.2

Upon arrival to the Kalepa point site, it was observed that two main areas experienced storm related impacts one being below the roadway and the other being the slope above the roadway. The overall length of the roadway facility affected was measured to be approximately 400 linear feet. Fortunately, due to low tide conditions access was possible to view the front face of the CRM wall below the roadway.

Below the Roadway:

A site plan provided by County of Maui illustrates the area including roadway Stations of 0+00 to 4+00. Beginning at approximately Station 0+25, the soils along the roadway edge of embankment slope appear to have been eroded with portions of the slope area sloughed off to the beach front below. In addition, the guardrail post foundations were partially exposed.

From Station 0+75 to approximately 4+10, the existing CRM grouted wall appears to have been compromised at various locations along the wall face. In the vicinity of Station 1+00, the entire wall face was missing and the roadway was undermined by approximately 5 feet from the original wall face. We understand that as part of the emergency response by the County of Maui Maintenance, boulders were placed into the resulted void in order to protect the remaining exposed face from wave splash. In addition, surface voids were present at approximately 3 feet into the roadway from the present top edge of slope. At Station 2+65, the utility pole foundation was compromised and 24 inches below present

surface grade of pole was exposed. The guardrail post foundations along the roadway edge were observed to be partially to fully exposed and suspended in the air.

Above the Roadway:

The exposed face of slope is presently covered with a galvanized ring net with Tecco-like mesh rock fall drapery net system. It was observed that the portion of the rock fall mesh from the toe of slope at the roadway up approximately 40 feet, from Station 0+50 to 2+50, was highly corroded most likely from the salt air blowing directly against the face. In addition, the lateral ¾-inch braided wire cables were high corroded as well. At approximately Station 1+50, an approximate 2 foot diameter boulder impacted the ring net system and deposited against the slope on the roadway. It appears that as the boulder passed along the ring nets, several components of the system were damaged including breaking two of the ¾-inch wire cables along with the spank ties for the seam of the Tecco-like mesh, which resulted in opening the net system at least 40 feet above the roadway. The remaining ring net system appeared to be unaffected by storm related events; however, beyond approximately 50 feet in height the condition was not visible from the roadway surface.

Conclusions:

It would appear that significant damage occurred to the CRM wall below the roadway during the 20 foot swell wave impacts from the storm Iselle. Much of the wall from Station 0+50 to 4+10 was damaged beyond a functional repair. It is recommended that a design be considered to replace the full section to restore the area of roadway back to original condition. The ring net system above the roadway is also an area of concern. Since much of the conditions of the materials and the face were not accessible during the site visit, It is recommended to consider a more in depth inspection of the conditions of the overall drapery net system, potentially with a contractor and Engineer/Geologist specializing in rockfall project and materials to provide an appropriate approach to the repairs.

If you have any questions, please feel free to call. Signed Nick Mitchell

Nick Mitchell
Project Geologist

Kalepa Point



Damaged CRM Wall below Roadway Station 0+50 to 2+50



Remnant Boulders from CRM Wall after undermined from Waves



CRM Wall Damage Station 2+60 to ~3+50 Complete Removal of Wall



Compromised Foundation of Utility Pole



Compromised Foundation of Guardrail



Voids in Roadway side from Undermined CRM Wall



Boulder Damage to Ring Net System

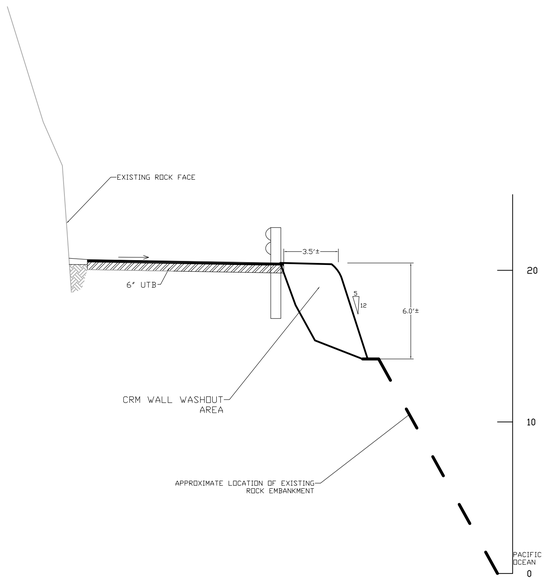


Seam and Broken Cable lines Damage from Boulder Fall

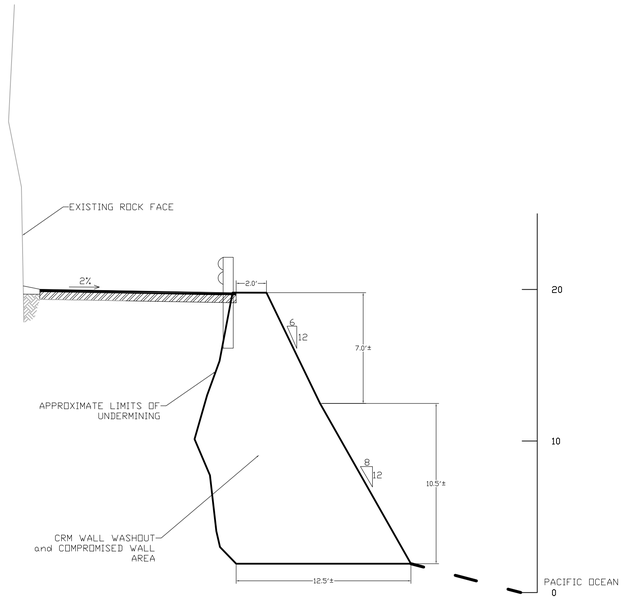


Two other ~ 2-foot Diameter Boulders Caught in Ring Net System

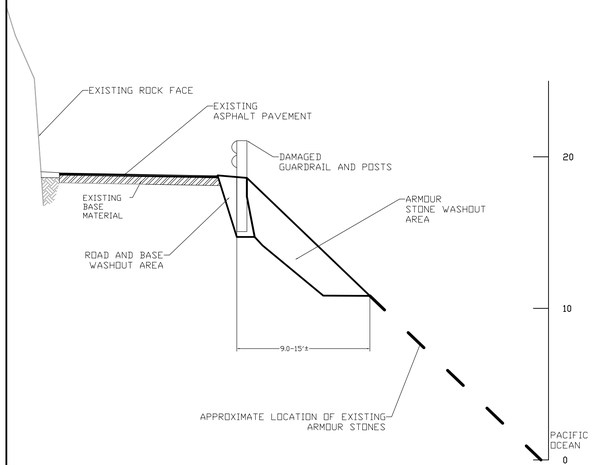




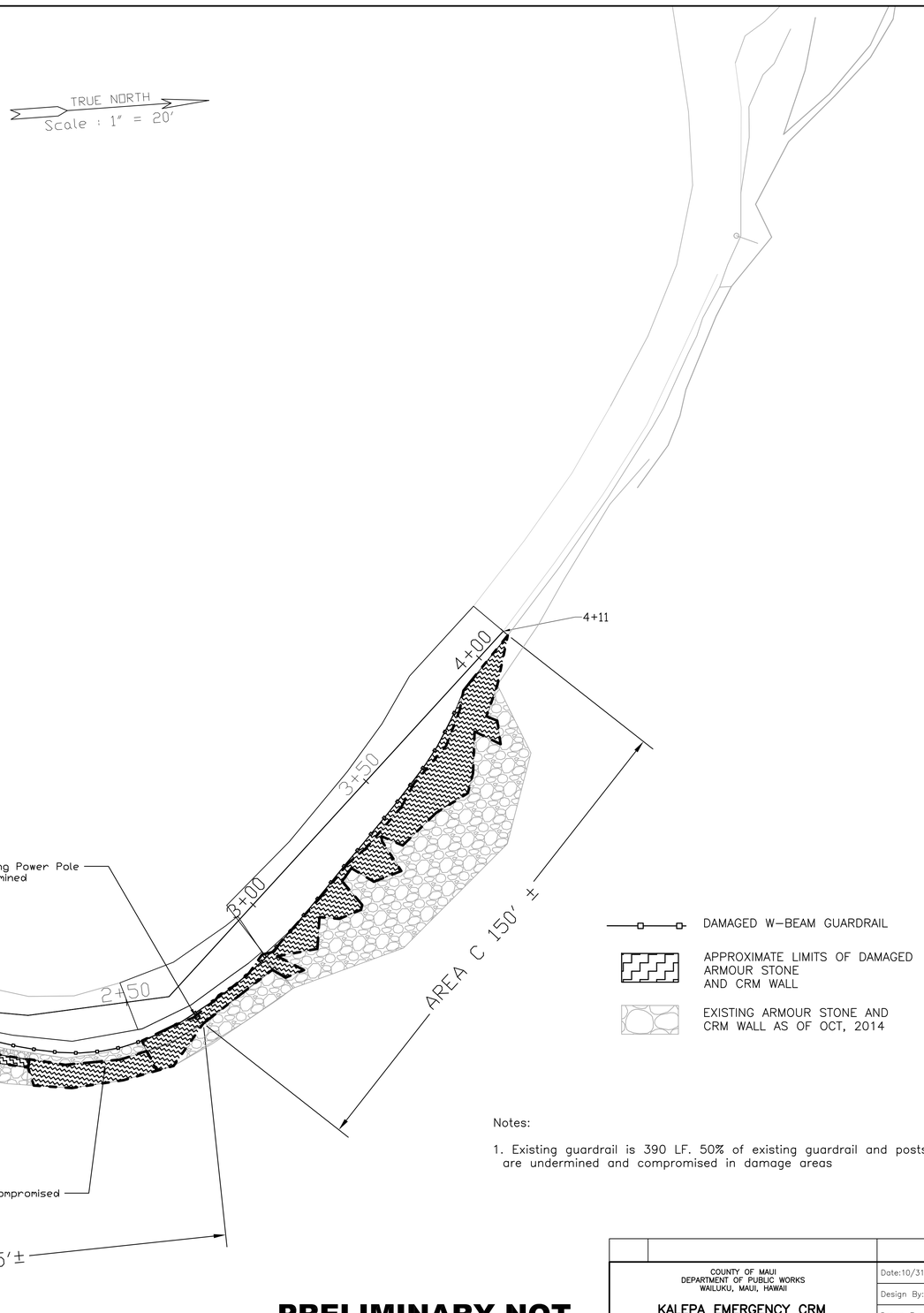
AREA A
TYPICAL CONCRETE ROCK MASONRY WASHOUT
NTS



AREA B
TYPICAL CONCRETE ROCK MASONRY WASHOUT
NTS



AREA C
TYPICAL ARMOUR STONE WASHOUT
NTS



Notes:

1. Existing guardrail is 390 LF. 50% of existing guardrail and posts are undermined and compromised in damage areas

PRELIMINARY NOT FOR CONSTRUCTION

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
WAILUKU, MAUI, HAWAII

KALEPA EMERGENCY CRM WALL REPAIRS
JOB NO. 14-54

DAMAGE AREA PLAN

Date:10/31/14
Design By: JS
Drawn By: JS
SHEET 1 of 1 Sheet

APPENDIX B:

GEOTECHNICAL ENGINEERING EXPLORATION

KALEPA POINT SHORELINE DAMAGE REPAIRS

KIPAHULU, MAUI, HAWAII

OCTOBER, 2016

GEOTECHNICAL ENGINEERING EXPLORATION

KALEPA POINT SHORELINE DAMAGE REPAIRS

KIPAHULU, MAUI, HAWAII

W.O. 7113-00 OCTOBER 13, 2016

Prepared for

SEA ENGINEERING, INC.

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL ENGINEERING EXPLORATION
KALEPA POINT SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

W.O. 7113-00 OCTOBER 13, 2016

Prepared for

SEA ENGINEERING, INC.



THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

4-30-18

SIGNATURE EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
2006 Kalihi Street • Honolulu, HI 96819

Hawaii • California

GEOLABS, INC.

Geotechnical Engineering and Drilling Services

October 13, 2016
W.O. 7113-00

Mr. James Barry
Sea Engineering, Inc.
863 North Nimitz Highway
Honolulu, HI 96817

Dear **Mr. Barry:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Engineering Exploration, Kalepa Point Shoreline Damage Repairs, Kipahulu, Maui, Hawaii" prepared for the design of the project.

Our work was performed in general accordance with the scope of services outlined in our fee proposal dated December 7, 2015.

Please note that the soil samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless special arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussion and specific design recommendations are contained in the body of this report. If there are any questions regarding this report, please contact our office.

Very truly yours,

GEOLABS, INC.

Gerald Y. Seki, P.E.
Vice President

GS:GB:as

2006 Kalihi Street • Honolulu, Hawaii 96819
Phone: (808) 841-5064 • Facsimile: (808) 847-1749 • E-mail: hawaii@geolabs.net

Hawaii • California

GEOTECHNICAL ENGINEERING EXPLORATION
KALEPA POINT SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

W.O. 7113-00 OCTOBER 13, 2016

TABLE OF CONTENTS

Page

SUMMARY OF FINDINGS AND RECOMMENDATIONS iii

1. GENERAL 1
1.1 Project Considerations 1
1.2 Purpose and Scope 1

2. SITE CHARACTERIZATION 3
2.1 Regional Geology 3
2.2 Existing Site Conditions 3
2.3 Subsurface Conditions 4

3. DISCUSSION AND RECOMMENDATIONS 6
3.1 Rock Rubblemound Revetment 6
3.2 Concrete Rubble Masonry (CRM) Retaining Wall 7
3.2.1 Retaining Wall Foundations 7
3.2.2 Static Lateral Earth Pressures 8
3.2.3 Dynamic Lateral Earth Pressures 8
3.2.4 Drainage 9
3.3 Reinforced Concrete Wall with Tie-Backs 9
3.4 Site Preparation 11
3.5 Pavements 13
3.6 Design Review 13
3.7 Services During Construction 14

4. LIMITATIONS 15

CLOSURE 17

PLATES
Project Location Map ..... Plate 1
Site Plan ..... Plates 2.1 and 2.2
Earth Pressure Diagram ..... Plate 3

APPENDIX A
Field Exploration ..... Page A-1
Soil Log Legend ..... Plate A-0.1
Soil Classification Log Key ..... Plate A-0.2
Rock Log Legend ..... Plate A-0.3
Logs of Borings ..... Plates A-1 thru A-3

Page

APPENDIX B

Laboratory Tests..... Page B-1
Laboratory Test Data ..... Plates B-1 thru B-4

GEOTECHNICAL ENGINEERING EXPLORATION
KALEPA POINT SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII
W.O. 7113-00 OCTOBER 13, 2016

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The subsurface conditions at the site generally consist of 1 inch of asphaltic concrete underlain by fill consisting of medium dense to dense silty sand with varying amounts of cobbles and stiff to very stiff clayey silt extending to depths of about 2 to 5 feet below the existing pavement surface. Talus deposits (medium dense to dense basaltic boulders and cobbles) were encountered below the fill in Boring Nos. 1 and 2 extending to depths of about 30 and 9 feet below the existing pavement surface, respectively. Residual soil, weathered clinker, and basalt rock interbedded with clinker were encountered below the talus deposits. In Boring No. 3, the fill was underlain by medium hard to very hard basalt rock interbedded with clinker extending to the maximum depth explored. We encountered groundwater in the borings at depths ranging from about 17 to 21.1 feet below the existing pavement surface, which corresponds to about +3.9 to +8 feet Mean Sea Level (MSL).

We understand that three options are being considered to repair the damaged shoreline and to reduce the potential for erosion of the roadway and shoreline due to wave action of the ocean waters. The three options being considered include the following:

1. Rock rubblemound revetment with a berm toe
2. Hybrid rock revetment and Concrete Rubble Masonry (CRM) gravity retaining wall
3. Hybrid rock revetment and reinforced concrete wall with tie-backs

The revetment generally consists of an armor layer with an underlayer and geotextile fabric below. The armor layer consists of larger stone to protect the existing slope from wave action. The underlayer and geotextile fabric placed below the armor layer reduces the potential for migration of the existing soil material through the voids in the larger stone of the armor layer. The underlayer generally consists of smaller stone but provides sufficient void space to allow water to pass through. To provide stability to the rubblemound revetment, a berm consisting of large stone (generally similar size to the armor stone) is placed at the toe of the revetment.

Based on the existing topography at the site, we believe that the rock rubblemound revetment is a viable option for Area “C.” The existing ground surface along the shoreline at Area “B” and the CRM Reach generally have very steep slope inclinations; therefore, constructing a revetment along the shoreline in these areas is likely not viable. A rock revetment in conjunction with a retaining wall may be more feasible for Area “B” and the CRM Reach locations. The text of this report should be referred to for detailed discussion and specific design recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

This report presents the results of our geotechnical engineering exploration performed for the proposed Kalepa Point Shoreline Damage Repairs project in the Kipahulu area on the Island of Maui, Hawaii. The project location and general site vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and laboratory testing, and presents our geotechnical recommendations derived from our analyses for the proposed project. These recommendations are intended for the design of shoreline revetment, retaining walls, site preparation, and pavements only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 Project Considerations

The project site is located on Piilani Highway at Kalepa Point, which is around Mile Post 38.2 in the Kipahulu area on the Island of Maui, Hawaii. We understand that, in October 2014, Tropical Storm Iselle caused damage to the existing roadway and seawall around Mile Post 38.2. The damages consist of eroded areas of the roadway edge, washed out portions of the existing wall facing, undermining of the roadway and metal guardrails at localized areas of the site.

Based on the information provided, several options are being considered to extend the width of the roadway and reduce the potential of erosion of the road and shoreline from wave action from the ocean waters. We believe that the subsurface conditions at the site may consist of shallow surface granular fills over boulders and/or rock formation.

1.2 Purpose and Scope

The purpose of our field exploration was to obtain an overview of the subsurface conditions at the project site to develop a soil data set to formulate geotechnical recommendations for design of the proposed project. In order to accomplish this scope, we conducted an exploration program consisting of the following tasks and work efforts:

1. Application of the necessary permits from the County of Maui to perform work on the right of way.

2. Mobilization and demobilization of a truck-mounted drill rig on the Island of Maui and two operators from Honolulu to the project site and back.

3. Coordinate staking of the borehole locations and evaluate the presence and locations of utilities, including submitting a One Call application.

4. Drilling and sampling of three borings extending to depths of about 35 to 37.8 feet below the existing pavement surface.

5. Coordination of the field exploration and logging of the borings by our field geologist.

6. Laboratory testing of selected samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.

7. Analyses of the field and laboratory data to formulate geotechnical engineering recommendations for the design of the project.

8. Preparation of this report summarizing our work on the project and presenting our findings and recommendations.

9. Coordination of our overall work on the project by our project engineer.

10. Quality assurance of our work and client/design team consultation by our principal engineer.

11. Miscellaneous work efforts, such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration methodology and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil samples obtained from our field exploration are presented in Appendix B.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Maui is the second largest island of the Hawaiian Archipelago with an area of approximately 728 square miles. Two major volcanoes built the Island of Maui. The older volcano is West Maui (Tertiary Epoch) and the more recent volcano is East Maui, also known as Haleakala (Pleistocene Epoch). The Isthmus of Maui is a narrow, gently sloping plain between these two volcanoes.

The project site is on the southeastern flank of the Haleakala Shield Volcano in the District of Hana. Haleakala was generally built in three distinguishable series of lava flows. The lower unit is the Honomanu Volcanic Series (late Pliocene, early Pleistocene Epoch), which consists of thinly-bedded tholeiitic basaltic pahoehoe and a'a lava flows. These lavas tend to be very permeable and carry basal water. Overlying this unit is the Kula Volcanic Series (late Pleistocene Epoch), which is primarily composed of thicker alkalic a'a flows that may contain many inter-stratified, thin ash-soil layers.

A long quiescent period with few eruptions followed. During which time, canyons were carved in the volcano due to eustatic changes (higher and lower stands of the sea level). At the end of the resting period, copious flows erupted along the southwest and east rifts. This is the third and upper rock unit, known as the Hana Volcanic Series (Holocene Epoch). The lavas from this volcanic series range in composition from ultra-basic olivine porphyries to non-porphyritic, alkalic basalts.

2.2 Existing Site Conditions

The project site is located on Piilani Highway at Kalepa Point, which is around Mile Post 38.2 in the Kipahulu area on the Island of Maui, Hawaii. The overall length of the site is approximately 350 linear feet.

In general, this portion of Piilani Highway is an asphaltic concrete road that is narrow and in relatively poor condition. The traffic volume along this portion of the highway can be considered low.

The project site has been divided into 3 zones identified as Area “B,” the CRM Reach, and Area “C.” Area “B” is located at the west end of the site and Area “C” is located at the east end of the site with the CRM Reach between Area “B” and Area “C.”

Basalt rock outcrops were observed at the west end of Area “B.” An existing low CRM wall was observed along the shoreline of Area “B.” A jersey barrier was placed along the southern edge of the roadway at Area “B” due to the missing metal guardrails. It appears that the CRM wall at the east end of Area “B” may have been washed out and boulders may have been placed in the area to reduce further erosion of the roadway.

At the CRM Reach, the existing metal guardrails at the west end of Area “B” is highly corroded and damaged. The metal guardrails are in fair condition at the eastern end of the CRM Reach. An existing high CRM wall was observed along the shoreline of the CRM Reach. The existing CRM wall was about 18 feet high. Portions of the existing CRM wall were missing at various locations along the CRM Reach area. A large void was observed along the top edge of the slope at the east end of the CRM Reach. This void was relatively deep and exposed the metal guardrail posts in this area.

The roadway edge along the top of slope at Area “C” have been eroded away resulting in partial exposure of the embedded portion of the metal guard rail posts. The metal guardrails were highly corroded and damaged. The embedded portion of the existing utility pole located at the west end of Area “C” was now reduced by about 24 inches due to erosion of the soils around the existing utility pole.

2.3 Subsurface Conditions

The subsurface conditions at the site were explored by drilling and sampling three borings, designated as Boring Nos. 1 through 3, extending down to depths of about 35 to 37.8 feet below the existing pavement surface. The approximate boring locations are shown on the Site Plan, Plate 2.

In general, our borings encountered 1 inch of asphaltic concrete underlain by fill consisting of medium dense to dense silty sand with varying amounts of cobbles and stiff to very stiff clayey silt extending to depths of about 2 to 5 feet below the existing pavement surface.

Below the fill, talus deposits consisting of medium dense to dense basaltic boulders and cobbles with gravel were encountered in Boring Nos. 1 and 2 extending to depths of about 30 and 9 feet below the existing pavement surface, respectively. Very stiff clayey silt (residual soil) and dense silty gravel (weathered clinker) were encountered below the talus deposits in Boring No. 1 extending to the maximum depth explored of about 37.8 feet below the existing pavement surface. In Boring No. 2, the talus deposits were underlain by medium hard to hard basalt rock interbedded with clinker consisting of medium dense gravelly cobbles.

In Boring No. 3, the fill was underlain by medium hard to very hard basalt rock interbedded with clinker extending to the maximum depth explored of about 35 feet below the existing ground surface. The clinker was generally weathered (stiff clayey silt) near the surface.

We encountered groundwater in the borings at depths ranging from about 17 to 21.1 feet below the existing pavement surface, which corresponds to about +3.9 to +8 feet Mean Sea Level (MSL), at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to tidal fluctuations, rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

Detailed descriptions of the materials encountered in the borings are presented on the Logs of Borings in Appendix A. Results of the laboratory tests performed on selected soil samples obtained from our field exploration are presented in Appendix B.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

The subsurface conditions at the site generally consisted of 1 inch of asphaltic concrete underlain by fill consisting of medium dense to dense silty sand with varying amounts of cobbles and stiff to very stiff clayey silt extending to depths of about 2 to 5 feet below the existing pavement surface. Below the fill, talus deposits consisting of medium dense to dense basaltic boulders and cobbles with gravel underlain by medium hard to hard basalt rock interbedded with clinker was encountered extending down to the maximum depths explored. We encountered groundwater in the borings at depths ranging from about 17 to 21.1 feet below the existing pavement surface, which corresponds to about +3.9 to +8 feet MSL.

We understand that three options are being considered to repair the damaged shoreline and to reduce the potential for erosion of the roadway and shoreline due to wave action of the ocean waters. The three options being considered include the following:

1. Rock rubblemound revetment with a berm toe
2. Hybrid rock revetment and Concrete Rubble Masonry (CRM) gravity retaining wall
3. Hybrid rock revetment and reinforced concrete wall with tie-backs

Detailed discussions of our findings and geotechnical recommendations for the project are presented in the following sections.

3.1 Rock Rubblemound Revetment

The revetment generally consists of an armor layer with an underlayer and geotextile fabric below. The armor layer consists of larger stone to protect the existing slope from wave action. The underlayer and geotextile fabric placed below the armor layer reduces the potential for migration of the existing soil material through the voids in the larger stone of the armor layer. The underlayer generally consists of smaller stone but provides sufficient void space to allow water to pass through. To provide stability to the rubblemound revetment, a berm consisting of large stone (generally similar size to the armor stone) is placed at the toe of the revetment.

Based on the existing topography at the site, we believe that the rock rubblemound revetment is a viable option for Area "C." The existing ground surface along the shoreline at Area "B" and the CRM Reach generally have very steep slope inclinations; therefore, constructing a revetment along the shoreline in these areas is likely not viable.

Based on the subsurface conditions encountered at the site, we recommend designing the rock revetment with a maximum slope inclination of 1.5H:1V. Prior to the construction of the rock revetment, loose materials encountered along the slope should be removed to the design bottom elevation of the revetment.

3.2 Concrete Rubble Masonry (CRM) Retaining Wall

In areas with a steep slope inclination, such as Area "B" and the CRM Reach, the rock revetment in conjunction with a CRM gravity retaining wall may be a viable option. The CRM gravity retaining wall will need to be designed to resist the static lateral earth pressures acting on the wall. Since the wall will be located along a sloping shoreline that is subjected to wave action, resistance from passive earth pressures should be neglected. This would require a larger and heavier CRM wall to resist lateral earth pressures acting on the wall. The following general guidelines may be used for design of the CRM gravity retaining wall.

3.2.1 Retaining Wall Foundations

For design of the gravity retaining wall foundation, an allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used for the design of shallow foundations bearing on the boulders/cobbles (talus deposits or stone underlayer) or basalt rock formation. This bearing value is for supporting dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as those caused by wind or seismic forces.

It should be noted that the stone underlayer below the revetment would likely move over time due to erosion from wave action. If the wall bears on the stone underlayer, movement of the stone underlayer could result in structural distress to the wall. To reduce potential for structural distress to the wall from movement of the stone underlayer, we recommend placing a minimum 2-foot thick layer of reinforced concrete below the full width of the wall to evenly distribute the load over the stone

underlayer and to act as a “bridging” layer if movement of the stone underlayer occurs.

Generally, wall footings should have a minimum width of 18 inches. In addition, wall footings should be embedded a minimum depth of 24 inches below the lowest adjacent finished grade of the new revetment.

Lateral loads may be resisted by friction developed between the bottom of the foundation and the bearing soil. A coefficient of friction of 0.5 may be used for footings bearing on the 2-foot thick layer of reinforced concrete. Resistance due to passive earth pressure acting against the near-vertical faces of the foundation should be neglected since the wall is located in an area that is prone to erosion by wave action.

3.2.2 Static Lateral Earth Pressures

For design of the retaining wall, we recommend using equivalent fluid pressures of 34 pcf and 53 pcf for the active and at-rest conditions, respectively. Surcharge and hydrostatic pressures are not accounted for in the above values. Surcharge stresses due to areal surcharges, live loads, and point loads should be considered in the wall design.

For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution with uniform pressure equal to 28 and 44 percent of the vertical surcharge pressure acting on the entire height of the wall may be used for the active and at-rest conditions, respectively. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.2.3 Dynamic Lateral Earth Pressures

Dynamic lateral earth forces due to seismic loading will need to be considered in the design of the retaining wall. Forces caused by dynamic lateral earth pressures due to seismic loading (amax= 0.26g) within the upper soil layer above the basalt rock formation may be estimated using $5.0H^2$ pounds per linear foot of wall length for level backfill conditions, where H is the height of the wall within the upper soil layer in feet. The resultant force should be assumed to act through the mid-height of the wall within

the upper soil layer. An appropriately reduced factor of safety may be used when dynamic lateral earth forces are accounted for in the design of the retaining wall.

It should be noted that the forces due to dynamic lateral earth pressures provided above assume that the wall will be allowed to move laterally by about 2 to 3 inches in the event of an earthquake. For restrained condition (less than 0.5 inches of lateral movement), forces caused by dynamic lateral earth pressures due to seismic loading may be estimated using $16.1H^2$ pounds per linear foot of wall length for level backfill conditions.

3.2.4 Drainage

Retaining walls should be well drained to reduce the build-up of hydrostatic pressures. A typical drainage system for the retaining walls should consist of about 1 cubic foot of permeable material, such as open-graded gravel (ASTM C 33, No. 67 gradation), wrapped with non-woven filter fabric (Mirafi 180N or equivalent) at each of the weep hole locations. The weep holes should be spaced no more than 6 feet apart.

Alternatively, a 1 to 2-foot wide strip of geocomposite drainage material extending the full height of the retaining wall may be used. The geocomposite drainage material should be connected hydraulically to a weep hole or drainage outlet. Unless covered by concrete, the upper 12 inches of backfill should consist of impervious material to reduce the potential for excessive water infiltration behind the walls.

3.3 Reinforced Concrete Wall with Tie-Backs

As mentioned previously, resistance from passive earth pressures should be neglected for the design of the retaining wall since the wall will be located along a sloping shoreline that is subjected to wave action. A larger and heavier gravity retaining wall may be required to resist the lateral earth pressures. However, it may not be feasible to use a larger and heavier gravity retaining wall; therefore, a reinforced concrete wall with a permanent tieback anchor system may be used in lieu of a gravity retaining wall to provide the lateral support.

In general, the permanent tieback anchor system is constructed by drilling a borehole, installing a reinforcing bar into the borehole, and grouting the borehole. The basic components of a grouted permanent tieback anchor consist of the anchorage and the bonded and unbonded lengths of the reinforcing bar. In general, the unbonded length of the tieback anchor is the portion of the reinforcing bar that does not have direct contact with the grout, allowing the reinforcing bar to elongate elastically and transfer the resisting force from the structure to the bonded length. The bonded length of the tieback anchor is the portion of the reinforcing bar that is directly bonded to the grout allowing it to transfer the applied load into the ground. Based on the depths of the boulders and cobbles encountered in the borings, we recommend that the unbonded length of the tieback anchor extend at least 25 feet behind the new concrete retaining wall so that the bonded length extends beyond the boulder and cobble layer and into the basalt rock formation. Due to the presence of boulders and cobbles at the site, there is a high potential for caving in of the borehole in the boulder and cobble layer. To reduce the potential for caving in of the borehole, we recommend using a permanent steel casing for the unbonded length of the tieback anchor. The permanent steel casing would also reduce the potential grout loss that could occur in the boulder and cobble layer if not cased.

We envision that the permanent tieback anchors would derive support principally from the bond between the grout and the basalt rock anticipated at the project site. The bond stress, which is the pullout resistance per unit area of the grout/soil interface contact, is variable depending on the type of soil/rock and grout, the overburden stress, and the construction procedures used in installing the permanent tieback anchors. An average bond stress of 2,000 pounds per square foot (psf) may be used for the basalt rock. The bond stress used in the design will need to be confirmed during construction by load testing.

In general, we believe the reinforced concrete retaining wall foundations may be designed in accordance with the recommendations and parameters presented in the "Concrete Rubble Masonry (CRM) Retaining Wall" section herein.

The permanent tieback anchor system will be designed to provide resistance to the lateral earth pressures and lateral loads imposed from the traffic loading on the

roadway. Details for the earth pressure diagram for one level of tieback anchors are presented on Plate 3.

3.4 Site Preparation

We believe that only minor site grading work will be required to achieve the finished grades at the site. In general, areas within the contract grading limits should be thoroughly cleared and grubbed at the on-set of earthwork. Vegetation, debris, deleterious materials, and other unsuitable materials should be removed and disposed of properly off-site. Soft, loose, and yielding areas encountered during clearing below areas designated to receive fill or future improvements should be over-excavated to expose firm or dense material, and the resulting excavation should be backfilled with well-compacted fill. The excavated soft, loose, and/or organic soils should be properly disposed of off-site. In addition, contract documents should include additive and deductive unit prices for over-excavation and compacted fill placement to account for variation in the over-excavation quantities.

Walls and foundations of the existing structures and pavements to be demolished should be completely removed. Over-excavations resulting from the demolition operations should be backfilled with compacted granular fill material. Existing underground utilities to be abandoned should be removed, and the resulting excavation should be properly backfilled with the excavated on-site materials. The on-site materials should be moisture-conditioned to above the optimum moisture content, placed in 6 to 8-inch level loose lifts, and compacted to a minimum of 90 percent relative compaction. Utilities to be abandoned in-place under the proposed addition should be backfilled by pumping lean concrete or CLSM (Controlled Low Strength Material) under low pressure.

After clearing, grubbing and demolition, areas to receive fill and finished subgrades in cut areas should be scarified to a depth of about 8 inches, moisture conditioned to at least 2 percent above the optimum moisture content, and compacted to a minimum of 90 percent relative compaction. The compaction requirement for the finished subgrades in areas subjected to vehicular traffic should be increased to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in

accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Scarification would not be possible in subgrades consisting mainly of boulders or basalt rock. Therefore, subgrades consisting mainly of boulders or basalt rock should be proof-rolled with a minimum 10-ton (static weight) vibratory drum roller for a minimum of eight passes to provide a firm and unyielding surface and to help detect and collapse near-surface cavities and/or voids. A Geolabs representative should observe the proof-rolling operations. Yielding areas, loose areas, or cavities disclosed during proof-rolling operations should be over-excavated and backfilled with compacted fill materials.

Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft and/or loose areas and replacement with well-compacted fill. A Geolabs representative should evaluate the need for over-excavation in the field.

In general, the excavated on-site soils may be re-used as a source of general fill or backfill materials, provided that they are free of deleterious materials (vegetation) and are screened of particles greater than 3 inches in largest dimension. Imported fill materials needed for site filling should consist of non-expansive, select granular materials, such as crushed coral or basalt. The materials should be well graded from coarse to fine with particles no larger than 3 inches in largest dimension and should contain between 10 and 30 percent particles passing the No. 200 sieve. The materials should have a laboratory CBR value of 20 or more and should have a maximum swell of 1 percent or less when tested in accordance with ASTM D1883.

Fills and backfills should be moisture-conditioned to at least 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. In general, compaction should be accomplished by sheepsfoot rollers, vibratory rollers, or other similar types of acceptable compaction equipment.

A Geolabs representative should monitor the earthwork operations to observe whether undesirable materials are encountered during the excavation process, and to

confirm whether the exposed soil conditions are similar to those encountered in our exploration.

3.5 Pavements

In general, we anticipate that the vehicle loading for the new pavements for this project will consist primarily of passenger vehicles and light pick-up trucks with occasional large trucks. We have made our preliminary pavement design using a design CBR value of 20. Based on the above, we recommend using the following flexible pavement section for preliminary design purposes:

Flexible Pavement

2.0-Inch Asphaltic Concrete
3.0-Inch Asphalt Concrete Base (92 Percent Max. Theoretical Specific Gravity)
6.0-Inch Aggregate Base Course (95 Percent Relative Compaction)
11.0-Inch Total New Pavement Thickness Over Compacted Subgrade

Aggregate base course required for the pavement should consist of crushed basaltic aggregates and should conform to Subsections 703.06 of the Hawaii Standard Specifications for Road and Bridge Construction (2005). Aggregate base course materials should be moisture-conditioned to above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to no less than 95 percent relative compaction. CBR and field density tests should be performed on the actual subgrade soils encountered during construction to confirm the adequacy of the above section.

The recommended section assumes that good drainage will be provided adjacent to paved areas. Paved areas should be sloped, and drainage gradients maintained to carry surface water off the site. Surface water ponding should not be allowed on the site during or after construction.

3.6 Design Review

Preliminary and final drawings and specifications for the project should be forwarded to Geolabs for review and written comments prior to construction. This review is necessary to evaluate conformance of the plans and specifications with the intent of

the geotechnical recommendations provided herein. If this review is not made, Geolabs cannot be held responsible for misinterpretation of our recommendations.

3.7 Services During Construction

Geolabs, Inc. should be retained to provide geotechnical engineering services during construction of the proposed project. The critical items of construction monitoring that require "Special Inspection" include the following:

- Review of the geotechnical aspects of the contractor submittals
- Observation of the permanent tieback anchor installation and testing
- Subgrade preparation
- Fill and backfill placement
- Footing excavation and preparation

A Geolabs representative also should monitor the other aspects of earthwork construction to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. Geolabs should be accorded the opportunity to provide geotechnical engineering services during construction to confirm our assumptions in providing the recommendations presented herein.

If the actual exposed subsurface conditions encountered during construction differ from those assumed or considered in this report, Geolabs should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based in part upon information obtained from the borings and bulk sample. Variations of the subsurface conditions between and beyond the borings and bulk sample locations may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations presented in this report.

The boring and bulk sample locations indicated in this report are approximate, having been taped from existing visible features shown on the Topographic Survey transmitted by Sea Engineering, Inc. on July 8, 2016. Elevations noted on the borings were obtained on the same plan. The boring locations and elevations should be considered accurate only to the degree implied by the methods used.

The stratification breaks on the Logs of Borings depict the approximate boundaries between the soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text herein. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that water level fluctuation may occur due to tidal fluctuations, rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

This report has been prepared for the exclusive use of Sea Engineering, Inc., their clients and their project consultants for specific application to the Kalepa Point Shoreline Damage Repairs project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the design engineers in the design of the project. Therefore, this report may not contain sufficient data and/or the proper information to form the basis for preparation of construction cost estimates or contract bidding. A contractor wishing to bid on this project should retain a competent geotechnical engineer to assist in the interpretation of this report and/or performance of site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil/rock conditions are commonly encountered. Unforeseen subsurface conditions such as soft deposits, hard layers, cavities, or perched groundwater may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

This geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of hazardous materials existing at the site. It should be noted that the equipment, techniques, and personnel used to conduct a geo-environmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

Project Location Map ..... Plate 1

Site Plan ..... Plate 2

Earth Pressure Diagram ..... Plate 3

Field Exploration ..... Appendix A

Laboratory Tests ..... Appendix B

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

GEOLABS, INC.

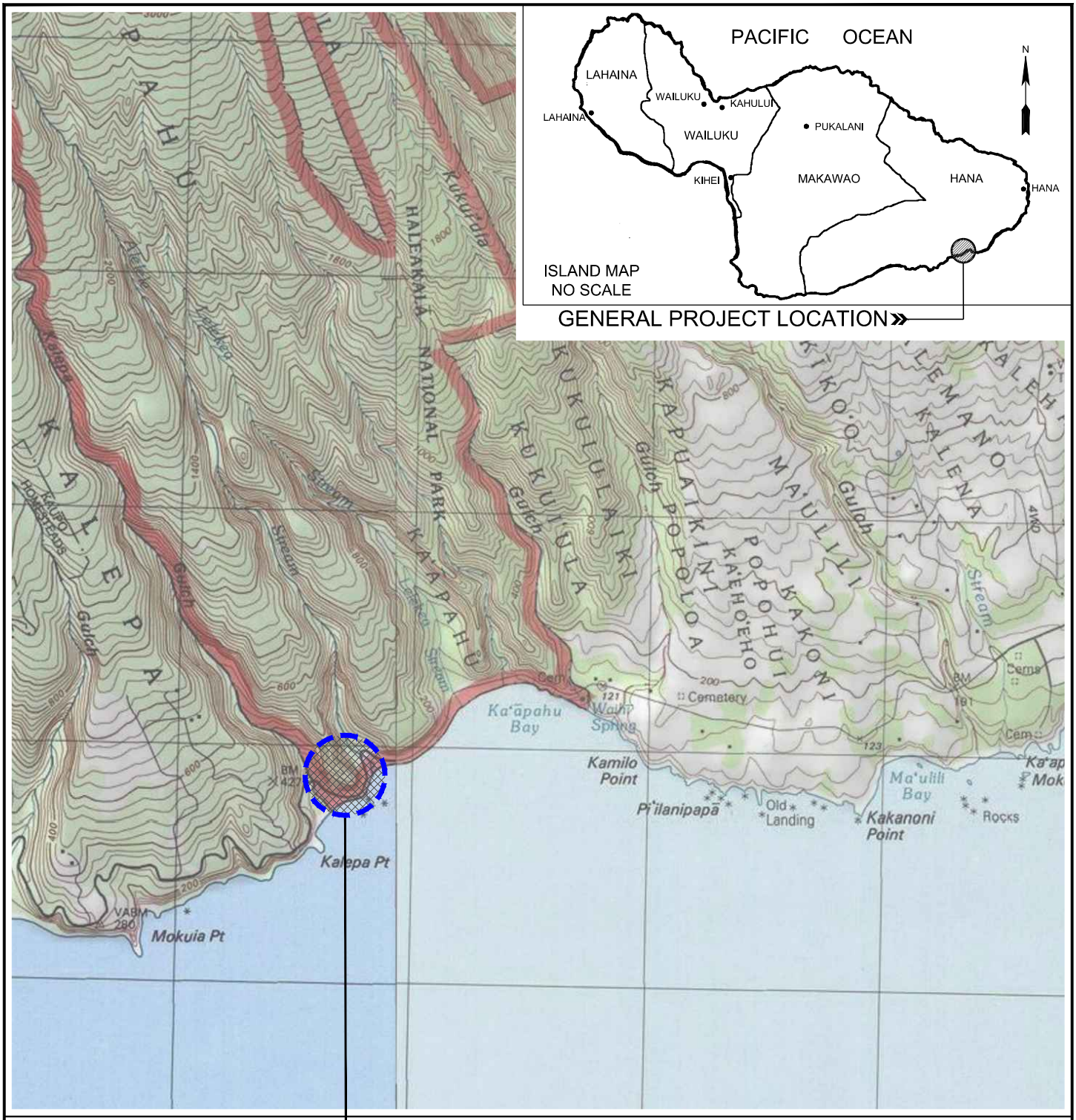
By _____
Glenn Barut, P.E.
Senior Project Engineer

By _____
Gerald Y. Seki, P.E.
Vice President

GS:GB:as

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PLATES



PROJECT LOCATION MAP

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

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Geotechnical Engineering

DATE	DRAWN BY	PLATE
AUGUST 2016	ASP	1
SCALE	W.O.	
1" = 2,000'	7113-00	

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Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb

PIILANI HIGHWAY

MATCHLINE
SEE SHEET 2.2

B-1 & BULK-1

B-2

AREA "B"

CRM REACH

LEGEND:

APPROXIMATE BORING LOCATION

APPROXIMATE BULK SAMPLE LOCATION

REFERENCE: TOPOGRAPHIC SURVEY MAP TRANSMITTED BY SEA ENGINEERING, INC. ON JULY 8, 2016.

0 10 20 30 60 90 FT.

GRAPHIC SCALE

N

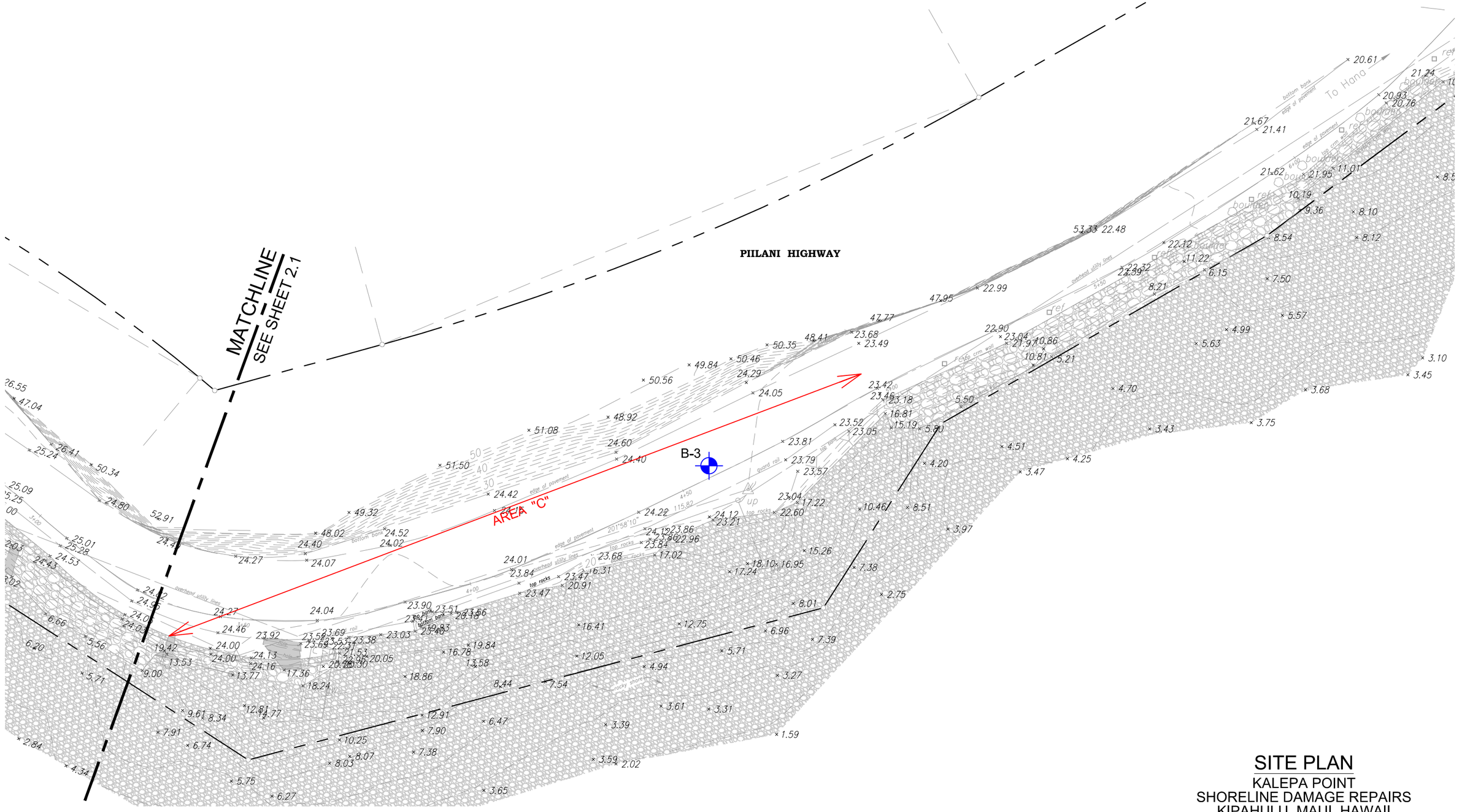
SITE PLAN

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb



LEGEND:

APPROXIMATE BORING LOCATION

0 10 20 30 60 90 FT.

GRAPHIC SCALE

REFERENCE: TOPOGRAPHIC SURVEY MAP TRANSMITTED BY SEA ENGINEERING, INC. ON JULY 8, 2016.

SITE PLAN

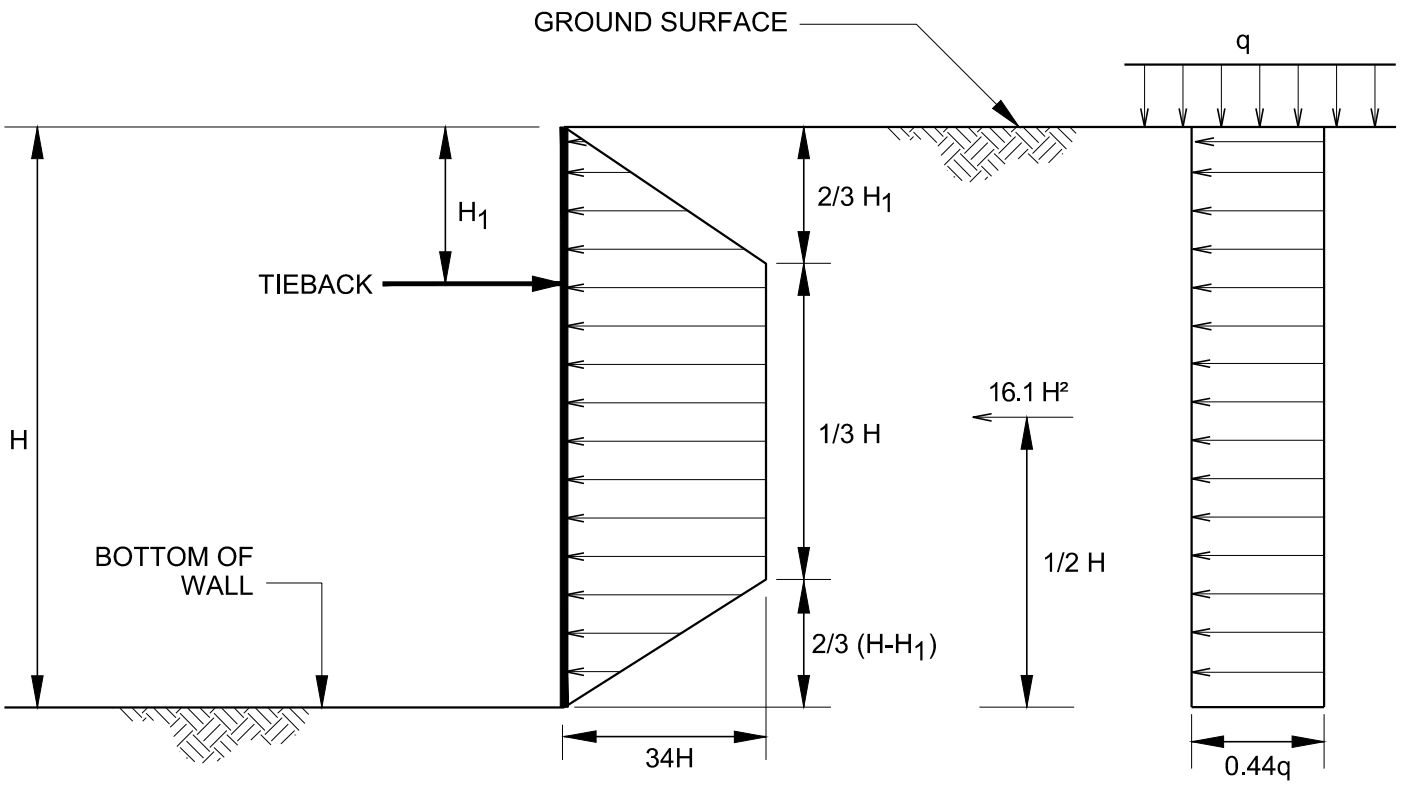
KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

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Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dithering.ctb

SINGLE LEVEL TIEBACK



NOTES:

1. ALL PRESSURES ARE IN UNITS OF POUNDS PER SQUARE FOOT.
2. H, H_1 AND D ARE IN FEET.
3. q= SURCHARGE LOADING IN POUNDS PER SQUARE FOOT.
4. SURCHARGE LOADING ACTING AT A HORIZONTAL DISTANCE FROM THE WALL EQUAL TO H SHOULD BE CONSIDERED IN THE DESIGN.

EARTH PRESSURE DIAGRAM

KALEPA POINT
SHORELINE DAMAGE REPAIRS
ISLAND OF MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
AUGUST 2016	HYC	3
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NOT TO SCALE	7113-00	

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APPENDIX A

A P P E N D I X A

Field Exploration

The subsurface conditions at the project site were explored by drilling and sampling three borings, designated as Boring Nos. 1 through 3, extending to depths of about 35 to 37.8 feet below the existing pavement surface. The borings were drilled with a truck-mounted drill rig equipped with augers and rotary coring tools. The borings were drilled at the approximate locations shown on the Site Plan, Plate 2.

Our geologist classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), as shown on the Soil Log Legend, Plate A-0.1. Deviations made to the soil classification in accordance with ASTM D2487 are described on the Soil Classification Log Key, Plate A-0.2. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1 through A-3.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM D3550-01 (2007), Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, some samples were obtained from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Penetration Resistance" on the Logs of Borings at the appropriate sample depths. The penetration resistance shown on the logs of borings indicates the number of blows required for the specific sampler type used. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

Core samples of the rock materials encountered at the project site were obtained by using diamond core drilling techniques in general accordance with ASTM D2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the rock formation. The rock material left in the hollow core of the bit is mechanically recovered for examination and description. Rock cores were described in general accordance with the Rock Description System as shown on the Rock Log Legend, Plate A-0.3.

The Rock Description System is based on the publication "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses" by the International Society for Rock Mechanics (March 1977).

Recovery (REC) is used as a subjective guide to the interpretation of the relative quality of rock masses. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of rock masses. RQD is defined as the percentage of the core run in rock that is sound material in excess of 4 inches in length without any discontinuities, discounting any drilling induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run in rock, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock based on the "Practical Handbook of Physical Properties of Rocks and Minerals."

Rock Quality	**RQD** (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

The rippability (or excavation characteristics) of a rock mass is a function of the relative hardness of the rock, its relative quality, brittleness, and fissile characteristics. Dense basalt formations with high RQD values would be very difficult to rip and would probably require more arduous methods of excavation.

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Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS — MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	GRAVELS — MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS — LESS THAN 5% FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES — MORE THAN 12% FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS — 50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	CLEAN SANDS — LESS THAN 5% FINES	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES — MORE THAN 12% FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS — 50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS — LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS — LIQUID LIMIT 50 OR MORE		MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

- (2-INCH) O.D. STANDARD PENETRATION TEST
- (3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
- SHELBY TUBE SAMPLE
- GRAB SAMPLE
- CORE SAMPLE
- WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
- WATER LEVEL OBSERVED IN BORING AFTER DRILLING
- WATER LEVEL OBSERVED IN BORING OVERNIGHT

- LL — LIQUID LIMIT (NP=NON-PLASTIC)
- PI — PLASTICITY INDEX (NP=NON-PLASTIC)
- TV — TORVANE SHEAR (tsf)
- UC — UNCONFINED COMPRESSION OR UNIAXIAL COMPRESSIVE STRENGTH
- TXUU — UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate

A-0.1

LOG LEGEND FOR SOIL 7113-00.GPJ GEOLABS.GDT 10/13/16

GEOLABS, INC.

Geotechnical Engineering

Soil Classification Log Key

(with deviations from ASTM D2488)

GEOLABS, INC. CLASSIFICATION*

GRANULAR SOIL (- #200 <50%)

- **PRIMARY** constituents are composed of the largest percent of the soil mass. Primary constituents are capitalized and bold (i.e., **GRAVEL, SAND**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent. If the soil mass consists of 12 percent or more fines content, a cohesive constituent is used (**SILTY** or **CLAYEY**); otherwise, a granular constituent is used (**GRAVELLY** or **SANDY**) provided that the secondary constituent consists of 20 percent or more of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** GRAVEL, **CLAYEY** SAND) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY GRAVEL **with a little sand**)

COHESIVE SOIL (- #200 ≥ 50%)

- **PRIMARY** constituents are based on plasticity. Primary constituents are capitalized and bold (i.e., **CLAY, SILT**)
- **SECONDARY** constituents are composed of a percentage less than the primary constituent, but more than 20 percent of the soil mass. Secondary constituents are capitalized and bold (i.e., **SANDY** CLAY, **SILTY** CLAY, **CLAYEY** SILT) and precede the primary constituent.
- **accessory descriptions** compose of the following:
  with some: >12%
  with a little: 5 - 12%
  with traces of: <5%
  accessory descriptions are lower cased and follow the Primary and Secondary Constituents
  (i.e., SILTY CLAY **with some sand**)

EXAMPLE: Soil Containing 60% Gravel, 25% Sand, 15% Fines. Described as: **SILTY GRAVEL** with some sand

RELATIVE DENSITY / CONSISTENCY

Granular Soils			Cohesive Soils			
N-Value (Blows/Foot)		Relative Density	N-Value (Blows/Foot)		PP Readings (tsf)	Consistency
SPT	MCS		SPT	MCS		
0 - 4	0 - 7	Very Loose	0 - 2	0 - 4		Very Soft
4 - 10	7 - 18	Loose	2 - 4	4 - 7	< 0.5	Soft
10 - 30	18 - 55	Medium Dense	4 - 8	7 - 15	0.5 - 1.0	Medium Stiff
30 - 50	55 - 91	Dense	8 - 15	15 - 27	1.0 - 2.0	Stiff
> 50	> 91	Very Dense	15 - 30	27 - 55	2.0 - 4.0	Very Stiff
			> 30	> 55	> 4.0	Hard

MOISTURE CONTENT DEFINITIONS

Dry: Absence of moisture, dry to the touch

Moist: Damp but no visible water

Wet: Visible free water, usually soil is below water table

ABBREVIATIONS

WOH: Weight of Hammer

WOR: Weight of Drill Rods

SPT: Standard Penetration Test Split-Spoon Sampler

MCS: Modified California Sampler

PP: Pocket Penetrometer

GRAIN SIZE DEFINITION

Description	Sieve Number and / or Size
Boulders	> 12 inches (305-mm)
Cobbles	3 to 12 inches (75-mm to 305-mm)
Gravel	3-inch to #4 (75-mm to 4.75-mm)
Coarse Gravel	3-inch to 3/4-inch (75-mm to 19-mm)
Fine Gravel	3/4-inch to #4 (19-mm to 4.75-mm)
Sand	#4 to #200 (4.75-mm to 0.075-mm)
Coarse Sand	#4 to #10 (4.75-mm to 2-mm)
Medium Sand	#10 to #40 (2-mm to 0.425-mm)
Fine Sand	#40 to #200 (0.425-mm to 0.075-mm)

Soil descriptions are based on ASTM D2488-09a, Visual-Manual Procedure, with the above modifications by Geolabs, Inc. to the Unified Soil Classification System (USCS).

Plate

A-0.2

GEOLABS, INC.

Geotechnical Engineering

Rock Log Legend

ROCK DESCRIPTIONS

	BASALT		**FINGER CORAL**
	BOULDERS		**LIMESTONE**
	BRECCIA		**SANDSTONE**
	CLINKER		**SILTSTONE**
	COBBLES		**TUFF**
	CORAL		**VOID/CAVITY**

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive: Greater than 24 inches apart

Slightly Fractured: 12 to 24 inches apart

Moderately Fractured: 6 to 12 inches apart

Closely Fractured: 3 to 6 inches apart

Severely Fractured: Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered: Rock shows no sign of discoloration or loss of strength.

Slightly Weathered: Slight discoloration inwards from open fractures.

Moderately Weathered: Discoloration throughout and noticeably weakened though not able to break by hand.

Highly Weathered: Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.

Extremely Weathered: Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard: Specimen breaks with difficulty after several "pinging" hammer blows.
Example: Dense, fine grain volcanic rock

Hard: Specimen breaks with some difficulty after several hammer blows.
Example: Vesicular, vugular, coarse-grained rock

Medium Hard: Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce.
Example: Porous rock such as clinker, cinder, and coral reef

Soft: Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot.
Example: Weathered rock, chalk-like coral reef

Very Soft: Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure.
Example: Saprolite

Plate
A-0.3

GEOLABS, INC.

Geotechnical Engineering

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Log of Boring

1

Approximate Ground Surface Elevation (feet): 25 *

Laboratory			Field								Description
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	
										SW-SM	1-inch **ASPHALTIC CONCRETE**
Sieve - #200 = 11.6% UC= 7110 psi	5		71		25/6" +25/0" Ref.						Grayish brown **SAND (BASALTIC)** with some gravel and a little cobbles and silt, dense, damp (fill)
			65				5				Gray subrounded **BOULDERS (BASALTIC)** with some cobbles, medium dense to dense, damp to moist (talus slope deposit)
			50				10				
UC= 7040 psi			48				15				
	12		81		23		20			GP	Grayish brown subrounded **GRAVEL (BASALTIC)** with some cobbles, medium dense, moist to wet (talus slope deposit)
			17				25				
LL=90 PI=32	63		33		23		30			MH	Brown with gray **CLAYEY SILT** with some gravel (basaltic), very stiff (residual soil)
	23				57		35			GM	Brownish gray **SILTY GRAVEL (BASALTIC)**, dense, very moist to wet (weathered clinker)
							40				Boring terminated at 37.75 feet

Date Started:	July 26, 2016	Water Level: ▽ 21.1 ft. 07/27/2016 0840 HRS	Plate
Date Completed:	July 27, 2016		
Logged By:	S. Latronic	Drill Rig: CME-75DG1 *(Energy Transfer Ratio = 80.3%)*	A - 1
Total Depth:	37.75 feet	Drilling Method: 4" Solid Stem Auger & HQ Coring	
Work Order:	7113-00	Driving Energy: 140 lb. wt., 30 in. drop	

BORING_LOG 7113-00.GPJ GEOLABS.GDT 10/13/16

GEOLABS, INC.

Geotechnical Engineering

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Log of Boring

2

Laboratory			Field							
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS
	16				37					SM
										ML
	26	72			50		5			
UC= 13490 psi			75	22						
			92	63			10			
UC= 9720 psi			72	20			15			
UC= 14800 psi										
			38	0			20			
			65	10			25			
			44	0			30			
							35			
							40			

Approximate Ground Surface Elevation (feet): 25 *

Description

1-inch **ASPHALTIC CONCRETE**

Brown **SILTY SAND (BASALTIC)** with some gravel, medium dense to dense, moist (fill)

Brown with some gray **CLAYEY SILT** with some gravel (basaltic), stiff to very stiff, moist (fill) grades with brown silty sand

Gray subrounded **BOULDERS (BASALTIC)** with some cobbles and a little gravel, dense, dry to damp (talus slope deposit)

Gray vugular **BASALT**, moderately fractured, slightly weathered, very hard (a'a basalt)

Brownish gray **GRAVELLY COBBLES (BASALTIC)** with a little sand, medium dense (clinker)

Brownish gray to gray vugular **BASALT**, closely fractured, slightly to moderately weathered, medium hard to hard (a'a basalt)

Brownish gray **GRAVELLY COBBLES (BASALTIC)** with some sand, medium dense (clinker)

Brownish gray vugular **BASALT**, severely fractured, highly weathered, soft to medium hard (a'a basalt)

Boring terminated at 35 feet

Date Started:	July 27, 2016	Water Level: ▼ 17.0 ft. 07/27/2016 1350 HRS		Plate
Date Completed:	July 27, 2016			
Logged By:	S. Latronic	Drill Rig:	CME-75DG1 *(Energy Transfer Ratio = 80.3%)*	A - 2
Total Depth:	35 feet	Drilling Method:	4" Solid Stem Auger & HQ Coring	
Work Order:	7113-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7113-00.GPJ GEOLABS.GDT 10/13/16

GEOLABS, INC.

Geotechnical Engineering

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Log of Boring

3

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											Approximate Ground Surface Elevation (feet): 24 *
	21		40		25/6" +20/0" Ref.					GP SM	1-inch **ASPHALTIC CONCRETE** Gray **SANDY GRAVEL (BASALTIC)**, dense, dry (fill)
											Grayish brown **SILTY SAND (BASALTIC)** with some gravel, dense, dry to damp (colluvium)
	44				3		5			ML	Gray vugular **BASALT**, closely fractured, moderately weathered, medium hard to hard (a'a basalt)
			47	0							Brown **CLAYEY SILT** with some sand (basaltic) and traces of decomposed gravel, medium stiff, moist (weathered clinker)
UC= 2230 psi			52	38			10				Gray vugular **BASALT**, slightly fractured, moderately to highly weathered, medium hard to hard (a'a basalt)
			20	0			15				Brownish gray **GRAVELLY COBBLES (BASALTIC)** with some sand and traces of silt, medium dense, moist to wet (clinker)
	12				11						
			94	15			20				Gray vugular **BASALT**, moderately to closely fractured, slightly to moderately weathered, hard to very hard (a'a basalt)
			100	35			25				grades to medium hard locally
UC= 1400 psi			85	0			30				
							35				Boring terminated at 35 feet
							40				

Date Started:	July 25, 2016	Water Level: ▼ 19.2 ft. 07/26/2016 1010 HRS		Plate
Date Completed:	July 26, 2016			
Logged By:	S. Latronic	Drill Rig:	CME-75DG1 *(Energy Transfer Ratio = 80.3%)*	A - 3
Total Depth:	35 feet	Drilling Method:	4" Solid Stem Auger & HQ Coring	
Work Order:	7113-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 7113-00.GPJ GEOLABS.GDT 10/13/16

APPENDIX B

APPENDIX B

Laboratory Tests

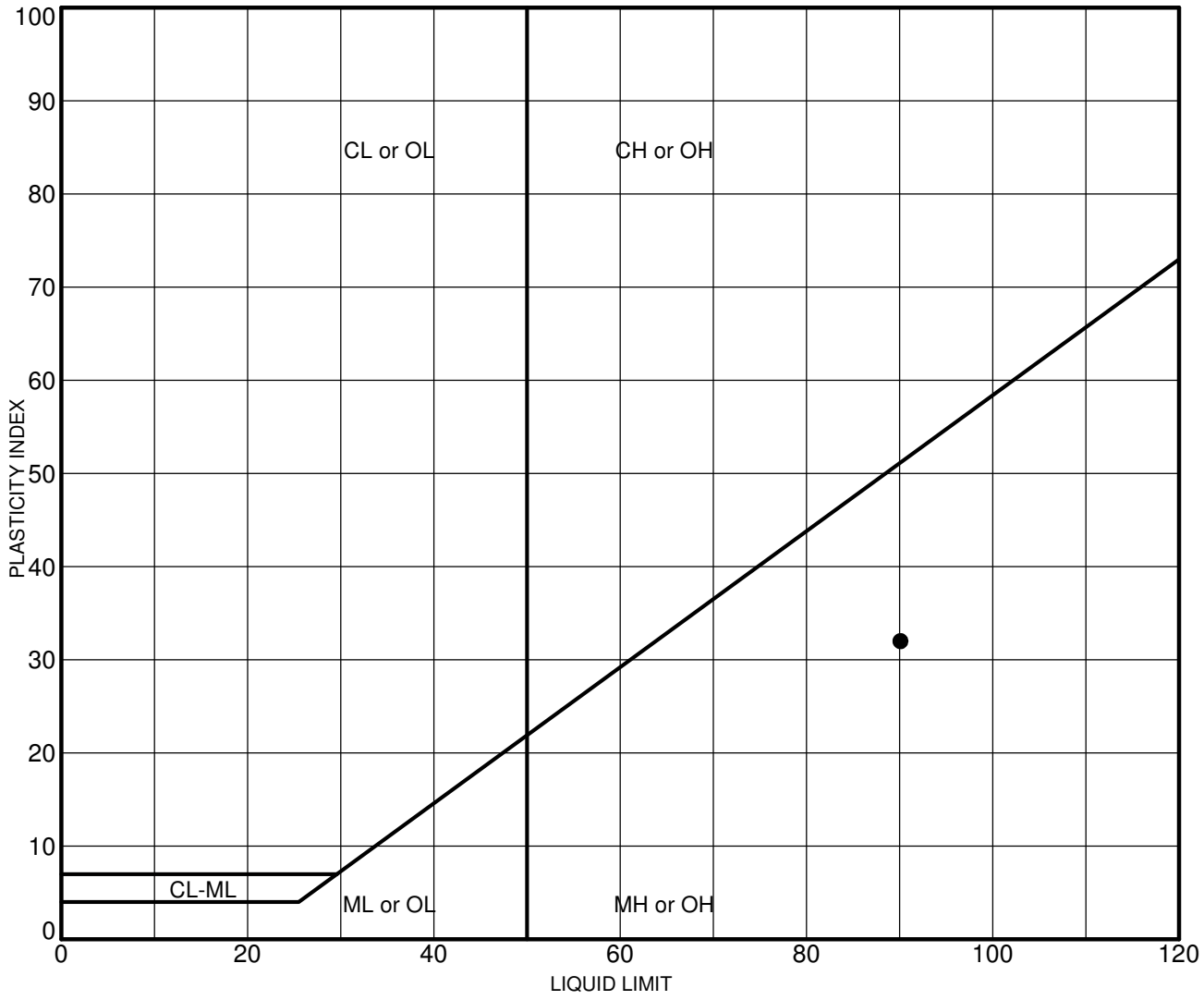
Moisture Content (ASTM D2216) and Unit Weight (ASTM D7263) determinations were performed on selected soil samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

One Atterberg Limits test (ASTM D4318) was performed on a selected soil sample to evaluate the liquid and plastic limits. The test results are summarized on the Logs of Borings at the appropriate sample depth. Graphic presentations of the test results are provided on Plate B-1.

One Sieve Analysis test (ASTM C117 & C136) was performed on a selected soil sample to evaluate the gradation characteristics of the soils and to aid in soil classification. Graphic presentation of the grain size distribution is provided on Plate B-2.

Seven Uniaxial Compressive Strength tests (ASTM D7012, Method C) were performed on selected core samples to evaluate the unconfined compressive strength of the boulders and basalt rock encountered. Uniaxial compressive strength test results are presented on Plate B-3.

One laboratory soaked California Bearing Ratio test (ASTM D1883) was performed on a bulk soil sample to evaluate the pavement support characteristics of the soils. The test results are presented on Plate B-4.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-1	31.0-33.0	90	58	32	Brown with gray clayey silt (MH)

GEOLABS, INC.
GEOTECHNICAL ENGINEERING

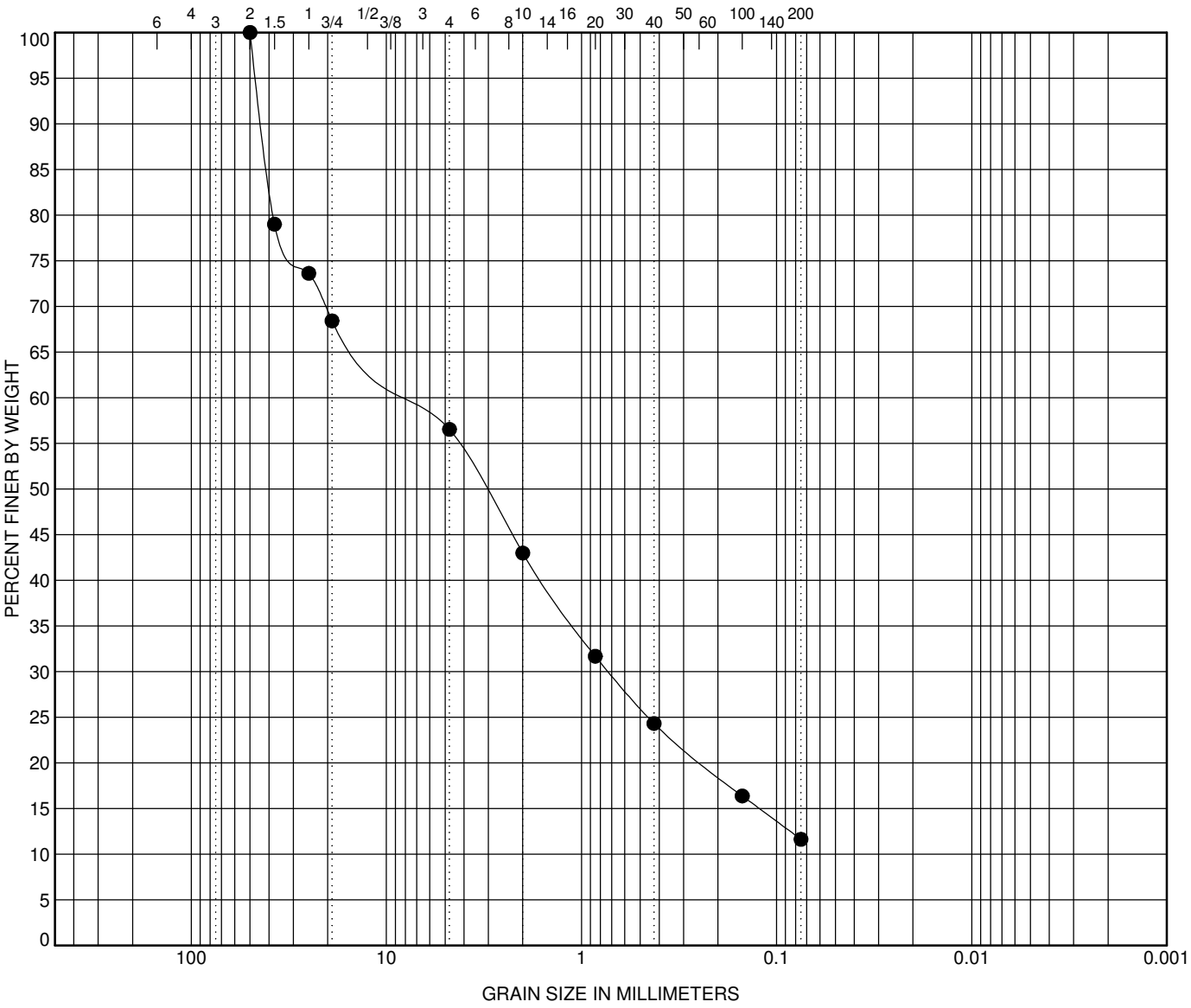
W.O. 7113-00

ATTERBERG LIMITS TEST RESULTS - ASTM D4318

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Plate
B - 1

G ATTERBERG PI-100 LL-120 7113-00.GPJ GEOLABS.GDT 10/13/16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-1	1.5-2.5	Grayish brown sand (SW-SM) with some gravel and a little silt				1.3	120.3

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-1	1.5-2.5	50	7.12	0.726		43.5	44.9	11.6

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GEOTECHNICAL ENGINEERING

W.O. 7113-00

GRAIN SIZE DISTRIBUTION - ASTM C117 & C136

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Plate
B - 2

G_GRAIN_SIZE_MOD_7113-00.GPJ GEOLABS.GDT 10/13/16

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)		(pcf)	(lbs.)	(psi)
B-1	3 - 3.5	6.000	2.380	2.52	162.7	31,620	7,110
B-1	16 - 16.5	6.000	2.380	2.52	179.6	31,320	7,040
B-2	6.75 - 7.25	6.000	2.380	2.52	172.6	60,020	13,490
B-2	13.75 - 14.25	6.000	2.380	2.52	183.1	43,240	9,720
B-2	17.5 - 18	6.000	2.380	2.52	185.2	65,860	14,800
B-3	12.25 - 12.75	6.000	2.380	2.52	150.6	9,920	2,230
B-3	28.5 - 29	5.000	2.380	2.10	114.5	6,220	1,400

ASTM D7012 (METHOD C)

GEOLABS, INC.

GEOTECHNICAL ENGINEERING

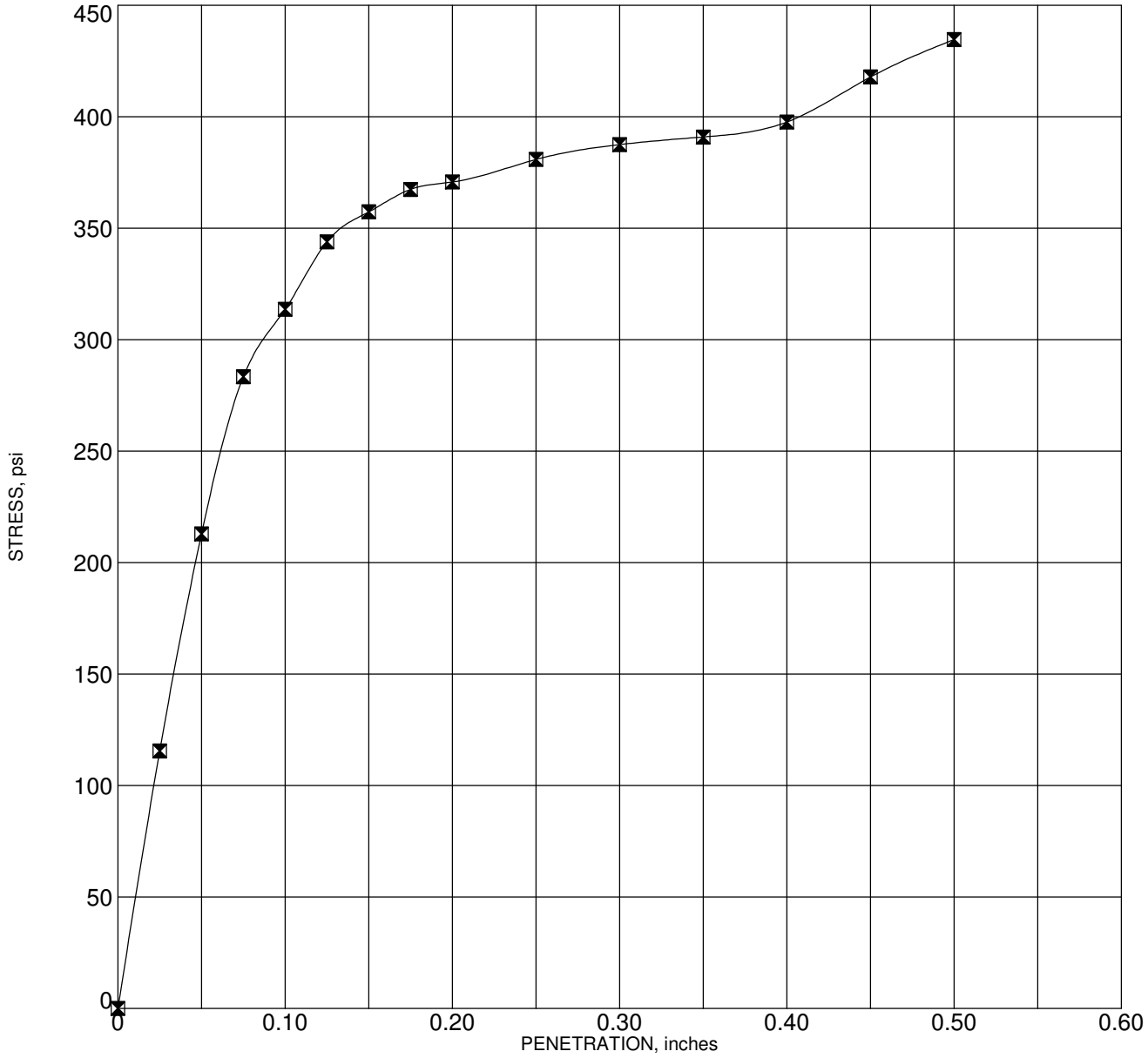
W.O. 7113-00

UNIAXIAL COMPRESSIVE STRENGTH TEST

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Plate
B - 3

G_ROCK_UC_TEST_PORTRAIT_7113-00.GPJ_GEOLABS.GDT_10/13/16



Corr. CBR @ 0.1"	31.4
Corr. CBR @ 0.2"	24.7
Swell (%)	0.39

Sample: Bulk-1
Depth: 0.0 - 2.0 feet
Description: Grayish sand with some gravel and a little silt

Molding Dry Density (pcf)	112.1	Hammer Wt. (lbs)	10
Molding Moisture (%)	13.0	Hammer Drop (inches)	18
Days Soaked	4	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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GEOTECHNICAL ENGINEERING

W.O. 7113-00

CALIFORNIA BEARING RATIO - ASTM D1883

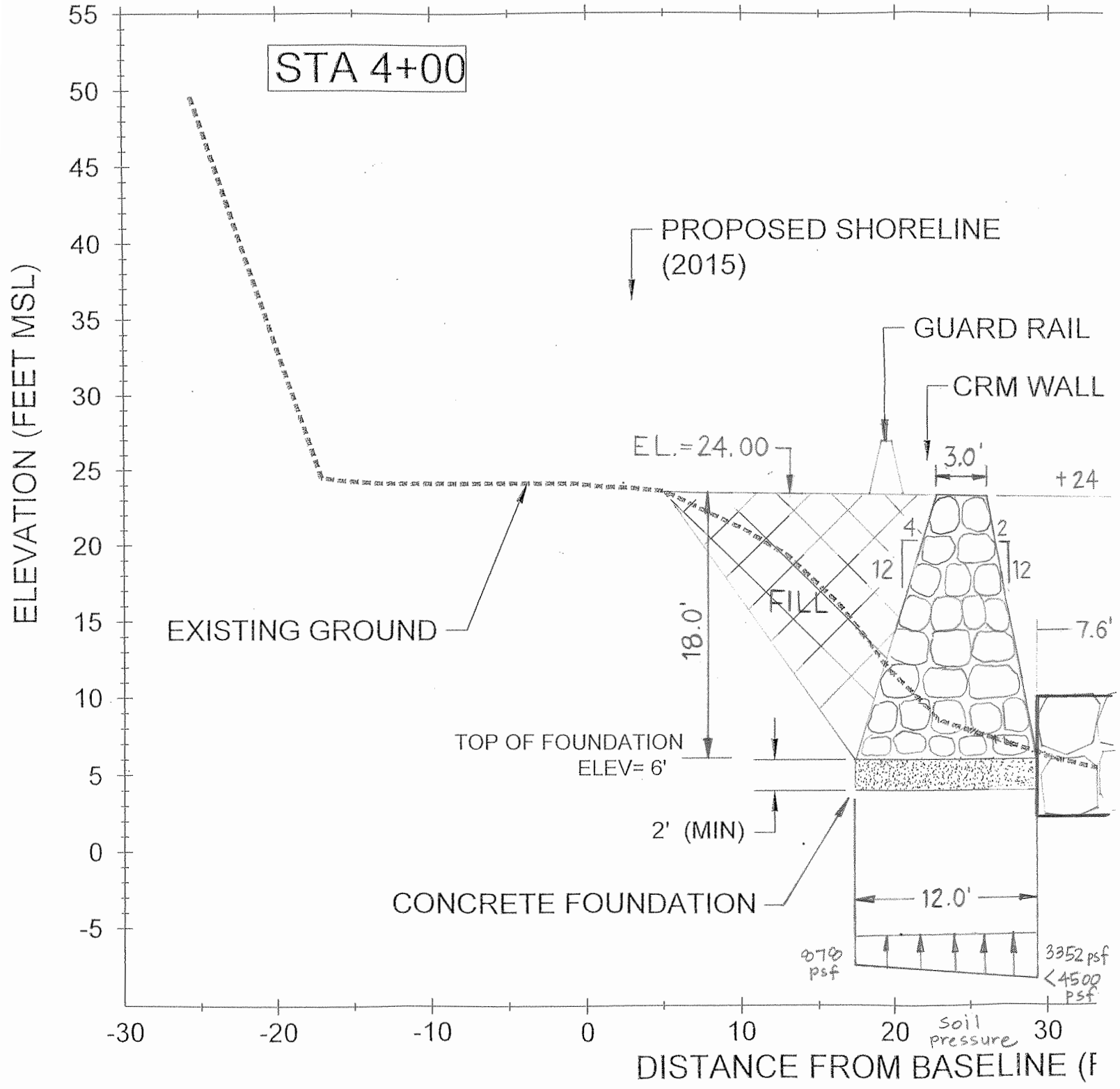
KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

Plate
B - 4

G_CBR_7113-00.GPJ GEOLABS.GDT 10/13/16

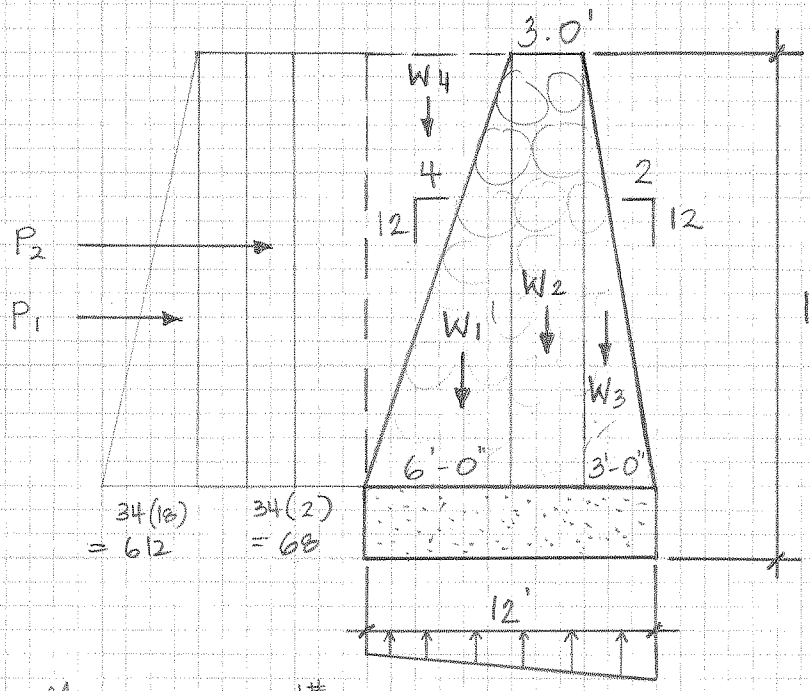
APPENDIX C:

STRUCTURAL CALCULATIONS
ARNOLD OKUBO & ASSOCIATES, INC.


STA 4+00
PROPOSED SHORELINE
(2015)
GUARD RAIL
CRM WALL
EL.=24.00
3.0'
+24
4.2
12
12
FILL
18.0'
7.6'
EXISTING GROUND
TOP OF FOUNDATION
ELEV= 6'
2' (MIN)
CONCRETE FOUNDATION
12.0'
870 psf
3352 psf
<4500 psf
soil pressure
ELEVATION (FEET MSL)
DISTANCE FROM BASELINE (F
55
50
45
40
35
30
25
20
15
10
5
0
-5
-30
-20
-10
0
10
20
30

DESCRIPTION	Arnold T. Okubo and Associates CONSULTING STRUCTURAL ENGINEERS	BY ATOkubo	CHECKED
		JOB NO.	SHEET / OF
	PROJECT: Kalepa Roadway (Shoreline) Repairs	DATE 01/03/17	

18' HT. @ STA. 4+00



$P_1 = 1/2(612)(18) = 5508^{\#}$

$P_2 = 68(18) = 1224^{\#}$

$\Sigma P_T = 6732^{\#}$

$M_O = 44,064^{1\#}$

ΣM_R:	W	X	M_R
$W_1 = 1/2(6)(18)140$	= 7560	8.0	60,480
$W_2 = 3.0 \times 18 \times 140$	= 7560	4.5	34,020
$W_3 = 1/2(3)(18)140$	= 3780	2.0	7,560
$W_4 = 1/2(18)6 \times 120$	= 6480	10.0	64,800
	$\Sigma W_T = 25,380$		$\Sigma M_R = 166,860$

S.F. against over turning $= \frac{166,860}{44,064} = 3.78 > 1.5$

okay

DESCRIPTION

Arnold T. Okubo and Associates
CONSULTING STRUCTURAL ENGINEERS

PROJECT:

BY: AT Okubo | CHECKED:
JOB NO.: | SHEET: | OF:
DATE: 01/03/17

S.F. against sliding

$$SF = \frac{25,380\,(0.5)}{6732} = 1.885 > 1.5 \quad \text{okay}$$

Soil Pressure

$$q = \frac{\Sigma M_R - \Sigma M_O}{\Sigma W_T} = \frac{166,860 - 44,064}{25,380} = 4.838'$$

$L/3 = 12/3 = 4.0$

$q > L/3$; resultant inside middle third

$$e = \frac{12}{2} - 4.83 = 1.17$$

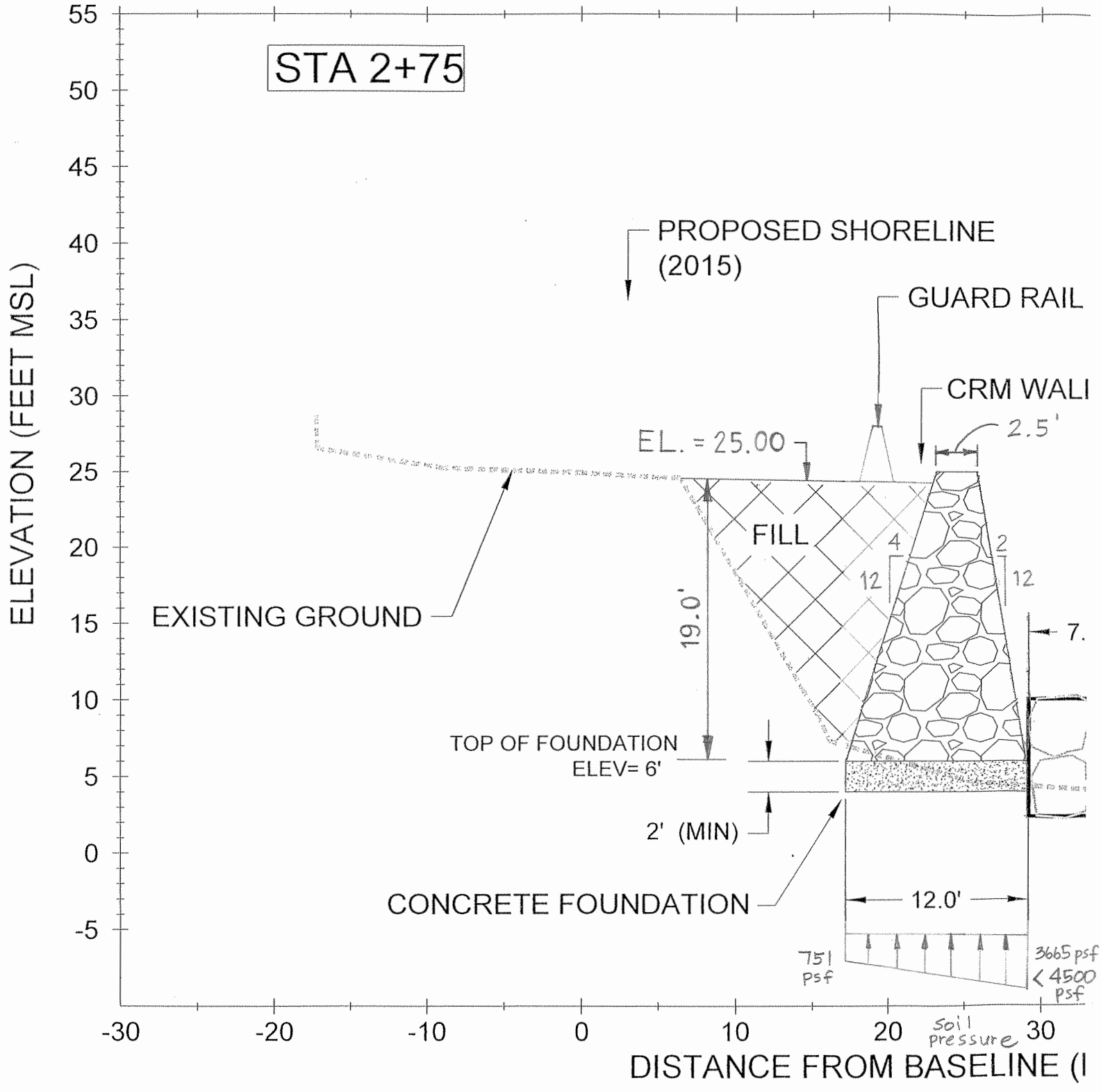
$$p = \frac{25,380}{12}\left(1 \pm \frac{6 \times 1.17}{12}\right)$$

$$= 2115\,(1 \pm 0.585)$$

$P_{max} = 3352$ psf < 4500 psf

$P_{min} = 878$ psf

okay


STA 2+75
PROPOSED SHORELINE
(2015)
GUARD RAIL
CRM WALI
2.5'
EL. = 25.00
FILL
4
12
2
12
19.0'
7.
EXISTING GROUND
TOP OF FOUNDATION
ELEV= 6'
2' (MIN)
CONCRETE FOUNDATION
12.0'
751
psf
3665 psf
< 4500
psf
soil
pressure
ELEVATION (FEET MSL)
55
50
45
40
35
30
25
20
15
10
5
0
-5
-30
-20
-10
0
10
20
30
DISTANCE FROM BASELINE (I

DESCRIPTION

Arnold T. Okubo and Associates
CONSULTING STRUCTURAL ENGINEERS

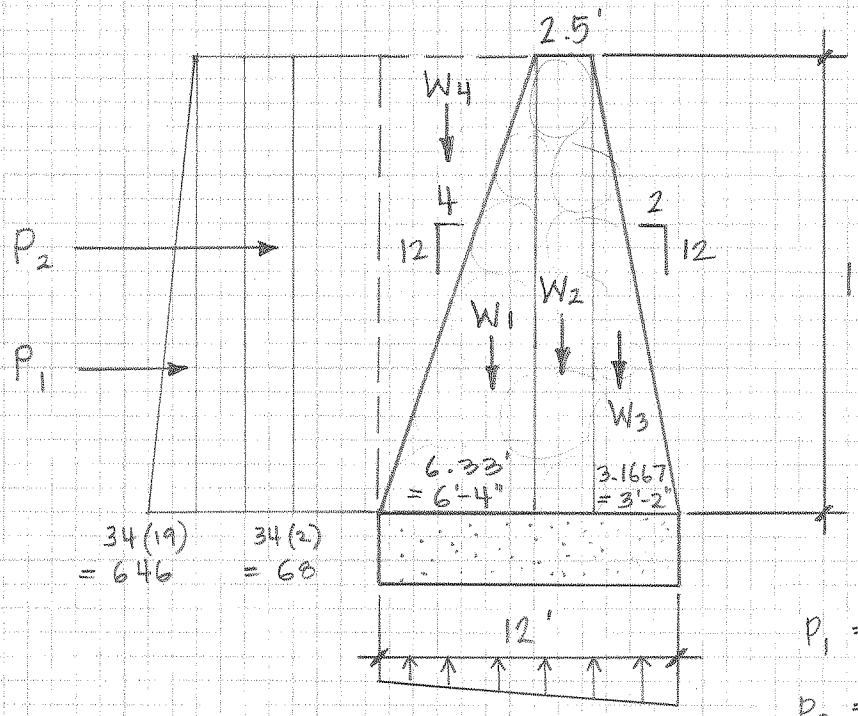
PROJECT:

BY ATOkubo | CHECKED

JOB NO. | SHEET | OF

DATE 01/03/17

19' HT. @ STA. 2+75



$W_s = 120$ psf

$W_a = 34$ pcf

$W_{conc} = 140$ lb/ft³

$f_u = 0.50$

$P_1 = \frac{1}{2}(646)19 = 6137^{\#}$

$P_2 = 68(19) = 1292^{\#}$

$\Sigma P_T = 7429^{\#}$

$W/o = 6137(19/3) + 1292(19/2) = 51,141^{\#}$

ΣM_R:

		W	X	M_R
W_1	$\frac{1}{2}(6.33)(19)140$	8419	7.77	65,415
W_2	$2.5(19)140$	6650	4.416	29,366
W_3	$\frac{1}{2}(3.167)(19)140$	4212	2.12	8,929
W_4	$\frac{1}{2}(6.33)(19)120$	7216	9.90	71,440
		ΣW_T = 26,497		ΣM_R = 175,150

S.F. against overturning $= \frac{175,150}{51,141} = 3.42 > 1.5$

okay

DESCRIPTION

Arnold T. Okubo and Associates
CONSULTING STRUCTURAL ENGINEERS

PROJECT:

BY: AT Okubo | CHECKED:
JOB NO.: | SHEET: | OF:
DATE: 01/03/12

S.F. against sliding

$$SF = \frac{26,497\,(0.5)}{7429} = 1.78 > 1.5 \quad \text{okay}$$

Soil Pressure

$$a = \frac{\Sigma M_R - \Sigma M_O}{\Sigma W_T} = \frac{175,150 - 51,141}{26,497} = 4.68'$$

$L/3 = 12/3 = 4.0$

$a > L/3$: resultant inside middle third

$$e = \frac{12}{2} - 4.68 = 1.32$$

$$p = \frac{26,497}{12}\left(1 \pm \frac{6 \times 1.32}{12}\right)$$

$$= 2208\ (1 \pm 0.66)$$

$P_{max} = 3665$ psf < 4500 psf

$P_{min} = 751$ psf

okay

APPENDIX D: (GUARDRAIL REPORT)

KALEPA REPAIRS PROJECT

KIPAHULU, HANA, MAUI, HAWAII

AUSTIN TSUTSUMI AND ASSOCIATES, INC.

APRIL, 2017

Kalepa Repairs Project

Kipahulu, Hana, Maui, Hawaii

Contract No. C5999

FEMA No. PW-27, DR4194



County of Maui
Department of Public Works-Engineering Division
200 South High Street
Wailuku, Maui, Hi 96793

Austin, Tsutsumi and Associates, Inc.
1871 Wili Pa Loop, Suite A
Wailuku, Hawaii 96793

April 6, 2017

EXECUTIVE SUMMARY

Installation of guardrails requires careful consideration and design. Improperly sited or designed guardrails can increase the severity of potential accidents, which in turn can increase the liability of the owner or installer of the guardrail. Guardrails are installed in locations where there is specific criteria that justifies the installation. In traffic engineering, a warrant is a particular set of criteria that is used to determine whether an improvement, such as a traffic signal or guardrail, is justified. The proposed improvement can only be recommended by the engineer if all the criteria of the warrant are met.

Once it is established that a guardrail is warranted, design procedures, detailed in Chapter 5 of the Roadside Design Guide, need to be followed to ensure that the barrier installed is appropriate for the location. Special consideration has to be given to the design of the ends of the barriers (often referred to as the terminal ends) so that vehicles leaving the traveled way do not impact the end of the barrier head on.

Taking into account aesthetics and longevity of the preferred barrier systems (listed in decreased order of preference) are:

No Barrier

No barrier should be provided unless warranted and the barrier installation, including end treatments, has been properly designed. Prior to the design and installation of any barrier system, the area of concern should be reviewed to see if the hazard can be reduced or removed.

Wood Guardrail with Steel Plate Backing

Wood guardrail is less visibly intrusive than metal guardrails but is still susceptible to corrosion due to the steel backing required to meet the FHWA requirements.

Galvanized Steel Guardrail

Galvanized Steel is what is presently being used and has to be replaced every 5 years.

Stone Masonry Guardwall

Stone Masonry Guardwalls are presently being used at many locations along the Hana Highway. Although these guardwalls blend very well with the environment they are not approved by the FHWA. If a Stone Masonry Guardwall is desired in order to blend with the environment, a concrete guardwall faced with cut stone should be used. This is the most costly option.

Concrete Guardwall

A concrete Barrier Wall is the recommended solution to prevent vehicles from travelling off the road and into the ocean. The cost is high, however the longevity of the structure will greatly outlast any ferrous guardrail system.

INTRODUCTION

A new guard rail in Hana Highway is being evaluated for a proposed improvement project adjacent to the Lone Keawe State Park. Within the project area, sections have been identified for a new sea wall and the installation of barriers to protect motorists from going off the roadway. The types of guardrails considered and selected are discussed in this report.



Deterioration of Existing Steel Guardrails along Highway

A new guardrail is needed along this portion of the highway for safety reasons. There is a steep drop off occurring on the makai side of the highway. A guardrail will prevent a vehicle from meandering off of the pave ment section due to reasons such as speed, inability to negotiate the abrupt curve in the road or not paying attention to the road while sightseeing. The existing galvanized guardrail has deteriorated beyond repair due to corrosion and needs to be replaced. Areas where the guardrail has deteriorated have been replaced by painted boulders or concrete jersey barriers. Other areas of the roadway have been undermined due to waves during storm conditions.

Approximately 512 square yards of pavement is expected to be replaced and 384 linear feet of guardrail installed as part of this restoration project. See attached exhibit for extent of proposed project.

GUARDRAIL OPTIONS

The proposed project site is a section of Hana Highway, adjacent to a very steep drop off on the Makai side of the roadway and a vertical cut on the Mauka side. The travel pavement width varies from 9 ft. to 13 ft. which will allow only one car to pass at a time in either direction. There is no posted signage for speed limits or as signage warning approaching vehicles of the winding road conditions and single lane roadway.

Decisions to determine the requirement of guardrails and design were referenced from the American Association of State Highway and Transportation Officials (AASHTO), Roadside Design Guide. 4th Edition (2011).

Guardrails should be considered at locations with a history of accidents or high accident potential. The accident history, which can be an important factor whether or not to use guardrail, was not available for this study. The factors that were considered for high accident potential for this area are:

- Roadside Recovery Area – From the edge of travel lane to the top of slope, there inadequate lane width for recovery. Any vehicle traveling off the roadway will potentially fall off a cliff and into the surf below with fatal consequence.

- Width of roadway – The width of the existing road will only allow for one car to pass. In the event where two cars meet, one car will have to reverse out to allow the other to pass. During this maneuver there is a potential of misjudgment and veering off the roadway is a concern

Guardrail Alternatives

The alternatives considered for this project are the following types:

- Timber Guardrail
- Steel Galvanized Guardrail
- Stone Masonry Guardwall
- Concrete Guardwall

Timber Guardrail

The Timber Guardrail is a rustic alternative to the standard metal beam guardrail. The Timber Guardrail is in use along Federal highways on the East Coast and is approved for use on California highways. A steel plate provides the needed tensile strength with the wood members providing a rustic



Timber Guardrail with Steel Backing Plate

appearance. The steel-backed timber guardrail has been crash tested and meets the requirements of NCHRP Report 350. The blocked-out option, Type A, is approved for Test Level 3 (design speeds of 100 km/h and less). Type B, is approved for use for Test Level 2 (design speeds of 70 km/h and less). The difference between Type A and Type B is the use of a block between the post and rail. Due to the low speeds is this area, the preferred installation for this application would be Type B. This guardrail has no approved terminal design. The end treatment will need crash cushions, must be buried in the embankment, or will require some other approved terminal design.

The potential for corrosion of the steel elements of the guardrails are a concern in coastal settings or areas with high rainfall. To reduce corrosion, the steel posts can be replaced by concrete posts, but the steel plate behind the timbers will be problematic in a costal environment.

Advantages

- Standards and specifications are available
- Minimal visual impact
- Rural character
- Accommodates small animal crossing
- Preserves/protects median planting

Disadvantages

- Corrosion of steel components in coastal environments
- Occasional roadside maintenance tasks due to corrosion of steel backing and decay of the wood beam
- Wood safety devises may be subject to burning

Steel Galvanized Guardrail



Steel Galvanized Guardrail along Hana Highway

Steel galvanized guardrail can be classified as a flexible or semi-rigid system depending on the types of posts used. In a semi-rigid guardrail system, strong posts are used and resistance is achieved through the combined flexure and tensile strength of the rail. The posts, by the point of impact, are designed to break or tear away, which in turn distributes the impact force by beam action to adjacent posts. The posts outside of the impact zone provide sufficient resistance to control the deflection of the beam to an acceptable limit and redirect the errant vehicle along the path of traffic flow. Flexible systems use weaker posts and are generally more forgiving than semi-rigid systems since much of the energy is absorbed by the deflection of the barrier and lower impact forces are imposed upon the vehicle. Steel galvanized guardrail systems may retain some degree of effectiveness after minor hits due to the rigidity of the rail element. Guardrail systems may or may not have a block installed between the post and the rail. When guardrail has a block installed between the post and the guardrail, it is called a “blocked-out” guardrail. The blockout minimizes vehicles snagging and reduces the likelihood of a vehicle vaulting over the barrier by maintaining rail height during the initial stages of post deflection. Blockouts are typically of the same material as the posts but can also be made from recycled plastics.

Steel beams often come in W-Beam or Thrie-Beam shapes. W-Beam steel guardrail with strong posts is the most frequently used type of guardrail on the nation's interstate roadway system. It is a roll-formed product that is shaped out of steel coil into the shape of a "W." The galvanized steel prevents corrosion and increases the product's life cycle. Strong post W-Beam guardrail can be installed on steel W6x8 or W6x8.5 posts or 6x8 timber posts, using a variety of different post spacing options, depending on the specific site situation (typically 6'-3" spacing). W-Beam guardrail can be ordered with the traditional galvanized (gray) coating, corten style (see description below), or poly-coated in a variety of colors to match specific aesthetic criteria. W-Beam guardrail comes in standard 12'-6" or 25' sections. Steel guardrail is recommended for use on high-speed roadways (greater than 35 miles per hour), although it can also be installed on low-speed roadways. The main difference between a W-Beam rail and a Thrie-Beam rail is that the Thrie-Beam rail has added depth of rail that can accommodate a greater range of vehicle sizes and can negate some of the problems associated with minor terrain irregularities. The additional corrugation in the rail element stiffens the system, making it less prone to damage during vehicle impacts. It also allows higher mounting of the rail, which increases its ability to contain vehicles somewhat larger than standard passenger vehicles. The deeper beam will minimize the possibility of underride or vaulting by impacted vehicles. It is relatively inexpensive to install when compared to other barriers. Typically, fewer drainage modifications are required than for placement of concrete barriers. Use of this barrier type may allow for preservation of existing median planting and can minimize visual impacts. Design modifications to the steel galvanized barrier, such as placing asphalt or concrete beneath the barrier to eliminate weed growth, will improve the visual appearance of the barrier, it will also eliminate the need for repetitive manual vegetation control by maintenance forces.

This type of steel galvanized guardrails is being used at this location. The galvanized rails are very susceptible to corrosion and the longevity is about 5 years before being replaced. The galvanized steel post last longer than the rails but these also require removal and replacement as the corrosion weakens its integrity.



Wood Post with Galvanized Steel Guardrails

As an option, 6x8 timber and the W6x8 or W6x8.5 may be used interchangeably. NCHRP Report 350 testing has shown that these posts may be substituted when not in a barrier terminal. Concerns of tropical pests such as termites and insects, as well as the rain, and ocean wave sprays may hinder the life expectancy of these types of posts.

Advantages

- Approved by the FHWA for use
- Standard plans and specifications available
- Minimal visual impact
- Rural character
- Accommodates small animal crossing

Disadvantages

- Due to a corrosive environment, replacement is estimated at every 5 years
- Additional roadside maintenance tasks

Stone Masonry Guardwall

The Stone Masonry Guardwall is being used in several locations along Hana Highway. These type of guardwalls consist of mortared local rock, laid on a concrete bed. A void is created between the faces of the wall where rebars are added for strength then a grout slurry is poured within the void to create a single wall. The look of this type of guardwall is very attractive and blends well with the local surroundings; however this has not been tested or approved by the FHWA. The end treatment will need crash cushions, must be buried in the embankment or will require some other approved terminal design.



Stone Masonry Guardrail along Hana Highway

Another option to retain this natural stone look consists of a concrete core faced and capped with natural stone. This type of Stone Masonry Guardwall has been crash tested and meets the requirements of NCHRP Report 230 and is accepted by the FHWA for use on the federal highway system. The FHWA has accepted it to meet the requirements of NRCHP Report 350 criteria, test level 3. This barrier system is approved for design speeds of 100 km/h or less. Specifications define maximum projections to be 38 mm beyond the neat line, 50 mm deep joints, and mortar beds 50 to 75 mm thick. Stone faces with critical dimensions greater than those listed above are not considered crashworthy.

Advantages

- Standards and specifications are available
- Minimal visual impact
- Rural character
- Long life and durability

Disadvantages

- Requires drainage modifications
- Very high installation costs
- Increased construction time
- Additional roadside maintenance tasks required in the event a vehicle hits the wall and the rock fascia is damaged

Concrete Guardwall

The Concrete Guardwall has been used increasingly as median widths have become narrower. This coincides with safety concerns becoming more prevalent for maintenance workers and motorists. The concrete barrier offers several positive attributes, including long life and durability, low maintenance costs, less exposure for maintenance workers, a clean urban character, and aesthetic surface treatment capabilities.

Aesthetic surface treatments include, chemical staining, painting, acid etching, textures, and spraying with bituminous emulsion for a faux “granite” finish to improve the appearance of concrete barriers. Other aesthetic treatments, such as sandblasting painted concrete to reveal graphic images, have been used to enhance the barrier appearance and respond to local concerns for context sensitive solutions.

Concrete barriers have higher installation costs than steel galvanized guardrails and, in some cases, require extensive drainage modification. Some communities consider

these barriers to have a negative visual impact because the mass and form are not compatible with the surrounding landscape.

Concrete Guardwalls are designed to mitigate the energy of crash impacts. These barriers begin with a 3-inch vertical face at the pavement level, then break to a sloped face, changing to a nearly vertical face at the top of the barrier. The overall height is at least 32 inches above the pavement. When a vehicle impacts a safety shape barrier, a significant portion of its energy is absorbed in the climbing or lifting action that occurs when the tires roll up the lower sloping face.

In low-speed impacts, the vehicle may redirect with no sheet metal contact with the face of the concrete wall. In medium speed impacts there is likely to be damage to the vehicle, but the force experienced by the occupants will be minimized. In high speed impacts there will be significant vehicle damage and minor to moderate injury potential to the occupants.

The four shapes considered for this project using concrete guardwalls are the following:

Jersey Barriers

Jersey barriers are the original and most widely used safety shape concrete barriers. The only difference between Jersey barriers and F-shape barriers is that the distance from the ground to the slope break point is 13 inches in Jersey barriers, versus 10 inches for F-shape barriers. In high speed impacts, there is a greater likelihood that a small car will be rolled by a Jersey barrier than by an F-shape barrier.

F-Shape Barriers

The F-shape barrier was specifically engineered to limit the potential for small cars to rollover upon impact. The F-shape barrier begins with a 3-inch vertical face at the pavement level, then breaks to a sloped face that rises to a height of 10 inches, before changing to a nearly vertical face at the top of the barrier. F-shape barriers are not

shaped like the letter “F.” They get their name from the research study that analyzed the performance of barrier design parameters, where barrier configurations were labeled A through F, and F was the best-performing design.

9.1 Degree Single-Slope Barriers

The 9.1 degree single-slope barrier, developed in California, has a constant-slope face that makes an angle of 9.1 degrees with respect to the vertical. It performs comparably with the F-shape barrier, with little potential for rollover. However, the single slope barrier will absorb none of the crash energy by lifting the vehicle, so there is always sheet metal damage, and the occupants feel the full force of hitting a concrete wall.

Constant-Slope Barrier

The constant-slope barrier has a constant-slope face that makes an angle of 10.8 degrees with respect to the vertical. It performs comparably with the Jersey barrier.

Advantages

- Standard Plans and Specifications available
- Aesthetic treatment for context sensitive designs
- Long life and durability
- Low maintenance cost
- Barriers can receive aesthetic treatments

Disadvantages

- May require drainage modifications
- High installation costs
- Increased construction time



Constant Slope Concrete Guardrail at the Maui International Airport

Considering the low speeds and corrosive environment occurring in this area a concrete guardwall with a Constant-Slope barrier was selected. The benefit of the constant-slope and single slope guardwall is that multiple roadway overlays can be applied without affecting the geometry, or performance, as long as the total height remains adequate. "Safety shapes" allow for no more than 3 inches of overlay unless constructed taller than 32 inches to accommodate the additional pavement.



Spalling of Rebars in Coastal Environments

Using reinforced concrete in coastal environments, if proper design, material selection and construction methods are not adhered to, spalling will occur. Coastal environments are salt laden which promotes the intrusion of chlorides into the concrete. Salt and other factors will cause the steel rebar to rust. This rusting process will expands the volume around the rebar causing the concrete to delaminate or spall. Since this project is constantly being exposed to salt and wave

action, to achieve a longer life of the concrete guardwall, epoxy coated rebar will be used. A water/cement ratio of 0.40 will be specified to achieve a higher strength concrete, adding durability to the concrete. Also code declares a 1" coverage over the rebar, 2" will be specified for added durability. Another option is the use of stainless steel rebars. Stainless steel rebar offers a good combination of high strength, toughness, ductility, fatigue resistance and corrosion resistance. The design life of a stainless steel reinforced project can be estimated up to 125 years. However, the rebar material cost of using stainless steel rebars will be approximately 3 times more than using epoxy coated steel bars.

To handle drainage during rain, the slope of the road will be towards the ocean. Reliefs at the base of the concrete guardrails will be provided to allow rainwater to flow off the pavement and through the concrete guardrails.

End treatments for a concrete guardrail have no approved terminal designs. Either crash cushions can be supplied at each end or other options will need to be developed. during design stage. During design, a dialogue between the Department of Public Works Engineering Division and the Consultant must be established to come up with a solution. Due to the low speeds (less than 20 mph) approaching this blind curve, the ends of the concrete guardrail can be angled towards the ocean where in the event a car does come in contact with the guardrail the vehicle will be guided back into the lane.

Appendix
Exhibits

TRUE NORTH
SCALE: 1"=20'

To Kaupo

APPROXIMATE LOCATION
OF PAVEMENT RESTORATION
STA=1+06±
TOTAL AREA=±512 SY

APPROXIMATE LOCATION
OF NEW GUARDWALL
STA 1+06±
TOTAL LENGTH=±384'

MATCHLINE STA. 3+00
FOR CONT. SEE SHEET EXHIBIT 2

0+00
sign
"slow horn"
up
gw
top bank
bottom bank
overhead utility lines
0+50
edge of pavement
top rock wall
bottom rock wall
1+00
guard rail
bottom bank @ top rock outcrop
rock outcrop
rocky shore
2+00
hole
2+50
guard rail
top crm wall
bottom crm wall
3+00
UP
crm wall
top
bottom
form
DW
rocky shore

KALEPA GUARDRAIL STUDY

KIPAHULU, HANA, MAUI, HAWAII

AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS,SURVEYORS ● HONOLULU, WAILUKU, HILO, HAWAII

GENERAL SITE PLAN 1

EXHIBIT 1

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OCT. 2016

TRUE NORTH
SCALE: 1" =20'

MATCHLINE STA. 3+00

END OF PAVEMENT
RESTORATION (APPROXIMATE)
STA=4+90±
TOTAL AREA=±512 SY

END OF GUARDWALL
(APPROXIMATE)
STA 4+90±
TOTAL LENGTH=±384'

To Hana

bottom bank
edge of pavement
overhead utility lines
3+50
4+00
4+50
5+00
5+50
top bank
bottom bank
top rocks
bottom rocks
guard rail
hole
gw
up
ref
boulder
top crm wall
bottom crm wall
rocky shore

KALEPA GUARDRAIL STUDY

KIPAHULU, HANA, MAUI, HAWAII

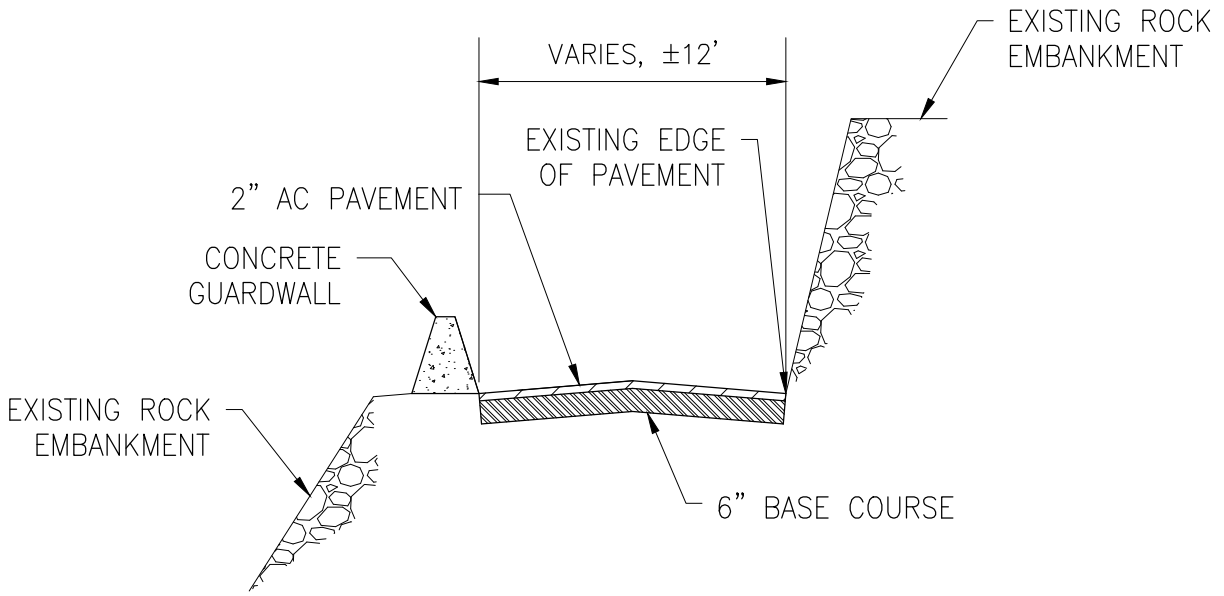
AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS,SURVEYORS ● HONOLULU, WAILUKU, HILO, HAWAII

GENERAL SITE PLAN 2

EXHIBIT 2

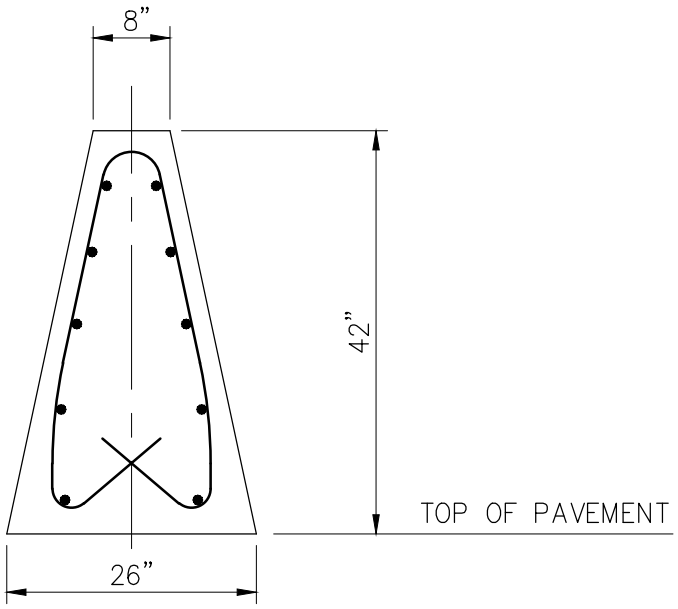
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OCT. 2016



TYPICAL SITE SECTION

NOT TO SCALE



CONSTANT SLOPE GUARDWALL

NOT TO SCALE

KALEPA GUARDRAIL STUDY

KIPAHULU, HANA, MAUI, HAWAII

AUSTIN, TSUTSUMI & ASSOCIATES, INC.

ENGINEERS, SURVEYORS • HONOLULU, WAILUKU, HILO, HAWAII

TYPICAL SITE SECTION

EXHIBIT

3

JOB NO. M-13-553.1

OCTOBER 2016

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APPENDIX E: BRIDGE ASSESSMENT

KALEPA REPAIRS PROJECT BRIDGE ASSESSMENT

HANA, MAUI

January, 2017



Prepared for:
County of Maui, Department Publice Works, Engineering Division
200 South High Street
Wailuku, HI 96793

Prepared by:
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Makai Research Pier
Waimanalo, HI 96795

SEI Job No. 25517

TABLE OF CONTENTS

INTRODUCTION **1**
PO'O PO'O #10 BRIDGE **3**
WAIOPAI #11 BRIDGE **6**
KOUKOUAI #16 BRIDGE **9**
HAHALAWE #19 BRIDGE **12**
MAHALAWA #20 BRIDGE **14**
PAEHALA # 21 BRIDGE **16**
PUUHAOA #22 BRIDGE **17**
SOUTH WAILUA #23 BRIDGE **20**
WAILUA #24 BRIDGE **22**
PAIHI #25 BRIDGE **25**
WAIKAKOI #26 BRIDGE **28**
ALAALAULA #27 BRIDGE **31**
PAPAHAWAHAWA #28 BRIDGE **34**
WAIOHONU #29 BRIDGE **36**
KAHAWAIOKAPIA #30 BRIDGE **39**
ALELELE #13 BRIDGE **44**
KAAPAHU #14 BRIDGE **47**
STRUCTURAL INVENTORY AND APPRAISAL **49**
KAHOLOPO #31 BRIDGE **50**
KALEPA #12 BRIDGE **52**
KUKUIULA #15 BRIDGE **55**
MANAWAINUI #9 BRIDGE **57**
MANAWAINUI #80 BRIDGE **61**

INTRODUCTION

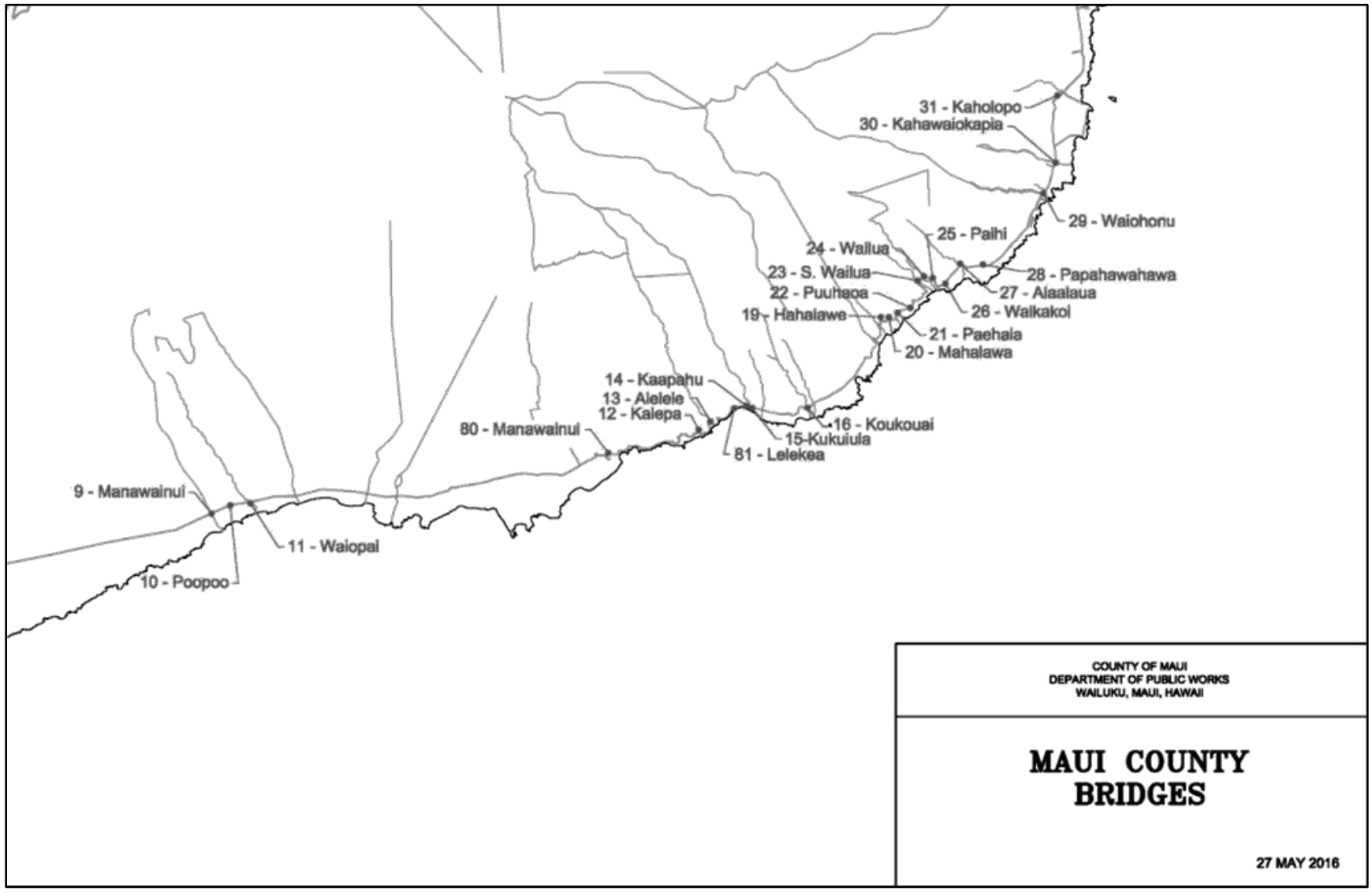
This report presents descriptions and load rating for 23 bridges on Maui, Hawaii, between the towns of Kula and Hana. The bridges provide access to Kalepa Point at approximately Milepost 38.2 of the Piilani Highway. The information is being provided in order to facilitate future construction of shore protection for the Piilani Highway at Kalepa Point. Construction will require the transport of large armor stone boulders on the order of 3 to 5 tons in weight, as well as other rock and construction materials to the remote site. Load limitations will likely be an important constraint for construction contract bids.

The information contained in this report, including text, tables, photographs and drawings, has been taken from the 2014/2015 routine inspection reports produced by Nagamine Okawa Engineers, Inc. (NOE), on behalf of the County of Maui, Department of Public Works, Engineering Division. The information has been edited for conciseness and compiled as a resource document for the Kalepa Repairs Project.

The following discussion on load ratings was taken from the bridge reports:

> *Bridge load ratings provide a basis for determining the allowable live load capacity of a bridge. Load ratings are calculated based on the Load and Resistance Factor Rating (LRFR). As specified by Hawaii Department of Transportation (HIDOT) Highways Division Load Rating guidelines, the acceptable load rating software to be used for derivation of rating factors is BRASS, Bridge Rating and Analysis of Structural Systems. Please note that BRASS analysis is limited to typical bridge types, in some conditions hand calculations and other analysis procedures must be used to obtain an accurate load rating.*
>
> *Bridges are load rated for AASHTO HL-93 Inventory and Operating loads. The inventory ratings represent the design live load for the bridge over an indefinite period of time, while the operating rating represents the maximum design live load for the bridge. The bridge was also analyzed for legal and permit loads in accordance with HIDOT Load Rating Guidelines.*

The following map shows the bridge locations and the project area on northeast Maui.


31 - Kaholopo
30 - Kahawaiokapia
29 - Waiohonu
25 - Paihi
24 - Wailua
23 - S. Wailua
28 - Papahawahawa
22 - Puuhaoa
27 - Alaalaua
19 - Hahalawe
26 - Waikakoi
21 - Paehala
20 - Mahalawa
14 - Kaapahu
13 - Alelele
12 - Kalepa
80 - Manawainui
16 - Koukouai
15-Kukuiula
81 - Lelekea
9 - Manawainui
11 - Waiopai
10 - Poopoo
COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
WAILUKU, MAUI, HAWAII
MAUI COUNTY
BRIDGES
27 MAY 2016

PO'O PO'O #10 BRIDGE



DESCRIPTION

The Po'o Po'o #10 bridge is a single span bridge constructed in 1997. The bridge is 36'-4" wide and 68'-0" long. A cast- in-place concrete deck is supported on eight precast prestressed concrete girders spanning between concrete stub abutments at the Hana and Kaupo ends of the bridge. Concrete wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the deck and therefore the wearing surface is the top surface of the concrete deck. The bridge deck abuts concrete approach slabs at both ends of the bridge.

The concrete stub abutments are built well above the streambed elevation. The embankments are retained by CRM walls and bedrock that form the sides of the channel under the bridge.

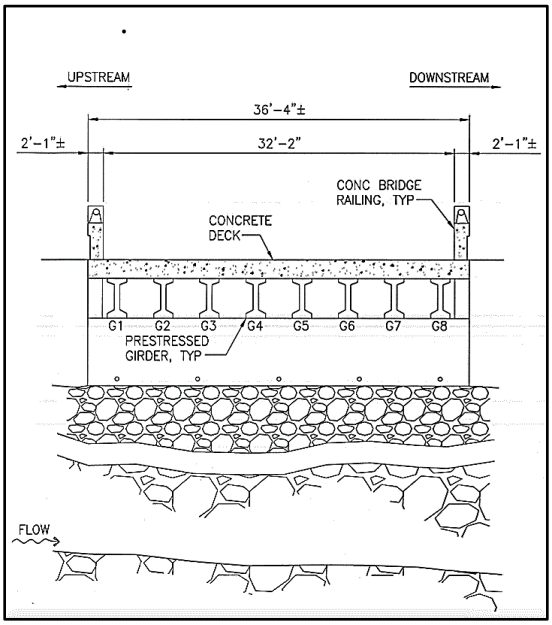
There are no utilities crossing the stream with the bridge.

The structure data of the existing bridge is as follows:

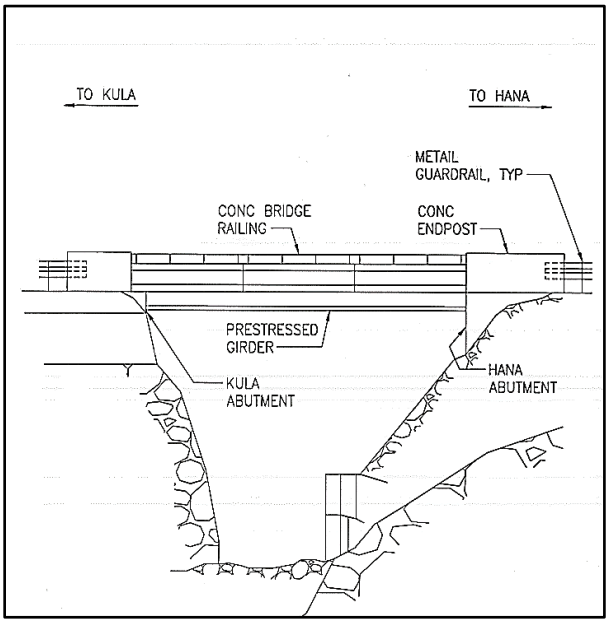
• Number of Spans:	1
• Total Length of Bridge:	68'-0"
• Roadway Width Curb to Curb:	32'-2"
• Total Bridge Width (Out-to-Out):	36'-4"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	None
• Bridge Rails:	Combination Concrete New Jersey Barrier with Single AL Tube Rail
• Height of Bridge Rail:	3'-8" Conc. New Jersey Barrier + 12" AL Tube Rail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit To Stream Water Level:	25'
• Water Depth Under Bridge:	0' (Dry Stream)
• Posted Load Limit	None

A combination concrete New Jersey barrier and single aluminum tubular rail with a total height of about 4'-8" is constructed along the upstream and downstream sides of the bridge. Metal approach guardrails are located at the approaches to the bridge and transitions to concrete end walls terminating at the bridge railing.

There are no utilities crossing the stream with the bridge.



Cross-section at Hana abutment



Downstream elevation

LOAD RATING

The load rating is based on record drawings dated FY1996 for Po'o Po'o Bridge Replacement FED Aid Project No. BR-0900(40).

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on November 2, 2015.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	1.26
		HL-93 Tandem + HL-93 Lane	1.41
	Operating Level	HL-93 Truck + HL-93 Lane	1.93
		HL-93 Tandem + HL-93 Lane	2.30
Legal Load	Type 3		4.15
	Type 3S2		4.07
	Type 3-3		3.96
	NRL		2.80
	SU4		3.66
	SU5		3.45
	SU6		3.19
	SU7		2.93
Permit Load	HP1		1.41
	HP2		1.51
	HP3		1.82

Bridge posting is not required for Po'o Po'o Bridge since the load rating factor for the legal loads is greater than 1.0.

Load Type			PS Exterior Girder (#1)				
			Strength Limit State		Service Limit State		Posting Load (Tons)
			Rating Factor	Load Rating (Tons)	Rating Factor	Load Rating (Tons)	
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	1.79		1.34		-
		HL-93 Tandem + HL-93 Lane	2.10		1.49		-
	Operating Level	HL-93 Truck + HL-93 Lane	2.32				-
		HL-93 Tandem + HL-93 Lane	2.72				-
Legal Load	Type 3		4.74	118.58			-
	Type 3S2		4.58	164.84			-
	Type 3-3		4.81	192.24			-
	NRL		3.01	120.22			-
	SU4		4.19	113.10			-
	SU5		3.81	118.15			-
	SU6		3.42	118.92			-
	SU7		3.14	121.68			-
Permit Load	HP1		2.51	150.53	1.41	84.82	-
	HP2		2.18	171.06	1.51	118.76	-
	HP3		3.30	346.77	1.82	190.50	-

Load Type			PS Interior Girder (#2)				
			Strength Limit State		Service Limit State		Posting Load (Tons)
			Rating Factor	Load Rating (Tons)	Rating Factor	Load Rating (Tons)	
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	1.50		1.26		-
		HL-93 Tandem + HL-93 Lane	1.78		1.41		-
	Operating Level	HL-93 Truck + HL-93 Lane	1.93				-
		HL-93 Tandem + HL-93 Lane	2.30				-
Legal Load	Type 3		4.15	103.65			-
	Type 3S2		4.07	146.62			-
	Type 3-3		3.96	158.60			-
	NRL		2.80	112.10			-
	SU4		3.66	98.79			-
	SU5		3.45	106.91			-
	SU6		3.19	110.89			-
	SU7		2.93	113.46			-
Permit Load	HP1		2.34	140.37	1.42	84.95	-
	HP2		1.74	136.75	1.54	120.61	-
	HP3		3.04	319.43	1.84	193.48	-

WAIOPAI #11 BRIDGE



DESCRIPTION

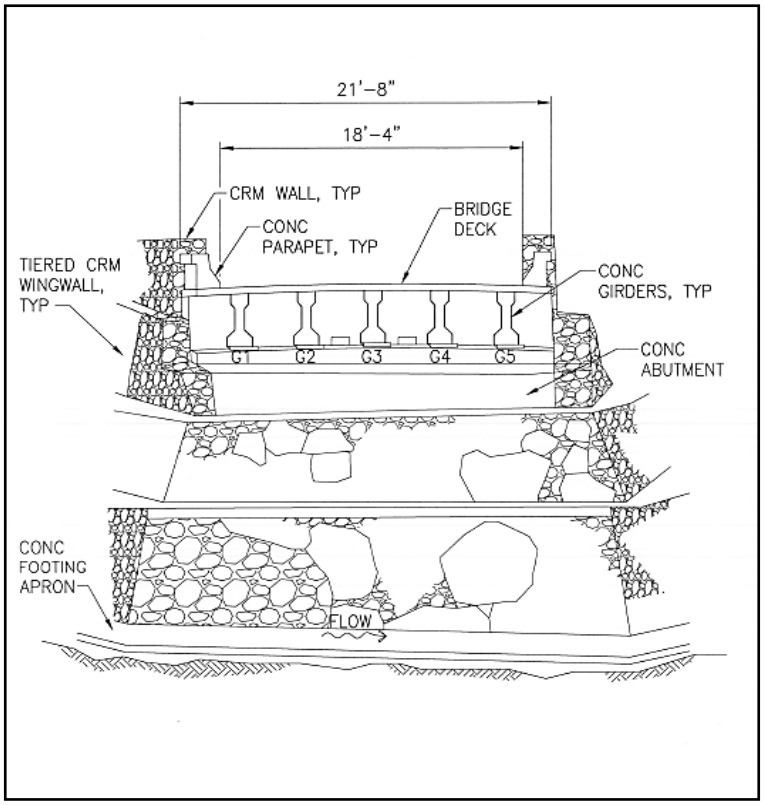
The Waiopai #11 bridge is a single span bridge constructed in 1982. The bridge is 21'-8" wide and 66'-4" long. A cast in-place concrete deck is supported on five precast prestressed concrete girders spanning between concrete stub abutments at the Hana and Kaupo ends of the bridge. CRM wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the deck and therefore the wearing surface is the top surface of the concrete deck. The bridge deck abuts concrete approach slabs at both ends of the bridge.

The concrete stub abutments are built well above the streambed elevation. The embankments are retained by thick tiered CRM walls that form the sides of the channel under the bridge. The base of the CRM walls is protected by a concrete apron slab.

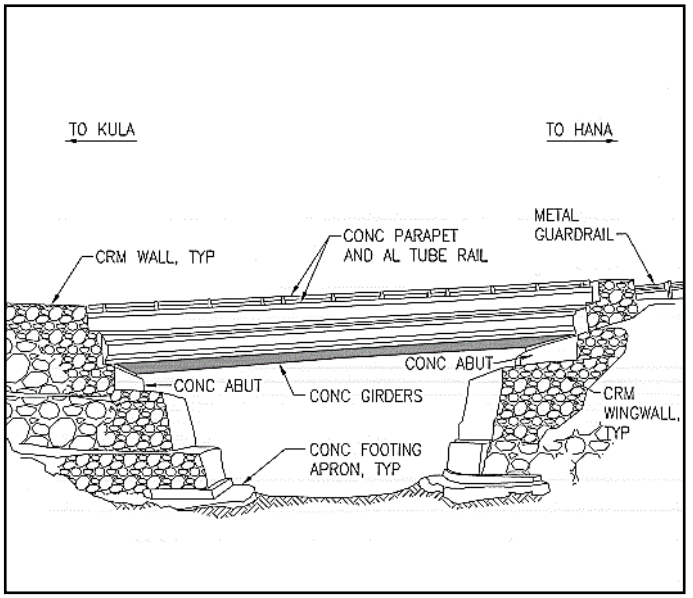
The structure data of the existing bridge is as follows:

• Number of Spans:	1
• Total Length of Bridge:	66'-4"
• Roadway Width Curb to Curb:	18'-4"
• Total Bridge Width (Out-to-Out):	21'-8"
• Skew:	10 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	Top Surface of Concrete Deck
• Bridge Rails:	Combination Concrete New Jersey Barrier with Single AL Tube Rail
• Height of Bridge Rail:	2'-4" Conc. New Jersey Barrier + 12" AL Tube Rail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit to Stream Water Level:	25'
• Water Depth Under Bridge:	0' (Dry Stream)
• Posted Load Limit	No Posted Sign at Bridge

A combination concrete New Jersey barrier and single aluminum tubular rail with a total height of about 3'-4" is constructed along the upstream and downstream sides of the bridge. Metal approach guardrails are located at the approaches to the bridge and transitions to CRM walls terminating at the bridge railing.



Cross-section at abutment



Downstream elevation

LOAD RATING

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on October 16, 2014.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.64
		HL-93 Tandem + HL-93 Lane	0.72
	Operating Level	HL-93 Truck + HL-93 Lane	1.42
		HL-93 Tandem + HL-93 Lane	1.57
Legal Load	Type 3		1.42
	Type 3S2		1.38
	Type 3-3		1.47
	NRL		0.90
	SU4		1.25
	SU5		1.14
	SU6		1.02
	SU7		0.94
Permit Load	HP1		1.20
	HP2		1.38
	HP3		1.56

Bridge posting is required for Waiopai Bridge since the load rating factor for the legal loads is less than 1.0. Recommend posting load for this bridge is 34 Tons. The bridge is currently not posted.

There are no utilities crossing the stream with the bridge.

KOUKOUAI #16 BRIDGE



DESCRIPTION

The Koukouai #16 bridge is a reinforced concrete open spandrel arch bridge constructed in 1911. The bridge is 16'-6" feet wide and 54'-6" long. The floor system consists of a CIP concrete deck overlaid with asphalt concrete (A.C.) pavement. The concrete deck spans in the longitudinal direction and is supported by eight 3-column concrete bents equally spaced between the CRM abutments at the Hana and Kaupo ends of the bridge.

The bridge consists of 4 spans as follows:
Span 1 – Span from the Hana abutment to the 1st spandrel arch bent
Span 2 – Open spandrel arch consisting of the 7 spandrel bents
Span 3 – Span from the 7th spandrel arch bent to the Kaupo 3-column bent
Span 4 – Span from the Kaupo 3-column bent to the Kaupo abutment.

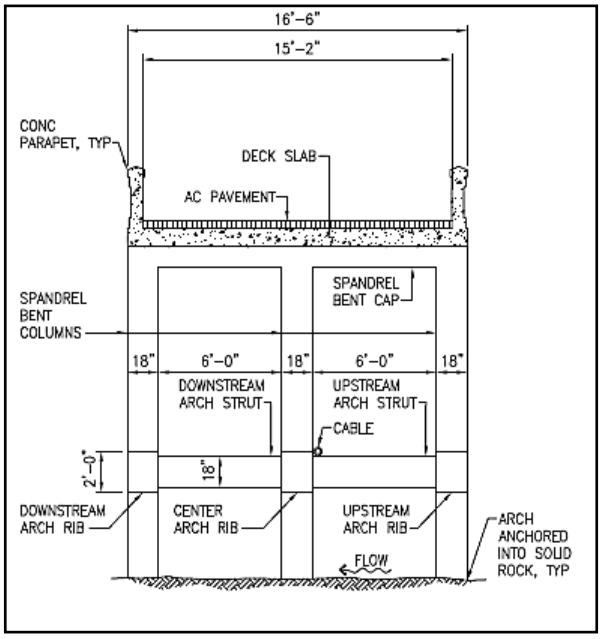
The ends of the arches are embedded in the bed rock which forms the sides of the stream below both CRM abutments. Six concrete arch struts, three located between the upstream and center arch ribs and three located between the center and downstream arch ribs, provides sway bracing for the arches.

The structure data of the existing bridge is as follows:

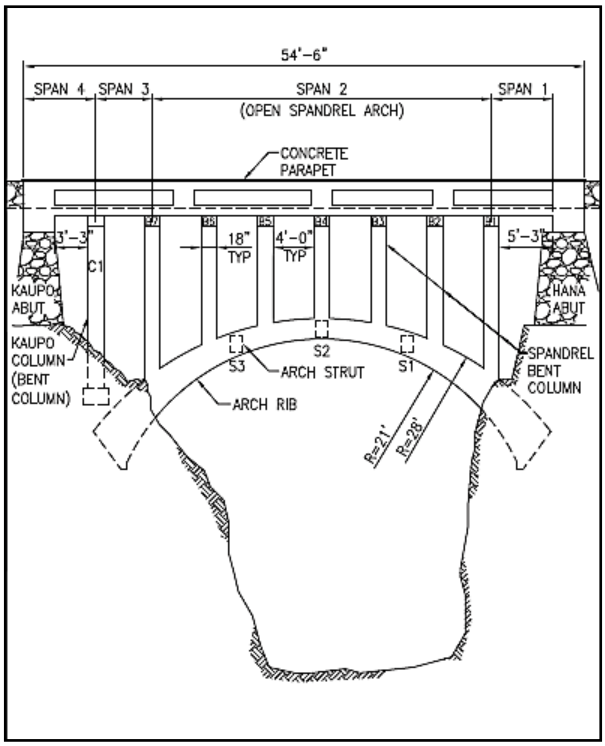
• Number of Spans:	4
• Total Length of Bridge:	54'-6"
• Roadway Width Curb-to Curb:	15'-2"
• Total Bridge Width (Out-to-Out):	16'-6"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	Varies 7" to 21"
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Arch Rib to Water Level:	23'-0"
• Water Depth Under Bridge:	0"
• Posted Load Limit:	8 tons

A concrete bridge parapet with a maximum height of about 21" runs along the upstream and downstream sides of the bridge. There are no approach guardrails except for rock walls leading up to the concrete bridge parapets.

There are no utilities crossing the stream with the bridge except for a loose cable laid along the center arch rib.



Cross-section



Downstream elevation

LOAD RATING

For Koukouai Bridge the controlling structural member is the deck slab. Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on December 4, 2013.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.14
		HL-93 Tandem + HL-93 Lane	0.16
	Operating Level	HL-93 Truck + HL-93 Lane	0.18
		HL-93 Tandem + HL-93 Lane	0.23
Legal Load	Type 3		0.33
	Type 3S2		0.36
	Type 3-3		0.35
	NRL		0.33
	SU4		0.33
	SU5		0.33
	SU6		0.33
	SU7		0.33
Permit Load	HP1		0.26
	HP2		0.13
	HP3		0.31

Bridge posting is required for Koukouai Bridge since the load rating factor for the legal loads is less than 1.0. Recommend posting load for this bridge is 5 Tons.

Using the LRFR Posting Load equation per HIDOT LRFR Guidelines, the actual calculated posting load based on a 0.33 Rating Factor for the Type 3 Legal Load is 1.0 Ton (See "Summary of Load and Resistance Factor Ratings (LRFR)" in Bridge Load Rating Section). However, actual Load Rating for the Type 3 legal load including all live load factors and impact factors is 8 Tons. Therefore, using engineering judgment, it is recommended that bridge be posted for 5 Tons. Concrete deterioration shall be repaired immediately. Due to the condition of the bridge and variation from LRFR Posting Load equation, it is recommended that this Load Rating and recommended posting load be re-evaluated in (1) one year. The bridge is currently posted at 8 tons.

HAHALAWE #19 BRIDGE



DESCRIPTION

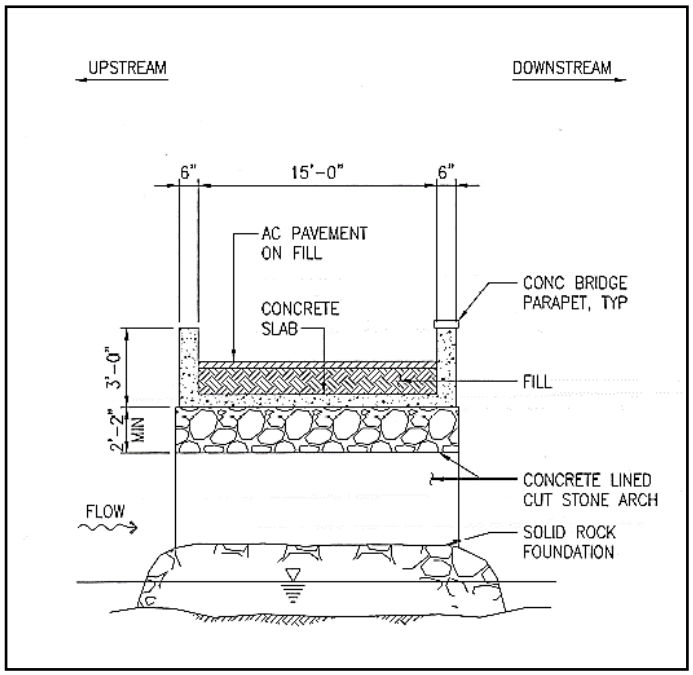
The Hahalawe #19 bridge is a masonry arch bridge constructed in 1910. The roadway curb to curb width is 14'-10" wide and the arch spans 20'. The arch ring is constructed of stone masonry with concrete lining the arch soffit. The arch supports a concrete slab constructed monolithically with the parapet walls. The AC pavement is placed over the concrete slab and retained by the parapets walls. The ends of the arch bear on the natural rock banks.

The structure data of the existing bridge is as follows:

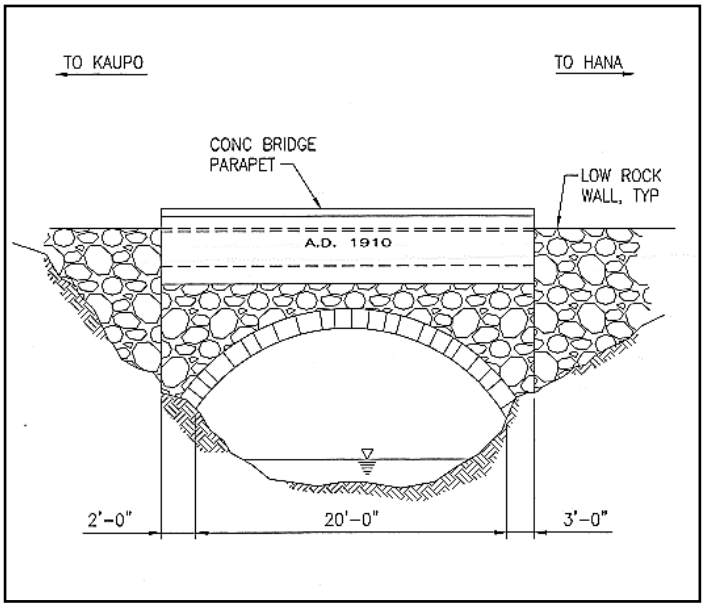
• Number of Spans:	1
• Roadway Width (Clear):	14'-10"
• Total Width (Out-to-Out or Length of Barrel):	16'-2"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface Over Bridge:	A.C.
• Bridge Parapet:	Concrete
• Height of Bridge Parapet:	1'-4" (D/S) & 1'-6" (U/S)
• Roadway Fill Over Arch Bridge:	Concrete Slab & AC overlay
• Type of Channel Under Bridge:	Unlined Natural Rock Channel
• Approx. Max Clearance From Arch Soffit To Stream Bed:	9'-2"
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	1'-0"
• Posted Load Limit	4 tons

The heights of the concrete parapets are 1 '-6" on the upstream and 1 '-4" on the downstream sides of the arch bridge measured from the A. C. pavement. There are no approach guardrails to the bridge.

There are no utilities crossing the stream with the bridge.

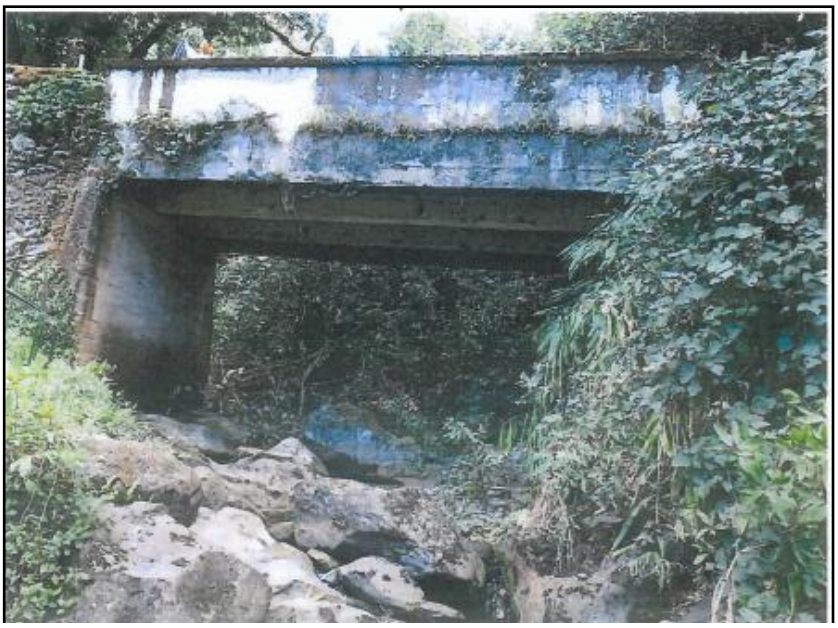


Cross-section



Elevation

MAHALAWA #20 BRIDGE



DESCRIPTION

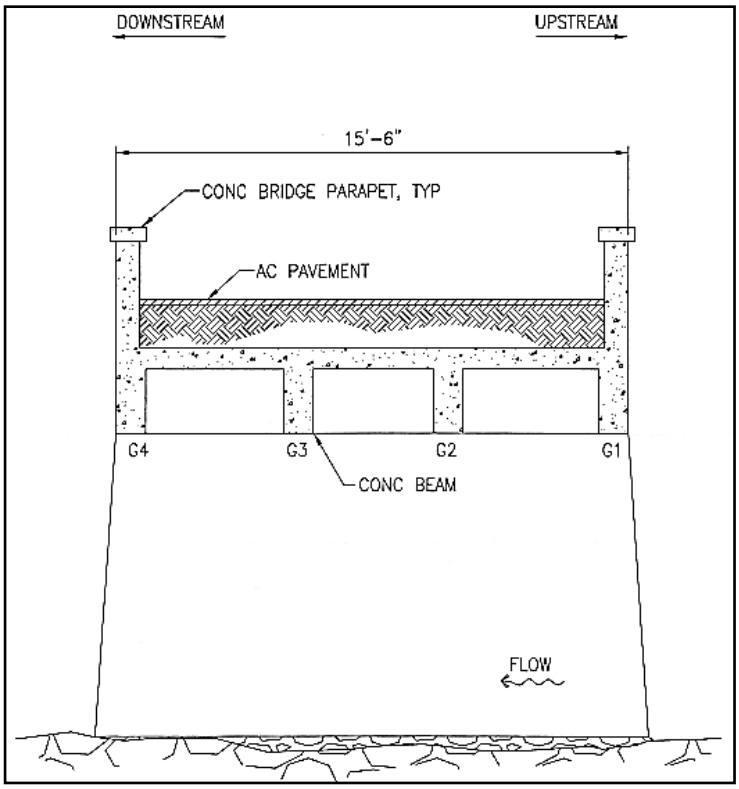
The Mahalawa #20 bridge is a single span reinforced concrete tee beam bridge constructed in 1910. The bridge is 15'-6" wide (out to out) and 30'-6" long. The concrete deck is overlaid with an A. C. pavement. The substructure consists of concrete abutments bearing on natural rock formation which also form the sides of the stream channel. CRM wingwalls extend back from both ends of the abutments.

The structure data of the existing bridge is as follows:

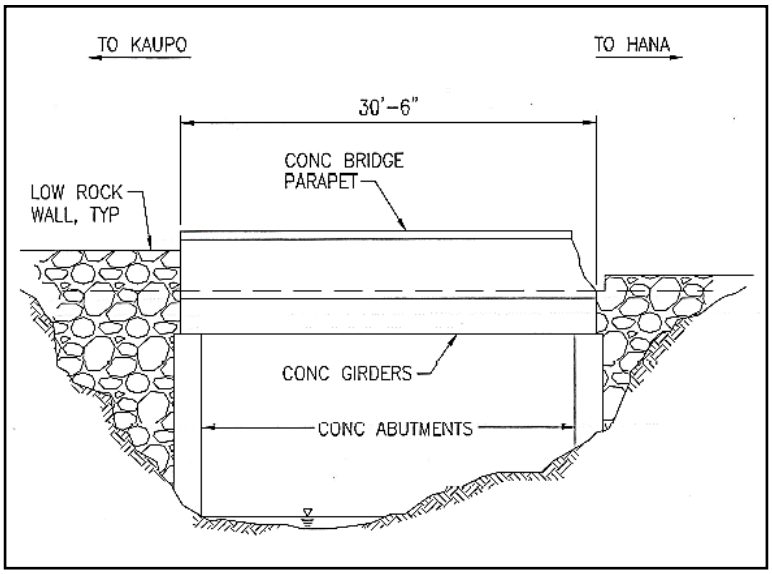
• Number of Spans:	1
• Total Length of Bridge:	30'-6"
• Roadway Width Curb-to Curb:	14'-2"
• Total Bridge Width (Out-to-Out):	15'-6"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	1'-9" (US) & 1'-6" (DS)
• Roadway Fill Over Bridge:	No
• Type of Channel Under Bridge:	Unlined Stream w/ Nautral Rock Channel
• Approx. Clearance From Slab Soffit to Water Level:	12'
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	1'-0"
• Posted Load Limit:	12 Tons

The bridge has concrete parapets on both sides with a height of 1 '-6"downstream and 1 '-9" upstream. There are no approach guardrails to the bridge.

No utilities cross the stream with the bridge.



Typical cross-section



PAEHALA # 21 BRIDGE



DESCRIPTION

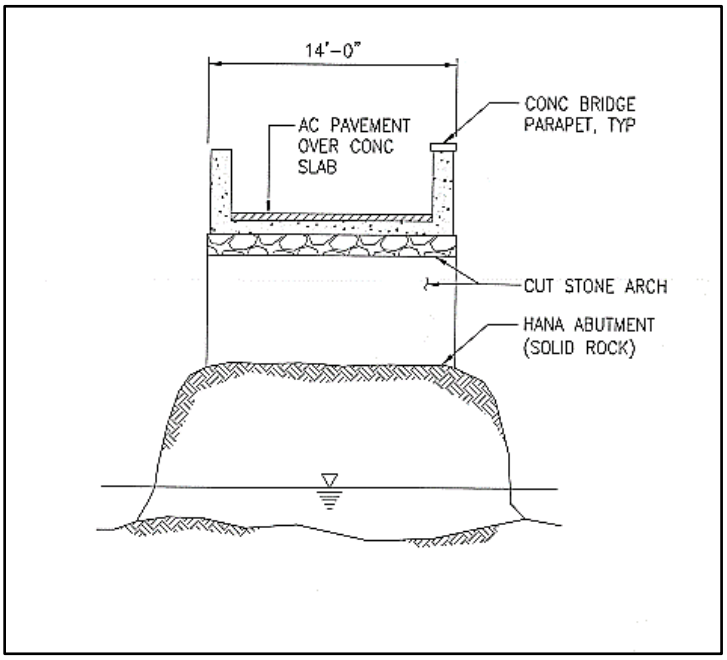
The Paehala #21 bridge is a masonry arch bridge constructed in 1910. The roadway curb to curb width is 12'-6" and the arch spans 19'-0". The arch ring is constructed of stone masonry with concrete lining the arch soffit. The arch supports a concrete slab with integral parapets and A. C. pavement. The base of the arch bears on the natural rock formation. CRM wingwalls are heavily covered with moss and vegetation.

The structure data of the existing bridge is as follows:

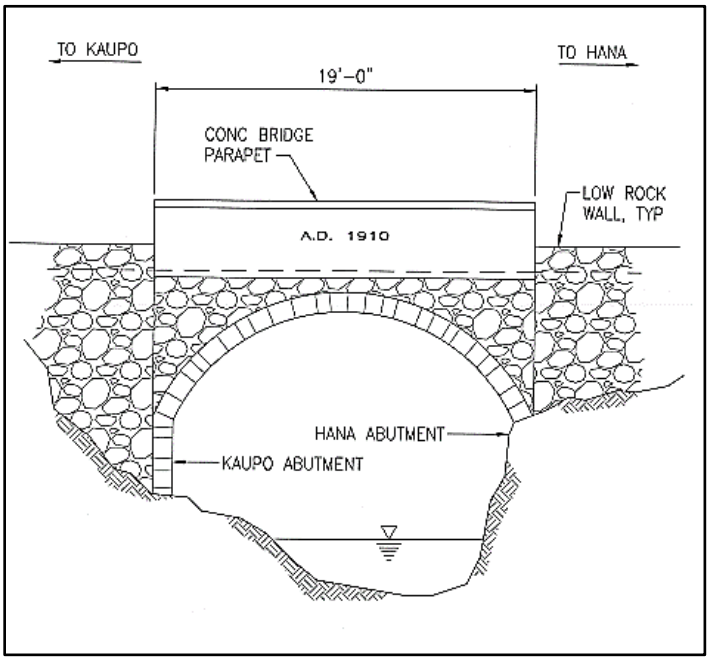
• Number of Spans:	1
• Total Span of Arch:	19'-0"
• Roadway Width:	12'-6"
• Total Width (Out-to-Out or Length of Barrel):	14'-00"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Parapet:	Concrete
• Height of Bridge Parapet:	2'-2" (D/S) & 1'-8" (U/S)
• Roadway Fill Over Bridge:	Concrete Slab & A.C. overlay
• Type of Channel Under Bridge:	Unlined Natural Rock Channel
• Approx. Clearance From Slab Soffit to Water Level:	10'-8"
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	6"
• Posted Load Limit:	5 tons

The heights of the concrete parapets are 2'-2" on the downstream and 1 '-8" on the upstream sides of the bridge measured from the A. C. pavement. There are no approach guardrails to the bridge

Two (2) PVC waterlines run under the bridge near the Kaupo abutment.



Cross-section



Downstream elevation

LOAD RATING

Existing arch appears to be constructed with large rocks, similar to CRM walls,with concrete cast on board forms. There are no as-built plans available for Paehala Bridge, therefore the thickness of the arch at the crown or the spring-line is not known.

Based on the AASHTO Manual for Bridge Evaluation Section 6B. 7.1, no decrease in posted load limit is required if a bridge "has been carrying normal traffic for an appreciable length of time and shows no signs of distress". Based on visual inspection of the concrete arch, there are no visible signs of distress at the current posted load.

Paehala Bridge is currently on a 12 month inspection cycle. It is recommended that inspections include observations of the arch footings for any possible settlement. Since this is an unreinforced stone/concrete arch, any settlement of the footings may lead to distress in the arch.

No change is recommended to the 5 ton posting limit for Paehala Bridge.

PUUHAOA #22 BRIDGE



DESCRIPTION

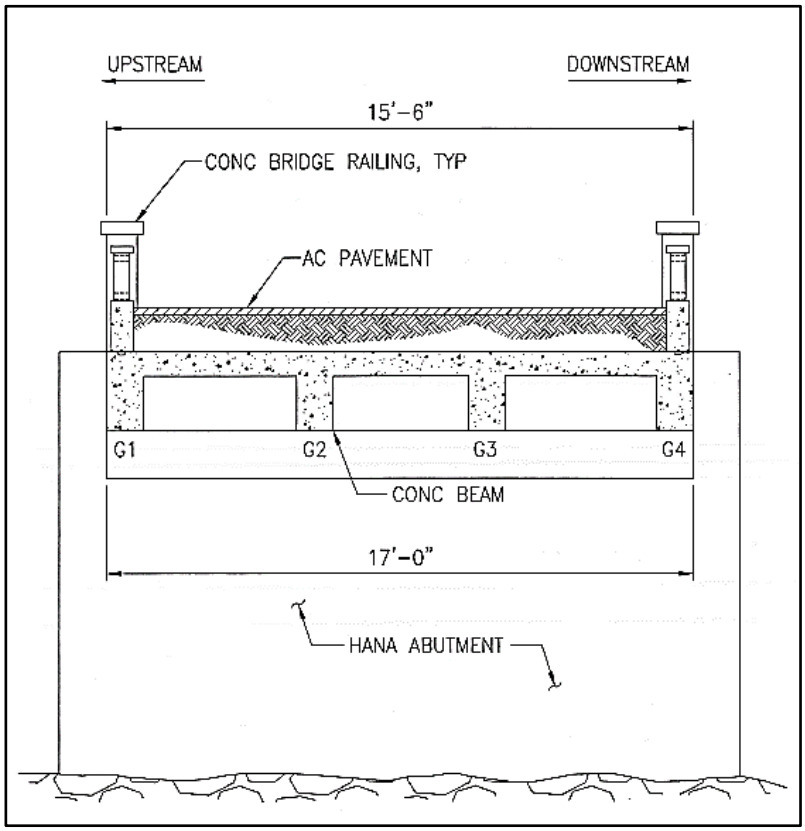
The Puuhaoa #22 bridge is a single span reinforce concrete tee beam bridge constructed in 1910. The bridge is 15'-6" wide and 23'-3" long. The concrete deck is overlaid with A. C. pavement. The tee beams span between concrete abutments. The abutments are bearing on natural rock formation which also forms the stream channel. CRM wingwalls are located along both sides of the abutments.

The structure data of the existing bridge is as follows:

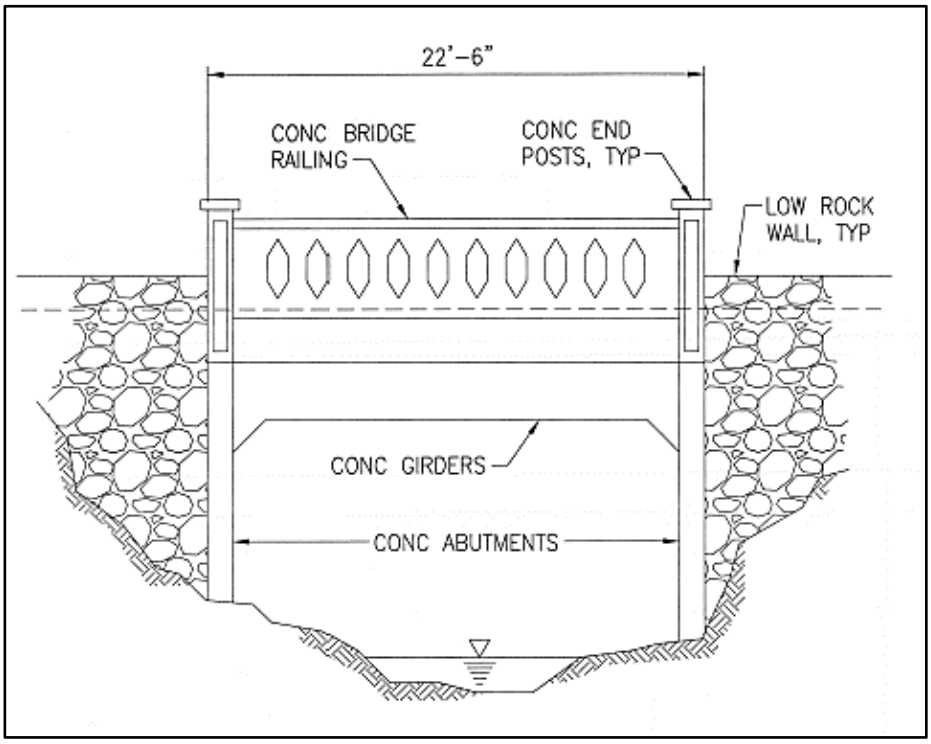
• Number of Spans:	1
• Total Length of Bridge:	23'-3"
• Roadway Width Curb-to Curb:	14'-3"
• Total Bridge Width (Out-to-Out):	15'-6"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete
• Height of Bridge Rail:	2'-8 ½"
• Roadway Fill Over Bridge:	Yes
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Slab Soffit to Water Level:	12'-0"
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	0'-6"
• Posted Load Limit:	12 tons

Concrete railings run along the upstream and downstream sides of the bridge. There are no approach guardrails.

No utilities cross the unnamed stream with the bridge.



Cross-section



Downstream elevation

SOUTH WAILUA #23 BRIDGE

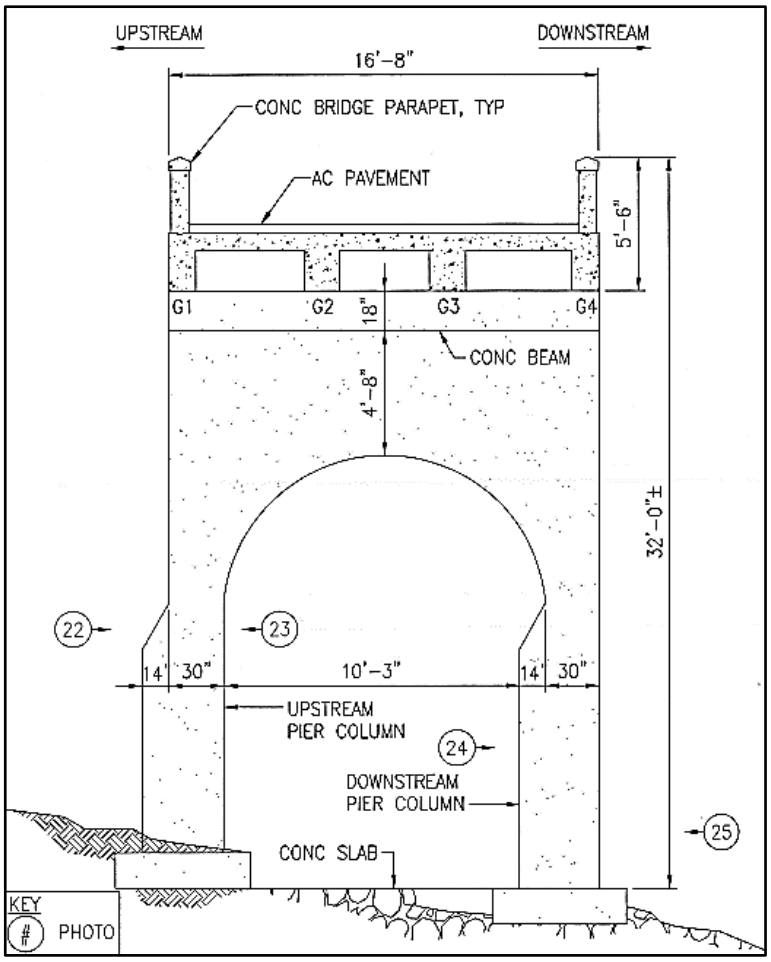


DESCRIPTION

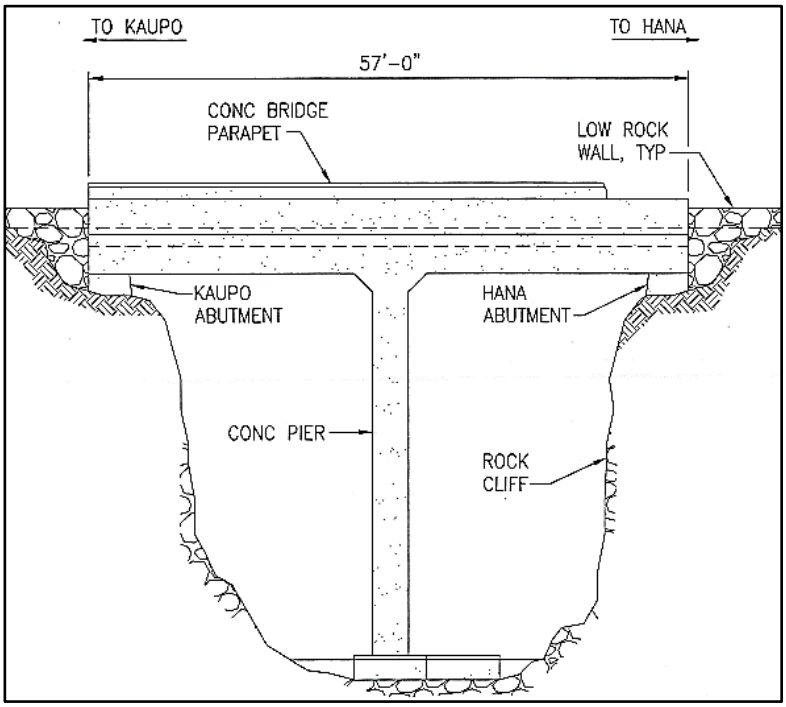
The South Wailua #23 bridge is a two-span reinforced concrete bridge constructed in 1911. The bridge is 16'-8" feet wide and 57'-0" long. The bridge consists of a cast-in-place (CIP) concrete deck overlaid with asphaltic concrete (A. C.) pavement. The concrete deck spans between four concrete girders. The concrete girders span to a center concrete pier from concrete abutments at the Kaupo and Hana ends of the bridge. The center pier consists of two concrete columns supporting a concrete cap. There are low rock walls at the roadway approaches to the bridge, but there are no wingwalls below the bridge as the channel was formed in natural rock formation. The structure data of the existing bridge is as follows:

• Number of Spans:	2
• Total Length of Bridge:	57'-0"
• Roadway Width Curb-to Curb:	15'-6"
• Total Bridge Width (Out-to-Out):	16'-8"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	19"
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Girder Soffit to Water Level:	26'
• Water Depth Under Bridge:	0" to 2"
• Posted Load Limit:	12 Tons

A low concrete bridge parapet with a total height of 19" runs along the upstream and downstream sides of the bridge. There are no approach guardrails except for low rock walls leading up to three ends of the concrete bridge parapets. There is no low rock wall at the upstream Hana end of the bridge, which results in the blunt end of the bridge parapet being exposed to vehicular traffic.



Cross-section



WAILUA #24 BRIDGE



DESCRIPTION

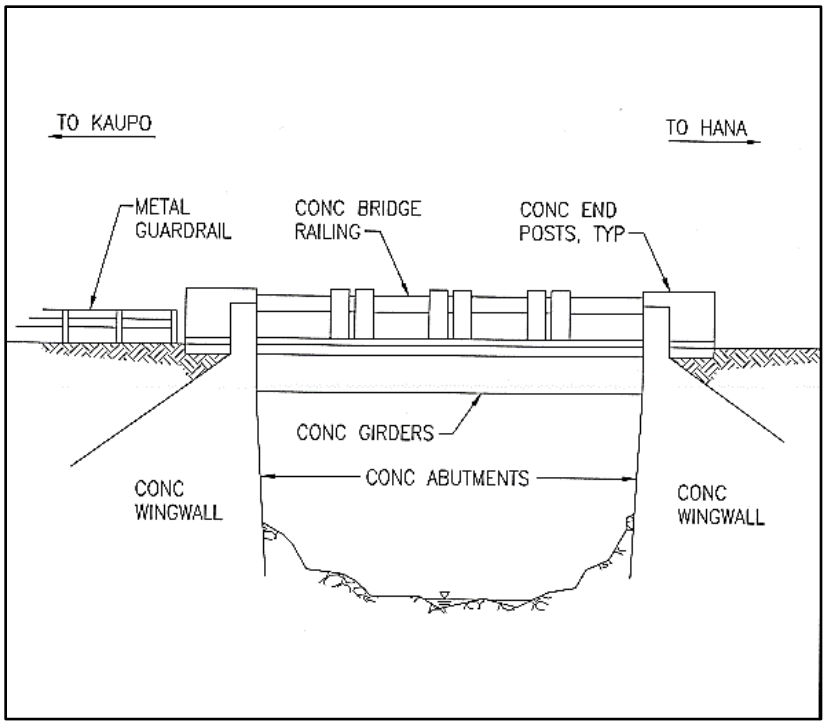
The Wailua #24 bridge is a curved single span reinforced concrete bridge constructed in 1947. The bridge is 18'-9" feet wide and 63'-0" long along the curve. The superstructure consists of a cast-in-place (CIP) concrete deck overlaid with asphaltic concrete (A.C.) pavement. The concrete deck spans between three curved concrete girders spanning between concrete abutments at the Hana and Kaupo ends of the bridge. Concrete wingwalls are located at the upstream and downstream ends of both abutments. The structure data of the existing bridge is as follows:

• Number of Spans:	1
• Total Length of Bridge:	63'-0" (along the curve)
• Roadway Width Curb-to Curb:	14'-2"
• Total Bridge Width (Out-to-Out):	18'-9"
• Skew:	33 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Beam & Post on Concrete Curb
• Height of Bridge Rail:	6" Concrete Curb + 26" Concrete Beam & Post
• Roadway Fill Over Bridge:	None (assumed)
• Type of Channel Under Bridge:	Unlined stream
• Approx. Clearance From Girder Soffit to Water Level:	22'
• Water Depth Under Bridge:	12"
• Posted Load Limit:	No sign posted at bridge

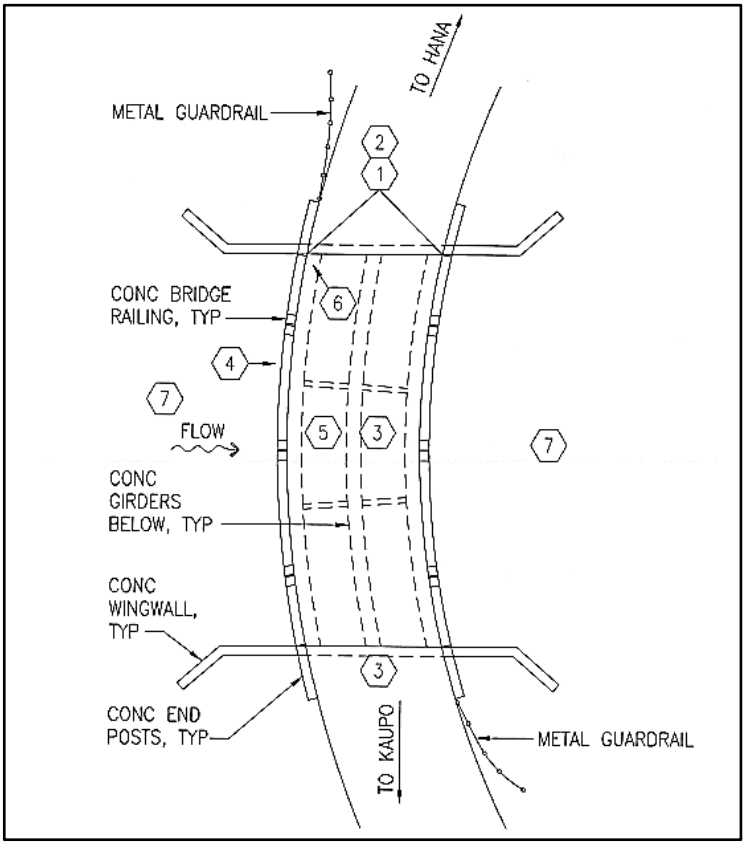
A concrete bridge railing, 26 inches high above top of concrete curb, runs along the upstream and downstream sides of the bridge. There are W-beam metal approach guardrails at the upstream Hana and downstream Kaupo ends of the bridge, but there are no approach guardrails at the upstream Kaupo

and downstream Hana ends of the bridge which causes the blunt end of the concrete bridge railing to be exposed to vehicular traffic.

There are no utilities crossing the stream with the bridge.



Downstream elevation



STRUCTURAL INVENTORY AND APPRAISAL

HAWAII DEPARTMENT OF TRANSPORTATION — STRUCTUSAL INVENTORY AND APPRAISAL — DATE PRINTED: 05/01/2007

Structure Number: 009003600904475

(209) Str Name: WAILUA #24
Princ Rte: 360 Milepost: 0.000

Geographic and Route Data

(1) State	Hawaii
(2) District	20
(3) County	Maui
(4) Place	
(6) Feature Under	WAILUA STRM(STRUCT #24)
(7) Facility on	HANA HWY
(9) Location	4.18MI S/RD TO HAMOA
(16) Latitude	20° 41' 12.00"
(17) Longitude	156° 01' 54.00"
(98) Border Bridge	
(99) Border Brdige Str No	
(103) Temportary Str	

On and Under Record Data

	Route On
(5) Inventory Route	141003602
(10) Min Vert Clr	99.99 M
(11) Kilometerpoint	0072.000
(19) Detour Length	199 km
(20) Toll	3
(26) Func Class	06
(28) Lanes on/under	0100
(29) ADT	450
(30) Year of ADT	1998
(47) Total Horz Clearance	04.3 M
(100) Defense Hwy	0
(101) Parallel Str	N
(102) Direction of Traffic	3
(104) Hwy System	0
(109) Truck Traffic	00%
(110) Natl Truck Network	No

General Data

(21) Maintenance Responsibility	02
(22) Owner	02
(31) Design Load	2
(33) Bridge Median	0
(34) Skew	33 deg
(35) Str Flared	No
(37) Hist Significance	4
(38) Navigation Control	N
(42) Type of Service	15
(43) Structure Type Main	104
(44) Structure Type Approach	000
(45) No of Span Main	001
(46) No of Approach Spans	0000
(27) Year Built	1947
(106) Year Reconstructed	0000
(107) Deck Str Type	1
(108) Wear Surf/Protv Sys	609
(111) Nav Pier/Abut Protection	

Dimensional Data

(32) Approach Rdwy Width	4.9 M
(39) Navigation Vert Clr	000.0 M
(40) Navigation Horz clr	0000.0 M
(48) Max Span Length	0018.3 M
(49) Str Length	00020.1 M
(50) Curb/Sidewalk Width Left	00.0 M
Right	00.0 M
(51) Brg Rdwy Width,curb-curb	004.3 M
(52) Deck Width out-out	005.8 M
(53) Min Vert Clr over	99.99 M
(54) Min Vert Clr under	N 00.00 M
(55) Min Lat Underclr R	N 00.0 M
(56) Min Lat Underclr L	00.0 M
(112) NBIS Bridge Length	Y
(116) Navigation Min Vert Clr	M

Proposed Improvements

(75) Type of Work	
(76) Improvement Length	000000 M
(94) Bridge Improv Cost	0
(95) Rdwy Improv Cost	0
(96) Total Proj Cost	0
(97) Year of Cost Est	
(114) Future ADT	0
(115) Year of Future ADT	

Condition Rating

(58) Deck	~~7~~ ~~6~~
(59) Superstructure	7
(60) Substructure	7
(61) Channel & Channel Protect	~~6~~ ~~7~~
(62) Culverts	N

Appraisal Rating

(67) Structure Evaluation	3
(68) Deck Geometry	2
(69) Underclrn Vert & Horz	N
(71) Waterway Adequacy	8
(72) Approach Rdwy Alignment	8
(36) Traffic Safety Features	0000

Scour Data

(113) Scour Critical Bridges	7
(202) Foundation Type	
(220) Foundation Embedment	0.0 M
(221) Scour Countermeasures	

Load Rate and Post

(41) Str Open/Post/Close	~~Open~~ Posted
(64) Operating Rating	16.1 ton
(66) Inventory Rating	09.5 ton
(70) Bridge Posting	0
(211) Posted Limit	12 Ton

Proposed Maintenance

(212) Repair Priority	
(213) Proposed Maint Type	
(215) Maintn Date Completed	/ /
(216) Actual Maint Cost	0

Inspection Data

(90) Inspection Date (MoYr)	0312 ~~0307~~
(91) Inspection Frequency	24 Mo
(92) Critical Feature Insp	(93) Date
Frac Crit Insp : N	/
Underwater Insp: N	/
Other Spec Insp: N	/
(207) Inspection Quarter	4
(208) Inspection Number	
(210) Date of Inspection	03/29/2012 ~~03/11/2007~~ ~~04/14/2008~~

Over 200 Items

(200) Princ Route Location	
(201) Wear Surface Thickness	0.0 mm
(203) District Maint Org	
(204) Original Proj #	
(205) Station Princ Rte	0.000
(206) Bridge Rail Type	
(217) Culvert Bbl Height	0.0 M
(218) Culvert Bbl Length	0.0 M
(219) Culvert Fill Height	0.0 M
(222) Date of Load Rating	08/04/1998
(223) Tracs No	
(224) Bridge Crew Region	
(225) Total Deck Area (M^2)	0.0
(226) Superstr Unit Cost	0.00
(227) Substr Unit Cost	0.00
(228) Next Insp Due Date (QuartYr)	307
(229) Agency	MAUI COUNTY
(230) Principal Route Number	360
(231) Principal Route Letter	
(232) Principal Route Milepost	0.000
(300) Comments: Bridge Structurally good.	

Sufficiency Rating = 027.8
Functionly Obsolete

PAIHI #25 BRIDGE



DESCRIPTION

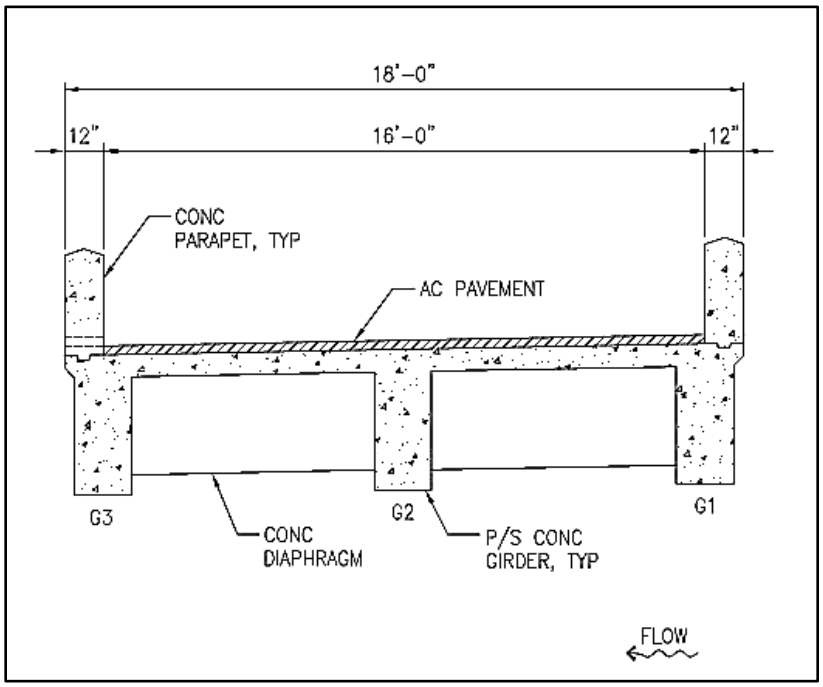
The Paihi Bridge is a single span prestressed concrete girder bridge constructed in 2008. The bridge is 18’-4" wide and 63’-0" long. The concrete deck is overlaid with A.C. pavement. The prestressed girders span between concrete abutments. The abutments are supported on drilled shaft foundations

The structure data of the existing bridge is as follows:

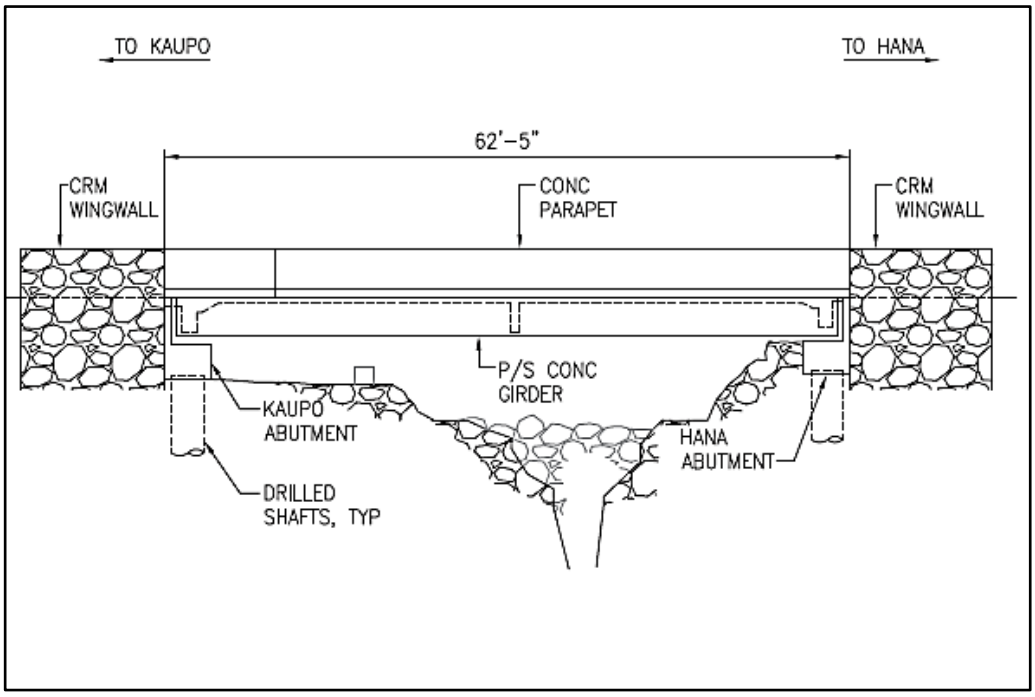
• Number of Spans:	1
• Total Length of Bridge:	62’-5"
• Roadway Width Curb-to Curb:	16’-0”
• Total Bridge Width (Out-to-Out):	18’-0”
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Parapet:	Concrete
• Height of Bridge Rail:	2’-8”
• Roadway Fill Over Bridge:	No
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Slab Soffit to Water Level:	5’-0” at Upstream Side
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	6”-12”
• Posted Load Limit:	None

Concrete parapets with rock veneer are located along both sides of the concrete approach slabs. Concrete parapets run along the upstream and downstream sides of the bridge.

No utilities cross Paihi Bridge.



Cross-section



Downstream elevation

LOAD RATING

The load rating is based on record drawings dated March 21, 2008 for Paihi Bridge Replacement FED Aid Project No. BR-0900(61).

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on October 20, 2015.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	1.17
		HL-93 Tandem + HL-93 Lane	1.37
	Operating Level	HL-93 Truck + HL-93 Lane	1.52
		HL-93 Tandem + HL-93 Lane	1.77
Legal Load	Type 3		2.81
	Type 3S2		2.65
	Type 3-3		2.81
	NRL		2.11
	SU4		2.53
	SU5		2.29
	SU6		2.19
	SU7		2.12
Permit Load	HP1		1.59
	HP2		1.53
	HP3		1.98

Bridge posting is not required for Paihi Bridge since the load rating factor for the legal loads is greater than 1.0.

WAIKAKOI #26 BRIDGE



DESCRIPTION

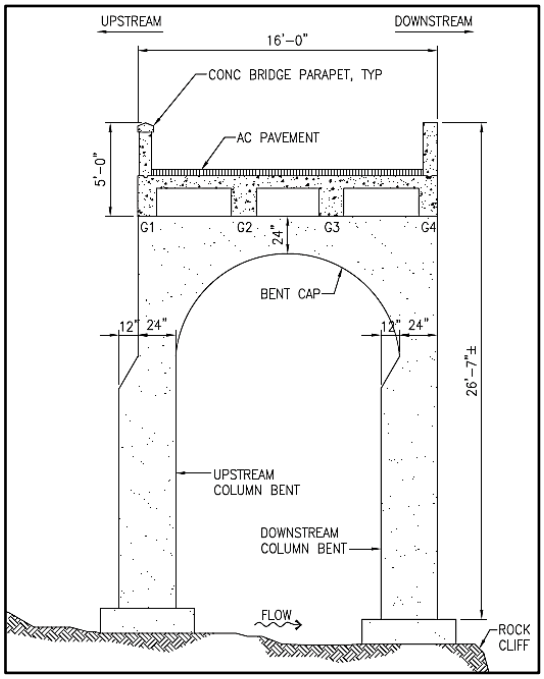
The Waikakoi #26 bridge is a two-span continuous reinforced concrete bridge constructed in 1911. The bridge is 16'-0" feet wide and 33'-0" long. The floor system consists of a cast-in-place (CIP) concrete deck overlaid with asphaltic concrete (A.C.) pavement over a roadway fill. The concrete deck spans in the transverse direction over four concrete girders. The concrete girders span to a center concrete pier and to a concrete abutment at the Kaupo end and to a CRM abutment at the Hana end of the bridge. The center pier consists of two concrete columns supporting a concrete cap. Concrete wingwalls are located upstream and downstream of the Kaupo abutment, and CRM wingwalls are located upstream and downstream of the Hana abutment.

The structure data of the existing bridge is as follows:

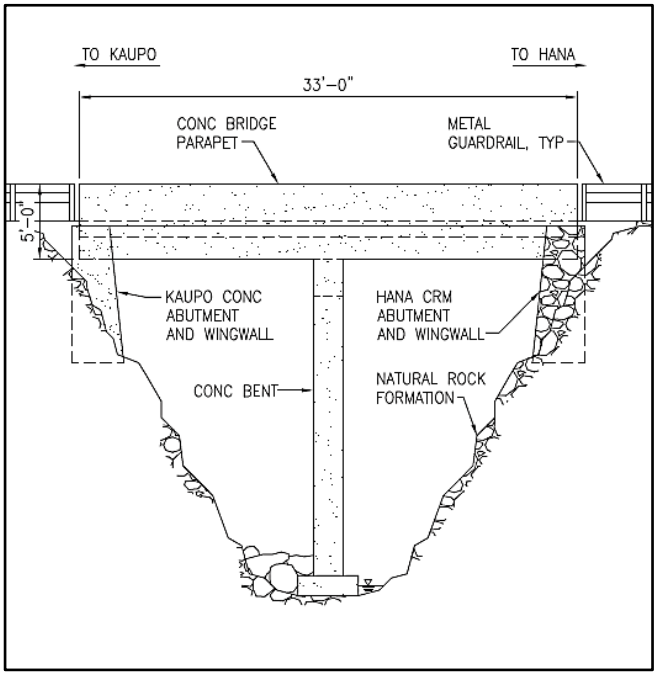
• Number of Spans:	2
• Total Length of Bridge:	33'-0"
• Roadway Width Curb-to Curb:	15'-0"
• Total Bridge Width (Out-to-Out):	16'-0"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	Varies (17" to 30")
• Roadway Fill Over Bridge:	Yes
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit to Water Level:	20'-0"
• Water Depth Under Bridge:	6"
• Posted Load Limit:	Unknown (no sign posted at bridge)

A low concrete bridge parapet with a height varying from 17” to 30” runs along the upstream and downstream sides of the bridge.

There are no utilities crossing the stream with the bridge, except for a Driscoll waterline that is drooped along upstream side of bridge.



Cross-section



Downstream elevation

LOAD RATING

The load rating is based on field survey during inspection in combination with correlations to similar bridge Haipuaena (Structure No. 009003600501145) on Hana Hwy. Both bridge were constructed in 1911, with similar span, piers and girder dimensions. Therefore since no as-builts are available for Waikakoi Bridge, Haipuaena as-built plans and engineering judgment were used to develop a baseline capacity for this bridge.

Calculations for the load rating were performed by Nagamine Okawa Engineers. Inc. on October 20, 2015.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.61
		HL-93 Tandem + HL-93 Lane	0.47
	Operating Level	HL-93 Truck + HL-93 Lane	0.79
		HL-93 Tandem + HL-93 Lane	0.61
Legal Load	Type 3		0.90
	Type 3S2		0.98
	Type 3-3		1.09
	NRL		0.78
	SU4		0.81
	SU5		0.78
	SU6		0.78
	SU7		0.78
Permit Load	HP1		0.75
	HP2		0.46
	HP3		0.86

Bridge posting is required for Waikakoi Bridge since the load rating factor for the legal loads is less than 1.0. Recommended posting load for this bridge is 12 Tons. Posting load is based on reduced capacity due to superstructure rating, therefore if repairs are done to increase superstructure rating, bridge posting may be increased to existing posting load. The bridge is currently posted at 12 tons.

ALAALAULA #27 BRIDGE



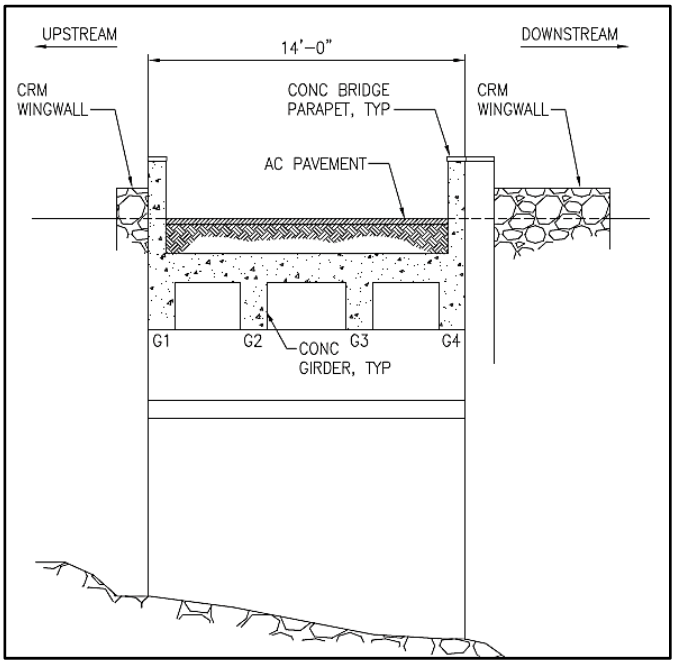
The Alaalaula #27 bridge is a single span reinforced concrete bridge constructed in 1915. The bridge is 14'-0" wide and 28'-0" long (clear span). The floor system consists of a cast-in-place (CIP) concrete deck overlaid with asphaltic concrete (A.C.) pavement over roadway fill. The concrete deck spans in the transverse direction and is supported by four concrete girders. The concrete girders span to concrete abutments at the Kaupo and Hana ends of the bridge.

The structure data of the existing bridge is as follows:

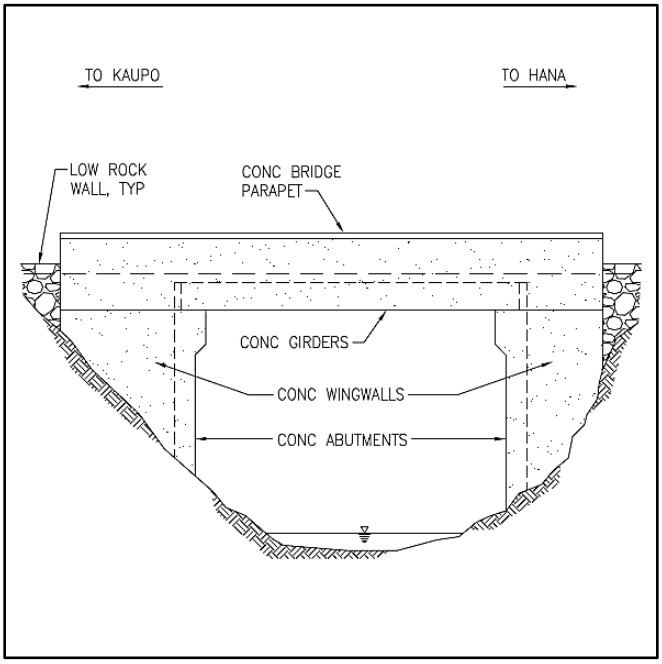
• Number of Spans:	1
• Total Length of Bridge:	28'-0" (clear span)
• Roadway Width Curb-to Curb:	12'-6"
• Total Bridge Width (Out-to-Out):	14'-0"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	varies from 30" to 40"
• Roadway Fill Over Bridge:	Yes
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit to Water Level:	22'-0"
• Water Depth Under Bridge:	12" to 18"
• Posted Load Limit:	7 tons

A concrete bridge parapet with a height of 30" to 40" runs along the upstream and downstream sides of the bridge. There are no approach guardrails except for low rock walls leading up to the ends of the concrete bridge parapets.

There are no utilities crossing the stream and supported by the bridge.



Cross-section



Downstream elevation

LOAD RATING

The load rating is based on field survey during inspection in combination with correlations to Oopuola Bridge on Hana Hwy constructed during the same time period. Oopuola as-built plans and engineering judgment were used to develop a baseline capacity for this bridge.

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on November 26, 2013.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.22
		HL-93 Tandem + HL-93 Lane	0.23
	Operating Level	HL-93 Truck + HL-93 Lane	0.34
		HL-93 Tandem + HL-93 Lane	0.35
Legal Load	Type 3		0.55
	Type 3S2		0.58
	Type 3-3		0.67
	NRL		0.38
	SU4		0.45
	SU5		0.42
	SU6		0.41
	SU7		0.39
Permit Load	HP1		0.34
	HP2		0.29
	HP3		0.54

Bridge posting is required for Alaalaula Bridge since the load rating factor for the legal loads is less than 1.0. Recommend posting load for this bridge is 5 Tons. Posting load is based on reduced capacity due to superstructure rating, therefore if repairs are done to increase superstructure rating, bridge posting may be increased to existing posting load. The bridge is currently posted at 7 tons.

PAPAHAWAHAWA #28 BRIDGE



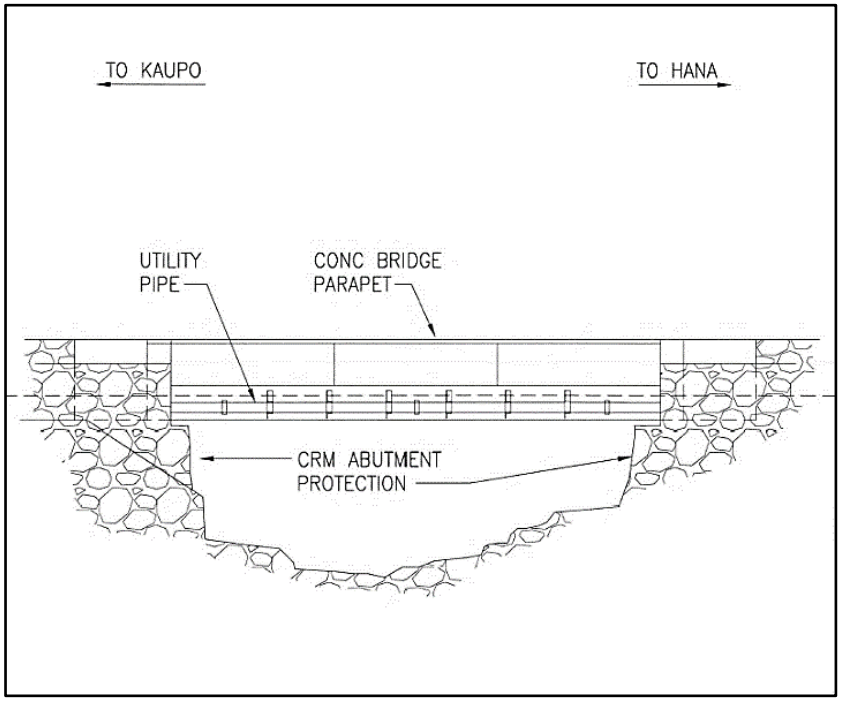
DESCRIPTION

The Papahawahawa #28 bridge is a one-span continuous reinforced concrete bridge constructed in 2011. The bridge is 18'-8" wide and 47'-0" long. The floor system consists of a cast-in-place (CIP) concrete slab overlaid with asphaltic concrete (A. C.) pavement over a roadway fill. The concrete slab spans between the Kaupo and Hana ends of the bridge. CRM walls protect the concrete abutments.

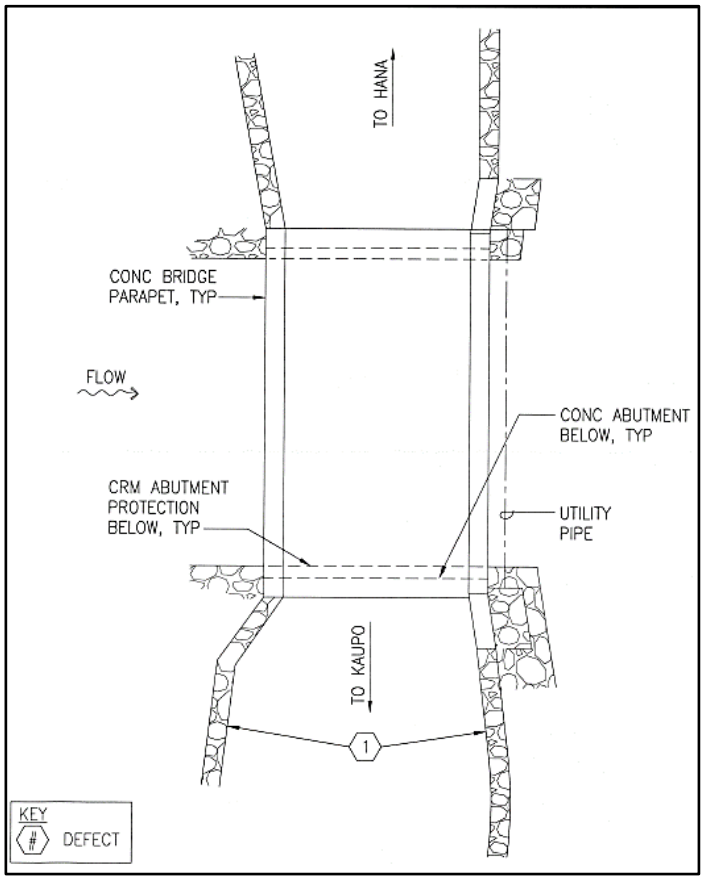
The structure data of the existing bridge is as follows:

• Number of Spans:	1
• Total Length of Bridge:	47'-0"
• Roadway Width Curb-to Curb:	16'-6"
• Total Bridge Width (Out-to-Out):	18'-8"
• Approximate Skew:	23 deg.
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete
• Height of Bridge Rail:	30"
• Roadway Fill Over Bridge:	Yes
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Girder Soffit to Water Level:	10'
• Water Depth Under Bridge:	0"
• Posted Load Limit:	None

A concrete parapet with a height of 30" runs along the upstream and downstream sides of the bridge. There are no approach guardrails at both ends of the bridge.



Downstream elevation



Bridge plan

WAIOHONU #29 BRIDGE

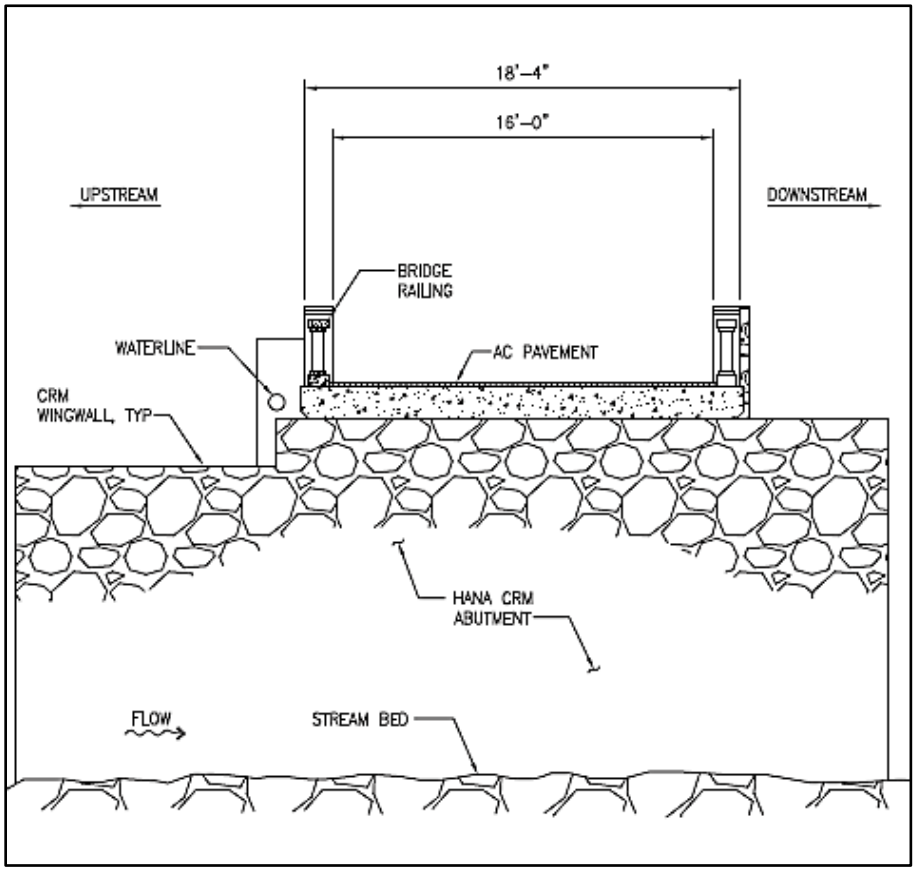


DESCRIPTION

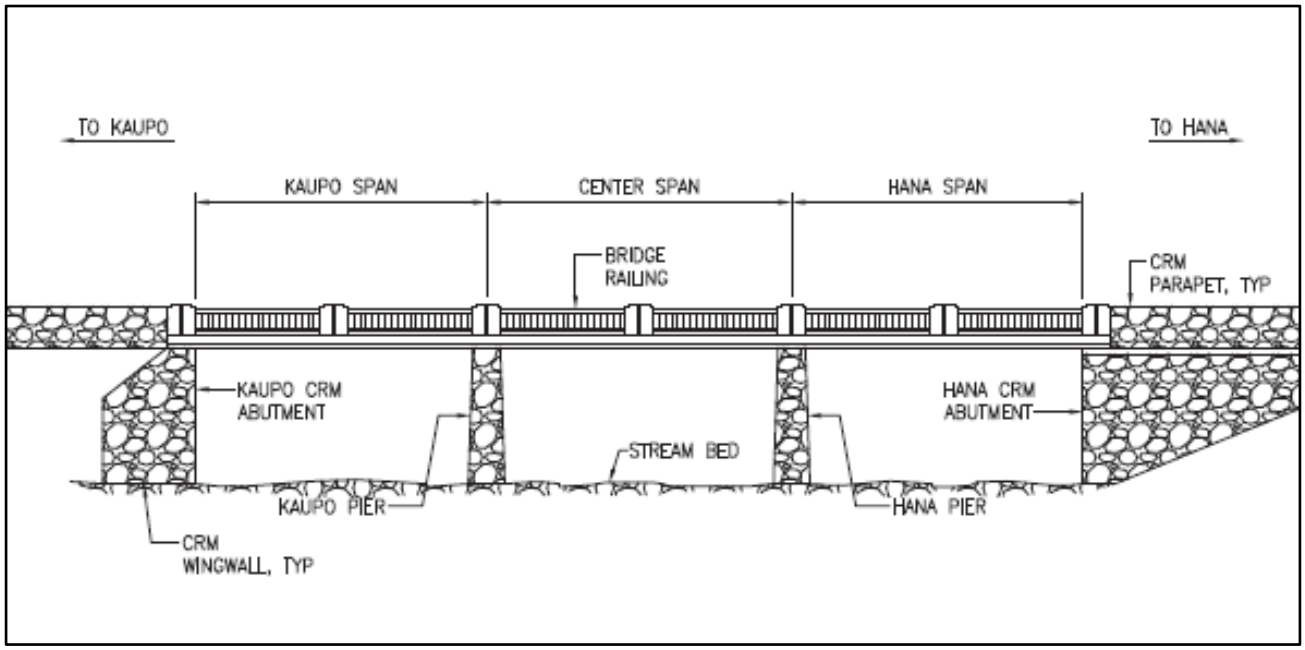
The Waiohonu bridge is a 3 span reinforced concrete bridge constructed in 2011.The bridge is 18'-4" wide and 103'-7" long. The bridge has a concrete slab with AC pavement overlay. The concrete slabs span between 2 CRM piers and CRM abutments.

The structure data of the existing bridge is as follows:

• Number of Spans:	3
• Total Length of Bridge:	103'-7"
• Roadway Width Curb-to Curb:	16'-0"
• Total Bridge Width (Out-to-Out):	18'-4"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	AC Pavement Overlay
• Bridge Rails:	Concrete
• Roadway Fill Over Bridge:	No
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Slab Soffit to Water Level:	18'-0"
• Approx. Silt & Debris Accumulation In Channel Under Bridge:	None
• Water Depth Under Bridge:	0"
• Posted Load Limit:	None



Abutment section



Downstream elevation

LOAD RATING

The load rating is based on record drawings dated March 2011 for Waiohonu Bridge Replacement FED Aid Project No. BR-0900(68).

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on October 29, 2015.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	1.25
		HL-93 Tandem + HL-93 Lane	1.31
	Operating Level	HL-93 Truck + HL-93 Lane	1.63
		HL-93 Tandem + HL-93 Lane	1.69
Legal Load	Type 3		2.42
	Type 3S2		2.62
	Type 3-3		2.90
	NRL		1.58
	SU4		2.07
	SU5		1.90
	SU6		1.73
	SU7		1.64
Permit Load	HP1		1.33
	HP2		1.45
	HP3		1.96

Bridge posting is not required for Waiohonu Bridge since the load rating factor for the legal loads is greater than 1.0.

KAHAWAIOKAPIA #30 BRIDGE



DESCRIPTION

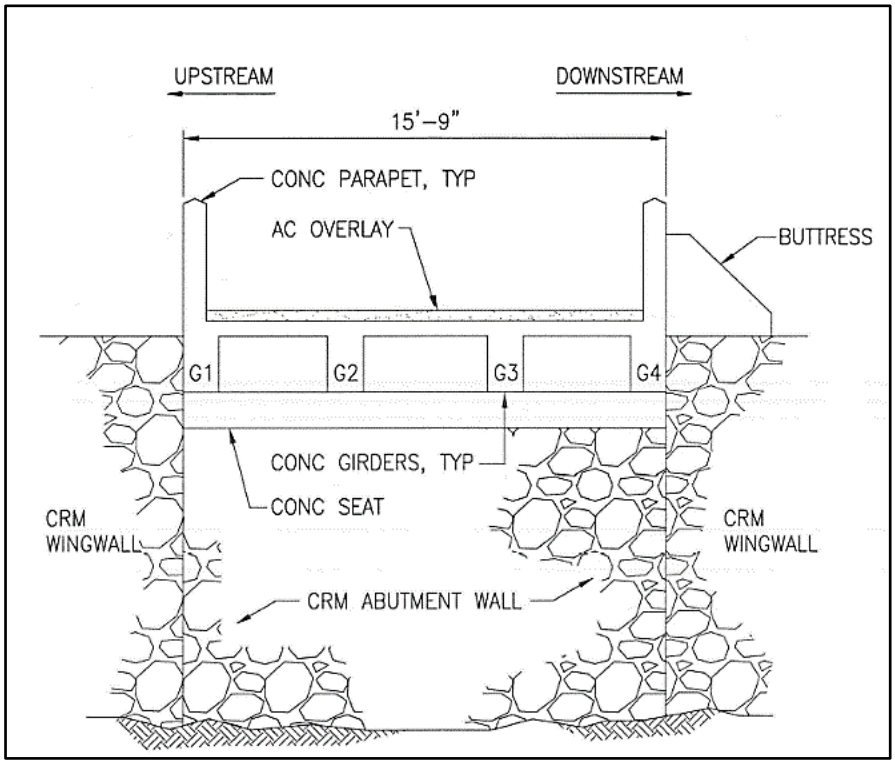
The Kahawaiokapia #30 bridge is a three-span reinforced concrete bridge constructed in 1915. The bridge is 15'-9" wide and 57'-6" long. A cast-in-place (CIP) concrete deck overlaid with an asphaltic concrete (A. C.) wearing surface spans between four cast-in-place concrete girders. The girders span between CRM abutments at each end of the bridge and two intermediate concrete pier walls. CRM wingwalls are located upstream and downstream of both abutments.

The structure data of the existing bridge is as follows:

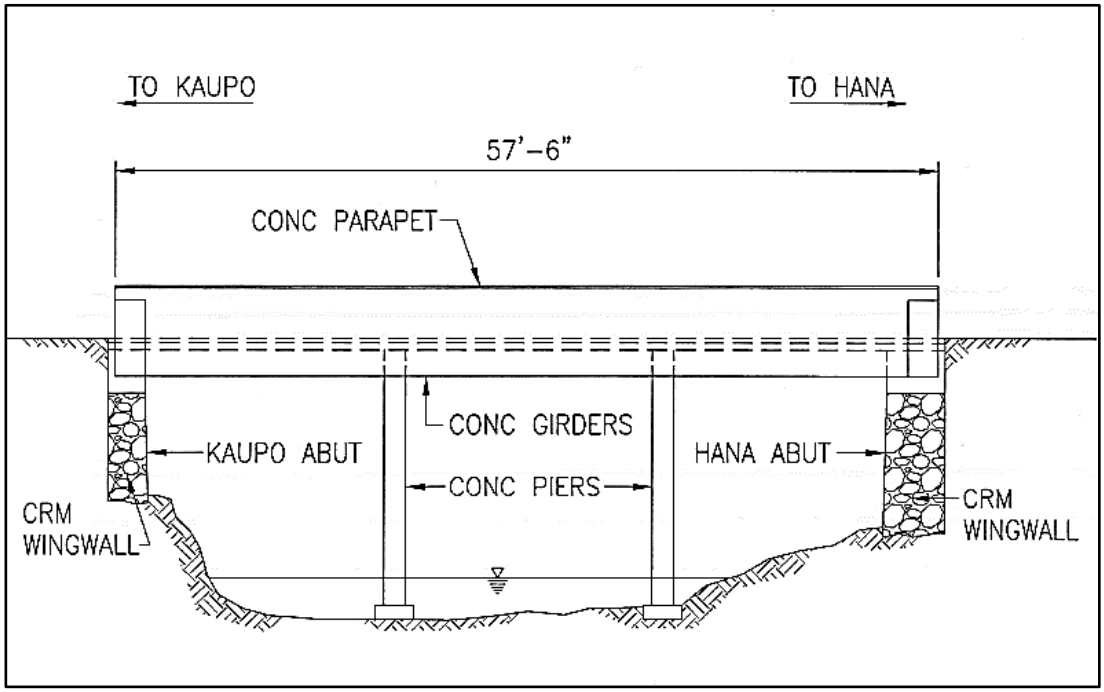
• Number of Spans:	3
• Total Length of Bridge:	57'-6"
• Roadway Width Curb-to Curb:	14'-2"
• Total Bridge Width (Out-to-Out):	15'-9"
• Skew:	12 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	A.C.
• Bridge Rails:	Concrete Parapet
• Height of Bridge Rail:	40”
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined natural rock formation
• Approx. Clearance From Girder Soffit to Water Level:	17’
• Water Depth Under Bridge:	None (Stream was dry)
• Posted Load Limit:	8 tons

A concrete parapet (bridge railing) with a height of 40" runs along the upstream and downstream sides of the bridge. There are no approach guardrails at both ends of the bridge.

An 8-inch waterline crosses the stream along the exterior side of the upstream bridge parapet.



Cross-section



Downstream elevation

LELEKEA #81 STEEL ARCH CULVERT



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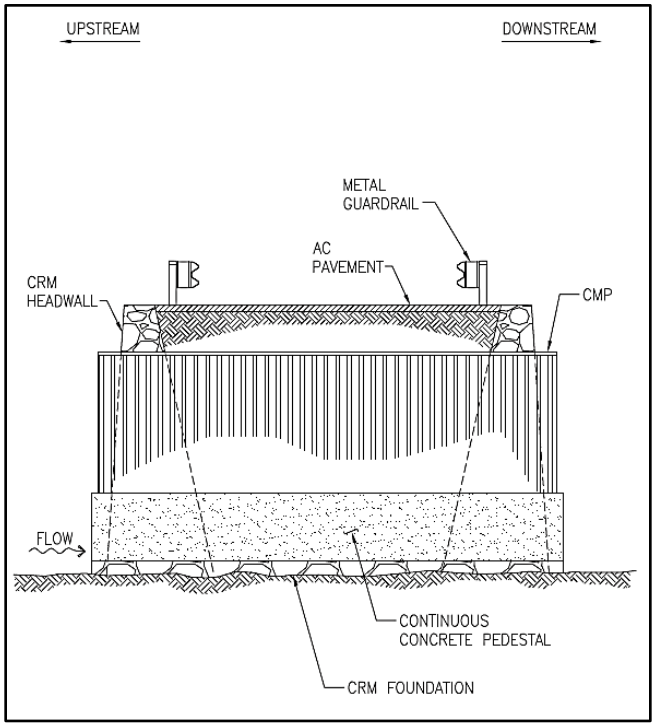
DESCRIPTION

The Lelekea #81 multi barrel combination steel arch and concrete culvert was constructed in 1947. Each of three steel arch barrels is 12' in diameter and 24' in length spanning a total of 40' across the stream. Each steel arch culvert barrel consists of half a corrugated metal pipe (CMP) supported on a continuous concrete pedestal wall and CRM foundation. A sloping CRM divider wall between the Kaupo and center steel arch barrels is located on the upstream end of the culvert. CRM headwalls along the upstream and downstream ends of the arch culvert retain embankment material supporting the AC pavement over the culvert. The top of the CRM headwalls terminates at the roadway elevation. The CMP arch culvert barrel extends about 12" beyond the CRM headwalls at both the upstream and downstream ends. The CRM headwalls extend beyond the Kaupo and Hana arch barrels about 25' (Total length of headwall = 90').

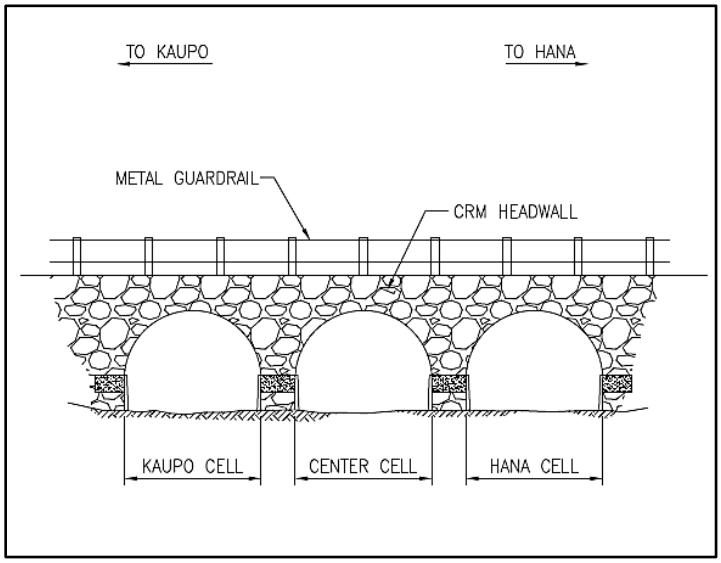
The structure data of the existing bridge is as follows:

• Number of Barrels:	3
• Length of Each Culvert Barrel:	24'-0"
• Roadway Width	
• Total Roadway Width (Out-to-Out):	22'-6"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface Over Culvert:	AC Pavement on Embankment Material
• Bridge Rails:	Metal Guardrail
• Height of Bridge Rail:	2'-0" ±
• Roadway Fill Over Bridge:	24" at Crown
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Crown To Stream Bed:	9'-6"
• Water Depth Under Bridge:	0" ±
• Posted Load Limit	No Posted Load Limit at the Bridge

The approach guardrails continue over the bridge. There are no utilities crossing the stream with the bridge.



Cross-section



Downstream elevation

LOAD RATING

The load rating is based on field survey and measurements during inspection. As-built record drawings are not available for Lelekea Culvert, however similar corrugated metal pipe culverts at Makani (Structure No. 009313201100001) and Kaupea (Structure No. 009313401100001) were assumed similar.

Calculations for the load rating were performed by Nagamine Okawa Engineers Inc. on October 28, 2015.

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.15
		HL-93 Tandem + HL-93 Lane	0.18
	Operating Level	HL-93 Truck + HL-93 Lane	0.19
		HL-93 Tandem + HL-93 Lane	0.23
Legal Load	Type 3		0.39
	Type 3S2		0.42
	Type 3-3		0.47
	NRL		0.43
	SU4		0.39
	SU5		0.39
	SU6		0.37
	SU7		0.38
Permit Load	HP1		0.27
	HP2		0.15
	HP3		0.35

Bridge posting is required for Lelekea Culvert since the load rating factor for the legal loads is less than 1.0. Recommend posting load for this bridge is 3 Tons. Posting load is based on reduced capacity due to deterioration and of metal culvert.

Load Type			Corrugate Metal Pipe Arch				
			Strength Limit State		Service Limit State		Posting Load (Tons)
			Rating Factor	Load Rating (Tons)	Rating Factor	Load Rating (Tons)	
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.15				-
		HL-93 Tandem + HL-93 Lane	0.18				-
	Operating Level	HL-93 Truck + HL-93 Lane	0.19				-
		HL-93 Tandem + HL-93 Lane	0.23				-
Legal Load	Type 3		0.39				3.1
	Type 3S2		0.42				6.4
	Type 3-3		0.47				9.7
	NRL		0.43				7.3
	SU4		0.39				3.4
	SU5		0.39				3.9
	SU6		0.37				3.4
	SU7		0.38				4.5
Permit Load	HP1		0.27				0.0
	HP2		0.15				0.0
	HP3		0.35				6.8

ALELELE #13 BRIDGE



DESCRIPTION

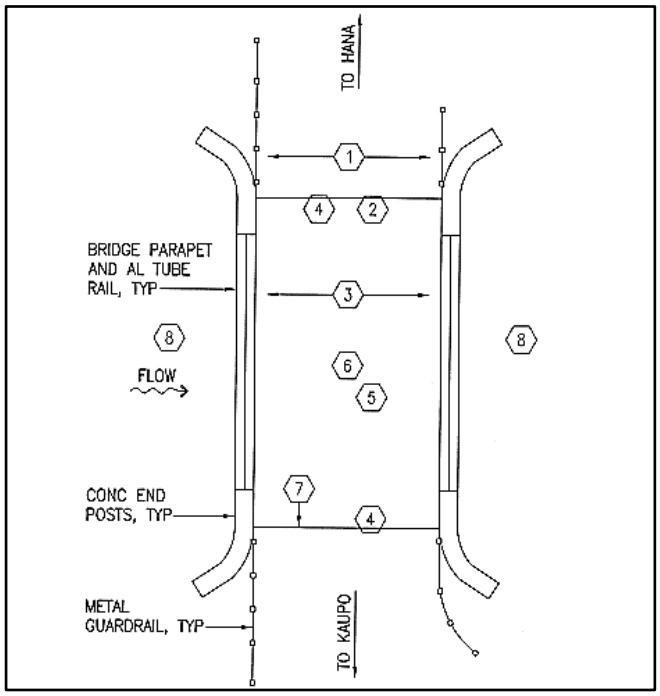
The Alelele #13 bridge is a single span bridge originally constructed in 1937 and rebuilt in 1983. The bridge is 23'-3" wide and 40'-0" long. A cast-in-place concrete deck is supported on four precast prestressed concrete girders spanning between concrete abutments at the Hana and Kaupo ends of the bridge. CRM wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the deck and therefore the wearing surface is the top surface of the concrete deck.

The structure data of the existing bridge is as follows:

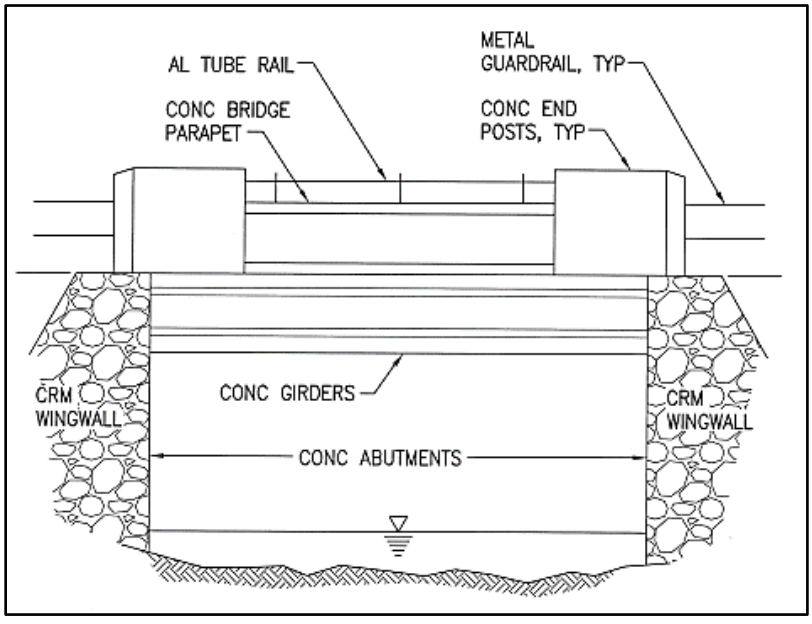
• Number of Spans:	1
• Total Length of Bridge:	38'-7"
• Roadway Width Curb to Curb:	20'-0"
• Total Bridge Width (Out-to-Out):	23'-3"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	Top Surface of Concrete Deck
• Bridge Rails:	Combination Concrete ~~New~~ Jersey Barrier with Single AL Tube Rail
• Height of Bridge Rail:	2'-4" Conc. New Jersey Barrier + 12" AL Tube Rail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit To Stream Water Level:	9'-0"
• Water Depth Under Bridge:	0' to 2'-0'
• Posted Load Limit	No Posted Sign at Bridge

A combination concrete New Jersey barrier and single aluminum tubular rail with a total height of about 3'-4" is constructed along the upstream and downstream sides of the bridge. Metal approach guardrails are located at the approaches to the bridge and transitions to concrete end posts at the terminus of the bridge rails.

There are no utilities crossing the stream with the bridge.



Bridge plan



Downstream elevation

HAWAII DEPARTMENT OF TRANSPORT. bm
STRUCTURAL INVENTORY AND APPRAI:
DATE PRINTED: 05/07/2007

Structure Number: 009003600903873

[209] Str Name: ALELELE #13
Princ Rte: 360 Milepost: 0.000

Geographic and Route Data

(1)	State	Hawaii
(2)	District	20
(3)	County	Maui
(4)	Place	
(6)	Feature Under	ALELELE STRM-STRUC #13
(7)	Facility on	HANA HWY
(9)	Location	10.29MI W/RD TO HAMOA
(16)	Latitude	20° 39' 06.00"
(17)	Longitude	156° 05' 18.00"
(98)	Border Bridge	
(99)	Border Brdige Str No	
(103)	Temporary Str	

On and Under Record Data

		Route On
(5)	Inventory Route	141000364
(10)	Min Vert Clr	99.99 M
(11)	Kilometerpoint	0060.622
(19)	Detour Length	199 km
(20)	Toll	3
(26)	Func Class	06
(28)	Lanes on/under	0100
(29)	ADT	245
(30)	Year of ADT	1998
(47)	Total Horz Clearance	06.1 M
(100)	Defense Hwy	0
(101)	Parallel Str	N
(102)	Direction of Traffic	2
(104)	Hwy System	0
(109)	Truck Traffic	00%
(110)	Natl Truck Network	No

General Data

(21)	Maintenance Responsibility	02
(22)	Owner	02
(31)	Design Load	5
(33)	Bridge Median	0
(34)	Skew	00 deg
(35)	Str Flared	No
(37)	Hist Significance	4
(38)	Navigation Control	N
(42)	Type of Service	15
(43)	Structure Type Main	502
(44)	Structure Type Approach	000
(45)	No of Span Main	001
(46)	No of Approach Spans	0000
(27)	Year Built	1937
(106)	Year Reconstructed	1983
(107)	Deck Str Type	1
(108)	Wear Surf/Protv Sys	288
(111)	Nav Pier/Abut Protection	

Dimensional Data

(32)	Approach Rdwy Width	6.1 M
(39)	Navigation Vert Clr	000.0 M
(40)	Navigation Horz clr	0000.0 M
(48)	Max Span Length	0010.1 M
(49)	Str Length	00012.2 M
(50)	Curb/Sidewalk Width	Left 00.0 M
		Right 00.0 M
(51)	Brg Rdwy Width,curb-curb	006.1 M
(52)	Deck Width out-out	007.1 M
(53)	Min Vert Clr over	99.99 M
(54)	Min Vert Clr under	N 00.00 M
(55)	Min Lat Underclr R	N 00.0 M
(56)	Min Lat Underclr L	00.0 M
(112)	NBIS Bridge Length	Y
(116)	Navigation Min Vert Clr	M

Proposed Improvements

(75)	Type of Work	
(76)	Improvement Length	000000 M
(94)	Bridge Improv Cost	0
(95)	Rdwy Improv Cost	0
(96)	Total Proj Cost	6
(97)	Year of Cost Est	
(114)	Future ADT	0
(115)	Year of Future ADT	

Condition Rating

(58)	Deck	~~6~~ 7
(59)	Superstructure	~~6~~ 7
(60)	Substructure	~~6~~ 7
(61)	Channel & Channel Protect	7
(62)	Culverts	N

Appraisal Rating

(67)	Structure Evaluation	5
(68)	Deck Geometry	
(69)	Underclrn Vert & Horz	N
(71)	Waterway Adequacy	8
(72)	Approach Rdwy Alignment	5
(36)	Traffic Safety Features	~~1100~~ 1010

Scour Data

(113)	Scour Critical Bridges	8
(202)	Foundation Type	
(220)	Foundation Embedment	0.0 M
(221)	Scour Countermeasures	

Load Rate and Post

(41)	Str Open/Post/Close	~~Open~~ Posted
(64)	Operating Rating	20.4 ton
(66)	Inventory Rating	17.0 ton
(70)	Bridge Posting	1
(212)	Posted Limit	12 Ton

Proposed Maintenance

(212)	Repair Priority	
(213)	Proposed Maint Type	
(215)	Maintn Date Completed	/ /
(216)	Actual Maint Cost	0

Inspection Data

(90)	Inspection Date (MoYr)	04/2008 ~~04/2006~~ ~~04/2004~~
(91)	Inspection Frequency	24 Mo
(92)	Critical Feature Insp	(93) Date
	Frac Crit Insp : N	/
	Underwater Insp: N	/
	Other Spec Insp: N	/
(207)	Inspection Quarter	~~1~~ ~~2~~ 3
(208)	Inspection Number	04/10/2018
(210)	Date of Inspection	~~04/04/2007~~ 04/19/2012 04/15/2014

Over 200 Items

(200)	Princ Route Location	
(201)	Wear Surface Thickness	0.0 mm
(203)	District Maint Org	
(204)	Original Proj #	
(205)	Station Princ Rte	0.000
(206)	Bridge Rail Type	
(217)	Culvert Bbl Height	0.0 M
(218)	Culvert Bbl Length	0.0 M
(219)	Culvert Fill Height	0.0 M
(222)	Date of Load Rating	/ /
(223)	Tracs No	
(224)	Bridge Crew Region	
(225)	Total Deck Area (M^2)	0.0
(226)	Superstr Unit Cost	0.00
(227)	Substr Unit Cost	0.00 ~~$1~~
(228)	Next Insp Due Date (QuartYr)	~~107~~ ~~010~~ 016
(229)	Agency	COUNTY OF MAUI
(230)	Principal Route Number	360
(231)	Principal Route Letter	
(232)	Principal Route Milepost	0.000
(300)	Comments: Rebuilt 1983 bridge in excellant shape.	

Sufficiency Rating = 065.1

KAAPAHU #14 BRIDGE



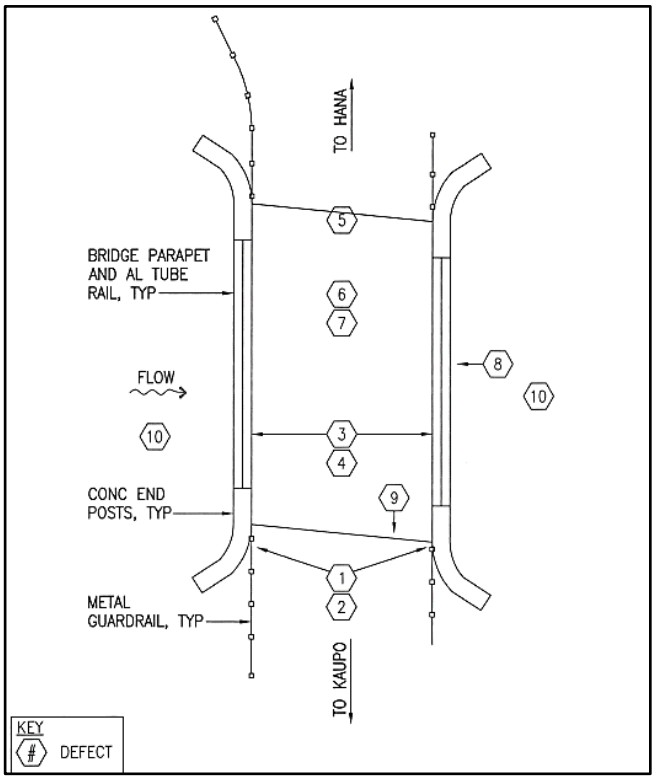
DESCRIPTION

The Kaapahu #14 bridge is a single span bridge originally constructed in 1937 and rebuilt in 1983. The bridge is 23'-3" wide and 34'-0" long. A cast-in-place concrete deck is supported on four precast prestressed concrete girders spanning between concrete abutments at the Hana and Kaupo ends of the bridge. CRM wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the deck and therefore the wearing surface is the top surface of the concrete deck.

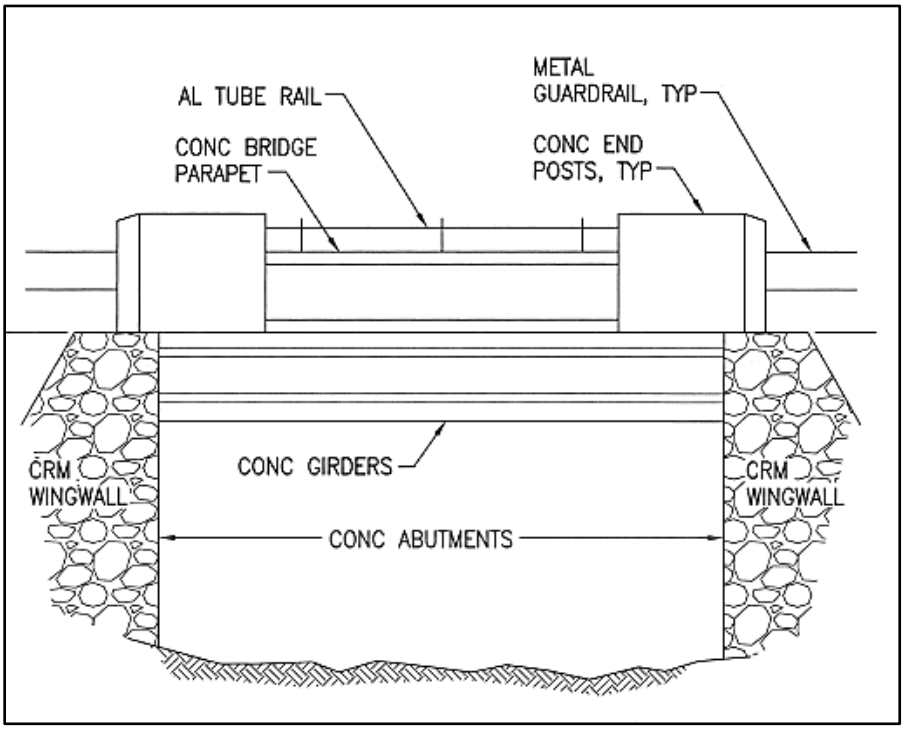
The structure data of the existing bridge is as follows:

• Number of Spans:	1
• Total Length of Bridge:	34'-0"
• Roadway Width Curb to Curb:	20'-0"
• Total Bridge Width (Out-to-Out):	23'-3"
• Skew:	unknown (bridge is skewed)
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	Top Surface of Concrete Deck
• Bridge Rails:	Combination Concrete New Jersey Barrier with Single AL Tube Rail
• Height of Bridge Rail:	2'-4" Conc. New Jersey Barrier + 12" AL Tube Rail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit To Stream Water Level:	9'-0"
• Water Depth Under Bridge:	0"-3"
• Posted Load Limit	No Posted Sign at Bridge

A combination concrete New Jersey barrier and single aluminum tubular rail with a total height of about 3'-4" is constructed along the upstream and downstream sides of the bridge. Metal approach guardrails are located at the approaches to the bridge and transitions to concrete end posts at the terminus of the bridge rails. There are no utilities crossing the stream with the bridge.



Bridge Plan



Elevation

STRUCTURAL INVENTORY AND APPRAISAL

HAWAII DEPARTMENT OF TRANSPORT)N STRUCTURAL INVENTORY AND APPRAIS DATE PRINTED: 05/23/2007

Structure Number: 009003600903909 (09) Str Name: KAAPAHU #14

Princ Rte: 360 Milepost: 0.000

Geographic and Route Data

(1)	State	Hawaii
(2)	District	20
(3)	County	Maui
(4)	Place	
(6)	Feature Under	KAAPAHU STRM-STRUC #14
(7)	Facility on	HAN HWY
(9)	Location	3.84MI W/RD TO HAMOA
(16)	Latitude	20° 39' 18.00"
(17)	Longitude	156° 49' 00.00"
(98)	Border Bridge	
(99)	Border Brdige Str No	
(103)	Terportary Str	

On and Under Record Data

		Route On
(5)	Inventory Route	1401003604
(10)	Min Vert Clr	99.99 M
(11)	Kilometerpoint	0056.599
(19)	Detour Length	199 km
(20)	Toll	3
(26)	Func Class	06
(28)	Lanes on/under	0100
(29)	ADT	245
(30)	Year of ADT	1998
(47)	Total Horz Clearance	06.1 M
(100)	Defense Hwy	0
(101)	Parallel Str	N
(102)	Direction of Traffic	3
(104)	Hwy System	1
(109)	Truck Traffic	00%
(110)	Natl Truck Network	No

General Data

(21)	Maintenance Responsibility	02
(22)	Owner	02
(32)	Design Load	5
(33)	Bridge Median	0
(34)	Skew	00 deg
(35)	Str Flared	No
(37)	Hist Significance	4
(38)	Navigation Control	N
(42)	Type of Service	15
(43)	Structure Type Main	502
(44)	Structure Type Approach	000
(45)	No of Span Main	001
(46)	No of Approach Spans	0000
(27)	Year Built	1937
(106)	Year Reconstructed	1983
(107)	Deck Str Type	1
(108)	Wear Surf/Protv Sys	109
(111)	Nav Pier/Abut Protection	

Dimensional Data

(32)	Approach Rdwy Width	6.1 M
(39)	Navigation Vert Clr	000.0 M
(40)	Navigation Horz clr	0000.0 M
(48)	Max Span Length	0006.1 M
(49)	Str Length	00009.2 M
(50)	Curb/Sidewalk Width	Left 00.0 M
		Right 00.0 M
(51)	Brg Rdwy Width,curb-curb	006.1 M
(52)	Deck Width out-out	006.7 M
(53)	Min Vert Clr over	99.99 M
(54)	Min Vert Clr under	N 00.00 M
(55)	Min Lat Underclr R	N 00.0 M
(56)	Min Lat Underclr L	00.0 M
(112)	NBIS Bridge Length	Y
(116)	Navigation Min Vert Clr	N

Proposed Improvements

(75)	Type of Work	
(76)	Improvement Length	000000 M
(94)	Bridge Improv Cost	0
(95)	Rdwy Improv Cost	0
(96)	Total Proj Cost	0
(97)	Year of Cost Est	
(114)	Future ADT	0
(115)	Year of Future ADT	

Condition Rating

(58)	Deck	6 ~~7~~
(59)	Superstructure	5 ~~8~~
(60)	Substructure	7 ~~8~~
(61)	Channel & Channel Protect	7
(62)	Culverts	N

Appraisal Rating

(67)	Structure Evaluation	6
(68)	Deck Geometry	N
(69)	Underclrn Vert & Horz	N
(71)	Waterway Adequacy	8
(72)	Approach Rdwy Alignment	7
(36)	Traffic Safety Features	~~1100~~ 1010

Scour Data

(113)	Scour Critical Bridges	8
(202)	Foundation Type	
(220)	Foundation Embedment	0.0 M
(221)	Scour Countermeasures	

Load Rate and Post

(41)	Str Open/Post/Close	~~Open~~ Posted
(64)	Operating Rating	18.5 ton
(66)	Inventory Rating	12.7 ton
(70)	Bridge Posting	0
(211)	Posted Limit	12 Ton

Proposed Maintenance

(212)	Repair Priority	
(213)	Proposed Maint Type	
(215)	Maintn Date Completed	/ /
(216)	Actual Maint Cost	0

Inspection Data

(50)	Inspection Date (MoYr)	~~0407~~ 0406 ~~0414~~
(51)	Inspection Frequency	24 Mo
(92)	Critical Feature Insp	(93) Date
	Frac Crit Insp : N	/
	Underwater Insp: N	/
	Other Spec Insp: N	/
(207)	Inspection Quarter	3 ~~2~~ ~~4~~ 2
(208)	Inspection Number	~~04192043~~ ~~04032057~~ 04052048
(210)	Date of Inspection	4/04/2006

Over 200 Items

(200)	Princ Route Location	
(201)	Wear Surface Thickness	0.0 mm
(203)	District Maint Org	
(204)	Original Proj #	
(205)	Station Princ Rte	0.000
(206)	Bridge Rail Type	
(217)	Culvert Bbl Height	0.0 M
(218)	Culvert Bbl Length	0.0 M
(219)	Culvert Fill Height	0.0 M
(222)	Date of Load Rating	/ /
(223)	Tracs No	
(224)	Bridge Crew Region	
(225)	Total Deck Area (M^2)	0.0
(226)	Superstr Unit Cost	0.00
(227)	Substr Unit Cost	0.00
(228)	Next Insp Due Date (QuartYr)	409 ~~310~~ 310
(229)	Agency	COUNTY OF MAUI
(230)	Principal Route Number	360
(231)	Principal Route Letter	
(232)	Principal Route Milepost	0.000
(300)	Comments: High-lited items have been revised.	

Sufficiency Rating = 062.1

KAHOLOPO #31 BRIDGE



DESCRIPTION

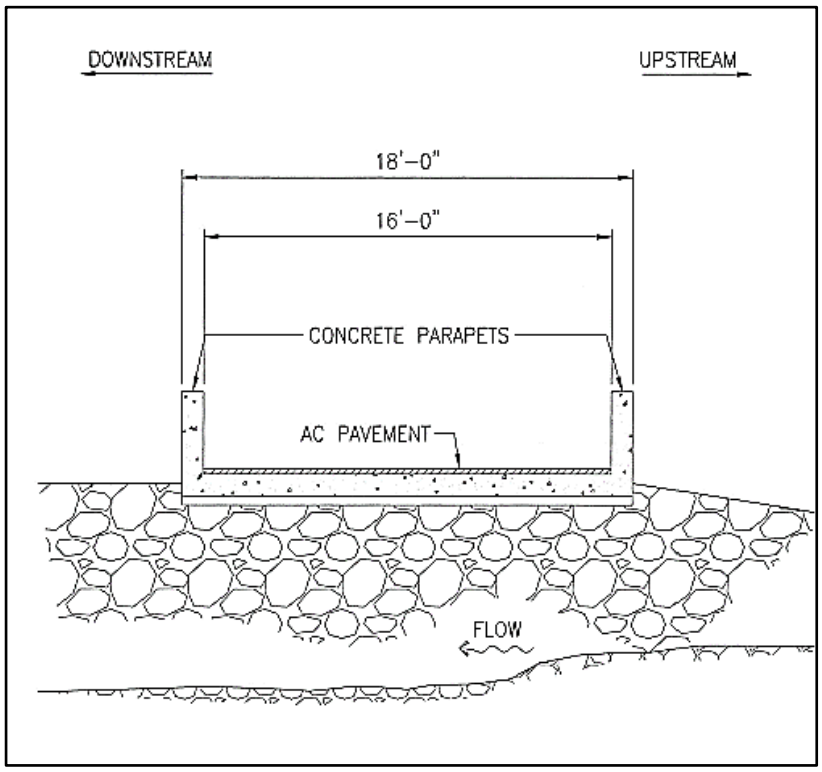
The Kaholopo #31 bridge is a single span bridge reconstructed in 2014. The bridge is 18'-0" feet wide and 44'-3" long. A cast in place concrete slab forms the superstructure and span between concrete abutments with a CRM protection at the Hana and Kaupo ends of the bridge. CRM protection wingwalls are located at the upstream and downstream ends of both abutments. There is an AC overlay bridge deck.

The structure data of the existing bridge is as follows:

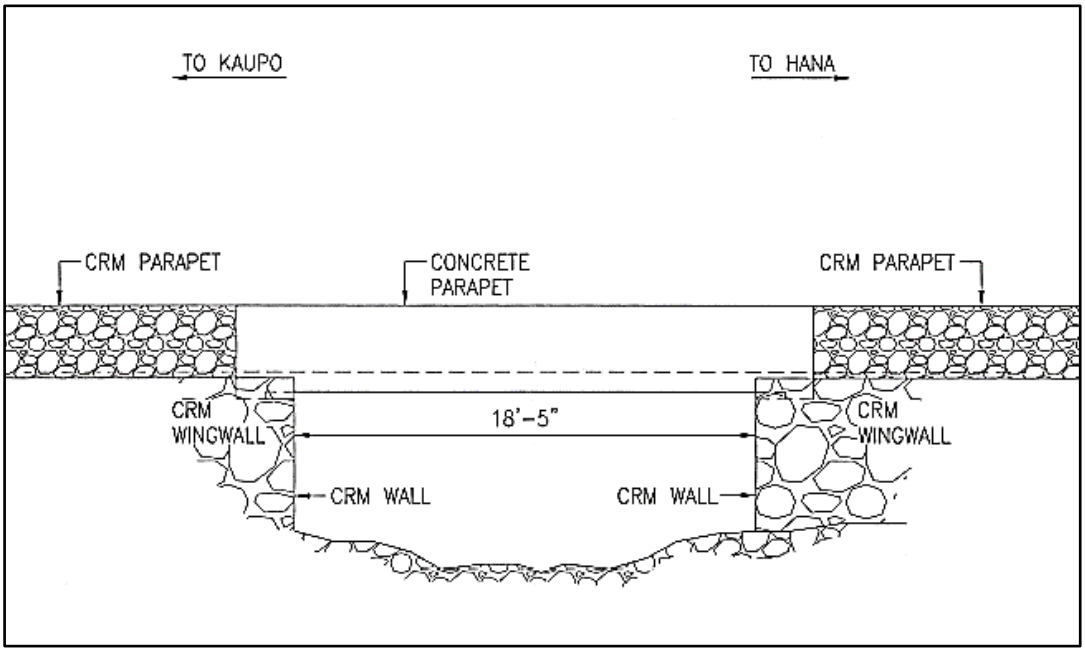
• Number of Spans:	1
• Total Length of Bridge:	44'-3"
• Roadway Width (Curb to Curb):	16'-0"
• Total Bridge Width (Out-to-Out):	18'-0"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	AC Pavement Overlay
• Bridge Parapets:	Concrete
• Height of Bridge Parapet:	2'-8"
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined Dry Stream
• Approx. Clearance From Slab Soffit To Stream Bed:	Varies 7' to 8'-6" ± ("dry-stream")
• Water Depth Under Bridge:	0'
• Posted Load Limit	None

There are guardrail ends, guardrails, and guardrail transitions at the Hana and Kaupo ends of the bridge that connect to CRM wall at the ends of the concrete bridge parapets.

There are no utilities crossing the stream with the bridge.



Cross-section



Downstream elevation

KALEPA #12 BRIDGE



DESCRIPTION

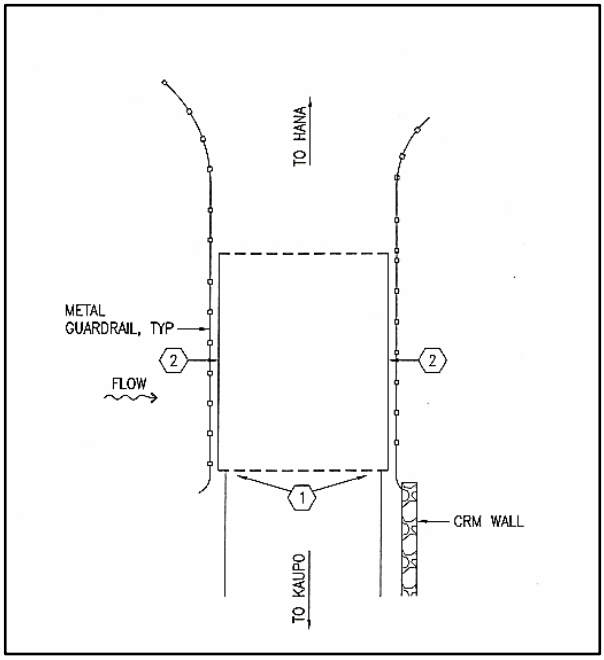
The Kalepa #12 bridge is a single span bridge originally constructed in 1937 and partially reconstructed 1993. The bridge is 15'-0" feet wide and 24'-0" long. Four 3'-9" wide precast concrete planks form the superstructure and span between combination concrete/CRM abutments at the Hana and Kaupo ends of the bridge. CRM wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the precast planks and therefore the top surface is exposed and serves as the wearing surface.

The structure data of the existing bridge is as follows:

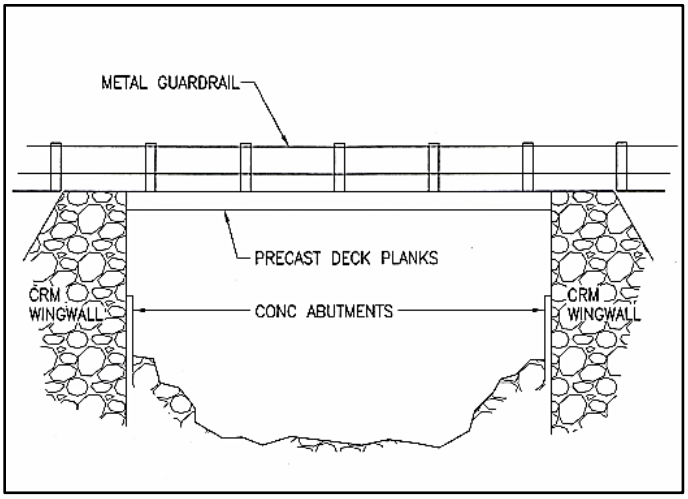
• Number of Spans:	1
• Total Length of Bridge:	24'-0"
• Roadway Width Guardrail to Guardrail:	14'-0"
• Total Bridge Width (Out-to-Out):	15'-0"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	Top Surface of Precast Concrete Planks
• Bridge Rails:	Metal Guardrail (Painted)
• Height of Bridge Rail:	2'-1"
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined Dry Stream
• Approx. Clearance From Slab Soffit To Stream Bed:	Varies 7' to 4'-8" ± ("dry-stream")
• Water Depth Under Bridge:	0'
• Posted Load Limit	9 tons

The approach guardrails at the Hana end of the bridge continue over the bridge and terminate at the Kaupo end of bridge. A 2' high rock wall at the Kaupo end of the bridge continues from the bridge along the downstream side of the approach roadway.

There are no utilities crossing the stream with the bridge.



Bridge plan



Elevation

LOAD RATING

Calculations are based on information contained in the as-builts drawings and observed conditions during the field inspections. For this bridge complete as- built drawings were not available. Sketches indicate five (5) prestressing strands to be designed by the prestressing plank fabricator. Load rating is based on field survey during inspection in combination with back calculations based on an assumed design using H-15 truck loading. Size, stresses and losses for prestressing strands were assumed based on probable prestressing at the time of construction. Based on the Structural Inventory and Appraisal coding it is assumed that prestressing planks were installed at time of reconstruction in 1993 (code 1 06). Therefore 1992 AASHTO specifications were used for back calculation to determine probably prestressing reinforcement.

The load ratings for Kalepa Bridge are summarized below

Load Type			Rating Factor
Design Load	Inventory Level	HL-93 Truck + HL-93 Lane	0.12
		HL-93 Tandem + HL-93 Lane	0.09
	Operating Level	HL-93 Truck + HL-93 Lane	0.47
		HL-93 Tandem + HL-93 Lane	0.40
Legal Load	Type 3		0.62
	Type 3S2		0.66
	Type 3-3		0.75
	NRL		0.47
	SU4		0.54
	SU5		0.51
	SU6		0.47
	SU7		0.47
Permit Load	HP1		0.41
	HP2		0.29
	HP3		0.52

Bridge posting is required for Kalepa Bridge since the load rating factor for the legal loads is less than 1.0. Recommend posting load for this bridge is 9 Tons.

KUKUIULA #15 BRIDGE



DESCRIPTION

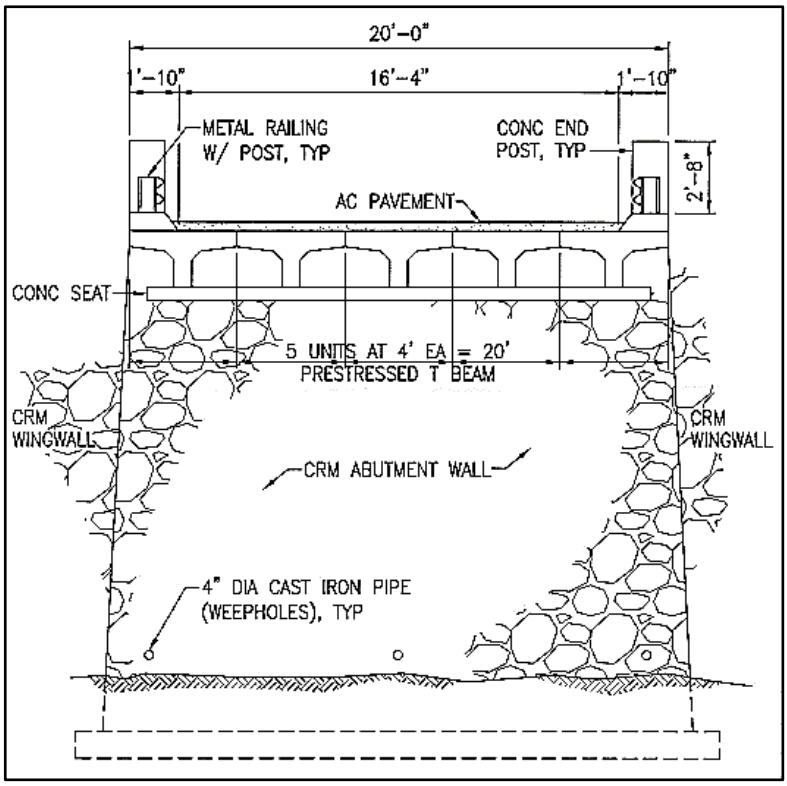
The Kukuiula #15 bridge is a single span precast prestressed concrete single tee girder bridge constructed in 1969. The bridge is 20'-0" feet wide and 34'-0" long. The deck is overlaid with an asphaltic concrete (A. C.) pavement. The bridge superstructure consists of five prestressed single tee girders spanning between CRM abutments at the Hana and Kaupo ends of the bridge. A concrete footing apron slab is exposed in front of the Hana abutment. CRM wingwalls are located at the upstream and downstream ends of both abutments.

The structure data of the existing bridge is as follows:

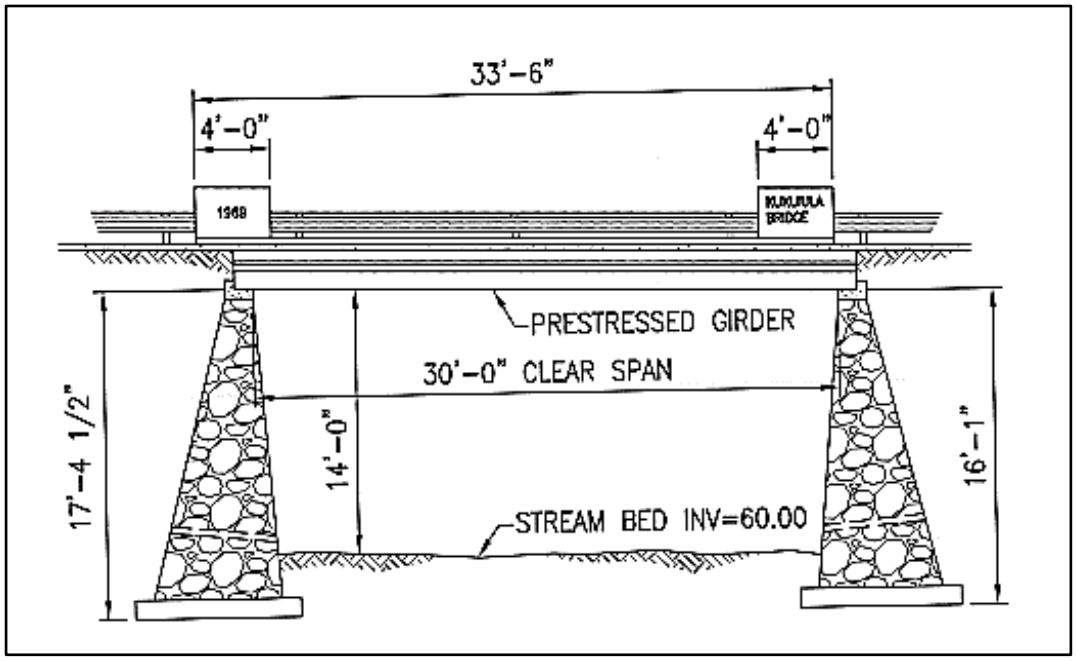
• Number of Spans:	1
• Total Length of Bridge:	34'-0"
• Roadway Width Guardrail to Guardrail:	16'-4""
• Total Bridge Width (Out-to-Out):	20'-0"
• Skew:	15 deg.
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	AC Overlay
• Bridge Rails:	Concrete Curb + Metal Guardrail & Concrete End Posts
• Height of Bridge Rail:	4" Conc. Curb + 16" Metal Guardrail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Girder Soffit To Water:	14'
• Water Depth Under Bridge:	0" to 18"
• Posted Load Limit	10 Tons

The bridge railing consists of a 16" high metal guardrail mounted on a 4" high concrete curb. The approach guardrails at each end of the bridge abruptly terminate at the end of concrete end posts.

There are no utilities crossing the stream with the bridge.



Cross-section



Elevation

MANAWAINUI #9 BRIDGE



DESCRIPTION

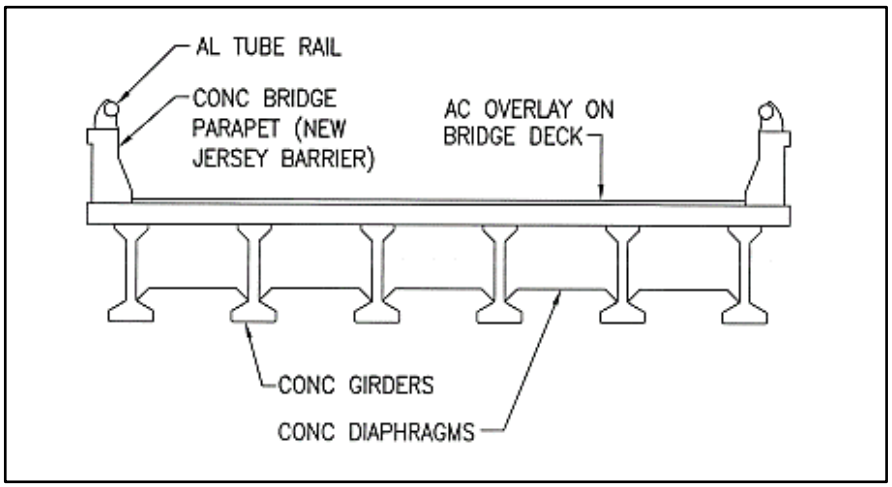
The Manawainui #9 bridge is a single span bridge constructed in 1993. The bridge is 27'-8" wide and 68'-8" long. A cast-in-place concrete deck is supported on six precast prestressed concrete girders spanning between concrete abutments at the Hana and Kaupo ends of the bridge. Concrete wingwalls are located at the upstream and downstream ends of both abutments. There is no overlay on the deck and therefore the wearing surface is the top surface of the concrete deck. The bridge deck abuts the AC paved roadway at both ends of the bridge. The channel under the bridge is lined with concrete which protects the embankments in front of the abutments and wingwalls. Remnants of an old bridge's substructure remain upstream of the bridge.

The structure data of the existing bridge is as follows:

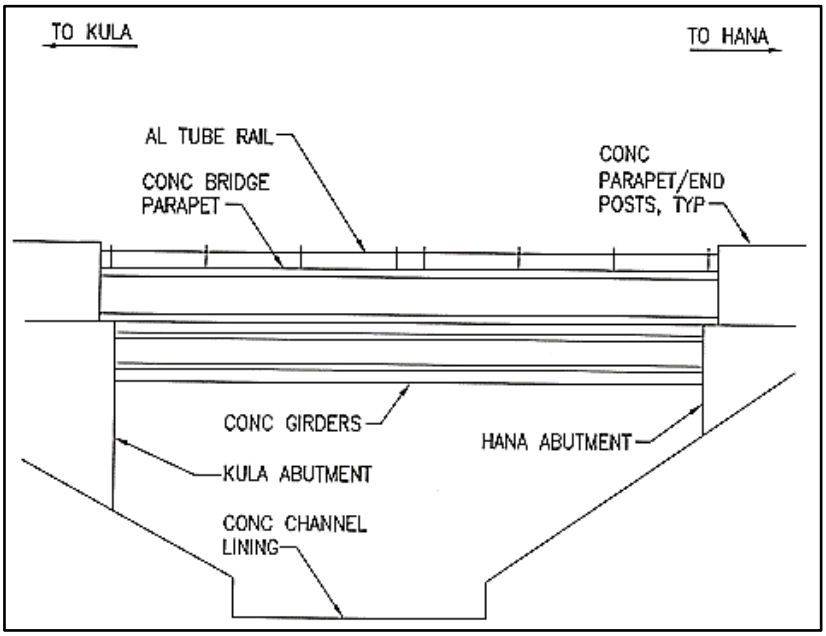
• Number of Spans:	1
• Total Length of Bridge:	68'-8"
• Roadway Width Curb to Curb:	24'-0"
• Total Bridge Width (Out-to-Out):	27'-8"
• Skew:	0 deg.
• No. of Lanes Crossing on Bridge:	2
• Wearing Surface on Bridge:	Top Surface of Concrete Deck
• Bridge Rails:	Combination Concrete New Jersey Barrier with Single AL Tube Rail
• Height of Bridge Rail:	2'-7" Conc. New Jersey Barrier + 12" AL Tube Rail
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Stream
• Approx. Clearance From Girder Soffit To Stream Water Level:	21'
• Water Depth Under Bridge:	0' (Dry Stream)
• Posted Load Limit	No Posted Sign at Bridge

A combination concrete New Jersey barrier and single aluminum tubular rail with a total height of about 3'-7" is constructed along the upstream and downstream sides of the bridge. Metal approach guardrails are located at the approaches to the bridge and transitions to concrete end posts at three corners of the bridge. At the downstream Kula end, a 4' high concrete barrier continues from the bridge railing and transitions to a metal guardrail.

There are no utilities crossing the stream with the bridge.



Cross-section



Elevation

MANAWAINUI #80 BRIDGE



DESCRIPTION

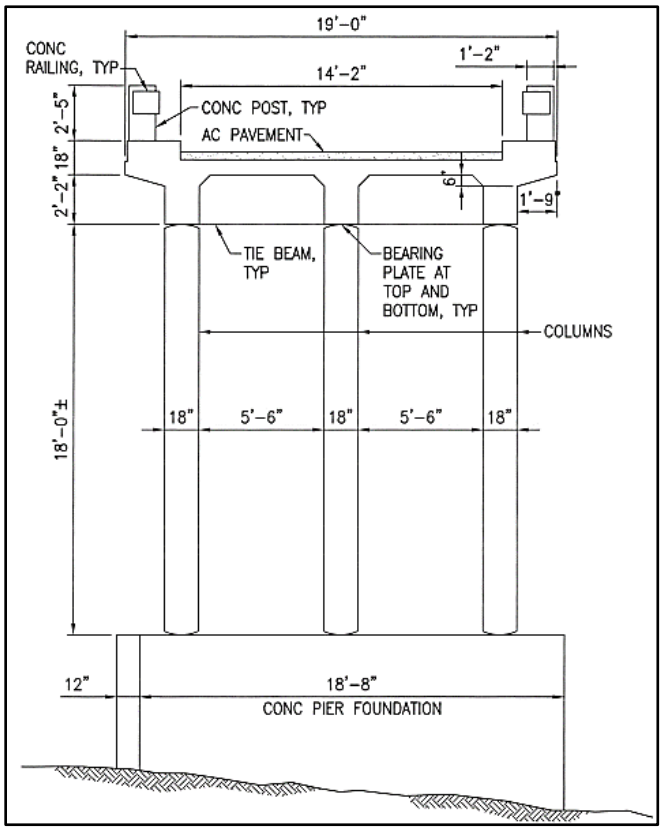
The Manawainui #80 bridge is a reinforced concrete tee beam bridge constructed in 1947. The bridge is 19'-0" wide and 101'-5" long. The 3-span cast-in-place monolithic deck and beam system is supported on concrete abutments at each end of the bridge and 2 intermediate concrete piers. Concrete wingwalls are constructed integrally with the breastwall on the upstream and downstream ends of the abutments. The piers consist of a concrete base wall supporting 3 tall concrete rockers directly under each of the tee beams. An A. C. overlay wearing surface covers the deck surface.

The structure data of the existing bridge is as follows:

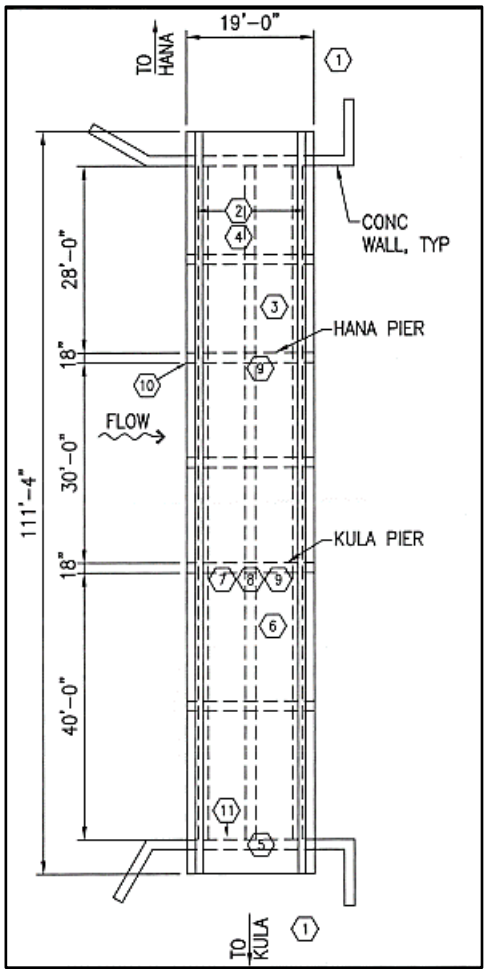
• Number of Spans:	3
• Total Length of Bridge:	101'-5"
• Roadway Width Curb to Curb:	14'-2"
• Total Bridge Width (Out-to-Out):	19'-0"
• Skew:	0
• No. of Lanes Crossing on Bridge:	1
• Wearing Surface on Bridge:	AC
• Bridge Rails:	Concrete Post and Beam
• Height of Bridge Rail:	26" High Concrete Rail on 8" High Concrete Curb
• Roadway Fill Over Bridge:	None
• Type of Channel Under Bridge:	Unlined Stream
• Approx. Clearance From Girder Soffit To Stream Water Level:	32'
• Water Depth Under Bridge:	0" To 18"
• Posted Load Limit	11 Tons

A concrete post and beam type rail with a height of about 26" is constructed on an 8" high curb along the upstream and downstream sides of the bridge. There are no approach guardrails.

A 2" diameter galvanized waterline cross over the bridge on top of the concrete curb along the downstream side of the bridge.



Cross-section



APPENDIX F: COST ESTIMATE

PACIFIC COST ENGINEERING, LLC

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
JOB NUMBER: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 12 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST

SUMMARY OF OPTION(S)

1. Repair to As-Built Condition	1	ls		$ 11,805,914
2. Rock Rubble Mound Revetment w/ Berm Toe (4 tn Stone)	1	ls		$ 15,357,802
3. Rock Rubble Mound Revetment w/ Berm Toe (9 tn Stone)	1	ls	*Not Feasiable Due to Project Site Conditions*	
4. Tribar Revetment w/ Berm Toe	1	ls	*Not Feasiable Due to Project Site Conditions*	
5. Low Angle Revetment w/ CRM Wall	1	ls		$ 15,822,442
6. Low Angle Revetment w/ Concrete Wall	1	ls		$ 25,414,408

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 12 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UNIT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
Repair to As-Built Condition								
PRIME CONTRACTOR								
DIV 01000								
Mobilization & temporary staging area	1	ls	$ 5,000.00	$ 5,000	$ 75,000.00	$ 75,000	$ 80,000.00	$ 80,000
Field office & supplies	12	mo	$ 2,750.00	$ 33,000	$ -	$ -	$ 2,750.00	$ 33,000
Field staff & management	12	mo	$ -	$ -	$ 36,268.13	$ 435,218	$ 36,268.13	$ 435,218
BMP' erosion/water control	1	ls	$ -	$ -	$ 250,000.00	$ 250,000	$ 250,000.00	$ 250,000
Turbidity/silt barrier	500	lf	$ 175.00	$ 87,500	$ 55.00	$ 27,500	$ 230.00	$ 115,000
Generator, 2 ea	12	mo	$ 230.00	$ 2,760	$ 920.00	$ 11,040	$ 1,150.00	$ 13,800
Vertical mast light tower, 3 ea	12	mo	$ -	$ -	$ 5,400.00	$ 64,800	$ 5,400.00	$ 64,800
Jersey barriers	1	ls	$ -	$ -	$ 23,375.00	$ 23,375	$ 23,375.00	$ 23,375
Steel road plates	12	mo	$ -	$ -	$ 4,500.00	$ 54,000	$ 4,500.00	$ 54,000
Traffic control	261	day	$ -	$ -	$ 1,050.40	$ 274,154	$ 1,050.40	$ 274,154
FOG	1	ls	$ 4,800.00	$ 4,800	$ -	$ -	$ 7,925.00	$ 4,800
Daily job clean-up	12	mo	$ -	$ -	$ 1,214.74	$ 14,577	$ 1,214.74	$ 14,577
Demobilization & final clean-up	1	ls	$ -	$ -	$ 50,000.00	$ 50,000	$ 50,000.00	$ 50,000
SUBTOTAL				$ 133,060		$ 1,279,664		$ 1,412,724
DIV 01000								
Mobilize/transport equipment	2	lds	$ -	$ -	$ 1,620.56	$ 3,241	$ 1,620.56	$ 3,241
Hydraulic excavator, 2 ea	24	mo	$ -	$ -	$ 9,500.00	$ 228,000	$ 2,300.00	$ 228,000
Demob/transport equipment	2	lds	$ -	$ -	$ 1,620.56	$ 3,241	$ 1,620.56	$ 3,241
SUBTOTAL				$ -		$ 234,482		$ 234,482
DIV 32000								
Kalepa #12 bridge retrofit	1	ea	$ 1,500,000	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 2,500,000	$ 2,500,000
SUBTOTAL				$ 1,500,000		$ 1,000,000		$ 2,500,000
DIV 31000								
Remove & dispose existing guard rail	430	lf	$ -	$ -	$ 30.53	$ 13,130	$ 30.53	$ 13,130
Site preparation & grading	1,526	cy	$ -	$ -	$ 13.74	$ 20,973	$ 13.74	$ 20,973
Geotextile fabric	2,150	sy	$ 2.25	$ 4,838	$ 5.00	$ 10,750	$ 7.25	$ 15,588
Place underlayer stones	763	cy	$ -	$ -	$ 17.15	$ 13,089	$ 17.15	$ 13,089
Place armor stones	2,508	cy	$ -	$ -	$ 25.73	$ 64,542	$ 25.73	$ 64,542
SUBTOTAL				$ 4,838		$ 122,484		$ 127,322
SUBTOTAL G.C.								$ 4,274,528
OVERHEAD: 25.00%								$ 1,068,632
TOTAL G.C.								$ 5,343,160

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 12 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
SUBCONTRACTOR(S)								
DIV 02000 & 31000								
Construction stake-out/survey	1	ls	$ -	$ -	$ 5,000.00	$ 5,000	$ 5,000.00	$ 5,000
Haul underlayer stone to job site	763	cy	$ 59.80	$ 45,627	$ 35.05	$ 26,745	$ 94.85	$ 72,372
Haul armor stone to job site	2,508	cy	$ 82.81	$ 207,715	$ 35.05	$ 87,923	$ 117.86	$ 295,638
Haul dredged material to off-site stockpile	1,526	cy	$ -	$ -	$ 35.05	$ 53,490	$ 35.05	$ 53,490
Concrete guardrail	430	lf	$ 172.93	$ 74,359	$ 951.30	$ 409,057	$ 1,124.22	$ 483,416
SUBTOTAL				$ 327,701		$ 582,215		$ 909,916

SUBTOTAL			$ 909,916
OVERHEAD:	45.00%		$ 409,462
PROFIT:	10.00%		$ 131,938
STATE TAX:	4.17%		$ 60,462
TOTAL SUBCONTRACTOR(S)			$ 1,511,778
TOTAL - G.C.			$ 5,343,160
TOTAL - SUBCONTRACT			$ 1,511,778
G.C. OVERHEAD ON SUBCONTRACT:	5.00%		$ 75,589
PROFIT:	8.00%		$ 554,442
BOND:	2.00%		$ 149,699
CONTINGENCIES:	15.00%		$ 1,145,200
STATE TAX:	4.17%		$ 302,789
FORCE ACCOUNTS & ALLOWANCES			$ 350,000
SUBTOTAL			$ 9,432,657
CONTINGENCIES		5.00%	$ 471,633
SUBTOTAL			$ 9,904,290
CONSTRUCTION ENGINEERING		15.00%	$ 1,485,643
CM/CSS/POST DES./NON-LABOR)	30.00%		$ 445,693
STAFF LABOR	70.00%		$ 1,039,950
ADMINSTRATION OF INDIRECT COST		40.00%	$ 415,980
TOTAL OF ALL ITEMS			$ 11,805,914

Additional Water Pollution, Dust, and Erosion Control	$ 50,000
Water Quality Monitoring	$ 250,000
Additional Police Officers, Additional Traffic Control Devices, and Advertisement	$ 50,000
TOTAL FORCE ACCOUNT & ALLOWANCES	$ 350,000

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 15 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UNIT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
Rock Rubble Mound Revetment w/ Berm Toe (4 tn Stone)								
PRIME CONTRACTOR								
DIV 01000								
Mobilization & temporary staging area	1	ls	$ 5,000.00	$ 5,000	$ 75,000.00	$ 75,000	$ 80,000.00	$ 80,000
Field office & supplies	15	mo	$ 2,750.00	$ 41,250	$ -	$ -	$ 2,750.00	$ 41,250
Field staff & management	15	mo	$ -	$ -	$ 36,268.13	$ 544,022	$ 36,268.13	$ 544,022
BMP' erosion/water control	1	ls	$ -	$ -	$ 250,000.00	$ 250,000	$ 250,000.00	$ 250,000
Turbidity/silt barrier	500	lf	$ 175.00	$ 87,500	$ 55.00	$ 27,500	$ 230.00	$ 115,000
Generator, 2 ea	15	mo	$ 230.00	$ 3,450	$ 920.00	$ 13,800	$ 1,150.00	$ 17,250
Vertical mast light tower, 3 ea	15	mo	$ -	$ -	$ 5,400.00	$ 81,000	$ 5,400.00	$ 81,000
Jersey barriers	1	ls	$ -	$ -	$ 23,375.00	$ 23,375	$ 23,375.00	$ 23,375
Steel road plates	15	mo	$ -	$ -	$ 4,500.00	$ 67,500	$ 4,500.00	$ 67,500
Traffic control	326	day	$ -	$ -	$ 1,050.40	$ 342,430	$ 1,050.40	$ 342,430
FOG	1	ls	$ 18,000.00	$ 18,000	$ -	$ -	$ 7,925.00	$ 18,000
Daily job clean-up	15	mo	$ -	$ -	$ 1,214.74	$ 18,221	$ 1,214.74	$ 18,221
Demobilization & final clean-up	1	ls	$ -	$ -	$ 50,000.00	$ 50,000	$ 50,000.00	$ 50,000
SUBTOTAL				$ 155,200		$ 1,492,848		$ 1,648,048
DIV 01000								
Mobilize/transport equipment	6	lds	$ -	$ -	$ 1,620.56	$ 9,723	$ 1,620.56	$ 9,723
Bobcat	15	mo	$ -	$ -	$ 1,380.00	$ 20,700	$ 2,300.00	$ 20,700
Hydraulic excavator, 2 ea	30	mo	$ -	$ -	$ 9,500.00	$ 285,000	$ 2,300.00	$ 285,000
Backhoe	15	mo	$ -	$ -	$ 2,300.00	$ 34,500	$ 2,300.00	$ 34,500
FE loader	15	mo	$ -	$ -	$ 3,800.00	$ 57,000	$ 3,800.00	$ 57,000
Crane	15	mo	$ -	$ -	$ 10,950.00	$ 164,250	$ 7,925.00	$ 164,250
Demob/transport equipment	6	lds	$ -	$ -	$ 1,620.56	$ 9,723	$ 1,620.56	$ 9,723
SUBTOTAL				$ -		$ 580,896		$ 580,896
DIV 32000								
Kalepa #12 bridge retrofit	1	ea	$ 1,500,000	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 2,500,000	$ 2,500,000
SUBTOTAL				$ 1,500,000		$ 1,000,000		$ 2,500,000
DIV 31000								
Remove & dispose existing guard rail	430	lf	$ -	$ -	$ 30.53	$ 13,130	$ 30.53	$ 13,130
Site preparation & grading	3,052	cy	$ -	$ -	$ 13.74	$ 41,946	$ 13.74	$ 41,946
Temporary access platform	1,200	cy	$ -	$ -	$ 120.99	$ 145,184	$ 120.99	$ 145,184
Geotextile fabric	4,300	sy	$ 2.25	$ 9,675	$ 5.00	$ 21,500	$ 7.25	$ 31,175
Place underlayer stones	1,526	cy	$ -	$ -	$ 17.15	$ 26,177	$ 17.15	$ 26,177
Place armor stones	4,625	cy	$ -	$ -	$ 25.73	$ 119,007	$ 25.73	$ 119,007
Remove & load temporary access platform	1,200	cy	$ -	$ -	$ 120.99	$ 145,184	$ 120.99	$ 145,184
SUBTOTAL				$ 9,675		$ 512,128		$ 521,803
SUBTOTAL G.C.								$ 5,250,747
OVERHEAD: 25.00%								$ 1,312,687
TOTAL G.C.								$ 6,563,434

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 15 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
SUBCONTRACTOR(S)								
DIV 02000 & 31000								
Construction stake-out/survey	1	ls	$ -	$ -	$ 5,000.00	$ 5,000	$ 5,000.00	$ 5,000
Load & haul dredged material to off-site stockpile	3,052	cy	$ -	$ -	$ 62.84	$ 191,774	$ 62.84	$ 191,774
Haul underlayer stone to job site	1,526	cy	$ 59.80	$ 91,255	$ 35.05	$ 53,490	$ 94.85	$ 144,745
Haul armor stone to job site	4,625	cy	$ 82.81	$ 382,996	$ 35.05	$ 162,118	$ 117.86	$ 545,114
Haul aggregate/stone to job site	1,200	cy	$ 39.65	$ 47,580	$ 35.05	$ 42,063	$ 74.70	$ 89,643
Concrete guardrail	430	lf	$ 172.93	$ 74,359	$ 951.30	$ 409,057	$ 1,124.22	$ 483,416
SUBTOTAL				$ 596,190		$ 863,502		$ 1,459,692
SUBTOTAL								$ 1,459,692
OVERHEAD: 45.00%								$ 656,861
PROFIT: 10.00%								$ 211,655
STATE TAX: 4.17%								$ 96,993
TOTAL SUBCONTRACTOR(S)								$ 2,425,201
TOTAL - G.C.								$ 6,563,434
TOTAL - SUBCONTRACT								$ 2,425,201
G.C. OVERHEAD ON SUBCONTRACT: 5.00%								$ 121,260
PROFIT: 8.00%								$ 728,792
BOND: 2.00%								$ 196,774
CONTINGENCIES: 15.00%								$ 1,505,319
STATE TAX: 4.17%								$ 379,755
FORCE ACCOUNTS & ALLOWANCES								$ 350,000
SUBTOTAL								$ 12,270,535
CONTINGENCIES				5.00%				$ 613,527
SUBTOTAL								$ 12,884,062
CONSTRUCTION ENGINEERING				15.00%				$ 1,932,609
CM/CSS/POST DES./NON-LABOR)			30.00%				$ 579,783	
STAFF LABOR			70.00%				$ 1,352,826	
ADMINSTRATION OF INDIRECT COST				40.00%				$ 541,131
TOTAL OF ALL ITEMS								$ 15,357,802

Additional Water Pollution, Dust, and Erosion Control	$ 50,000
Water Quality Monitoring	$ 250,000
Additional Police Officers, Additional Traffic Control Devices, and Advertisement	$ 50,000
TOTAL FORCE ACCOUNT & ALLOWANCES	$ 350,000

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 17 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
Low Angle Revetment w/ CRM Wall								
PRIME CONTRACTOR								
DIV 01000								
Mobilization & temporary staging area	1	ls	$ 5,000.00	$ 5,000	$ 75,000.00	$ 75,000	$ 80,000.00	$ 80,000
Field office & supplies	17	mo	$ 2,750.00	$ 46,750	$ -	$ -	$ 2,750.00	$ 46,750
Field staff & management	17	mo	$ -	$ -	$ 36,268.13	$ 616,558	$ 36,268.13	$ 616,558
BMP' erosion/water control	1	ls	$ -	$ -	$ 250,000.00	$ 250,000	$ 250,000.00	$ 250,000
Turbidity/silt barrier	500	lf	$ 175.00	$ 87,500	$ 55.00	$ 27,500	$ 230.00	$ 115,000
Generator, 2 ea	17	mo	$ 230.00	$ 3,910	$ 920.00	$ 15,640	$ 1,150.00	$ 19,550
Vertical mast light tower, 3 ea	17	mo	$ -	$ -	$ 5,400.00	$ 91,800	$ 5,400.00	$ 91,800
Jersey barriers	1	ls	$ -	$ -	$ 23,375.00	$ 23,375	$ 23,375.00	$ 23,375
Steel road plates	17	mo	$ -	$ -	$ 4,500.00	$ 76,500	$ 4,500.00	$ 76,500
Compactor, vibratory plate	6	mo	$ -	$ -	$ 420.00	$ 2,520	$ 420.00	$ 2,520
Traffic control	370	day	$ -	$ -	$ 1,050.40	$ 388,648	$ 1,050.40	$ 388,648
FOG	1	ls	$ 30,600.00	$ 30,600	$ -	$ -	$ 7,925.00	$ 30,600
Daily job clean-up	17	mo	$ -	$ -	$ 1,214.74	$ 20,651	$ 1,214.74	$ 20,651
Demobilization & final clean-up	1	ls	$ -	$ -	$ 50,000.00	$ 50,000	$ 50,000.00	$ 50,000
SUBTOTAL				$ 173,760		$ 1,638,192		$ 1,811,952
DIV 01000								
Mobilize/transport equipment	9	lds	$ -	$ -	$ 1,620.56	$ 14,585	$ 1,620.56	$ 14,585
Bobcat	17	mo	$ -	$ -	$ 1,380.00	$ 23,460	$ 2,300.00	$ 23,460
Hydraulic excavator, 2 ea	34	mo	$ -	$ -	$ 9,500.00	$ 323,000	$ 2,300.00	$ 323,000
Backhoe	17	mo	$ -	$ -	$ 2,300.00	$ 39,100	$ 2,300.00	$ 39,100
FE loader	17	mo	$ -	$ -	$ 3,800.00	$ 64,600	$ 3,800.00	$ 64,600
Drum roller	3	mo	$ -	$ -	$ 5,525.00	$ 16,575	$ 3,800.00	$ 16,575
Crane	17	mo	$ -	$ -	$ 10,950.00	$ 186,150	$ 7,925.00	$ 186,150
Demob/transport equipment	9	lds	$ -	$ -	$ 1,620.56	$ 14,585	$ 1,620.56	$ 14,585
SUBTOTAL				$ -		$ 682,055		$ 682,055
DIV 32000								
Kalepa #12 bridge retrofit	1	ea	$ 1,500,000	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 2,500,000	$ 2,500,000
SUBTOTAL				$ 1,500,000		$ 1,000,000		$ 2,500,000
DIV 31000								
Remove & dispose existing guard rail	430	lf	$ -	$ -	$ 30.53	$ 13,130	$ 30.53	$ 13,130
Site preparation & grading	1,702	cy	$ -	$ -	$ 13.74	$ 23,392	$ 13.74	$ 23,392
Temporary access platform	1,200	cy	$ -	$ -	$ 85.76	$ 102,908	$ 85.76	$ 102,908
Geotextile fabric	1,194	sy	$ 2.25	$ 2,688	$ 5.00	$ 5,972	$ 7.25	$ 8,660
Place underlayer stones	851	cy	$ -	$ -	$ 17.15	$ 14,598	$ 17.15	$ 14,598
Place armor stones	3,432	cy	$ -	$ -	$ 25.73	$ 88,309	$ 25.73	$ 88,309
Remove & load temporary access platform	1,200	cy	$ -	$ -	$ 13.74	$ 16,492	$ 13.74	$ 16,492
CRM wall	854	cy	$ 25.00	$ 21,350	$ 177.42	$ 151,516	$ 202.42	$ 172,866
Place & compact fill/base course	1,403	cy	$ -	$ -	$ 20.51	$ 28,778	$ 20.51	$ 28,778
SUBTOTAL				$ 24,038		$ 445,095		$ 469,133

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 17 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
SUBTOTAL G.C.								$ 5,463,140
OVERHEAD: 25.00%								$ 1,365,785
TOTAL G.C.								$ 6,828,925
SUBCONTRACTOR(S)								
DIV 02000 & 31000								
Construction stake-out/survey	1	ls	$ -	$ -	$ 5,000.00	$ 5,000	$ 5,000.00	$ 5,000
Load & haul dredged material to off-site stockpile	1,702	cy	$ -	$ -	$ 62.84	$ 106,946	$ 62.84	$ 106,946
Haul underlayer stone to job site	851	cy	$ 59.80	$ 50,890	$ 35.05	$ 29,830	$ 94.85	$ 80,720
Haul armor stone to job site	3,432	cy	$ 82.81	$ 284,204	$ 35.05	$ 120,300	$ 117.86	$ 404,504
Haul aggregate/stone to job site	1,200	cy	$ 39.65	$ 47,580	$ 35.05	$ 42,063	$ 74.70	$ 89,643
Haul CRM to job site	854	cy	$ 59.80	$ 51,069	$ 35.05	$ 29,935	$ 94.85	$ 81,004
Haul structural fill/base course to job site	1,403	cy	$ 25.50	$ 35,777	$ 35.05	$ 49,179	$ 60.55	$ 84,956
Mobilize/transport paving equipment	1	ls	$ -	$ -	$ 25,000.00	$ 25,000	$ 25,000.00	$ 25,000
AC pavement	717	sy	$ 42.50	$ 30,458	$ 108.00	$ 77,400	$ 150.50	$ 107,858
Concrete guardrail	430	lf	$ 172.93	$ 74,359	$ 951.30	$ 409,057	$ 1,124.22	$ 483,416
SUBTOTAL				$ 574,337		$ 894,710		$ 1,469,047
SUBTOTAL								$ 1,469,047
OVERHEAD: 45.00%								$ 661,071
PROFIT: 10.00%								$ 213,012
STATE TAX: 4.17%								$ 97,615
TOTAL SUBCONTRACTOR(S)								$ 2,440,745
TOTAL - G.C.								$ 6,828,925
TOTAL - SUBCONTRACT								$ 2,440,745
G.C. OVERHEAD ON SUBCONTRACT: 5.00%								$ 122,037
PROFIT: 8.00%								$ 751,337
BOND: 2.00%								$ 202,861
CONTINGENCIES: 15.00%								$ 1,551,886
STATE TAX: 4.17%								$ 393,981
FORCE ACCOUNTS & ALLOWANCES								$ 350,000
SUBTOTAL								$ 12,641,772
CONTINGENCIES				5.00%				$ 632,089
SUBTOTAL								$ 13,273,861
CONSTRUCTION ENGINEERING				15.00%				$ 1,991,079
CM/CSS/POST DES./NON-LABOR)			30.00%				$ 597,324	
STAFF LABOR			70.00%				$ 1,393,755	
ADMINSTRATION OF INDIRECT COST				40.00%				$ 557,502
TOTAL OF ALL ITEMS								$ 15,822,442
Additional Water Pollution, Dust, and Erosion Control								$ 50,000
Water Quality Monitoring								$ 250,000
Additional Police Officers, Additional Traffic Control Devices, and Advertisement								$ 50,000
TOTAL FORCE ACCOUNT & ALLOWANCES								$ 350,000

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 27 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UNIT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
Low Angle Revetment w/ Concrete Wall								
PRIME CONTRACTOR								
DIV 01000								
Mobilization & temporary staging area	1	ls	$ 5,000.00	$ 5,000	$ 75,000.00	$ 75,000	$ 80,000.00	$ 80,000
Field office & supplies	27	mo	$ 2,750.00	$ 74,250	$ -	$ -	$ 2,750.00	$ 74,250
Field staff & management	27	mo	$ -	$ -	$ 36,268.13	$ 979,239	$ 36,268.13	$ 979,239
BMP' erosion/water control	1	ls	$ -	$ -	$ 250,000.00	$ 250,000	$ 250,000.00	$ 250,000
Turbidity/silt barrier	500	lf	$ 175.00	$ 87,500	$ 55.00	$ 27,500	$ 230.00	$ 115,000
Generator, 2 ea	27	mo	$ 230.00	$ 6,210	$ 920.00	$ 24,840	$ 1,150.00	$ 31,050
Vertical mast light tower, 3 ea	27	mo	$ -	$ -	$ 5,400.00	$ 145,800	$ 5,400.00	$ 145,800
Jersey barriers	1	ls	$ -	$ -	$ 23,375.00	$ 23,375	$ 23,375.00	$ 23,375
Steel road plates	27	mo	$ -	$ -	$ 4,500.00	$ 121,500	$ 4,500.00	$ 121,500
Compactor, vibratory plate	6	mo	$ -	$ -	$ 420.00	$ 2,520	$ 420.00	$ 2,520
Traffic control	587	day	$ -	$ -	$ 1,050.40	$ 616,585	$ 1,050.40	$ 616,585
FOG	1	ls	$ 48,600.00	$ 48,600	$ -	$ -	$ 7,925.00	$ 48,600
Daily job clean-up	27	mo	$ -	$ -	$ 1,214.74	$ 32,798	$ 1,214.74	$ 32,798
Demobilization & final clean-up	1	ls	$ -	$ -	$ 50,000.00	$ 50,000	$ 50,000.00	$ 50,000
SUBTOTAL				$ 221,560		$ 2,349,157		$ 2,570,717
DIV 01000								
Mobilize/transport equipment	9	lds	$ -	$ -	$ 1,620.56	$ 14,585	$ 1,620.56	$ 14,585
Bobcat	27	mo	$ -	$ -	$ 1,380.00	$ 37,260	$ 2,300.00	$ 37,260
Hydraulic excavator, 2 ea	54	mo	$ -	$ -	$ 9,500.00	$ 513,000	$ 2,300.00	$ 513,000
Backhoe	27	mo	$ -	$ -	$ 2,300.00	$ 62,100	$ 2,300.00	$ 62,100
FE loader	27	mo	$ -	$ -	$ 3,800.00	$ 102,600	$ 3,800.00	$ 102,600
Drum roller	3	mo	$ -	$ -	$ 5,525.00	$ 16,575	$ 3,800.00	$ 16,575
Crane	27	mo	$ -	$ -	$ 10,950.00	$ 295,650	$ 7,925.00	$ 295,650
Demob/transport equipment	9	lds	$ -	$ -	$ 1,620.56	$ 14,585	$ 1,620.56	$ 14,585
SUBTOTAL				$ -		$ 1,056,355		$ 1,056,355
DIV 32000								
Kalepa #12 bridge retrofit	1	ea	$ 1,500,000	$ 1,500,000	$ 1,000,000	$ 1,000,000	$ 2,500,000	$ 2,500,000
SUBTOTAL				$ 1,500,000		$ 1,000,000		$ 2,500,000
DIV 31000								
Remove & dispose existing guard rail	430	lf	$ -	$ -	$ 30.53	$ 13,130	$ 30.53	$ 13,130
Site preparation & grading	1,702	cy	$ -	$ -	$ 13.74	$ 23,392	$ 13.74	$ 23,392
Temporary access platform	1,200	cy	$ -	$ -	$ 85.76	$ 102,908	$ 85.76	$ 102,908
Geotextile fabric	1,194	sy	$ 2.25	$ 2,688	$ 5.00	$ 5,972	$ 7.25	$ 8,660
Place underlayer stones	851	cy	$ -	$ -	$ 17.15	$ 14,598	$ 17.15	$ 14,598
Place armor stones	3,432	cy	$ -	$ -	$ 25.73	$ 88,309	$ 25.73	$ 88,309
Remove & load temporary access platform	1,200	cy	$ -	$ -	$ 13.74	$ 16,492	$ 13.74	$ 16,492
Place & compact fill/base course	1,403	cy	$ -	$ -	$ 20.51	$ 28,778	$ 20.51	$ 28,778
SUBTOTAL				$ 2,688		$ 293,579		$ 296,267

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 27 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
SUBTOTAL G.C.								$ 6,423,339
OVERHEAD: 25.00%								$ 1,605,835
TOTAL G.C.								$ 8,029,174
SUBCONTRACTOR(S)								
DIV 02000 & 31000								
Construction stake-out/survey	1	ls	$ -	$ -	$ 5,000.00	$ 5,000	$ 5,000.00	$ 5,000
Load & haul dredged material to off-site stockpile	1,702	cy	$ -	$ -	$ 62.84	$ 106,946	$ 62.84	$ 106,946
Haul underlayer stone to job site	851	cy	$ 59.80	$ 50,890	$ 35.05	$ 29,830	$ 94.85	$ 80,720
Haul armor stone to job site	3,432	cy	$ 82.81	$ 284,204	$ 35.05	$ 120,300	$ 117.86	$ 404,504
Haul aggregate/stone to job site	1,200	cy	$ 39.65	$ 47,580	$ 35.05	$ 42,063	$ 74.70	$ 89,643
Haul structural fill/base course to job site	1,403	cy	$ 25.50	$ 35,777	$ 35.05	$ 49,179	$ 60.55	$ 84,956
Mobilize/transport paving equipment	1	ls	$ -	$ -	$ 25,000.00	$ 25,000	$ 25,000.00	$ 25,000
AC pavement	717	sy	$ 42.50	$ 30,458	$ 108.00	$ 77,400	$ 150.50	$ 107,858
Micro piles & tie back anchor testing program	1	ls	$ 10,000.00	$ 10,000	$ 65,000.00	$ 65,000	$ 75,000.00	$ 75,000
Mobilize/transport paving equipment	1	ls	$ -	$ -	$ 7,500.00	$ 7,500	$ 7,500.00	$ 7,500
Micro piles	144	ea	$ 1,125.00	$ 162,375	$ 2,812.50	$ 405,938	$ 3,937.50	$ 568,313
Tie back anchors	577	ea	$ 750.00	$ 433,000	$ 1,875.00	$ 1,082,500	$ 2,625.00	$ 1,515,500
Concrete seawall	392	cy	$ 582.18	$ 228,214	$ 1,044.31	$ 409,369	$ 1,626.49	$ 637,583
Concrete guardrail	430	lf	$ 172.93	$ 74,359	$ 951.30	$ 409,057	$ 1,124.22	$ 483,416
SUBTOTAL				$ 1,356,857		$ 2,835,082		$ 4,191,939
SUBTOTAL								$ 4,191,939
OVERHEAD: 45.00%								$ 1,886,373
PROFIT: 10.00%								$ 607,831
STATE TAX: 4.17%								$ 278,545
TOTAL SUBCONTRACTOR(S)								$ 6,964,688
TOTAL - G.C.								$ 8,029,174
TOTAL - SUBCONTRACT								$ 6,964,688
G.C. OVERHEAD ON SUBCONTRACT: 5.00%								$ 348,234
PROFIT: 8.00%								$ 1,227,368
BOND: 2.00%								$ 331,389
CONTINGENCIES: 15.00%								$ 2,535,128
STATE TAX: 4.17%								$ 519,554
FORCE ACCOUNTS & ALLOWANCES								$ 350,000
SUBTOTAL								$ 20,305,535

PROJECT TITLE: KALEPA ROAD REPAIRS
LOCATION: MAUI, HAWAII
FEMA NO.: PW-27, DR 4194
ARCHITECT: Sea Engineering, Inc.
ESTIMATOR: Pacific Cost Engineering, LLC

DATE: 10 APRIL 2017
Design Stage: REPORT
Construction Period: 27 MONTHS
Bid Opening on or Before: FY17

ITEMS OF WORK	QUANTITIES		MATERIAL COST		LABOR/EQUIPMENT COST		TOTAL COST	
DESCRIPTIONS	NO OF UNITS	UN-IT	UNIT COST	COST	UNIT COST	COST	UNIT COST	COST
CONTINGENCIES				5.00%				$ 1,015,277
SUBTOTAL								$ 21,320,812
CONSTRUCTION ENGINEERING				15.00%				$ 3,198,122
CM/CSS/POST DES./NON-LABOR)			30.00%				$ 959,437	
STAFF LABOR			70.00%				$ 2,238,685	
ADMINSTRATION OF INDIRECT COST				40.00%				$ 895,474
TOTAL OF ALL ITEMS								$ 25,414,408

Additional Water Pollution, Dust, and Erosion Control	$ 50,000
Water Quality Monitoring	$ 250,000
Additional Police Officers, Additional Traffic Control Devices, and Advertisement	$ 50,000
TOTAL FORCE ACCOUNT & ALLOWANCES	$ 350,000

APPENDIX G: PERMITTING ANALYSIS

MUNEKIYO & HIRAGA, INC.

MUNEKIYO HIRAGA
Planning. Project Management. Sustainable Solutions.

Michael T. Munekiyo
PRESIDENT
Karlynn K. Fukuda
EXECUTIVE VICE PRESIDENT
Mark Alexander Roy
VICE PRESIDENT
Tessa Munekiyo Ng
VICE PRESIDENT

July 13, 2017

James H. Barry, P.E., Coastal Engineer
Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Highway
Waimānalo, Hawai'i 96795

SUBJECT: Preliminary Permitting Analysis for Proposed Roadway Repairs Project at Kalepa, Maui, Hawai'i

Dear Mr. Barry:

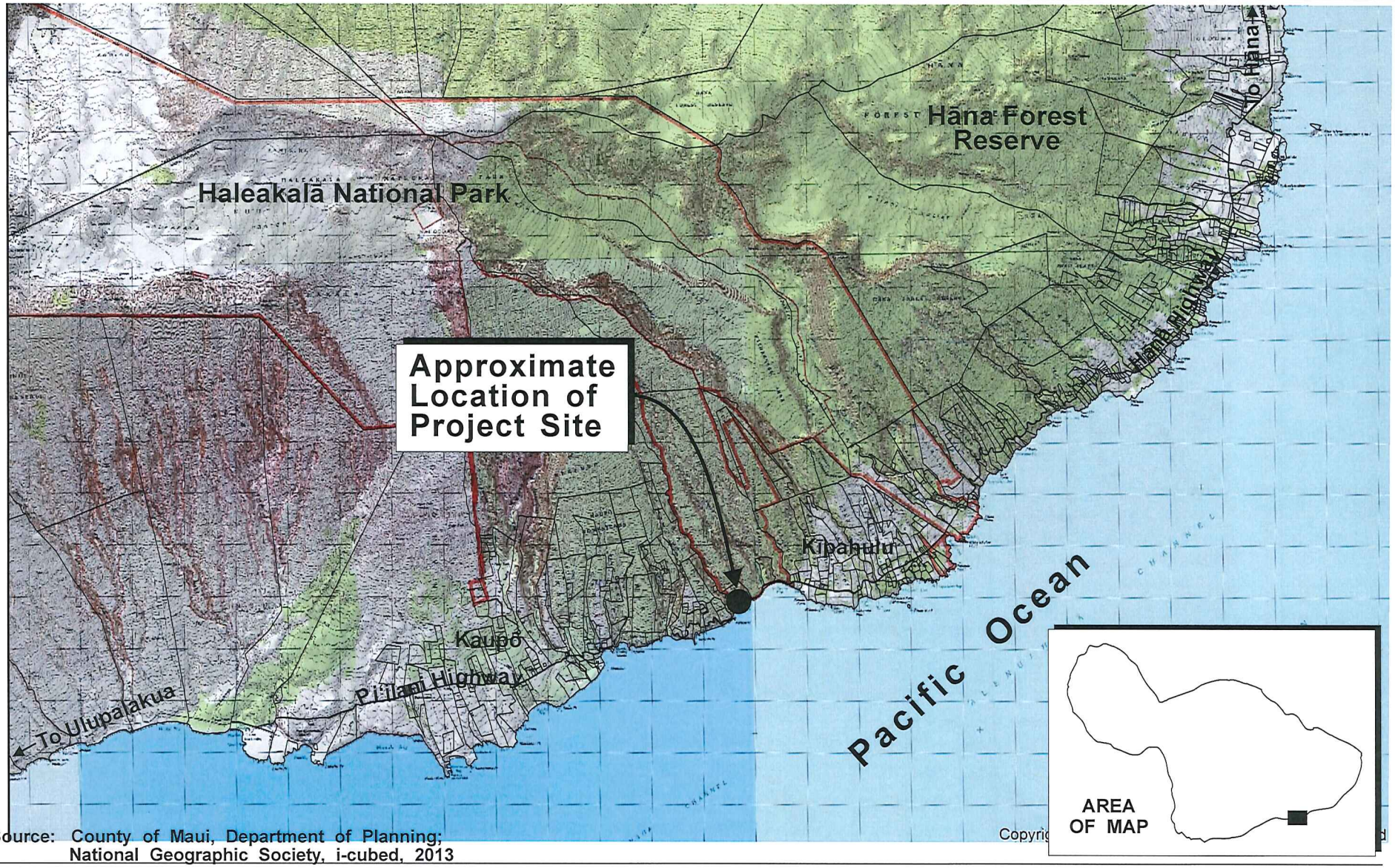
This letter report has been prepared for Sea Engineering, Inc. (SEI) to provide a preliminary permitting analysis for the preferred design alternative for the proposed Kalepa Repairs Project (Job No. 16-37) at Kalepa, Maui, Hawai'i as discussed in the Basis of Design Report prepared for the County of Maui, Department of Public Works (DPW) by SEI.

A. PROJECT LOCATION AND BACKGROUND

The project site is located on the southeast coast of Maui approximately 14 miles southwest of Hāna Town, on Hāna Highway near its transition to the Pi'ilani Highway in the vicinity of Kalepa Bridge. See **Figure 1**.

The site is a headland between two existing drainage ways, the Kalepa Gulch and Alelele Stream, and is a particularly exposed section of the roadway. See **Figure 2**. The roadway is at an elevation of approximately 25 feet above mean sea level (amsl) as it passes around the headland, with a shear rock road cut draped in steel rock fall netting on the landward side of the road and a sloping rock embankment on the ocean side. See **Figure 3**. In places the rock embankment has been modified with sections of concrete rubble masonry (CRM) and rock rubble mound shore protection.

In August 2014, Tropical Storm Iselle, a Category 4 storm, with maximum sustained winds of approximately 140 miles per hour, made landfall on the southeast coast of the island of Hawai'i, bringing large waves to the east side of the island, as well as to the east shore of Maui. Road protection structures along Hāna Highway were considerably damaged in the area of Kalepa gulch



Source: County of Maui, Department of Planning; National Geographic Society, i-cubed, 2013

Figure 1

Kalepa Roadway Repairs Project

Regional Location Map

0 4500 FEET
2250 9000

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Regional Location



Figure 2

Kalepa Roadway Repairs Project
Aerial Photo

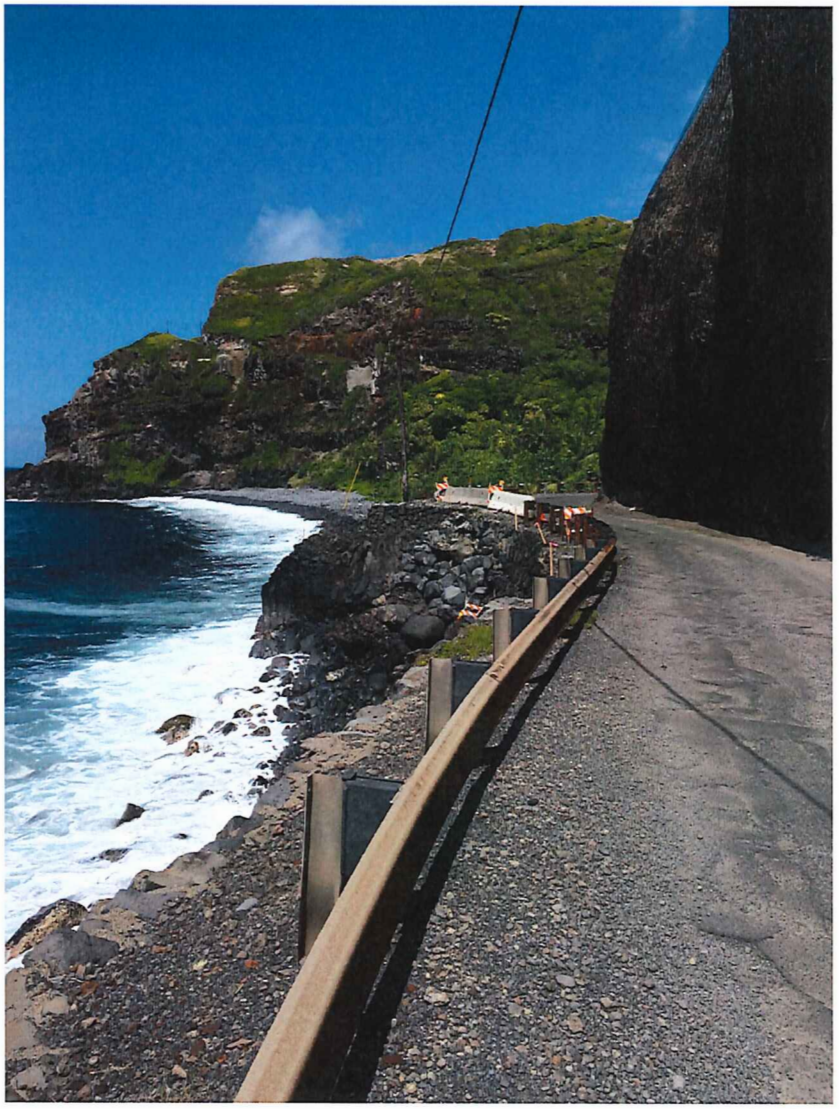
0 250 FEET
125 500

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K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Aerial Photo





Source: Munekiyo Hiraga

Figure 3

Kalepa Roadway Repairs Project
Site Photos

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

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southwest of the town of Hāna.

Maintaining Hāna Highway in this particular area is a difficult engineering problem due to the road elevation, terrain steepness, and constant wave exposure. Wave impacts can be quite severe, and results in the constant erosion of the substrate beneath the roadway surface.

The existing protection features consist of reaches containing both CRM rock walls and uncemented rubble mound. The existing rubble mound revetment was designed and built in the late 1980s. The damage caused by wave action – including slumping of the revetment, and holes in the CRM - reveal layers of past road protection efforts, indicating a long and problematic history since the original construction of the roadway and attempts at protection features from the 1930s and 1940s.

In an effort to maintain the use of the roadway, the DPW has contracted SEI to propose repair design alternatives for the Kalepa headland area. As indicated in **Figure 4**, Area "A", Area "B", and Area "C" are the areas that have been targeted for repair by the DPW. In addition, adjacent to Damage Area "B", the road embankment consists of a reach of CRM approximately 115 feet in length. While much of the CRM is in reasonable condition, there are at least two sections where the CRM has been breached where the rock has fallen away leaving holes in the rock wall.

In addition to the proposed roadway and roadway protection features repair work, the proposed action will also consist of repair and retrofitting work to the existing Kalepa Bridge. Refer to **Figure 2**. The bridge, as it exists today, has a posted weight limit of nine (9) tons, and has the smallest posted weight limit of the five (5) bridges between Kula, in the upcountry region of Maui, and the project site. The proposed roadway repair work action will necessitate the transport of heavy equipment and boulders to the project site, most of which will exceed the current posted weight limit of the Kalepa Bridge. As such, repair and retrofit work at the Kalepa Bridge will be required so that it will be able to accommodate the anticipated heavy loads of equipment and boulders. This bridge repair and retrofit action is contemplated as part of the overall project.

B. BASIS OF DESIGN REPORT

A number of site visits following the 2014 storm revealed much of the damage caused by Tropical Storm Iselle. Site visits were made in October 2014 by Geolabs, Inc., resulting in the preparation of an Engineering Field Report; on

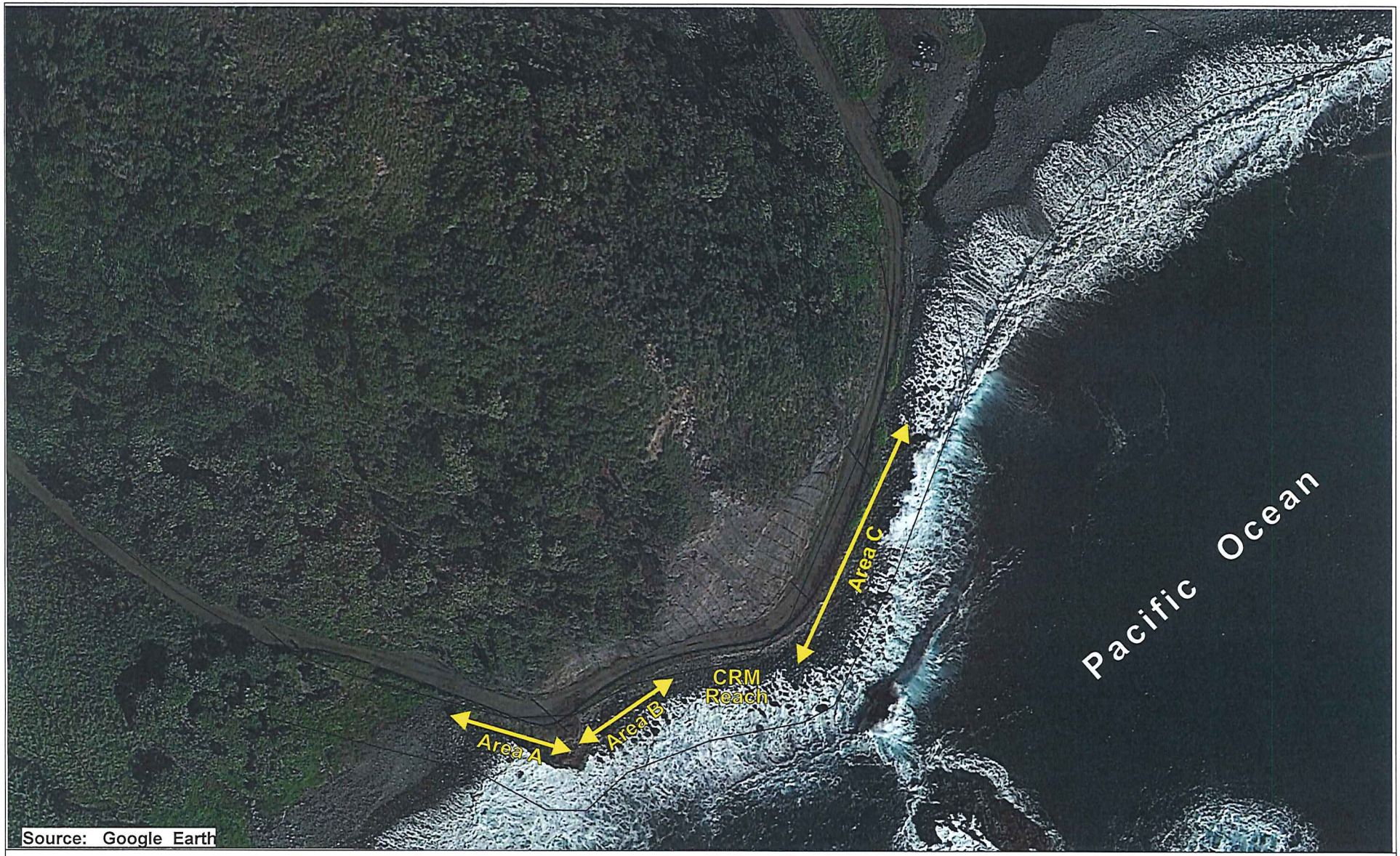


Figure 4

Kalepa Roadway Repairs Project
Areas of Repairs

0 150 FEET
75 300

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Areas of Repairs

June 30, 2015 by SEI with representatives of the DPW, Munekiyo Hiraga (MH), and Austin, Tsutsumi & Associates, Inc. (ATA); on October 7, 2015 by Arnold Okubo & Associates, structural engineers; and on January 5, 2016 by the DPW, Federal Emergency Management Agency (FEMA) and the Hawai'i State Civil Defense (CD). DPW is currently in the process of requesting emergency funding from FEMA in order to repair the damage that occurred from Tropical Storm Iselle and improve the long-term structural integrity of the shoreline protection at the site.

A Preliminary Coastal Engineering Report was completed by SEI for DPW in February 2016, which concluded that simply repairing the damaged areas would not represent the best long-term solution for the roadway. The preliminary coastal engineering report presented several conceptual design alternatives for consideration by DPW. The report contained a discussion of the project site conditions, the oceanographic setting, damaged incurred by Tropical Storm Iselle, oceanographic design parameters derived from existing available information, and shore protection concept plans. Following submission of the coastal engineering report and coordination with both FEMA and CD representatives, it was recommended that SEI prepare a follow-up comprehensive Basis of Design (BOD) study to further examine different potential mitigation strategies for the long-term protection of the subject roadway segment.

The BOD report was prepared to thoroughly examine the coastal engineering options available for protection of the Hāna Highway where it skirts the Kalepa headland. The report includes:

1. A review and update of oceanographic design parameters including nearshore bathymetry, wind and wave hind casts, water level calculations, and hind casts of Tropical Storm Iselle;

2. Revetment and seawall design concepts including concept designs with joint input from coastal and structural engineers;

3. An update of topographic information;

4. Additional geotechnical information, including borings;

5. Anticipated permitting requirements (discussed herein); and

6. Preliminary cost estimates of alternatives.

C. SUMMARY OF DESIGN ALTERNATIVES

The BOD report resulted in the formulation of a number of mitigative and design alternatives for the proposed action. As stated in the report, due to the extreme topography of the site, a strategy of retreat is not feasible. As such, options for the site include:

1. **No Action Alternative**: Allowing the condition of the highway to continue to degrade, ultimately resulting in the long-term closure of the roadway.

2. **Abandonment of the Existing Roadway Alignment Alternative**: Although the Kalepa area is a remote, exposed, and difficult terrain, the abandonment of this section of the roadway by dead-ending the highway is not likely to be acceptable as the roadway is utilized by tourists and a number of residents who live in this remote area of Maui.

3. **Engineered Shore Protection (Seawalls and Revetments) Alternatives**: Shore protection alternatives for this high energy open coast environment include uncemented sloping revetments made from rock rubble mound or tribars, seawalls, or a hybrid combination of these structures.

Three (3) preliminary design options for the engineered shore protection alternative were then prepared and discussed in the report, including:

1. Rock Revetment Design

2. Hybrid CRM Wall and Rock Revetment Design

3. Hybrid Anchored Concrete Wall and Rock Revetment Design

These three (3) designs incorporate an emergent berm toe configuration that is a key design feature. The berm toe is robust due to the amount of material used, and eliminates the need for toe excavation in a difficult environment. Although the ocean bottom conditions in the area of the proposed action are not well known, visual observations made suggest that some of the existing revetment armor stones have slid down and collected at the base of the slope underwater. Toe design for rock rubble mound structures typically use an extended apron for scour protection on erodible substrates, or use toe embedment for a hard bottom condition. Extensive work in the water at this project site is not seen as feasible due to the exposure and difficult access. Once in place, the emergent berm toe

will help reduce wave inundation and facilitate construction of the revetment slope.

Water elevation assumed during the design was 3.4 feet amsl and includes the estimated 50-year sea level rise event. However it is noted that updated bathymetry and oceanographic design analysis have resulted in an increase in the design wave height (from the Preliminary Coastal Engineering Report) to 10.4 feet, and additional geotechnical information has further constrained the design.

D. PREFERRED DESIGN ALTERNATIVE

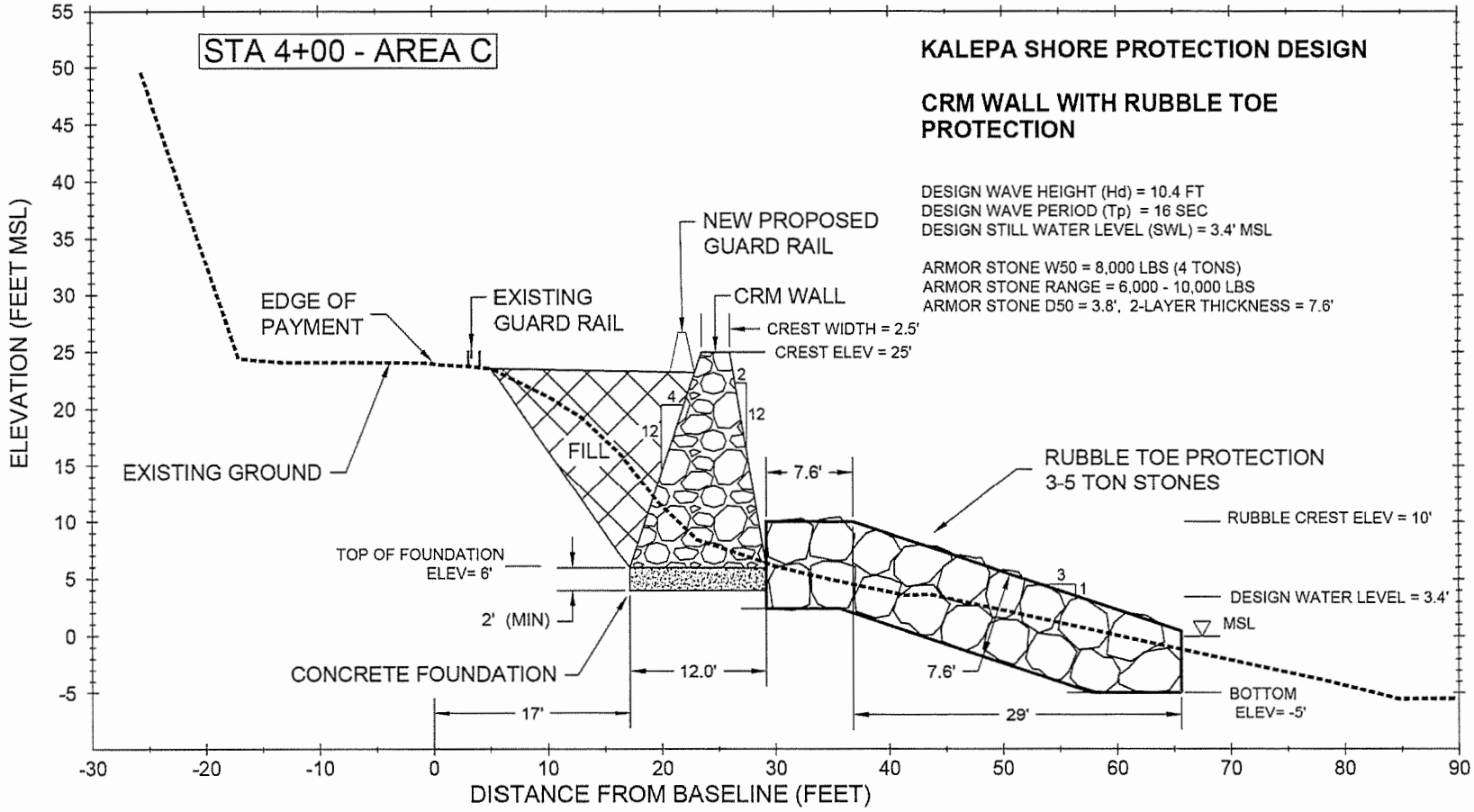
The preferred design alternative as discussed in the BOD report is referred to as the Combined Low Angle Revetment and CRM Wall option.

As the design steepness of a structure is decreased, the stability increases. However, decreasing the slope will generally increase the structure footprint. The estimated armor stone sized for a 10.4 foot design wave for a structure of 1-Vertical to 3-Horizontal (1V:3H) is four (4) tons, or 8,000 pounds, which is roughly equivalent to the existing stone size.

The low angle of a 1V:3H design broadens the footprint of the structure to the extent that it will no longer fit the topography. To fit a shore protection structure using the reduced slope, the low angle revetment is paired with a wall to form a hybrid combination of seawall and revetment.

This option, as shown in **Figure 5** and **Figure 6**, combines a low angle revetment and a free-standing CRM wall, which can be applied along the entire Kalepa headland. A free-standing CRM gravity wall with a rock rubble mound toe protection will allow upgraded erosion protection as well as the potential for road widening.

The revetment portion of the structure has a low angle at 1V:3H. Because it approaches the low angle of repose of the existing rock on the lower reaches of the site, the structure will require minimal excavation or displacement of existing stone. The new stone is meant to overlie the existing stone, and will not require an under layer, although some slope preparation will be required. The stability generated by the low angle will not require a toe treatment like the berm toe necessary for stability of a steeper revetment structure. However, excess stone from the slope preparation can be moved downslope to buttress the toe area for added protection.



Source: Sea Engineering, Inc.

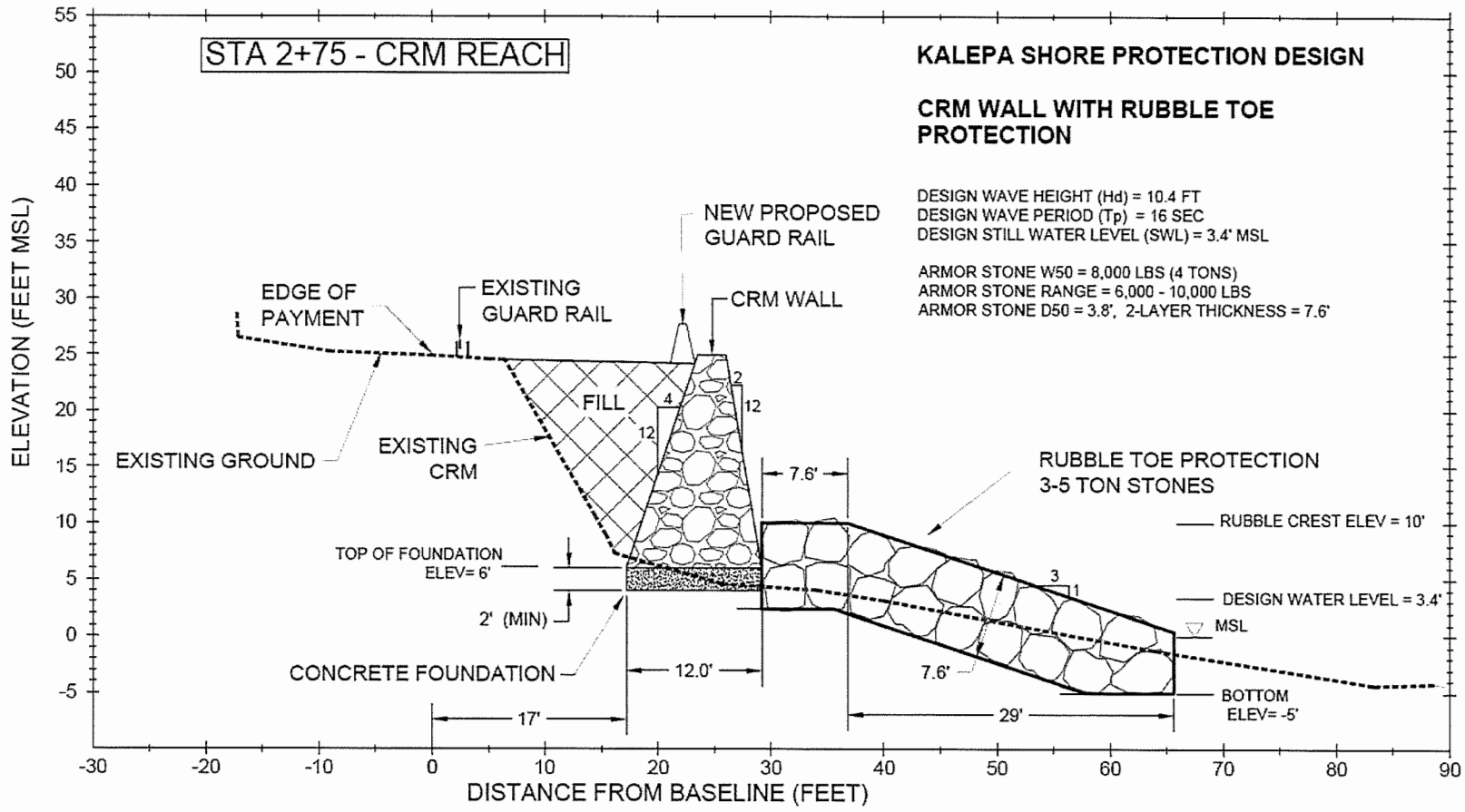
Figure 5 Kalepa Roadway Repairs Project

Preferred Design Alternative Section at Area C

MUNEKIYO HIRAGA

Prepared for: Sea Engineering, Inc.

K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Preferred Design Alternative Section at Area C



Source: Sea Engineering, Inc.

Figure 6 Kalepa Roadway Repairs Project

Preferred Design Alternative Section at CRM Reach

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Preferred Design Alternative Section at CRM Reach

The two-layer rock rubble mound structure will protect the foundation of the wall from wave energy near the shoreline. The nominal weight for the armor stones is 8,000 pounds, with an allowable weight range from 6,000 to 10,000 pounds. The crest of the revetment is set at approximately ten (10) feet amsl, with a horizontal crest two (2) armor stones in width in front of the CRM wall for additional stability.

Following recommendations contained in the geotechnical report prepared, the CRM wall is set on a concrete foundation approximately two (2) feet in thickness. The base of the wall is set at approximately six (6) feet amsl, and the wall crest is at 25 feet amsl, for a total wall height of 19 feet. The wall has a minimum crest width of 2.5 feet, and a base width of 12 feet. Placing the wall at the nominal base of the existing scarp allows approximately 20 feet of additional width to be available for the roadway area.

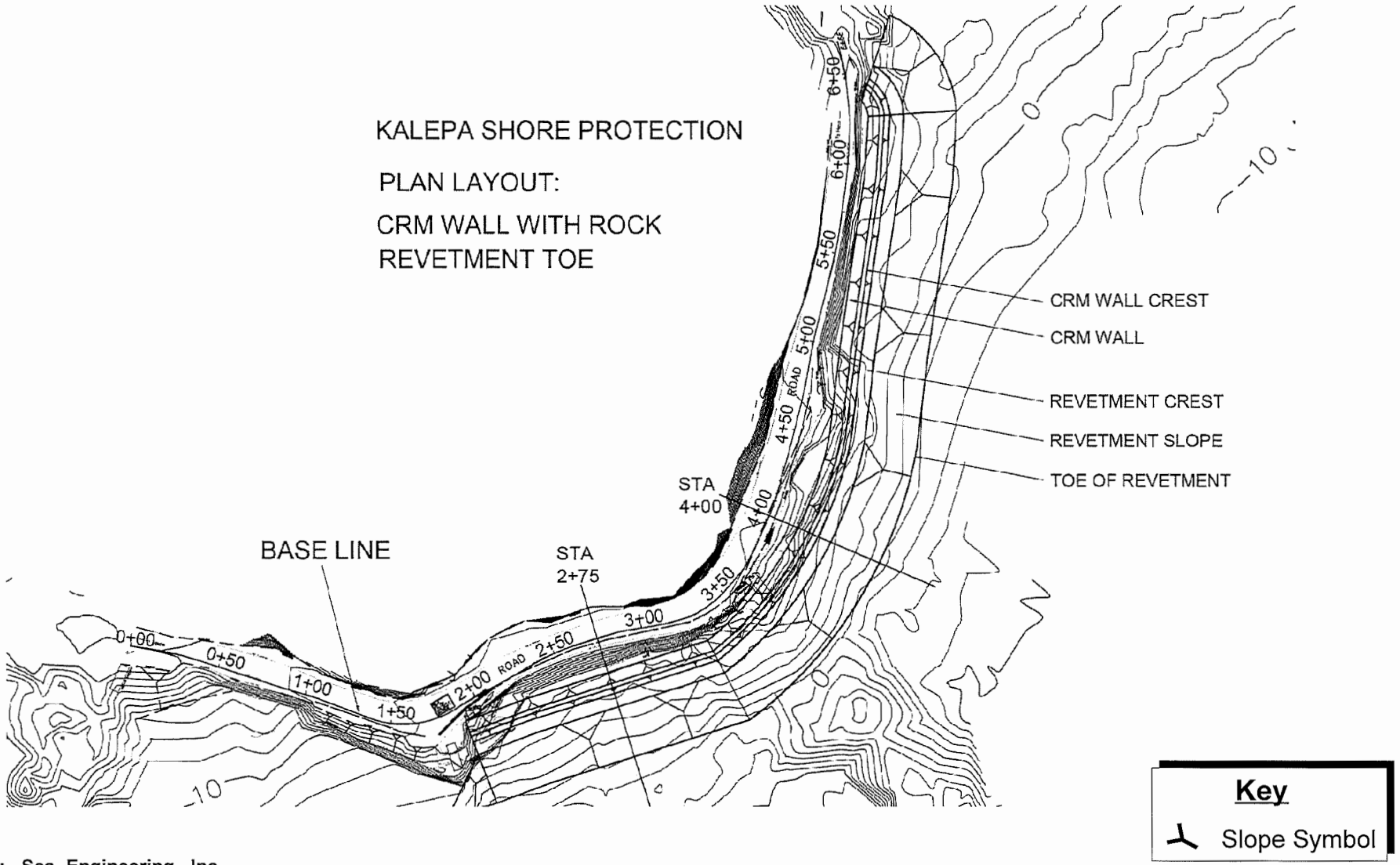
Figure 7 shows the plan view of the proposed upgraded CRM wall with a rubble mound toe protection spanning over the Kalepa headland.

A preliminary cost estimate for the preferred alternative was prepared in April 2017 and estimated the total construction cost of this alternative to be at approximately $16,000,000.00.

E. ASSOCIATED ROADWAY REPAIRS

The guardrails around the Kalepa headland are in a particularly corroded condition. See **Figure 8**. ATA conducted a study of potential guardrail alternatives that are anticipated to better withstand the harsh site conditions. The study recommends the use of concrete guardwalls at the site. There are several guardwall types which were evaluated, including jersey barriers, "F-shape" barriers, 9.1 degree single-slope barriers, and 10.8 degree constant-slope barrier. Of these, the study recommends the use of the 10.8 degree constant-slope barrier. The concrete design can be constructed to withstand the salt air conditions with the use of epoxy-coated rebar and adequate concrete coverage. In addition, the design has an aesthetically pleasing appearance and low maintenance costs. Reliefs (holes) at the base of the guardwalls will be placed to allow for drainage of storm water runoff.

In addition, the roadway surface around the Kalepa headland is currently paved, but in a seriously damaged condition. See **Figure 9**. An option for new light paving consists of a 6-inch base course and 2-inch asphalt concrete.



Source: Sea Engineering, Inc.

Figure 7

Kalepa Roadway Repairs Project
Site Plan

0 25 50 Feet 100

MUNEKIYO HIRAGA

Prepared for: Sea Engineering, Inc.

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Source: Munekiyo Hiraga

Figure 8

Kalepa Roadway Repairs Project
Photos of Existing Guardrails

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

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Source: Munekiyo Hiraga

Figure 9

Kalepa Roadway Repairs Project
Photos of Existing Roadway Surface Conditions

Prepared for: Sea Engineering, Inc.

MUNEKIYO HIRAGA

K:\DATA\SeaEngineering\Kalepa BOD\Applications\Figures\Photos of Existing Roadway Conditions

F. ASSOCIATED BRIDGE REPAIRS

As previously mentioned, the project area is remote, the road is narrow, and there a several small bridges with restrictive maximum load ratings along the road to the site. There are five (5) main bridges from Kula to the project site. The smallest posted weight limit along this route is nine (9) tons at Kalepa Bridge. Refer to **Figure 2**. As such, repairs and retrofitting to the Kalepa Bridge to allow construction vehicles and equipment access to the site will likely be required as part of the overall project action. For the purposes of this permitting assessment, it is assumed that the repairs to Kalepa Bridge will be confined to the existing structure and be above the ordinary high water mark, and as such, will not trigger additional Department of Army permitting requirements.

G. PRELIMINARY PERMITTING ANALYSIS AND ASSUMPTIONS

The land use designations underlying the proposed project site are outlined in **Table 1** below.

Table 1. Land Use Designations

State Land Use Commission	Conservation District Subzones: Limited and General
Maui Island Plan	Area mauka of Pi'ilani Highway in the vicinity of the proposed project area is classified as Sensitive Lands as depicted on Protected Areas Diagram E-1 in the Maui Island Plan
Hana Community Plan	Conservation District
Maui County Zoning	Interim on either side of the headland makai of Pi'ilani Highway, and Agricultural and Interim mauka of Pi'ilani Highway
Special Management Area	Located within the Special Management Area (SMA) for the County of Maui
Flood Hazard Zone	VE

In consideration of the above information and the preferred option design as advanced in the BOD report, MH has prepared the enclosed preliminary analysis of permitting requirements for the project. It is noted that this assessment is confined to applicable environmental review and discretionary permitting requirements and does not include construction-related permits such as building/grading and Special Flood Hazard Area Development (SFHAD) permits. The permits anticipated to be required for the proposed action are based on a number of project assumptions, including the following:

1. That the proposed action is determined to be a permitted use in the context of the underlying land use designations such that land use amendments (such as Community Plan Amendment, Change in Zoning

etc.) will not be required.

2. That the proposed action represents an expansion of the existing footprint of the revetment;

3. That the proposed project will have no impacts on coral colonies or fish habitats that may be located in the area of the proposed work;

4. That the current roadway and shoreline protection structures will be considered previously authorized structures by the applicable Federal, State and County agencies;

5. That the project area is located in both the (L) Limited and (G) General Conservation District Subzones;

6. That the proposed action is subject to U.S. Army Corps of Engineers (USACE) Honolulu District conditions;

7. That much of the proposed work is located outside of the existing right-of-way, seaward of the certified shoreline and will involve the use of State beach lands and Waters of the United States;

8. That the lead federal agency for administration of the National Environmental Policy Act (NEPA) environmental review and consultation process will be the USACE due to the need to process a Department of Army permit;

9. That the proposed action is not a regularly permitted action within the shoreline setback area as it involves hardening the shoreline and an expansion of the existing use; and

10. That there will not be any significant impacts identified during the environmental review process that would warrant consideration for the preparation of Federal and/or State Environmental Impact Statement documentation.

Table 2, enclosed, outlines the environmental review and discretionary permit requirements anticipated to be triggered by the proposed action, agencies from which the permits are to be sought, and estimated cost of permitting work. It is noted that the estimated costs provided in Table 1 are rough order of magnitude (R-O-M) costs and will need to be further evaluated as project plans become

more defined and additional pre-consultation with key agencies is completed.

Should you have any questions regarding the preliminary permitting analysis contained herein, please do not hesitate to contact me at (808) 244-2015.

Very truly yours,

Bryan Esmeralda, AICP
Associate

BE:lh
KK:\DATA\SeaEngineering\Kalepa BOD\Preliminary Permitting Analysis.doc

Table 2. Preliminary Discretionary Permitting Analysis for Preferred Alternative

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
FEDERAL					
1.	National Environmental Policy Act (NEPA)	U.S. Army Corps of Engineers (USACE)	A stand-alone NEPA EA is not anticipated to be required based on indication from the USACE that proposed action may qualify for a Department of Army (DA) Nationwide Permit (NWP) – see below.	NEPA is triggered by use of federal funding and requirement for federal permit (DA permit) Assumes that USACE (following consultation with FEMA) is determined to be the lead federal agency for the project due to NWP requirement. Assumes that a NWP is issued for the project. Should an Individual (DA) permit be required, a NEPA Environmental Assessment (EA) /Environmental Impact Statement (EIS) (or Categorical Exclusion) would need to be prepared in support of the DA permit application. This permitting analysis matrix does not include an estimated cost for preparation/processing a NEPA EA/EIS document.	N/A
2.	Section 10 (Rivers and Harbors Act)/Section 404 (Clean Water Act) Department of Army (DA) Permit	USACE	Based on feedback received at meeting held with the USACE Regulatory Branch on June 9, 2017, the proposed action could be considered to qualify for a NWP under NWP 3 (Maintenance). A meeting memorandum from the June 9, 2017 is enclosed herein as **Exhibit A**. *3. Maintenance. (a) The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3, provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification. Minor deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, requirements of other regulatory agencies, or current construction codes or safety standards that are necessary to make the repair, rehabilitation, or replacement are authorized. This NWP also authorizes the removal of previously authorized structures or fills. Any stream channel modification is limited to the minimum necessary for the repair, rehabilitation, or replacement of the structure or fill; such modifications, including the removal of material from the stream channel, must be immediately adjacent to the project. This NWP also authorizes the removal of accumulated sediment and debris within, and in the immediate vicinity of, the structure or fill. This NWP also authorizes the repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events, provided the repair, rehabilitation, or replacement is commenced, or is under contract to commence, within two years of the date of their destruction or damage. In cases of catastrophic events, such as hurricanes or tornadoes, this two-year limit may be waived by the district engineer, provided the permittee can demonstrate funding, contract, or other similar delays.*	Assumes current structure is determined to meet 'previously authorized structure' provision. Assumes that USACE would agree to issue a waiver of two-year time limit. NWP 3 would be subject to Honolulu District (Regional) conditions. If NWP cannot be granted, an Individual Permit would be required. This permitting analysis matrix does not include an estimated cost for preparation/processing an Individual Permit. The (State) Final EA would act as the primary technical supporting document for the DA application process (see below).	$30,000.00

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
3.	Section 106, National Historic Preservation Act	USACE	A consultation process pursuant to Section 106, Historic Preservation Act requirements would need to be completed for the project.	Consultation process would be initiated (during State EA process) following completion of baseline archaeological and cultural studies.	$15,000.00
4.	Section 7, Endangered Species Act (ESA) and Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)	U.S. Fish and Wildlife Service (USFWS) / National Oceanic and Atmospheric Administration (NOAA)	Consultation with USFWS /NOAA would need to be undertaken pursuant to applicable ESA and Essential Fish Habitat (EFH) requirements.	Consultation process would be initiated (during State EA process) following completion of baseline flora/fauna and marine biological studies.	$15,000.00
STATE OF HAWAI'I					
5.	Hawai'i Environmental Policy Act - Chapter 343, Hawai'i Revised Statutes (HRS)	County of Maui, Department of Public Works (DPW)	Preparation and processing of a State EA document pursuant to requirements set forth in Chapter 343, HRS. The following technical studies /documents would need to be prepared in support of the EA: • Conceptual plans/elevations/sections • Preliminary Engineering/Drainage Report • Archaeological Inventory Survey • Cultural Impact Assessment • Flora/Fauna Survey • Marine Biological Survey • Traffic Assessment & Control Plan	Triggered due to use of Conservation District lands, shoreline area and County funds/lands. Assumes that proposed action would not qualify for an EA exemption determination due to expansion of use. Assumes that DPW would be determined to be appropriate approving agency for EA following consultation with the State of Hawaii, Department of Land and Natural Resources (DLNR) and the County of Maui, Department of Planning. Compliance with related Federal Consultation processes would need to be addressed during environmental review process (i.e. Section 106 National Historic Preservation Act; Section 7 Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act). If significant impacts are anticipated by findings of EA process, then a State EIS would need to be prepared and processed.	$250,000.00
6.	Conservation District Use Permit	Department of Land and Natural Resources (DLNR), Office of Conservation and Coastal Lands (OCCL)	Preparation and processing of a Conservation District Use Application (CDUA) based on following land use provisions in the State Conservation District Rules: *§13-5-22 Identified land uses in the protective subzone.* *P-8 Structures And Land Uses, Existing* *<u>If classified as a Moderate Alteration:</u>* *(C-1) Moderate alteration of existing structures, facilities, uses, and equipment.* *Identified land uses beginning with letter (C) require a departmental permit.* *<u>If classified as a Major Alteration:</u>* *(D-1) Major alteration of existing structures, facilities, uses, and equipment, or topographical features which are different from the original use or different from what was allowed under the original permit. When county permit(s) are required for the associated plan(s), the department's approval shall also be required.* *P-15 Shoreline Erosion Control* *<u>If classified as a "Shoreline Erosion Control action:</u>*	Project area is located in both the (L) Limited and (G) General Conservation District Subzones. In addition to the land uses identified in the respective sections of the OCCL's administrative rules pertaining to the L and G Subzones, all identified land uses and their associated permit or site plan approval requirements listed for the Protective Subzone also apply, unless otherwise noted. The proposed action may be classified as either a "Moderate Alteration", "Major Alteration". • *A Moderate Alteration is defined as: work done to an existing structure, facility, or use that results in more than a ten per cent increase, but no more than a fifty per cent increase, in the size of the structure, facility, or use.* • *A Major Alteration is defined as: work done to an existing structure, facility, or use that results in more than fifty per cent increase in the size of the structure, facility, or use.* The (State) Final EA would act as the primary technical supporting document for the CDUA application process.	$30,000.00

No.	Regulation/Discretionary Permit Requirement	Agency	Description	Key Assumptions/Considerations	Estimated Cost Including Supporting Technical Documentation
			(D-1) Seawall, revetment, groin, or other coastal erosion control structure or device, including sand placement, to control erosion of land or inland area by coastal waters, provided that the applicant shows that (1) the applicant would be deprived of all reasonable use of the land or building without the permit;(2) the use would not adversely affect beach processes or lateral public access along the shoreline, without adequately compensating the State for its loss; or (3) public facilities (e.g., public roads) critical to public health, safety, and welfare would be severely damaged or destroyed without a shoreline erosion control structure, and there are no reasonable alternatives (e.g., relocation). Requires a shoreline certification. *Identified land uses beginning with letter (D) require a board permit, and where indicated, a management plan.*	Pre-consultation with the OCCL will be necessary to determine classification of project and confirm permitting requirements.	
7.	Section 401 Water Quality Certification (WQC)	Department of Health, Clean Water Branch	Preparation and processing of a Section 401 Water Quality Certification Approval. The following additional technical study would need to be prepared in support of the application: • Applicable Monitoring and Assessment Plan (AMAP)	The (State) Final EA would act as the primary technical supporting document for the Section 401 WQC application process.	$40,000
8.	Coastal Zone Management Consistency (CZM) Determination	Office of Planning	Preparation and processing of a CZM Consistency Determination Application		$20,000
COUNTY OF MAUI					
9.	Special Management Area (SMA) Use Permit	County of Maui, Department of Planning	Preparation and Processing of SMA Use Permit application.	A SMA Use Permit is anticipated to be required based on the expansion in use and project valuation being in excess of $500,000.00. The (State) Final EA would act as the primary technical supporting document for the SMA application process. Pre-consultation with the Department of Planning will be necessary to confirm SMA permitting requirements.	$30,000.00
10.	Shoreline Setback Variance (SSV)	County of Maui, Department of Planning	Preparation and processing of SSV application.	Action is not a regularly permitting action within the shoreline setback area as it involves hardening the shoreline and an expansion of existing use. The (State) Final EA would act as the primary technical supporting document for the SSV application process. The need for a SSV also triggers the requirement for preparation of a Chapter 343, HRS EA. Pre-consultation with the Department of Planning will be necessary to confirm SSV permitting requirements.	$30,000.00
				TOTAL	**$460,000.00**

EXHIBIT A

June 9, 2017 USACE Meeting Memorandum

MUNEKIYO HIRAGA
Planning. Project Management. Sustainable Solutions.

Michael T. Munekiyo
PRESIDENT

Karlynn Fukuda
EXECUTIVE VICE PRESIDENT

Mark Alexander Roy
VICE PRESIDENT

Tessa Munekiyo Ng
VICE PRESIDENT

June 30, 2017

MEETING MEMORANDUM

Date of Meeting: June 9, 2017

Participants: Jim Barry, Sea Engineering (SE)
Rebecca Frager, U.S. Army Corps of Engineers (USACE)
Wendy Kobashigawa, County of Maui, Department of Public Works (DPW) (via telephone)
Mark Roy, Munekiyo Hiraga (MH)
Bryan Esmeralda, MH

Subject: Discussion of Kalepa Roadway Repairs Project Background, Alternatives, and U.S. Army Corps of Engineers Permitting Requirements

Meeting Purpose:

A meeting was held at the USACE Regulatory Branch office on June 9, 2017 at 10:00 a.m. to discuss the proposed Kalepa Roadway Repairs Project background, design alternatives as advanced by the Basis of Design (BOD) report prepared by SE, and anticipated USACE permitting requirements.

Summary of Discussion:

1. B. Esmeralda facilitated introductions of meeting participants and provided project location information.

2. M. Roy summarized project background, including initial proposal of performing work as a repair and maintenance action; Federal Emergency Management Agency (FEMA) involvement and request for BOD report; and preparation of BOD report necessitating need to determine permitting requirements at Federal, State, and County levels.

3. J. Barry discussed preparation of BOD report and reviewed findings and project design alternatives.

4. B. Frager stated that based on project description, work may be permitted under Nationwide Permit (NWP) No. 3 – Maintenance. If the proposed work is determined to not qualify for an NWP, it would require an Individual Permit. It was also stated that should any excavation be carried out, Section 106 consultation must also be carried out.

5. Regarding NWP No. 3, it is stated that projects seeking approval under this permit must have started, or be contracted to start work, within two (2) years of the catastrophic event which necessitates the proposed work. R. Frager noted that a waiver of the two (2) year time stipulation could potentially be sought as work and discussion regarding the proposed project commenced within two (2) years of Hurricane Iselle.

6. R. Frager stated that all projects requiring USACE approval also require a Water Quality Certification (WQC) determination from the State Department of Health (DOH) before USACE permits may be issued.

7. Because FEMA will be providing funding for the project, National Environmental Protection Act (NEPA) requirements are triggered. However, R. Frager stated that if the project can qualify for an NWP, no NEPA Environmental Assessment or Environmental Impact Statement is required for the project as federal environmental review has taken place during the NWP adoption process by the USACE.

8. In order to apply for an NWP, the first step is to complete and submit a NWP Pre-Construction Notification (PCN), which provides information on the project and specifies which NWP is being sought. The PCN must also demonstrate compliance with the criteria for the specific NWP, USACE regional conditions, and general conditions. The PCN is reviewed and a determination is made as to whether the requested NWP can be granted or if an Individual Permit is required.

9. Regarding NEPA requirements, M. Roy inquired as to whether the Lead Agency will be the USACE or FEMA should a NEPA EA be required. R. Frager stated that should FEMA not want to assume this responsibility, the USACE could act as the Lead Agency. It was suggested that further discussion be had with FEMA.

Follow-Up Action Items

1. R. Frager to consult with USACE Regulatory Branch Chief regarding NWP No. 3 two (2) year waiver possibility and assuming Lead Agency responsibility.

There being no other business, the meeting was adjourned at 11:20 a.m.

Bryan Esmeralda, AICP
Associate

BE:lh
cc: Jim Barry, Sea Engineering
Rebecca Frager, U.S. Army Corps of Engineers
Wendy Kobashigawa, County of Maui, Department of Public Works
K:\DATA\SeaEngineering\Kalepa BOD\6.9.17 Meeting Memo.doc

APPENDIX B – BASIS OF DESIGN REVISIONS MEMO (SEA ENGINEERING, INC.)

Sea Engineering, Inc.
Makai Research Pier
41-305 Kalanianaole Hwy.
Waimanalo, Hawaii 96795-1820
Ph: (808) 259-7966
Website: www.seaengineering.com

MEMORANDUM

DATE:	May 7, 2020
TO:	Wendy Kobashigawa, County of Maui DPW
FROM:	Derek Linsley
SUBJECT:	Kalepa Revetment and Seawall Repair – Design Revisions

Sea Engineering, Inc. (SEI) is working with the County of Maui Department of Public Works (DPW) on the design and permitting of shore and road protection along an approximate 450-ft reach of the Piilani Highway at the Kalepa headland. The existing shore and road protection consists of a rock rubblemound revetment and concrete rubble masonry (CRM) walls built over previously existing structures circa 1987. These were extensively damaged in August 2014 during the close passage of Hurricane Iselle.

A site visit by Geolabs, Inc. detailed much of the damage in an Engineering Field Report (October 2014). Another site visit was conducted in June 2015 by a diverse team that included representatives of the Department of Public Works (DPW), Munekiyo & Hiraga, Inc. (M&H), Austin Tsutsumi & Associates, Inc. (ATA), Arnold Okubo & Associates, Inc. (AOA), and Sea Engineering, Inc. (SEI). ATA provided a topographic and shoreline survey at that time. All companies contributed to a Basis of Design (BOD) Report that was submitted in July 2017.

The BOD Report discussed several concept plans in detail and made a recommendation to construct a retaining wall fronted by a low-angle rock revetment for protection from wave forces. The BOD Report also included results of county bridge inspection reports for the approach to Kalepa, and guardrail and roadway improvements.

The design presented in the 2017 BOD Report has been updated to include revised sea level rise projections, design wave events, design wave heights, and cross-sections. This memo details the changes made to the design approach and proposed structure.

SEA LEVEL RISE

The National Oceanographic and Atmospheric Administration (NOAA) has released new sea level rise projections since the 2017 BOD Report was submitted. New sea level rise values based on data from Kahului Harbor were calculated using the USACE sea level rise calculator. The site calculates six different scenarios for sea level rise based on NOAA studies that were published in 2017.

Sea level rise for Maui using the six NOAA scenarios is shown in Figure 1. The NOAA *intermediate* rate is used as a prediction for future sea level at the project site based on recent discussions with University of Hawaii and other scientists. For a project design life of 50 years, the calculations predict an increase of 2.85 ft. from 2000 levels in the year 2080 (50 years post-construction). The 50-year and 100-year change in sea level are listed in Table 1. The sea level rise value used in the 2017 BOD Report was 1.81 feet (2012 NOAA Int-High for the year 2067).

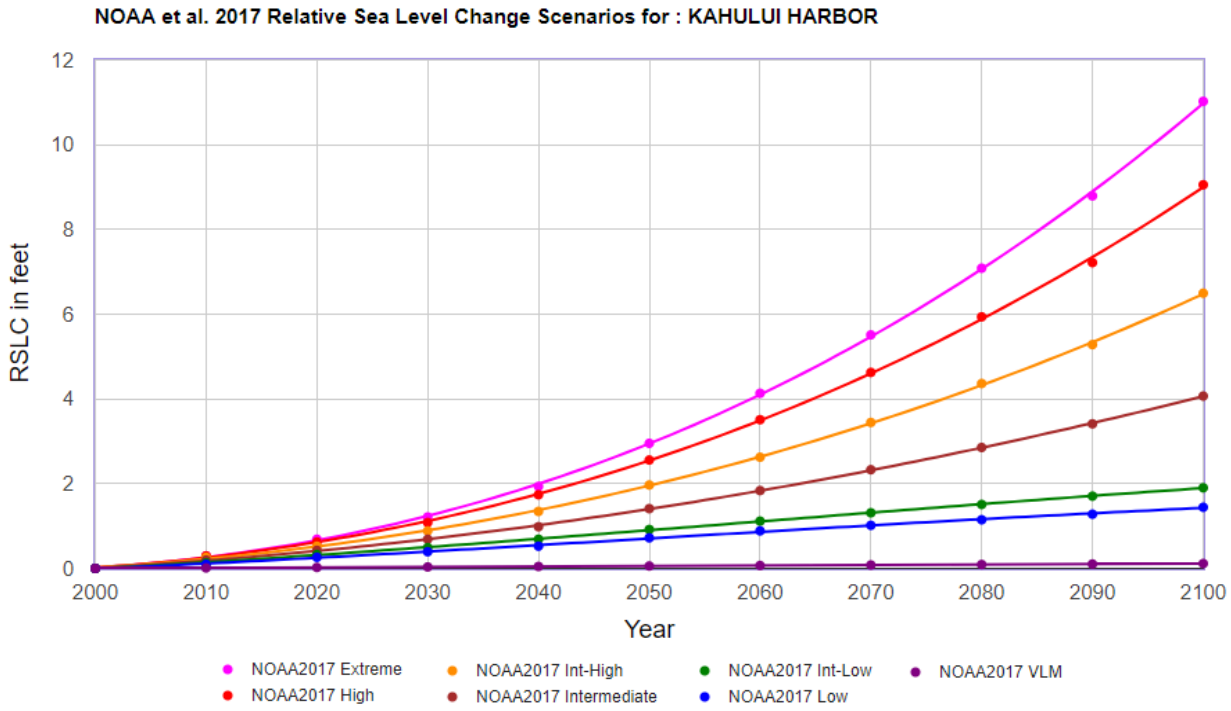


Figure 1. Projected Sea Level Change, Kahului Harbor (NOAA, 2017)

Table 1. Projected Sea Level Change from 2000

Year	*Low*	*Int-Low*	*Int*	*Int-High*	*High*	*Extreme*
2080	1.15	1.51	**2.85**	4.36	5.94	7.09
2120	1.67	2.26	4.92	8.10	11.75	14.99

MODEL HURRICANES

Additional storm modeling was completed to further quantify the project site's vulnerability to tropical cyclones. The tracks and intensities of Hurricane Iselle and Hurricane Lane were used to develop model hurricanes that could impact the project site. With slight deviations from their actual tracks and/or intensities, the effects on the islands could have been much more significant during these events.

Seven hurricane scenarios were developed and are shown in Table 2. The actual storm track and parameters for Hurricane Iselle were obtained from National Hurricane Center Hurricane

Database (HURDAT2). The Lane Scenarios were modified from the 2018 *Makani Pahili* (Hawaiian: *strong winds*), a desktop exercise by the Hawaii Emergency Management to study potential effects of a hurricane disaster and exercises the necessary emergency response to direct hit hurricanes.

The storm tracks/intensities were modified to generate model storms with severities that range from a "near-miss" event (Iselle 1/2 and Iselle Cat 5) to a worst-case scenario event (Iselle Shifted Cat 5, Lane Shifted Cat 5). The parametric wind fields were then used to calculate wind generated waves in a numerical wave model. The model storm tracks and intensities for the seven scenarios are shown in Figure 2. A time series of wave height (Hs), peak wave period (Tp), and peak direction for the various scenarios at a location in deep water offshore of the project site is shown in Figure 3.

Table 2. Model Hurricane Scenarios

Scenario	*Base Scenario*	*Track/Intensity Modification*
Iselle 1/2	Hurricane Iselle	None
Iselle Cat 5	Hurricane Iselle	Intensity increased to Category 5
Iselle Shifted	Hurricane Iselle	Track shifted north
Iselle Shifted Cat 2	Hurricane Iselle	Track shifted north, Category 2 landfall
Iselle Shifted Cat 5	Hurricane Iselle	Track shifted north, Category 5 landfall
Lane Shifted Cat 4	Hurricane Lane	Track continues through Maui, maintains intensity
Lane Shifted Cat 5	Hurricane Lane	Track continues through Maui, Category 5 landfall

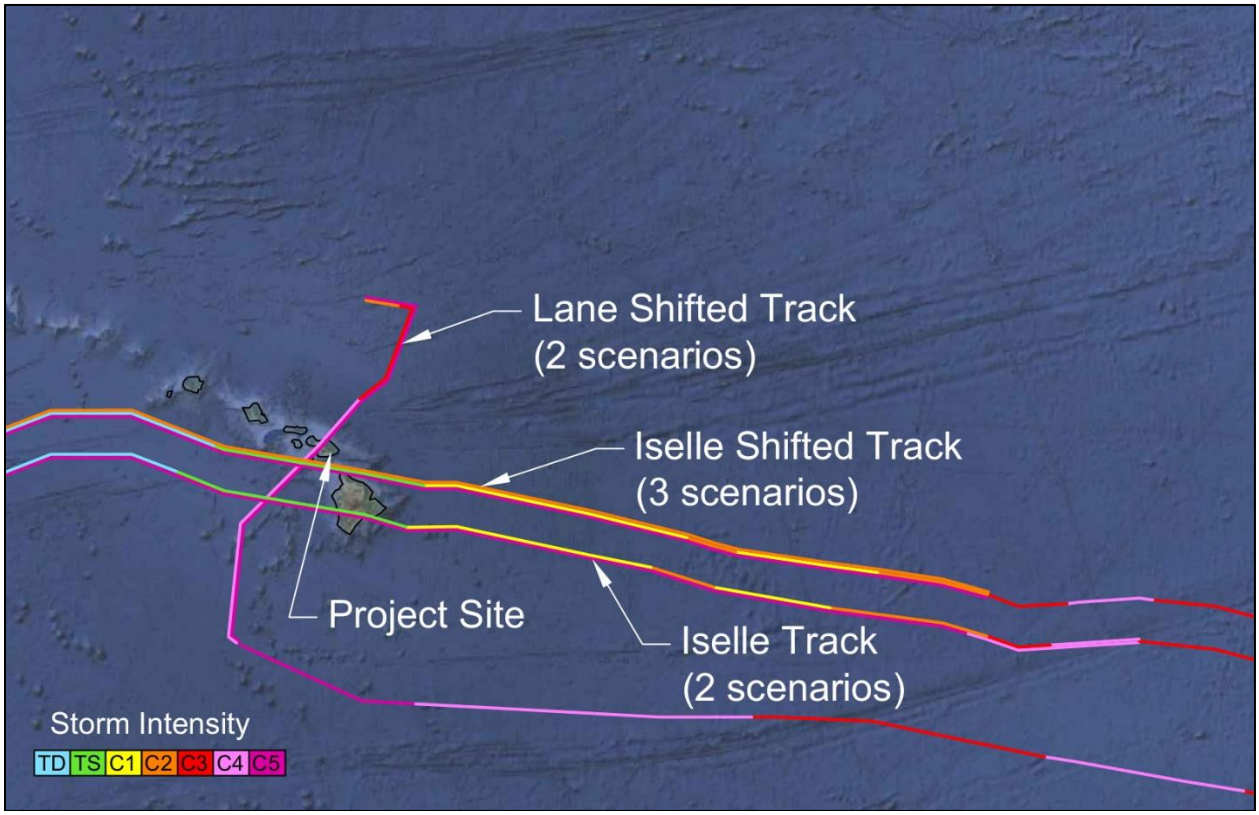
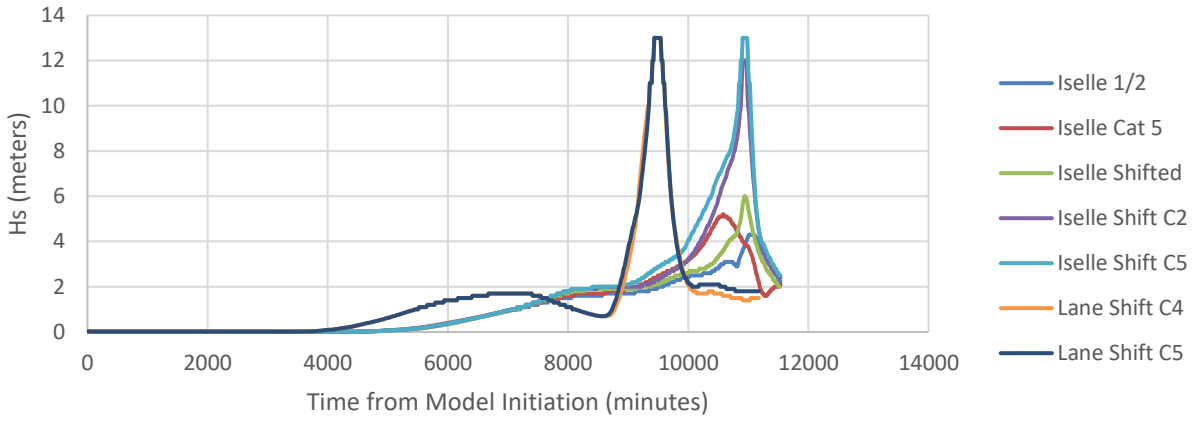
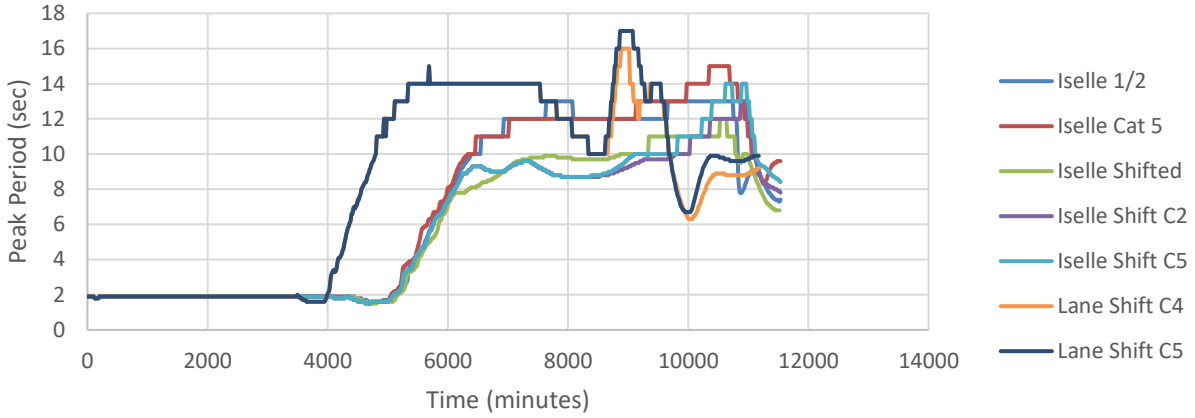


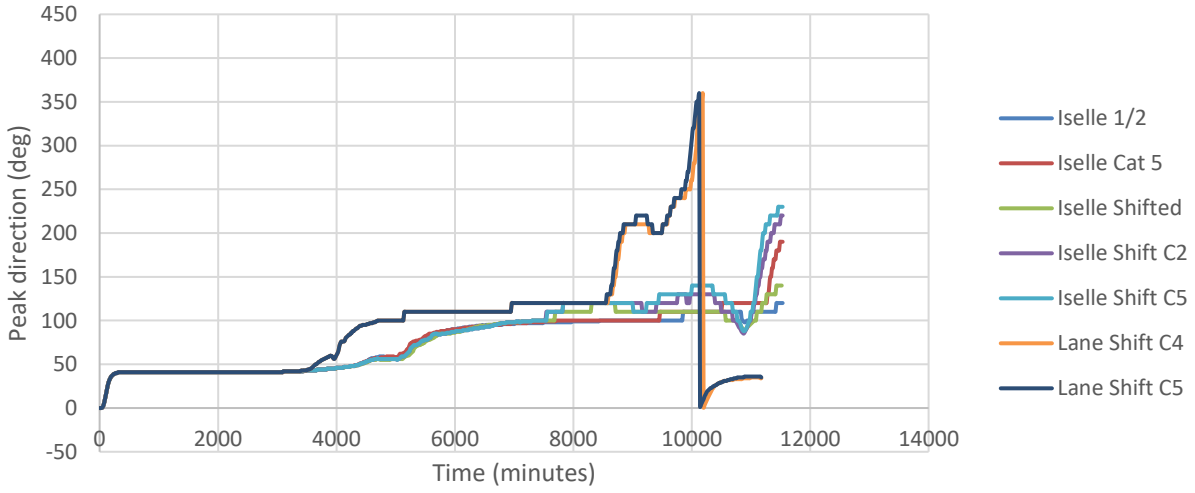
Figure 2. Projected Sea Level Change, Kahului Harbor (NOAA, 2017)



a)



b)



c)

Figure 3. Virtual buoy a) height, b) period, and c) direction time series.

DESIGN WAVE HEIGHT

Wave refraction effects were calculated from the wave angle change between deepwater and nearshore depths shown in the numerical wave modeling. Shoaling effects were calculated using the wave model and the nearshore depth profile. Initial wave breaking height (Hb) was calculated using Rattanapitikon and Shibayama (2006) and occurs in water depths of approximately 15 to 20 ft.

Finally, a depth-limited criteria was used to calculate the design wave height. The design wave height is the nearshore breaking wave height that occurs in proximity of the toe of the proposed structure. Depth limited waves are calculated by applying a breaker index to the nearshore water depths that have been adjusted for tide, wave setup and a 50-year sea level rise. The wave setup was calculated in the SWAN wave model. The breaker index was calculated using Goda (2010). This empirical approach was used to determine the design wave height instead of numerical modeling because numerical models can potentially become unstable for large waves and steep irregular bathymetry.

Using this methodology, the wave events that raise the local still water level the highest will generate the largest waves at the structure. Table 3 lists the wave breaking, water level rise, and wave height at the structure results for the model hurricane scenarios. The nearshore nominal water depth of 4.5 ft. MSL was estimated from the 2013 Lidar data set.

The event selected for structural design of the wall and revetment is the the Iselle Shifted Category 2 model hurricane, with a design wave height of 10.7 feet and a total stillwater elevation rise of 5.6 feet relative to MSL. This event was chosen because it has a reasonable chance of occurring during the design life of the project. The 2017 BOD Report used the actual Iselle track and intensity.

DESIGN CROSS SECTIONS

The corresponding stone size for the 10.7-foot design wave is 4.85 tons with a nominal diameter of 3.9 feet. The stone size given in the 2017 BOD Report was 4 tons with a nominal diameter of 3.8 feet. Table 4 lists the armor stone size for a 10.7 foot design wave for a rock rubblemound structure with a 1V:3H slope. Figures 4 and 5 show the revised cross sections with a combined low angle revetment and free-standing CRM wall. Figure 6 shows the cross section for a low angle revetment with a reinforced concrete wall.

Table 3. Summary of nearshore depth limited design wave heights

	Iselle 1	*Iselle 2*	*Iselle Cat 5*	*Iselle Shifted*	*Iselle Shifted Cat 2*	*Iselle Shifted Cat 5*	*Lane Shifted*	*Lane Shifted Cat 5*
Ho (ft)	10.2	14.3	16.9	19.8	40.2	43.9	43.8	44.0
Tp (s)	13	9	15	10	13	14	14	14
Dir (deg TN)	110	110	120	92	92	93	200	200
Nearshore slope (cotθ)	9	9	9	9	9	9	9	9
Breaker Index	1.14	1.07	1.13	1.06	1.06	1.06	1.06	1.06
Tide (MHHW)	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
Sea Level Rise (ft)	2.85	2.85	2.85	2.85	2.85	2.85	2.85	2.85
Pressure Setup	0.00	0.00	0.42	0.21	0.95	1.61	1.33	1.80
Wave Setup	0.0	0.0	0.2	0.1	0.7	0.8	1.5	1.4
Nominal Depth (ft MSL)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Total Depth (ft MSL)	8.5	8.5	9.1	8.8	10.1	10.9	11.3	11.7
H design (ft)	**9.7**	**9.1**	**10.3**	**9.3**	**10.7**	**11.5**	**12.0**	**12.4**

Note:
Ho: Deepwater Significant Wave Height
Tp: Deepwater Wave Period
Dir: Deepwater wave direction

Table 4. Rock rubble mound to protection unit weight and nominal diameter

Design Wave Height (ft.)	K	cot(θ)	Armor		Underlayer	
			W_{50} (lb.)	D_{50} (ft.)	W_{50} (lb.)	D_{50} (ft.)
10.7	2	3	9,700	3.9	-	-

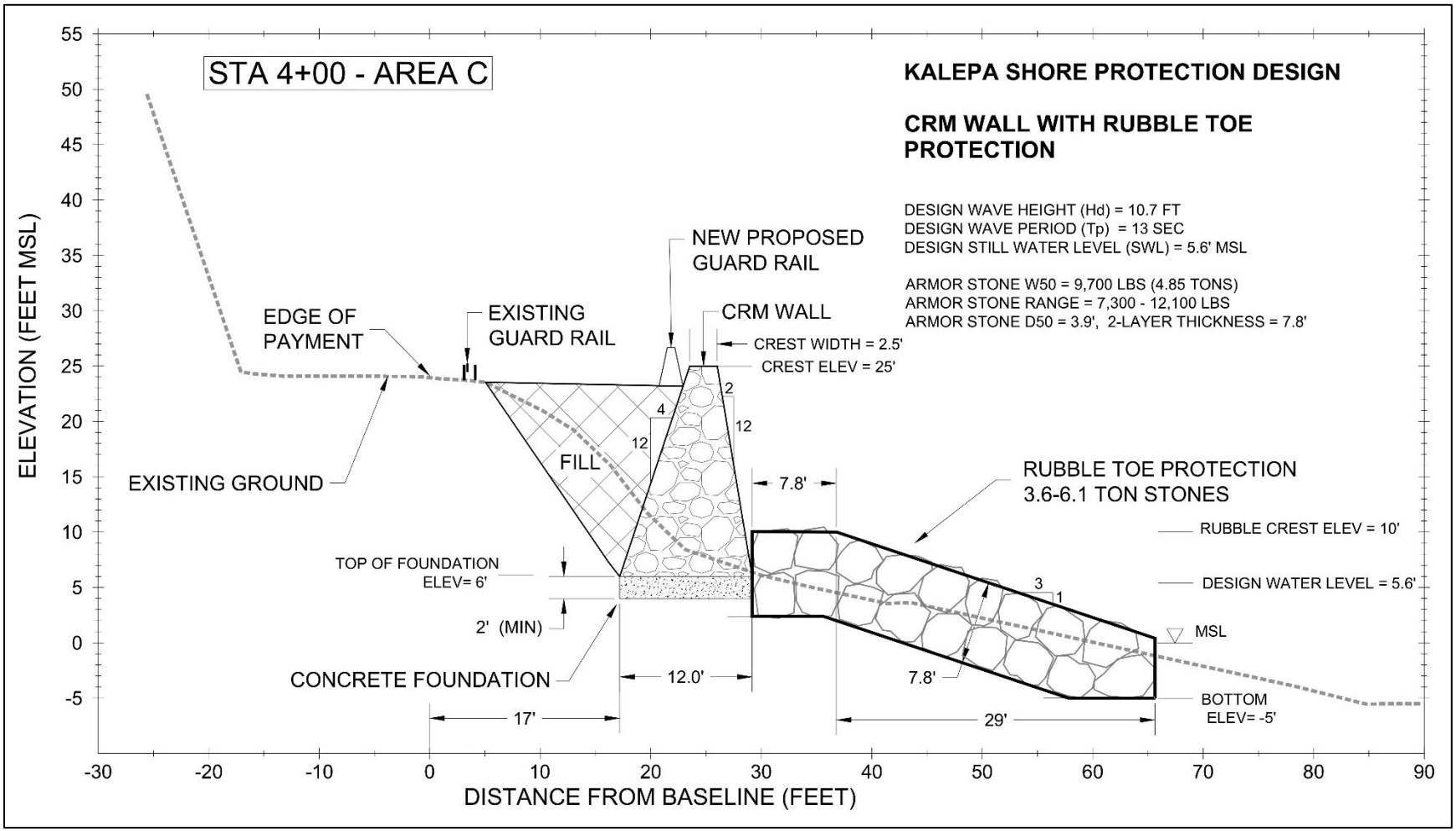


Figure 4. Hybrid CRM wall with rock rubblemound revetment toe protection at Area C

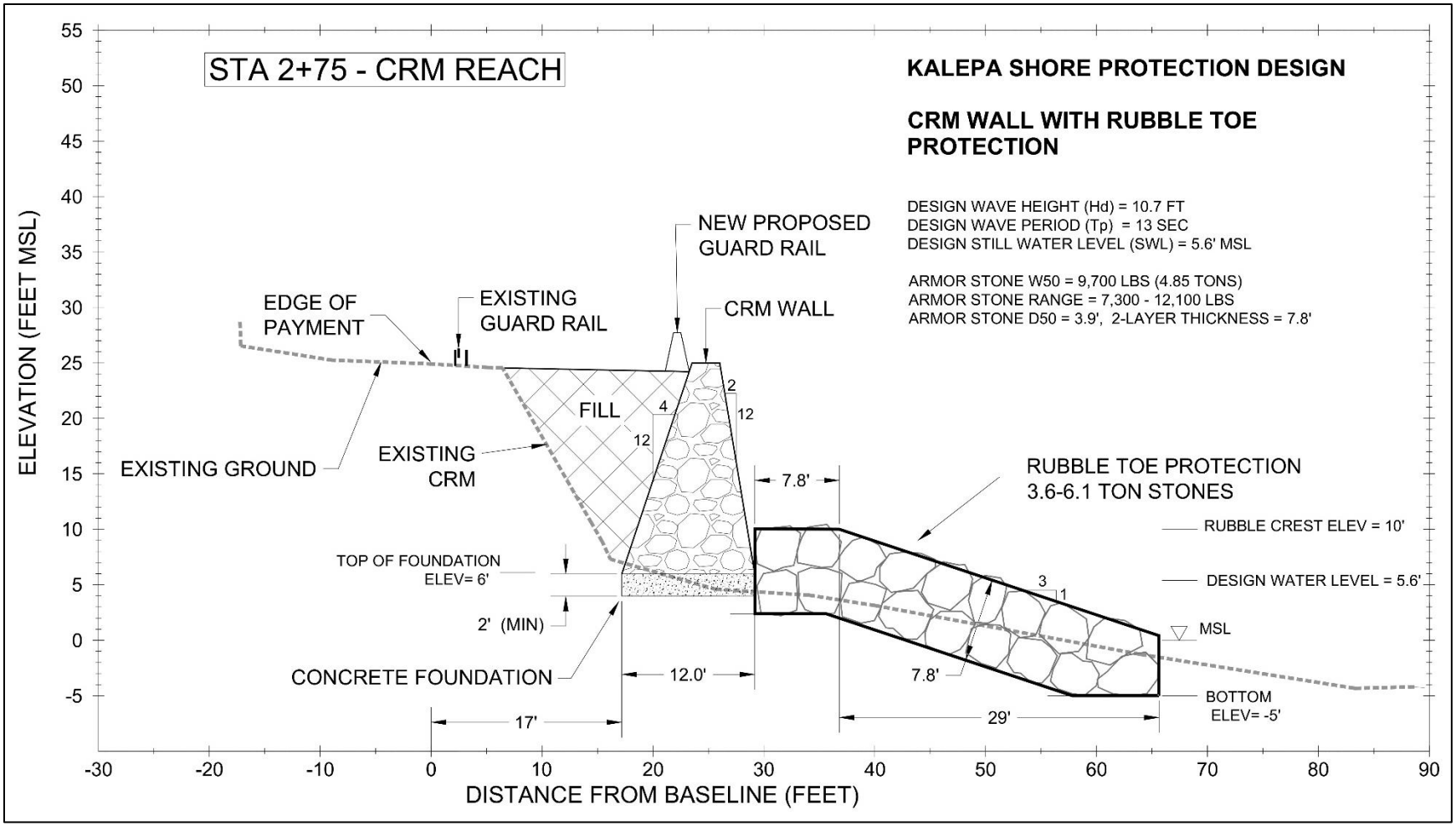


Figure 5. Hybrid CRM wall with rock rubblemound revetment toe protection at CRM Reach

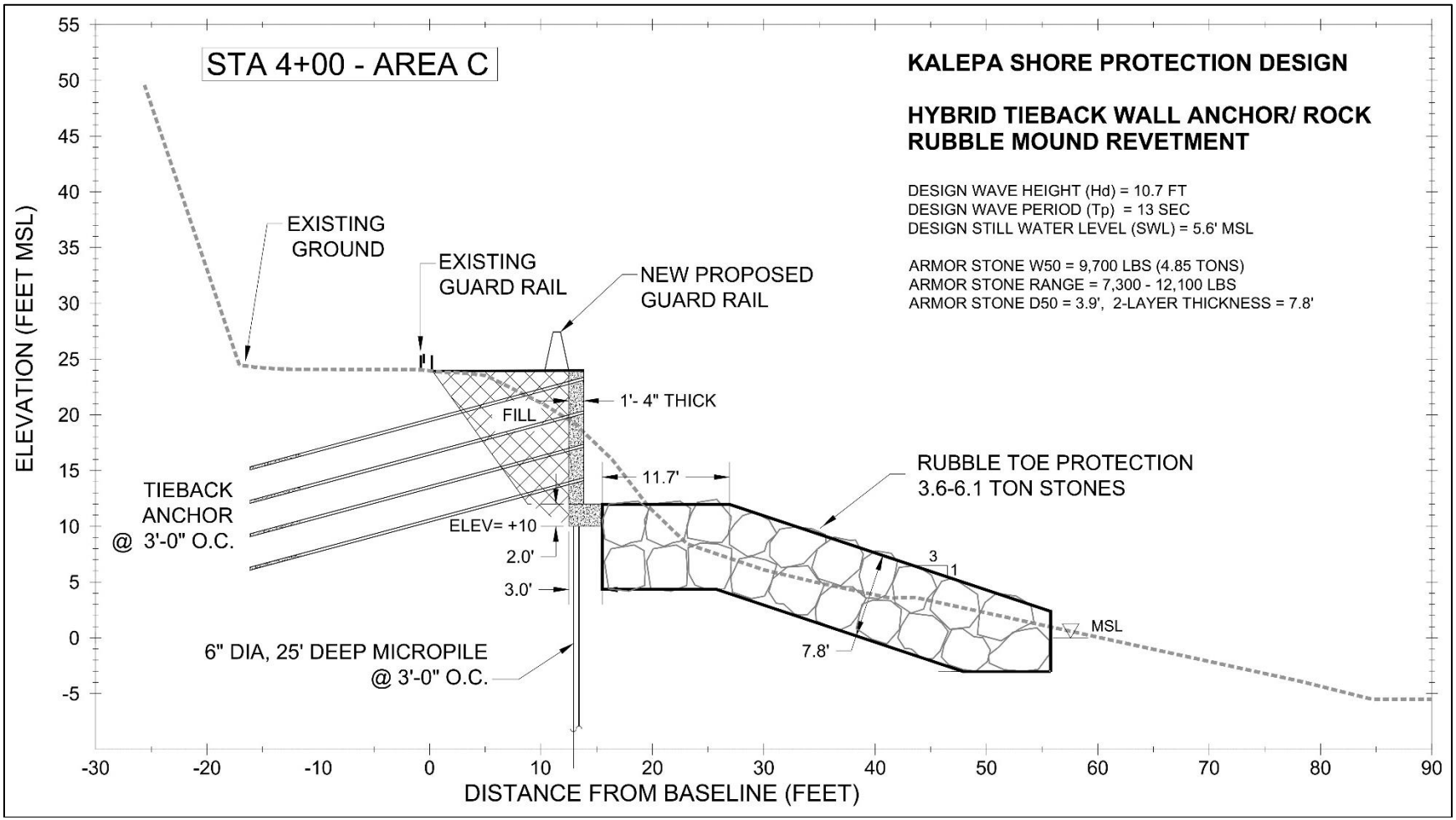


Figure 6. Layout of concrete wall with rubble mound toe protection

APPENDIX C – KALEPA POINT TUNNEL FEASIBILITY STUDY (GEOLABS, INC.)

GEOTECHNICAL CONSULTATION SERVICES

KALEPA POINT TUNNEL FEASIBILITY STUDY

PIILANI HIGHWAY

KIPAHULU, MAUI, HAWAII

W.O. 8090-00 DECEMBER 20, 2021

Prepared for

SEA ENGINEERING, INC.

and

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

GEOTECHNICAL CONSULTATION SERVICES
KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

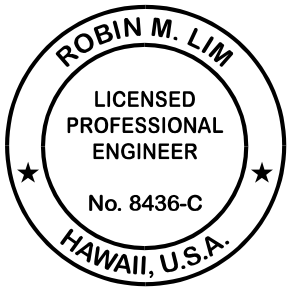
W.O. 8090-00 DECEMBER 20, 2021

Prepared for

SEA ENGINEERING, INC.

and

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION



THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

4-30-20
SIGNATURE / EXPIRATION DATE OF THE LICENSE

GEOLABS, INC.
Geotechnical Engineering and Drilling Services
94-429 Koaki Street, Suite 200 • Waipahu, HI 96797

Hawaii • California

GEOLABS, INC.

Geotechnical Engineering and Drilling Services

December 20, 2021
W.O. 8090-00

Mr. Marc Ericksen
Sea Engineering, Inc.
863 North Nimitz Highway
Honolulu, HI 96817

Dear **Mr. Ericksen:**

Geolabs, Inc. is pleased to submit our report entitled "Geotechnical Consultation Services, Kalepa Point Tunnel Feasibility Study, Piilani Highway, Kipahulu, Maui, Hawaii" prepared for the planning and evaluation of the project.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated September 26, 2019 and the Professional Services Subconsultant Agreement dated December 24, 2019.

Detailed discussion and geotechnical considerations for the tunnel design and construction are contained in the body of this report. If there are any questions regarding this report, please contact our office.

Very truly yours,

GEOLABS, INC.

_____
Robin M. Lim, P.E.
President

RML:rl

GEOTECHNICAL CONSULTATION SERVICES
KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

W.O. 8090-00 DECEMBER 20, 2021

TABLE OF CONTENTS

Page

SUMMARY OF FINDINGS AND RECOMMENDATIONS iii

1. GENERAL 1
1.1 Project Considerations 1
1.2 Purpose and Scope 2

2. SITE CHARACTERIZATION 4
2.1 Regional Geology 4
2.2 Surface and Subsurface Conditions 7
2.3 Future Geotechnical Explorations for Site Characterization 7

3. TUNNEL DESIGN AND CONSTRUCTION 8
3.1 Design Considerations 8
3.1.1 Tunnel Portals 8
3.1.2 Tunnel Configuration 9
3.1.3 Ventilation Options 9
3.1.4 Fire Suppression Systems 10
3.1.5 Tunnel Egress Considerations 10
3.1.6 Fire Suppression Systems 11
3.2 Construction Considerations 11
3.2.1 Portal Work Sites 11
3.2.2 Anticipated Rock Mass Classification for Tunnel Construction 11
3.2.3 Roadheader vs. Drill and Blast Construction Methods 12
3.3 Muck Handling and Disposal 13
3.4 Probable Construction Cost Estimate 14
3.5 Design Level Geotechnical Exploration 16

4. LIMITATIONS 17

CLOSURE 18

PLATES
Project Location Map ..... Plate 1
Site Plan ..... Plate 2
Geologic Map ..... Plate 3
Proposed Tunnel Alignment ..... Plate 4
Rock Class & Rock Load Classification for Steel Arch Supported Tunnels ..... Plate 5

GEOTECHNICAL CONSULTATION SERVICES
KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII
W.O. 8090-00 DECEMBER 20, 2021

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The existing cut slope observed at the site encompasses moderately to highly weathered a`a basalt rock formation containing some dense and massive hard rock seams interbedded with medium hard welded basalt clinker. Therefore, the assumed ground conditions at the Kalepa Point Tunnel include some clinker materials within the basalt formation that are potentially porous and friable. A highly fractured interval is expected to occur within the basalt formation, which has relatively high RQD values consistent with “Fair” to “Very Good” quality rock.

The Kalepa Point Tunnel will be a horseshoe shaped tunnel with approximate dimensions of 31 feet wide by 16 feet high (clear height). The tunnel cross section assumed for this report would contain two 12-foot travel lanes, one 2-foot shoulder on one side, and one 5-foot pedestrian walkway on the opposite side for a nominal total width of 31 feet. The tunnel would consist of one bore that would be constructed using the Sequential Excavation Method (SEM) designed to be excavated and supported in sequential stages as twin top headings and a single bench.

The portal work site likely would require several preparatory tasks including coordination with local landowners for access, locating utility lines in the subsurface, construction of a staging area, felling trees, leveling ground for machinery and drill rigs, and excavating into hillslopes. The tunnel portals would commence with near-vertical cuts at the rock face and require spiling above the crown down to each springline to support the excavation. The length of the spiles should be one equivalent tunnel diameter long to provide adequate longitudinal support to the tunnel crown. Each spile would be spaced at approximately 18-inch on centers. Feasibility level estimates of muck are about 20,000 cubic yards for the proposed tunnel alignment assuming a 1.4 swell factor.

Given the available level of design and lack of project-specific geotechnical information, we prepared a cost estimate consistent with a Class 5 cost estimate per ACEE. Based on this characterization and AACE guidance, the cost estimate should be considered to have an approximate accuracy range of from up to -50% to +100% relative to our specific cost estimate. Using this method, the estimated probable costs for construction of the proposed Kalepa Point Tunnel alignment ranges from $10 Million to $38.5 Million.

The text of this report should be referred to for detailed discussion and geotechnical considerations for design and construction of the proposed vehicular tunnel.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

This report presents the findings and discussions pertaining to the proposed vehicular tunnel performed for the proposed Kalepa Point Tunnel Feasibility project along Piilani Highway in the Kipahulu area on the Island of Maui, Hawaii. The project location and general site vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our site reconnaissance and literature research and presents our geotechnical assessment of the proposed vehicular tunnel at Kalepa Point. The findings and discussions presented herein are subject to the limitations noted at the end of this report.

1.1 Project Considerations

The proposed tunnel project site is located along Piilani Highway at Kalepa Point, which is approximately at Mile Post 38.2 in the Kipahulu area on the Island of Maui, Hawaii. We understand that Tropical Storm Iselle (in October 2014) caused damage to the existing roadway and seawall at around Mile Post 38.2. The damages consist of eroded areas of the roadway edge, washed out portions of the existing wall facing, undermining of the roadway and metal guardrails at localized areas of the site.

Based on the information provided, several options are being considered to extend the width of the roadway and reduce the potential for erosion of the road and shoreline from wave action from the ocean waters. The existing Kalepa Slope has been a source of rockfall events onto the Piilani Highway roadway below the slope. In addition, Piilani Highway at this location below Kalepa Slope is right adjacent to the shoreline and is subject to wave erosion. Due to these conditions, we understand that a shoreline protection alternative to protect the roadway of Piilani Highway has been studied.

To provide another alternative to this shoreline protection alternative, a vehicular tunnel to bypass the Kalepa Slope area has been proposed. The approximate alignment of the proposed vehicular tunnel is shown on the Site Plan (Plate 2). Geolabs would assist the project team in establishing alternatives for grade and alignment of the tunnel and would characterize methods of construction, tunnel linings, and other general tunnel

requirements including issues at the tunnel portals. For the identified tunnel alternative, we would prepare a feasibility level cost estimate. This report presents the feasibility study conducted for this tunnel alignment and the estimated probable construction cost for evaluation purposes.

1.2 Purpose and Scope

The purpose of our geotechnical consultation is to obtain an overview of the existing conditions to assist in the planning and evaluation of a vehicular tunnel. The length of the tunnel alternative would be approximately 600 linear feet in length. To accomplish this, we propose a study program generally consisting of the following tasks and work efforts:

1. Review of available information pertaining to the project site and vicinity including our previous assessments conducted for the slope site.

2. Coordination and reconnaissance of the Kalepa Slope project site from the roadway level and from accessible portions of the slope by our geologist, project engineer, and principal engineer. The reconnaissance would be to assist in developing the tunnel clearance envelope and tunnel alignment alternatives.

3. Research and review of available project summaries of precedent and trends in the design and construction of vehicular tunnels. Based on our experience, this research and review would focus on selected tunnels in the US and others in the world that appear to have relevance.

4. Tunnel Cross Section: Develop approximate cross-section for tunnel excavation based on the established clearance envelope to assist the project team in the tunnel alignment.

5. Tunnel Excavation and Tunnel Linings: For the established cross-section, provide generic scheme for tunnel excavation, type of initial ground support, and alternative final linings of shotcrete and cast in place concrete.

6. Assessment of the Influence of Tunnel Construction on the Kalepa Slope: Some concerns exist for the impact of constructing the tunnel by the drill and blast excavation method of a large roadway tunnel close to the existing slope face that is quite susceptible to rockfall.

7. Assessment of Fire Life Safety and Ventilation Requirements: The general need for ventilation would be assessed. Emergency egress would be evaluated. Current regulations and policies would be considered. However, establishing the definitive requirements would require analysis of

site-specific weather and traffic and would be beyond the feasibility effort, such as at a preliminary design level of effort. The feasibility study would only characterize the range of facilities required in order that a cost could be estimated.

8. Evaluation of Tunnel Alignment Alternatives: Provide evaluation of the plan, profiles, and roadway sections of the tunnel alternatives that are established by the project Civil Engineer.

9. Cost Estimates: Perform feasibility level cost estimates on the basis of the tunnel as finally characterized in the other parts of the study. Costing of one tunnel alignment is envisioned with two alternative linings and ventilation requirements.

10. Design Support: Perform engineering analyses and provide consultation on the design of retaining structures and shoreline protection structures.

11. Geotechnical Consultation Report: Prepare a report outlining our assessment and probable construction cost estimates.

12. Coordination of our overall work on the project by our engineer.

13. Quality assurance of our work and client/design team consultation by our principal engineer.

14. Miscellaneous work efforts, such as drafting, word processing, and clerical support.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

Of interest to our geotechnical analysis for the tunnel feasibility study are the subsurface materials anticipated at the project site, the engineering properties of the materials anticipated along the tunnel alignment, and the variability of the subsurface conditions along the tunnel alignment. Therefore, the following subsections provide a description of the geologic setting of the project site, the surface and subsurface conditions anticipated at the site, and a discussion of the future geotechnical exploration requirements.

2.1 Regional Geology

The Island of Maui is the second largest island of the Hawaiian Archipelago with an area of approximately 728 square miles. It was formed by the activity of two volcanoes, East Maui (or Haleakala) and West Maui. The broad, gently sloping plain connecting the two volcanoes, known as the Maui Isthmus, was formed when lavas of the Haleakala Volcano banked against the already existing West Maui Volcano.

The East Maui Volcano, known as Haleakala Mountain, makes up the eastern portion of the Island of Maui. Haleakala Mountain is considered to be dormant with the last eruption taking place on the southern corner of the mountain around 1790. The core of Haleakala consists largely of thin-bedded lavas of the Honomanu Volcanic Series that built the base of the mountain from three primary rift zones, during the early Pleistocene Epoch. Eruption of thicker-bedded a`a and clinker lavas containing embedded ash soils of the Kula Volcanic Series lavas, followed in the late Pleistocene Epoch and further built upon the foundation created by the Honomanu Volcanic Series.

Many cinder cone vents formed along the principal rift alignments; therefore, appreciable volcanic ash and cinder deposits are interbedded within the Kula Volcanic Series lavas. A long period of dome erosion and volcanic inactivity occurred until finally, lavas and cone deposits of the youngest volcanic series, the Hana Volcanic Series, were expelled from vents aligned along the eastern and southwestern rift zones of Haleakala. These late stage lavas partly filled some pre-existing valley floors and draped over some pre-existing steep valley walls as thin “plastered” veneer lavas.

The volcanic rocks of the West Maui Volcano are divided into three volcanic eruption series. The oldest, the Wailuku Volcanic Series, is comprised of basaltic lava flows and associated pyroclastic and intrusive rocks, which built the major shield volcano. The Wailuku Volcanic Series was covered by a thin, discontinuous “frosting” of andesitic and trachytic flows, domes, and pyroclastic deposits known as the Honolua Volcanic Series. After a long period of inactivity, where erosion incised deep valleys into the volcanic flows, volcanic activity returned with eruptions that produced the flows and cones of the Lahaina Volcanic Series.

In the mountainous regions of the Island of Maui, the erosion processes are dominated by mass wasting, which is the detachment and fall by rockfall and landslide activity, of various soil and rock materials from the steep-sided valley walls. These mobilized and mixed colluvial deposits are then transported by gravity down slope toward the axis of a valley. Once these materials reach the stream in the central portion of a valley, alluvial transport processes become dominant, and the sediments are further mobilized and deposited as alluvium.

In general, many Hawaiian stream flows are intermittent and flashy, such that the discharge flows may transmit very large volumes of water for a very short duration. Because of this, the transport of sediment is intermittent, and the bulk of the stream's hydraulic load consists of a poorly-sorted mixture of boulders, cobbles, gravel, sands, and fines. When the land mass erosion base level changes, these sediment loads and deposits are either scoured and remobilized or buried in place as alluvial and colluvial deposits.

When alluvial and colluvial deposits are buried in place for long periods of time, chemical processes begin to alter the materials simultaneously causing a breakdown or further weathering of the material. Chemical processes also may cause induration, or cementation, of the sediment resulting in a poorly to moderately consolidated sedimentary rock, such as siltstone, sandstone and conglomerate. Simultaneously, erosion may continue in the upland areas above the valley floors. This continued upland erosion generates additional unconsolidated materials, which are then transported down slope to further bury the older consolidated alluvial and colluvial deposits. Depending on the local

erosion base level and rate of transport, these newer sediments may be generally transient in terms of geologic time. In addition, their consistency and density are generally less than those of the older, partially consolidated deposits.

During the Pleistocene Epoch (Ice Age), a variety of sea level changes occurred as a result of widespread glacial advance and retreat in the worldwide continents. As the great continental glaciers advanced and accumulated, the level of the ocean fell due to a lower quantity of water contained in the oceanic basins. Conversely, as the glaciers receded/melted, global sea levels rose due to the increase in melt water. The land mass of the Island of Maui remained essentially stable in terms of uplift and settlement during these changes; therefore, the fluctuations of sea level were eustatic with respect to the landmass elevation. These glacio-eustatic fluctuations resulted in stands of the sea that were both higher and lower relative to the present sea level on Maui. Thus, in the present time, ancient marine deposits may be exposed on the land surface and ancient terrestrial deposits may be encountered buried in today's offshore depositional environment.

The processes of erosion and deposition also were affected by these glacio-eustatic sea level fluctuations. When the sea level was low, the landmass erosional base level was correspondingly lower, and deep valleys were carved to depths below the present sea level. When the sea level was high, the erosion base level was raised such that sediments accumulated at higher elevations.

The project site is located along the remote south and southeast facing coastline in the vicinity of the Kipahulu areas of the Island of Maui. Based on the available geologic information, the project site is underlain by extensive a`a lava flows and clinker belonging to the Kula Volcanic Series, as shown on the Geologic Map (Plate 3). Lavas from this volcanic series range in composition from ultra-basic olivine porphyries to non-porphyritic, alkalic basalts. The landform of the various project sites was created by stream incision and the formation of deep valleys trending from inland toward the sea in conjunction with coastal erosion by ocean wave attack with varying sea levels and resulting changes in the erosion base level with the passage of time.

2.2 Surface and Subsurface Conditions

The proposed Kalepa Point Tunnel alignment site is located on Piilani Highway at Kalepa Point, which is at approximately Mile Post 38.2 in the Kipahulu area on the Island of Maui, Hawaii. The overall length of the tunnel alignment is approximately 600 linear feet, as shown on the Site Plan (Plate 2) and Proposed Tunnel Alignment (Plate 4). In general, this portion of Piilani Highway is an asphaltic concrete road that is narrow and in relatively poor condition. The traffic volume along this portion of the highway can be considered low.

The Kalepa Point project site consists of a rock cut slope. We observed that the existing cut slope encompasses generally moderately to highly weathered a`a basalt rock formation containing some dense and massive hard rock seams interbedded with medium hard welded basalt clinker. The cut slope has a generally smooth to slightly irregular and undulating exposed surface with limited differential weathering that typically results in the development of undercut erosion and rock overhangs between the contrasting layers of basaltic rock. Occasional protrusions of dense rock extend outward from the slope face as evidenced by some widely scattered occurrences of point loading of the drapery on portions of the slope face. Based on our observations, the basalt rock comprising the upper portion of the cut slope face appears to be more deeply weathered containing some zones of completely weathered rock resembling saprolite.

2.3 Future Geotechnical Explorations for Site Characterization

Due to the limited access and steep slopes above the tunnel alignment, conventional vertical and angled geotechnical borings will be difficult to perform. Therefore, we recommend performing horizontal boreholes through the tunnel horizon to characterize the geology along the entire alignment. Boreholes should be drilled from each portal toward the tunnel center, and continuous rock cores (either HQ-size or PQ-size cores) should be obtained. Additionally, some geophysical survey and laboratory testing of the recovered core samples also should be performed to characterize the basalt rock formation for tunnel design and construction considerations.

END OF SITE CHARACTERIZATION

SECTION 3. TUNNEL DESIGN AND CONSTRUCTION

The following sections of this feasibility study present the geotechnical considerations in support of the design and construction for the Kalepa Point Tunnel Feasibility Study.

3.1 Design Considerations

Based on the available topographic survey map and our site reconnaissance, we anticipate the tunnel design considerations for development of the Kalepa Point Tunnel will involve the following items.

1. Tunnel Portals
2. Tunnel Configuration
3. Ventilation Options
4. Fire Suppression Systems
5. Tunnel Egress Considerations

3.1.1 Tunnel Portals

Generally, both tunnel portals will commence with near-vertical cuts at the rock face and require spiling above the tunnel crown down to each springline to support the excavation. The length of the spiles should be at least one equivalent tunnel diameter long to provide adequate longitudinal support to provide pre-support to the tunnel crown in the anticipated soil-like and/or weathered rock conditions. Spiles (drilled “looking up” at a shallow angle) would be drilled in advance of each round and of sufficient length to achieve overlap of two to three spile rounds spanning over each excavation round. Each spile would be spaced at approximately 18 inches on-centers.

A general spiling design consists of No. 8 tensioned bar grouted into a 2-inch diameter drilled hole. Typically, spiles are installed above the tunnel crown downward to each springline. Each spile would be spaced at approximately 18-inch on-centers depending on geology. Alternatively, the more robust grouted pipe-spile arch canopy using approximately 4-inch diameter drilled steel pipes could be installed. It is important to note that the portals have limited rock cover and likely will be entirely constructed within weathered rock or clinker materials

depending upon portal development excavation prior to turning under to begin tunneling. This may require additional stabilization such as supplemental, more closely spaced spiles, grouting, or soil nails, or the pipe arch as noted.

3.1.2 Tunnel Configuration

The tunnel cross section assumed for this report would contain two 12 foot travel lanes, one 2-foot shoulder on one side, and a 5-foot pedestrian walkway on the opposite side for a nominal total width of 31 feet. The tunnel would consist of one bore that would be constructed using the Sequential Excavation Method (SEM) designed to be excavated and supported in sequential stages as twin top headings and a single bench. The top heading would consist of two side drifts, left and right, followed by the bench. The dimensions for the bench would be about 16 feet high and the full tunnel width of 31 feet. The combined top heading drifts are estimated to be advanced at about 12 feet per day in individual blast rounds of 8 to12 feet. The bench is estimated to be advanced at about 25 to 30 feet per day in 10 to 15-foot rounds, with the top headings staggered horizontally during the excavation sequence to provide additional sidewall and crown stability during construction.

Generally, we anticipate that it will take different methods to support the tunnel during the mining operation including the use of rock bolts, rock dowels, shotcrete, lattice, girders, grouted and self-drilled spiles, and possibly a grouted pipe canopy for initial arch support at the portals. The design of the above support systems will be dependent on rock type and quality and the means and methods employed by the Contractor. It is recommended the final lining be shotcrete backed by a waterproof membrane installed from invert to crown on each side of the tunnel along with a drainage fleece.

3.1.3 Ventilation Options

The tunnel will be classified as either non-gassy, potentially gassy, or gassy in accordance with OSHA and/or FHWA standards. Typically, the geologic formations to be excavated for the tunnel are assessed for the presence of methane and hydrogen sulfide gas. Future geotechnical investigations for the

tunnel will include using environmental probes to measure gas levels. For this study the tunnel is assumed to be non-gassy based on the local geology.

Considering the length of the tunnel alignment (approximately 600 linear feet), mechanical ventilation may not be required for congested conditions and for a fire emergency condition per the National Fire Protection Association (NFPA) 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways. Chapter 7 of the Standard requires mechanical ventilation for tunnels with a length greater than 790 feet.

Because of the length of the tunnel, we anticipate ventilation with jet fans at appropriate locations would suffice for the Kalepa Point Tunnel at an approximate length of 600 linear feet.

3.1.4 Fire Suppression Systems

The fire suppression system assumes an 8-inch diameter fire water line to be installed on each side of the tunnel but the system is not designed to have automated fire suppression features, just nominal standpipe/connection locations for local fire department hook-ups. This estimate only addresses the basic delivery of the fire suppression medium (water) and does not address any foam, sprinkler, or automated water delivery valves/standpipes etc.

3.1.5 Tunnel Egress Considerations

Tunnel egress systems using a longitudinal ventilation system would dictate installing pass through openings at nominal 750 foot centers in the diaphragm wall. Walkways are assumed to be installed on each side of the tunnel having a width of 60-inches wide. Although ADA guidelines state a minimum of 36-inches width, this smaller width requires installing passing niches at locations relevant to the length of the path. Designing with 60-inches width walkways relieves the requirement for the passing niches.

Because the Kalepa Point Tunnel is less than 790 linear feet in length, the tunnel egress systems will not be required.

3.1.6 Fire Suppression Systems

The fire suppression system assumes an 8-inch diameter fire water line to be installed on each side of the tunnel but the system is not designed to have automated fire suppression features, just nominal standpipe/connection locations for local fire department hook-ups. This estimate only addresses the basic delivery of the fire suppression medium (water) and does not addressany foam, sprinkler, or automated water delivery valves/standpipes etc.

3.2 Construction Considerations

The tunnel configuration will be a horseshoe shaped tunnel with approximate dimensions of 31 feet wide at the invert and 16 feet clear. The tunnel will be designed to be constructed as a two-lane road with and an elevated pedestrian walkway on one side of the roadway to keep the tunnel width to a minimum considering the low traffic volumes anticipated for this portion of Piilani Highway.

3.2.1 Portal Work Sites

Both portal work sites will need to be prepared and levelled prior to both the horizontal drilling campaign and excavation of the tunnel. This is particularly important as the tunnel portals are in a remote and difficult access area for heavy construction equipment. The portal work sites likely will require several preparatory tasks including coordination with local landowners for access, locating utility lines in the subsurface, construction of a staging area, felling trees, leveling ground for machinery and drill rigs, and excavating into hillslopes.

3.2.2 Anticipated Rock Mass Classification for Tunnel Construction

The assumed ground conditions includes encountering some clinker materials within the basalt formation that are potentially porous and friable. A weathered and highly fractured/jointed interval commonly is expected to occur within the basalt formation. This interval has low RQD (generally less than 15%) indicative of poor quality. Below the clinker material zone, the RQD values of the cores are expected to increase significantly and generally would range between 70% to 100%, indicating good to excellent quality rock. These observations demonstrate that the quality of rock typically increases significantly with depth.

Using the rock mass rating system (RMR) (Bieniawski, 1989), we anticipate the quality of basalt rock formation for tunneling purposes to vary between “Fair” to “Very Good”. The basalt formation will need to be supported after excavation, particularly in the areas near the portals where there is minimal good quality rock anticipated and in the zones exposing clinker materials where the material has a lower RMR value. Potential support systems could include (and are not limited to) local rock bolt patterns, wire mesh, lattice girders, and shotcrete.

Groundwater levels are anticipated to be below the tunnel invert for the majority of the tunnel alignments and should not be a significant design and construction consideration.

Understanding how the ground will behave during construction is paramount to the successful and safe completion of any tunnel construction. Ground behavior during construction is typically a function of numerous factors including strength and structure of the excavated material, local groundwater conditions, and excavation method. We have estimated the rock class and rock load factor classification (Terzaghi, 1946), which predicts how rock in a tunnel will behave as a function of its quality (Plate 5).

3.2.3 Roadheader vs. Drill and Blast Construction Methods

It is unlikely that a roadheader would be able to efficiently excavate at least portions of the massive basalt formation anticipated along the tunnel alignment. The basalt formation is assumed to be stronger and does not contain frequent preferential planes of weakness that can be exploited with a roadheader. Therefore, we anticipate the conventional drill-and-blast techniques likely will be required to excavate through the stronger, massive basalt formation. Drill and blast sequences would typically be performed in rounds of 8 to 12 feet. A typical excavation cycle by drill and blast is as follows:

1. Drill holes into rock face and load with explosives,
2. Detonate blast,
3. Ventilate to remove blast fumes,
4. Remove blasted rock via mucking,
5. Scale crown and walls to remove the loose rock,

6. Install initial ground support, and
7. Advance ventilation system and utilities (water and power).

Tunneling by drill-and-blast is still the most common method in the underground mining industry. When the geological formation of underground construction is in hard, competent rock, drill-and-blast mining can be very efficient and economical. However, it is important to note that a drill-and-blast option also requires explosives permitting and other considerations including delivery, handling, and storage.

3.3 Muck Handling and Disposal

The method of removal for the excavated materials (muck) from the tunnel is a critical decision to be made by the Contractor as part of their successful construction strategy. As the excavation advances, the muck must be transported back toward the portal for collection and disposal while the tunnel's support system is simultaneously being advanced. Movement of these materials past each other along with requirements for personnel access, ventilation, lighting, power, and water create an ongoing logistical challenge for the Contractor.

The most feasible muck removal system for the Kalepa Point Tunnel would be to transport the muck back to the portals in rubber tired loaders with side dump buckets and then transferring the muck to dump trucks. The Contractor may even consider muck utilization for sand and aggregate for on-site shotcrete and concrete batching in lieu of importing ready mix shotcrete and concrete as the batch plant facilities are at least 60 to 75 minutes away from the site.

Once the muck is loaded onto dump trucks, it will be hauled off site for disposal (assumed to be within 35 miles from the project site). Adequate provisions for dust control and erosion control, vehicle wash down, and roadway sweeping should be incorporated into the contract documents and enforced during construction.

The estimated muck yields would be approximately 20,000 bank cubic yards. The estimates assume a swell factor of 1.45 for the muck materials.

3.4 Probable Construction Cost Estimate

Our cost estimate generally, but not strictly, conforms to the methods proposed by Association for the Advancement ofCost Estimating (AACE). Given the available level of design and lack of project-specific geotechnical information, we prepared a cost estimate consistent with a Class 5 cost estimate per ACEE. The following table shows the relationship between cost estimate class and level of project definition. Based on this characterization and AACE guidance, the probable construction cost estimate we developed should be considered to have an approximate accuracy range of from up to -50% to +100% relative to our specific cost estimate.

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4

The following table provides a summary of the concept screening level probable construction cost estimate for the Kalepa Point Tunnel project.

KALEPA POINT TUNNEL FEASIBILITY STUDY			
Item	**Description**	**Estimated Cost**	**Remarks**
1.	Tunnel Raw Materials	$3,300,000	
2.	Tunnel Interior Tiling	$650,000	
3.	Tunneling Equipment	$3,010,000	
4.	Other Equipment	$3,730,000	
5.	Tunneling Labor	$1,300,000	

KALEPA POINT TUNNEL FEASIBILITY STUDY			
Item	**Description**	**Estimated Cost**	**Remarks**
6.	Indirect Labor and Project Costs	$850,000	The sum of Items Nos. 1 through 6 equals "baseline" cost as defined below
7.	Indirect Costs	$6,400,000	Includes mobilization, bond and insurance, overhead and profit, and contractor contingency.
	TOTAL	**$19,210,000**	**Class 5 Cost Estimate**
	Probable Estimated Construction Cost Range: $10 Million to $38.5 Million		

Assumptions:

1. The tunnel needs to have 31'-0" W x 16'-0" H minimum interior clearance dimensions. We assume the tunnel will have the 16'-0" minimum height at the tunnel centerline and will be less at the springlines where the walls meet the crown. Resulting wall heights are assumed to be suitable for roadway and vehicle dynamic envelope requirements.

2. The roadway "prism" will consist of two 12 feet wide travel lanes, one 5 feet wide ADA walkway on one side of the tunnel, and one 3 feet wide raised curb on the opposite side of the tunnel, comprising the 31 feet minimum width.

3. Assume concrete paving for the roadway inside the tunnel.

4. Assume initial support comprised of rock bolts and shotcrete as required and a final lining of 12 inches of fiber reinforced shotcrete. We will assume 6,000 psi strength shotcrete.

5. There were no available geotechnical borings of the tunnel horizon, but we assumed relatively good quality basalt bedrock will comprise the ground conditions for the majority of the tunnel. We have assumed a mix of "fair" (RQD = 50 to 75) and "good" (RQD = 75 to 90) rock quality based on the Rock Quality Designation (RQD) rock mass classification system. We have assumed rock strength based on intact Uniaxial Compressive Strength (UCS) values ranging from approximately 7,500 to 15,000 psi. We have assumed a high abrasivity value for tool wear assumptions based on Cerchar Abrasivity Index (CAI) values of about 2.0 to 4.0.

6. There will be two short portal structures required at each portal that will be constructed within short (approximately 150 linear feet) new approach roadways that will connect the new tunnel to the existing roadway.

7. No relocation of existing subsurface or surface utilities will be required.

8. Assume potable water and power for construction is readily available at the site.

9. Assume there is a tunnel “muck” (excavated material) and debris disposal site within 35 miles of the site.

3.5 Design Level Geotechnical Exploration

The preliminary findings and discussions presented herein are based on the available boring data within proximity of the proposed tunnel alignment and field observations made during a site reconnaissance only. Therefore, a design-level geotechnical exploration program should be undertaken to formulate geotechnical recommendations in support of the detailed design of the proposed tunnel project.

END OF TUNNEL DESIGN AND CONSTRUCTION

SECTION 4. LIMITATIONS

The findings and discussions presented in this geotechnical consultation report are based upon information obtained from site reconnaissance, literature research, and experience in the vicinity of the proposed tunnel alignment. It should be noted that it is not possible to observe and/or anticipate all the site conditions based on a brief reconnaissance of the project site and review of the literature. Variations of the subsurface conditions from those described in this report may occur, and the nature and extent of these variations may not become evident until further design-level geotechnical engineering exploration is conducted at the project site or construction is underway.

This report has been prepared for the exclusive use of Sea Engineering, Inc. and their client, County of Maui – Department of Public Works, Engineering Division, for specific application to the *Kalepa Point Tunnel Feasibility Study* project along the Piilani Highway on the Island of Maui in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

Project Location Map..... Plate 1

Site Plan..... Plate 2

Geologic Map..... Plate 3

Proposed Tunnel Alignment..... Plate 4

Rock Class and Rock Load Classification for Steel Arch Supported Tunnels..... Plate 5

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Respectfully submitted,

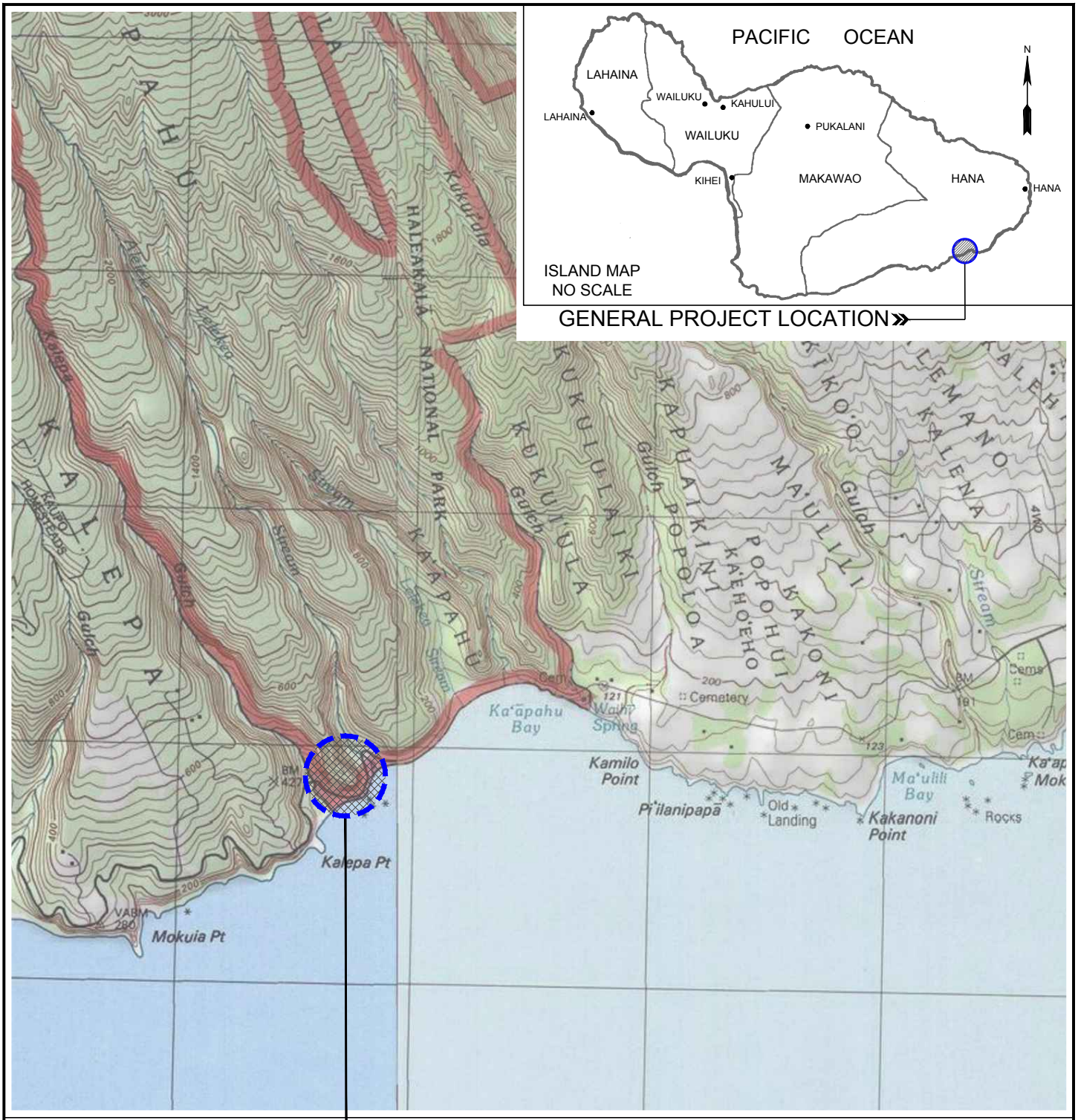
GEOLABS, INC.

By _____
Robin M. Lim, P.E.
President

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PLATES



PROJECT LOCATION MAP

KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

2000 1000 0 2000 FT.
GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
DECEMBER 2021	KHN	1
SCALE	W.O.	
1" = 2,000'	8090-00	

CAD User: KIM File Last Updated: October 22, 2021 8:10:12pm Plot Date: December 20, 2021 - 8:24:49pm
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Plotter: DWG To PDF-GEO.pc3 Plotstyle: GEO-No-Dither-RBGC-HEAVY.ctb

ALELELE BRIDGE

8+23.84

8+00

7+00

6+00

5+00

4+00

3+00

2+00

1+00

0+00

KALEPA GULCH

APPROXIMATE TUNNEL EDGES

APPROXIMATE TUNNEL CENTERLINE

KALEPA BRIDGE

KALEPA POINT

HANA HIGHWAY;
REPAVE BETWEEN KALEPA
AND ALELELE BRIDGES

+25
+20
+15
+10
+5
+0
−5
−10
−15
−20
−25
−30

PRIMARY STAGING AREA
(2,650 SF)

STA.3
3/4" PIPE
ELEV.=20.59
114512.71 N
1839405.79 E

STA.7
HUB W/ TACK
ELEV.=24.05
114324.77 N
1839382.52 E

STA. 301
1/2" PIPE
ELEV.=23.94
114217.36 N
1839339.19 E

STA. 8
1/2" PIPE
ELEV.=25.50
114143.34 N
1839182.48 E

NEW ROCK RUBBLEMOUND REVETMENT
AND CONCRETE SEAWALL

0 40 80 160 240 FT.
GRAPHIC SCALE

N

SITE PLAN

KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE		PLATE
DECEMBER 2021		2
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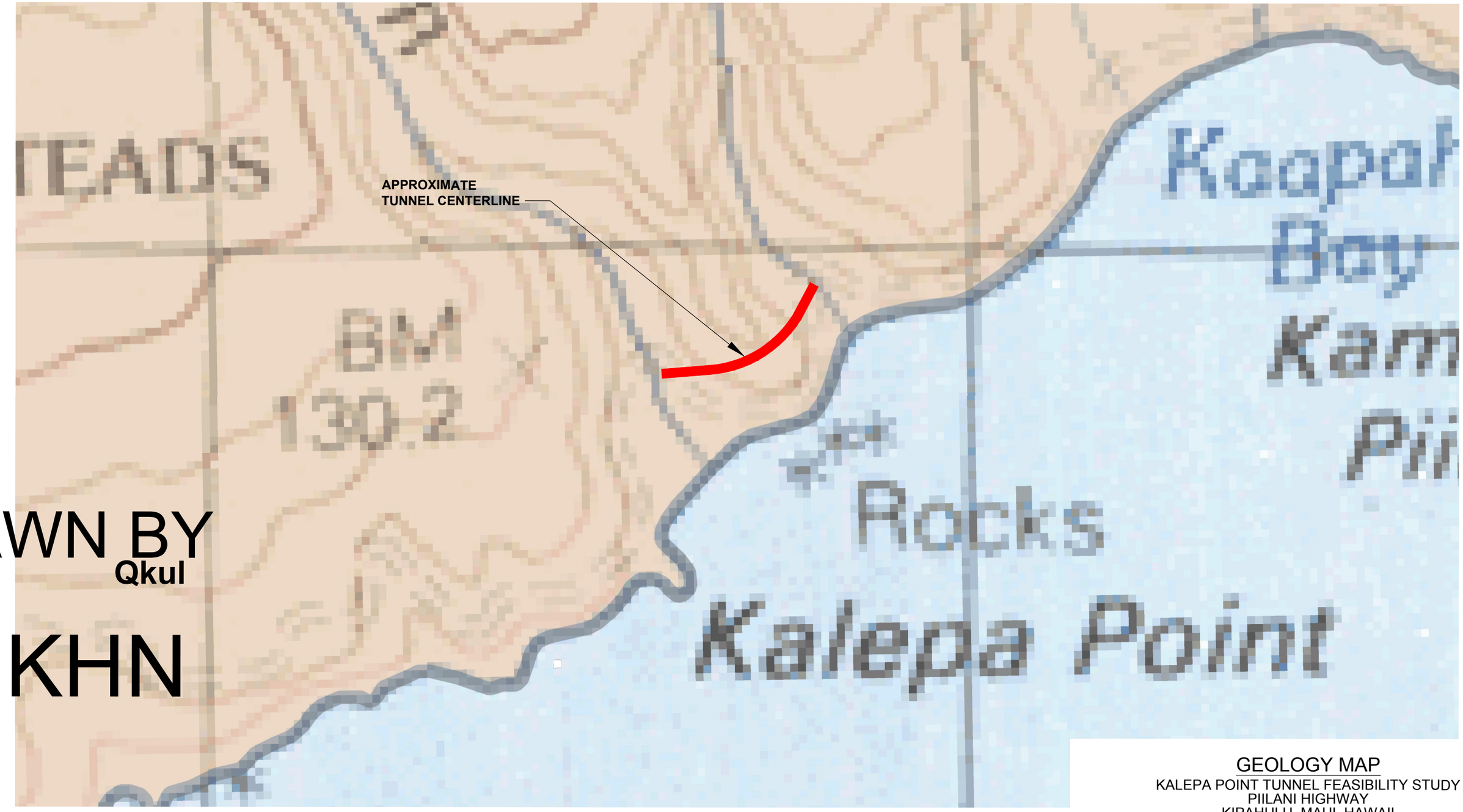
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KHN

8090-00

REFERENCE: XX

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Last Updated: December 20, 2021 4:22:33pm Plot Date: December 20, 2021 - 8:25:22pm



AWN BY
Qkul

KHN

LEGEND:

Qkul Quaternary Kula Volcancics

8090-00

REFERENCE: GEOLOGIC MAP OF THE STATE OF HAWAII, SHEET 7 - ISLAND OF MAUI BY DAVID A. SHERROD, JOHN M. STIMAC, SARAH K. WATKINS AND KEVIN M. [illegible] COUNT DATED 20[illegible]

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GRAPHIC SCALE

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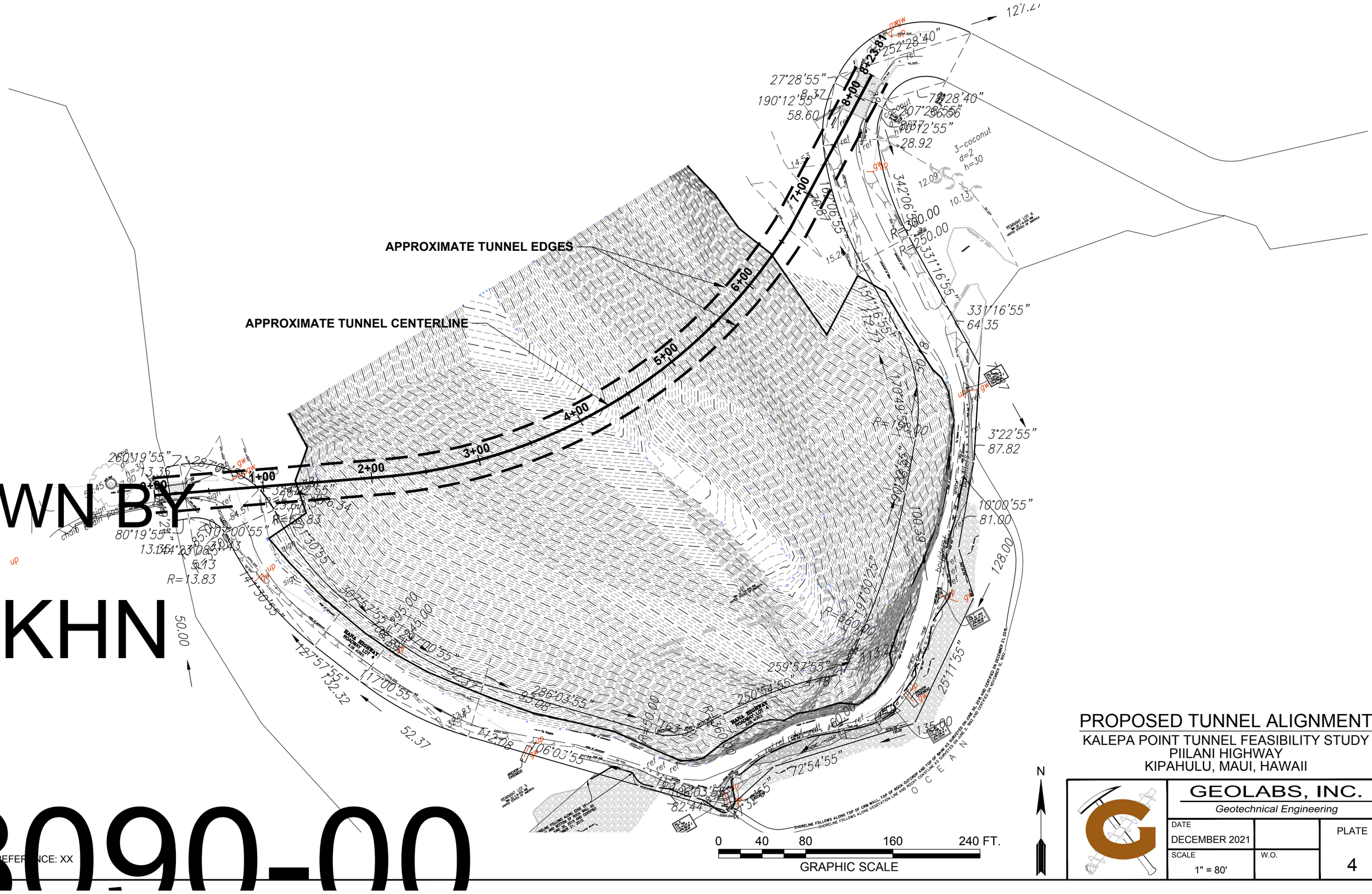
GEOLOGY MAP

KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE		PLATE
DECEMBER 2021		3
SCALE: 1" = 400'	W.O.	

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AWN BY

KHN

8090-00

REFERENCE: XX

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Plotstyle: ATAS TANDARD HALF.ctb
To Plot: GEO.pc3

PROPOSED TUNNEL ALIGNMENT

KALEPA POINT TUNNEL FEASIBILITY STUDY
PIILANI HIGHWAY
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE		PLATE
DECEMBER 2021		4
SCALE 1" = 80'	W.O.	

Rock Class and Rock Load Classification for Steel Arch Supported Tunnels (After Terzaghi, 1946)

Rock Class	Definition	Rock Load Factor Hp (in feet, B and Ht in feet)	Remark
I. Hard and intact	Hard and intact rock contains no joints and fractures. After excavation, the rock may have popping and spalling at excavated face.	0	Light lining required only if spalling or popping occurs.
II. Hard stratified and schistose	Hard rock consists of thick strata and layers. The interface between strata is cemented. Popping and spalling at the excavated face is common.	0 to 0.5 B	Light support for protection against spalling. Load may change between layers.
III. Massive, moderately jointed	Massive rock contains widely spaced joints and fractures. Block size is large. Joints are interlocked. Vertical walls do not require support. Spalling may occur.	0 to 0.25 B	Light support for protection against spalling.
IV. Moderately blocky and seamy	Rock contains moderately spaced joints. Rock is not chemically weathered and altered. Joints are not well interlocked and have small apertures. Vertical walls do not require support. Spalling may occur.	0.25 B to 0.35 $(B + H_t)$	No side pressure.
V. Very blocky and seamy	Rock is not chemically weathered and contains closely spaced joints. Joints have large apertures and appear separated. Vertical walls need support.	(0.35 to 1.1) $(B + H_t)$	Little or no side pressure.
VI. Completely crushed but chemically intact	Rock is not chemically weathered and highly fractured with small fragments. The fragments are loose and not interlocked. Excavation face in this material needs considerable support.	1.1 $(B + H_t)$	Considerable side pressure. Softening effects by water at tunnel base. Use circular ribs or support rib lower end.
VII. Squeezing rock at moderate depth	Rock slowly advances into the tunnel without a perceptible increase in volume. Moderate depth is considered as 150 ~ 1000 m.	(1.1 to 2.1) $(B + H_t)$	Heavy side pressure. Invert struts required. Circular ribs recommended.
VIII. Squeezing rock at great depth	Rock slowly advances into the tunnel without a perceptible increase in volume. Great depth is considered as more than 1000 m.	(2.1 to 4.5) $(B + H_t)$	
IX. Swelling rock	Rock volume expands (and advances into the tunnel) due to swelling of clay minerals in the rock at the presence of moisture.	up to 250 feet, irrespective of B and H_t	Circular ribs required. In extreme cases use yielding support.

Notes: The tunnel is assumed to be below the ground water table. For tunnel above water tunnel, Hp for Classes IV to VI reduces 50 %.
The tunnel is assumed excavated by blasting. For tunnel boring machine and road header excavated tunnel, Hp for Classes II to VI reduces 20 - 25 %.

APPENDIX D – FLORA AND FAUNA SURVEY (ROBERT W. HOBDY)

Flora and Fauna Survey for the

Kālepa Revetment and Seawall Repair Project job no. 19-31

Ka`apahu, Kīpahulu, Maui

by

Robert W. Hobdy
Kokomo, Maui
January 2021

Prepared for: Sea Engineering, Inc.

Flora and Fauna Survey
Kālepa Revetment and Seawall Repair Project
Ka`apahu, Kīpahulu, Maui

INTRODUCTION

The Kālepa Revetment and Seawall Repair Project is located along the Pi`ilani Highway on the coastline in southwestern Kīpahulu, East Maui (see Figures 1 & 2). The project area includes the above structural improvements as well as a potential alternative tunnel design and a staging area. This biological study, inventorying and assessing the flora and fauna resources, was initiated by Sea Engineering, Inc. for this County of Maui, Department of Public Works project, in fulfillment of environmental requirements of the planning process.

SITE DESCRIPTION

The project is located near the base of an approximately 200 foot sea cliff that separates the coastal outlets of Kālepa Stream and `Alelele Stream. The present section of the project road stretches about 500 feet in length, at an elevation of 24 feet above mean sea level and is about 20 feet wide with an unpaved cinder surface. The alternative tunnel design includes tunnel entrances adjacent to the eastern end of Kālepa Bridge and the western end of `Alelele Bridge. The main staging area is located above the road on the west side of `Alelele Stream along with an additional overflow area below the road. Vegetation is very sparse along the project road and sea cliff with only the most wind and salt tolerant species present. The two proposed tunnel entrance sites are thickly forested and the staging area has mostly grasses and bare gravel. Annual rainfall averages around 80 inches and is well distributed throughout the year. Soils are mostly steep and rocky down to the shoreline but is more plentiful in the stream bottoms near the bridges.

SURVEY OBJECTIVES

This report summarizes the findings of a flora and fauna survey of the proposed Kālepa Revetment and Seawall Repair Project which was conducted during January 2021. The objectives of the survey were to:

1. Document what plant and animal species occur on the property or may likely occur in the existing habitat.

2. Document the status and abundance of each species.

3. Determine the presence or likely occurrence of any native flora and fauna, particularly any that are Federally listed as Threatened or Endangered. If such occur, identify what features of the habitat may be essential for these species.

4. Determine if the project area contains any special habitats which if lost or altered might result in a significant negative impact on the flora and fauna in this part of the island.

FLORA SURVEY REPORT

SURVEY METHODS

A walk-through botanical survey method covering all portions of this project area was used following routes to ensure complete coverage of the area. Areas most likely to harbor native or rare plants were more intensively examined. Notes were made on plant species, distribution and abundance as well as on terrain and substrate.

DESCRIPTION OF THE VEGETATION

Much of the roadway, cliff face and shoreline were rocky and barren of vegetation. Areas more protected from salt and wind had increasingly diverse species representation. A total of 62 plant species were recorded during the survey. Seven species were of common occurrence: hala (*Pandanus tectorius*), swollen fingergrass (*Chloris barbata*), tropical crabgrass (*Digitaria ciliaris*), `ākulikuli (*Sesuvium portulacastrum*), naupaka kahakai (*Scaevola taccada*), buttonweed (*Spermacoce capitata*) and napier grass (*Cenchrus purpureus*).

Eleven native plant species were found in the project area. The ākoko (*Euphorbia celastroides*) was the only endemic species (occurring only in Hawaii). Ten indigenous species (plants native in Hawaii but also native in other places as well) were recorded: `ahu`awa (*Cyperus javanicus*), many-spiked sedge (*Cyperus polystachyos*), mau`u `aki`aki (*Fimbristylis cymosa*), hala, `ākulikuli, naupaka kahakai, koali `awa (*Ipomoea indica*), nanea (*Vigna marina*), `ae`ae (*Bacopa monnieri*) and ūlei (*Osteomeles anthyllidifolia*).

Four Polynesian introductions were recorded: niu or coconut (*Cocos nucifera*), kī (*Cordyline fruticosa*), kukui (*Aleurites moluccana*) and noni (*Morinda citrifolia*).

Forty-seven species were non-native trees, shrubs or herbaceous plants.

DISCUSSION AND RECOMMENDATIONS

The vegetation in the project area is predominantly non-native in character. While eleven native species were recorded, all are found throughout Hawaii and none are rare. The 47 non-native plant species are of no conservation concern.

No endangered or threatened plant species (U.S.F.W.S., 2020) were found to occur in the project area. No special native plant habitats were found here either.

The proposed roadway improvements project is not expected to have a significant negative impact on the native botanical resources in this part of Maui.

FLORA SPECIES LIST

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically within each of three groups Ferns, Monocots and Dicots. Taxonomy and nomenclature of the flowering plants (Monocots and Dicots) are in accordance with Wagner et al. (1999).

For each species, the following information is provided:

1. Scientific name with author citation

2. Common English or Hawaiian name.

3. Bio-geographical status. The following symbols are used:

   endemic = native only to the Hawaiian Islands; not naturally occurring anywhere else in the world.

   indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).

   Polynesian = those plants brought to the islands by the Hawaiians during their migrations.

   non-native = all those plants brought to the islands intentionally or accidentally after western contact.

4. Abundance of each species within the project area:

   abundant = forming a major part of the vegetation within the project area.

   common = widely scattered throughout the area or locally abundant within a portion of it.

   uncommon = scattered sparsely throughout the area or occurring in a few small patches.

   rare = only a few isolated individuals within the project area.

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
FERNS			
POLYPODIACEAE (Polypody Fern Family)			
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	laua'e	non-native	uncommon
MONOCOTS			
ARACEAE (Aroid Family)			
Epipremnum pinnatum (L.) Engl.	pothos	non-native	uncommon
ARECACEAE (Palm Family)			
Cocos nucifera L.	niu, coconut	Polynesian	uncommon
ASPARAGACEAE (Asparagus Famiy)			
Cordyline fruticosa (L.) A. Chev.	kī, tī	Polynesian	rare
Furcraea foetida (L.) Haw.	Mauritius hemp	non-native	uncommon
CANNACEAE (Canna Family)			
Canna indica L.	ali'i poe	non-native	uncommon
COMMELINACEAE (Spiderwort Family)			
Commelina diffusa N.L. Burm.	honohono	non-native	uncommon
CYPERACEAE (Sedge Family)			
Cyperus javanicus Houtt.	'ahu'awa	indigenous	rare
Cyperus polystachyos Rottb.	many-spiked sedge	indigenous	rare
Fimbristylis cymosa R. Br.	mau`u `aki`aki	indigenous	rare
Kyllinga nemoralis (J.R. Forster & G. Forster) Dandy	kili'o'opu	non-native	rare
PANDANACEAE (Screw-pine Family)			
Pandanus tectorius S. Parkinson ex Z.	hala	indigenous	common
POACEAE (Grass Family)			
Axonopus compressus (SW.) P. Beauv.	broad-leaved carpetgrass	non-native	uncommon
Cenchrus purpureus (Schumach.) Morrone	Napier grass	non-native	common
Chloris barbata (L.) Sw.	swollen fingergrass	non-native	common
Cynodon dactylon (L.) Pers.	Bermuda grass	non-native	uncommon
Digitaria ciliaris (Retz.) Koeler	tropical crabgrass	non-native	common
Eleusine indica (L.) Gaertn.	wiregrass	non-native	common
Eragrostis pectinacea (Michx.) Nees	Carolina lovegrass	non-native	rare
Megathyrsus maximus (Jacq.) Simon & Jacobs	Guinea grass	non-native	uncommon
Oplismenus hirtellus (L.) P. Beauv.	basketgrass	non-native	rare
Paspalum conjugatum Bergius	Hilo grass	non-native	rare
Sporobolus indicus (L.) R. Br.	West Indian dropseed	non-native	uncommon
Urochloa mutica (Forssk.) T.Q. Nguyen	California grass	non-native	uncommon

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
DICOTS			
AIZOAECEAE (Fig-marigold Family)			
Sesuvium portulacastrum (L.) L.	'ākulikuli	indigenous	common
AMARANTHACEAE (Amaranthus Family)			
Amaranthus spinosus L.	spiny amaranth	non-native	uncommon
ANACARDIACEAE (Mango Family)			
Mangifera indica L.	mango	non-native	rare
Schinus terebinthifolius Raddi	Christmas berry	non-native	uncommon
ASTERACEAE (Sunflower Family)			
Ageratum conyzoides L.	hairy horseweed	non-native	rare
Cyanthillium cinereum (L.) H. Rob.	little ironweed	non-native	rare
Emilia fosbergii Nicolson	red pualele	non-native	uncommon
Parthenium hysterophorus L.	Santa Maria	non-native	rare
Pluchea carolinensis (Jacq.) G. Don	sourbush	non-native	uncommon
Sonchus oleraceus L.	pualele	non-native	rare
Synnedrella nodiflora (L.) Gaert.	nodeweed	non-native	uncommon
Youngia japonica (L.) DC.	Oriental hawksbeard	non-native	rare
CARICACEAE (Papaya Family)			
Carica papaya L.	papaya	non-native	rare
CONVOLVULACEAE (Morning Glory Family)			
Ipomoea indica (J.Burm.) Merr.	koali 'awa	indigenous	rare
EUPHORBIACEAE (Spurge Fmaily)			
Aleurites moluccana (L.) Willd.	kukui	Polynesian	rare
Euphorbia celastroides Boiss.	'akoko	endemic	rare
Euphorbia prostrata Aiton	prostrate spurge	non-native	rare
Euphorbia thymifolia L.	thyme-leaved spurge	non-native	rare
FABACEAE (Pea Family			
Canavalia cathartica Thouars	maunaloa	non-native	uncommon
Desmodium heterophyllum (Willd.) DC.	variable-leaf ticktrefoil	non-native	rare
Leucaena leucocephala (Lam.) de Wit	koa haole	non-native	rare
Macroptilium atropurpureum (DC.) Urb.	siratro	non-native	rare
Mimosa pudica L.	hilahila	non-native	uncommon
Neonotonia wightii (Wight & Arnott) Lackey	glycine	non-native	rare
Vigna marina (J. Burm.)	nanea	indigenous	uncommon
GOODENIACEAE (Goodenia Family)			
Scaevola taccada (Gaertn.) Roxb.	naupaka kahakai	indigenous	common

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
DICOTS			
MALVACEAE (Mallow Family)			
Sida rhombifolia L.	arrowleaf sida	non-native	uncommon
MYRTACEAE (Myrtle Family)			
Syzygium cumini (L.) Skeels	Java plum	non-native	uncommon
PASSIFLORACEAE (Passion Flower Family)			
Passiflora edulis Sims	passion fruit	non-native	rare
PHYLLANTHACEAE (Phyllanthus Family)			
Phyllanthus debilis Klein ex Willd.	niruri	non-native	uncommon
PLANTAGINACEAE (Plantain Family)			
Bacopa monnieri (L.) Pennell	'ae'ae	indigenous	rare
Plantago major L.	broad-leaved plantain	non-native	rare
PORTULACEAE (Purslane Family)			
Portulaca oleracea L.	common purslane	non-native	rare
ROSACEAE (Rose Family)			
Osteomeles anthyllidifolia (Sm.) Lindl.	ūlei	indigenous	rare
RUBIACEAE (Coffee Family)			
Morinda citrifolia L.	noni	Polynesian	rare
Spermacoce capitata Ruiz & Pav.	buttonweed	non-native	common
VERBENACEAE (Verbena Family)			
Lantana camara L.	lantana	non-native	rare
Stachytarpheta australis Moldenke	ōwī	non-native	rare

FAUNA SURVEY REPORT

SURVEY METHODS

A walk-through fauna survey method was conducted in conjunction with the botanical survey. All parts of the project area were covered. Field observations were made with the aid of binoculars and by listening to vocalizations. Notes were made on species, abundance, activities and location as well as observations of trails, tracks, scat and signs of feeding. In addition, an evening visit was made to the area to record crepuscular activities and vocalizations and to see if there was any evidence of occurrence of the Endangered `ōpe`ape`a or Hawaiian hoary bat *(Lasiurus cinereus semotus)* in the area.

RESULTS

MAMMALS

Two mammal species were recorded during the survey. Two wild goats (*Capra hircus*) were seen on the slope of Kālepa Gulch above the bridge. Goats roam on these forested mountains.

At least one `ōpe`ape`a was identified during an evening survey with the use of a bat detector device set to the frequency of 27,000 Hertz that these bats are known to emit when echolocating for nocturnal flying insects (mostly moths) upon which they feed. These Endangered bats utilize a wide variety of habitats and move about seasonally following spikes in insect populations. Little is known of their population numbers as they are rarely seen because of their nocturnal lifestyle and because they cannot be heard because their high-pitched calls are undetectable to human hearing.

Other non-native animals likely to occur in the area but which were not seen include mongoose (*Herpestes auropunctatus*), rats (*Rattus* spp.) and mice (*Mus domesticus*).

BIRDS

Birdlife was sparse in this mostly barren and windy coastal project habitat. Five species of non-native bird species were observed during two site visits: common myna (*Acridotheres tristis*), nutmeg mannikin (*Lonchura punctulata*), cattle egret (*Bubulcus ibis*), zebra dove (*Geopelia striata*) and hwamei or Chinese laughing thrush (*Leucodioptron canorum*).

Some other non-native birds that are likely to occur here include Japanese white-eye (*Zosterops japonicus*) and northern cardinal (*Cardinalis cardinalis*). Other native species likely to occur here include the `auku`u (*Nycticorax nycticorax hoactli*) a water bird, migratory shorebirds kōlea (*Pluvialis fulva*), `akekeke (*Arenaria interpres*) and `ūlili (*Tringa incana*). Seabirds that would fly over head but not land here include the `ua`u (*Pterodroma sandwichensis*) and the `a`o (*Puffinus newelli*).

INSECTS

Insects were very uncommon in this windy, salty and mostly barren habitat. Just three non-native insects were seen during two site visits: the southern house mosquito (*Culex quinquefasciatus*), the long-tailed blue butterfly (*Lampides boeticus*) and the Asian spiny-backed spider (*Gasteracantha mammosa*). No native insects were seen.

DISCUSSION AND RECOMMENDATIONS

The fauna species recorded during the survey, were nearly all non-native mammals, birds, and insects that are of no special conservation concern. Only the `ōpe`ape`a was a native species. This endemic and Endangered bat is highly mobile and able to avoid disturbances. It is mainly vulnerable during the summer months when it is breeding and raising pups which it places in trees. At these times, before the pups can fly, they may be harmed or killed by tree removal. This situation would only occur in this project if the alternative 2 option of constructing a tunnel were selected, as this is the only place that there are trees that would be removed within the scope of the project.

While no Endangered or Threatened birds occur within the project area, two seabird species, the `ua`u and the `a`o do fly over the area at dawn and dusk during their summer and fall breeding season to go to and from their nesting burrows high on the mountain slopes. At these times they are easily distracted by bright lights and can crash and be injured or killed. This can be avoided by not performing any project work in the evening or at night.

With observance of the above recommendations, there are no further environmental issues of concern, and the project would not have a significant negative impact on the fauna resources in this part of Maui.

FAUNA SPECIES LIST

Following is a checklist of the fauna species inventoried during the field work. Fauna species are arranged in descending abundance within three groups: Mammals, Birds and Insects. For each species the following information is provided:

1. Common name

2. Scientific name

3. Bio-geographical status. The following symbols are used:

   endemic = native only to Hawaii; not naturally occurring anywhere else in the world.

   indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).

   non-native = all those animals brought to Hawaii intentionally or accidentally after western contact.

   migratory = spending a portion of the year in Hawaii and a portion elsewhere. In Hawaii, the migratory birds are usually in the overwintering/non-breeding phase of their life cycle.

4. Abundance of each species within the project area:

   abundant = many flocks or individuals seen throughout the area at all times of day.

   common = a few flocks or well scattered individuals throughout the area.

   uncommon = only one flock or several individuals seen within the project area.

   rare = only one or two seen within the project area.

SCIENTIFIC NAME	COMMON NAME	STATUS	ABUNDANCE
MAMMALS			
BOVIDAE (Cattle Family)			
Capra hircus L.	domestic goat	non-native	rare
VESPERTILIONIDAE (Common Bat Family)			
Lasiurus cinereus semotus H. Allen	'ōpe'ape'a	endemic	rare
BIRDS			
ARDEIDAE (Heron Family)			
Bubulcus ibis L.	cattle egret	non-native	rare
COLUMBIDAE (Dove Family)			
Geopelia striata L.	zebra dove	non-native	rare
ESTRILDIDAE (Estrildid Finch Family)			
Lonchura punctulata L.	nutmeg mannikin	non-native	rare
LEIOTHRICHIDAE (Leiothrichid Family)			
Leucodioptron canorum L.	hwamei	non-native	rare
STURNIDAE (Starling Family)			
Acridotheres tristis L.	common myna	non-native	rare
INSECTS			
Order ARANAE - true spiders			
ARENEIDAE (Orb Weaer Spider Family)			
Gasteracantha mammosa	Asian spiny backed spider	non-native	rare
Order DIPTERA - flies			
CULICIDAE (Mosquito Family)			
Culex quinquefasciatus Say	Southern house mosquito	non-native	uncommon
Order LEPIDOPTERA - butterflies, moths			
LYCAENIDAE (Gossamer-winged Butterfly Family)			
Lampides boeticus L.	long-tailed blue butterfly	non-native	uncommon

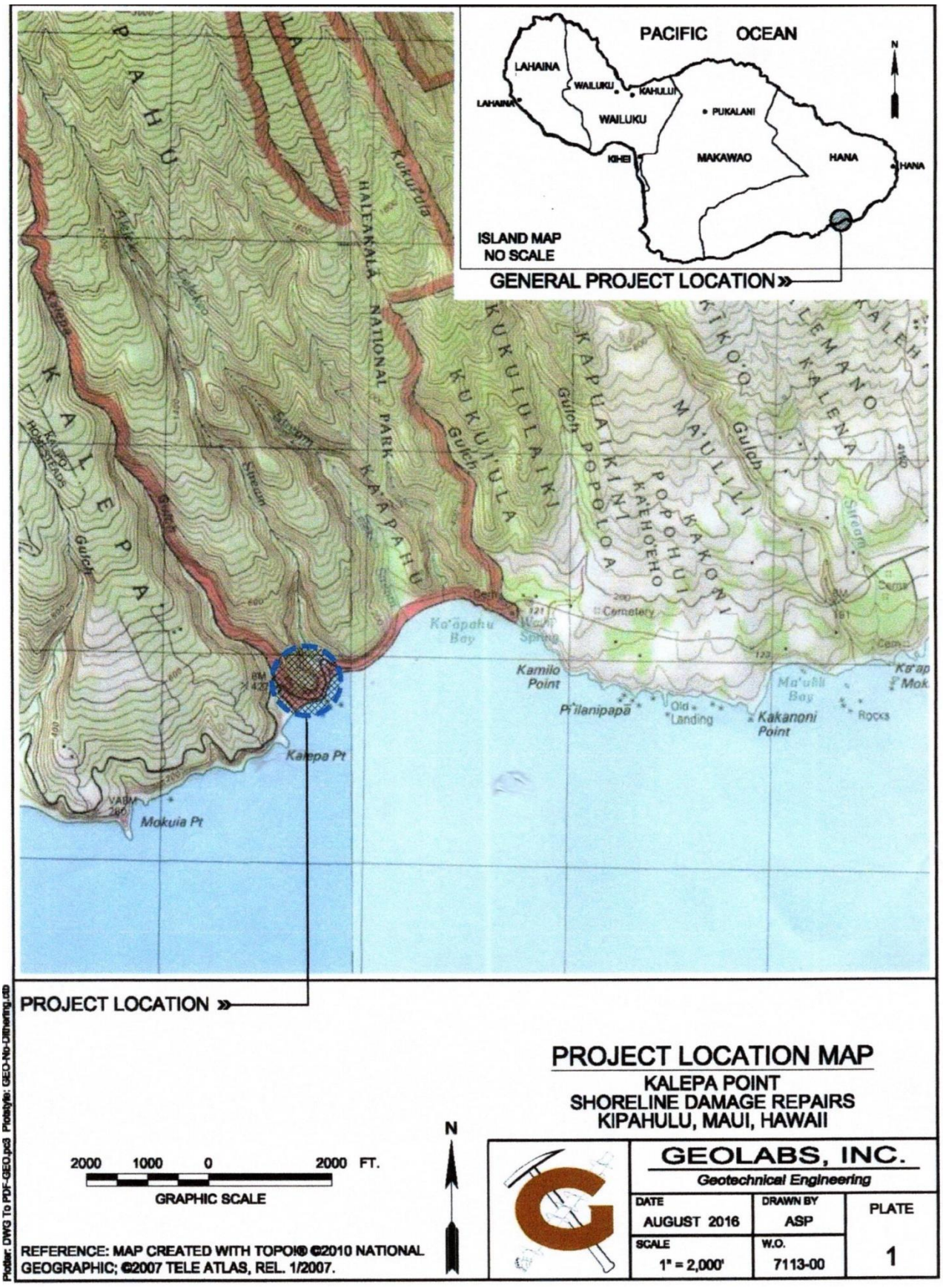


Figure 1. Project Area

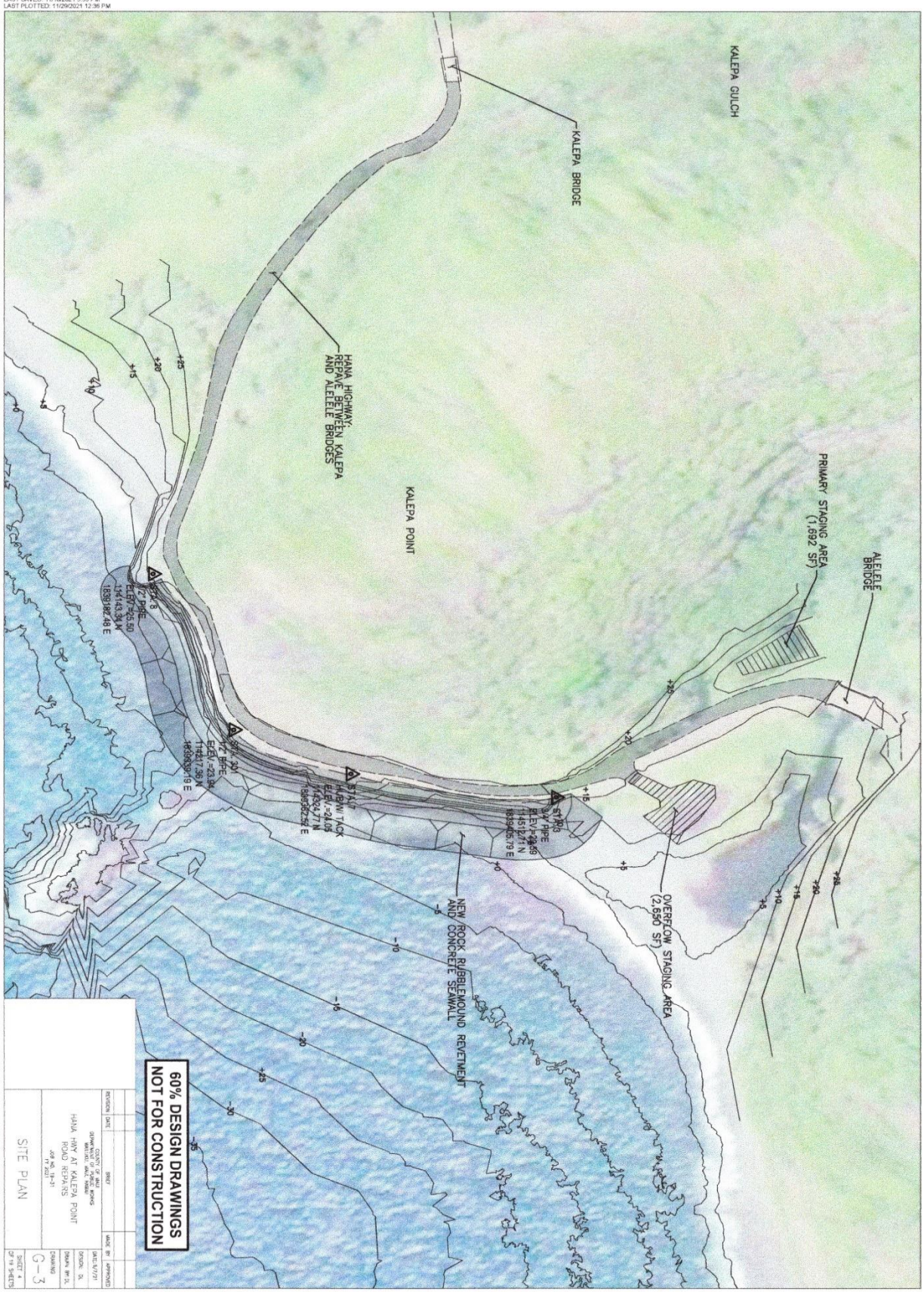


Figure 2. Project Area

Literature Cited

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APPENDIX E – KALEPA POINT ROAD REPAIR PROJECT STAGING AREA FLORA AND FAUNA SURVEY (SWCA ENVIRONMENTAL CONSULTANTS)

Kalepa Point Road Repair Project Staging Area Flora/Fauna Survey

MAY 2024

PREPARED FOR

Sea Engineering, Inc.

PREPARED BY

SWCA Environmental Consultants

KALEPA POINT ROAD REPAIR PROJECT
STAGING AREA FLORA/FAUNA SURVEY

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SWCA Project No. 82742

May 2024

EXECUTIVE SUMMARY

Sea Engineering, Inc., requested that SWCA Environmental Consultants (SWCA) conduct a terrestrial flora and fauna biological resources survey for two proposed staging areas for materials and equipment for the Kalepa Point road repair project at Kalepa Point, east of Kaupo, Maui.

This report summarizes the findings of the flora and fauna survey conducted for the project by SWCA biologists on February 22, 2024. The flora and fauna survey covered approximately 1.3 acres on two parcels (TMK 1-7-003:001 and 1-7-001:006) along Piʻilani Highway. All vascular plant species (and their relative abundance), vegetation types, and wildlife species were recorded.

The vegetation types and plant species identified during the survey are not considered unique. Two indigenous plants, naupaka (*Scaevola taccada)* and ʻulei (*Osteomeles anthyllidifolia)* were observed in the survey area. These species are not considered rare, nor are they federally or state-listed threatened or endangered species, species proposed for listing, or candidate species. No federally or state-listed endangered plant species were observed in or near the survey area. Therefore, the proposed project is not expected to have a significant, adverse effect on terrestrial vegetation.

No federally or state-listed endangered birds were observed in the survey area. Three bird species in total were observed in the survey area, all of which are common, nonnative introduced bird species. No federally or state-listed endangered wildlife species were observed in or near the survey area; however, potential roosting trees for the Hawaiian hoary bat (*Lasiurus cinereus semotus*), a federally and state-listed endangered mammal, exist in the survey area. Mitigation recommendations to address potential roosting habitat are outlined in the report. The survey area does not overlap critical habitat of any listed terrestrial faunal species. For these reasons, the proposed project is not expected to have a significant, adverse effect on terrestrial wildlife.

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CONTENTS

1 Introduction 1
2 Regulatory Environment 1
2.1 Endangered Species Act 1
2.2 Migratory Bird Treaty Act 2
2.3 Hawai‘i Revised Statutes 195D 2
3 Literature Review 2
4 Site Information 2
5 Methods 3
6 Results 3
6.1 Flora 3
6.2 Fauna 6
6.2.1 Avifauna 6
6.2.2 Mammals 6
6.2.3 Terrestrial Reptiles and Amphibians 6
6.2.4 Insects and Other Invertebrates 6
7 Special-Status Species and Critical Habitat 7
7.1 Flora 7
8 Discussion and Recommendations 7
8.1 Flora 7
8.2 Fauna 8
8.2.1 Seabirds 8
8.2.2 Hawaiian Hoary Bat 8
9 Literature Cited 9

Appendices

Appendix A Survey Plant List

Figures

Figure 1. Project Areas. 4
Figure 2. Ruderal Vegetation in the proposed staging area TMK 1-7-001:006. 5
Figure 3. Ruderal vegetation in the proposed staging area TMK1-7-003:001 5

Tables

Table 1. Birds Observed by SWCA in and near the Survey Area on February 22, 2024 6

1 INTRODUCTION

Sea Engineering, Inc., requested that SWCA Environmental Consultants (SWCA) conduct a terrestrial flora and fauna biological resources survey for two proposed staging areas for materials and equipment for the Kalepa Point road repair project at Kalepa Point, east of Kaupo, Maui. This report summarizes the findings of the biological resources survey conducted for the project by SWCA biologists on February 22, 2024. The proposed staging areas covered by the survey lie within two parcels along Hana Highway and will be used to stage construction equipment and building materials for the Kalepa Point road repair project.

2 REGULATORY ENVIRONMENT

This section describes laws and regulations applicable to aquatic and terrestrial flora and fauna in the context of the project.

2.1 Endangered Species Act

The Endangered Species Act of 1973, as amended (ESA), is regulated by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration National Marine Fisheries Service and protects wildlife and plant species that have been listed as threatened or endangered. The ESA is designed to conserve the ecosystems on which species depend. Candidate species, which may be listed in the near future, are not afforded protection under the ESA until they are formally listed as endangered or threatened. Section 9 of the ESA and rules promulgated under Section 4(d) of the ESA prohibit the unauthorized take of any endangered or threatened species of wildlife listed under the ESA. Under the ESA, the term *take* means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect species listed as endangered or threatened, or to attempt to engage in any such conduct." As defined in regulations, the term *harm* means "an act that actually kills or injures wildlife; it may include significant habitat modification or degradation, which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (50 Code of Federal Regulations [CFR] 17.3). The rules define *harass* to mean "an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent, as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering" (50 CFR 17.3).

The ESA affords maximum legal protections to species listed as threatened or endangered under the law, and also provides authorization for incidental take permits for take that occurs incidental to otherwise legal operations. To comply with federal laws, additional measures must be taken to ensure that take of federally listed species does not occur. Any fatality of a listed species should be reported to the USFWS and the Hawai‘i Division of Forestry and Wildlife as soon as possible, and an incident report should be filed within 24 hours of detection.

The ESA also provides for the designation of critical habitat for listed species if there are areas of habitat believed to be essential to conservation of the species. Critical habitat can be designated for a single species or a group of species. A critical habitat designation does not necessarily restrict further development but prevents federal actions from destroying or adversely modifying that habitat.

2.2 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918, as amended (MBTA), is regulated by the USFWS and prohibits the take of migratory birds. A list of birds protected under MBTA is published under 50 CFR 10.13. Unless permitted by regulations, under the MBTA, "it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product" (16 United States Code 703–712). The MBTA provides no process for authorizing incidental take of MBTA-protected birds. As a result, birds that are not covered under the ESA, but may be adversely affected by the project, cannot be covered by take authorizations. Regardless, incidental take of individual MBTA-protected species is unlikely to adversely affect MBTA-protected species as a whole; however, any take of MBTA-protected species should be documented and reported in a similar manner as any endangered or threatened species of wildlife listed under the ESA.

2.3 Hawai‘i Revised Statutes 195D

The purpose of Hawai‘i Revised Statutes (HRS) 195D is "to ensure the continued perpetuation of indigenous aquatic life, wildlife, and land plants, and their habitats for human enjoyment, for scientific purposes, and as members of ecosystems" and is regulated by the Hawai‘i Department of Land and Natural Resources Division of Forestry and Wildlife. HRS 195D-4 states that any endangered or threatened species of fish or wildlife recognized by the ESA shall be so deemed by the state statute. Like the ESA, the unauthorized take of such endangered or threatened species is prohibited (HRS 195-D-4(e)), but incidental take licenses can be obtained (HRS 195D-21). In addition to species protected under the ESA, rules adopted under HRS 195D-4 allow for the listing of indigenous species as threatened or endangered for the following reasons:

- Habitat destruction or alteration (current or predicted)
- Overexploitation
- Disease or predation
- Lack of regulatory mechanisms
- Other factors threatening the species' continued existence

Determinations are made based on all available sources of data (scientific, commercial, and other) and consultation with appropriate agencies (federal, state, and county) and interested organizations and parties.

3 LITERATURE REVIEW

SWCA performed a literature review during preparation of the field survey. The purpose of the literature review was to conduct a preliminary desktop habitat assessment to evaluate whether special-status species (or their habitats) and sensitive natural communities are known to occur in the survey area.

4 SITE INFORMATION

The survey area is within the ahupua‘a (land division) of Kaupo in the moku (district) of Kaupo on the mokupuni (island) of Maui. The survey area is within two parcels (TMK 1-7-003:001 and 1-7-001:006) on the southeastern end of the island of Maui, on Pi‘ilani Highway near Kaupo; the total survey area

covers 1.3 acres (Figure 1). Piʻilani Highway—a remote, narrow two-lane highway—is maintained by the County of Maui and stretches approximately 24 miles from Kīpahulu to Kahikinui. There are no other state or county roads on this part of the island, and Piʻilani Highway is only road that connects Hana Highway (Route 331) to Kula Highway (Route 37).

Mean annual rainfall for the survey area is approximately 82 inches (2,087 millimeters). Rainfall is typically highest in November and lowest in June (Giambelluca et al. 2013).

5 METHODS

SWCA reviewed available scientific and technical literature regarding natural resources in and near the survey area. This literature review encompassed a thorough search of referenced scientific journals, technical journals and reports, environmental assessments, environmental impact statements, relevant government documents, USFWS online data, and unpublished data that provide insight into the area's natural history and ecology. SWCA also reviewed available geospatial data, aerial photographs, and topographic maps of the survey area.

On February 22, 2024, SWCA conducted comprehensive surveys of the proposed staging areas footprint (Figure 1). The surveys were conducted on foot and documented all vascular plant, vertebrate (birds, mammals, and amphibians), and macroinvertebrate (gastropods and arthropods) species within the survey area. These surveys specifically focused on locating populations of special-status species; however, specific acoustic surveys for the endangered Hawaiian hoary bat, or ʻopeʻapeʻa (*Lasiurus cinereus semotus*), were not conducted. Identification of birds was aided by 10 × 42–millimeter binoculars, as well as auditory vocalization identifications. Any signs of animals, such as scat or tracks, were noted. All vegetation types in the survey area were described and mapped in ArcGIS Field Maps on a Samsung Galaxy 2 tablet. Figures were created using ArcGIS Pro 2.7. Photographs were taken during the survey using an iPhone XR and Samsung Galaxy S20.

6 RESULTS

6.1 Flora

No state- or federally listed threatened, endangered, proposed listed, or candidate plant species, or rare native Hawaiian plant species, were observed in the survey area. In all, 23 plant species were recorded in the survey area. Of these, two indigenous plants, naupaka (Scaevola taccada) and ʻulei (Osteomeles anthyllidifolia) were observed in the survey area. (Wagner et al. 1999). Appendix A provides a list of all plant species observed by SWCA biologists in the survey area.

The vegetation in the survey area consists entirely of ruderal vegetation. The ruderal vegetation type is typically found on fallow land, along the edges of roads or cultivated land, surrounding existing facilities, and in other frequently disturbed areas. Ruderal or weedy vegetation is found in areas that are infrequently maintained, if at all, and is usually subject to vehicular and pedestrian traffic. The ruderal vegetation type is found throughout the survey area (Figure 2). Most of the plant species found in this vegetation type are herbaceous species adapted to colonizing disturbed areas, with some weedy shrubs and small trees.

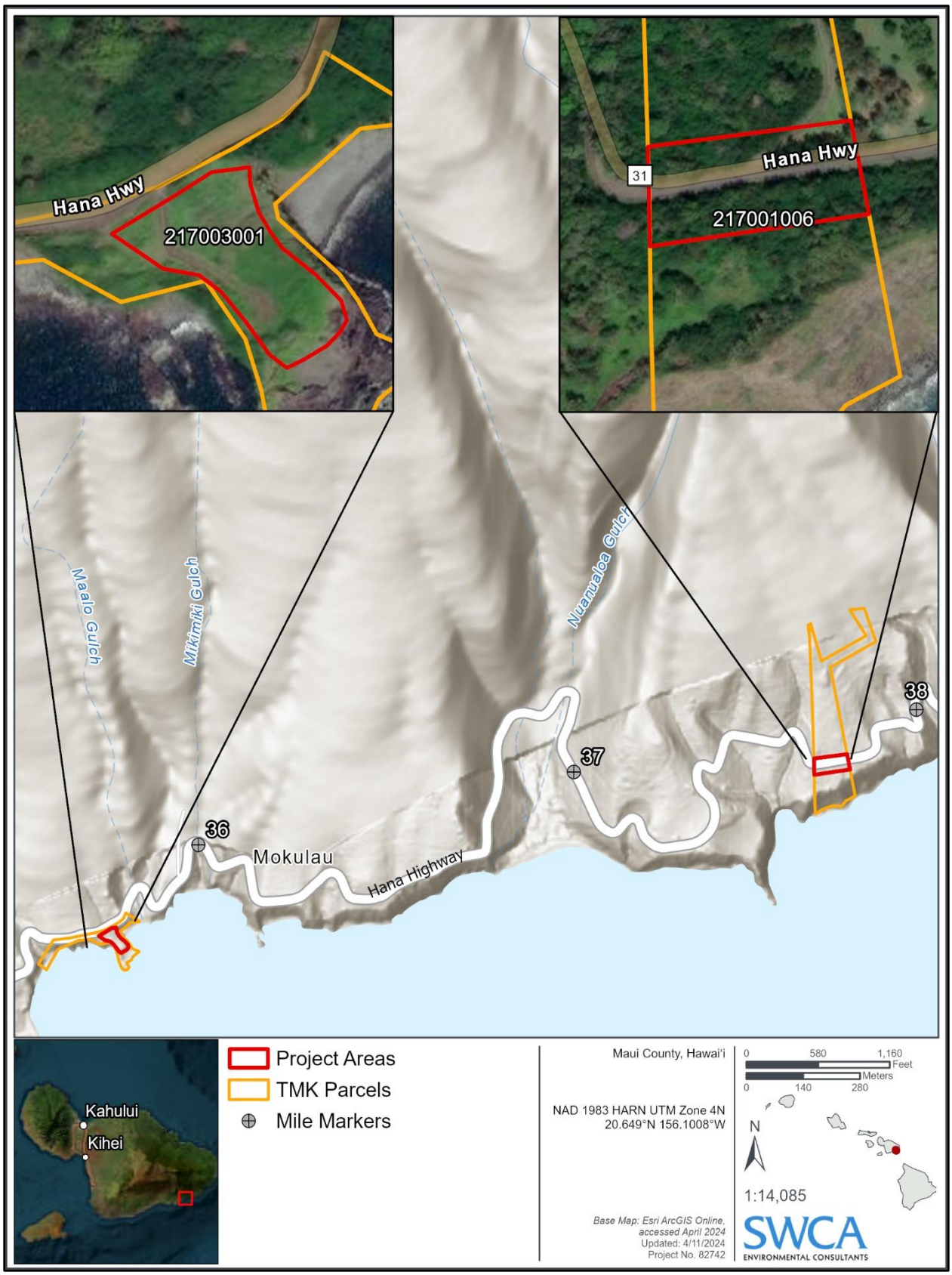


Figure 1. Survey area.



Figure 2. Ruderal vegetation in the proposed staging area (TMK 1-7-001:006).

Napier grass was found in a small portion (less than 20%) of the survey area. This grass forms dense, monotypic stands that can reach heights of around 15 to 20 feet and exclude all other species (Figure 3).



Figure 3. Ruderal vegetation in the proposed staging area (TMK1-7-003:001).

6.2 Fauna

6.2.1 Avifauna

Three nonnative bird species were observed during the survey (Table 1). These three species are common in disturbed mid-elevation areas on Maui.

Table 1. Birds Observed by SWCA in and near the Survey Area on February 22, 2024

Common Name	Scientific Name	Status	MBTA
House finch	*Haemorhous mexicanus*	NN	–
House sparrow	*Passer domesticus*	NN	–
Zebra dove	*Geopelia striata*	NN	–
Total		**3**	**0**

Notes: Status: E = endangered, M = migrant, NN = nonnative permanent resident; MBTA = protected under the Migratory Bird Treaty Act.

Endangered Hawaiian waterbirds were not detected during the field survey, and the project footprint does not consist of potential foraging habitat such as lowland streams with herbaceous riparian vegetation or tidal mudflats that would support waterbird foraging.

Seabirds were not observed in the survey area but may potentially fly over the survey area to and from higher-elevation nesting areas during the seabird fledging period.

6.2.2 Mammals

One mammal, the nonnative mongoose (*Herpestes javanicus*), was observed during the survey. Although the feral cat (*Felis catus*), feral goat (*Capra hircus*), feral pig (*Sus scrofa*), axis deer (*Axis axis*), house mouse (*Mus musculus*), and rats (*Rattus* spp.) were not detected, they are likely to occur in the survey area. In addition, forage and roost habitat for the federally and state endangered Hawaiian hoary bat does occur in the survey area within the ruderal vegetation type.

6.2.3 Terrestrial Reptiles and Amphibians

No reptiles or amphibians were detected. No terrestrial reptiles and amphibians are native to Hawai‘i.

6.2.4 Insects and Other Invertebrates

No native insects or other invertebrates were observed during the survey. Nonnative invertebrates observed were the big-headed ant (*Pheidole megacephala*), black earwig (*Chelisoches morio*), and Surinam cockroach (*Pycnoscelus surinamensis*).

7 SPECIAL-STATUS SPECIES AND CRITICAL HABITAT

No special-status species were observed in the survey area.

7.1 Flora

No USFWS-designated critical habitat for federally endangered plant species was observed within the survey area.

8 DISCUSSION AND RECOMMENDATIONS

The following relevant avoidance and mitigation measures are provided to reduce or eliminate project-related impacts and to avoid adverse effects on special-status species. These measures should be implemented as part of the project.

8.1 Flora

The vegetation type and species identified during the survey are not considered unique, and the native plant species recorded at the site are not threatened or endangered, proposed for listing, or a candidate plant. Of the plant species observed in the survey area, 98% are not native to the Hawaiian Islands. The proposed project is not expected to have a significant, adverse impact to botanical resources.

Weedy nonnative plant species are common in the survey area. Most of these weedy species are widespread in Hawai‘i, and their control is not expected to result in a significant decrease in their number or distribution. However, construction activities are known to spread invasive species to new areas through the movement of vehicles and materials. For this reason, SWCA recommends the following invasive species minimization measures to avoid the unintentional introduction or transport of new terrestrial invasive species to Maui:

- All construction equipment and vehicles arriving from outside of Maui should be washed and inspected before entering the survey area.
- Construction materials arriving from outside of Maui should also be washed and/or visually inspected (as appropriate) for excessive debris, plant materials, and invasive or harmful nonnative species (plants, amphibians, reptiles, and insects).
- Inspection and cleaning activities should be conducted at a designated location before entering the survey area. The inspectors should be qualified botanists and/or entomologists able to identify invasive species that are of concern relevant to the point of origin of the equipment, vehicle, or material.
- When possible, raw materials (e.g., gravel, rock, soil) should be purchased from a local supplier on Maui to avoid introducing nonnative species to the island.
- If landscaping occurs as part of the project, native Hawaiian plants or noninvasive plants should be used to the maximum extent possible. Additional information on selecting appropriate (noninvasive) plants for landscaping can be obtained from the following online sources:
    - http://www.plantpono.org
    - http://www.hear.org/alternativestoinvasives/pdfs/mcaac_hpwra_a2i_list.pdf
    - http://www.hear.org/oisc/oahuearlydetectionproject/pdfs/oedposterwhatnottoplant.pdf

8.2 Fauna

8.2.1 Seabirds

Major threats to the endangered Hawaiian petrel (*Pterodroma sandwichensis*) and threatened Newell's shearwater (*Puffinus newelli*) include the attraction of adults and newly fledged juveniles to bright lights while transiting between their nest sites and the ocean. Juvenile birds are particularly vulnerable to light attraction and are sometimes grounded when they become disoriented by lights (Mitchell et al. 2005). Many of these grounded birds are vulnerable to mammalian predators or to being struck by vehicles. The following recommendations are provided to avoid and minimize light attraction of the endangered Hawaiian petrel and threatened Newell's shearwater to the survey area:

- Construction activity should be restricted to daylight hours as much as practicable during the seabird breeding season (April–November) to avoid the use of nighttime lighting that could attract seabirds.
- All outdoor lights should be shielded to prevent upward radiation. This has been shown to reduce the potential for seabird attraction (Reed et al. 1985; Telfer et al. 1987).
- Outside lights that are not needed for security and safety should be turned off from dusk to dawn during the fledgling fallout period (September 15–December 15).

8.2.2 Hawaiian Hoary Bat

Hawaiian hoary bats occur on Maui in native, nonnative, agricultural, and developed landscapes (U.S. Department of Agriculture 2009; USFWS 1998). Hawaiian hoary bats forage in open, wooded, and linear habitats with a wide range of vegetation types. These animals are insectivores and are regularly observed foraging over streams, reservoirs, and wetlands up to 300 feet (about 92 meters [m]) offshore (U.S. Department of Agriculture 2009). Hawaiian hoary bats typically roost in trees greater than 16 feet (about 5 m) with: 1) dense canopy foliage or 2) in the subcanopy when the canopy is sparse and there is open access for launching into flight (Gorresen et al. 2013; U.S. Department of Agriculture 2009). Hawaiian hoary bats have been documented roosting in mango trees (*Mangifera indica*) and may roost in other trees (e.g., Chinese banyan) that occur in the survey area. In addition, the Hawaiian hoary bat could forage over the ruderal vegetation type and within the corridor created by the road.

Direct impacts to bats could occur during vegetation removal if a juvenile bat that is too small to fly but too large to be carried by a parent is present in a tree or branch that is cut down. To prevent direct impacts to the Hawaiian hoary bat, the following measures are recommended:

- No trees taller than 15.0 feet (4.6 m) in the survey area should be trimmed or removed between June 1 and September 15 when flightless juvenile bats may be roosting in the trees.
- Any fences that are erected as part of the project should have a barbless, top-strand wire to prevent entanglements of the Hawaiian hoary bat on barbed wire.

Implementation of these measures, which have been promulgated by the USFWS (1998), is expected to result in avoidance of all direct impacts to Hawaiian hoary bats. Because all impacts to the Hawaiian hoary bat will be discountable, the proposed project *may affect, but is not likely to adversely affect*, individuals or populations of the species.

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Gorresen M.P., F.J. Bonaccorso, C.A. Pinzari, C.M. Todd, K. Montoya-Aiona, and K. Brinck, K. 2013. *A Five-year Study of Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) Occupancy on the Island of Hawai'i (HSCU-041).* Hilo, Hawai'i: Hawai'i Cooperative Studies Unit.

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APPENDIX A

Survey Plant List

Table A-1 lists the plant species observed by SWCA on February 22, 2024. The plant names are arranged alphabetically by family and then by species in three groups: monocots, dicots, and pteridophytes. The taxonomy and nomenclature of the flowering plants are in accordance with Wagner et al. (1999) and Staples and Herbst (2005). Recent name changes are those recorded in Wagner et al. (2012).

Table A-1. Vascular Plants Observed within the Proposed Survey Area on February 22, 2024

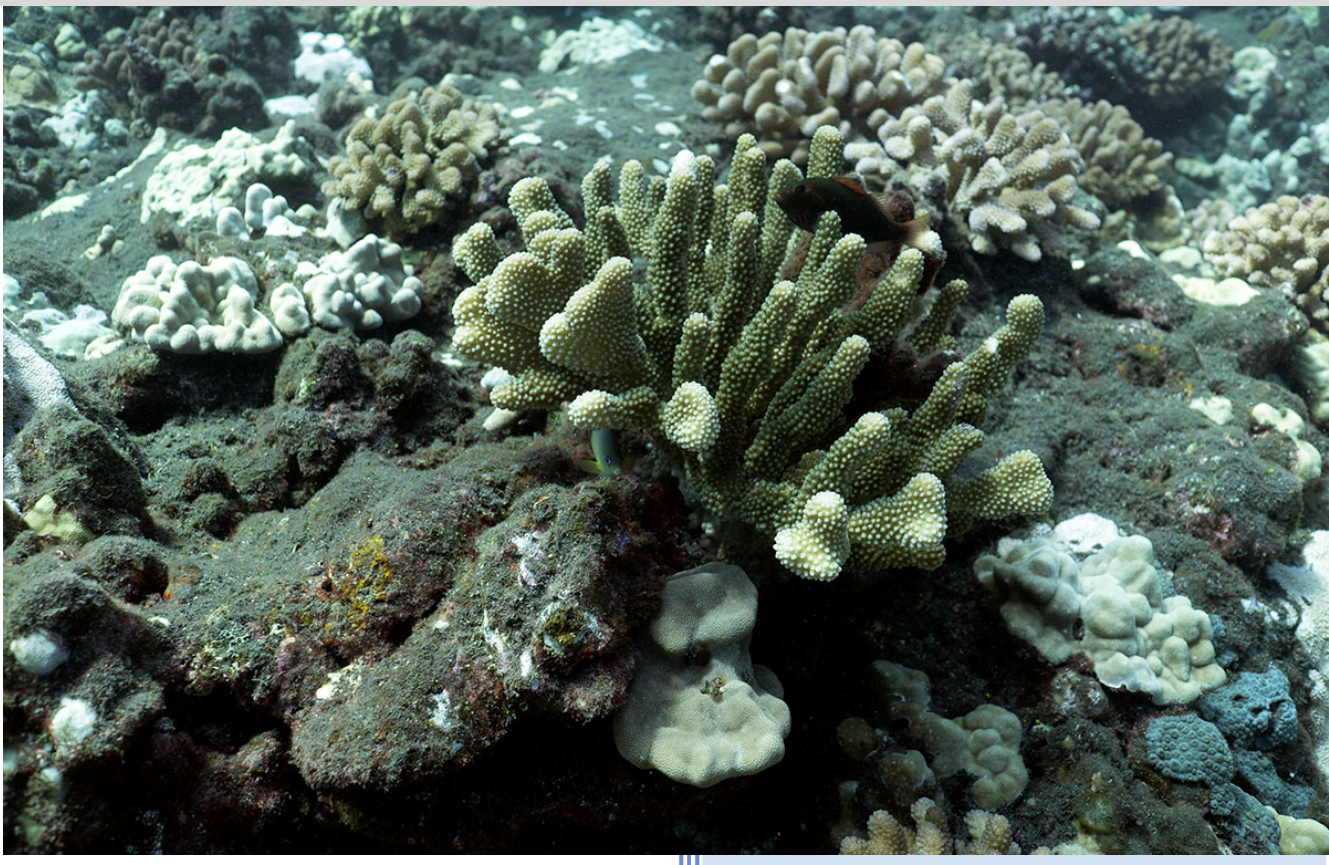
Family	Scientific Name and Authorship	Hawaiian and/or Common Name	Status*
Monocots			
Agavaceae	*Cordyline fruticosa* (L.) A.Chev.	kï, ti	P
Arecaceae	*Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude	king palm	X
Asphodelaceae	*Aloe arborescens*	Shrub aloe	X
Commelinaceae	*Commelina diffusa* Burm.f.	honohono, honohono wai, mākolokolo, dayflower	X
Dicots			
Acanthaceae	*Asystasia gangetica*	Chinese violet, coromandel	X
Acanthaceae	*Thunbergia fragrans* Roxb.	white thunbergia, sweet clock-vine	X
Anacardiaceae	*Mangifera indica* L.	mango, manakō, manakō meneke, meneke	X
Anacardiaceae	*Schinus terebinthifolius* Raddi	Christmas berry, wilelaiki, nani o Hilo (Moloka‘i)	X
Asclepiadaceae	*Hoya australis* R.Br. ex Traill	–	X
Euphorbiaceae	*Aleurites moluccana* (L.) Willd.	kukui, kuikui, candlenut	P
Fabaceae	*Canavalia cathartica* Thouars	maunaloa	X
Fabaceae	*Desmodium intortum* (Mill.) Urb.	tick trefoil, tick clover	X
Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	koa haole	X
Fabaceae	*Scaevola taccada (Gaertn.) Roxb*	naupaka kahakai	I
Melastomataceae	*Dissotis rotundifolia* (Sm.) Triana	–	X
Moraceae	*Ficus microcarpa* L.f.	Chinese banyan, Malayan banyan	X
Myrsinaceae	*Ardisia elliptica* Thunb.	shoebutton ardisia	X
Myrtaceae	*Psidium guajava* L.	common guava	X
Myrtaceae	*Syzygium cumini (L.) Skeels*	Java plum	X
Rosaceae	*Osteomeles anthyllidifolia*	‘ulei, Hawaiian rose	I
Rubiaceae	*Morinda citrifolia*	Noni	P
Verbenaceae	*Stachytarpheta cayennensis* (Rich.) Vahl	ōwï, oï	X
Pteridophytes			
Polypodiaceae	*Phymatosorus grossus* (Langsd. & Fisch.) Brownlie	laua‘e, maile-scented fern	X

* I = indigenous; P = Polynesian introduced; X = nonnative.

APPENDIX F – MARINE BIOLOGICAL ASSESSMENT (MARINE RESEARCH CONSULTANTS, INC.)

MARINE RESEARCH CONSULTANTS, INC.

MARINE ASSESMENT FOR THE REVETMENT AND SEAWALL REPAIRS AT KALEPA, MAUI, HAWAII



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DATE December 8, 2021

1 Introduction

1.1 Project Location and General Site Description

Kalepa Point is located on the southeast coast of Maui approximately 14 miles southwest of Hana Town, on the Hana Highway (State Route 360) near the transition to the Piilani Highway (County Route 31) at Kalepa Bridge. The Kalepa Headland is located between two drainage systems, Kalepa Gulch and Alelele Stream. The Kalepa Bridge crosses the ephemeral stream at the base of Kalepa Gulch, and the Alelele Bridge crosses the Alelele Stream. The water body fronting the roadway is the Alenuihaha Channel, which separates Maui and the Hawaii Island (Figure 1).

The County of Maui, Department of Public Works (DPW), Highways Division proposes to replace approximately 500 feet of shore protection, repave approximately 0.25 miles of roadway, and install new concrete guardrails along Hana Highway at Kalepa Point. The objective of the Proposed Action is to maintain vehicular and pedestrian access around the Kalepa Point headland. The existing shore and road protection consists of a rock rubblemound revetment and concrete rock masonry (CRM) wall built circa 1987 over previously existing structures. These structures were extensively damaged in August 2014 during the close passage of Hurricane Iselle. A Basis of Design Report (BOD) that was submitted in July 2017 discussed several concept plans in detail and made a recommendation to construct a hybrid structure consisting of a CRM retaining wall fronted by a low-angle rock revetment to protect the road from wave forces.

1.2 Summary Description of the Proposed Action

The Proposed Action is to remove and replace approximately 500 feet of damaged CRM and rock shore protection with a hybrid rock revetment and concrete retaining. Additionally, approximately 0.25 miles of Hana Highway between Kalepa Bridge and Alelele Bridge is to be repaved and new concrete guardrails will be placed on the makai side of the road. Figure 2 shows an overview of the Proposed Action, and Figure 3 shows a photograph from the ocean of Kalepa Point where the repairs will take place.

In support of the proposed action Sea Engineering Inc. has begun the final planning and permitting phase of the project. As part of the preparation of a Draft Environmental Assessment (DEA) a baseline marine survey has been completed. This report provides the findings of the survey which characterizes the marine environment off of the site of the revetment and seawall repairs off of Kalepa Point.

2 METHODS

2.1 Water Quality/Chemistry

Water chemistry sampling was conducted on November 1, 2021 by investigators working from a small boat. Water chemistry was assessed along three survey transects that spanned the shoreline length of the Kalepa Point Repairs site. Two sampling stations were established on each transect. The inner sampling stations was located at the most accessible area near the shoreline; the offshore station was located at a distance of approximately 75 m offshore (Figure 4). At each sampling station water was collected within 20 cm of the surface and 50 cm above the ocean floor. Such a sampling scheme is designed to span the area that could potentially experience impacts from the shoreline work.

Water quality constituents evaluated included all specific criteria designated for open coastal waters in Chapter 11-54, Section 06 (b) (Open Coastal waters) of the State of Hawaii Department of Health (DOH) Water Quality Standards. These criteria include: total nitrogen (TN), nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium nitrogen (NH_4^+), total phosphorus (TP), Chlorophyll a (Chl *a*), turbidity, temperature, pH, and salinity. In addition, dissolved silica (Si) and orthophosphate phosphorus (PO_4^{-3}) were also reported as these constituents are sensitive indicators of biological activity and the degree of groundwater mixing.

Laboratory analyses were conducted by Marine Consulting and Analytical Resources LLC (MCAR) (Lab number HI 00928). Analyses for Si, NH_4^+, PO_4^{-3}, and NO_3^- were performed with a Seal Analytical AutoAnalyzer 3 HR (AA3HR) using standard methods for seawater analysis. Total nitrogen (TN) and total phosphorus (TP) were analyzed in a similar fashion following digestion. Total organic nitrogen (TON) was calculated as TN minus NH_4^+ and NO_3^-, and total organic phosphorus (TOP) was calculated as TP minus PO_4^{-3}.

Salinity was determined using a Mettler Toledo Seven Excellence Multi-parameter meter with an InLab 731-ISM conductivity probe. Chl *a* was measured by filtering 150 ml through a GFF/F glass-fiber filters; pigments on filters were extracted in 90% acetone in the dark at -20 °C for 24 hours. Fluorescence of the extract was measured with a Turner Designs Trilogy Fluorometer model 7200-000 equipped with an extracted chlorophyll non-acidification module. Salinity was determined using a Mettler Toledo Seven Excellence Multi-parameter meter with an InLab 731-ISM conductivity probe, calibrated to a Hach Instruments traceable salinity standard of 35.00 parts per thousand (‰ or ppt), 53.0 mS/cm, with a readability of 0.01 ppt. Turbidity was determined using a Hanna Instruments Model #HI88703 Turbidimeter and reported in nephelometric turbidity units (NTU) (precision of 0.01 NTU).

In situ field measurements of water temperature, pH, dissolved oxygen, and salinity were acquired using RBR Concerto CTDs calibrated to factory specifications. The CTD has a readability of 0.001°C, 0.001pH units, 0.001% saturation, and 0.001 ppt (salinity).

EPA and Standard Methods (SM) methods that were employed for chemical analyses, as well as detection limits, are listed in the Code of Federal Regulations (CFR) Title 40, Chapter 1, Part 136, are as follows:

NH_4^+: EPA 350.1, Rev. 2.0 or SM4500-NH3 G, detection limit 0.042 µg/L.
NO_3^- + $NO2^-$: EPA 353.2, Rev. 2.0 or SM4500-NO3F, detection limit 0.084 µg/L
PO_4^{-3}: EPA 365.5 or SM4500-P F, detection limit 0.28 µg/L.
Total P: EPA 365.1, Rev. 2.0 or SM4500-P E J, detection limit 0.93 µg/L.
Total N: SM 4500-N C., detection limit 1.96 µg/L.
Si: EPA 370.1 or SM 4500 SiO2 E, detection limit 0.45 µg/L.
Chlorophyll *a*: SM 10200, detection limit 0.006 µg/L.
pH: EPA 150.1 or SM4500H+B, detection limit 0.002 pH units
Turbidity: EPA 180.1, Rev. 2.0 or SM2130 B, detection limit 0.008 NTU.
Temperature: SM 2550 B, detection limit 0.01 degrees centigrade.
Salinity: SM 2520, detection limit 0.003 ppt.
Dissolved Oxygen: SM4500 O G, and detection limit 0.01% sat.

2.2 Marine Biotic Community Structure

Physical and biotic composition of the survey area was assessed by divers using self-contained underwater breathing apparatus (SCUBA) and working from a 42-foot boat. Dive surveys were conducted by swimming in a zigzag pattern from the shoreline to approximately 75 m offshore throughout the areas designated as water chemistry transects 2 and 3 that fronted the Kalepa Point Repairs area (Figure 4). During these underwater investigations, notes on species composition were recorded, and numerous digital photographs recorded the existing conditions of the area.

3 RESULTS

3.1 Water Quality/Chemistry

3.1.1 Distribution of Chemical Constituents

Table 1 shows results of all water chemistry analyses on samples collected along three transects off Kalepa shoreline mitigation project site on November 1, 2021. Several patterns of distribution are evident in Table1. It can be seen that the dissolved nutrients, Si and NO_3^-, are

consistently elevated in shoreline surface samples relative to offshore surface samples. In addition, all surface values of Si, and most surface values of NO_3^- are elevated relative to deep samples. Salinity displays the opposite trend, with lower concentrations in the nearshore samples, and surface samples (Table 1). These patterns are most pronounced on Transect 3, and least pronounced on Transect 1.Over the entire sampling area, the range in NO_3^- is approximately 5 µg/L, while the range of salinity is approximately 1.25 ppt.

As there were no streams discharging to the ocean at the time of the sampling, the horizontal gradients of Si, NO_3^-, and salinity likely represent input of groundwater to the ocean near the shoreline. Low salinity groundwater, which typically contains high concentrations of Si and NO_3^-, percolates to the ocean at the shoreline, resulting in a nearshore zone of mixing. In many areas of the Hawaiian Islands, such groundwater percolation results in steep horizontal gradients of increasing salinity and decreasing nutrients with increasing distance from shore. The gradients in the nearshore zone off of the Kalepa Point revetment repair site are substantially different, indicating a low volume groundwater discharge at the southwestern area (Transect 1) compared to the northeastern area (Transect 3).

Phosphate phosphorus (PO_4^{-3}) is also generally elevated in groundwater relative to ocean water. In the data set collected off the Kalepa Point site, there is a pattern of decreasing concentration of PO_4^{-3} at the inshore stations, particularly on Transect 3, indicating some groundwater flux from land to the ocean. Horizontal gradients of TN/TON and TP/TOP mirror the patterns of NO_3^- and PO_4^{-3}, respectively.

Ammonium nitrogen (NH_4^+) is usually not elevated in groundwater relative to ocean water. However, concentrations of NH_4^+ on the transects off of the Kalepa Point site show the opposite pattern, with a consistent trend of elevated values at the offshore surface stations relative to the nearshore surface stations (Table 1). It is not evident if these gradients originate from groundwater discharge or biotic metabolic activity.

With the exception of Transect 1, the distributions of turbidity display highest values near the shoreline, with diminishing values moving seaward (Table 1). Overall, values of Chlorophyll *a* show no discernible pattern with respect to depth and distance from shore. All vales are considered low for nearshore ocean settings with all values with all measurements below 0.23 µg/L. At all sites temperatures at the surface were slightly higher than near the bottom. Dissolved oxygen displayed no gradient of consistent change across the transects (Table 1).

3.1.2 Compliance with DOH Criteria

State of Hawaii Department of Health Water Quality Standards (HDOH-WQS) that apply to the areas offshore of Kalepa Point area are listed as "open coastal water" in HRS Chapter §11-54-6(b). Two sets of standards are listed depending on whether an area receives more than 3 million gallons per day (mgd) of freshwater input per shoreline mile ("wet standards"), or less

than 3 mgd of freshwater input per shoreline mile ("dry"). As the Kalepa shoreline area probably receives less than 3 mgd per mile, dry criteria were used for this evaluation.

The HDOH-WQS are also separated into three standards: geometric means, "not to exceed more than 10% of the time," and "not to exceed more than 2% of the time." As these classifications require multiple samplings, they cannot be used for a strict evaluation of whether waters at the sampling site were within compliance standards. However, these values provide a guideline to evaluate the overall status of sampled waters in terms of the relation with State standards.

It can be seen in Table 1 that a single sample of any dissolved nutrient constituents (NH_4^+ at Site 4S) exceeded State of Hawaii water quality standards for the most stringent percentage standard "not to exceed more than 10% of the time" criteria under dry conditions. One measured values of turbidity exceeded the 10% criterion and one value exceeded the 2% criterion. The elevated concentrations of turbidity are likely a result of resuspension of fine-grained, naturally occurring sediment by breaking waves in the nearshore zone.

3.2 Coral Reef Community Structure

3.2.1. Physical Structure

The section of the east Maui shoreline at Kalepa Point where shoreline mitigation is planned abuts a steep eroded soil and rock escarpment that terminates in a basaltic boulder field that extends from the roadway to the waterline (Figure 3). The boulders extends through the intertidal zone and continue to cover the nearshore ocean floor for a distance of approximately 75 meters, and to a water depth of approximately 15 meters (Figure 5). At the seaward edge of the boulder zone, bottom composition grades into a flat basaltic platform interspersed with pockets of rubble (Figure 6). The basaltic platform extends seaward for the entire offshore range of the study area.

3.2.2. Biotic Community Structure

Biotic composition of the reef communities fronting the survey section of Kalepa Point fits well into the classification of a "*Pocillopora meandrina* – boulder zone" that has been described as part of the typical zonation pattern of reef on the West Coast of the Island of Hawaii (Dollar1982, Dollar and Tribble 1993). Such communities typify Hawaiian reefs that are located in open coastal areas that receive substantial impact from breaking waves. At the Kalepa site such wave stress is sufficient to prevent all coral growth within area from the shoreline to approximately 50 feet offshore. The only colonization of boulders in this area is by calcareous algae (Figure 6).

With increasing distance offshore and increasing depth, coral, predominantly of the species *Pocillopora meandrina*, begin to colonize the surfaces of the basalt boulders (Figure 7). The

predominance of *Pocillopora meandrina* is not surprising as this species is considered a "pioneer species" that is the first to inhabit newly cleared substratum and can persist in areas that are too harsh for other species. *Pocillopora meandrina* is typically the most common coral on a wave impacted shallow reefs in Hawaii (Dollar 1982, Dollar and Tribble 1993).

With increasing distance from shore, other species of coral colonize the boulder surfaces. These include *Porites lobata*, which in the overall most abundant coral on Hawaiian reefs. *Porites lobata* occurs in a variety of growth forms, ranging from flat encrustations to dome-shaped structures. Other species observed on the mid-reef were *Pocillopora grandis* and several species of Montipora (*M. flabellata*, *M. patula*, and *M. capitata*). All of the species of Montipora occurred as flat encrusting growth forms (Figure 8).

Of particular note in terms of benthic community structure off Kalepa Point is the predominance of a species of colonial *Zoanthus* that occurs as mats growing on the boulder and platform surfaces (Figure 9). While this species is often seen on Hawaiian reefs, it generally occurs as small isolated colonies. In contrast, at Kalepa it was observed as extensive expanses that sometimes covered the entirety of boulder surfaces (Figure 9).

At a distance of approximately 75 m from shore, where bottom structure grades from boulders to a flat platform, coral species included clumps of *Porites compressa*, often referred to as "finger coral" (Figure 10). As the growth form of this species is very susceptible to breakage from wave impact, it is restricted to the flatter bottom and deeper water habitats on the reef.

Motile macro-invertebrates were essentially absent from the survey area. Particularly conspicuous by their absence were sea urchins, which are generally common in nearshore reef areas throughout the Hawaiian Islands. Typically, the most common urchin on Hawaiian reefs, *Echinometra matheai* burrow into the limestone reef platform, and are thus somewhat protected from wave stress. As the reef surface at Kalepa is entirely basalt, with essentially no limestone, no urchins of the species *Echinometra matheai* were observed. *Larger urchins that typically occur on the surface of the reef such as Heterocentrotus mammilatus, Echinothrix diadema* and *Diadema paucispinum* were not observed in the survey area. No sea cucumbers (e.g., *Actinopyga* spp, *Holothuria* spp.) were observed. The lack of motile benthic invertebrates is consistent with surveys of areas that are subjected to constant wave forces and/or shifting sediment which result in physical conditions too harsh for these species.

Frondose benthic algae were uncommon throughout the study area. The high wave energy and continual scouring action of moving water to be a limiting factor for many species of fleshy frondose algae on the reef platforms.

Reef fish were abundant throughout the entire survey area. The most common and conspicuous fish were the surgeonfish (*Acanthuridea), wrasses (*Labridae), butterfly fish (Chaetodontidae) and dameselfish (Pomacentridae). Particularly abundant were several species of goatfish (Mullidae) that occurred in schools throughout the survey area (Figure 11).

The abundance of fish is likely a response to abundant habitat space and low fishing pressure in the area.

Green sea turtles (*Chelonia mydas*) are commonly found within the nearshore areas of Maui. However, no turtles were observed during the present survey, although they undoubtedly occur on the reefs off the Kalepa site.

4 Discussion

The purpose of this assessment is to assemble the information to make valid evaluations of the potential for impact to the marine environment from the proposed revetment and seawall repairs at Kalepa Point on the eastern shoreline of Maui, Hawaii. Permanent shore protection is intended to prevent future erosion damage to protect the highway that fronts the shoreline. The information collected in this study provides a baseline data set that describes the physical, chemical and biotic composition of the area, as well as the processes driving such structure. Such information can be used to address any concerns that might be raised concerning effects to the marine environment that might arise during the planning process for the shoreline mitigation.

Results of this baseline study reveal that the composition of the nearshore area consists of a boulder field that extends from the shoreline through the nearshore ocean and terminates in a basalt platform that extends seaward beyond the limits of the present survey. The predominant biotic composition of the area is a coral community consisting of relatively few species, based on the physiological and growth form tolerance to high levels of water movement in the form of breaking waves. Fish community structure was rich with typical reef species, likely in response to low fishing pressure at the remote location.

Results of analyses of water chemistry indicate a small component of groundwater entering the ocean near the shoreline. The groundwater input is rapidly mixed to background coastal oceanic values through wind, wave and current action. The magnitude of effect from such terrestrial input is so low that it does not result in extensive elevation above State of Hawaii DOH water quality standards. The only constituent with values above DOH limits is turbidity, likely as a result of wave resuspension of naturally occurring bottom sediments. None of these factors are likely to be affected beyond the range of natural variability by the proposed erosion mitigation program.

In summary, it is not likely that the proposed action to stabilize shoreline erosion adjacent to Kalepa Point would have any negative effect to existing biotic communities. Best Management Practices (BMPs) will be implemented to restrict or eliminate any transfer of terrigenous material to the marine environment. The boulder zone extends seaward to a

distance that is likely beyond the limit of influence of any shoreline activities. As the area is essentially an open coastline subjected to wind, waves, and tides, normal currents flush the area on a regular basis, preventing the buildup of any input of materials from land. In addition, biota inhabiting the area appear to be pre-adapted to substantial wave stress that would facilitate rapid removal of any terrigenous input to the marine environment. Perhaps most importantly, the ongoing erosion of the shoreline is likely causing some input of terrigenous material to the nearshore ocean at the present time. The proposed mitigation is intended to halt such erosion along with any associated detrimental effects. Thus, the proposed project has the potential to eliminate any such impacts, and may provide long-term improvement to both water quality and marine biota resources.

5 References

Dollar, S. J. 1982. Wave stress and coral community structure in Hawaii. Coral Reefs 1:71-81.

Dollar, S. J. and G. W. Tribble. 1993. Recurrent storm disturbance and recovery: a long- term study of coral communities in Hawaii. Coral Reefs. 12:223-233.



Figure 1. Project Location

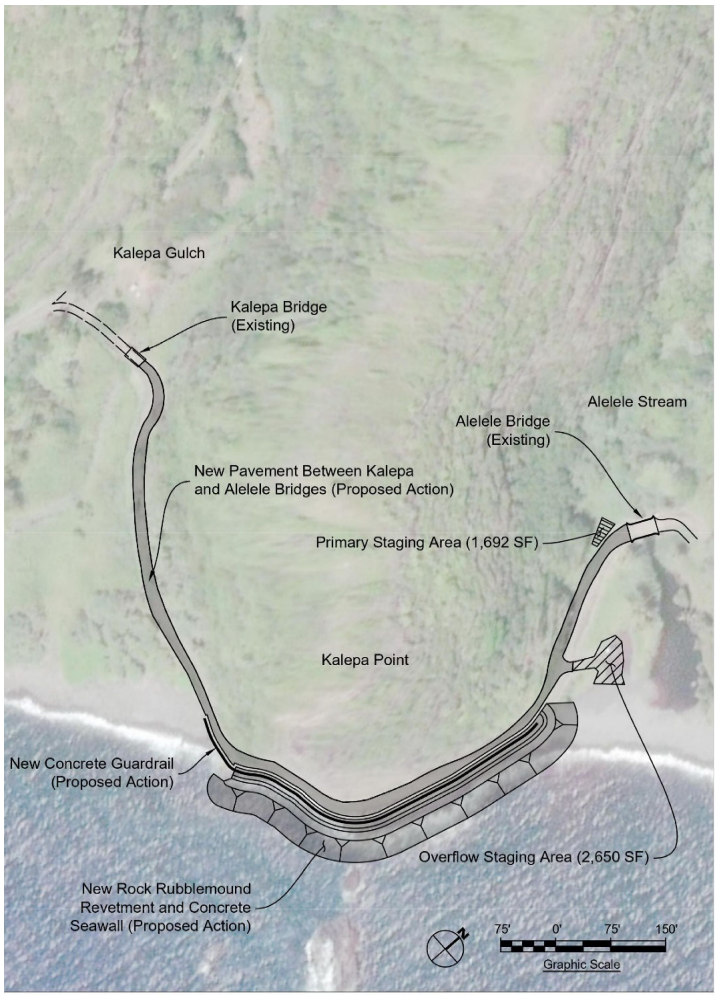


Figure 2. Overview of the Proposed Action



Figure 3. View of Kalepa Point Headland showing shoreline area



Figure 4. Aerial view of Kalepa Point Headland showing water sampling transect locations

TABLE 1. Results of water chemistry analyses from three ocean sampling transects in the vicinity of the Kalepa Point Revetment and Seawall Repairs project. Samples were collected on November 1, 2021. See Figure 4 for locations of sampling stations. Also shown are DOH WQS for "open coastal waters" under "wet" and "dry" conditions, "not to exceed more than 10% and 2% of the time" criteria. Grey shaded values indicate surface samples. Yellow shaded values exceed the "not to exceed more than 10% of the time under dry conditions" standards; blue shaded values exceeded the "not to exceed more than 2% of the time dry standards.

SITE	DFS	DEPTH	PO_4^{3-}	$NO_3^-+NO_2^-$	NH_4^+	Si	TP	TN	TURB	SALT	pH	Chl-a	TEMP	Diss. O_2
	(m)	(m)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(NTU)	(o/oo)	(std. units)	(µg/L)	deg. C	% sat.
T-1	1-S	0.3	3.04	1.00	1.53	60.67	12.36	85.43	0.25	34.74	8.15	0.16	25.53	104.7
	1-D	9.5	2.82	1.19	1.34	59.11	11.94	82.70	0.61	34.82	8.15	0.18	25.51	109.5
	2-S	0.4	2.17	0.89	1.65	66.68	11.10	81.10	0.40	34.82	8.16	0.16	25.59	106.9
	2-D	14.8	3.41	1.00	1.55	61.02	12.61	81.80	0.38	34.78	8.16	0.17	25.51	111.5
T-2	3-S	0.3	3.97	2.62	1.43	99.79	11.69	83.03	0.45	34.55	8.17	0.16	25.69	111.2
	3-D	14.2	3.53	1.59	1.46	63.33	12.28	80.86	0.29	34.74	8.17	0.17	25.54	109.5
	4-S	0.0	4.34	1.31	5.70	77.89	12.61	79.30	0.41	34.74	8.16	0.16	25.63	108.5
	4-D	14.5	3.35	0.94	1.48	55.82	12.67	81.89	0.28	34.85	8.16	0.18	25.59	109.7
T-3	5-S	0.7	7.07	5.75	1.11	337.81	14.70	85.33	1.54	33.60	8.17	0.23	25.56	108.9
	5-D	10.0	3.22	1.34	1.43	79.86	11.87	80.82	0.49	34.74	8.16	0.18	25.52	109.5
	6-S	0.3	2.64	0.84	1.37	71.42	11.16	83.09	0.53	34.74	8.16	0.19	25.59	107.6
	6-D	14.8	3.13	0.65	1.27	58.83	11.92	81.23	0.32	34.74	8.16	0.18	25.59	106.5
DOH WQS	DRY	10%		10.00	5.00	-	30.00	180.00	0.50	*	**	0.50	***	****
		2%		20.00	9.00	-	45.00	250.00	1.00	*	**	1.00	***	****
	WET	10%		14.00	8.50	-	40.00	250.00	1.25	*	**	0.90	***	****
		2%		25.00	15.00	-	60.00	350.00	2.00	*	**	1.75	***	****

* = Salinity shall not vary more than 10% from natural or seasonal changes considering hydrologic input and oceanographic factors.
** = pH shall not deviate more than 0.5 units from a value of 8.1.
*** = Temperature shall not vary more than one degree C. from ambient conditions.
**** = Dissolved Oxygen not less than 75% saturation
DOH = Department of Health
BDL = below detection limit
NTU = nephelometric turbidity units
µg/L = micrograms per liter
WQS = water quality standards

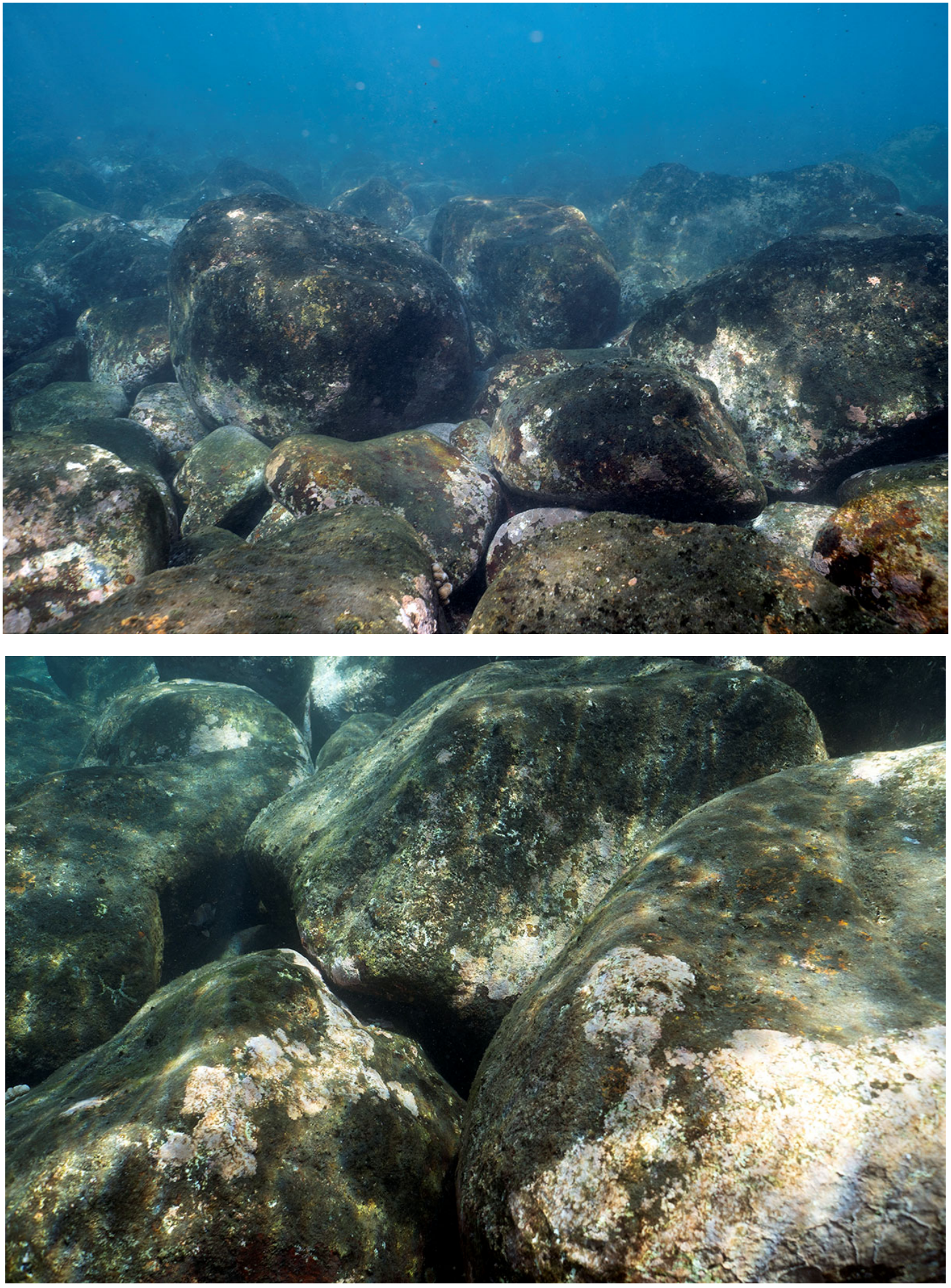


Figure 5. Two views of uncolonized bare basaltic boulders in the nearshore area off Kalepa Point

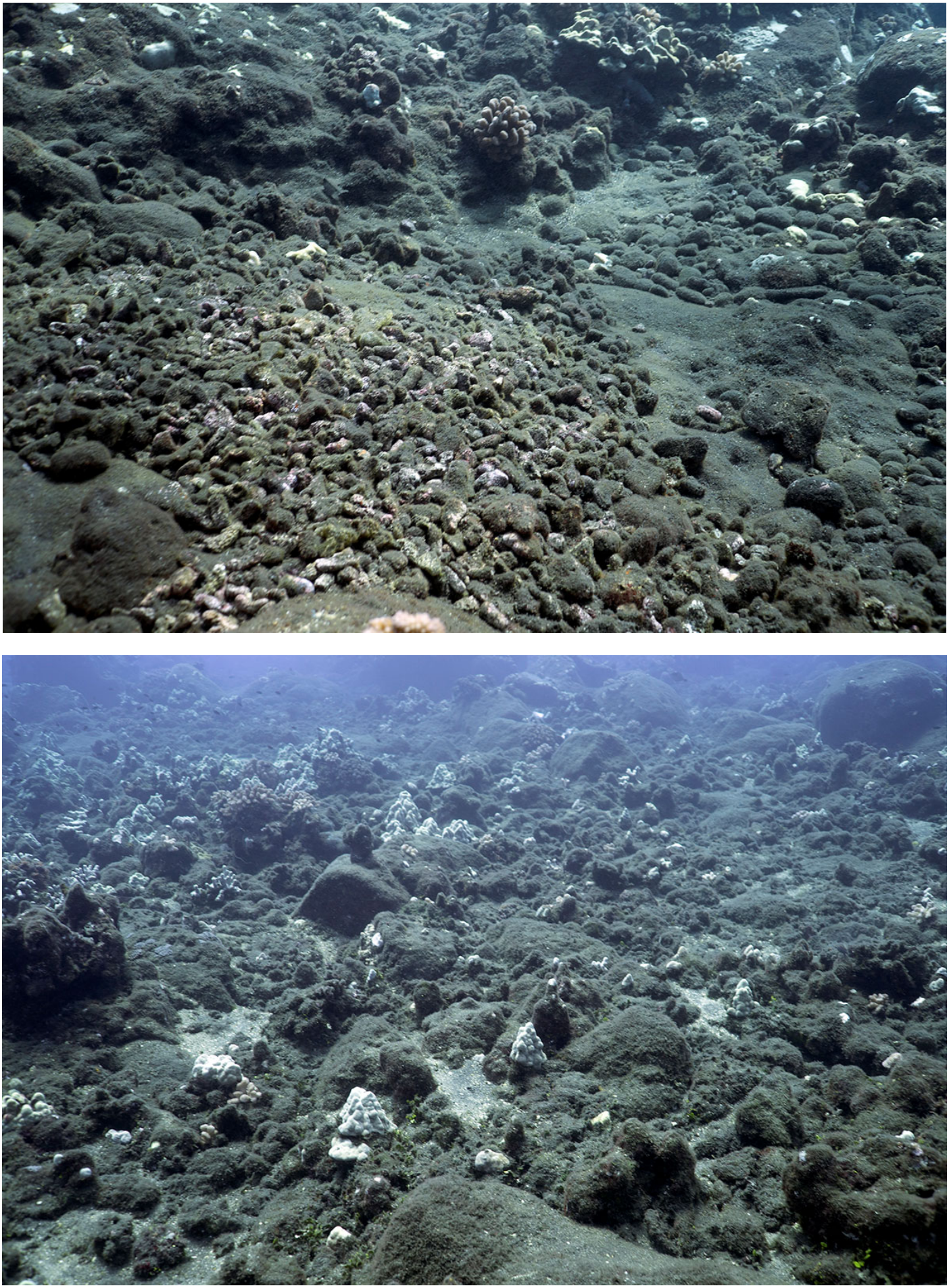
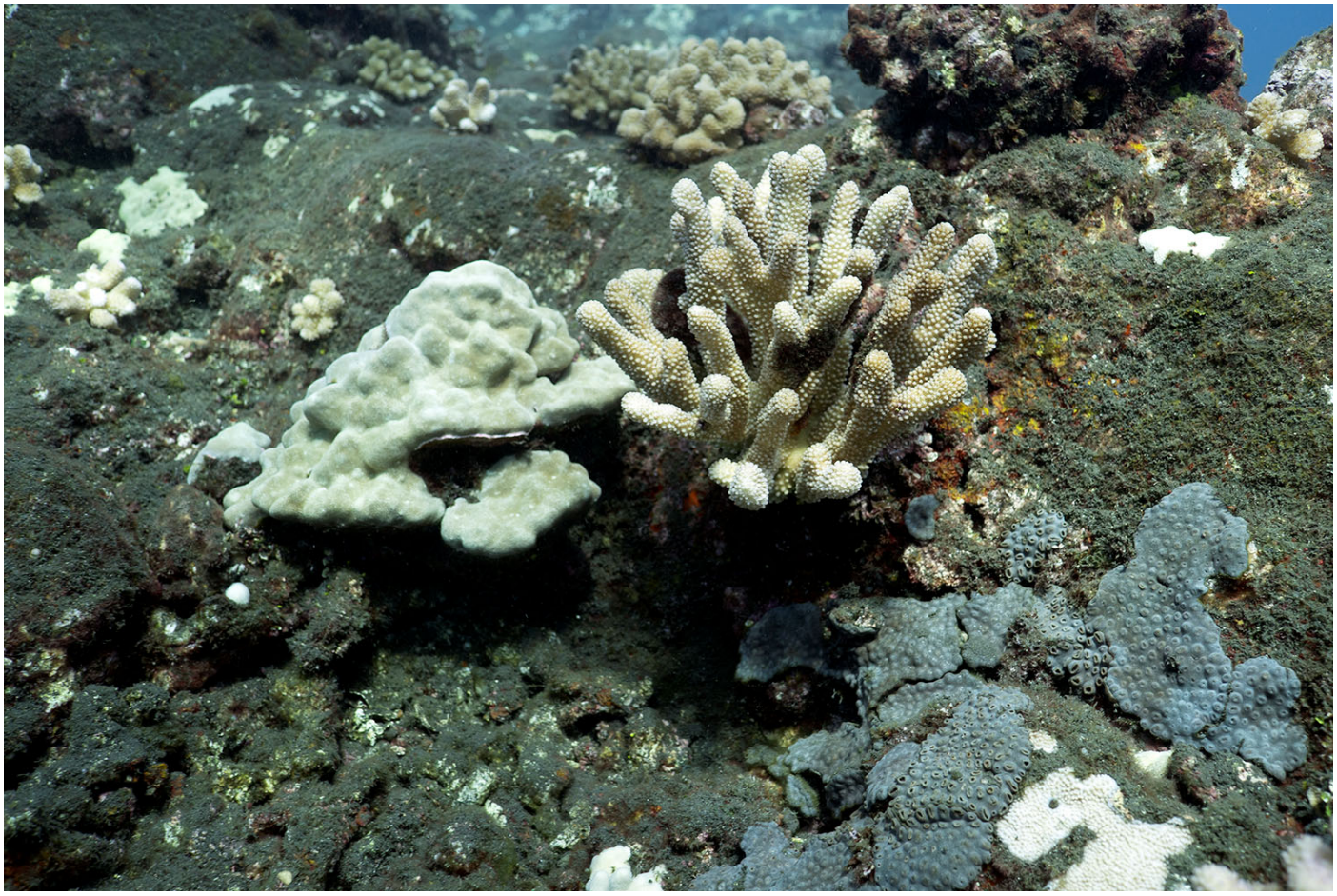


Figure 6. Two views of basalt reef platform seaward of boulder zone. Water depth is approximately 10 meters.





Figure 7. Two views of basaltic boulders colonized by *Pocillopora meandrina* in the nearshore area off Kalepa Point



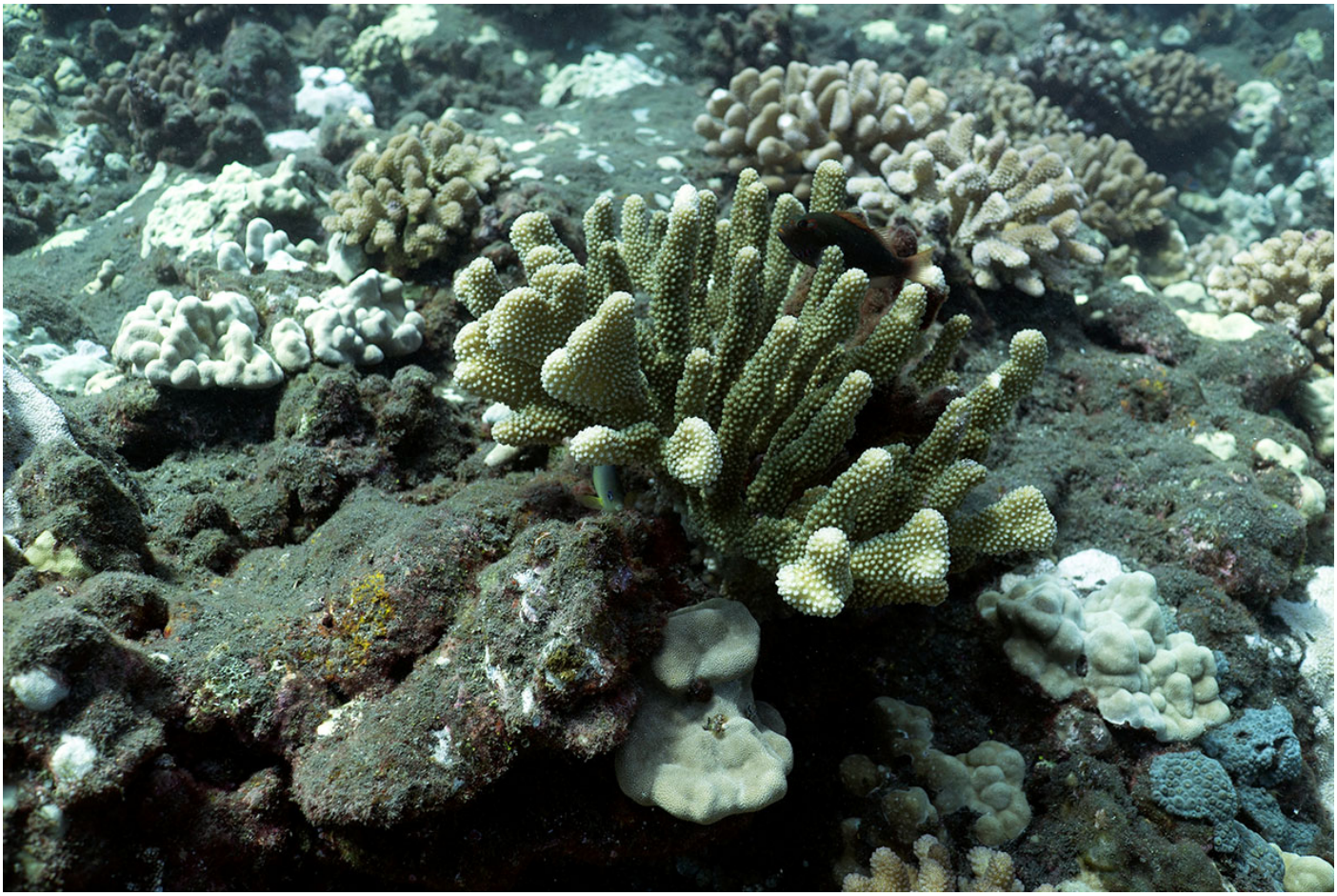


Figure 8. Two views of colonies of branching *Pocillopora grandis* and dome-shaped *Porites lobata* on Kalepa reef platform. . Water depth is approximately 10 meters.

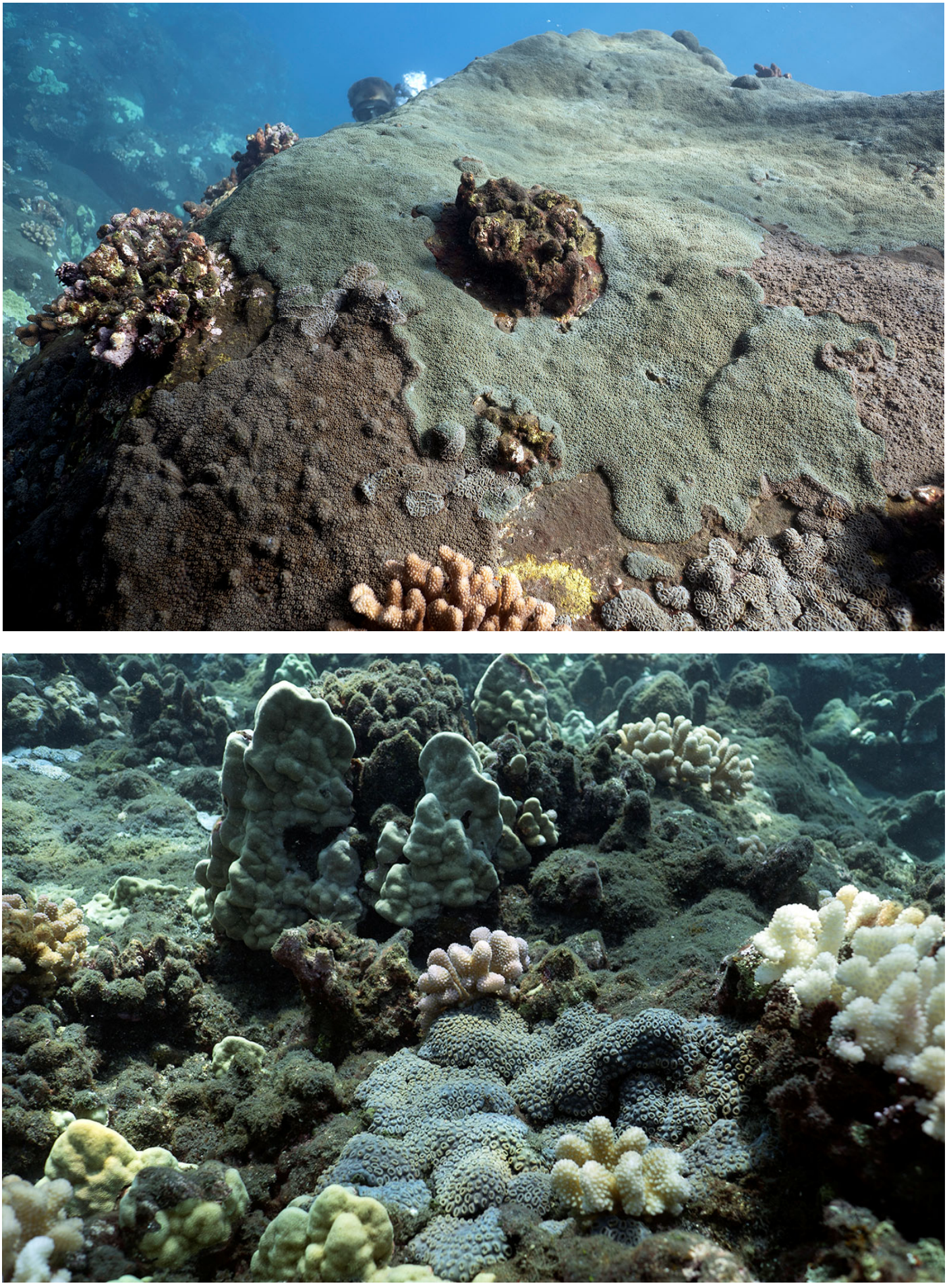


Figure 9. Two views of mats of colonial *Zoanthus* sp. on boulders (top) and reef platform (bottom)

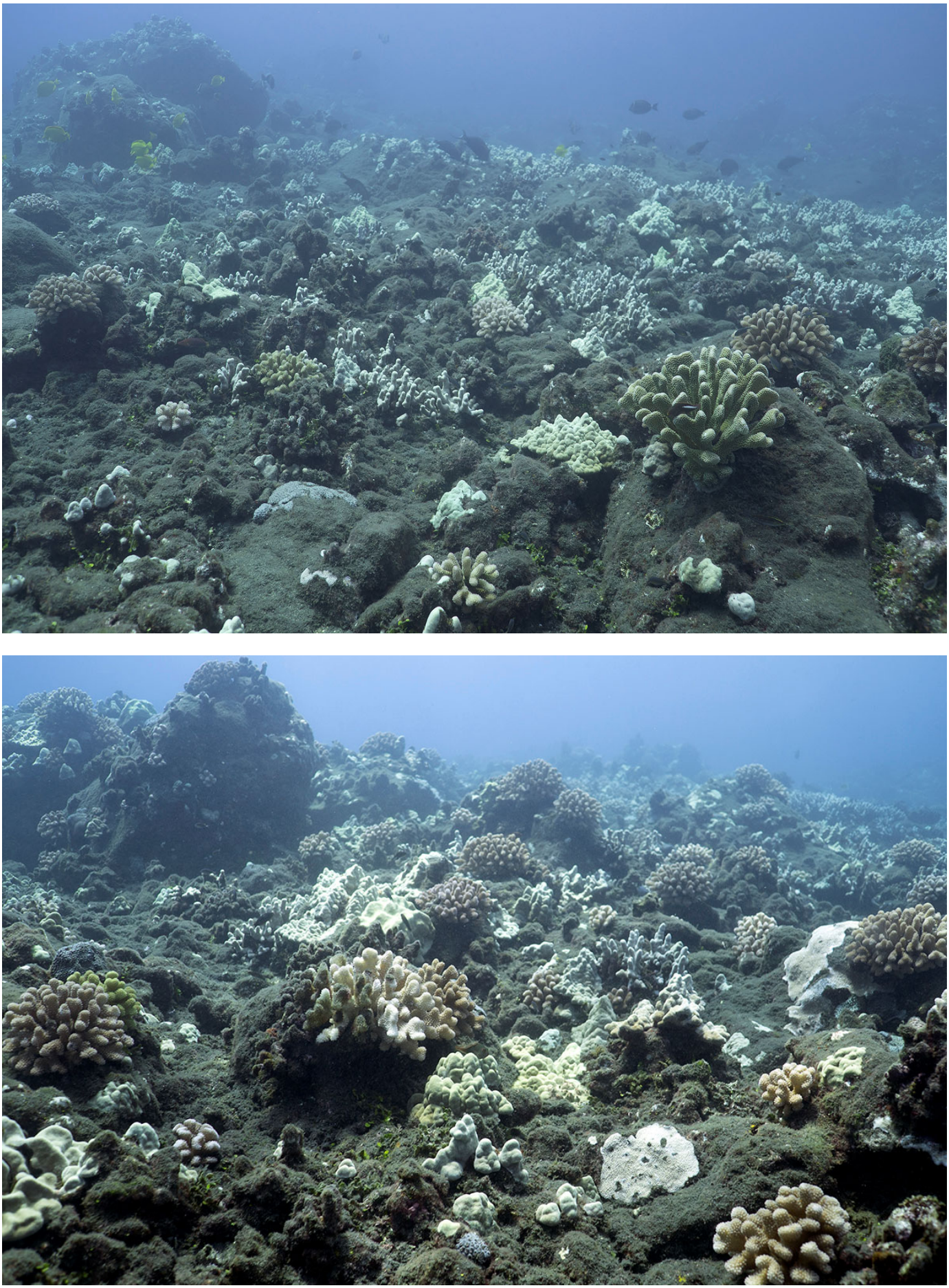


Figure 10. Two views of basaltic platform colonized by a mixed assemblage of coral species including *Pocillopora meandrina*, *Porites lobata* and *Porites compressa*. Water depth is approximately 8 meters.

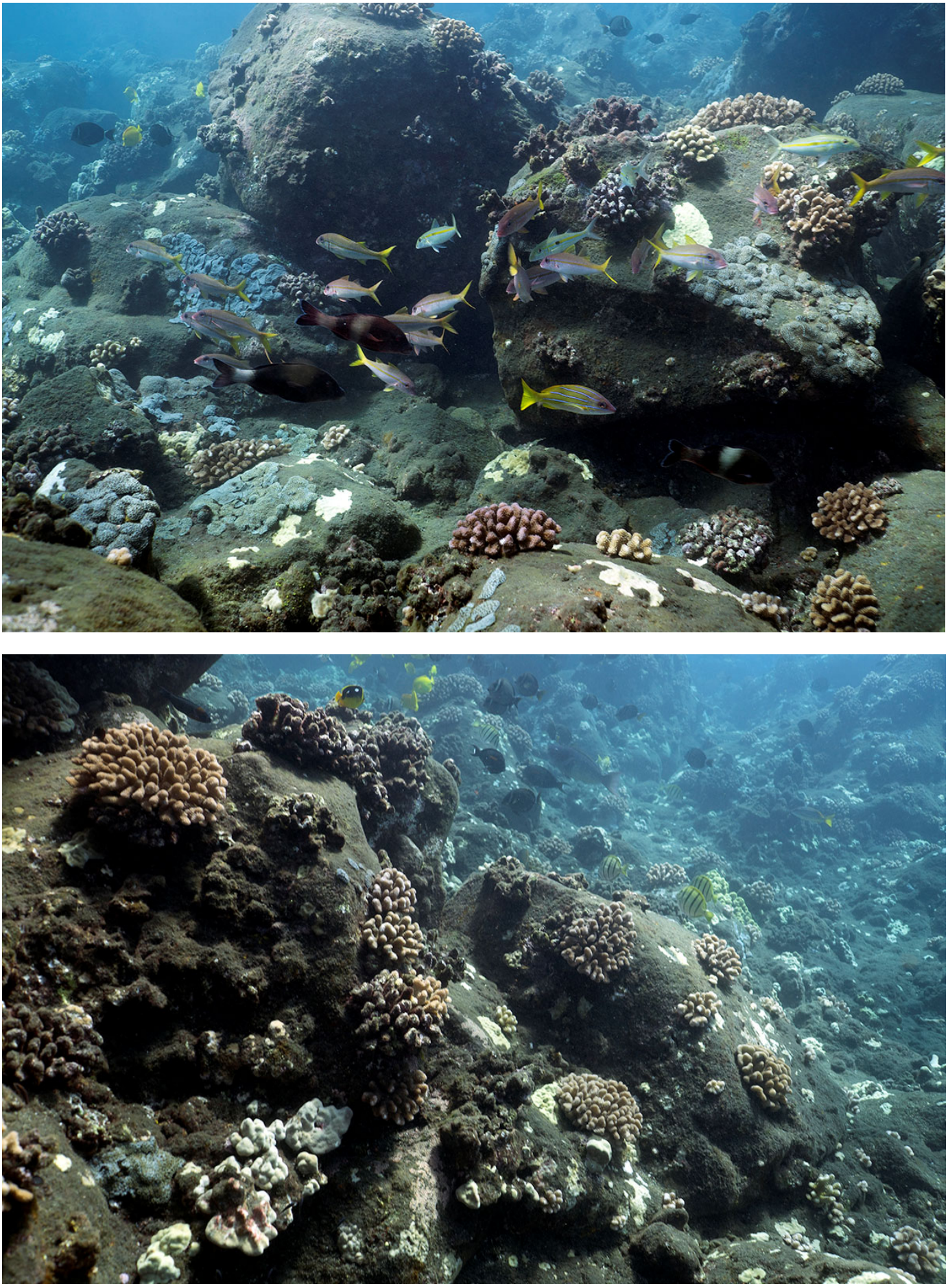


Figure 11. Two views of basaltic boulder zone inhabited by a variety of reef fish

APPENDIX G – A LITERATURE REVIEW AND FIELD INSPECTION FOR THE KALEPA REVETMENT AND SEAWALL REPAIRS PROPOSED PROJECT (SCIENTIFIC CONSULTANT SERVICES, INC.)

SCS Proj. 2592 LRFI-2.1

A LITERATURE REVIEW AND FIELD INSPECTION FOR THE KĀLEPA REVETMENT AND SEAWALL REPAIRS PROJECT, NAHOLOKU AHUPUA‘A, KAUPŌ DISTRICT, ISLAND OF MAUI, HAWAI‘I

[TMK: (2) 1-6-010:006 por., (2) 1-6-010-008 por., (2) 1-6-010:999 por., (2) 1-7-003:001 por., (2) 1-7-001:006]

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TABLE OF CONTENTS

INTRODUCTION 1

ENVIRONMENTAL SETTING 6

- **PROJECT AREAS** 6
- **SOILS AND VEGETATION** 7
- **HYDROLOGY AND CLIMATE** 9

HISTORICAL CONTEXT 9

- **PRE-CONTACT SETTLEMENT, ECONOMY, AND MYTHOLOGY** 10
- **PRE-CONTACT POLITICAL HISTORY** 11
- **EARLY POST-CONTACT HISTORY** 12
- **THE MĀHELE** 16
- **LATE POST-CONTACT PERIOD TO PRESENT** 17

PREVIOUS ARCHAEOLOGY 18

RESULTS OF THE FIELD INSPECTION 25

DISCUSSION AND CONCLUSION 36

REFERENCES 38

APPENDIX A: PROJECT SITE MAP FOR KĀLEPA POINT SHORELINE DAMAGE REPAIRS ..... A

APPENDIX B: NATIONAL REGISTER OF HISTORIC PLACES REGISTRATION FORM FOR HĀNA BELT ROAD ..... B

LIST OF FIGURES

Figure 1: Portion of 2017 USGS topographic map showing the locations of the Project Site and three potential Staging Areas....2
Figure 2: Tax Map Key [TMK: (2) 1-6-010] showing the locations of the Project Site and Staging Area 1 3
Figure 3: Tax Map Key [TMK: (2) 1-7-001] showing the locations of Staging Area 2 and Staging Area 3 4
Figure 4: Google Earth aerial photograph (imagery date: January 13, 2013) showing the locations of the Project Site and three potential Staging Areas....5
Figure 5: Google Earth aerial photograph showing the soil series in the Project Site and three potential Staging Areas and in the surrounding vicinity (USDA-NCSS SSURGO and STATSGO Soil Survey Products)....8
Figure 6: *Chart of the Sandwich Islands*, detail. Henry Roberts, 1778–1779....13
Figure 7: *Carte des Iles Sandwich*, detail. Sebastian Bernizet, 1786....15
Figure 8: Portion of a USGS topographic map showing previous archaeological studies in the vicinity of the Project Site and three potential Staging Areas....19
Figure 9: Portion of a USGS topographic map showing the proposed vehicular tunnel alignment in relation to the Project Site and three potential Staging Areas with historic properties in the vicinity....24
Figure 10: Location of the proposed sea wall construction (view to 189°; September 2021)....26
Figure 11: Road at the Project Site (view to 191°; September 2021) 27
Figure 12: SIHP Site 50-50-16-06577 (trail) shown in current overgrown state; adjacent stacked stone terrace visible (view to 10°; September 2021)....28
Figure 13: Photograph of *makai* portion of Staging Area 2 from Highway 31 (view to 150°; April 2024)....30
Figure 14: Overview photograph of *makai* portion of Staging Area 2 (view to 230°; April 2024) 31
Figure 15: Overview photograph of clearing in *makai* portion of Staging Area 2 (view to 210°; April 2024) ..32
Figure 16: Photograph of dense vegetation and grubbed push pile berm serving as temporary sea wall (view to 90°; April 2024 Staging Area 2)....33
Figure 17: Photograph of vegetation in *mauka* portion of Staging Area 2 (view to 360°; April 2024)....34
Figure 18: Overview photograph of Staging Area 3 from *makai* side (view to 290°; April 2024) 35
Figure 19: Approximate alignment of proposed vehicular tunnel 37

INTRODUCTION

At the request of Sea Engineering, Inc., Scientific Consultant Services, Inc. (SCS) has prepared this literature review and field inspection for the Kālepa Revetment and Seawall Repairs Project proposed by the Highways Division for the County of Maui Department of Public Works. The project areas (Project Site, Staging Area 1, Staging Area 2, and Staging Area 3) are located in Naholoku Ahupuaʻa, Kaupō District, Island of Maui [TMK: (2) 1-6-010:006 por., (2) 1-6-010-008 por., (2) 1-6-010:999 por. (County Right-of-Way), (2) 1-7-001:006 (Staging Area 2), and (2) 1-7-003:001 por. (Staging Area 3)] (Figures 1 through 3). The Project Site is on Hāna Highway (State Route 360), near the transition to the Piʻilani Highway (County Route 31) at the Kālepa Bridge. The purpose of the overall project is to ensure Hāna Highway remains safe and passable by rehabilitating the county road and bridge infrastructure.

Approximately 500 feet (ft) of roadway was undermined by large waves during Hurricane Iselle. Hurricane Iselle was the 11th named storm of the 2014 hurricane season and made landfall on the island of Hawaiʻi on August 7, 2014 as a tropical storm. Large waves hit the east shore of Hawaiʻi island, as well as that of Maui. Iselle caused considerable damage to the Hāna Highway, as well as road protection structures, including the rock rubble revetment slopes and concrete masonry walls, on the makai ("oceanward") side of Piʻilani Highway.

The project involves shore protection and roadway improvements in the area of the Kālepa Gulch, 14 miles southwest of Hāna Town. Shore protection consists of repairing 500 ft of rock rubblemound revetment and concrete rubble masonry wall with a hybrid rock rubblemound revetment and concrete retaining wall. The roadway improvements will involve replacing damaged steel guardrails with new concrete guardrails and repaving the roadway between the Kālepa and ʻAlelele Bridges. The construction staging will likely require clearing of vegetation and some grading.

In September of 2021, SCS completed a field inspection of the Project Site and a potential storage and construction staging area location (Staging Area 1). Unfortunately, the landowner of Staging Area 1, the National Park Service (NPS), is not allowing the use of the land for this project. The County of Maui has identified two parcels owned by the State of Hawaiʻi as potential storage and construction staging area locations (Staging Areas 2 and 3). A subsequent field inspection was performed in these two additional areas, located on Piʻilani Highway, in April of 2024.

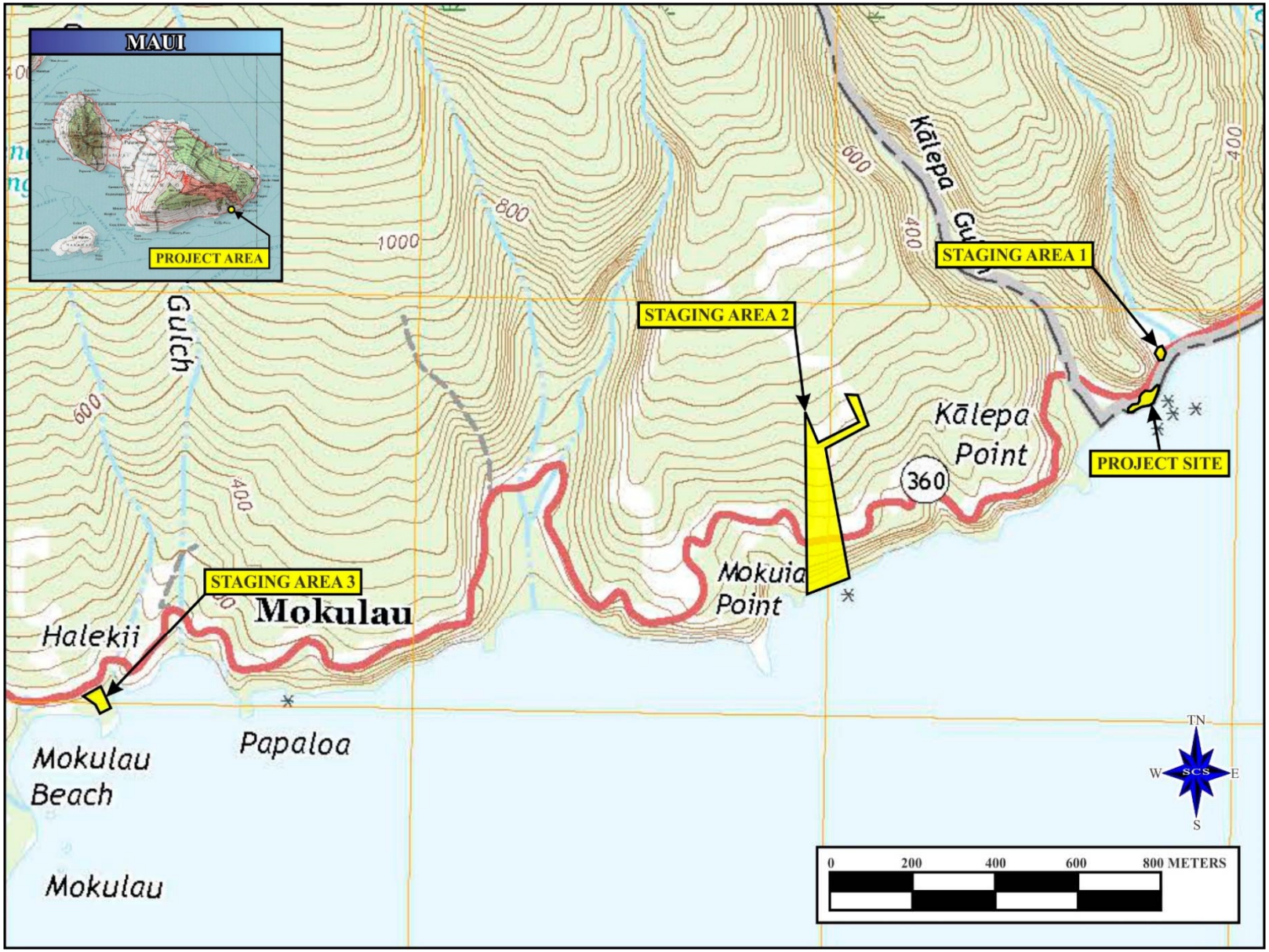


Figure 1: Portion of 2017 USGS topographic map showing the locations of the Project Site and three potential Staging Areas

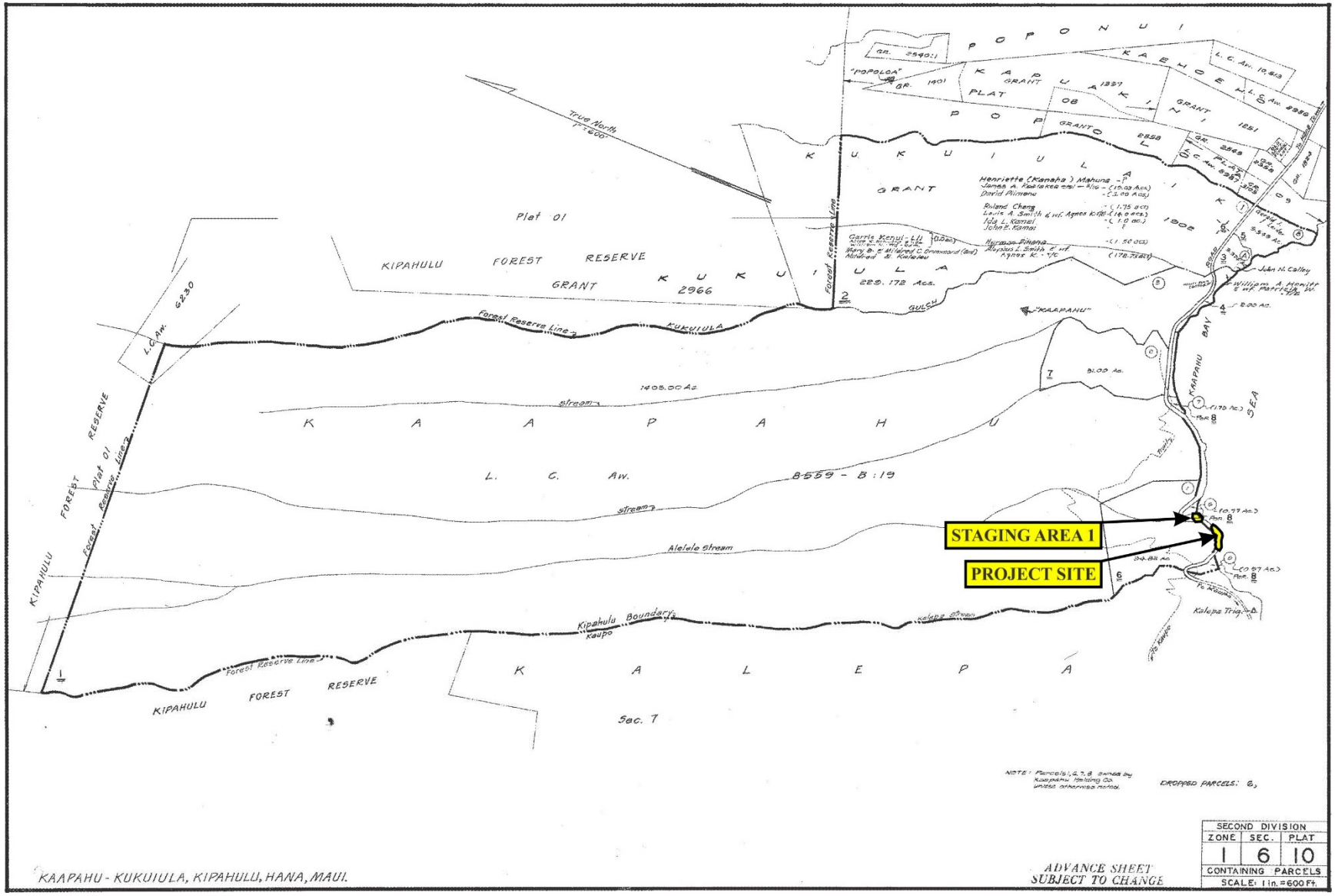


Figure 2: Tax Map Key [TMK: (2) 1-6-010] showing the locations of the Project Site and Staging Area 1

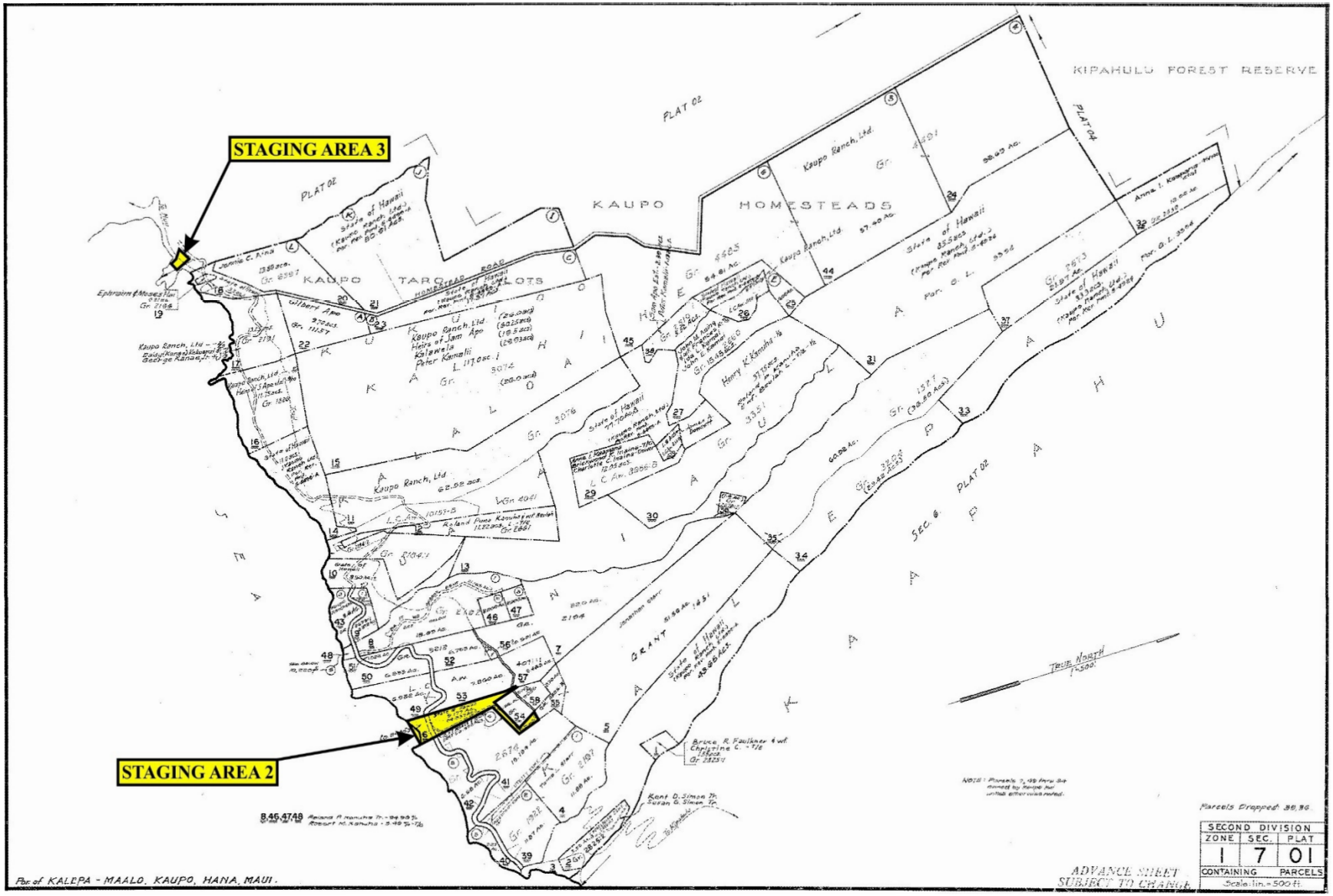


Figure 3: Tax Map Key [TMK: (2) 1-7-001] showing the locations of Staging Area 2 and Staging Area 3

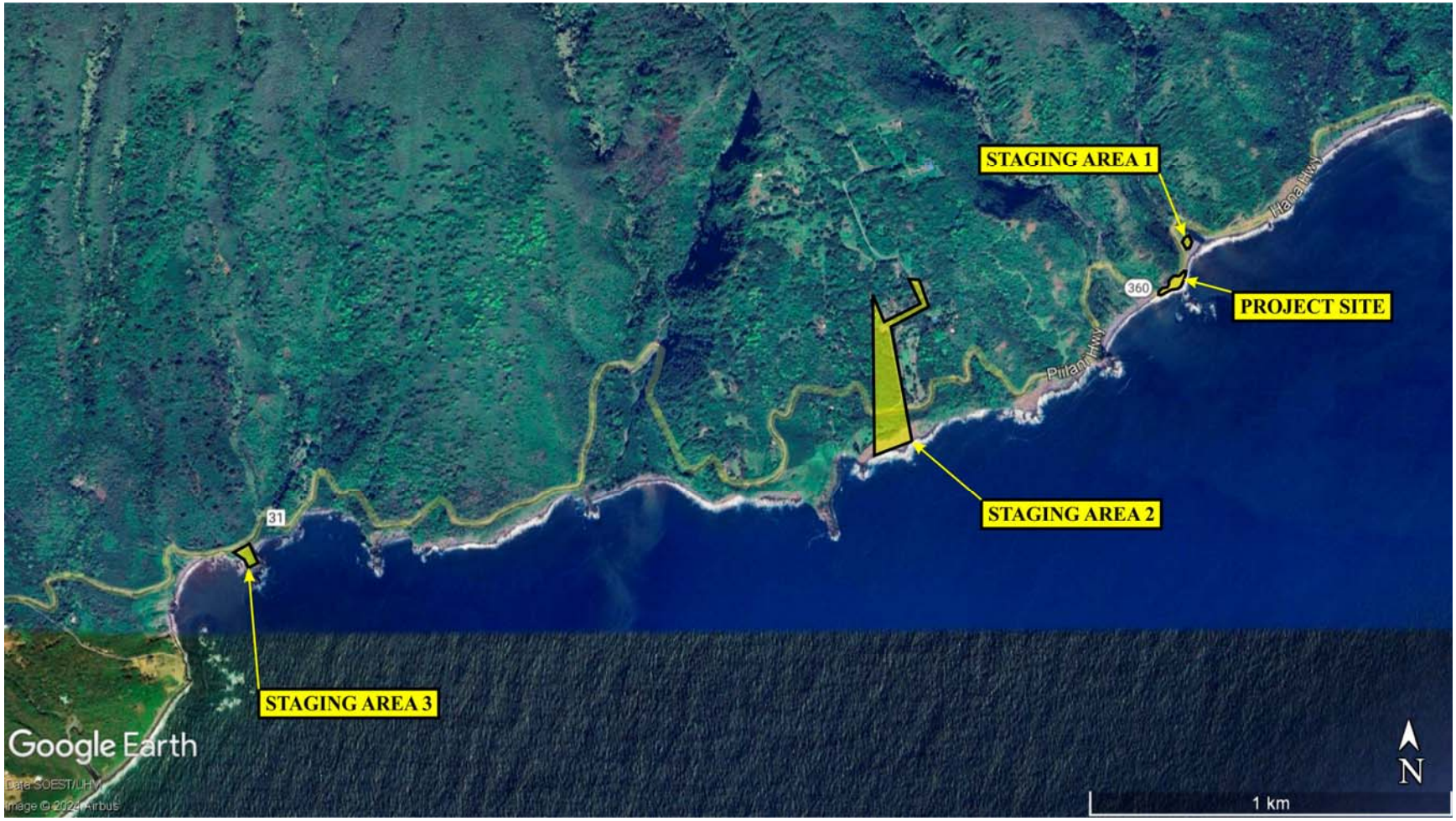


Figure 4: Google Earth aerial photograph (imagery date: January 13, 2013) showing the locations of the Project Site and three potential Staging Areas

This report is not intended to meet HAR§13-276 requirements for an archaeological inventory survey but to identify potential cultural resources in the project areas and the greater vicinity, as well as provide in brief its cultural history. The scope of work for this report includes:

- Historical research in order to (1) construct a history of land use and (2) determine if archaeological sites have been recorded on or are likely to be recorded on the subject property and the terrain adjacent to it.

- Field inspection via pedestrian survey of the project areas. This inspection is conducted in order to (1) identify any surface archaeological features and (2) investigate and assess the potential for impact to such sites. This assessment will also identify any sensitive areas that may require further investigation or mitigation before work on the project proceeds.

ENVIRONMENTAL SETTING

The island of Maui was formed by two volcanoes, Puʻu Kukui – older and extinct – and Haleakalā – younger and dormant, joined by an isthmus of dry, open country or kula ("plain, pasture"). The land between the volcanoes were formed by erosional deposits and are noticeably drier than those at higher elevations. Puʻu Kukui ("candlenut peak") forms the western part of the island, rising to 1,764 meters (m; 5,788 ft) above mean sea level (amsl). It is surrounded by large, heavily eroded amphitheater valleys that support permanent streams. The deep valleys of the West Maui Mountains (Mauna Kahālāwai) are surrounded by large, heavily eroded amphitheater valleys that sustain permanent streams watering the fertile agricultural lands along the coasts. Haleakalā ("house of the Sun") soars 3,055 m (10,023 ft) amsl, dominating the southeastern section of the island. The flanks of Haleakalā are distinguished by gentle slopes toward the isthmus. Although they receive more rain than their counterparts in the west, the permeable lavas prevent the formation of rain-fed perennial streams. Thus, the few perennial streams found on the windward (eastern) side of Haleakalā originate from springs located at lower elevations, while valleys and gulches on the leeward side were formed by intermittent water run-off.

PROJECT AREAS

The Project Site (Appendix A) is a 500-ft section of shoreline and 18,400 sq ft of paved roadway near Kālepa Point (mile post 38.2±) on the southeast coast of Maui [TMK: (2) 1-6-010:006 por., (2) 1-6-010:999 por.]. The area is on the Kālepa headland located between two drainage systems, the Kālepa Gulch and ʻAlelele Stream. The highway is at an elevation of approximately 25 ft amsl, as it passes around the Kālepa headland with a shear rock road cut on the mauka ("mountainward") side of the road and a sloping rock embankment on the makai side. The road cut is draped in steel rock fall netting. In some areas, the rock embankment has been modified with sections of concrete rubble masonry and rock rubble mound shore protection.

The project area is part of the Kīpahulu Cliff and Valley physiographic division, composed of a series of cliffs and small valleys carved by streams leading out to the ocean (Armstrong 1983). The topography ranges from relatively flat valleys that were cut by ʻAlelele and Kālepa Streams to steep ridges that dominate the landscape. Geologically, the project area is part of the lower southeastern slopes of the Haleakalā Volcano. Haleakalā National Park, a federal site managed by the NPS of the U.S. Department of the Interior, makes up the *mauka* side of the project area, and County of Maui lands make up the *makai* portion.

In addition to the Project Site, the project area includes three potential staging areas. Staging Area 1 [TMK: (2) 1-6-010-008 por.] is *mauka* of Hāna Highway and was inspected during the initial survey in September 2021. Staging Area 2 [TMK: (2) 1-7-001:006] and Staging Area 3 [TMK: (2) 1-7-003:001] are both situated to the west of the Project Site. Staging Area 2 is the shoulder of a road closer to Kālepa Point, and Staging Area 3 is about 2.5 miles to the west from the project area towards Kaupō, Staging Areas 2 and 3 were inspected during the follow-up survey in April 2024.

SOILS AND VEGETATION

According to Foote et al. (1972:10; Figure 5), soils in the project areas are classified within the Hāna-Makaalae-Kailua soil association. Developed in material from weathered volcanic ash originating from Haleakalā, these soils are well-drained with moderately fine textured subsoils on the intermediate uplands of East Maui.

The potential Project Site and Staging Area 1 partially occur in Rock Land (rRK) and Rough Mountainous Land (rRT). Rock Land features exposed rock covering 25 to 90 percent of its surface. Its primarily characterized by basalt and andesite rock outcrops and very shallow soils. Structures constructed on this soil type are susceptible to sliding, and their foundations and retaining walls are vulnerable to cracking. At lower elevations, natural vegetation includes *kiawe* (mesquite, *Prosopis pallidia*), pili grass (*Heteropogon contortus*), and *koa haole* (*Leucaena leucocephala*), while lantana (*Lantana camara*), guava (*Psidium guajava*), and molasses grass (*Melinis minutiflora*) dominate at higher elevations. Rough Mountainous Land (rRT) consists of very steep land broken by drainage channels. The soil mantle is very thin and is permeable to roots and water. The land surface "is dominated by deep, V-shaped valleys that have extremely steep slopes and narrow ridges between the valleys" (Foote et al. 1972:119). This soil type's natural vegetation consists of lantana, *ʻōhiʻa* (*Metrosideros polymorpha*), *kukui* (candlenut, *Aleurites moluccana*), and *pūakeawe* (heather, *Leptecophylla tameiameiae*).



Figure 5: Google Earth aerial photograph showing the soil series in the Project Site and three potential Staging Areas and in the surrounding vicinity (USDA-NCSS SSURGO and STATSGO Soil Survey Products)

Staging Area 3 fully falls within rRK soils, and a small portion of Staging Area 2 also consists of rRK. The majority of Staging Area 2 occurs within Makaalae soil, specifically Makaalae clay (MWE), 7 to 40 percent slopes. Makaalae soils are typified by their strong physical structure and a relatively high proportion of rock fragments (Foote et al. 1972:87).

HYDROLOGY AND CLIMATE

The Project Site is a roadway, which inherently has disturbed native soils and vegetation, preventing absorption of water into the ground. The constructed surface allows for increased water runoff, which is positively impacted by high rainfall (National Park Service 1999).

The average annual rainfall is 2,252.1 mm (7.39 ft). Much of the rainfall occurs during the winter months. The area's perennial streams (i.e., ʻAlelele Stream) gain volume from heavy precipitation, rapidly changing current velocity. Low precipitation, usually experienced in the summer months, can result in little to no flow (Armstrong 1983). The driest month is August with a mean rainfall of 146 mm (0.48 ft) (Giambelluca et al. 2013).

Located on the windward coast of Maui, the proximity of the ocean and trade winds moderate the temperature, maintaining a year-round average of 21.4 °C (70.5 °F). August is the hottest month with a mean air temperature of 23.0 °C (73.5 °F). The area is at its coldest in February with an average temperature of 19.8 °C (67.6 °F) (Giambelluca et al. 2014).

HISTORICAL CONTEXT

Traditional Hawaiian land tenure was a system formed in order to care for the land (*malama ʻāina*) (Kamakau 1961). Around the 14th century, various island *mōʻī* ("kings") believed the land should be surveyed and permanently marked in order to institute a boundary system that would settle disputes between neighboring *aliʻi* ("chiefs"). A *kahuna* ("priest") named Kalaihaʻōhiʻa ("hew the bark of the *ōhiʻa* tree"), who lived during the reign of Kakaʻalaneo, is said to have carved the land into districts and sub-districts (Beckwith 1940:383); Abraham Fornander (1916/1917, Vol. 6:248) places Kakaʻalaneo at the end of the 15th or the beginning of the 16th century. Land was considered the property of the king or "*aliʻi ʻai moku*" ("the chief who eats the island/district"), which he held in trust for the gods. The title of "*aliʻi ʻai moku*" ensured rights and responsibilities pertaining to the land but did not confer absolute ownership. The king kept the parcels he wanted, his higher chiefs received large parcels from him, and the higher chiefs, in turn, distributed smaller parcels to lesser chiefs. The *makaʻāinana* ("commoners") worked the individual plots of land collectively given to them by the chiefs.

A district (*moku*) contained smaller land divisions (*ahupua'a*) that incorporated the natural resources relevant to traditional subsistence stretching from the ocean to the mountain peaks (Lyons 1875:111). These ancient divisions have remained the same and are still commonly used to locate and refer to geographical features of the islands, even though land tenure has gone through radical changes (Sterling 1998:3). The land holding of a tenant (in Hawaiian, *hoa 'āina*) was called a *kuleana* ("right, privilege") (Lucas 1995:61).

PRE-CONTACT SETTLEMENT, ECONOMY, AND MYTHOLOGY

Ross Cordy (1981) suggests that the earliest settlements on Maui occurred between 300–600 C.E. in windward and coastal areas, with populations expanding into the dry leeward areas and the uplands by 1000 C.E. (see also Kolb et al. 1997). However, the earliest human presence in the project area is more likely to be traced to the early period of agricultural development, which on Maui began circa 1200-1400 C.E. (Kirch 1974:142). There is little doubt that Kīpahulu, along with Hāna and Kaupō, was part of an important economic and political center from the early days of human settlement in Maui.

The *moku* of Kīpahulu is the smallest in Maui and is bordered by the *moku* of Hāna (to the northeast) and Kaupō (to the west). This three-district area was home to a large settled population of fishermen and farmers, who utilized the abundant natural resources of the area, including plentiful rain and access to the ocean. Edward S.C. Handy and Elizabeth Green Handy (1972:507) wrote:

> Kīpahulu was an *'okana* (district) with rich and diverse but scattered agricultural resources. Its great valley and lower fringing forests nourished forest taro and other native food plants, as did the lower *kula* lands above the sea. Transformed under foreign enterprise into a sugar plantation, this land became a cattle ranch, but there were still some pockets of taro culture as late as 1934.

Abundant rainfall enabled the cultivation of *kalo* (taro, *Colocasia esculenta*), *mai'a* (banana, *Musa spp*.), and *kō* (sugarcane, *Saccharum officinarum*). On Maui, coastal lands were used for settlement, while *kalo* was cultivated in the near-coastal reaches and in the uplands. Lands further from the coast contained large garden enclosures, ceremonial structures, and permanent habitation sites by c. 1600 C.E. According to Van James (2001:98):

> Kīpahulu was a fairly populated area in former times and over 700 features have been surveyed on parklands. Stabilized house sites and other ancient ruins such as fishing shrines, *heiau,* canoe ramps, and old taro patches, can be seen all along the coastal areas.

Oral tradition tells of a number of high chiefs that made Kīpahulu District their home, likely because of its centrality and strategic location allowing access to Hawai‘i Island. The area is also known to contain numerous *heiau* (Pre-Christian Hawaiian shrines) built by the chiefs to honor their deities before and after battle. Elspeth Sterling (1998:12) calculated that the entire island of Maui contained 11 well-documented "mega *heiau*" (i.e., exceeding 200 ft in length), and six of these occur in the traditional districts of Kaupō-Kīpahulu-Hāna. The density of large *luakini* (sacrificial *heiau*) is a measure of the regional importance of this portion of East Maui.

PRE-CONTACT POLITICAL HISTORY

According to Kamakau (in Sterling 1998:2), "the ancient name of the island of Maui was Ihikapalaumaewa." The island was renamed "after a famous child of Wakea and Papa who became ancestor of the people of Maui." Another former name of the island is "Kūlua" ("pair; twins"), "perhaps called so because of the two divisions, East Maui and West Maui" (Sterling 1998:2).

Before the unification by the *ali‘i* Pi‘ilani in the late 1500s, the whole of Maui was ruled by two separate kingdoms – one centered in Hāna on the windward coast and one in Wailuku. Along with consolidating power on the island, Wailuku's chief, Pi‘ilani, also raised Maui's political status in the archipelago by ruling judiciously and using his connections with the reigning chiefly families of O‘ahu and Hawai‘i (Fornander 1916/1917, Vol. 2:87).

Pi‘ilani's heir was his firstborn son, Lono-a-Pi‘ilani. Oral tradition states that after a rift between Lono-a-Pi‘ilani and his brother, Kiha-a-Pi‘ilani (born c. 1626). Kiha traveled to the island of Hawai‘i, which was the kingdom of their brother-in-law, ‘Umi-a-Līloa. He convinced ‘Umi to send an army to Maui to avenge Kiha and dethrone Lono (Fornander 1919, Vol. 5:178–180). After the successful invasion, Kiha-a-Pi‘ilani became the sole ruler of Maui, and the royal residence was relocated to the eastern part of the island.

The 18th century was marked by a rivalry between Maui and Hawai‘i Island. At the end of his reign, the ambitious but ruthless Kekaulike (c. 1700–1736) raided Hawai‘i from his seat at Kaupō. Fearful of retaliation, Kekaulike withdrew to Wailuku, but he developed an acute and fatal case of what Kamakau (1961:69) classifies as epilepsy ("*ka maka huki lani*" or "eyes drawn heavenward"). His heir was Kamehameha-nui, the son of a half-sister of the Hawai‘i Island chief, Alapa‘i. With the help of his uncle, Kamehameha-nui defeated his older half-brother, Ka‘uhi, in 1738 and secured his rule over Maui (Kamakau 1961:74).

Maui enjoyed some time of relative peace and prosperity before the conflict returned with the wars between Kahekili II (c. 1737–1794), who was another of Kekaulike's sons, and Hawai'i Island chief Kalani'ōpu'u. Shortly before the arrival of Captain James Cook, Kalani'ōpu'u's armies had landed and plundered the southern district of Honua'ula before moving to Mā'alaea Bay, from where the chief planned to invade Wailuku (Fornander 1916/1917, Vol. 2:147–157). After losing two battles to Kahekili II, Kalani'ōpu'u welcomed a truce, concentrating his efforts on the eastern side of Maui, protecting Kīpahulu and Hāna, which were his spoils from an earlier battle in 1759 (Fornander 1916/1917, Vol. 2:147).

Although Kahekili at first tried to maintain peaceful relations with his contemporaries, Kalani'ōpu'u "loved war and display and had no regard for another's right over land" (Kamakau 1961:79). Sometime between 1775 and 1779, he launched a surprise attack on the people of Kaupō, killing hundreds of villagers. The cruelty of the Hawaiian soldiers was so famous in Kaupō that the battle was called "Kalaehohoa," or "the forehead beaten by clubs" (Fornander 1880:150–151). The Battle at Lelekea occurred c. 1786, when Kamehameha attempted to take the districts of Hāna and Kīpahulu, and the Battle of the Red Mantle occurred shortly after in response to the invasion. An ancient *pu'ukaua* ("fortification") is said to exist on the Kaupō side of the valley (Sterling 1998:163–164).

EARLY POST-CONTACT HISTORY

The Post-Contact Period in Maui begins on November 26, 1778, when British Explorer Captain James Cook's passed by the island on his way back from the extreme Northern Pacific (Daws 1974:8; Beaglehole 1967:Part I, Vol. III).). Cook's cartographer, Henry Roberts, also created the first known map of the Hawaiian Islands (Figure 6).

At the time of Cook's visit, the war between Kalani'ōpu'u and Kahekili II had not been over, and the latter was preparing for another attack (Speakman 1978:26). The internal affairs on the island proceeded independently of any significant Western influence for quite some time. In fact, the height of Maui's political power was reached during the reign of Kahekili II in 1783, five years after the encounter with Captain Cook (Kolb et al. 1997:3). Upon hearing of the natural death of his rival, Kalani'ōpu'u, the ambitious Kahekili II started a war of succession, which soon resulted in his conquest of O'ahu (Speakman 1978:48–51).

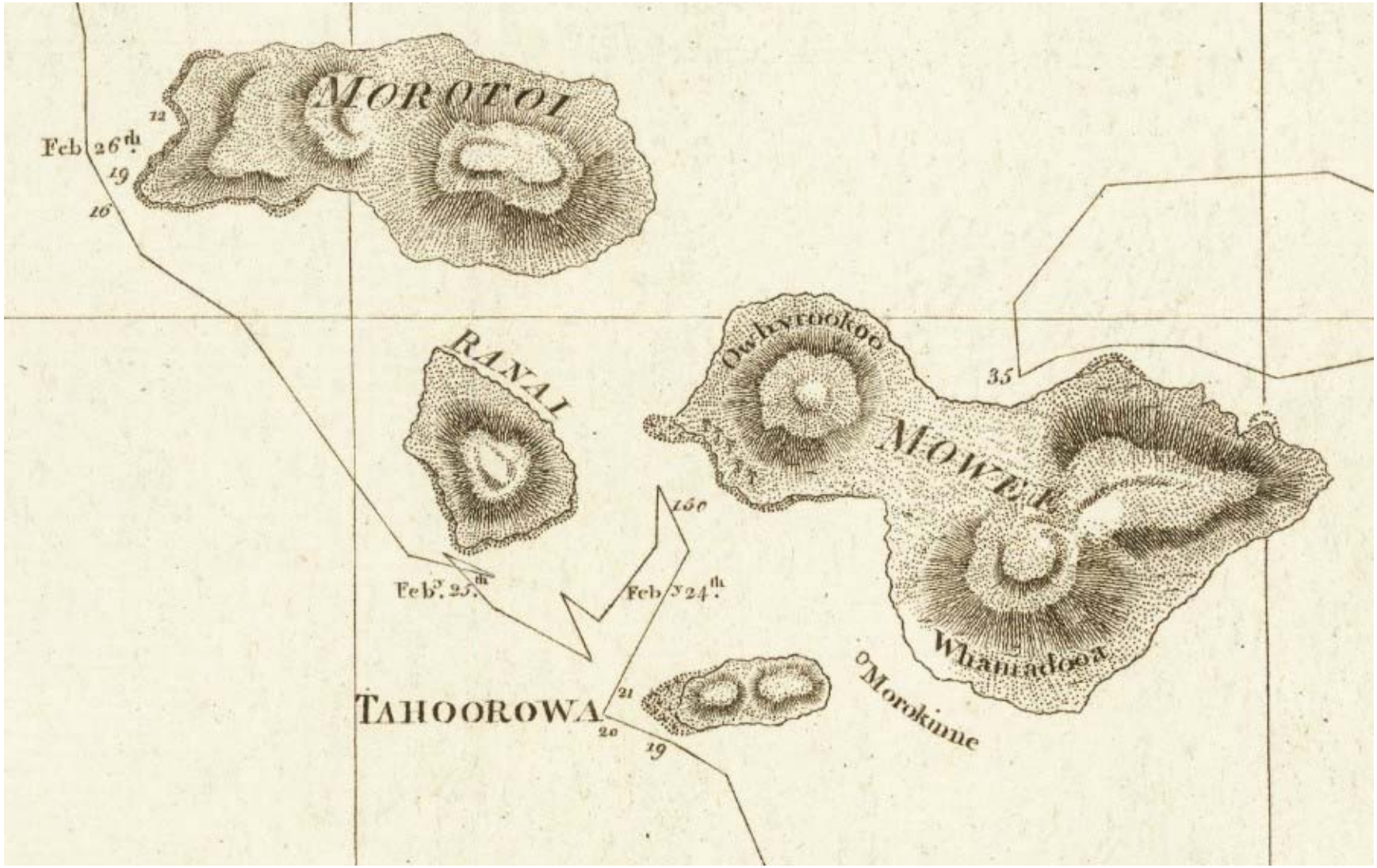


Figure 6: ***Chart of the Sandwich Islands*****, detail. Henry Roberts, 1778–1779**

After Kahekili's death at Waikīkī in 1794, his inherently unstable realm succumbed to fratricidal conflicts and the mounting pressure from the young and powerful chief of the island of Hawai'i, Kamehameha I (1758–1819) (Daws 1974:38). In the following years, the descendants of Pi'ilani and the chiefly Maui families were for the most part robbed of their possessions, unless they surrendered to the Hawai'i Island conquerors (Fornander 1916/1917, Vol. 6:310).

On May 29, 1786, Jean-François de Galaup, comte de Lapérouse, became the first European in recorded history to have set foot on Maui. Lapérouse's hydrographer, Sebastian Bernizet, created a map of the archipelago. However, it proved less accurate than the one created by Cook's team (Figure 7).

Maui, along with the rest of the newly named Sandwich Isles, quickly became an important stop for fur traders on their way to Canton (Guangzhou), China. In the following decades, the traditional way of life was changed by commercial activities (sandalwood trade, whaling, etc.) and the introduction of Christianity. By the mid-1830s, the Hāna and Kīpahulu areas of Maui had undergone a drastic change (Yzendoorn 1927). Missionaries and other settlers who came to Maui established homesteads, schools, churches, and literacy programs. Population estimates during this time can be vaguely inferred from the various population censuses of missionaries and local officials. An 1860 census of the Hāna area recorded a population of 4,491 people; the 1884 census shows that the population had declined to 2,061 people (Soehren 1963:4).

In 1853, John Rae described the heart of the Kaupō District and its agricultural yields. Much like Kaupō, the project area's dry, rocky land likely made taro cultivation difficult. Thus, in order to survive, local people made use of the soil deposits collected under stones, or they walked high onto the mountain and planted in the rich volcanic soil that lay there. Rae (1853:10) observed:

> Looking inland one sees forest broken acclivities of small height very stony and promising little to reward the labour of their cultivation. Yet when the surface stones are thrown into the form of low rude fences, the intervening spaces cultivated in the native manner yield largely of the sweet potato, & the onion, with here and there a few head of tolerable maise.

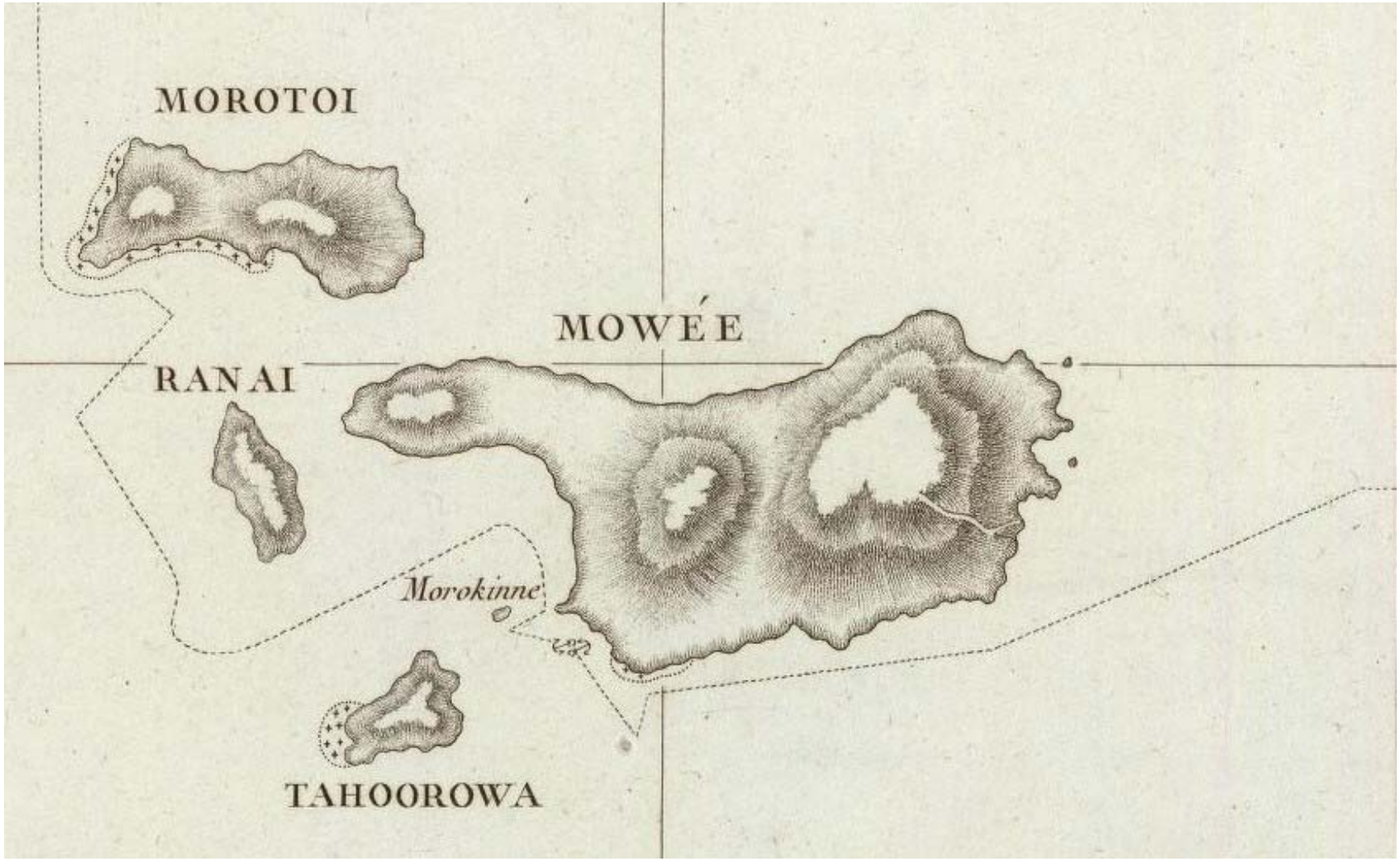


Figure 7: ***Carte des Iles Sandwich*****, detail. Sebastian Bernizet, 1786**

THE MĀHELE

The most impactful changes were related to land ownership. In the 1840s, land tenure shifted drastically as Kauikeaouli (Kamehameha III, r. 1825–1854) introduced private ownership based on Western practices. The transition to private land use is commonly called the "Māhele" ("division") and set the stage for consequential changes to property possession in the islands.

As early as 1841, the legislature allowed island governors to lease lands to foreigners for up to 50 years via leases that were to be registered "in writing so that there be no misunderstandings about terms and rents" (Daws 1974:125). The question of land reform was set aside in 1843 because of the five-month occupation of the islands by British naval officer George Paulet, but once the kingdom was stable again and Kauikeaouli felt secure at its helm it was brought back. By 1844, many chiefs were warming up to the proposal for a formal land division, and the Board of Commissioners to Quiet Land Titles (the Land Commission), was established in 1845 for "the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any land property" (Chinen 1958:8). The Commission had no authority to divide lands or change their tenure, but was created solely for approval of land claims (Kuykendall Vol. I, 1938:280).

The Māhele of 1848 divided Hawaiian lands between the king, the chiefs (*ali'i* and *konohiki*), and the government and instituted private land ownership. The subsequently awarded parcels were called Land Commission Awards (LCAs). Once lands were made available and private ownership was instituted, the *maka'āinana* were able to claim the plots on which they had been living and which they had been cultivating through the Kuleana Act of 1850. These claims did not include fallow land and many resources necessary for traditional survival (Kame'eleihiwa 1992:295). If occupation could be established through the testimony of two witnesses, the petitioners were awarded the claimed LCA and issued a Royal Patent after which they could take legal possession of the property (Chinen 1961:16).

Foreigners could acquire land through the Alien Landownership Act of 1850. Oftentimes, they were simply given lands by the *ali'i*. Commoners, however, would only make claims if they had first been made aware of foreign procedures such as the awarding of *kuleana* lands and LCAs. Many *maka'āinana* found these procedures unfamiliar, lengthy, and costly, and, as a result, a number of Hawaiians missed an opportunity to claim for themselves the lands that had been sustaining their ancestors (Daws 1974:127–128; Chinen 1961:16). These factors may have contributed to the relatively low number and size of claims, as only 8,421 *kuleana* awards were issued, totaling only 28,658 acres (Moffat and Fitzpatrick 1995:50).

According to the Office of Hawaiian Affairs' Kipuka Online Database (n.d.), Naholoku Ahupuaʻa was ceded as government land in 1848. All of the TMKs that are part of this project are situated in the *ahupuaʻa* of Naholoku. A part of the project area within TMK: (2) 1-6-010:006 por. falls within Land Award 2825:2 granted to Kainapau in 1862. TMK: (2) 1-6-010:006 por., (2) 1-6-010-008 por., and (2) 1-6-010:999 por. are all within LCA 8559 B:19, which was awarded to William C. Lunalilo (King Lunalilo, r. 1873–1874) (Buke Māhele 1848, Vol. 10:481). No testimony was necessary for Lunalilo's claim as he was an *ali'i*. Thus, there is no information about the land use in the LCA at the time of the claim (Waihona ʻĀina n.d.).

William Lunalilo was born in 1833 to Miriam ʻAuhea Kekāuluohi (niece of Kamehameha I) and Charles Kanaʻina. His predecessor on the throne, Kamehameha V (r. 1863–1872), had died in December of 1872 without naming a successor. Of the two viable successors, the legislature unanimously selected Lunalilo over David Kalākaua. A non-binding popular vote was also held, which Lunalilo also won. Because of his popularity and his endorsement of the democratic process, he is sometimes referred to as "The People's King." Lunalilo served as king for just over a year before dying of tuberculosis in February of 1874 (Day 1984:88).

Four land awards are associated with TMK: (2) 1-7-001:006 (Staging Area 2). LCA 4074:1 was awarded to Akaʻa in 1856 as Patent Grant 2947. Grant 2674 was awarded to Puʻu in 1859. Grant 2825:3 was awarded to Kainapau in 1862. Grant 3205 was awarded to Manu Kahunaʻaiole in 1879.

TMK: (2) 1-7-003:001 por. (Staging Area 3) falls within LCA 11216:25, which was claimed by M. Kekauʻōnohi, granddaughter of Kamehameha I. Kekauʻōnohi claimed five *ahupuaʻa* in Kaupō that were remnant portions after government grants and LCAs were mapped. The parcel was maintained by the Territory of Hawaii as part of the Kaupō Homesteads.

LATE POST-CONTACT PERIOD TO PRESENT

Because of the Māhele, land was easier to obtain, and vast areas were purchased for sugar cultivation. Sugar dominated Maui's economy for nearly a century starting in the 1860s. Commercial sugarcane agriculture and cattle ranching came to East Maui during the middle to late 19th century. However, rough terrain in the project area prevented large-scale endeavors. The scant evidence of domestic and small-scale farming activity in the project area is indicative of small-scale rural settlement (Hommon 1994).

Kipahulu Sugar Company operated from 1879 to 1925. William Dorrance and Francis Morgan (2000:67) call the business "unusual in the sense that it was incorporated with all shares of stock owned by German nationals." Interestingly enough, Kipahulu Plantation was used as an internment camp during World War I when "several Germans classified as alien enemies" were sent to Kīpahulu "to wield hoes" (Bartholomew and Bailey 1994:135).

The Māhele forced many rural farmers to relocate to commercial centers on Maui. Following the collapse of sugarcane agriculture in East Maui, ranchers began to purchase large swathes of land for cattle grazing. The completion of the Hāna Belt Road [State Inventory of Historic Places (SIHP) Site 50-50-06-01638], now called the Hāna Highway, in 1926, linked Hāna with the rest of Maui, allowing easier access for residents and prospective businesses (NRHP 2004). In 1997, the state declared the upper reaches of East Maui a forest reserve (Kolb 1993).

Along with the political and economic changes, the 20th century also brought a dramatic shift in Maui's demographics. Because of rampant diseases among the native population and the resulting labor shortage, Maui's plantations began importing foreign workers. Many Chinese laborer came in the 19th century, followed by Portuguese and Japanese at the turn of the 20th century. After Japan was closed as a source of immigration to Hawai'i in 1907, nearly 120,000 Filipinos moved to the Territory until 1931 (Speakman 1978:151). Caucasians began moving to the islands in greater numbers only after Hawai'i "began to figure prominently as a military and tourist frontier" (Speakman 1978:161).

Today, East Maui serves as a reminder of traditional Hawai'i – rural and relatively untouched by development (i.e., no resorts or industrialized areas). Commercial horseback riding stables and local farming are the primary business in the area (National Park Service 1998:35).

PREVIOUS ARCHAEOLOGY

Thomas G. Thrum (1908) conducted some of the earliest archaeological investigations on Maui. His surveys focused on coastal *heiau* and were closely tied to legends in the area. Thrum recorded the *heiau* of Ma'ulili located near Hāna, close to the Kīpahulu sugar mill, which was built in 1878. He stated that it was of a *luakini* class and had been re-dedicated by Liholiho (Kamehameha II). This is possibly the structure described by Kamakau (1961:188): "the Peleleu set sail, touching first at Kīpahulu where Kamehameha erected the god house called Ma'ulili." According to Thrum (1908), only a paramount chief, such as Kamehameha, could have a *luakini* class of *heaiu* built.

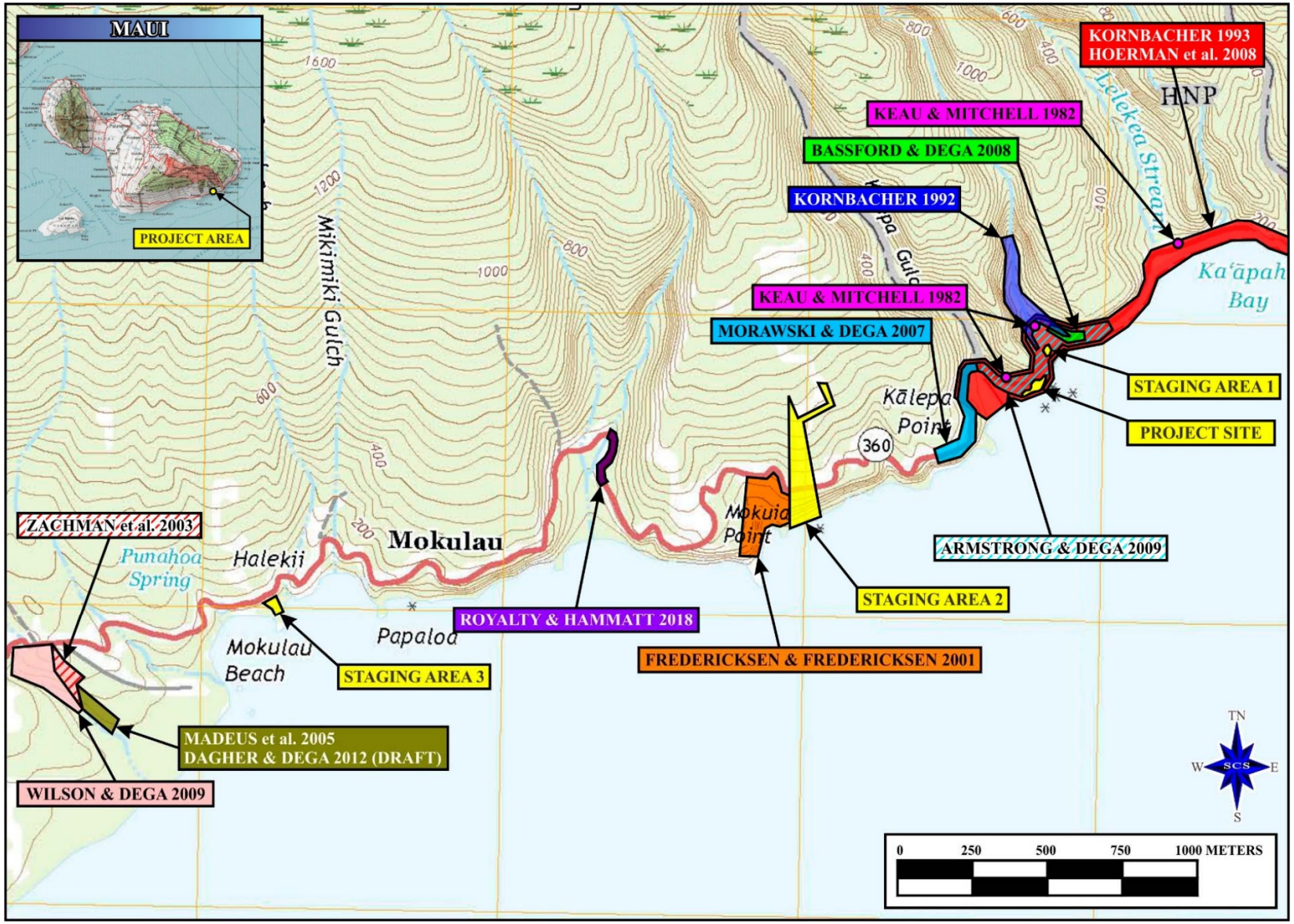


Figure 8: Portion of a USGS topographic map showing previous archaeological studies in the vicinity of the Project Site and three potential Staging Areas

Eight years later, Thrum (1917) returned to the southeastern coast of Maui and recorded six more *heaiu* along the Kīpahulu coastal area, as well as a *pu'ukaua* in Lelekea Valley. The *pu'ukaua* may have played a role in the 1786 Battle of the Red Mantle between Kalanikupule of Maui and Kamehameha's brother, "the good chief," Keali'imaika'i from Hawai'i Island (Kamakau 1961:143). Thrum (1917) also recorded Manekineki Heiau, near the road at Kukui'ula, and described the large 100-ft-wide by 149-ft-long Paokahi Heiau at Lelekea as in ruins. Thrum (1917:56–57) corrected his previous noted location of the Ma'ulili Heiau, stating that it was near the shore, and explained that the name of Lelekea ("breath flown") referred to "the incident of an ancient *ali'i* being brought to the temple in a weak condition and expiring there" (Sterling 1998:162).

Winslow Walker (1931) began his island-wide survey of Maui in 1928 as research for the Bernice P. Bishop Museum (BPBM). He mostly recorded *heaiu* located along the coast. Walker located Paokahi Heiau (Walker Site 139, SIHP Site 50-50-16-01492, Soehren Site A25-1) in Lelekea Gulch, on the left bank of 'Alelele Stream, approximately 150 yards above the trail leading to Kaupō. He described it as measuring 100 ft wide by 130 ft long and:

> built 12 feet above the stream. It is the open platform type with possibly three terraces on top, but pigs have so disturbed the area that it is difficult to determine accurately the structures. At the southwest corner are two small enclosures, paved with flat stones and pebbles. A low wall 5 feet thick runs along the north side of the *heiau*. Only on the east is a double step-terrace visible…The name Kumuula was also given for the *heiau* by informant Kaiwiaea. [Walker in Soehren 1963:76]

The BPBM (Soehren 1963) was contracted by the NPS to reinvestigate several areas on Maui, particularly in the Kaupō-Kīpahulu area. Lloyd Soehren conducted an archaeological survey of East Maui to supplement Walker's survey and identify, (re)locate and "improve on existing data" (Kornbacher 1993:15). Despite that, Soehren was unable to relocate many of Walker's *heiau* either because commercial sugar endeavors in the 19th and early 20th centuries have destroyed many of the features or because of the dense vegetation covering the sites. Walker's sites were recorded with "estimated locations," including that of the Paokahi Heiau (SIHP Site 50-50-16-01492 – Lelekea Complex; Soehren Site A25-1) [TMK: (2) 1-6-010:001]. The Paokahi Heiau was re-located during subsequent surveys (Kornbacher 1993) and was dated to the Pre-Contact Period.

Soehren identified four new sites in Kiko'o and seven sites in Ma'ulili, including a rock shelter, a possible *heiau*, and a petroglyph site. He noted:

> Agricultural terraces and irrigation ditches were recorded in several places, and many more have been destroyed by the [sugar] plantation…. The abundance of water made Kīpahulu ideal for the cultivation of wet taro (*Colocasia esculenta*). [Soehren 1963:22]

Soehren's sites include Sites A25-2 and A25-3 (Kukuiʻula Complex – SIHP Site 50-50-17-03147) [TMK: (2) 1-6-010:001], Site A25-5 (ʻAlelele Stream Terraces – SIHP Site 50-50-16-01129) [TMK: (2) 1-6-010:001], Site A25-6 (Kālepa Fishing Shrine – SIHP Site 50-50-16-01130) [TMK: (2) 1-6-010:001], Site A26-1 [TMK: (2) 1-7-001:003], and Site A26-2 [TMK: (2) 1-7-001:002]. All of the sites were reported to be Pre-Contact in origin. Connolly (1974) conducted a survey of East Maui in 1974, resulting in the re-identification of many of Soehren's sites. It also provided updated information on site preservation conditions (Kornbacher 1993:15–16).

In response to destruction caused by Hurricane Eva in 1982, Charles Keau and Muffy Mitchell (1982) surveyed areas near the Lelekea, Kaʻāpahu, and ʻAlelele Bridges [TMK: (2) 1-6-010:001, (2) 1-6-010:002] to determine the presence of archaeological sites in the vicinity of the proposed bridge reconstructions. SIHP Site 50-50-16-03142 (Keau and Mitchell Site III), a possible burial cave, was discovered at ʻAlelele. Partially constructed out of waterworn boulders on the west side of the cave, a section of natural rocks appears to have collapsed from the cave roof, obstructing the cave's opening (Keau and Mitchell 1982:01). Kornbacher (1993:28) supported the interpretation as a burial site. SIHP Site 50-50-16-03144 (Keau and Mitchell Site I) consists of two rock shelters at Lelekea. Additionally, Kornbacher (1993:28) noted a possible third rock overhang situated above the road and obscured by vegetation. The rock shelters were estimated to have been used during the Pre-Contact Period. No sediment or cultural artifacts, save for modern debris, were observed.

Kornbacher (1992) conducted an archaeological reconnaissance survey in 1992, including SIHP Site 50-50-16-01129, originally recorded by Soehren in 1962 [TMK: (2) 1-6-010:001]. Five terraces, one mound, and one retaining wall were located and mapped, and it was concluded that the features were associated with wetland agriculture (Soehren 1963; Connolly 1974). Kornbacher hypothesized that the site may have also been used as seasonal habitation, as modern debris and evidence of cooking suggests habitation-like activities. Because of its potential to yield information about the Pre-Contact Period, Kornbacher (1992:12) considered the complex as potentially eligible for the National Register of Historic Places (NRHP) and the Hawaiʻi Register of Historic Places (HRHP).

The archaeological survey conducted by Kornbacher (1993) along Hāna Highway [TMK: (2) 1-6-010] in 1993 included the re-location of SIHP Sites 50-50-16-01129, 50-50-16-01130, and 50-50-16-01492. Several new sites were also identified. SIHP Site 50-50-16-03140 consists of a large rock shelter 5 m above the beach surface and measuring approximately 1.5 m high; the shelter measures 17 m from opening to back wall. A pictograph was noted on the second face of the cave overhang. SIHP Site 50-50-16-03141 is an "alluvial sedimentary deposit with an exposure of approximately 2.3 meters" located on the east side of ʻAlelele Stream (Kornbacher 1993:23). SIHP Site 50-50-16-03145 is a series of disturbed "wall segments, linear rock alignments, and retaining walls" (Kornbacher 1993:28). The function of the walls could not be determined because of vegetative overgrowth and alteration caused by access roads and highway and bridge construction. SIHP Site 50-50-16-03146 is composed of two rock shelters. No historic artifacts were observed, and no modern use was noted. All sites are reported to be from the Pre-Contact era.

In preparation for the acquisition of 1,474.29 acres of land in Kaʻāpahu for Haleakalā National Park, the National Park Service (1996) completed a pre-acquisition environmental hazard site assessment. The landowner, David Dodds, was willing to sell the property located between Kīpahulu and Kaupō [TMK: (2) 1-6-010:001, 006–008] to the park, and, per the briefing statement supplied by Elizabeth Gordon of Haleakalā National Park, no opposition was met. The unique environment and endangered species within the area are deemed significant along with the presence of archaeological sites.

Fredericksen and Fredericksen (2001) conducted an archaeological inventory survey of a 6.5-acre parcel in Kālepa Ahupuaʻa in 2001. The survey was conducted just *mauka* of Mokuia Point along the coast. No sites were located, and only one artifact, a basalt flake, was found. While no sites of significance were found on the subject parcel, Mokuia Point, *makai* of the surveyed area, was given a State Site number (SIHP Site 50-50-16-05058) because of its position as a traditional Hawaiian fishing area.

During an archaeological inventory survey of an area *mauka* of Piʻilani Highway, Morawski and Spear (2007) confirmed the presence of SIHP Site 50-50-15-06272. Consisting of three areas of stacked rock terracing under the Piʻilani Highway and Hāna Belt Road, the features of the site are located in close proximity to each other. The features are arches that were constructed in conjunction with the historic roadway through Hāna, Kīpahulu, Kaupō, and Kahikinui.

SCS was contracted to oversee a slope stabilization project along Kālepa and ʻAlelele slopes, adjacent to Hāna Highway in the Kaʻāpahu Ahupuaʻa. Two historic properties were previously identified in the survey area. SIHP Site 50-50-06-01638, the Hāna Belt Road, links East Maui with the rest of the island. SIHP Site 50-50-16-03143 is the King's Trail, a cobble-based conduit used by Hawaiians to facilitate travel around the island (Hoerman et al. 2008). An archaeological inventory survey was completed, followed by archaeological monitoring. The archaeological work was supported by a burial treatment plan (Bassford and Dega 2008).

During the survey (Hoerman et al. 2008), two previously unidentified sites were identified. Located on the west side of Kālepa Stream, SIHP Site 50-50-16-06438 is a three-sided terrace. The structure may have been a habitation locus or a small ceremonial site. Located within the boundaries of Haleakalā National Park along the western slope of ʻAlelele Valley, the second site, SIHP Site 50-50-16-06439, is a rock shelter/burial locus approximately 200 ft (61 m) north of SIHP Site 50-50-16-03142. The rock shelter entry was partially sealed by a stacked rock wall composed of angular *ʻaʻā* (lava) blocks five to seven courses high. The wall was presumed to function in securing the location from pedestrian traffic and appeared to be a recent construction. The single chamber shelter contained surface human remains (lumbar vertebra, three tibiae) thought to represent multiple individuals (MNI=2+) were contained within the shelter. A full walk-through of the shelter was not completed as the crew did not wish to disturb the sealing wall. With the confirmation of human remains, no additional investigation was needed.

Armstrong and Dega (2009) identified two sites during monitoring for the Kaupō-Kīpahulu Rockfall Project. SIHP Site 50-50-16-06486 consists of a single adult individual (MNI=1). Consistent with traditional Native Hawaiian burial contexts, the burial is located in a rock shelter without grave goods, and the flexed burial position suggests Polynesian ancestry. SIHP Site 50-50-16-06577 is a trail with an adjacent stacked stone terrace. Located on a steep slope, it roughly follows the ridge contours, running parallel to a cliff face. The *makai* section of the trail is paralleled by a stacked stone terrace constructed of sub-rounded to sub-angular cobbles and boulders. Although altered via fauna (pigs and goats), flora (hala and mango trees), erosion (trail's eastern terminus has been washed out), and gravitational forces (2006 earthquake), SIHP Site 50-50-16-06577 is in fair condition. No surface artifacts were observed.

Royalty and Hammatt (2018) completed archaeological monitoring in 2018 for a landslide repair project on a 0.074-acre section of Piʻilani Highway (State Route 31) south of the Nuanualoa Gulch. The excavations comprised of two trenches. No potential cultural deposits were exposed, and no historic properties were observed.

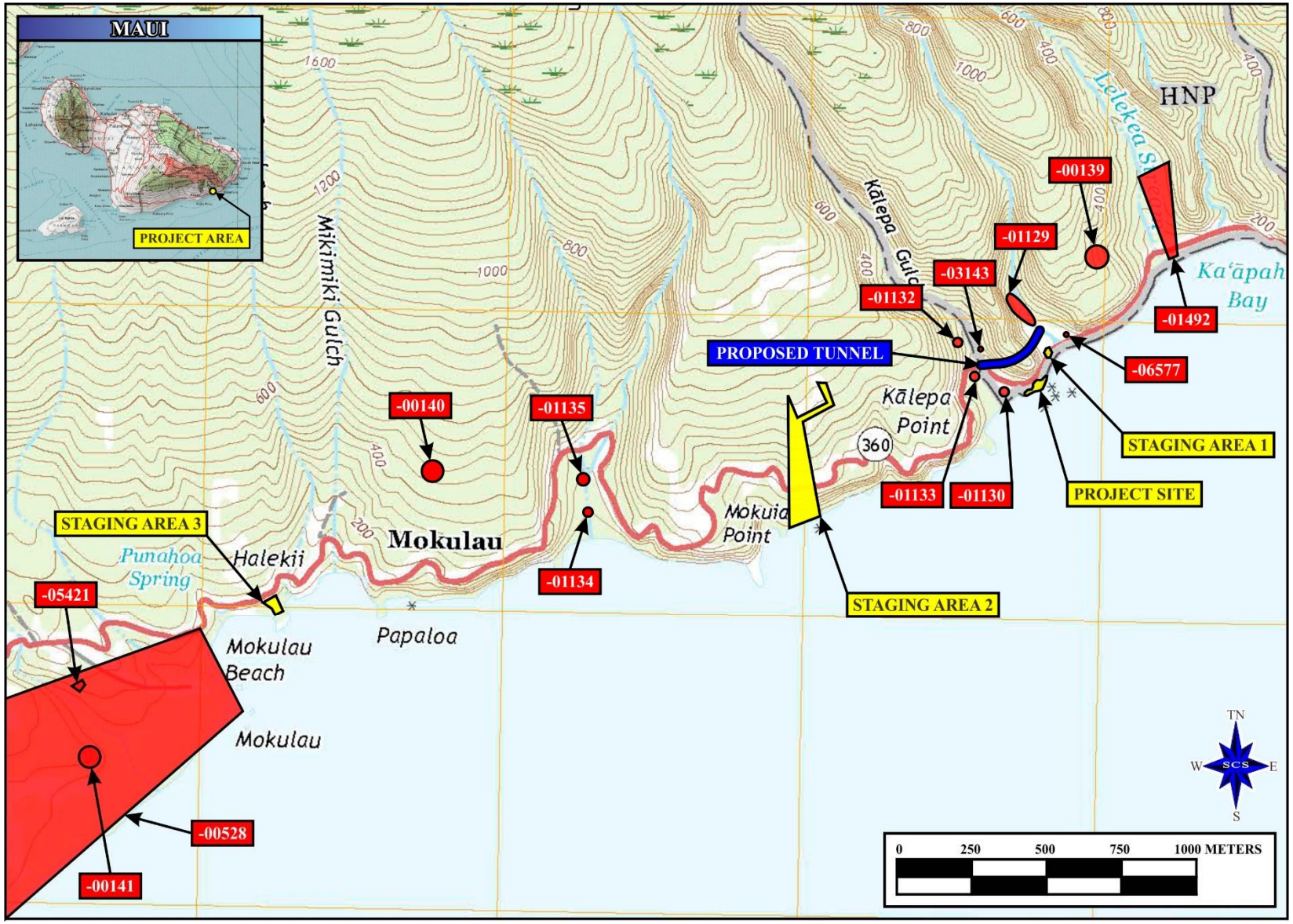


Figure 9: Portion of a USGS topographic map showing the proposed vehicular tunnel alignment in relation to the Project Site and three potential Staging Areas with historic properties in the vicinity

RESULTS OF THE FIELD INSPECTION

The Kīpahulu District is rich in archaeological resources with a wide variety of recorded site types and occurrences. Rock shelters and other exposed bedrock features (e.g., overhangs) with evidence of human occupation are common in Kīpahulu. In some parts of Kīpahulu, these exposed bedrock features extend all the way down to the seashore, making them attractive locations for habitation and planting features; burials were also suspected to be present in such caves. Previous archaeology in the area has identified agricultural features, such as walls, terraces, and mounds, as well as habitation features, including C-shaped structures (see Figure 9). Several *heiau* have been also identified in the area. Unlike other parts of Maui, Kīpahulu has not been subject to extensive urbanization and resort development. Available physiographic, archaeological, and historical evidence suggests a high probability for finding Pre-Contact sites and features in the project areas, particularly as those that had been previously recorded remained intact through time.

An archaeological field inspection of the Project Site and Staging Area 1 was conducted on September 9, 2021 by SCS archaeologist A. Yo-Han Gallo, B.A., under the supervision of Principal Investigator Michael F. Dega, Ph.D. At this time, the project areas consisted of the Project Site and Staging Area 1. The fieldwork entailed a 100% pedestrian survey of the proposed construction area, as well as the adjacent beach south of Kālepa Point and ʻAlelele Stream.

The pedestrian survey of the Project Site did not lead to the identification of any new surface sites of any non-modern temporal period. The Project Site exhibited significant damage to a previously present guardrail, which is no longer intact. However, no other significant damage was observed to roadways. No Pre-Contact surface features were observed during the pedestrian survey of the stone shoreline and nearby beach to the east and west of the project area, which is an area primarily accessed by tourists during the late summer and early fall. Staging Area 1 was also assessed to have no identified historic properties present and to be of low risk for containing cultural resources.

The only easily accessible sites adjacent to the project areas are those along a now prohibited hiking trail along ʻAlelele Stream. All other areas that had previously accessible routes have since been overgrown and hidden by thick growth of razor grass (*Paspalum virgatum L.*) and *hala* (*Pandanus tectorius*). A previously identified trail (SIHP Site 50-50-16-06577; Armstrong and Dega 2009) is no longer easily accessible and is likewise overgrown and eroded.

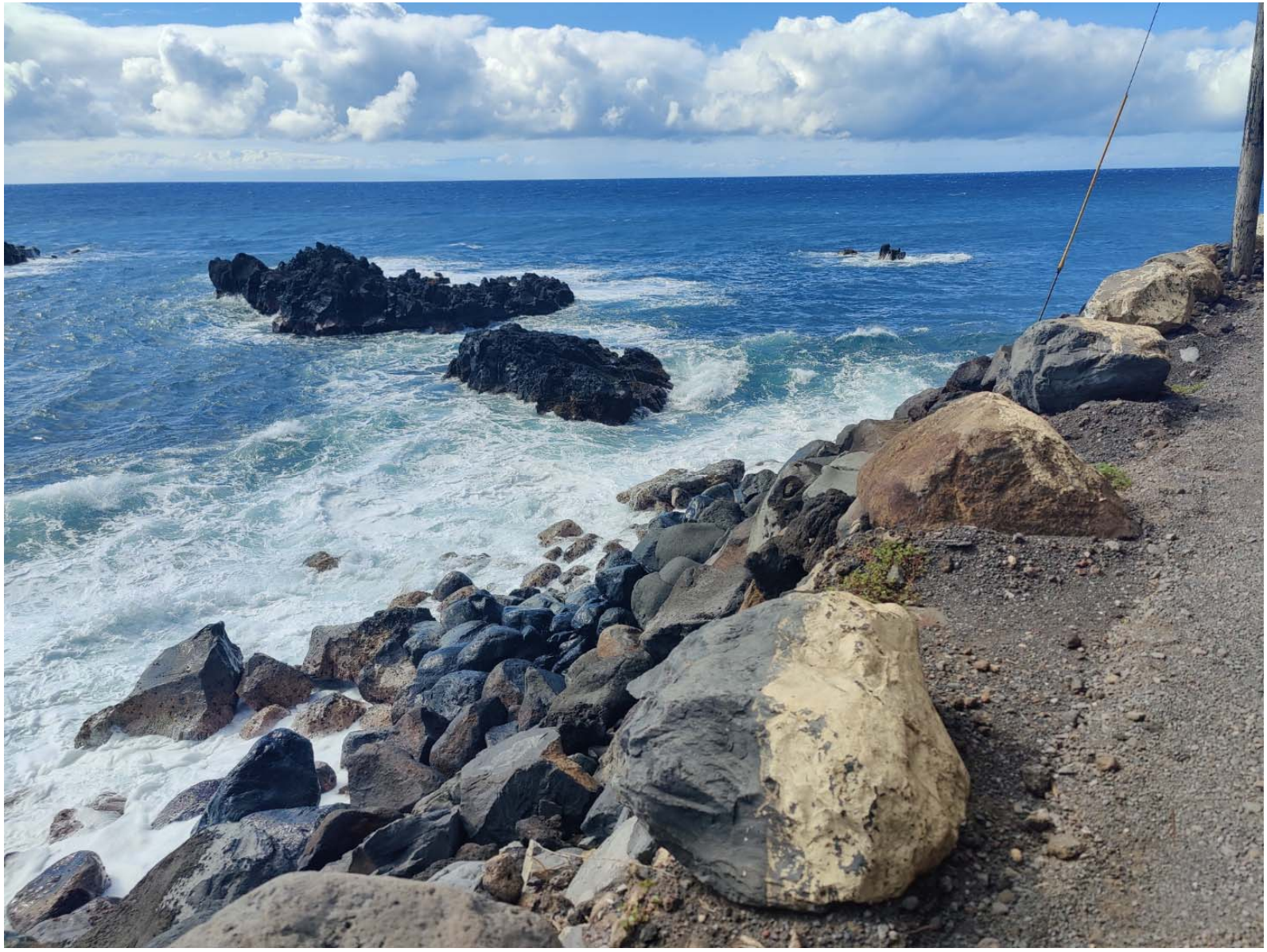


Figure 10: Location of the proposed sea wall construction (view to 189°; September 2021)

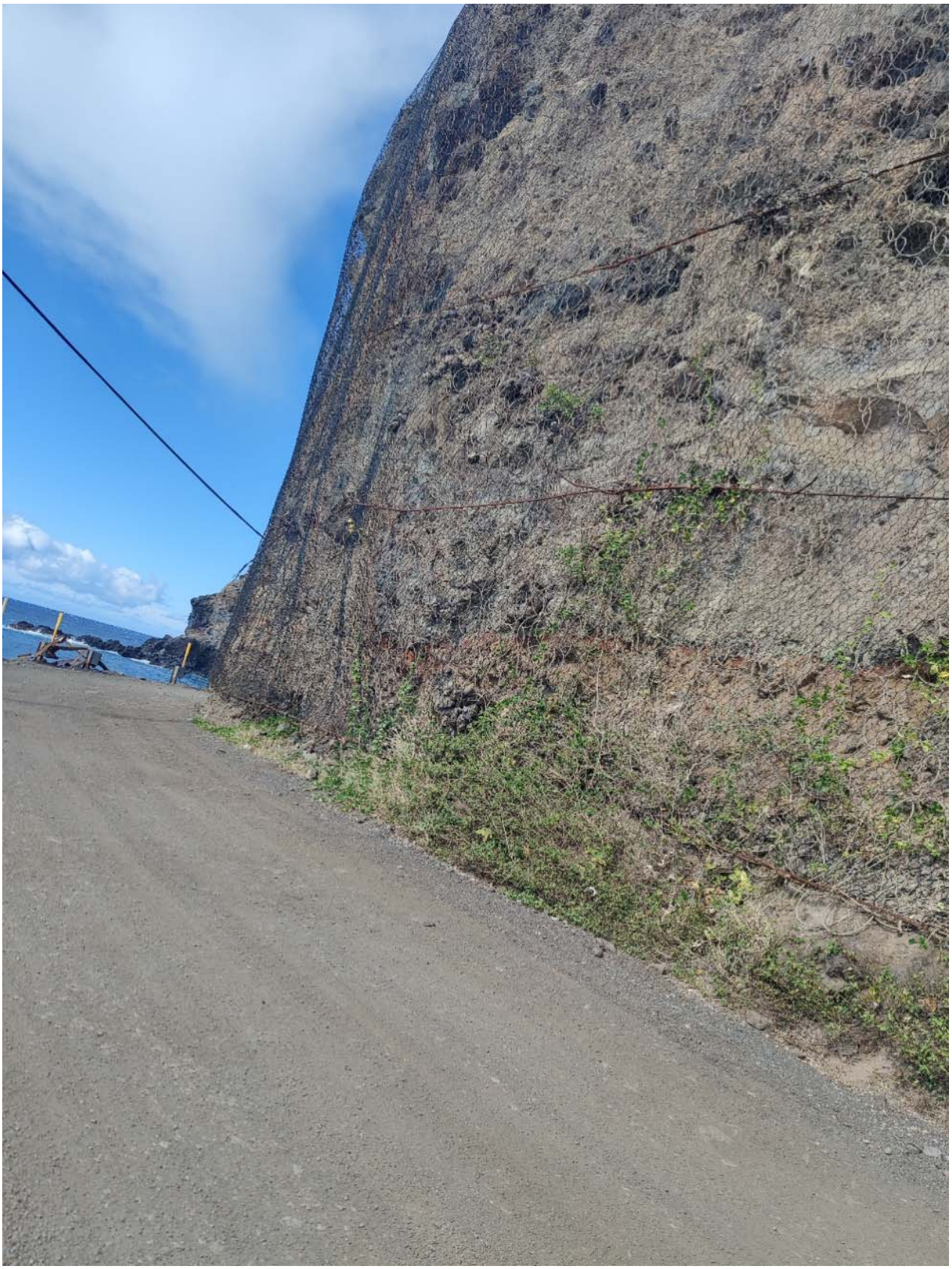


Figure 11: Road at the Project Site (view to 191°; September 2021)



Figure 12: SIHP Site 50-50-16-06577 (trail) shown in current overgrown state; adjacent stacked stone terrace visible (view to 10°; September 2021)

On April 7, 2024, a subsequent field inspection of two potential staging area locations (Staging Area 2 and Staging Area 3) for the Kālepa Revetment and Seawall Repairs Project was performed by SCS archaeologist, David Stielow, B.A., under the supervision of Principal Investigator Michael F. Dega, Ph.D. Staging Area 2 is located near 182 Highway 31, and Staging Area 3 is on the *makai* side of the highway, near Huialoha Church, founded in 1859.

Access to the *mauka* side of the Staging Area 2 was limited due to private property and the presence of dense vegetation. The lower portion of the project area was accessed via the roadside down a moderately steep slope with thick vegetation, and it opened into a clearing in the trees. The clearing was accessed by a road, which was followed until it strayed outside the project area. This project area is shaped like the letter Y. In the area where the Y splits, the vegetation (trees and invasive vines) is extremely dense and impenetrable.

Staging Area 3 is a small parcel only accessible via four-wheel drive vehicles. A small pull-off the highway leads to a fishing location. Vegetation in the area includes tall grasses and small seaside shrubs., which obscure extremely treacherous drop-offs.

Approximately 80% of Staging Area 2 was inspected, and a full (100%) inspection was completed of Staging Area 3. While the field inspection did not result in the identification of cultural resources, and the likelihood of encountering historic properties is low, there is potential to observe terraces on the *mauka* portion of the Staging Area 2, which was not fully accessible during the field inspection.



Figure 13: Photograph of *makai* portion of Staging Area 2 from Highway 31 (view to 150°; April 2024)



Figure 14: Overview photograph of *makai* portion of Staging Area 2 (view to 230°; April 2024)



Figure 15: Overview photograph of clearing in *makai* portion of Staging Area 2 (view to 210°; April 2024)



Figure 16: Photograph of dense vegetation and grubbed push pile berm serving as temporary sea wall (view to 90°; April 2024 Staging Area 2)



Figure 17: Photograph of vegetation in *mauka* portion of Staging Area 2 (view to 360°; April 2024)



Figure 18: Overview photograph of Staging Area 3 from *makai* side (view to 290°; April 2024)

DISCUSSION AND CONCLUSION

On the behalf of Sea Engineering, Inc., Scientific Consultant Services, Inc. (SCS) has conducted this literature review and field inspection for the Kālepa Revetment and Seawall Repairs Project proposed by the County of Maui Department of Public Works, Engineering Division. This report is not intended to meet HAR§13-276 requirements for an archaeological inventory survey, but to identify potential cultural resources in the project areas and the greater vicinity, as well as to provide in brief its cultural history.

The field inspection was conducted via pedestrian surveys. The project areas are defined as a previously utilized environment, as it is associated with a roadway. The investigation did not include subsurface testing. While the possibility of subterranean cultural deposits exists, the likelihood of disturbing any during proposed seawall construction is extremely unlikely.

The archival research and literature search identified several previous archaeological studies that have been conducted in the vicinity of the project areas, and multiple sites have been identified around the project areas (see Figure 9). Nonetheless, research suggests limited potential for archaeological sites within the proposed project areas (Project Site and Staging Areas 1, 2, and 3). There is no evidence that any of the sites or features observed would be disturbed by the repair of the rock rubblemound revetment. Any ground altering or subsurface activities associated with proposed rehabilitation work is not expected to negatively impact any archaeologically significant sites or structures.

Due to concerns regarding stability above the roadway, permanent closure of the existing roadway and the construction of a by-pass tunnel through the Kālepa headland has been proposed. The highway would be rerouted through a 600-ft long, two-lane tunnel between Kālepa Bridge and ʻAlelele Bridge. In addition to the requisite excavation of the 31-ft wide, 16-ft-high tunnel, the tunnel entrances would be levelled, to include clearing and grading the land. The tunnel would involve a drill and blast excavation method on the steep slope face above the existing roadway. Blasting would have possible negative impacts on SIHP Site 50-50-16-06577, as well as any potential cultural resources in the surrounding area.

As the project areas encompass portions of the Hāna Belt Road (SIHP Site 50-50-06-01638), the SHPD should be consulted regarding any future ground disturbance. Possible realignment of tunnel should also be considered to avoid impacting SIHP Site 50-50-16-06577.

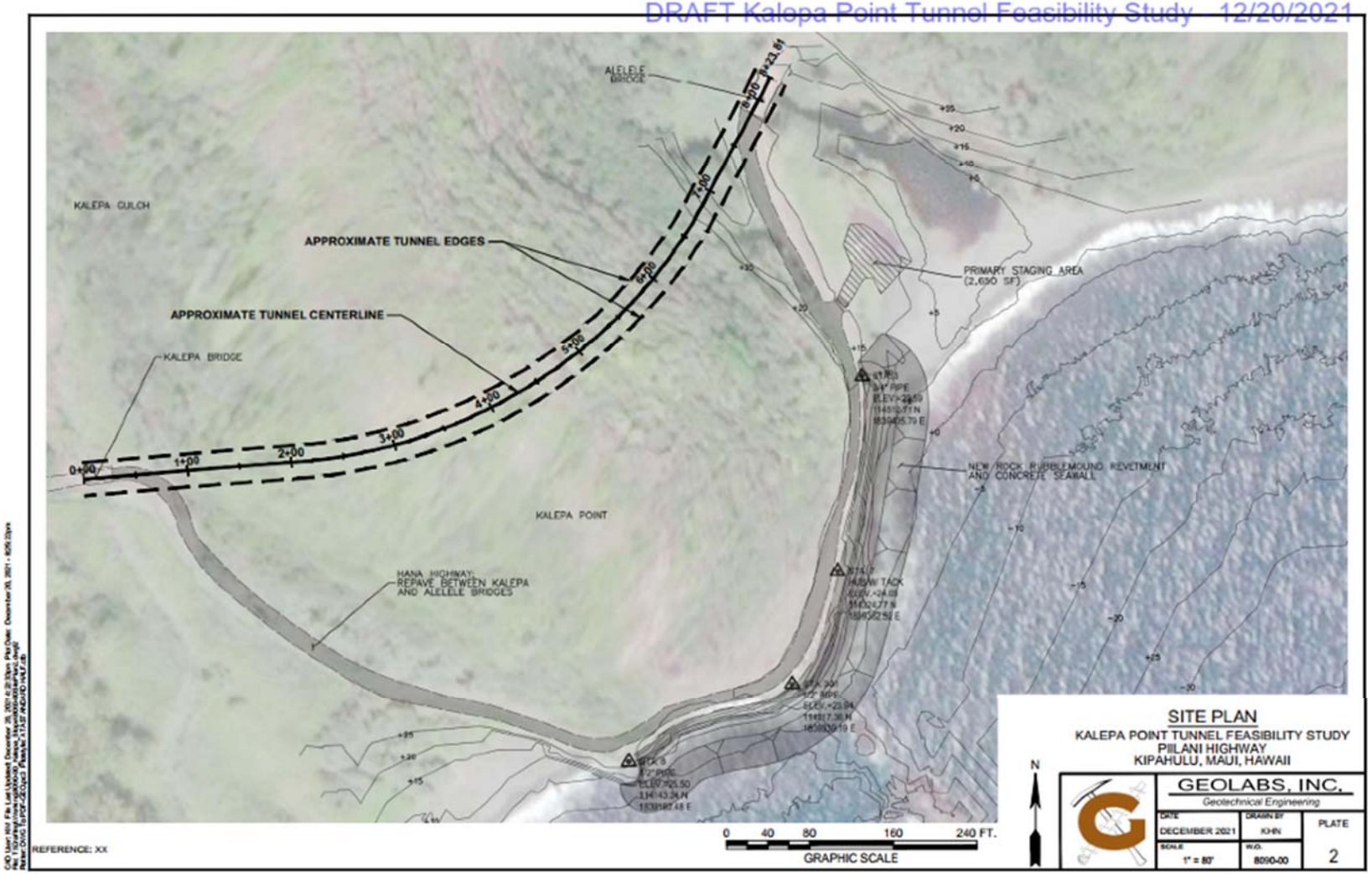


Figure 19: Approximate alignment of proposed vehicular tunnel

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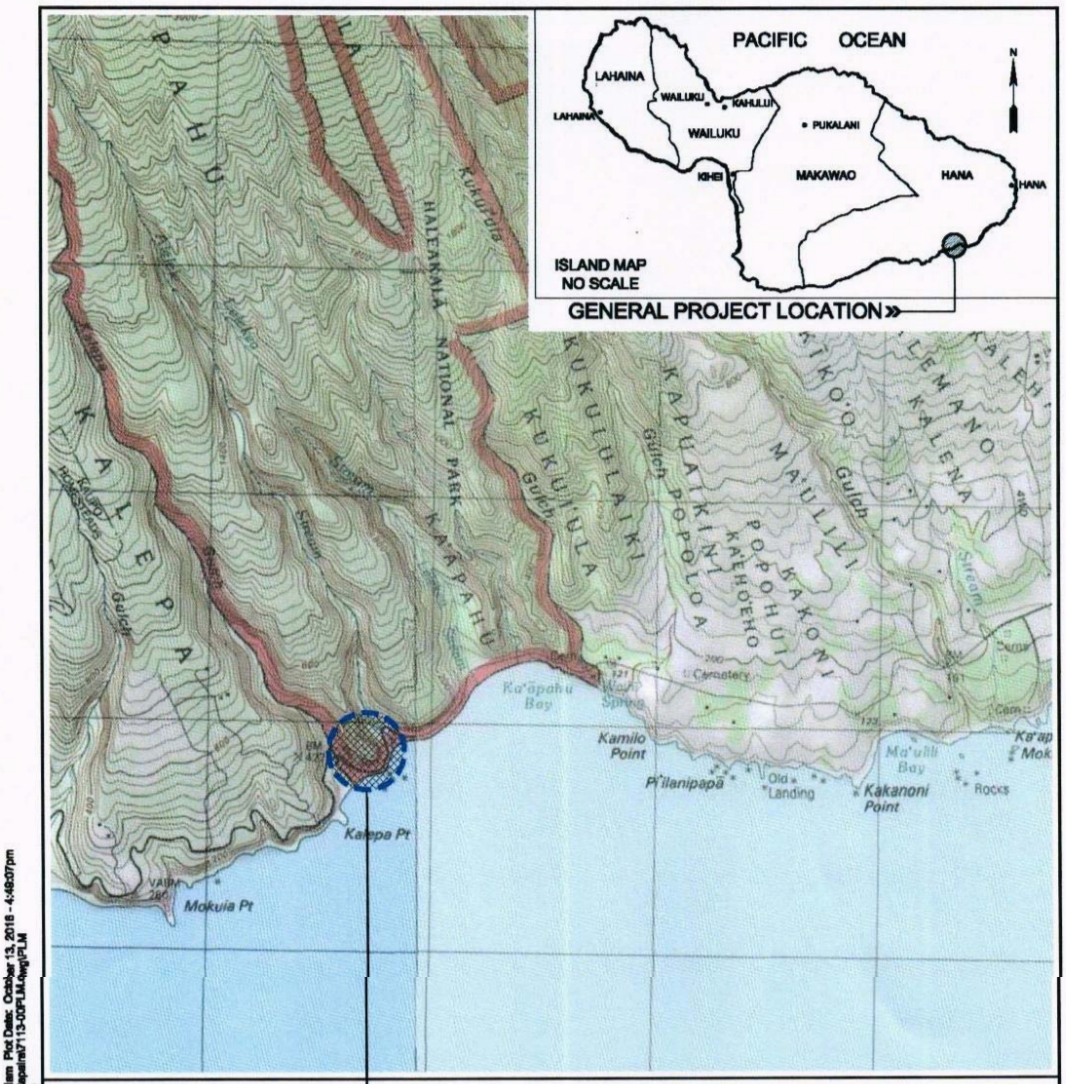
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APPENDIX A: PROJECT SITE MAP FOR KĀLEPA POINT SHORELINE DAMAGE REPAIRS



PROJECT LOCATION MAP

KALEPA POINT
SHORELINE DAMAGE REPAIRS
KIPAHULU, MAUI, HAWAII

GEOLABS, INC.		
Geotechnical Engineering		
DATE: AUGUST 2016	DRAWN BY: ASP	PLATE: 1
SCALE: 1" = 2,000'	W.O.: 7113-00	

CAD User: HENRY File Last Updated: August 31, 2016 10:44:41am Plot Date: October 13, 2016 - 4:48:07pm
File: T:\Drafting\Working\7113-00\KalepaPointShorelineDamageRepair\mi\7113-00PLM.Awg\PLM
Plotter: DWG To PDF-GEO.pc3 PlotStyle: GEO-No-Dithering.ctb

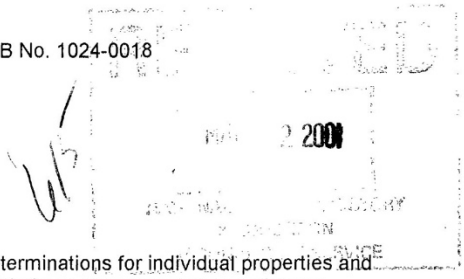
APPENDIX B: NATIONAL REGISTER OF HISTORIC PLACES REGISTRATION FORM FOR HĀNA BELT ROAD

NPS Form 10-900
(Rev. 10-90)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
REGISTRATION FORM



This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in How to Complete the National Register of Historic Places Registration Form (National Register Bulletin 16A). Complete each item by marking "x" in the appropriate box or by entering the information requested. If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions. Place additional entries and narrative items on continuation sheets (NPS Form 10-900a). Use a typewriter, word processor, or computer, to complete all items.

1. Name of Property

historic name Hāna Belt Road
other names/site number Belt Road, Hāna Road, Hāna Highway, Pi'ilani Highway

2. Location
street & number Hāna Highway (State Rte. 360), Pi'ilani Highway (Rte. 31) not for publication __
city or town Makawao District to Hāna District
vicinity Ha'ikū, Ke'anae, Nāhiku, Hāna, Kīpahulu
state Hawai'i code HI county Maui code 009 zip code __

3. State/Federal Agency Certification
As the designated authority under the National Historic Preservation Act of 1986, as amended, I hereby certify that this ____ nomination ____ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ✓ meets ____ does not meet the National Register Criteria. I recommend that this property be considered significant ___ nationally ✓ statewide ___ locally. (___ See continuation sheet for additional comments.)

4-20-01
Signature of certifying official Date

State or Federal agency and bureau

In my opinion, the property ____ meets ____ does not meet the National Register criteria.
(___ See continuation sheet for additional comments.)

Signature of commenting or other official Date

State or Federal agency and bureau

4. National Park Service Certification

I, hereby certify that this property is: Signature of Keeper Date of Action

√ entered in the National Register
See continuation sheet. Signature of Keeper Date of Action 6/15/01

___ determined eligible for the National Register
__ See continuation sheet. _____

___ determined not eligible for the National Register
_____ _____

___ removed from the National Register
_____

____ other (explain): _____
_____ _____
_____ _____
_____ _____
_____ _____

5. Classification
Ownership of Property
(Check as many boxes as apply)

___ private

_x_ public-local

_x_ public-State

___ public-Federal

Category of Property
(Check only one box)

___ building(s)

_x_ district

___ site

___ structure

___ object

Name of related multiple property listing
(Enter "N/A" if property is not part of a multiple property listing.)

N/A _____ _____

Number of Resources within Property

Contributing	Noncontributing	
____	_____	buildings
____	_____	sites
73___	__1__	structures (bridges and culverts)
_____	_____	objects
73___	___1_	Total

Number of contributing resources previously listed in the

National Register N/A_____

6. Function or Use

Historic Functions (Enter categories from instructions)

Cat: Transportation_____Sub: road-related

Current Functions (Enter categories from instructions)

Cat: Transportation_____Sub: road-related_____

7. Description

Architectural Classification
(Enter categories from instructions)

Other: OTHER: roadways; bridges: reinforced concrete, girder, flat slab, masonry (basalt or lava rock)_____

Materials
(Enter categories from instructions)

foundation _____

roof _____

walls _____

_____

other asphalt, concrete, masonry (lava rock)_____

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing)

__X__ A Property is associated with events that have made a significant contribution to the broad patterns of our history.

____ B Property is associated with the lives of persons significant in our past.

__X__ C Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

____ D Property has yielded, or is likely to yield information important in prehistory or history.

Criteria Considerations

(Mark "X" in all the boxes that apply.)

Property is:

____ A owned by a religious institution or used for religious purposes.

____ B removed from its original location.

____ C a birthplace or a grave.

____ D a cemetery.

____ E a reconstructed building, object, or structure.

____ F a commemorative property.

____ G less than 50 years of age or achieved significance within the past 50 years.

Areas of Significance
(Enter categories from instructions)

Engineering _____

Social History _____

Transportation _____

Commerce _____

Period of Significance

circa 1900 to 1947

Significant Dates

circa 1900 to 1947

Significant Person
(Complete if Criterion B is marked above)

Cultural Affiliation

Architect/Builder

County engineers, including Hugh Howell, Paul Low, and A. H. Wong; builders were county employees, prison labor, and private contractors. Private contractors included Wilson and McCandless, Hugh Howell Engineering Company, and Moses Akiona, Ltd. Designers also included William D'Esmond, architect; Joseph Matson, and D. Kapohakimohewa.

9. Major Bibliographical References Bibliography (Cite the books, articles, and other sources used in preparing this form on one or more continuation sheets.)

Previous documentation on file (NPS)

___ preliminary determination of individual listing (36 CFR 67) has been requested

___ previously listed in the National Register

___ previously determined eligible by the National Register

___ designated a National Historic Landmark

___ recorded by Historic American Buildings Survey

_____

___ recorded by Historic American Engineering Record

_____

Primary Location of Additional Data

___ State Historic Preservation Office

_X_ Other State agency

___ Federal agency

___ Local government

___ University

___ Other

Name of repository:

State of Hawai'i Department of Transportation

10. Geographical Data Acreage of Property _ _____

UTM References
(Place additional UTM references on a continuation sheet)

	Zone	Easting	Northing		Zone	Easting	Northing
1	04	787810	2314160	3	04	789510	2312640
2	04	788850	2313440	4	04	789860	2312530

_X_ See continuation sheet.

Verbal Boundary Description
(Describe the boundaries of the property on a continuation sheet.)

The boundaries of the nominated district are delineated by the course of the Hāna Belt Road. The right-of-way is approximately 40' wide and is variable along the entire length of the road. The historic district begins .2 miles west of Mile Marker 3 on the Hāna Highway, State Route 360, near Huelo, and ends on the south end of Koukou'ai Bridge near Kīpahulu on Route 31.

Boundary Justification
(Explain why the boundaries were selected on a continuation sheet.)

The boundaries are coterminus with the Hāna Belt Road's historic right-of-way. The beginning and end points were selected to encompass the portion of the Hāna Belt Road that retains the greatest historic integrity and character. This section of roadway is relatively unaltered and is the most spectacular portion of Maui's historic belt road system, both in its scenery and its historic character. The boundaries include the highest concentration of stylistically consistent historic bridges in the State of Hawai'i.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 10 Geographical Data Page 2

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

UTMs continued:

	zone/easting	northing	
5	04/790890	2311540	points 1-4: Ha'ikū, Hawai'i quad
6	04/791260	2311740	
7	04/791400	2311610	
8	04/792250	2310930	
9	04/793400	2310360	
10	04/793620	2310280	points 5-17: Ke'anae, Hawai'i quad
11	04/794270	2309800	
12	04/794310	2309020	
13	04/795250	2309060	
14	04/796560	2309440	
15	04/796790	2309280	
16	04/797770	2308430	
17	04/797540	2306640	
18	04/797580	2305320	
19	04/797800	2305090	
20	04/798000	2304760	
21	04/798680	2304860	
22	04/798890	2304800	
23	04/799550	2304630	points 18-32: Nāhiku, Hawai'i quad
24	04/799760	2304420	
25	04/799920	2304330	
26	04/800000	2304410	
27	04/800520	2304260	
28	04/800880	2304190	
29	04/801930	2303950	
30	04/802190	23033830	
31	04/		
32	04/	2303830	

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 10 Geographical Data Page 3

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

UTMs continued:

	zone/easting	northing	
33	04/803810	2303440	
34	04/803910	2303270	
35	04/804000	2303160	
36	04/804170	2303130	
37	04/804290	2303000	
38	04/804900	2303020	points 33-47: Hāna, Hawai'i quad
39	04/805350	2303020	
40	04/805650	2302900	
41	04/806060	2302760	
42	04/807160	2302510	
43	04/807630	2302290	
44	04/812440		
45	04/812960	2295650	
46	04/812960	2293760	
47	04/812580	2292900	
48	04/811030	2290640	
49	04/810240	2290700	
50	04/809900	2290260	
51	04/809480	2290260	
52	04/809190	2290300	
53	04/809070	2290210	points 48-60: Kīpahulu, Hawai'i quad
54	04/808730	2289420	
55	04/808500	2289330	
56	04/808210	2289200	
57	04/808000	2289200	
58	04/807770	2288590	
59	04/807680	2288060	
60	04/805910	2286630	

11. Form Prepared By

name/title Dawn E. Duensing, historian
organization Maui County Cultural Resources Commission date 1/13/01
street & number P.O. Box 888 telephone (808)572-6583
city or town Makawao state HI zip code 96768

Additional Documentation. Submit the following items with the completed form:

Continuation Sheets

Maps

A USGS map (7.5 or 15 minute series) indicating the property's location.

A sketch map for historic districts and properties having large acreage or numerous resources.

Photographs

Representative black and white photographs of the property.

Additional items
(Check with the SHPO or FPO for any additional items)

Property Owner(Complete this item at the request of the SHPO or FPO.)

name State of Hawai'i, Department of Transportation
street & number 869 Punchbowl Street telephone (808)587-2150
city or town Honolulu state Hawai'i zip code 96813

name County of Maui, Department of Public Works & Waste Management
street & number 200 S. High Street telephone (808)270-7845
city or town Wailuku state Hawai'i zip code 96793

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

The Hāna Belt Road is coterminous with its historic right-of-way. The Hāna Highway portion of the "belt road" traverses approximately fifty-one miles along Maui's north and east coast from Kahului in central Maui to the remote East Maui community of Hāna. After Hāna, the road continues as the Pi'ilani Highway and circles back around East Maui's south side, a distance of thirty-seven miles. Together, these East Maui roads were part of Maui's "belt" road system around the entire island. The proposed historic district includes approximately forty-two miles of road from .2 miles west of Mile Marker 3 on the Hāna Highway near Huelo to Koukou'ai Bridge on Pi'ilani Highway near the Kīpahulu section of Haleakalā National Park. The narrow road winds around more than 600 curves and over fifty-nine bridges. The Hāna Belt Road is famous for its one-lane bridges with sharp approaches and encompasses the highest concentration of unaltered and stylistically consistent historic bridges in Hawai'i. The Belt Road to Hāna is notable for its breathtaking scenery as it passes waterfalls, v-shaped valleys, and small villages, often hugging the precipitous sea cliffs on Maui's rugged coastline. The roadway width varies from less than 16' wide along the sea cliffs and other rugged terrain to approximately 22' wide through level topography and residential areas. Along most of the roadway, there is no shoulder or a very narrow shoulder. The road's alignment dates to its construction in the 1920s. The Belt Road is the only overland automobile route that connects East Maui communities with the rest of the island. The period of significance is circa 1900 when Mauians began calling for an improved road and a rudimentary wagon road was constructed near Nāhiku, to 1947 when the last bridge was built to service the Hāna Belt Road.

TOPOGRAPHY AND EARLY ROAD

The Hāna Belt Road traverses through some of Hawai'i's most rugged topography and rainiest climate. The island of Maui is comprised of two shield volcanoes joined by an isthmus, which constitutes east and west Maui. East Maui, where the Hāna Belt Road is located, is the immense Haleakalā, a dormant volcano more than 10,000' in elevation. In earlier times, lava flows poured into the ocean to create the jagged coastline along which the road is aligned. Centuries of stream erosion from the wet, tradewind climate on Haleakalā's windward (northeastern) slope cut a rugged terrain of great sea cliffs and v-shaped valleys. The wet climate allowed

dense forests to grow over the rough terrain and helped make the Hāna District in East Maui one of Hawai'i's most isolated and inaccessible areas.

Prior to 1450 A.D., Maui was divided into two separate kingdoms, one with a court at Lahaina, the other with a court in Hāna. The East Maui coastal area was well populated in ancient times, but had little contact with the rest of Maui due to its isolated location. Traditionally, Hawaiians preferred to rely on their highly-developed navigational skills and traveled by canoe. As a result, Hāna was often politically tied to the more accessible communities across the channel on the island of Hawai'i. In the sixteenth century, Maui's King Pi'ilani conquered East Maui and pulled Hāna into his political sphere. Pi'ilani was notable for his public works projects, including the *Alaloa*, or main road, which began in West Maui.[1]

The predecessor trail to the Hāna Belt Road was built by Pi'ilani's son, Kihapi'ilani, in the sixteenth century. The trail was paved with hand-fitted basalt (lava) rocks. The 1848 account of Moses Manu noted, "This road was treacherous and difficult for the stranger, but when it was paved by Kihapi'ilani this road became a fine thing." When completed, the road was 4' to 6' wide, 138 miles long, and encircled the entire island. With the completion of Kihapi'ilani's East Maui trail, known as the King's Highway, Maui became the only island in the Hawaiian chain to have a "belt" road that completely encircled it.[2] In 1828, missionaries noted that the trail was "paved" and extended over thirty miles. They reported that it was a great help in ascending and descending the steep mountains and cliffs in the area. The early trail's switchbacks over the mountains near Honomanū were still visible in the 1940s.[3] Today, intact portions of the King's Highway remain, although most of the road has been obliterated by agriculture or paved over by modern roadways, including the Hāna Belt Road.

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[1] Gail Bartholomew, *Maui Remembers: A Local History*. (Honolulu: Mutual Publishing), 1994, 2.

[2] Bartholomew, *Maui Remembers*, 2; Trust for Public Land and Bay Pacific Consulting, *East Maui Resource Inventory*, Prepared for the Rivers, Trails, and Conservation Assistance Program, National Park Service, U.S. Department of the Interior (Honolulu: 1998), 9.

[3] E. E. Pleasant, "Maui 100 Years Ago: The Old Trail to Hāna." *The Maui News*, June 13, 1942.

THE HĀNA BELT ROAD

The modern history of the Hāna Belt Road began in the 1870s when fifteen miles of unpaved road was built from central Maui into East Maui's rain forest to facilitate the construction of the Hāmākua Ditch, which was completed in 1878. The ditch was an extraordinary nineteenth century engineering marvel built to ensure the economic success of sugar by bringing water from rainy East Maui to central Maui's arid plantations. In 1900, Mauians began considering the necessity of extending a good wagon road through to Hāna, which would be part of the island's "belt" (around-the-island) road system. That year, a rudimentary road was built from Ke'anae to Nāhiku to service the Nāhiku Rubber Company. Construction through this country was difficult due to the terrain and climate. The road was surfaced with cinder, but was not adequate for automobile traffic. In 1905, the Superintendent of Public Works reported that the road in East Maui traversed through very rough country and as a result, was built "as narrow as possible in order to construct, with the money available, the maximum length of road."[4] Overland travel continued by horse and many travelers followed the trails along the irrigation ditches. Steamer remained the preferred mode of transportation for travel along the Hāna Coast.[5]

By the early 1900s, Maui leaders began planning for an improved route to Hāna. Beginning in 1908 and reaching a peak in 1911, numerous concrete bridges were built along the Hāna Coast in anticipation of road improvements.[6] In 1914, the Maui County Board of Supervisors lobbied the Territory of Hawai'i Legislature for funding to extend the road from Kailua to Ke'anae. Territorial Governor Pinkham was adamantly opposed to the Hāna Belt Road and blocked most of its funding. Despite the governor's opposition, money was appropriated and the Wilson and McCandless firm completed a "several-mile" section of road between Ke'anae and Nāhiku in

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[4] Bartholomew, *Maui Remembers*, 161; Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, prepared for the State of Hawai'i, Department of Transportation, Highways Division. Draft. (Honolulu), 1996, IV 12.

[5] "Raymond Adds Ginger To Loan Fund Meeting," *The Maui News*, May 23, 1914.

[6] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 12.

1914. *The Maui News* reported that this "fine piece of road" was of "practically no benefit" since it ended in a forest reserve miles from any habitation. The newspaper noted that one section of road closely traversed along the mountainside a few thousand feet above sea level, with other sections following the Ko'olau Ditch. The road was praised for passing through some of the most spectacular scenery in the islands. Although money had been pledged to carry the road all the way into Ke'anae, Governor Pinkham refused to approve the appropriation and Maui was left with an inaccessible stretch of road.[7]

By 1920, the belt road from central Maui to Kailua was suitable for modern automobile traffic. Parts of the road were paved with macadam to ensure that it was passable during the rainy season. Keeping the road open was essential as it was the primary transportation route into Maui's pineapple country and muddy roads had periodically shut down pineapple operations. Maui County stretched funding as far as it could by using convict labor on the belt road projects.[8] Territorial funding to extend and complete the coastal highway to Hāna, however, continued to be a problem and was not resolved until Wallace Farrington became governor. Major sections of the Hāna Coast remained inaccessible to automobile traffic, namely the region between Kailua and Nāhiku, the area with the most challenging topography. With Governor Farrington's strong backing, the major portion of today's Hāna Highway was constructed in two separate construction projects between 1923 and 1926. The road between Kailua and Ke'anae was built from 1923 to 1925. Immediately thereafter, a road between Wailua and Nāhiku that connected with the route into Hāna was constructed and opened to the public in 1926.

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[7] "Raymond Adds Ginger To Loan Fund Meeting," *The Maui News*, May 23, 1914; "Belt Road Or Nothing Says Board," *The Maui News*, June 20, 1914; "Let's Have The Belt Road Money," *The Maui News*, June 20, 1914; "No Ke'anae Highway Says Governor," *The Maui News*, July 18, 1914; "Road Pau on Nāhiku Part Belt Road," *The Maui News*, November 14, 1914.

[8] "No Money For Belt Road For Two Years," *The Maui News*, May 7, 1920; "Convict Labor to Work on Belt Road," *The Maui News*, September 17, 1920.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 5

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Maui County Engineer Paul Low was credited with supervising "one of the most difficult and at the same time finest pieces of road engineering" on Maui.[9] In January 1923, Low presented his estimates to complete the Hāna road as two projects, the first of which was the roadway extension from Kailua to Ke'anae, a distance of 11.67 miles, which would require the excavation of 273,000 cubic yards of earth. The second phase of the project extended the road from Ke'anae to Wailuaiki near Nāhiku, a distance of 5.67 miles that called for almost 30,000 cubic yards of earth to be excavated. Low used earlier survey work done by engineers of the Maui Loan Fund Commission, which had been created by the Territorial Legislature to oversee special funds for Hawai'i's belt road systems. Low credited engineers Harvey and Howell with designing the original plans. (Hugh Howell also served as Maui County engineer between 1906 and 1914.) In addition to the earlier surveys, Low and a team of county surveyors scouted the route for the Hāna Belt Road, took field notes, and prepared plans and specifications. Low's 1923 estimates included engineering costs, excavation, fill, retaining walls, culverts, bridges, macadam pavement, and tunnels to relocate some ditches. The new road was to be built on a 16'-wide bench, with a pavement width of 12'-0".[10]

The Kailua to Ke'anae section of the belt road took two years to build. Crews worked from both ends of the project and met in May 1925. The road opened to the public on June 11, 1925. The new section of road was described as "serpentine" as it passed through a dozen gulches and wound around "mountain sides that dip into the ocean." Although the distance between the two communities was only four miles as the crow flies, the mileage needed to complete the road around the difficult topography was nearly twelve miles. In order to build the new road, workers were lowered by rope over the steep cliffs and gulches to dig a footing, set their drills, bore holes, and set the powder and fuses that would blast the new roadbed. The most spectacular piece of the road was also considered its most impressive engineering feat. This portion of road traversed down the mountainside (west) to the bottom of Honomanū Gulch,

[9] "Steam Shovels Meet Next Week," *The Maui News*, July 31, 1926.

[10] "Itemized Costs Proposed Belt Road Presented," *The Maui News*, January 19, 1923; "Estimate Made Belt Road Cost By Way Kailua," *The Maui News*, January 13, 1923; "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926.

where it crossed a bridge and proceeded up the other mountainside (east side of the gulch) to a peak on the Ke'anae side. Motorists had impressive views from both sides of the gulch, including a view of the road on the other side. Governor Farrington described the scene as a "gorgeous spectacle [with] the blue sea in many places hundreds of feet below you, the white surf beating against the shore line and these wonderful green hills, the many gulches and every playing light, shade and color on the sides of beautiful and majestic Haleakalā." *The Maui News* noted that the road was still rough in many places, unsurfaced, and in need of widening so that cars could pass each other at any point. The article pointed out the road opened up "marvelously beautiful scenery" that most Maui residents had never seen. As a piece of engineering, the editor claimed that there was nothing in the Territory of Hawai'i or perhaps the world quite like the new road to Ke'anae. A Los Angeles-based writer admired the landscape features, including bamboo thickets, mountain apple, and native kukui trees.[11]

Work began immediately on the final link of the Hāna Belt Road project. In 1925, Maui's road program received a substantial boost when President Calvin Coolidge approved a bond issue for the Territory of Hawai'i that included $150,000 to continue construction of the Hāna Belt Road. County Engineer Low reported that finishing work was being done on the newly completed section to Ke'anae, including top-dressing the road, finishing culverts, and improving bridge approaches. Stone masons were building wing walls on the bridges and retaining walls in the valleys. Crews with forty men each had started to build the last link of the road from both the Hāna and Ke'anae sides, which was a length of 3.5 miles. This section was benched at 16'-0" wide, although plans called for the road to eventually be widened to 20'-0" after it had settled. Several bridges near Wailua were also built during this phase, including the Waikani Bridge and the bridge at West Wailuanui. Construction of the last link of road was difficult as

[11] "First Car Runs Over Belt Road Kailua-Ke'anae," *The Maui News*, May 23, 1925; "Dream Of Thirty Years Ago About To Be Realized," *The Maui News*, June 6, 1925; "Hundreds Motor to Ke'anae: Maui Turns Out To See Opening Of Scenic Road," *The Maui News*, June 13, 1925; "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Maui's New Road," editorial, *The Maui News*, June 17, 1925; "Wonder And Charm Of Maui Scenery To Be Pictured And Told Hundreds Of Thousands Readers On Mainland," *The Maui News*, August 15, 1925.

much of the work consisted of blasting the solid rock in the area. Shovels on both sides of the project failed due to the stresses of working on solid rock cuts and the necessity of removing hundreds of tons of rock along the right-of-way. At times, the steam shovels could not do the work without considerable blasting and hand work. Heavy rains disrupted the project as well, causing floods and undermining embankments. In November 1926, a flood in the Wailuanui Valley caused a landslide over the road, washed out the scaffolding on the Waikani Bridge, and carried away 600 bags of cement to be used on the bridge.[12]

The Hāna Belt Road was opened to the public on December 18, 1926. *Honiron*, a publication of Honolulu Iron Works, described the road as "spectacularly chiseled out of abrupt cliffs and precipitous valleys." It noted that miles of the roadway were nothing more than a 16'-wide shelf cut into the mountainside, with towering masses of rock above and sheer drops measuring hundreds of feet to the ocean below. When asked how the scenery of the new section of road compared to the Kailua-Ke'anae section, Low commented that there was no comparison. He admired the section of road above the Wailua Valley that traveled along a narrow ledge for about a mile and provided a lovely panorama of *taro* patches and rice fields in the quaint village of Wailua below. *The Maui News* noted that the newly completed Hāna Belt Road was the "great road making achievement in the Islands, fraught with tremendous difficulties in engineering and construction work" and completed by "dare-devil exploits." The paper claimed the road was the most scenic driveway in the world, with vistas of lofty mountains, the Pacific Ocean, wild canyons, cataracts, waterfalls, and luxurious tropical vegetation. Signs marked "bad turn" and "go slow" were installed to mark dangerous curves and other points in the road. The average speed for driving the Hāna Belt Road was 20 m.p.h. Although Low's

[12] "Coolidge Approves Proposed $2,590,000 Hawai'i Bond Issue," *The Maui News*, August 22, 1925; "Kailua-Kōpili'ula Road Work Making Headway, Says Low," *The Maui News*, March 13, 1926; "Workers Blast Tons Of Rock On Belt Road," *The Maui News*, May 15, 1926; "Builders Progress In Construction Of Belt Road Project," *The Maui News*, April 17, 1926; "Flood Threatens Belt Road Bridge," *The Maui News*, November 17, 1926.

Narrative Description (continued)

1923 estimates to complete the road to Hāna included pavement, the road was not paved when it was opened in 1926.[13]

Approximately six miles west of Hāna, near Upper Nāhiku, the Hāna Belt Road enters a coastal plain, which permits the alignment to run in a relatively straight path. The road passes over some minor gulches via a number of culverts and several bridges. Approximately four miles south of Hāna, the coastal plain ends and the road again passes through East Maui's challenging terrain. South of Ala'ala'ula Bridge, the road traverses through a series of rugged gulches similar to those near Ke'anae. South of Waikakoi Bridge, the road is benched into the high cliffs, around steep mountains and into the deep valley of Wailua Cove, before climbing back out of the valley. This portion of road is similar to the road near Honomanū Gulch near Ke'anae. Near Kīpahulu, the Hāna Belt Road passes through the scenic 'Ohe'o Gulch and Koukou'ai Gulch, which were spanned by concrete arch bridges in 1916 and 1911 respectively. It is uncertain when the belt road between Hāna and Kīpahulu was built, although it was being used for automobile traffic by the time the belt road was completed between Kailua and Hāna in 1926.[14]

BRIDGES and CULVERTS

The Hāna Belt Road includes fifty-nine bridges and numerous culverts constructed between 1908 and 1947. Sixteen of these bridges are located on the Hāna Belt Road south of Hāna (Pi'ilani Highway, Route 31) and forty-three on the Hāna Belt Road between Hāna and Huelo

[13] "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Honiron Tells Of Maui Road To Hāna," *The Maui News*, March 5, 1927; "Linking Up Maui," *The Maui News*, editorial, December 18, 1926; "Celebration Typical Of Maui," editorial, *The Maui News*, December 22, 1926.

[14] "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Maui Belt Road Circled," *The Maui News*, January 15, 1927.

Narrative Description (continued)

(Hāna Highway, Route 360). The narrowest bridges are approximately 12'-6" wide and the widest bridge is approximately 20'-6". More than half of the bridges are single span.

The majority of bridges in the district were constructed of reinforced cast-in-place concrete. County and territorial engineers utilized structural systems typical for the early twentieth century, including concrete arch, flat slab, girder, and simple tee-beam spans. Eighty percent of the concrete bridges were constructed between 1908 and 1929. Two unique bridges in the proposed historic district are rare surviving examples of masonry arch construction with basalt (lava rock). Many of the bridges have wingwalls, abutments, and piers constructed of concrete rubble masonry with basalt.

The majority of bridges featured two styles of parapet construction. Twenty-four bridges built between 1908 and 1915 had a solid-paneled, reinforced-concrete parapet with a peaked concrete rail cap. From 1916 to 1929, thirty-one bridges were built with a reinforced-concrete parapet of simple vertical concrete balusters and a square concrete rail cap.[15] The Pu'uhaoa Bridge, built in 1910, and the Waiokamilo Bridge, built in 1921, featured a more ornate open-rail parapet. Two bridges constructed in 1947, Kawaipapa and Wailua, are unique along the corridor, with concrete post-and-beam railings. Some of the bridges have construction dates inscribed on the parapets.

Masonry Arch Bridges

Two masonry arch bridges are located on the Hāna Belt Road south of Hāna, the Hāhālawe Bridge and Wai'ele Bridge. Constructed in 1910, both bridges utilized cut basalt blocks to build the abutments and arch rings. The bridges feature solid reinforced-concrete parapets with rail caps. "A.D. 1910" is inscribed on the outer parapet of each bridge. The bridge walls and rock abutments may date to different construction periods, with the concrete parapets being from a later date. The bridges retain their historic integrity, and feature fine craftsmanship and uncommon materials.[16]

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[15] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191.
[16] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192.

Narrative Description (continued)

Concrete Arch Bridges

After 1904, concrete arch bridges were built in Hawai'i, often using standardized plans. Two types of concrete arch bridges were constructed in Hawai'i, solid and open spandrel. The solid-spandrel bridges were generally arch-deck bridges in which the traffic deck rested upon the arch. Between 1916 and 1926, several bridges of this type were built on Maui, including three bridges built along the Hāna Coast: 'Ohe'o Bridge, Hanawī Bridge, and Kūhiwa Bridge. The 'Ohe'o Bridge spans the scenic 'Ohe'o Gulch in Haleakalā National Park.

The open-spandrel concrete arch bridges demonstrated sophisticated engineering for their day and marked the evolution of concrete technology toward lighter, yet larger structures. Koukou'ai Bridge was the first open-spandrel arch bridge on Maui and is an excellent example of early twentieth century bridge construction in the Hawaiian Islands. Built in 1911, it spans a deep gorge just south of Haleakalā National Park. The other open-spandrel concrete arch bridge on the Hāna Coast is the Waikani Bridge, built in 1926 by the Akiona Contracting Company and designed by local architect William D'Esmond. The bridge dramatically crosses a deep gorge at the end of a long valley and is perhaps the most aesthetically pleasing bridge along the Hāna Belt Road.[17]

Concrete Deck Girder and Flat Slab Bridges

Concrete deck girder, including tee-beam spans and simple deck girder, were the most common types of bridge built along the Hāna Belt Road. Territorial and county engineers realized that these structures were both economical and strong over short spans. As a result, the government began using concrete deck bridges rather than arch or timber bridges after 1911. The majority of these bridges were built between 1911 and 1928. The 1912 Waikamoi Bridge is one of the earliest remaining examples of a concrete slab bridge in Hawai'i. Concrete slab bridges were cast on site using formwork built by local carpenters. The earlier bridges featured a solid-

[17] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192-194.

paneled reinforced-concrete parapet, with the later bridges utilizing simple vertical concrete balusters and a square concrete rail cap.[18] Three bridges date to the 1930s and two were built in 1947. The bridges constructed in 1947 utilized a post-and-beam design that is unique in the Hāna Belt Road corridor.

Culverts

Honolulu Iron Work's publication *Honiron* reported that numerous culverts along the Hāna Belt Road were necessary due to the to the demanding topography. During the 1920s, Calco Corrugated Culverts manufactured from Armco Ingot Iron were used in road construction.[19] Today, there are also culverts constructed of basalt, which are visible from the road. Many of the culverts are topped by lava rock walls on the road. Numerous culverts are not visible from the road and are covered by dense vegetation, which makes it difficult to establish an accurate count of culverts, both contributing and non contributing, along the Hāna Belt Road.

Many culverts along the Hāna Belt Road were built using concrete abutments, concrete slabs, and small concrete parapets. Example of this type of structure include: Culvert #1 between Nā'ili'ilihā'ele Bridge and 'O'opuola Bridge; Culverts #2, #3, and #4 near Ke'anae between Palauhulu Bridge and Waiokamilo Bridge; Culverts #9 and #10 located in the town of Hāna, south of Kawaipapa Bridge near the Hāna Fire Station; and Kalena Culvert north of Koukou'ai Bridge.

Four distinctive culverts (Culverts #5, #6, #7, and #8) constructed of concrete abutments, concrete slabs, and open parapets with simple vertical concrete balusters and concrete rail caps are located west of Hāna and east of Honomā'ele Bridge. These structures vary in span length from 5'-5" to 14'-7". Another distinctive culvert is located adjacent to (east of) Waiokamilo Bridge and spans the Hāna Highway at the "Y" intersection with Wailua Road. Its parapets were built to match those of the Waiokamilo Bridge. Two culverts with concrete abutments,

[18] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 195-198.

[19] "Honiron Tells Of Maui Road To Hāna," *The Maui News*, March 5, 1927.

concrete slabs, and solid parapets are Mo'omonui Culvert and Maluhiana'iwi Culvert. The construction dates are inscribed on each of these culverts.

To most observers, many of these culverts would be regarded as bridges, even though they are considered to be culverts by the State Department of Transportation. The State of Hawai'i Department of Transportation (DOT) considers a culvert to have a span of less than 10'-0" in accordance with Federal Highway Administration guidelines. Some of these structures measured longer than 10'.

VISTAS and VIEWS

There is hardly a place along the Hāna Belt Road where motorists are not rewarded with a variety of scenic views, including the ocean, mountains, sea cliffs, waterfalls, small villages, native and exotic vegetation, and traditional landscapes.

Although it is sometimes difficult to find pullouts along the narrow road, viewpoints are scattered throughout the Hāna Belt Road corridor. At most of the bridges, motorists can park on either side to view waterfalls and valleys. The most impressive waterfalls are located at the Waikani Bridge, 'Ohe'o Bridge, and Wailua Bridge. The Kīpahulu District of Haleakalā National Park includes the picturesque 'Ohe'o Gulch; its pools are a popular swimming spot. Elements of the East Maui Irrigation Company ditchworks can be seen at numerous bridges along the road, including the Kōpili'ula Bridge. Just after the Kōpili'ula Bridge, the Hāna Belt Road runs parallel to the irrigation ditch for a short distance. Scenic views are provided at Kaumahina State Wayside near Ke'anae and Wailua Valley Lookout Park above the village of Wailua. Pua'a Ka'a State Park is directly adjacent to the road near Nāhiku. Traditional cultural landscapes of taro patches are viewed in the villages of Ke'anae and Wailua. Native vegetation along the Hāna Belt Road includes hapu'u fern, ko'a, kukui, and pandanus forests. Most of the vegetation along the road, however, is exotic, with species such as bamboo and ginger impacting the landscape. On the coastal plain near the town of Hāna are large ranching areas that were formerly used for sugar cane cultivation.

Narrative Description (continued)

ALTERATIONS

Maintaining the Hāna Belt Road over the years has been no easy task. Since the earliest days, highway crews have struggled to keep up with damage caused by landslides, rocks, vegetation, downed trees, and floods. A journalist driving the road in 1940 referred to it as a "paved trail following the line of the ditch through the wild jungle."[20] The road was not completely paved until 1962. Over the years, lava-rock retaining walls and guardwalls were constructed in various locations along the road. These walls complement the historic character of the Hāna Belt Road.

In 1969, the State of Hawai'i transferred jurisdiction over the portion of the Hāna Belt Road between Hāna and Kīpahulu, which is now known as the Pi'ilani Highway, to the County of Maui. The Hāna Belt Road between Huelo and Hāna remained under the jurisdiction of the State of Hawai'i. The manner in which the road is maintained and preserved is significantly different between the two government agencies.

Although the state's portion of the Hāna Belt Road (Hāna Highway) between Huelo and Hāna retains its historic character and integrity, there have been alterations along the roadway. The most noticeable change to the state section of the Hāna Belt Road is the addition of w-beam and thrie-beam steel guardrails. It is unknown when the first guardrails were installed along the Hāna Belt Road. Concrete posts from earlier guardrails are still present along the roadside in some areas. Another change over the years has been road widening. There are still many segments of the road that are close to the original 16' width (especially on the cliffs near Ke'anae) and too narrow for cars to pass each other without yielding. The road, however, has been widened in most areas. In a few places where there is a more level topography, as through villages and near the beginning of the road near Huelo, the pavement is up to 22'-0" wide. In several locations, the Department of Transportation has used the new layers of asphalt during

[20] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 14.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 14

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

repaving projects to super-elevate curves, particularly in the area east of Wailua. On many bridges, added layers of asphalt have significantly shortened the height of the bridge parapets and asphalt often fills part of the openings between bridge railings. Other changes along the road include painting some bridges and lava rock walls white to increase nighttime visibility, installation of numerous cautionary signs ("one-lane bridge," "narrow road"), reflector signs, and reflectors in the pavement. There have been a few jersey barriers added to the road, usually in places where the roadbed is being undermined alongside a steep cliff.

In the mid 1990s, the road west of Ke'anae that traverses the steep mountainside on the east side of Honomanū Gulch was widened. Work included blasting and removing a large section of the mountain near the road's summit to relocate the damaged road (which was collapsing into the ocean) away from the cliff. A rock wall which does not match the character of the typical basalt parapets seen along the Hāna Belt Road was built between the mountain and the road to catch falling rocks. Concrete gutters were installed and wide shoulders were added. The state Department of Transportation has installed concrete gutters and new culverts in other locations along the road, especially in the area between Wailua and Nāhiku.

The bridges along the Hāna Belt Road retain their historic character. One notable exception is Kawaipapa Bridge. Constructed in 1947, the bridge was altered in 1991 when a new bridge was added to the to the west end of the original structure. The 1991 bridge expansion was modeled on the original bridge, with replications of the post-and-beam bridge walls. The consequence of the expanded bridge was that the original bridge lost its historic integrity and is a non-contributing structure.

The County of Maui section of the Hāna Belt Road, now called the Pi'ilani Highway, has been subjected to fewer changes than the state-maintained portion of the belt road. The county has widened the road in a few locations, but for the most part, the pavement is no widr than 18'-0" and often averages 15' to 16' wide. Some guardrails have been added, but not to the same extent as the state-maintained section of the Hāna Belt Road.

Narrative Description (continued)

Although the Hāna Belt Road has been improved over the years, many of the bridges along the road have suffered from a lack of maintenance. Many of the bridge walls originally averaged 34" high. The walls are now shorter due to repeated layers of asphalt. In many cases, the additional asphalt is approximately 12" deep. The majority of the bridges in the Hāna corridor have weeds and vegetation growing in the concrete joints. A few bridge walls have been damaged by accidents. Many of the damaged walls were repaired to match the original design, although in a few cases, damage was not repaired neatly or was repaired with a non-matching element. An example of repaired bridge wall is the Waikani Bridge balustrades, which were severely damaged on the west end. Rather than restoring the end of the bridge wall, the repair consisted of building a rock wall in place of the balustrades. Another example of a bridge alteration that does not match the original structure is Nua'ailua Bridge. Altered in 1940, the *mauka* (mountain side) parapet was replaced with a non-matching concrete wall, most likely as a result of road widening.

The Hāna Belt Road retains its historic character and integrity. For the most part, the road is relatively unaltered. The road's alignment has not been changed since it was completed in 1926, although sections of the road on sea cliffs have collapsed into the ocean and necessitated reconstruction. The road retains its historic character and integrity in its rural location and narrow lanes. The bridges retain historic integrity with sharp and narrow approaches, original materials, and original design. Although a majority of the bridges are quite simple in appearance, several bridges are more elaborate and were designed and built by masters. The bridge designs and materials survive intact, with a few minor exceptions.

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

Inventory of Contributing Bridges & Significant Culverts

Listed in geographical order east from Huelo:

Hōlua Bridge: constructed 1929; concrete tee-beam; one span, 48'-0"; total length 49'-0"; bridge width 16'-7"; approximate height above stream 28'-0".

Kailua Bridge: constructed 1929; concrete tee-beam; one span, 39'-0"; total length 40'-0"; bridge width 20'-6"; approximate height above stream 18'-0".

Nā'ili'ilihā'ele Bridge: constructed 1930; concrete tee-beam; three spans, 21'-6"; total length 64'-0"; bridge width 20'-3"; approximate height above stream 20'-6". Designer: County Engineer Office.

Culvert #1: concrete, one span, approximate length 9'-0".

'O'opuola Bridge: constructed 1925, altered 1931; concrete tee-beam; one span, 29'-0"; total length 30'-0"; bridge width 19'-8"; approximate height above stream 18'-6". Designer: County Engineer Office.

Makanali Bridge: constructed 1928; concrete slab; one span, 18'-0"; total length 18'-0"; bridge width 16'-6". Designer/builder: Department of Public Works.

Ka'aiea Bridge: constructed 1928; concrete tee-beam; one span, 20'-0"; total length 22'-0"; bridge width 16'-6"; approximate height above stream 15'-0". Designer/Builder: Department of Public Works.

Waikamoi Bridge: constructed 1912; concrete slab; two spans, 19'-0"; total length 41'-0"; bridge width 12'-9"; approximate height above stream 17'-0". Designer/Builder: Hugh Howell, Senior Engineer.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 17

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Puohokamoa Bridge: constructed 1912; concrete tee-beam; two spans, 25'-0"; total length 56'-4"; bridge width 15'-3", approximate height above stream 13'-0".

Haipua'ena Bridge: constructed 1912; concrete slab; two spans, 16'-0"; total length 34'-6"; bridge width 12'-9"; approximate height above stream 11'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Kōlea (Punala) Bridge: constructed 1911; concrete tee-beam; one span, 30'-0"; total length 34'-0"; bridge width 12'-8"; approximate height above stream 13'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Honomanū Bridge: constructed 1911; concrete tee-beam; two spans, 23'-0"; total length 48'-0"; bridge width 12'-8"; approximate height above stream 15'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Nua'ailua Bridge: constructed 1911/altered 1940; concrete tee-beam; one span, 22'-0"; total length 35'-0"; bridge width 24'-0"; approximate height above stream 13'-0". Designer/Builder: Joseph Matson, Senior Engineer.

Pi'ina'au Bridge: constructed 1916; concrete tee-beam; one span, 27'-0"; total length 28'-5"; bridge width 19'-0"; approximate height above stream 19'-0".

Palauhulu Bridge: constructed 1916; concrete tee-beam; one span, 30'-0"; total length 31'-0"; bridge width 19'-10"; approximate height above stream 20'-6".

Culvert #2: concrete, one span, approximate length 10'-0".

Culvert #3: concrete, one span, approximate length 15'-0".

Culvert #4: concrete, one span, approximate length 13'-0".

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 18

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Waiokamilo Bridge: constructed 1921, altered 1937; concrete tee-beam; one span, 20'-0"; total length 24'-0"; bridge width 22'-1"; approximate height above stream 11'-0". Designer: D. K. Kapohakimohewa.

Waiokamilo Culvert: concrete, one span, approximate length 10'-3".

Waikani Bridge: constructed 1926; concrete arch, open spandrel; one span, 82'-6"; total length 108'-0"; bridge width 17'-7"; approximate height above stream 32'-0". Designer: William D'Esmond. Builder: Moses Akiona.

West Wailuaiki Bridge: constructed 1926, altered 1937; concrete tee-beam; three spans, 24'-6"; total length 62'-6"; bridge width 19'-7"; approximate height above stream 15'-0". Designer: A. H. Wong.

East Wailuaiki Bridge: constructed 1926; concrete tee-beam; one span, 31'-0"; total length 34'-5"; bridge width 18'-4"; approximate height above stream 16'-0". Designer/builder: A. P. Low, County Engineer.

Kōpili'ula Bridge: constructed 1926; concrete tee-beam; two spans, 34'-2"; total length 76'-7"; bridge width 14'-4"; approximate height above stream 6'-0".

Pua'aka'a (Waiohue) Bridge: constructed 1926; concrete tee-beam; one span, 19'-6"; total length 20'-2"; bridge width 22'-0"; approximate height above stream 7'-8".

Waiohue Bridge: constructed 1926, altered 1937; concrete tee-beam; two spans, 16'-7"; total length 40'-0"; bridge width 13'-2"; approximate height above stream 10'-0".

Waiohuolua Bridge: constructed 1920, altered 1970; concrete tee-beam; one span, 15'-0"; total length 19'-0"; bridge width 12'-9"; approximate height above stream 8'-0". One bridge wall was replaced by w-beam guardrail; the original bridge wall is in the stream below.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 19

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Bridge #2: constructed 1920; concrete tee-beam; one span, 16'-7"; total length 20'-0"; bridge width 12'-6"; approximate height above stream 8'-0".

Pa'akea Bridge: constructed 1920, altered 1937; concrete tee-beam; two spans, 16'-0"; total length 40'-0"; bridge width 12'-9"; approximate height above stream 8'-0".

Kapā'ula Bridge: constructed 1926; concrete tee-beam; two spans, 21'-0"; total length 49'-0"; bridge width 16'-0"; approximate height above stream 51'-0".

Hanawī Bridge: constructed 1926; concrete arch, solid spandrel; one span, 36'-0"; total length 61'-0"; bridge width 20'-4"; approximate height above stream 19'-0".

East Hanawī Bridge: constructed 1926; concrete tee-beam; one span, 18'-5"; total length 22'-10"; bridge width 15'-11"; approximate height above stream 15'-0".

East Hanawī Culvert: concrete, one span, approximate length 11'-8".

Makapipi Bridge: constructed 1926; concrete tee-beam; two spans, 22'-5"; total length 39'-10"; bridge width 16'-0"; approximate height above stream 12'-0".

Kūhiwa Bridge: constructed 1926; concrete arch, solid spandrel; one span, 36'-6"; total length 60'-0"; bridge width 16'-4"; approximate height above stream 35'-0". Builder: County Engineer's Office.

Kupukoi Bridge: constructed 1926; concrete tee-beam; one span, 21'-5"; total length 24'-7"; bridge width 16'-0"; approximate height above stream 15'-0".

Kahalaowaka Bridge: constructed 1926; concrete tee-beam; one span, 22'-4"; total length 24'-5"; bridge width 15'-0"; approximate height above stream 9'-0".

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 20

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Pupape-Manawaikeae Bridge: constructed 1926; concrete tee-beam; one span, 20'-8"; total length 24'-4"; bridge width 16'-2"; approximate height above stream 16'-0".

Kahawaihapapa Bridge: constructed 1922; concrete tee-beam; three spans, 17'-0"; total length 60'-0"; bridge width 16'-0"; approximate height above stream 15'-0". Builder: County Engineer's Office.

Kea'ā'iki Bridge: constructed 1921; concrete tee-beam; one span, 20'-10"; total length 22'-10"; bridge width 16'-1"; approximate height above stream 27'-0". Builder: County Engineer's Office.

West Waioni Bridge: constructed 1920; concrete tee-beam; one span, 24'-5"; total length 29'-5"; bridge width 16'-6"; approximate height above stream 15'-0".

Waioni Bridge: constructed 1920; concrete tee-beam; one span, 20'-7"; total length 24'-5"; bridge width 15'-11"; approximate height above stream 10'-0".

Lanikele Bridge: constructed 1917; concrete tee-beam; two spans, 22'-4"; total length 51'-6"; bridge width 16'-0"; approximate height above stream 13'-0".

Helele'ike'ōhā Bridge: constructed 1917; concrete tee-beam; one span, 23'-7"; total length 28'-6"; bridge width 16'-1"; approximate height above stream 12'-0".

'Ula'ino Bridge: constructed 1914; concrete tee-beam; two spans, 18'-10"; total length 39'-7"; bridge width 16'-0"; approximate height above stream 12'-0".

Mokulehua Bridge: constructed 1908; concrete tee-beam; three spans, 14'-0"; total length 48'-7"; bridge width 13'-11"; approximate height above stream 21'-0".

Oilowai Bridge: constructed 1914; concrete tee-beam; one span, 20'-7"; total length 22'-10"; bridge width 16'-2"; approximate height above stream 22'-0". Builders: Wilson & McCandless.

Narrative Description (continued)

Honomā'ele Bridge: constructed 1924; concrete tee-beam; two spans, 20'-4"; total length 38'-10"; bridge width 16'-1"; approximate height above stream 14'-0". Builders: County Engineer's Office.

Culvert #5: concrete, one span, approximate length 17'-6".

Culvert #6: concrete, one span, approximate length 12'-0".

Culvert #7: concrete, one span, approximate length 5'5".

Culvert #8: concrete, one span, approximate length 13'-0".

Culvert #9: concrete, one span, approximate length 14'-7".

Culvert #10: concrete, one span, approximate length 14'-0".

Mo'omonui Culvert: constructed 1911, concrete, one span approximate length 8'-3".

Haneo'o (Kaholopo) Bridge: constructed 1900, altered 1917; concrete slab; two spans, 10'-0"; total length 22'-6"; bridge width 15'-1".

Kapi'a (Kahawaiokapia) Bridge: constructed 1915, altered 1931; concrete slab; three spans, 17'-6"; total length 58'-4"; bridge width 14'-4"; approximate height above stream 17'-0". Designer/Builder: Wilson and McCandless.

Waiohonu Bridge: constructed 1915; concrete tee-beam; five spans, 18'-6"; total length 97'-6"; bridge width 15'-0"; approximate height above stream 14'-0". Designer/Builder: Wilson and McCandless.

Narrative Description (continued)

Papa'ahawahawa Bridge: constructed 1913; concrete tee-beam and concrete slab; two spans, 22'-0"; total length 40'-4"; bridge width 14'-5"; approximate height above stream 9'-0". Designer/Builder: County Engineer's Office.

Ala'ala'ula Bridge: constructed 1915; concrete slab; one span, 30'-0"; total length 54'-0"; bridge width 12'-6"; approximate height above stream 22'-0".

Waikakoi Bridge: constructed 1911; concrete slab; two spans, 14'-0"; total length 33'-6"; bridge width 15'-4"; approximate height above stream 18'-0".

Pa'ihi Bridge: constructed 1911; concrete slab; one span, 36'-6"; total length 42'-4"; bridge width 13'-9"; approximate height above stream 10'-0".

Wailua Bridge: constructed 1947; concrete tee-beam; one span, 60'-0"; total length 66'-1"; bridge width 14'-0"; approximate height above stream 17'-0".

South Wailua (Honolewa) Bridge: constructed 1911; concrete slab; two spans, 25'-0"; total length 57'-0"; bridge width 15'-2"; approximate height above stream 26'-0".

Pu'uhoao Bridge: constructed 1910; concrete tee-beam; one span, 20'-0"; total length 23'-2"; bridge width 12'-9"; approximate height above stream 13'-0".

Waiele (Paehala) Bridge: constructed 1910; masonry arch; one span, 20'-0"; total length 25'-0"; bridge width 12'-6"; approximate height above stream 7'-0".

Kakiweka (Mahalawa) Bridge: constructed 1910; concrete slab; one span, 28'-6"; total length 30'-10"; bridge width 13'-10"; approximate height above stream 16'-0".

Hāhālawe Bridge: constructed 1910; masonry arch; one span, 22'-0"; total length 25'-0"; bridge width 14'-9"; approximate height above stream 10'-0".

Narrative Description (continued)

Maluhiana'iwi Culvert: constructed 1910; concrete, one span, approximately 13'-9".

Pua'alu'u Bridge: constructed 1910; concrete slab; two spans, 15'-0"; total length 32'-10"; bridge width 14'-5"; approximate height above stream 10'-0".

'Ohe'o Bridge: constructed 1916; concrete arch, solid spandrel; one span, 58'-0"; total length 77'-0"; bridge width 14'-5"; approximate height above stream 44'-0".

Kalena Culvert: concrete, one span, approximate length 13'-5".

Koukou'ai (Kaukau'ai) Bridge: constructed 1911; concrete arch, open spandrel; one span, 31'-10"; total length 58'-0"; bridge width 15'-2"; approximate height above stream 34'-0".[21]

[21] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, prepared for the State of Hawai'i, Department of Transportation, Highways Division. Draft. (Honolulu), 1996, VI 196-198. All bridge widths and culvert span lengths were measured by Dawn Duensing as part of field work in December 2000.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 8 Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Statement of Significance
(Explain the significance of the property on one or more continuation sheets.)

The Hāna Belt Road achieves state and local significance in the areas of engineering, transportation, commerce, and social history under criteria A and C. The construction of bridges and a road to Hāna between 1900 and 1947 was a major engineering achievement, as the County of Maui and private contractors benched a road into precipitous mountainsides and through the wilderness of East Maui. Fifty-nine of the bridges built between 1908 and 1947 remain along the route as an example of bridge engineering and construction in Hawai'i during the early twentieth century. The completion of an automobile route to Hāna in 1926 ended that community's isolation from the rest of Maui. The road opened East Maui to settlement, agricultural enterprises, and tourism. The Hāna Belt Road is the best remaining intact example of the old belt road system in Hawai'i. The Hāna Belt Road retains historic integrity in its original road alignment, narrow lanes, bridges, and spectacular setting along Maui's northeast coast.

Engineering

A 1905 Superintendent of Public Works report noted that road construction in the Hāna District was through "very rough country."[22] The plan for a belt road around East Maui was popular with Maui officials and businessmen, but took decades to complete due to high costs and construction difficulties. Building the Hāna Belt Road was an expensive and difficult proposition due to the challenging topography. Miles of road were blasted out of the mountainsides and numerous bridges were required to carry the road across streams and gulches. Construction was complicated by heavy vegetation, torrential rains, and landslides.

The majority of bridges in the Hāna District were built using construction methods and materials typical in Hawai'i during the early twentieth century. Most of the Hāna District bridges (eighty percent) were constructed prior to 1930. County and territorial engineers utilized common structural systems, including concrete arch, flat slab, girder, and simple tee-beam spans. The majority of bridges along the Hāna Belt Road were simple but functional, constructed with tee-beam spans and simple deck girders. The 1912 Waikamoi Bridge is one of

[22] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 12.

Narrative Statement of Significance (continued)

the earliest remaining examples of a concrete slab bridge in Hawai'i. Reinforced concrete was the most prevalent construction material due to the corrosive nature of the Pacific Ocean's salt air and the presence of wood-boring insects that made the use of steel and timber bridges less practical in Hawai'i than in the mainland United States. The Loan Fund Commission, established in 1911 to oversee belt road projects, decided that concrete would be used on Hawai'i's bridges rather than steel. The Commission observed that the concrete was more expensive in the beginning, but realized that the increased cost was justified due to concrete's durability as well as lower maintenance and repair costs. The use of reinforced concrete was an indication of the commitment of the Territory of Hawai'i and Maui County governments to building permanent public works improvements.[23]

Five concrete arch bridges on the Hāna Belt Road remain as excellent examples of early twentieth century bridge construction in the Hawaiian Islands. These bridges used the most modern engineering technology of their day. Today, the bridges make a significant statement regarding Maui's civic pride during the early twentieth century. The open-spandrel concrete arch bridges demonstrated sophisticated engineering and marked the evolution of concrete technology toward lighter yet larger structures. These bridges were constructed for their strength and permanence, although only a few remain in Hawai'i. Koukou'ai Bridge near Kīpahulu was the first open-spandrel arch bridge on Maui and one of the earliest to be built in Hawai'i. The 'Ohe'o Bridge, a solid spandrel concrete arch, spans the scenic 'Ohe'o Gulch in Haleakalā National Park and was declared eligible for the National Register of Historic Places in 1977 as part of the Kīpahulu Historic District (50-17-299). The open-spandrel Waikani Bridge was designed by Maui architect William D'Esmond and built by a well-known contractor, Moses Akiona.[24] D'Esmond designed Maui's County Office Building, built in 1927;

[23] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191, 195; V 10-12.

[24] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192-194.

Pā'ia School, 1926; St. Anthony's School, 1925; and numerous residences on Maui.[25]

Two unique bridges on the Hāna Belt Road are rare surviving examples of masonry arch construction with basalt, Hāhālawe Bridge and Wai'ele Bridge. Fewer than ten masonry arch bridges remain in the state of Hawai'i. Constructed in 1910, both bridges utilized cut basalt blocks for the abutments and arch rings. Basalt arch construction was common in Hawai'i prior to 1898. The bridge walls and rock abutments may date to different construction periods, with the concrete parapets being from a later date. The bridges retain their historic integrity, with each featuring fine craftsmanship and uncommon materials.[26]

The bridges along the Hāna Belt Road present a visual record and timeline of bridge construction technology and innovation on Maui and in Hawai'i. Many bridges are unique due to the use of vernacular materials (basalt). In addition to the masonry arch bridges, a number of bridges used basalt for the construction of abutments, piers and wingwalls. The majority of bridges, however, were built with the latest in construction technology, reinforced concrete. The bridges were built during a period when formal engineering expertise in bridge building was first introduced in Hawai'i and are good examples of the Territory of Hawai'i's progressive highway system. Each county in the territory had a County Engineer's Office, within which was a bridge design office. Many of the bridges on the Belt Road were designed by the County Engineer's Office and the engineers proved themselves to be not only technologically skilled, but also sensitive to aesthetics. In many cases, the bridges also demonstrate the work of skilled builders. The masonry arch and concrete arch bridges show a high degree of detailing and workmanship. Together, the bridges played a integral role in the development of belt roads on

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[25] *The Maui News*, December 4, 1926, section 8; "Drawings and Floor Plans of Proposed St. Anthony School Building," *The Maui News*, March 28, 1925; Dawn E. Duensing, *Historic Architectural Survey of Wailuku, Maui, Hawai'i*, prepared for the County of Maui Department of Planning, 1993, 20.

[26] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192.

Narrative Statement of Significance (continued)

Maui as well as on other Hawaiian Islands. Today, the Hāna Belt Road bridges remain as the highest concentration of unaltered and stylistically consistent historic bridges in Hawai'i.[27]

Talented local engineers were responsible for the design and construction of the Hāna Belt Road. A substantial portion of the road and bridge design as well as the majority of engineering work was completed by County Engineer's Office. Hugh Howell, who was appointed Maui County engineer in 1906 and again in 1914, had served as an engineer with the Loan Fund Commission and participated in the early survey work for the Hāna Belt Road. He also designed several bridges on the Hāna Belt Road while serving as a county engineer. The Hugh Howell Engineering Company worked on Hāna Belt Road contracts once construction began. Paul Low was Maui County Engineer from 1918 until 1928 and was responsible for supervising the two major phases of Hāna Belt Road construction between 1923 and 1926. He and his county crews used Howell's earlier survey work as the basis for their road design and built the most spectacular sections of road between Kailua and Nahikū. During his tenure as county engineer, Low also supervised a number of Maui's other public works projects, including the County Office Building in 1924. A. H. Wong, who designed the West Wailuaiki Bridge, was appointed county engineer in 1928 to replace Low. After his service with the county, he worked on the construction of Haleakalā Highway and became an engineering supervisor with the Works Progress Administration project building Maui Airport.[28]

Notable local contractors built portions of the Hāna Belt Road and several bridges. The Honolulu firm Wilson and McCandless built the 1914 section of road near Nahikū and Oilowai Bridge. Another important local builder, Moses Akiona, was born in Ke'anae and established his contracting firm, Moses Akiona, Ltd., in 1920. In addition to Waikani bridge, Akiona's firm worked on other Maui projects, including Malulani Hospital, Kula Sanitarium, and the Lahaina

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[27] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 7-9.
[28] Howell noted in *The Maui News*, January 10, 1914; January 9, 1915; and February 4, 1916. Low noted in *The Maui News*, February 15, 1918; October 3, 1928; in Duensing, *Historic Architectural Survey*, 35. Wong noted in *The Maui News*, October 17, 1928.

Courthouse. His business eventually grew to become one of the largest contracting firms in the territory. In the 1960s, Akiona and his sons built a section of the H-1 freeway on O'ahu.[29]

Transportation & Commerce

Belt road projects are a significant element in the transportation history of Maui. This road-building program was concurrent with the strategy of all the major Hawaiian Islands to develop belt road systems. By 1900, Mauians were concentrating on the Hāna section of the belt road, calling for a good wagon road to connect central Maui and Hāna. "What the Central Pacific was to California, and what the Panama Canal would be to the Islands," *The Maui News* emphasized in 1903, was "relatively what a good road all the way from Pā'ia to Hāna would mean to Maui." A road to Hāna was believed necessary for the economic development of East Maui and its success in sugar, minor industries, and small-scale farming.[30] Prior to the completion of a road from central Maui to Hāna, travel to East Maui villages was by steamship or an unpaved wagon and horse trail. The route along the Hāna Coast was often impassable due to heavy rain. Various sections of the coastal road were built by 1914, but the lack of a continuous road to Hāna was considered a nuisance. One Maui legislator complained that Maui was "the only island on which you cannot traverse by road around it."[31]

The improved transportation provided by the Hāna Belt Road was considered essential for Maui's commercial development. *Maui News* editorials noted that East Maui had plenty of fertile land and emphasized that a road to Hāna would open the area to settlement. Mauians predicted that a road through East Maui to Hāna would make homestead lands available and would also facilitate trade between East Maui and the rest of the island. Benefits to be obtained from improved transportation to Hāna included increased tax revenues, population, and

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[29] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191, V 14.

[30] *The Maui News*, editorial, April 25, 1903.

[31] "Roads First Need View of Fassoth," *The Maui News*, February 11, 1921.

production. Roads connecting the various parts of the island, including Hāna, were viewed as essential to Maui as arteries were to the human body. Some Mauians believed that the Hāna Belt Road project was the most needed road in the territory and noted that Maui was ten years behind the other islands in its belt road construction.[32]

The opening of the Hāna Belt Road in 1926 was a major transportation milestone for Maui. *The Maui News* labeled it "the greatest road making achievement in the Island, one fraught with tremendous difficulties in engineering and construction work." The new road eliminated Hāna's reliance on the weekly steamer for its transportation and communication needs to the outside world. With the new road, the trip to Hāna could now be made overland on one's own timetable rather than by the schedule of a steamer or horse trip. Instead of a round-trip journey of a week, the trip was shortened to 3.5 hours each way.[33]

Another significant commercial aspect of the Hāna Belt Road was tourism. By the 1920s, Maui's businessmen and civic leaders recognized the importance of scenic roads and considered them to be commercial enterprises, without which Maui could not develop its tourism industry. As early as 1912, the Hāna Belt Road, as well as a proposed route to the summit of Haleakalā, were planned as the centerpieces of Maui's road-building projects. Mauians realized that building a road to Hāna would open up some of the finest scenery in the Hawaiian Islands and put Maui "on the tourist map." One civic group claimed that a magnificent scenic highway could be one of Maui's greatest assets. Local businessmen argued that tourism would not thrive on Maui unless the island had good roads to accommodate its visitors. One Mauian claimed that the mere mention of the term "horseback ride" scared tourists from visiting Maui. A businessman pointed out that tourists expected to travel comfortably by automobile and were not always willing to climb into the saddle to go sightseeing. Mauians realized that more tourists visited

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[32] *The Maui News*, editorials, June 28, 1902; November 15, 1902; December 27, 1902; March 7, 1903; July 4, 1903; "Advocates Belt Road: Maui is Ten Years Behind in Road Matters," *The Maui News*, November 6, 1909.

[33] "Linking Up Maui," *The Maui News*, editorial, December 18, 1926; "Maui Takes Day Off for Road Opening," *The Maui News*, December 22, 1926.

the Big Island of Hawai'i because that island's attractions, especially Kilauea Volcano, were accessible by automobile, while Maui's attractions remained almost inaccessible. The Hāna Belt Road was a significant piece of a road-building program that aimed to make Maui's scenic attractions easily available. Maui's plans to develop a tourist industry received a tremendous boost with the completion of the Hāna Belt Road in 1926 and the Haleakalā Highway in 1935.[34] These two roads were Maui's crowning achievements in transportation public works projects during the twentieth century. Both highways were important commercial enterprises and remain the island's most popular scenic drives today. The Hāna Belt Road has become an attraction in itself, with tourists driving the route to experience the narrow road and its historic bridges, not just the scenery. Motorists appreciate this unique route that is relatively unchanged from the 1920s and provides an opportunity to visit a rural area that is uniquely Hawaiian.

Social History

The immediate impact of opening the Hāna Belt Road was to end East Maui's centuries of isolation from the rest of Maui. Prior to the belt road's construction, many on Maui maintained that Hāna might as well be on another island.[35] Indeed, in ancient times, Hāna was more connected to communities on the island of Hawai'i that were more easily accessible by canoe. Until the Hāna Belt Road was completed, many Mauians had never seen the 'other side' of Maui, whether they lived in West Maui or East Maui.

The completion of the Hāna Belt Road is a testament to civic pride on Maui during the early twentieth century. The County Act in 1905 authorized the establishment of local governments

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[34] "No Ke'anae Highway Says Governor," *The Maui News*, July 18, 1914; "The Key to Progress," *The Maui News*, May 16, 1914; "Road to Ke'anae Now Maui's Best Bet To Draw Tourist Travel, *The Maui News*, October 7, 1925; Connect Maui Up," *The Maui News*, February 11, 1921; Duensing, Dawn E., *Haleakalā Highway, HAER No. HI-52.* [Washington D.C.], National Park Service, Historic American Engineering Record, 1999.

[35] "New Comer Doesn't Like Our Road Policy," *The Maui News*, August 14, 1915; "Connect Maui Up," *The Maui News*, February 11, 1921.

on Hawai'i's four major islands. On Maui, numerous public works projects during the next thirty years demonstrated residents' keen sense of civic awareness. Substantial public buildings were constructed in the county seat of Wailuku, including the Wailuku Courthouse (built in 1907), County Office Building (1924), Wailuku Library (1928), and Territorial Building (1931). In the Lahaina District, the courthouse was renovated and the Pali Highway was improved in 1925. Prominent schools were built, including the Wailuku Public School in 1905 and Maui High School in 1921, both designed by well-known architect C. W. Dickey. Many of the structures built during this intense period of civil works projects were designed by prominent architects, including Dickey, H. L. Kerr, and William D'Esmond.[36]

The Hāna Belt Road was part of this great, early twentieth century public works movement. First suggested in 1895, the Maui Board of Supervisors sought funding for the road as early as 1900. Although numerous bridges were constructed on the Hāna Belt Road starting in 1908, little money was available for road construction or improvement. Mauians lobbied Hawai'i's governors and legislators for decades before receiving funding to build the dream of an automobile road to Hāna. A 1923 estimate of $692,000 to complete the road was a substantial undertaking for an island with limited resources and a population of approximately 38,000, most of whom were agricultural laborers. Maui's leaders found ways to finance the Hāna Belt Road through the sale of territorial bonds and the savings gained from the use of public employees and prison labor rather than private contractors. In early 1923, the county government demonstrated its determination to go ahead with the project by purchasing a steam shovel and drill and assigning a gang of twenty men to begin work on the new road, even though the territorial legislature had not yet approved the sale of bonds for the project. The county established a prison camp in Kailua to house the fifty convicts expected to work on the road. Within months, leaders purchased another steam shovel and drill so that work could proceed from both ends of the road. Funding eventually was secured from the territorial and federal governments.[37]

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[36] Duensing, *Historic Architectural Survey*, 5-12, 19-20.

[37] "Belt Road Plans Further Advanced," *The Maui News*, February 10, 1923; "Belt Road Funds Knotty Problem Chamber Finds," *The Maui News*, March 9, 1923; "Belt Road Work Will Be

A number of bridges on the Hāna Belt Road were significant civic statements for Maui. Altogether, the concrete bridges along the road demonstrated the county's commitment to permanent and modern improvements. Several bridges were visually prominent both in style and location, and also demonstrated fine workmanship. Bridges such as Waikani, Koukou'ai, and 'Ohe'o indicated both the technical and aesthetic sophistication of the community in which they were built. Many of the bridges are examples of exceptional work by important local builders, including Johnny Wilson of Honolulu (in partnership with McCandless) and Moses Akiona. Waikani Bridge is one of the most aesthetically pleasing bridges along the road and was a collaboration of Akiona and D'Esmond. Many other bridges were not quite so grand, but also made pleasing visual statements, including Hanawī Bridge, Kūhiwa Bridge, Waiokamilo Bridge, and Pu'uhaoa Bridge.

The extent of economic development predicted by *Maui News* writers never happened, although many homes and small farms were built along the Hāna Belt Road corridor over the years as land became available and accessible. Census statistics indicate that the Hāna District was home to 3,100 residents in 1920 before the road opened. In 1930, population in the district declined to 2,436. Agriculture remained the dominant activity, with the communities of Ke'anae and Wailua noted for their production of *taro* and rice. Despite the improvements in transportation and the possibilities for more development, the Hāna District's population dwindled to 1,495 by 1950.[38]

The lack of road improvements over the past seventy years has not only preserved the historic character of the Hāna Belt Road, but has also helped to maintain the historic rural character of the Hāna District itself. The absence of an easily-traveled, high-speed traffic artery has served to impede substantial development, which has subsequently allowed Hāna and other communities in East Maui to remain rural. There are no fast food chains, chain stores, strip malls or

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Started By Maui County," *The Maui News*, March 10, 1923; "Belt Road Project Is To Go Forward At Once," *The Maui News*, May 26, 1923, Robert C. Schmitt, *Historical Statistics of Hawai'i*, Honolulu: The University Press of Hawai'i, 1977, 13.

[38] Robert C. Schmitt, *Historical Statistics of Hawai'i*, 13-14.

sprawling subdivisions along the Hāna Belt Road. Travelers along the Hāna Coast are served by the occasional roadside stand and must drive all the way to Hāna for conveniences such as groceries, gas, and restaurants. With a sizable population of residents of Hawaiian ancestry, Hāna is often cited as Maui's "most Hawaiian community." The Hāna community has worked together to "Keep Hāna Hawaiian," as a bumper sticker urges, and preserve its rural lifestyle and values. In the 1990s, residents rallied against the approval of major developments such as a golf course and an adjacent residential community. Many Hāna residents believe that the narrow, winding, and slow Hāna Belt Road is a means to "Keep Hāna Hawaiian."

Today, a trip along the Hāna Belt Road allows a motorist to see much of what would have been viewed in 1926 when the road opened: a spectacular thoroughfare chiseled out of cliffs, passing through huge gullies and past waterfalls, while always presenting stunning views of the Pacific Ocean and East Maui's natural features. Ke'anae still practices traditional ways, with *taro* being farmed and a Hawaiian lifestyle. A three-room rural school is still in operation in Ke'anae. The section of road above the Wailua Valley, which was admired by Engineer Paul Low, still travels along a narrow ledge for a mile, providing a panoramic view of *taro* patches in the quaint village of Wailua below. Along the way motorists view the historic irrigation ditches, weirs, and intakes still used for Maui's sugar industry. The journey to Hāna provides an opportunity to experience a rural way of life that is uniquely Hawaiian and also a way of life that is becoming more rare in the Hawaiian Islands.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 9 Page 1

Name of property Hāna Belt Road

County and State Maui County, Hawai'i

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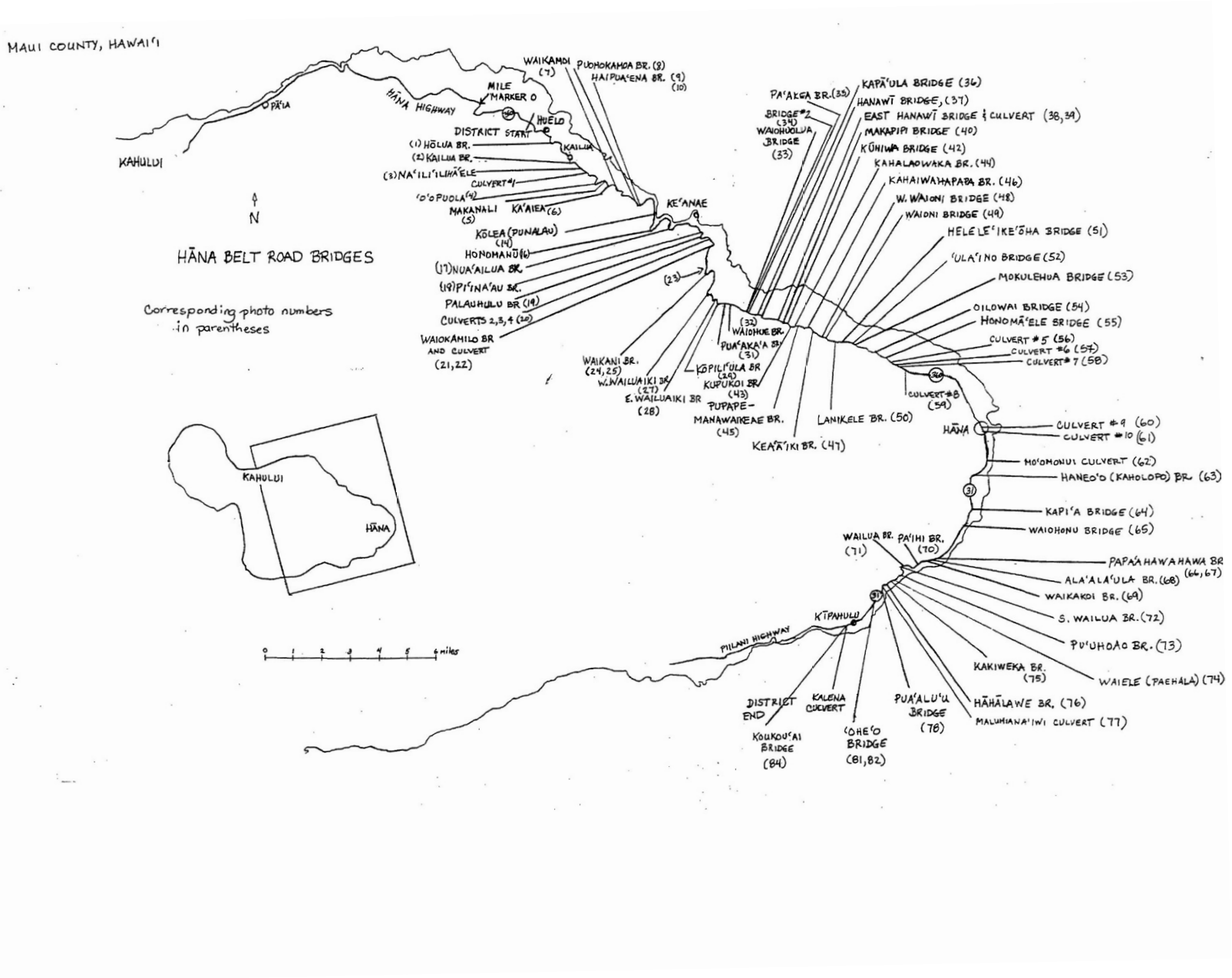
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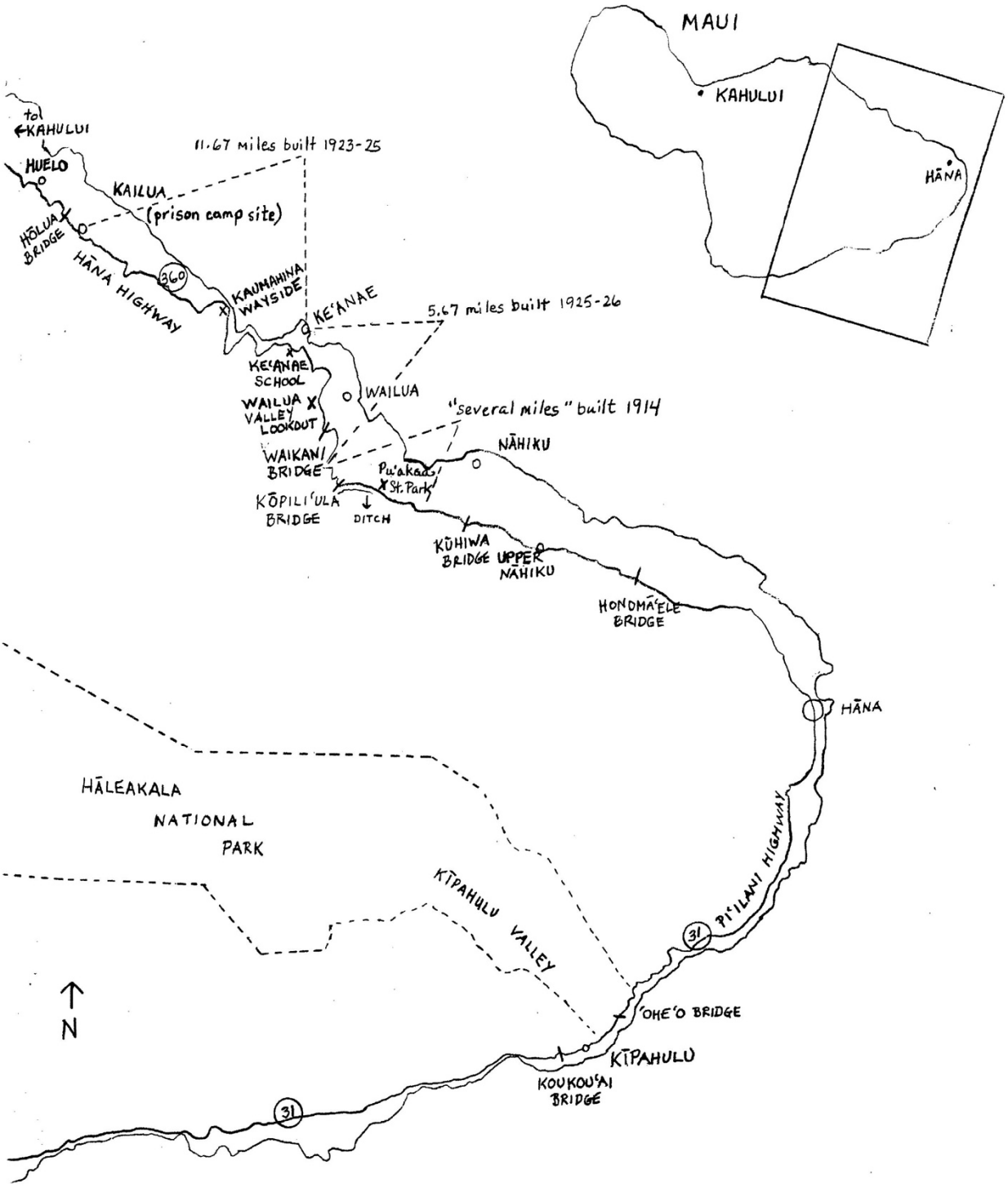
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The Maui News, 1900-1950.


MAUI COUNTY, HAWAI'I
KAHULUI
PĀ'IA
HĀNA HIGHWAY
MILE MARKER 0
HUELO
DISTRICT START
KAILUA
WAIKAMOI (7)
PUOHOKAMOA BR. (8)
HAIPUA'ENA BR. (9) (10)
(1) HŌLUA BR.
(2) KAILUA BR.
(3) NA'ILI'ILIHĀ'ELE CULVERT #1
'O'OPUOLA (4)
MAKANALI (5)
KA'AIEA (6)
KŌLEA (PUNALAU) (14)
HONOMANŪ (16)
(17) NUA'AILUA BR.
(18) PI'INA'AU BR.
PALAUHULU BR (19)
CULVERTS 2,3, & 4 (20)
WAIOKAMILO BR AND CULVERT (21,22)
KE'ANAE
N
HĀNA BELT ROAD BRIDGES
Corresponding photo numbers in parentheses
WAIKANI BR. (24,25)
W. WAILUAIKI BR (27)
E. WAILUAIKI BR (28)
KŌPILI'ULA BR (29)
KUPUKOI BR (43)
PUPAPE-MANAWAIKEAE BR. (45)
PUA'AKA'A BR (31)
WAIOHUE BR. (32)
KEĀ'IKI BR. (47)
LANIKELE BR. (50)
PA'AKEA BR. (35)
BRIDGE #2 (34)
WAIOHUOLUA BRIDGE (33)
KAPĀ'ULA BRIDGE (36)
HANAWĪ BRIDGE, (37)
EAST HANAWĪ BRIDGE & CULVERT (38,39)
MAKAPIPI BRIDGE (40)
KŪNIWA BRIDGE (42)
KAHALAOWAKA BR. (44)
KAHAIWA HAPAPA BR. (46)
W. WAIONI BRIDGE (48)
WAIONI BRIDGE (49)
HELELE'IKE'ŌHA BRIDGE (51)
'ULA'INO BRIDGE (52)
MOKULEHUA BRIDGE (53)
OILOWAI BRIDGE (54)
HONOMĀ'ELE BRIDGE (55)
CULVERT #5 (56)
CULVERT #6 (57)
CULVERT #7 (58)
CULVERT #8 (59)
HĀNA
CULVERT #9 (60)
CULVERT #10 (61)
MO'OMONUI CULVERT (62)
HANEO'O (KAHOLOPO) BR. (63)
KAPI'A BRIDGE (64)
WAIOHONU BRIDGE (65)
WAILUA BR. (71)
PA'IHI BR. (70)
PAPA'A HAWAHAWA BR (66,67)
ALA'ALA'ULA BR. (68)
WAIKAKOI BR. (69)
S. WAILUA BR. (72)
PU'UHOAO BR. (73)
WAIELE (PAEHALA) (74)
KAKIWEKA BR. (75)
HĀHĀLAWE BR. (76)
MAUHIANA'IWI CULVERT (77)
PUA'ALU'U BRIDGE (78)
'OHE'O BRIDGE (81,82)
KALENA CULVERT
DISTRICT END
KOUKOU'AI BRIDGE (84)
KĪPAHULU
PIILANI HIGHWAY
KAHULUI
HĀNA
0 1 2 3 4 5 6 miles


Hāna Belt Road
Maui County, Hawai'i
MAUI
KAHULUI
HĀNA
to KAHULUI
HUELO
11.67 miles built 1923-25
KAILUA
(prison camp site)
HŌLUA BRIDGE
HĀNA HIGHWAY
360
KAUMAHINA WAYSIDE
KE'ANAE
5.67 miles built 1925-26
KE'ANAE SCHOOL
WAILUA VALLEY LOOKOUT
WAILUA
"several miles" built 1914
NĀHIKU
WAIKANI BRIDGE
Pu'aka'a St. Park
KŌPILI'ULA BRIDGE
DITCH
KŪHIWA BRIDGE
UPPER NĀHIKU
HONDMĀ'ELE BRIDGE
HĀNA
HĀLEAKALA NATIONAL PARK
KĪPAHULU VALLEY
PI'ILANI HIGHWAY
31
'OHE'O BRIDGE
KĪPAHULU
KOUKOU'AI BRIDGE
N

NPS Form 10-900-a
(8-86)

OMB Approval No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Section number _____ Page _____

SUPPLEMENTARY LISTING RECORD

NRIS Reference Number: 01000615 **Date Listed: 06/15/01**

Property Name: Hana Belt Road **County:** Maui **State:** HI

Multiple Name: N/A

This property is listed in the National Register of Historic Places in accordance with the attached nomination documentation subject to the following exceptions, exclusions, or amendments, notwithstanding the National Park Service certification included in the nomination documentation.

Sarah D Pope 6/15/01

(fax) **Signature of the Keeper** **Date of Action**

==========

Amended Items in Nomination:
The following amendments are hereby made to the documentation and confirmed with the HI SHPO:

Section 5. Classification
The road itself, not just the bridges and culverts, should be counted as a contributing structure. Therefore, the total number of contributing structures is changed to 74. The one (1) non-contributing structure remains the same.

Section 10. Geographical Data
The acreage of the property was not provided. The correct acreage of the district is 153 acres.

DISTRIBUTION:National Register property file;Nominating Authority

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

All photographs, with the exception of photograph #84 (Koukou'ai Bridge), were taken by Dawn E. Duensing. Dawn E. Duensing has all negatives except for that for #84, which is located at the State of Hawai'i Department of Transportation.

1. Hāna Belt Road
2. Maui County, Hawai'i
3. Dawn E. Duensing
4. November 19, 2000
5. Dawn E. Duensing
6. Hōlua Bridge, view looking east
7. Photograph #1

4. November 19, 2000
6. Kailua Bridge, view looking east
7. Photograph #2

4. November 19, 2000
6. Nā'ili'ilihā'ele Bridge, view looking west
7. Photograph #3

4. November 19, 2000
6. 'O'opuola Bridge, view looking west
7. Photograph #4

4. November 19, 2000
6. Makanali Bridge, view looking west
7. Photograph #5

4. November 19, 2000
6. Ka'aiea Bridge, view looking west, with ditchworks in the background
7. Photograph #6

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 2

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 19, 2000
6. Waikamoi Bridge, view looking east
7. Photograph #7

4. November 19, 2000
6. Puohokamoa Bridge, view looking *makai* (towards the ocean)
7. Photograph #8

4. November 19, 2000
6. Haipua'ena Bridge, view looking *mauka* (toward the mountain or inland)
7. Photograph #9

4. November 19, 2000
6. Haipua'ena Bridge, view looking east
7. Photograph #10

4. November 19, 2000
6. View from road looking east, just east of Kaumahina State Wayside
7. Photograph #11

4. December 2, 2000
6. Aerial view of road on west side of Honomanū Valley.
7. Photograph #12

4. November 26, 2000
6. West side of Honomanū Valley portion of road as viewed from the road on Honomanū Valley's east side
7. Photograph #13

4. December 2, 2000
6. Kōlea (Punala) Bridge, looking *mauka*
7. Photograph #14

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 3

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. Hāna Belt Road through Honomanū Gulch, between Kōlea Bridge and Honomanū Bridge, looking east
7. Photograph #15

4. November 26, 2000
6. Honomanū Bridge, looking *mauka*
7. Photograph #16

4. November 26, 2000
6. Nua'ailua Bridge, looking east
7. Photograph #17

4. November 26, 2000
6. Pi'ina'au Bridge, looking west
7. Photograph #18

4. November 26, 2000
6. Palauhulu Bridge, looking *mauka*
7. Photograph #19

4. November 26, 2000
6. Culverts #2 & #3, looking west, culvert #4 is of similar construction.
7. Photograph #20

4. November 26, 2000
6. Waiokamilo Bridge, looking west
7. Photograph #21

4. December 2, 2000
6. Waiokamilo Bridge, *makai* wall. Waiokamilo Culvert, adjacent to bridge, has identical walls.
7. Photograph #22

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 4

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. View of road on cliff's edge above Wailua Village, after Wailua Valley lookout, looking west
7. Photograph #23

4. December 3, 2000
6. Waikani Bridge, looking *mauka* from west side of bridge
7. Photograph #24

4. November 26, 2000
6. Road view of Waikani Bridge, looking west
7. Photograph #25

4. December 3, 2000
6. View from road on east side of Wailuanui Valley, east of Waikani Bridge; overlooking Wailua Village, with Hāna Belt Road above Wailua visible on left
7. Photograph #26

4. November 26, 2000
6. West Wailuaiki Bridge, looking *mauka* from east side of bridge
7. Photograph #27

4. November 26, 2000
6. East Wailuaiki Bridge, looking east
7. Photograph #28

4. November 26, 2000
6. Kōpili'ula Bridge, looking east
7. Photograph #29

4. November 26, 2000
6. Ditch running alongside Hāna Belt Road after Kōpili'ula Bridge
7. Photograph #30

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 5

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. Pua'aka'a (Waiohue) Bridge, looking *mauka*
7. Photograph #31

4. November 26,2000
6. Waiohue Bridge, looking east / *makai*
7. Photograph #32

4. November 26, 2000
6. Waiohuolua Bridge, looking east
7. Photograph #33

4. November 26, 2000
6. Bridge #2, looking east, Pa'akea Bridge is in background
7. Photograph #34

4. January 27, 2001
6. Pa'akea Bridge, with Bridge #2 in background, looking west
7. Photograph #35

4. December 2, 2000
6. Kapā'ula Bridge, looking west
7. Photograph #36

4. December 2, 2000
6. Hanawī Bridge, from west side of bridge looking *mauka*
7. Photograph #37

4. December 2, 2000
6. East Hanawī Bridge, looking east
7. Photograph #38

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 6

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 2, 2000
6. East Hanawī Culvert, looking east/ *mauka*
7. Photograph #39

4. December 2, 2000
6. Makapipi Bridge, looking *mauka*
7. Photograph #40

4. December 2, 2000
6. View of Hāna Belt Road east of Makapipi Bridge, looking east
7. Photograph #41

4. December 2, 2000
6. Kūhiwa Bridge, looking east
7. Photograph #42

4. December 2, 2000
6. Kupukoi Bridge, looking east
7. Photograph #43

4. December 2, 2000
6. Kahalaowaka Bridge, view looking *mauka*
7. Photograph #44

4. December 2, 2000
6. Pupape-Manawaikeae Bridge, view looking east
7. Photograph #45

4. December 2, 2000
6. Kahawaihapapa Bridge, looking east
7. Photograph #46

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 7

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 2 , 2000
6. Kea'ā'iki Bridge, looking east
7. Photograph #47

4. December 2, 2000
6. West Waioni Bridge, looking east
7. Photograph #48

4. December 2, 2000
6. Waioni Bridge, looking east
7. Photograph #49

4. December 2, 2000
6. Lanikele Bridge, looking west
7. Photograph #50

4. December 2, 2000
6. Helele'ike'ōhā Bridge, looking east
7. Photograph #51

4. December 2, 2000
6. 'Ula'ino Bridge, looking west
7. Photograph #52

4. December 3, 2000
6. Mokulehua Bridge, looking east
7. Photograph #53

4. December 3, 2000
6. Oilowai Bridge, looking east
7. Photograph #54

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 8

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Honoma'ele Bridge, looking west
7. Photograph #55

4. December 3, 2000
6. Culvert #5, looking west
7. Photograph #56

4. December 3, 2000
6. Culvert #6, looking *makai*
7. Photograph #57

4. December 3, 2000
6. Culvert #7, looking *makai*
7. Photograph #58

4. December 3, 2000
6. Culvert #8, looking west
7. Photograph #59

4. December 3, 2000
6. Culvert #9, looking *mauka*
7. Photograph #60

4. December 3, 2000
6. Culvert #10, looking west
7. Photograph #61

4. January 27, 2001
6. Mo'omonui Culvert, looking *mauka*
7. Photograph #62

4. December 3, 2000
6. Haneo'o (Kaholopo) Bridge, looking *mauka*
7. Photograph #63

4. December 3, 2000
6. Kapi'a (Kahawaiokapia) Bridge, looking north
7. Photograph #64

4. December 3, 2000
6. Waiohonu Bridge, looking south
7. Photograph #65

4. December 3, 2000
6. Papa'ahawahawa Bridge, looking *mauka*
7. Photograph #66

4. December 3, 2000
6. Papa'ahawahawa Bridge, road view looking north
7. Photograph #67

4. December 3, 2000
6. Ala'ala'ula Bridge, looking *mauka*
7. Photograph #68

4. December 3, 2000
6. Waikakoi Bridge, looking north
7. Photograph #69

4. December 3, 2000
6. Pa'ihi Bridge, looking *mauka*
7. Photograph #70

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 10

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Wailua Bridge, looking north
7. Photograph #71

4. December 3, 2000
6. South Wailua (Honolewa) Bridge, looking *mauka*
7. Photograph #72

4. December 3, 2000
6. Pu'uhoao Bridge, looking north
7. Photograph #73

4. December 3, 2000
6. Waiele (Paehala) Bridge, looking north
7. Photograph #74

4. December 3, 2000
6. Kakiweka Bridge, looking *mauka*
7. Photograph #75

4. December 3, 2000
6. Hāhālawe Bridge, looking *mauka*
7. Photograph #76

4. December 3, 2000
6. Maluhiana'iwi Culvert, looking *mauka*
7. Photograph #77

4. December 3, 2000
6. Pua'alu'u Bridge, looking *mauka*
7. Photograph #78

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 11

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Roadscape south of Pua'alu'u Bridge, looking north
7. Photograph #79

4. December 3, 2000
6. Roadscape north of 'Ohe'o Bridge, looking north
7. Photograph #80

4. December 3, 2000
6. 'Ohe'o Bridge, looking *makai*
7. Photograph #81

4. December 3, 2000
6. 'Ohe'o Bridge, looking *mauka*
7. Photograph #82

4. December 3, 2000
6. Roadscape south of 'Ohe'o Bridge in Haleakalā National Park, looking north
7. Photograph #83

3. August Riccio, Hawai'i Heritage Center
4. 1990
5. State of Hawai'i Department of Transportation
6. Koukou'ai (Kaukau'ai) Bridge, looking *mauka*
7. Photograph #84

APPENDIX H – A CULTURAL IMPACT ASSESSMENT REPORT IN ADVANCE OF THE PROPOSED HANA HIGHWAY AT KALEPA POINT ROAD REPAIRS PROPOSED PROJECT (SCIENTIFIC CONSULTANT SERVICES, INC.)

SCS PROJECT NO. 2594-Final CIA

A CULTURAL IMPACT ASSESSMENT REPORT IN ADVANCE OF THE PROPOSED HĀNA HIGHWAY AT KĀLEPA POINT ROAD REPAIRS PROJECT

KA‘ĀPAHU AHUPUA‘A, HĀNA (KĪPAHULU) DISTRICT
ISLAND OF MAUI , HAWAI‘I
[TMK: (2) 1-6-010:999]

Prepared by:
Cathleen A. Dagher, B.A.

November 2021

FINAL

Prepared for:
County of Maui
Department of Public Works
Engineering Division

SCIENTIFIC CONSULTANT SERVICES, Inc.



1357 Kapiolani Blvd., Suite 850 Honolulu, Hawai‘i 96814

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TABLE OF CONTENTS

INTRODUCTION 1

CULTURAL IMPACT ASSESSMENT METHODOLOGY 5

GEOGRAPHICAL EXTENT 6
OEQC GUIDELINES FOR ASSESSING CULTURAL IMPACTS 6
CULTURAL IMPACT ASSESSMENT CONTENTS 7
PROJECT METHODOLOGY 9
ARCHIVAL RESEARCH 9
INTERVIEWS 9
KA PA‘A KAI O KA‘AINA V. LAND USE COMM’N, STATE OF HAWAI‘I 10

ENVIRONMENTAL SETTING 11

VEGETATION 12
PROJECT AREA 12
CLIMATE AND HYDROLOGY 13
SOILS 13

TRADITONAL AND HISTORICAL CULTURAL CONTEXT 15

PAST POLITICAL BOUNDARIES 15
TRADITIONAL SETTLEMENT PATTERNS 17
PRE-CONTACT PERIOD (PRE-1778) 17
HISTORIC PERIOD (POST-1778) 18
THE MĀHELE 20
LAND GRANTS 22
WAHI PANA (LEGENDARY PLACES) 23

PREVIOUS ARCHAEOLOGY 26

CONSULTATION 33

RESULTS 37

WRITTEN RESPONSES 37
THE FIFTEEN WRITTEN RESPONSES RECEIVED BY SCS ARE PRESENTED IN THIS SECTION OF THE REPORT. 37
MR. ANDREW “KEALANA” PHILLIPS, BURIAL SITES SPECIALIST, STATE HISTORIC PRESERVATION DIVISION 37

MR. CHRIS "IKAIKA" NAKAHASHI, CULTURAL HISTORIAN, STATE HISTORIC PRESERVATION DIVISION 37
MR. SKIPPY HAU, DLNR DIVISION OF AQUATIC RESOURCES 39
ROBERT W. HOBDY, ENVIRONMENTAL CONSULTANT ENVIRONMENTAL 44
MR. DANE MAXWELL, CHAIR, MAUI/ LĀNA'I ISLAND BURIAL COUNCIL... 47
DR. FERN P. DUVALL II, MAUI NUI PROGRAM MANAGER, NATIVE ECOSYSTEMS PROTECTION AND MANAGEMENT 48
DR. SCOTT FISHER, CHIEF CONSERVATION OFFICER, HAWAI'I LAND TRUST; MAUI/LĀNA'I BURIAL COUNCIL REPRESENTATIVE; AND FORMER ASSOCIATE DIRECTOR OF CONSERVATION, HAWAIIAN ISLANDS LAND TRUST 60

CULTURAL IMPACT ASSESSMENT SUMMARY 65

IDENTIFED CULTRAL RECOURCES AND CULTURAL PRACTICES 65

BURIALS 66
FLORA AND FAUNA 66
FRESHWATER, COASTAL, AND MARINE ENVIRONMENT RESOURCES 66
TRAILS 67

HISTORIC PROPERTIES 67

CONCLUSION AND RECOMMENDATIONS 68

REFERENCES 69

APPENDIX A: NAT IONAL REGISTER OF HISTORIC PLACES NOMINATION FORM FOR THE HĀNA BELT BIGHWAY ..... A

APPENDIX B: EXAMPLE LETTER OF INQUIRY ..... B

APPENDIX C: EXAMPLE FOLLOW-UP LETTER C

APPENDIX D: CIA NOTICE PUBLISHED IN KA WAI OLA, SEPTEMBER 2019 ..... D

APPENDIX E: SIGNED INFORMATION RELEASE FORMS ..... E

LIST OF FIGURES

FIGURE 1: USGS QUADRANGLE (KAUPO, HI: 1996; 1:24,000 AND KIPAHULU 1996; 1:24,000) SHOWING PROJECT AREA LOCATION. 2
FIGURE 2: TAX MAP KEY [TMK: (2) 1-6-010] SHOWING PROJECT AREA LOCATION. 3
FIGURE 3: SATELLITE IMAGE (GOOGLE 2021; IMAGERY DATE 1/13/2013) SHOWING PROJECT AREA LOCATION 4
FIGURE 4: USDA SOIL SURVEY (FOOTE ET AL. 1972; SHEET NUMBER 126) OVERLAY ON SATELLITE IMAGE (GOOGLE 2021; IMAGERY DATE 1/13/2013) SHOWING SOIL TYPES WITHIN THE PROJECT AREA AND SURROUNDING ENVIRONS. 14
FIGURE 5: MAP OF THE ISLAND OF MAUI SHOWING AHUPUA‘A WITHIN THE TRADITIONAL DISTRICTS (COURTESY OF ISLAND BREATH.ORG). 16
FIGURE 6: THE KĪPAHULU-KAUPŌ TRAIL THROUGH THE KA‘ĀPAHU VALLEYS, AS SHOWN ON THE 1929 MAP BY J.M. DUNN (FROM TOMONARI-TUGGLE ET AL. 2015:22). 19
FIGURE 7: PREVIOUSLY IDENTIFIED ARCHAEOLOGICAL SITES IN THE VICINITY OF THE PROPOSED PROJECT AREA (FROM TOMONARI-TUGGLE ET AL. 2015) 28
FIGURE 8: AN EARLY PHOTOGRAPH OF NUANUALOA NOT FAR TO THE WEST OF KA‘ĀPAHU AHUPUA‘A. (FROM THE BAKER COLLECTION IN THE STATE ARCHIVES; PROVIDED COURTESY OF DR. ANDREW WALMISLEY) 51
FIGURE 9: PHOTOGRAPH OF THE "OLD GOVERNMENT ROAD” (PROVIDED COURTESY OF DR. ANDREW WALMISLEY). 52
FIGURE 10: PHOTOGRAPH OF THE "OLD GOVERNMENT ROAD” (PROVIDED COURTESY OF DR. ANDREW WALMISLEY). 53
FIGURE 11: PHOTOGRAPH OF THE "OLD GOVERNMENT ROAD” (PROVIDED COURTESY OF DR. ANDREW WALMISLEY). 54
FIGURE 12: PAGE 1 OF LETTER WRITTEN BY LOUIS MITCHELL, PASTOR OF KAUPŌ, DATED NOVEMBER 11, 1911 (PROVIDED COURTESY OF DR. ANDREW WALMISLEY). 55
FIGURE 13: PAGE 2 OF LETTER WRITTEN BY LOUIS MITCHELL, PASTOR OF KAUPŌ, DATED NOVEMBER 11, 1911 (PROVIDED COURTESY OF DR. ANDREW WALMISLEY). 56

LIST OF TABELS

TABLE 1: PREVIOUSLY IDENTIFIED HISTORIC PROPERTIES IN THE VICINITY OF THE CURRENT PROJECT AREA. 32
TABLE 2: LIST OF CULTURAL CONTACTS. 34

INTRODUCTION

At the request of the County of Maui, Department of Public Works, Engineering Division, Scientific Consultant Services, Inc. (SCS) has prepared a Cultural Impact Assessment (CIA) in advance of the proposed Hāna Highway at Kālepa Point Road Repairs project. The project area is located in Kaʻāpahu Ahupuaʻa, Hāna (Kīpahulu) District, Island of Maui [TMK: (2) 1-6-010:999]. The project area is situated within the Hāna Highway (State Route 360) roadway corridor, near the transition to the Piʻilani Highway (County Route 31) at the Kālepa Bridge (Figures 1 through 3). The project area is owned by the County of Maui (Robin Shishido, Engineering Program Manager, Hawaii Department of Transportation, personal communication, June 8, 2021). However, lands on either side of the Hāna Highway (State Route 360) roadway corridor are owned by the United States of America.

The proposed project will consist of the reconstruction of the revetment, seawall, and roadway in the area of the Kālepa Gulch, 14 miles southwest of Hāna Town. An approximately 400 feet (121.92 meters) section of roadway was undermined by large waves during Hurricane Iselle. Hurricane Iselle was the 11th named storm of the 2014 hurricane season and made landfall on the Island of Hawaiʻi on August 7, 2014 as a tropical storm. Large waves hit the east shore of Hawaiʻi island, as well as that of Maui. Hurricane Iselle caused considerable damage to the Hāna Highway, as well as road protection structures, including the rock rubble revetment slopes and concrete masonry walls, on the makai (west) side of Piʻilani Highway. Hāna Highway (also known as the Hana Belt Road, Hāna Road, Hāna Highway, Piʻilani Highway), including the project area corridor, is a historic property designated State Inventory of Historic Properties (SIHP) Site #50-50-15-1638 and is listed on the National Register of Historic Places as 01000615 (Appendix A).

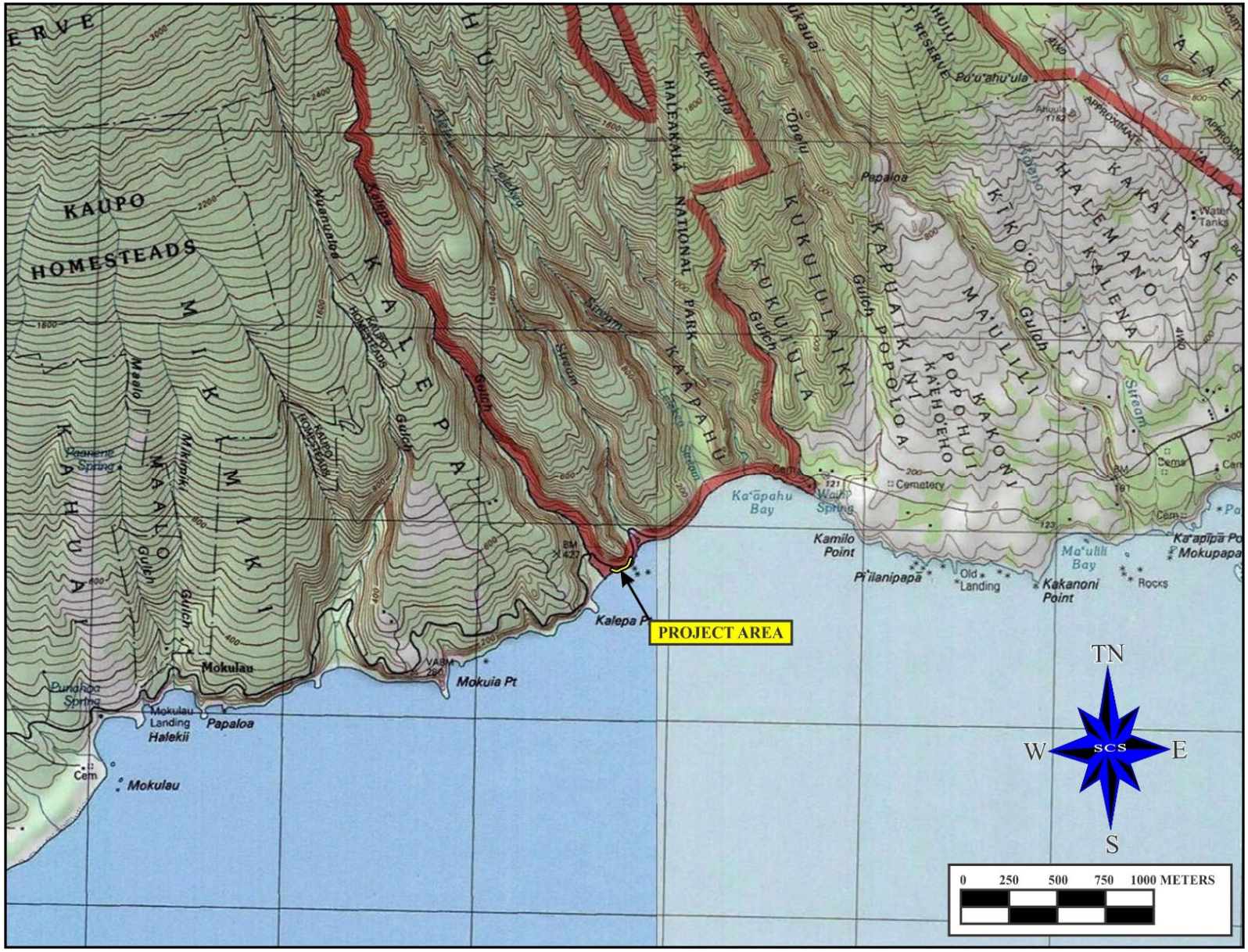


Figure 1: USGS Quadrangle (Kaupo, HI: 1996; 1:24,000 and Kipahulu 1996; 1:24,000) Showing Project Area Location.

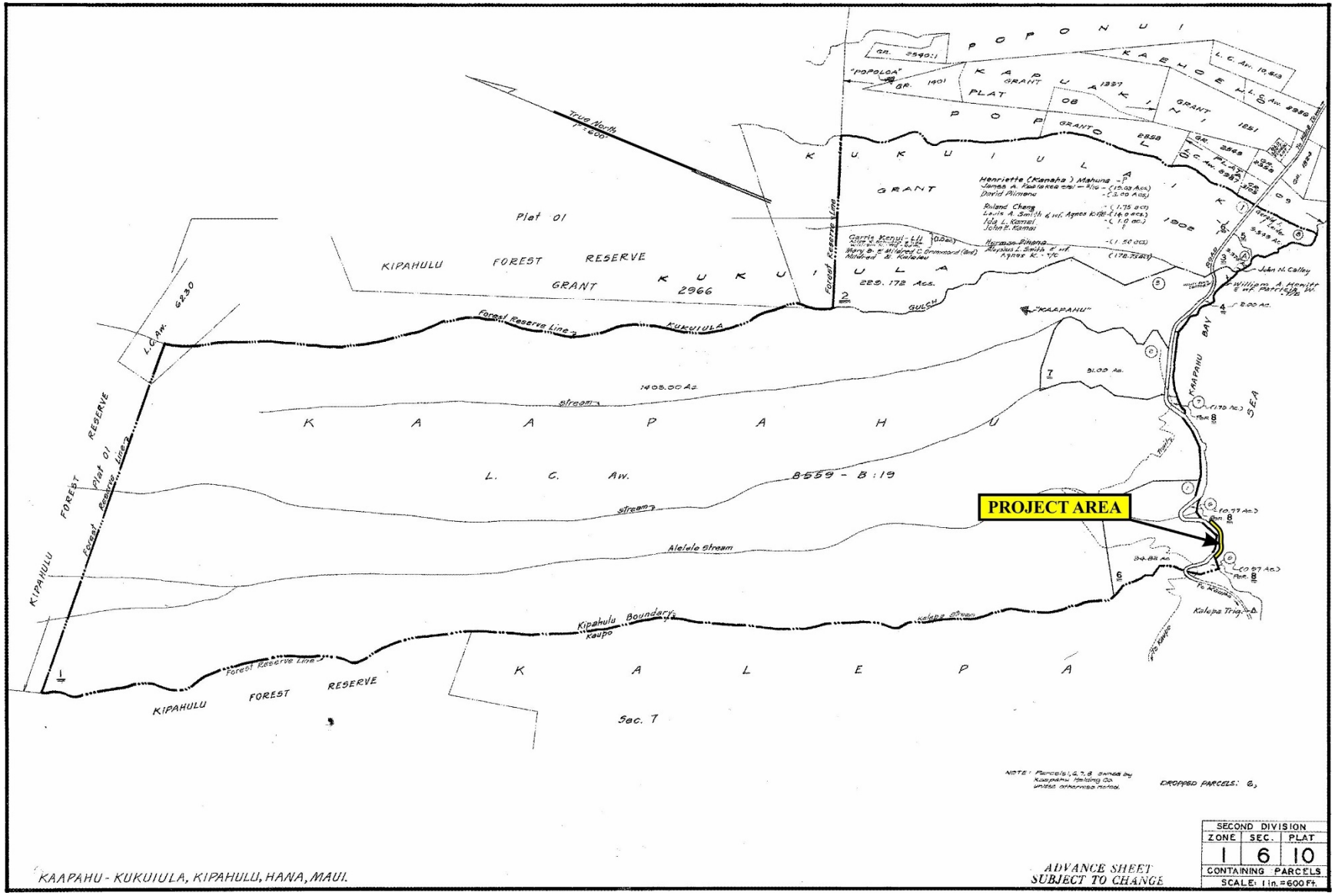


Figure 2: Tax Map Key [TMK: (2) 1-6-010] Showing Project Area Location.



Figure 3: Satellite Image (Google 2021; Imagery Date 1/13/2013) Showing Project Area Location.

The Hawaii State Office of Environmental Quality Control (OEQC 1997:11) states that "an environmental assessment of cultural impacts" gathers information about cultural practices and cultural features that may be affected by significant environmental effects:

> Cultural impacts differ from other types of impacts assessed in environmental assessments or environmental impact statements. A cultural impact assessment includes information relating to the practices and beliefs of a particular cultural or ethnic group or groups.

The purpose of a CIA is to identify the possibility of on-going cultural activities and resources within a project area, or its vicinity, and then assess the potential for impacts on these cultural resources. The CIA is not intended to be a document of in depth archival-historical land research, or a record of oral family histories, unless these records contain information about specific cultural resources that might be impacted by a proposed project.

CULTURAL IMPACT ASSESSMENT METHODOLOGY

The Constitution of the State of Hawai‘i clearly states the duty of the State and its agencies is to preserve, protect, and prevent interference with the traditional and customary rights of native Hawaiians. Article XII, Section 7 (2000) requires the State to "protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by *ahupua‘a* tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778." Additionally, Article IX and XII, of the state constitution, other state laws, and the courts of the State, impose on government agencies a duty to promote and protect cultural beliefs and practices, and resources of native Hawaiians as well as other ethnic groups.

Kamehameha III (Kauikeaouli) preserved the peoples traditional right to subsistence. As a result, in 1850, the Hawaiian Government confirmed the traditional access rights to native Hawaiian ahupua‘a tenants to gather specific natural resources for customary uses from undeveloped private property and waterways under the Hawaiian Revised Statutes (HRS) 7-1. In 1992, the State of Hawai‘i Supreme Court, reaffirmed HRS 7-1 and expanded it to include, "native Hawaiian rights…may extend beyond the *ahupua‘a* in which a native Hawaiian resides where such rights have been customarily and traditionally exercised in this manner" [Pele Defense Fund v. Paty, 73 Haw.578, 620, 837 P.2d 1247, 1272 (1992)].

Act 50, enacted by the Legislature of the State of Hawai‘i (2000) with House Bill (HB) 2895, relating to Environmental Impact Statements, proposes that:

> there is a need to clarify that the preparation of environmental assessments or environmental impact statements should identify and address effects on Hawaii's culture, and traditional and customary rights… [H.B. NO. 2895].

Act 50 also requires state agencies and other developers to assess the effects of proposed land use or shoreline developments on the "cultural practices of the community and State" as part of the HRS Chapter 343 (2001) environmental review process. It also re-defined the definition of "significant effect" to include "the sum of effects on the quality of the environment including actions that impact a natural resource, limit the range of beneficial uses of the environment, that are contrary to the State's environmental policies, or adversely affect the economic welfare, social welfare or cultural practices of the community and State." Cultural resources can include a broad range of often overlapping categories, including places, behaviors, values, beliefs, objects, records, stories, etc. (H.B. 2895, Act 50, 2000).

GEOGRAPHICAL EXTENT

As defined by the Hawaii State Office of Environmental Quality Control (OEQC 2012:11), the geographical extent should be greater than the area over which the proposed project will take place in order to ensure that cultural practices that occur outside of the project area, but which may still be affected, are included in the assessment. For example, a project that may not itself physically impact traditional gathering practices but may block access to those locations would be included within the assessment. The concept of geographical expansion is recognized by using, as an example, "the broad geographical area, e.g. district or *ahupua'a.*" In some cases, the geographical extent could extend beyond the ahupua'a if cultural practices do so as well.

OEQC GUIDELINES FOR ASSESSING CULTURAL IMPACTS

According to the Guidelines for Assessing Cultural Impacts established by the Hawaii State Office of Environmental Quality Control (OEQC 2012:12):

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religions and spiritual customs. The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural, which support such cultural beliefs.

The meaning of "traditional" was explained by in *National Register Bulletin 38*:

> "Traditional" in this context refers to those beliefs, customs, and practices of a living community of people that have been passed down through the generations', usually orally or through practice. The traditional cultural significance of a historic property then is significance derived from the role the property plays in a

> community's historically rooted beliefs, customs, and practices. . . [Parker and King 1998:1]

This CIA was prepared as much as possible in accordance with the suggested methodology and content protocol in the Guidelines for Assessing Cultural Impacts (OEQC 2012:11-13). In outlining the "Cultural Impact Assessment Methodology," the OEQC (2012:11) states that:

> …information may be obtained through scoping community meetings, ethnographic interviews and oral histories…

This Cultural Impact Assessment was prepared in accordance with the Guidelines for Assessing Cultural Impacts (OEQC 2012:11-13). The Guidelines recommend that preparers of assessments analyzing cultural impacts adopt the following protocol:

- Identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices and beliefs found within the broad geographical area, e.g., district or ahupua'a;
- Identify and consult with individuals and organizations with knowledge of the area potentially affected by the proposed action;
- Receive information from or conduct ethnographic interviews and oral histories with persons having knowledge of the potentially affected area;
- Conduct ethnographic, historical, anthropological, sociological, and other culturally related documentary research;
- Identify and describe the cultural resources, practices and beliefs located within the potentially affected area; and
- Assess the impact of the proposed action, alternatives to the proposed action, and mitigation measures, on the cultural resources, practices and beliefs identified.

CULTURAL IMPACT ASSESSMENT CONTENTS

The OEQC Guidelines state that an assessment of cultural impacts should address, but not be limited to the following:

- Discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints or limitations which might have affected the quality of the information obtained.
- Description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken.

- Ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained.

- Biographical information concerning the individuals and organizations consulted their particular expertise and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area.

- Discussion concerning historical and cultural source materials consulted, the institutions and repositories searched and the level of effort undertaken. This discussion should include, if appropriate, the particular perspective of the authors, any opposing views, and any other relevant constraints, limitations or biases.

- Discussion concerning the cultural resources, practices and beliefs identified, and, for resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site.

- Discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area affected directly or indirectly by the proposed project.

- Explanation of confidential information that has been withheld from public disclosure in the assessment.

- Discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs.

- Analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place.

- A bibliography of references and attached records of interviews which were allowed to be disclosed.

If on-going cultural activities and/or resources are identified within the project area, assessments of the potential effects on the cultural resources in the project area and recommendations for mitigation of these effects can be proposed.

PROJECT METHODOLOGY

This report contains archival and documentary research, as well as communication with organizations and individuals having knowledge of the project area, its cultural resources, and its practices and beliefs. An example of the initial letter of inquiry, which briefly describes the purpose of the CIA, the consultation process, and the proposed project, is presented in Appendix B. An example of the follow up letter is presented in Appendix C. A copy of the posted CIA newspaper notice is presented in Appendix D. Signed information release forms are presented in Appendix E. This Cultural Impact Assessment was prepared in accordance with the suggested methodology and content protocol provided in the Guidelines for Assessing Cultural Impacts (OEQC 2012:13), whenever possible. The assessment concerning cultural impacts may include, but not be limited to the following items discussed below.

ARCHIVAL RESEARCH

Archival research focused on a historical documentary study involving both published and unpublished sources. These included legendary accounts of native and early foreign writers; early historical journals and narratives; historic maps, land records, such as Land Commission Awards, Royal Patent Grants, and Boundary Commission records; historic accounts, and previous archaeological reports.

Historical and cultural source materials were extensively used and can be found listed in the References Cited portion of this report. Such scholars as Samuel Kamakau, Martha Beckwith, Jon J. Chinen, Lilikalā Kameʻeleihiwa, R. S. Kuykendall, Marion Kelly, E. S. C. Handy and E.G. Handy, John Papa ʻĪʻī, Gavin Daws, A. Grove Day, and Elspeth P. Sterling, and Mary Kawena Pukuʻi and Samuel H. Elbert continue to contribute to our knowledge and understanding of Hawaiʻi, past and present.

The works of these and other authors were consulted and incorporated in this report where appropriate. Historic land use document research was supplied by the Waihona ʻAina (2021) Database, the Office of Hawaiian Affairs Kipuka Database (2021), and the County of Maui County Real Property Assessment Division Database (2021).

INTERVIEWS

In general, interviews are conducted in accordance with Federal and State laws and guidelines when knowledgeable individuals are able to identify traditional cultural practices and/or resources procured in the project area or in the environs. If they have knowledge of traditional stories, practices and beliefs, and resources associated with a project area or if they know of historical properties within the project area, they are sought out for additional

consultation and interviews. Individuals who have particular knowledge of traditions passed down from preceding generations and a personal familiarity with the project area are invited to share their relevant information concerning particular cultural resources. Often people are recommended for their expertise, and indeed, organizations, such as Hawaiian Civic Clubs, the Island Branch of Office of Hawaiian Affairs (OHA), historical societies, Island Trail clubs, and Planning Commissions are depended upon for their recommendations of suitable informants. These groups are invited to contribute their input and suggest further avenues of inquiry, as well as specific individuals to interview. It should be stressed again that this process does not include formal or in-depth ethnographic interviews or oral histories as described in the OEQC's *Guidelines for Assessing Cultural Impacts* (2012). The assessments are intended to identify potential impacts to ongoing cultural practices, or resources, within a project area or in its close vicinity.

If knowledgeable individuals are identified, personal interviews are sometimes taped and then summarized. These draft summaries are returned to each of the participants for their review and comments. After corrections are made, each individual is to sign an information release form, making the interview available for this study. When telephone interviews occur, a summary of the information is also sent for correction and approval or dictated by the informant and then incorporated into the document. If no cultural resource information is forthcoming and no knowledgeable informants are suggested for further inquiry, interviews are not conducted.

KA PA'A KAI O KA'AINA V. LAND USE COMM'N, STATE OF HAWAI'I

The Land Use Commission (LUC) is also required to apply the analytical framework set forth by the Hawaii Supreme Court in Ka Pa'akai O Ka'Aina v. Land Use Comm'n, State of Hawai'i, 94 Hawai'i 31, 7 P.3d 1068 (2000) (hereinafter, "Ka Pa'akai"). In this case, a coalition of native Hawaiian community organizations challenged an administrative decision by the Land Use Commission (the "LUC") to reclassify 1,010 acres of land from conservation to urban use, to allow for the development of a luxury project including upscale homes, a golf course, and other amenities. The native Hawaiian community organizations appealed, arguing that their native Hawaiian members would be adversely affected by the LUC's decision because the proposed development would infringe upon the exercise of their traditional and customary rights. Noting that "[a]rticle XII, section 7 of the Hawaii Constitution obligates the LUC to protect the reasonable exercise of customarily and traditionally exercised rights of native Hawaiians to the extent feasible when granting a petition for reclassification of district boundaries," the Hawai'i Supreme Court held that the LUC did not provide a sufficient basis to determine "whether [the agency] fulfilled its obligation to preserve and protect customary and traditional rights of native

Hawaiians" and, therefore, the LUC "failed to satisfy its statutory and constitutional obligations." Ka Paʻakai, 94 Hawaiʻi at 46, 53, 7 P.3d at 1083, 1090.

The Hawaiʻi Supreme Court in Ka Paʻakai provided an analytical framework in an effort to effectuate the State's obligation to protect native Hawaiian customary and traditional practices while reasonably accommodating competing private interests. In order to fulfill its duty to preserve and protect customary and traditional native Hawaiian rights to the extent feasible, the LUC must—at a minimum—make specific findings and conclusions as to the following:

A. the identity and scope of "valued cultural, historical, or natural resources" in the petition area, including the extent to which traditional and customary native Hawaiian rights are exercised in the petition area;

B. the extent to which those resources--including traditional and customary native Hawaiian rights--will be affected or impaired by the proposed action; and

C. the feasible action, if any, to be taken by the LUC to reasonably protect native Hawaiian rights if they are found to exist.

See Ka Paʻakai, 94 Hawaiʻi at 47, 7 P.3d at 1084.

To fulfill these purposes outlined by Ka Paʻakai, the Cultural Impact Assessment has reviewed historical research and suggestions from contacts knowledgeable about traditional cultural practices which were conducted within the project area corridor and in the surrounding environs. The potential effect of the proposed project on cultural resources, practices or beliefs, its potential to isolate cultural resources, practices or beliefs from their setting, and the potential of the project to introduce elements which may alter the setting in which cultural practices take place has been analyzed, as required by the OEQC (2012).

ENVIRONMENTAL SETTING

Island of Maui ranks second in size of the eight main islands in the Hawaiian Archipelago (Stearns 1966:155, Handy and Handy 1972:485). Maui Island was formed by two volcanoes, Puʻu Kukui in the west and Haleakalā in the east. Puʻu Kukui stands 1,215 meters (m.) above mean sea level (amsl.) is composed of large, heavily eroded amphitheater valleys that contain well-developed permanent stream systems that watered fertile agricultural lands extending to the coast. The isthmus between the two volcanoes is primarily composed of alluvial fans made of out-washed silts and gravels overlain by coralline sands blown inland from the coast. Lower sand strata have become firmly lithified, forming a soft rock known as eolianite (Stearns 1966:10).

Pu‘u Kukui (from Hawaiian, “candlenut peak”) dominates the western part of the island, rising to 1,764 m (5,788 ft) above mean sea level (amsl). The West Maui Mountains (Mauna Kahalawai) are surrounded by large, heavily eroded amphitheater valleys that sustain permanent stream systems and fertile agricultural lands extending to the coasts.

Haleakalā soars 2,727 m (10,023 ft) amsl, forming the larger eastern section of the island. The flanks of Haleakalā are distinguished by gentle slopes. Although they receive more rain than their counterparts in the west, the permeable lavas of the Honomanū and Kula Volcanic Series prevent the formation of rain-fed perennial streams. Thus, the few perennial streams found on the windward side of Haleakalā originate from springs located at lower elevations, while valleys and gulches on the leeward side were formed by intermittent water run-off.

VEGETATION

The Kipahulu region of Maui is classified as a “closed guava forest with shrubs” Vegetation Zone (Armstrong 1983:70). The project area interspersed with course patches of mango (*Mangifera* spp.), cane grass (*Pennisetum purpureum*), *waiwi* (strawberry guava, *Psidium cattleianum sabine*), guava (*Psidium guajava*), *‘awapuhi* (wild ginger, *Zingiber zerumbet*), *‘ulu* (breadfruit, *Artocarpus altilis*), *hau* (*Hibiscus tiliaceus*), *lauhala* (*Pandanus odoratissimus*), *niu* (coconut, *Cocos nucifera*), *kukui* (*Aleurites moluccana*), and *ti* (*cordyline fruiticosa)*. Other vegetation common throughout the project area consists mostly of introduced, post-Contact species, including sisal (*Agave sisalana*), papaya (*Carica papaya*), tamarind (*Tamarindus indica*), be-still tree (*Cascabela thevetia*), Mauna Loa (*Canavalia cathartica*), indigo (*Indigofera suffruticosa*), castor bean (*Ricinius cummunis*), Christmas berry (*Schinus terebinthifolius*), smooth rattlepod (*Crotalaria pallida*), lantana (*Lantana camara*), flora’s paintbrush (*Emilia fosbergh*), garden spurge (*Chamaesyce hirta*), partridge pea (*Chamaecrista nictitams*), *koa haole* (*Leucaena leucocephala*), sow thistle (*Sonchus oleraceus*), and hare’s foot fern (*Phlebodium aureum*) (Sohmer and Gustafston 1993).

PROJECT AREA

The proposed project area is a 400-foot (121.92 m) section of the Pi‘ilani Highway near Kālepa Point (mile post 38.6±) and situated immediately adjacent and east of the southeast coast of Maui (see Figures 1 through 3). The area is on the Kālepa headland located between two drainage systems, the Kālepa Gulch and Alelele Stream. The highway is at an elevation of approximately 25 ft. amsl. as it passes around the Kālepa headland with a shear rock road cut on the east side of the road and a sloping rock embankment on the west side. The road cut is draped in steel rock fall netting. In some areas, the rock embankment has been modified with sections of concrete rubble masonry and rock rubble mound shore protection.

The project area is part of the Kīpahulu Cliff and Valley physiographic division, composed of a series of cliffs and small valleys carved by streams leading out to the ocean. (Armstrong 1983). The topography ranges from relatively flat valleys that were cut by Alelele and Kālepa Streams to steep ridges that dominate the landscape. Geologically, the project area is part of the lower southeastern slopes of the Haleakalā Volcano. Haleakalā National Park, a federal site managed by the U.S. National Park Service, makes up the east side of the project area, and County of Maui lands make up the western portion.

CLIMATE AND HYDROLOGY

The project area is an existing roadway corridor and the existing adjacent revetment and seawall. Thus, the project area is comprised of inherently disturbed soil, fill materials, and artificial materials..

Located on the southern coast of East Maui, the proximity of the ocean and trade winds moderate the temperature, maintaining a year-round average of 23.09 °C (73.5°F) (Giambelluca et al. 2014). Along with being the driest month, August is also the hottest month with a mean air temperature of 24.9°C (76.8°F). The area is at its coldest in February with an average temperature of 21.3°C (70.4°F) (Giambelluca et al. 2014).

In the Kīpahulu District, the average annual rainfall is 1495.9 mm (58.8 in). Much of the area's rainfall occurs over the winter months with January being the rainiest, averaging 191.73 mm (7.58 in). The driest month is August with a mean rainfall of 81.5 mm (3.2 in) (Giambelluca et al. 2014). The area's perennial streams (i.e., Alelele Stream) gain volume from heavy precipitation, rapidly changing current velocity. Low precipitation, usually experienced in the summer months, can result in little to no flow (Armstrong 1973).

SOILS

According to Foote et al. (1972:Sheet 126; Figure 4), the project area is located within the Rough Mountainous Land (rRT) soil type. The rRT soils consist of very steep land broken by drainage channels. The soil mantle is very thin and is permeable to roots and water. The land surface "is dominated by deep, V-shaped valleys that have extremely steep slopes and narrow ridges between the valleys" (Foote et al. 1972:119). This soils type's natural vegetation consists of ʻōhiʻa (*Metrosideros polymorpha*), lantana (*Lantana camara)*, *kukui* (candlenut, *Aleurites moluccana*), and pūakeawe (heather, *Leptecophylla tameiameiae).*



Figure 4: USDA Soil Survey (Foote et al. 1972; Sheet Number 126) Overlay on Satellite Image (Google 2021; Imagery Date 1/13/2013) Showing Soil Types within the Project Area and Surrounding Environs.

TRADITONAL AND HISTORICAL CULTURAL CONTEXT

Traditionally, the Hawaiian economy was based on agricultural production and marine exploitation, as well as raising livestock and collecting wild plants and birds. Extended household groups settled in various ahupuaʻa. During pre-Contact times, there were primarily two types of agriculture, wetland and dry land, both of which were dependent upon geography and physiography. River valleys provided ideal conditions for wetland *kalo* (*Colocasia esculenta*) agriculture that incorporated pond fields and irrigation canals. Other cultigens, such as kō (sugar cane, *Saccharum officinaruma*) and maiʻa (banana, *Musa* sp.), were also grown and, where appropriate, such crops as ʻuala (sweet potato, *Ipomoea batatas*) were produced. This was the typical agricultural pattern seen during traditional times on all the Hawaiian Islands (Kirch and Sahlins 1992, Vol. 1:5, 119; Kirch 1985).

PAST POLITICAL BOUNDARIES

Approximately 600 years ago, the Hawaiian population had expanded throughout the Hawaiian Islands to a point where large, political districts could be formed (Lyons 1903; Kamakau 1961). During the pre-Contact Period, Maui was divided into twelve districts (moku) (Sterling 1998:3). Following the Civil Code of 1859, the twelve districts were consolidated into four districts: Lāhainā, Wailuku, Makawao, and Hāna (Sterling 1998:3). Approximately 600 years ago, the Island of Maui was divided into twelve districts: Lāhainā, Kula, Honuaʻula, Kahikinui, Kaupō, Kīpahulu, Hāna, Koʻolau, Hāmākualoa, Hāmākuapoko, Wailuku, and Kāʻanapali (Sterling 1998:3; Figure 5). The division of Maui Island lands into districts and sub-districts was performed by a kahuna (priest, expert) named Kalaihaʻōhia, during the time of the aliʻi Kakaʻalaneo (Beckwith 1940:383; Fornander [1919-20, Vol. 6:248] places Kakaʻalaneo at the end of the 15th century or the beginning of the 16th century). Land was considered the property of the king or aliʻi ʻai moku (the aliʻi who eats the island/district), which he held in trust for the gods. The title of aliʻi ʻai moku ensured rights and responsibilities to the land but did not confer absolute ownership. The king kept the parcels he wanted, his higher chiefs received large parcels from him and, in turn, distributed smaller parcels to lesser chiefs. The makaʻāinana (commoners) worked the individual plots of land.

In general, several terms, such as moku, ahupuaʻa, ʻili or ʻili ʻāina were used to delineate various land sections. A moku contained smaller land divisions (ahupuaʻa), which customarily continued inland from the ocean and upland into the mountains. Extended household groups living within the ahupuaʻa were therefore, able to harvest from both the land and the sea. Ideally, this situation allowed each ahupuaʻa to be self-sufficient by supplying needed resources from different environmental zones (Lyons 1875:111). The ʻili ʻāina or ʻili were smaller land divisions next to importance to the ahupuaʻa and were administered by the chief who controlled the ahupuaʻa in which it was located (Lyons 1875:33; Lucas 1995:40). The moʻoʻāina were narrow strips of land within an ʻili. The land holding of a tenant or hoa ʻāina residing in an ahupuaʻa was called a kuleana (Lucas 1995:61).

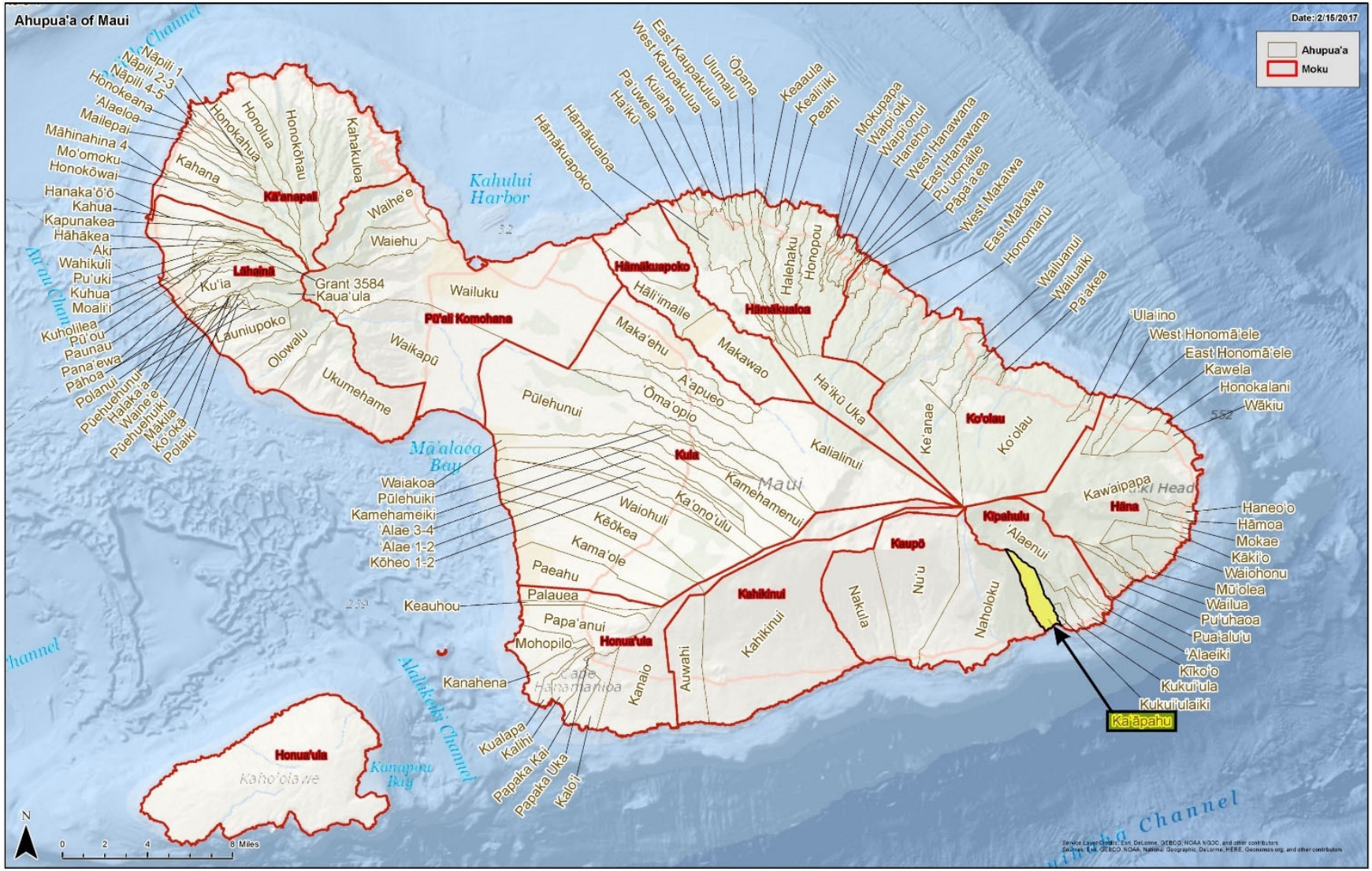


Figure 5: Map of the Island of Maui Showing Ahupua‘a within the Traditional Districts (Courtesy of Island Breath.org).

TRADITIONAL SETTLEMENT PATTERNS

Archaeological settlement pattern data suggests that initial colonization and occupation of the Hawaiian Islands first occurred on the windward shoreline areas of the main islands between A. D. 850 and 1100, with populations eventually settling in drier leeward areas during later periods (Kirch 2011). Although coastal settlement was dominant, native Hawaiians began cultivating and living in the upland kula (plains) zones. Greater population expansion to inland areas began around the 14th century and continued through the 16th century. Large scale or intensive agriculture was implemented in association with habitation, religious, and ceremonial activities.

In Hawaiʻi, much of the coastal lands were preferred for chiefly residence. Easily accessible resources such as offshore and onshore fishponds, the sea with its fishing and surfing—known as the sports of kings, and some of the most extensive and fertile wet taro lands were located in the coastal areas (Kirch and Sahlins, 1992 Vol. 1:19). Inland resources necessary for subsistence could easily be brought to the aliʻi residences on the coast from nearby inland plantations. The majority of farming was situated in the lower portions of stream valleys where there were broader alluvial flat lands or on bends in the streams where alluvial terraces could be modified to take advantage of the stream flow. Dry land cultivation occurred in colluvial areas at the base of gulch walls or on flat slopes (Kirch 1985; Kirch and Sahlins 1992, Vol. 2:59).

PRE-CONTACT PERIOD (PRE-1778)

The project area is located within the traditional District (moku) of Kīpahulu, which is now part of the modern District of Hāna. The District of Kīpahulu (see Figure 5), the smallest district on the Island of Maui, is bordered by the District of Hāna, on the northeast, and Kaupō, on the southwest. Kīpahulu, which literally translates to “fetch [from] exhausted gardens” (Pukuʻi et al. 1974:112).

Trails extended from the coast to the mountains, linking the two for both economic and social reasons. The King’s Trail or ala nui (“long road”) which was built by Kihapiʻilani, extended along the coast passing through all the major communities and connected West Maui to East Maui. These trails were not only used in the prior to 1778 and the introduction of westerners to the Hawaiian Islands, but were expanded to accommodate wagons bringing produce to the coast in the 1850s (Kolb et al. 1997:61). Handy and Handy (1972:507) mention trails they observed in the area in their description of:

> …an *ʻokana* (district) with rich and diverse but scattered agricultural resources. Its great valley and lower fringing forests nourished forest taro and other native food plants, as did the lower *kula* lands above the sea… there were still some pockets of taro culture as late as 1934.
>
> Kukuiʻula Stream, where the rugged ridge-and-valley trail to Kaupo begins [Figure 6], watered several small group of terraces; the small valley of Lolokea once had a few small terraces, no longer cultivated.
>
> In Hanawi there are a few small terraces watered by Alelele Stream as it flow down through Hanawi Valley to the sea, which were being replanted in wet taro in 1934. There are a few dry terraces in Kālepa which presumably were used for wet taro in ancient times. Nuanualoa, the last valley before one sights the plains of Kaupo, traveling westward. had a handful of hou es with a few cultivated terraces.

HISTORIC PERIOD (POST-1778)

On November 26, 1778, British Explorer Captain James Cook and his fleet passed by the island of Maui on their return from the extreme Northern Pacific (Daws 1974: 8; Beaglehole 1967: Part I, Vol. III).).The Historic Period begins with Cook's cartographer, Henry Roberts, documenting the islands by creating the first known map of the Hawaiian Islands.

At the time of Cook's visit, the war between Kalaniʻōpuʻu and Kahekili had not been over, and the latter was preparing for another attack (Speakman 1978: 26). The internal affairs on the island proceeded independently of any significant Western influence for quite some time. In fact, the height of Maui's political power was reached during the reign of Kahekili in 1783, five years after the encounter with Captain Cook (Kolb et al. 1997: 3). Upon hearing of the natural death of his rival, Kalaniʻōpuʻu, the ambitious Kahekili started the so-called "War of Hawaiian Succession," which soon resulted in his conquest of Oʻahu (Speakman 1978: 48–51).

After Kahekili's death at Waikīkī in 1794, his realm succumbed to fratricidal conflicts and the mounting pressure from the powerful chief of the island of Hawaiʻi, Kamehameha I (1758–1819) (Daws 1974: 38). In the following years, the descendants of Piʻilani and the chiefly Maui families were for the most part robbed of their possessions, unless they surrendered to the Hawaiʻi Island conquerors (Fornander 1916/1917, Vol. 6: 310).

On May 29, 1786, Jean-François de Galaup, comte de Lapérouse, became the first European in recorded history to have set foot on Maui. Lapérouse's hydrographer, Sebastia*n* Bernizet, created a map of the archipelago. However, it proved less accurate than the one created by *C*ook's team.

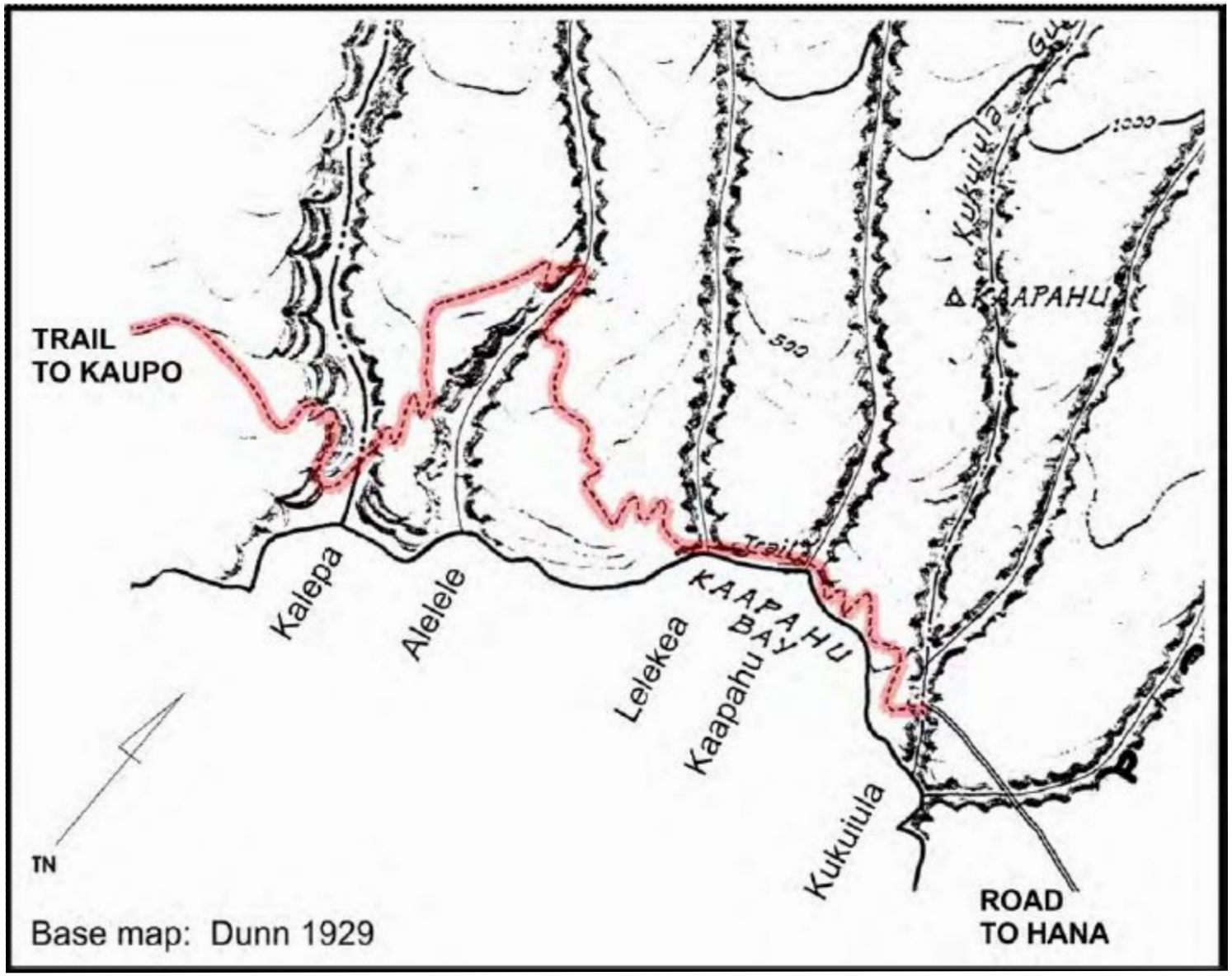


Figure 6: The Kīpahulu-Kaupō trail through the Ka‘āpahu valleys, as shown on the 1929 map by J.M. Dunn (From Tomonari-Tuggle et al. 2015:22).

Maui, along with the rest of the newly named Sandwich Isles, quickly became an important stop for fur traders on their way to Canton (Guangzhou), China. In the following decades, the traditional way of life was changed by commercial activities (sandalwood trade, whaling) and the introduction of Christianity.

By the mid-1830s, the Hāna and Kīpahulu areas of Maui had undergone a drastic change (Yzendoorn 1927). Missionaries and other settlers who came to Maui established homesteads, schools, churches, and literacy programs. Population estimates during this time can be inferred from the various population censuses of missionaries and local officials. An 1860 census of the Hāna area recorded a population of 4,491 people; the 1884 census showed the population had declined to 2,061 people (Soehren 1963: 4).

THE MĀHELE

In the 1840s, traditional land tenure shifted drastically with the introduction of private land ownership based on Western concepts. At the time of Kauikeaouli (Kamehameha III, r. 1825–1854), a consequential transition from traditional land tenure to private ownership took place; that change is known as the Māhele (from Hawaiian, "division"). As early as 1841, the legislature allowed island governors to lease lands to foreigners for up to fifty years. These leases were then registered "in writing so that there be no misunderstandings about terms and rents" (Daws 1974: 125). The question of land reform was set aside in 1843 because of the five-month occupation of the islands by British naval officer George Paulet, but once the kingdom was stable again, discussions pertaining to land reform resumed (Daws 1974: 125). By 1844, the aliʻi were warming up to the proposal for a formal land division, and in 1845 the Board of Commissioners to Quiet Land Titles (the Land Commission), was established for "the investigation and final ascertainment or rejection of all claims of private individuals, whether natives or foreigners, to any land property" (Chinen 1958: 8). The Commission had no authority to divide lands or change their tenure, but solely presided over the granting/denying of land claims (Kuykendall Vol. I, 1938: 280).

The Māhele of 1848 divided Hawaiian lands between the king, the chiefs (aliʻi and konohiki), and the government, introducing the foreign concept of private land ownership and setting the stage for vast changes to land holdings in the islands. Article IV of the Board of Commissioners to Quiet Land Titles was passed in December 1845, initiating legal private land ownership. In January 1846, land was made available to the commoners (makaʻāinana). Once lands private ownership was instituted, Hawaiians, including the makaʻainana, were able to claim land plots upon which they had been cultivating and living through the Kuleana Act of 1850. These claims did not include any previously cultivated but presently fallow land, stream fisheries, or many other resources necessary for traditional survival (Kameʻeleihiwa 1992: 295). Once Hawaiians established their occupation of property through the testimony of two witnesses, the petitioners

were awarded the claimed land, which was called Land Commission Award (LCA), or kuleana lands, and issued a Royal Patent (RP), after which they could take possession of the property (Chinen 1961: 16). Commoners claiming house lots in Honolulu, Hilo, and Lāhainā were also required to pay commutation to the government before obtaining a Royal Patent for their awards.

Foreigners could acquire land through the Alien Landownership Act of 1850. Oftentimes, they were simply given lands by the aliʻi. Commoners, however, could make claims only if they had first been made aware of the foreign procedures. Many of them found them unfamiliar, lengthy and costly, and as a result many Hawaiians missed an opportunity to claim for themselves the lands that had been sustaining their ancestors (Daws 1974: 127–128; Chinen 1961: 16).

The Waihona ʻAina Database (2021) indicates Kaʻāpahu Ahupuaʻa was claimed by King Lunalilo and Charles Kanaina, under LCA number 8559 B:19. Of note is there is that no Royal Patent was issued. According to the Office of Hawaiian Affairs Kipuka Database (2021):

> Lunalilo claimed all of Kaapahu ahupuaa in Buke Mahele vol.10 pg.481. Based on RM 1268A there is a possibility the mauka-most portion of the parcel was Government: Needs More Research.

Lunalilo was the son of Miriam Kekāuluohi, sister of Kamāmalu and Kīnaʻu and wife of Kamehameha I. Following the death of Kamehameha I, Kekāuluohi became the wife of Kamehameha II. Later she married Charles Kanaina, a friend of Kamehameha I, and produced the future King Lunalilo (Day 1984:74). Kamehameha V (Lot) died in December 1872 without naming a successor. Of the two viable successors, David Kalākaua and Lunalilo, the legislature unanimously selected Lunalilo. A He served as king for just over a year before dying of tuberculosis in 1874 (Day 1984:88).

As a result of the Māhele, land was easier to obtain, and vast areas were purchased for sugar cultivation. Sugar dominated Maui's economy for nearly a century starting in the 1860s. Commercial sugarcane agriculture and cattle ranching came to East Maui during the middle to late nineteenth century. However, rough terrain in the project area prevented large-scale endeavors. Scant evidence of domestic and small-scale farming activity in the project area is indicative of the small-scale rural settlement that took place there (Hommon 1994). According to Dorrance and Morgan (2000), the Kīpahulu Sugar Company operated from 1879 to 1925. The authors go on to call the business "unusual in the sense that it was incorporated with all shares of stock owned by German nationals" (Dorrance and Morgan 2000: 67). Interestingly enough, Kīpahulu Plantation was used as an internment camp during World War I: "several Germans classified as alien enemies" were sent to Kīpahulu "to wield hoes" (Bartholomew and Bailey 1994: 135).

The Māhele forced many rural farmers to relocate to commercial centers on Maui. Following the collapse of sugarcane agriculture in East Maui, ranchers began to purchase large swathes of land for cattle grazing. The completion of the Hāna Belt Road (SIHP Site #50-50-06-1638), now called the Hāna Highway, in 1926, linked Hāna with the rest of Maui, allowing easier access for residents and prospective businesses. In 1997, the state declared the upper reaches of East Maui a forest reserve (Kolb 1993; Fredericksen and Fredericksen 2001).

LAND GRANTS

In some cases, the Hawaiian government sold lands to generate income for the Kingdom. These lands were referred to as land grants. According to the Waihona ʻAina Online Database (2019):

> At the time of the Mahele, some of the land was the King's own land which later became known as Ceded Lands. Other lands in the possession of aliʻi were returned to the King in exchange for Commutation of property the aliʻi kept. Some of these returned lands became Government lands and were sold by the government to generate income for the Kingdom, since the King gave up his traditional right to collect taxes and goods following the Mahele.

No Land Grants were identified in the vicinity of the proposed project area.

In 1853, John Rae described the heart of the Kaupō District and its agricultural yields. Much like Kaupō, the project area's dry, rocky land made taro cultivation difficult. Thus, in order to survive, local people made use of the soil deposits collected under stones, or they walked high onto the mountain and planted in the rich volcanic soil that lay there. Rae (1853:10) observed:

> Looking inland one sees forest broken acclivities of small height very stony and promising little to reward the labour of their cultivation. Yet when the surface stones are thrown into the form of low rude fences, the intervening spaces cultivated in the native manner yield largely of the sweet potato, & the onion, with here and there a few head of tolerable maise.

Along with the political and economic changes, the 20th century also brought a dramatic shift in Maui's demographics. Because of rampant diseases among the native population and the resulting labor shortage, Maui's plantations began importing foreign workers. Many Chinese came to the Islands in the 19th century, followed by the majority of the Portuguese and the Japanese at the turn of the 20th century. After Japan was closed as a source of immigration to Hawaiʻi in 1907, approximately 120,000 Filipinos moved to the Territory, until 1931 (Speakman 1978: 151). Finally, Caucasians began moving to the islands in greater numbers only after Hawaiʻi "began to figure prominently as a military and tourist frontier" (Speakman 1978: 161).

In 1997, David Dodd, the former landowner, sold his lands between Kīpahulu and Kaupō [TMK: (2) 1-6-010:001, 006, 007, and 0008] to Haleakalā National Park (statement supplied by Elizabeth Gordon, n.d., former Archaeologist, of Haleakalā National Park). The purchase, which increased the land holdings of Haleakalā National Park from 28,000 to 34,000 acres, occurred during the seventeen year (1988 – 2005) tenure of Donald "Don" Reeser as Superintendent of Haleakalā National Park (Haleakalā National Park Website 2021).

Today, East Maui serves as a reminder of traditional Hawai‘i – rural and relatively untouched by development (i.e., no resorts or industrialized areas). Commercial horseback riding stables and local farming are the primary business in the area (National Park Service 1998: 35).

WAHI PANA (LEGENDARY PLACES)

"Wahi Pana" can be defined as celebrated or noted places or locations (Pukui and Elbert 1986:313, 376), and refers to legendary places or landmarks of historical significance. These places of note have distinctive features (i.e., mountain peaks, streams, wind, rain) that are given specific names through which the history of an area is passed down from generation to generate on through chants, legends, and songs.

According to Kamakau (1870, cited in Sterling 1998:2), "the ancient name of the island of Maui was Ihikapalaumaewa." The island was renamed "after a famous child of Wakea and Papa who became ancestor of the people of Maui" (Sterling 1998:2). Another former name of the island is "Kūlua" (from Hawaiian, "pair; twins"), "perhaps called so because of the two divisions, East Maui and West Maui" (Sterling 1998:2).

Before the unification by the ali‘i Pi‘ilani in the late 1500s, the whole of Maui was ruled by two separate kingdoms – one centered in Hāna on the windward coast and one in Wailuku. Along with consolidating power on the island, Wailuku's chief, Pi‘ilani, also raised Maui's political status in the archipelago by ruling judiciously and using his connections with the reigning chiefly families of O‘ahu and Hawai‘i (Fornander 1916/1917, Vol. 2: 87).

Pi‘ilani's heir was his firstborn son, Lono-a-pi‘ilani. Oral tradition states that after a rift between Lono-a-pi‘ilani and his younger brother, Kiha-a-pi‘ilani (born c. 1626), the latter took refuge in a place known as Ke‘eke‘e (from Hawaiian, "zigzag") in the Kula District. Subsequently, he traveled to the island of Hawai‘i, which was the kingdom of their brother-in-law, Umi. He convinced Umi to send an army to Maui to avenge Kiha and dethrone Lono (Fornander 1919, Vol. 5:178–180). One version of the story claims Lono was captured and killed by Umi's troops in Waihe‘e, northwest of Kahului. However, Kamakau (1961: 31) states that the Wailuku-based chief died of terror before the invading army reached his residence. In any case, after the successful invasion, Kiha-a-pi‘ilani became the sole ruler of Maui and the royal residence was relocated to the eastern part of the island.

The 18th century was marked by a rivalry between Maui and Hawai‘i Island. At the end of his reign, Kekaulike (c. 1700–1736) raided Hawai‘i from his seat at Kaupō. Fearful of retaliation, Kekaulike withdrew to Wailuku, but he developed an acute and fatal case of what Kamakau (1961: 69) classifies as epilepsy (“ka maka huki lani” or “eyes drawn heavenward”). His heir was Kamehameha-nui, the son of a half-sister of the Hawai‘i Island chief, Alapa‘i. With the help of his uncle, Kamehameha-nui defeated his older half-brother, Ka‘uhi, in 1738 and secured his rule over Maui (Kamakau 1961:74).

Maui experienced a period of relative peace and prosperity before the conflict returned with the wars between another of Kekaulike’s sons named Kahekili (c. 1737–1794), ruling chief of Maui, and Hawai‘i Island chief Kalani‘ōpu‘u. Shortly before the arrival of Captain James Cook, Kalani‘ōpu‘u's armies had landed and plundered the southern district of Honua‘ula before moving to Mā‘alaea Bay, from where the chief planned to invade Wailuku (Fornander 1916/1917, Vol. 2: 147-157). After losing two battles to Kahekili, Kalani‘ōpu‘ū welcomed a truce, concentrating his efforts on the eastern side of Maui, protecting Hāna and Kīpahulu, which were his spoils from an earlier battle in 1759 (Fornander 1916/1917, Vol. 2:147).

Between 1775 and 1779, Kalani‘ōpu‘u launched a surprise attack on the people of Kaupō, killing hundreds of villagers. The violent attack the Hawai‘i Island warriors unleashed on the Maui Island forces was so well known throughout Kaupō that the battle became known as the Kalaehohoa, for “the forehead beaten by clubs” (Fornander 1880).

In the mid-1780s, Kahekili and his chiefs were living on O‘ahu when word reached them that trouble was brewing on Maui. “During this period there were disturbance among the country people, not only on Oahu but also on Maui” (Kamakau 1961:142). In response to these uprisings on Maui, Kahekili chose his son, Kalanikūpule, to be ruling chief of Maui and to return to Maui with some of the other chiefs to put these types of events to rest. Shortly after this c. 1786, chiefs from Hawai‘i Island, which included Kamehameha’s brother, Kalanimālokuloku-i-Kepo‘okalani, attempted to overtake the Maui districts of Hāna and Kīpahulu, which subsequently became known as the Battle of the Red Mantle . (Kamakau 1961: 143).

Prior to this battle, Kalanimālokuloku-i-Kepo‘okalani had been living for some time on Maui, in Kīpahulu and Hāna, where he earned the name Keali‘imaika‘i (Keli‘imaika‘i), “the Good Chief,” because of his many acts of kindness. During the Battle of the Red Mantle, Keli‘imaika‘i forbid his warriors from “touching the property of the common people” (Kamakau 1961:143). As Kamakau (1961: 143) recounts:

> On the day of the battle of "The-red-mantle" (Koʻahuʻula), the foe came down to Kipahulu on the Kaʻapahu side of Lelekea; the hills reflected the red of Kamohomoho's mantle. Ke-aliʻi-maikaʻi hastily made his war canoes ready, met the main body of warriors at the Kukuiʻula, and encountered some of the skirmishes; then both sides attacked. Finally Ke-aliʻi-n1aikaʻi retreated to Waipalua. Both sides had lost alike, but Ka-mohomoho had the stronger force. At Kapukaiʻolena in Maʻulili the fighting was resumed and Ke-aliʻi-maikaʻi was in jeopardy.

According to Kamakau (1961:143), it was said that Keliʻimaikaʻi's reputation for protecting the Maui people saved his life when he was captured by the Maui warriors during this Battle of the Red Mantle.

In addition to being associated with battles and warfare, Kīpahulu District is known for a wind called "Makani kaili aloha o Kīpahulu (love snatching wind of Kīpahulu)… [that] blows down from the mountain and goes out to the sea." This wind is associated with the story a woman who returns to her husband in Kīpahulu after leaving him to live with her lover on Oʻahu. The heartbroken husband sought the help of a kahuna, who filled the calabash with "the saddest, heart-rending love songs" before releasing it into the ocean. After finding the calabash on the beach in Waikīkī, the woman immediately embarked on her journey back to her husband in Kīpahulu, "where they lived…comfortably and happily to their old age" (Maunupau 1922, cited in Sterling 1998:157-158).

Heleipawa "was a high chief of the ʻUlu line of chiefs, born in the legendary period of Hawaiian royal genealogy" (Cachola-Abad 2000 cited in Tomonari-Tuggle et al. 2015:18). It is believed that Heleipawa was born at Lelekēa, in Kaʻāpahu Ahupuaʻa (Malo 1951:246). Kamakau (1961:137-138, cited in Tomonari-Tuggle et al. (2015:18) elaborates:

> The site of the house that [Heleipawa] built is well known and is still clearly discernible; Ka-hale-i-kalalea was its name. His freshwater spring, called Kuaʻi, is in the sea about ten chains from land, where the sea is about twenty feet deep.

Although Heleipawa and Kapawa, his father, precede the beginnings of a ruling elite on the island (Tomonari-Tuggle et al. 2015:18), Beckwith (1940:377-378) states:

> It was from the time of Heleipawa of Maui, whom some identify with Kapawa, that there began to be composed chants for a ruling chief in which were named his birth and burial places, the spots in which afterbirth, umbilical cord, and navel string were deposited, his house site, and other places sacred to his history. The site of the famous pleasure house (Hale-i-ka-lea) in Kipahulu built by Heleipawa was still to be seen in Kamakau's day, and the tapu spring of fresh water, welling up in the sea at Kaui [Kuaʻi] from a depth of twenty feet and walled up so firmly that the waves had nor loosened the stones, where the chiefs of his day washed off the salt water when coming in from surfing.

PREVIOUS ARCHAEOLOGY

Archaeological studies on the Island of Maui began in the early 20th Century by T. Thrum (1909), J. Stokes (1909–1916), and W. M. Walker (1931), under the auspice of the Bernice Pauahi Bishop Museum. These studies are briefly discussed below, and the project locations are presented in Figure 7 and the locations of previously identified archaeological sites area shown in Figure 8.

Thomas George Thrum focused on coastal heiau and legends in the area. In 1909, Thrum recorded the heiau of Maʻulili located near Hāna, near the Kīpahulu Mill, a sugar mill built in 1878. Thrum (1909) stated that the heiau was of luakini ("human sacrifice") class and had been re-dedicated by Liholiho, the son and successor of Kamehameha I. This is possibly the structure described by Kamakau (1961: 188): "…the Peleleu set sail, touching first at Kīpahulu where Kamehameha erected the god house called Maʻulili". Only a paramount chief, such as Kamehameha, could have a luakini class of heiau built (Thrum 1909).

Eight years later, Thrum returned to the southeastern coast of Maui and recorded six more heiau along the Kīpahulu coastal area, as well as a puʻukaua (fort) in the Lelekēa Valley in Kaʻāpahu Ahupuaʻa (1917). The puʻukaua may have played a role in the Battle of The Red Mantle described in the Wahi Pana section of this report. In 1917, Thrum recorded Manekineki Heiau, near the road at Kuikuiʻula, and wrote of the Paokahi Heiau at Lelekēa in Kīpahulu, describing the large 100-foot wide by 149-foot long *heiau* as "in ruins." Thrum (1917) corrected his previous noted location of the Maʻulili Heiau, stating that it was near the shore. He explained that the name of Lelekēa ("breath flown") referred to "the incident of an ancient *aliʻi* being brought to the temple in a weak condition and expiring there" (Thrum 1917: 56–57; Thrum in Kornbacher 1993: 13; Sterling 1998: 162).

Winslow Walker, who began his island-wide survey of Maui in 1928 as research for the Bernice Pauahi Bishop Museum, also focusing on traditional legends and heiau. He mostly recorded heiau located along the coast (Walker 1931). Walker located Paokahi Heiau (Walker Site

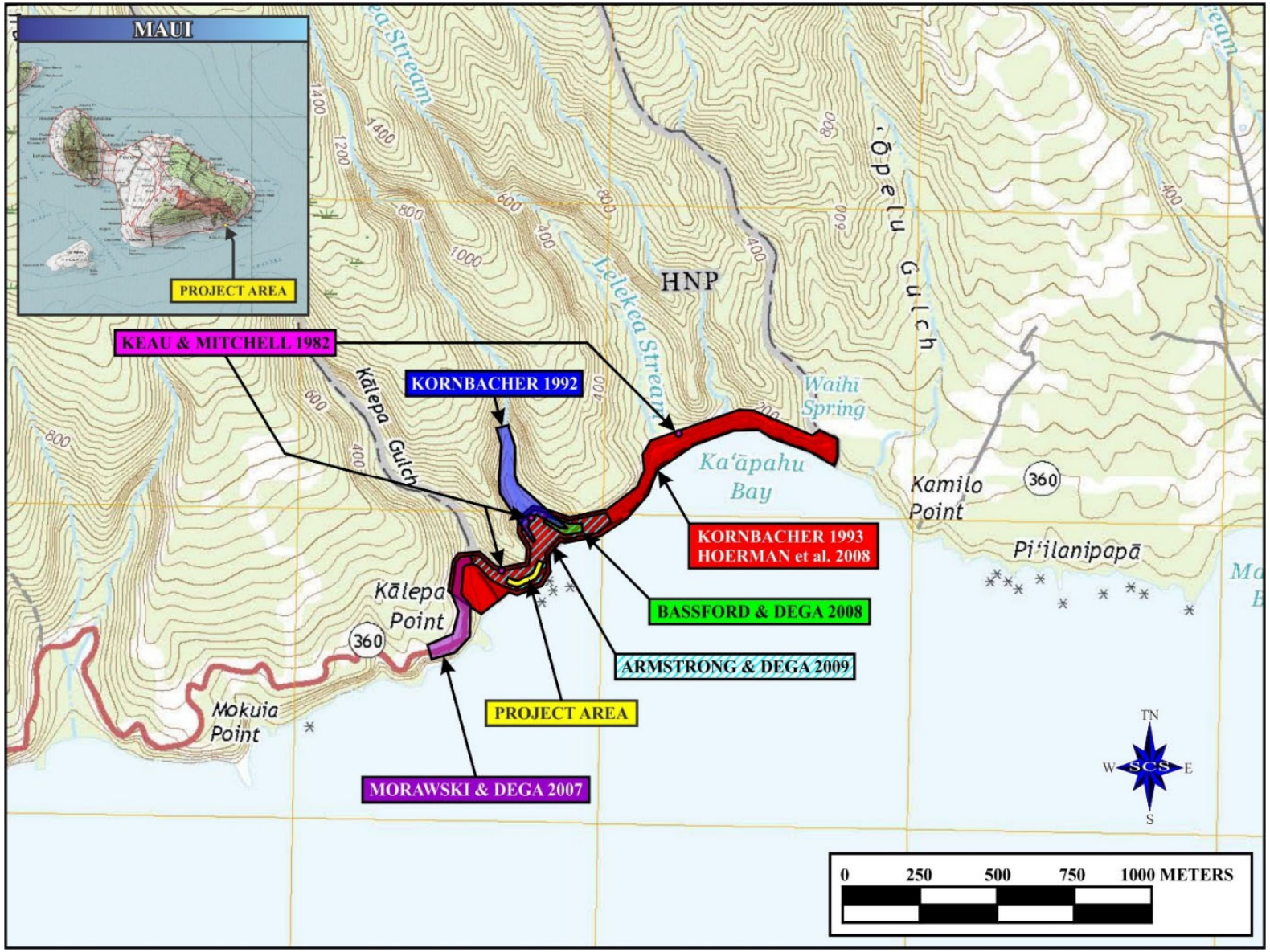


Figure 7: USGS Quadrangle (Kaupo 2017: 1;24,000) Showing Locations of Previous Archaeological Work in the Vicinity of the Project Area.

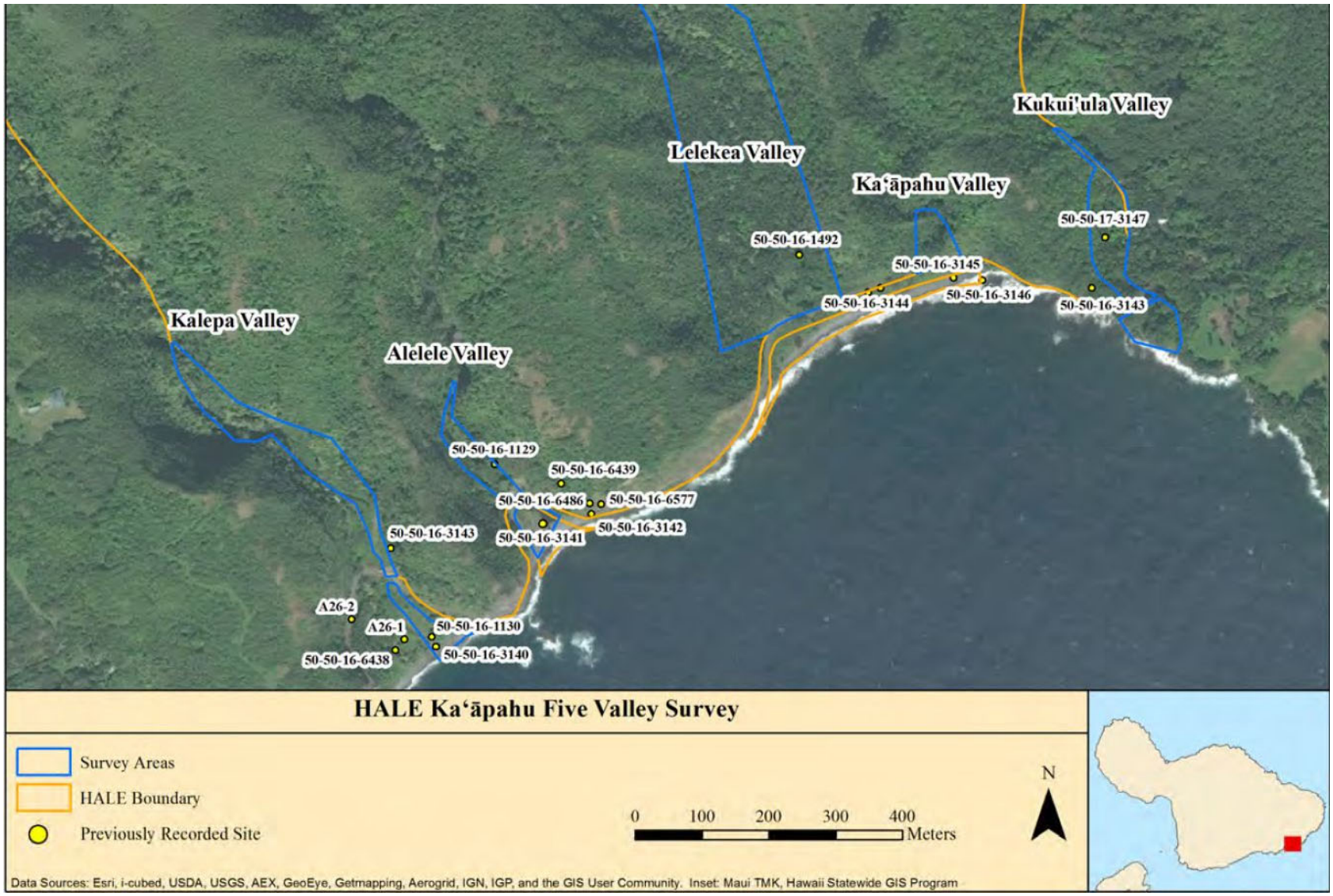


Figure 8: Previously Identified Archaeological Sites in the Vicinity of the Proposed Project Area (From Tomonari-Tuggle et al. 2015).

139, SIHP Site #50-50-16-1492, Soehren Site A25-1) in Lelekēa Gulch, on the left bank of the Alelele Stream, approximately 150 yards above the trail leading to Kaupō. Walker (cited in Soehren 1963: 76) described the heiau as measuring 100-feet wide by 130 feet long and:

> …built 12 feet above the stream. It is the open platform type with possibly three terraces on top, but pigs have so disturbed the area that it is difficult to determine accurately the structures. At the southwest corner are two small enclosures, paved with flat stones and pebbles. A low wall 5 feet thick runs along the north side of the *heiau*. Only on the east is a double step-terrace visible…The name Kumuula was also given for the *heiau* by informant Kaiwiaea.

The Bernice Pauahi Bishop Museum (BPBM) was contracted by the National Park Service to reinvestigate several areas on Maui, particularly in the Kaupō-Kīpahulu area (Soehren 1963: v, vii). L.J. Soehren conducted an archaeological survey of East Maui to supplement Walker's survey and identify, relocate and "improve on existing data" (Kornbacher 1993: 15). Soehren was unable to relocate many of Walker's heiau, due to either the destruction resulting from commercial sugarcane in the 19th and early 20th centuries or due to dense vegetation covering the sites. Walker's (1931) sites were recorded with "estimated locations," including that of the Paokahi Heiau (SIHP Site #50-50-16-1492 – Lelekēa Complex; Soehren Site A25-1) in TMK: (2) 1-6-010: 001. The Paokahi Heiau was re-located during subsequent surveys (Hommon 1994, Kornbacher 1993) and was interpreted to be of Pre-Contact Period origin. Soehren identified four new sites in Kikoʻo, and seven sites in Maʻulili, including a rockshelter, a possible heiau, and a petroglyph site. Soehren (1963: 22) noted:

> Agricultural terraces and irrigation ditches were recorded in several places, and many more have been destroyed by the [sugar] plantation…The abundance of water made Kīpahulu ideal for the cultivation of wet taro (*Colocasia esculenta*).

Soehren's sites include Kukuiʻula Complex (SIHP Site #50-50-17-3147) located in TMK: (2) 1-6-010:001, Alelele Stream Terraces (SIHP Site #50-50-16-1129) located in TMK: (2) 1-6-010:001, and Kālepa Fishing Shrine (SIHP Site #50-50-16-1130) located in TMK: (2) 1-6-010: 001. All of the sites were interpreted to be of Pre-Contact origin. R.D. Connolly (1974) conducted survey of East Maui in 1974, which resulted in the relocation of many of the sites documented by Soehren (1963) and provided updated information on site preservation conditions (Kornbacher 1993: 15–16).

In response to destruction caused by Hurricane Eva in 1982, Charles Keau of the Parks Department and Muffy Mitchell of the Planning Department surveyed areas near the Lelekēa, Kaʻāpahu, and Alelele Bridges [TMK: (2) 1-6-010:001, 002] in order to determine the presence of archaeological sites in the vicinity of the proposed bridge reconstructions. Keau and Mitchell (1982) identified two previously unrecorded sites: SIHP Site #50-50-16-3142, which consisted of a possible burial cave discovered at Alelele, 3.5 meters above the road bed, and SIHP Site #50-50-16-3144,

which consisted of two rockshelters at Lelekēa. Additionally, Kornbacher (1993: 28) noted a possible third rock overhang situated above the road, obscured by vegetation. The rockshelters were interpreted as having been used during the Pre-Contact Period. No sediment or cultural artifacts, save for modern debris, were observed.

In 1992, the International Archaeological Research Institute, Inc. (Kornbacher 1992) conducted an archaeological reconnaissance survey of Kaʻāpahu Subdivision Lot 1: Alelele Stream, Kīpahulu, Hāna, Maui, Hawaiʻi. During the survey SIHP Site #50-50-16-1129, originally recorded by Soehren (1962), was relocated. The site consisted of five terraces, one mound, and one retaining wall, which were interpreted to associated with wetland agriculture (Soehren 1963, Connolly III 1974). Kornbacher (1992) hypothesized that the site may have also been used as seasonal habitation, as modern debris and evidence of cooking suggests habitation-like activities. Due to its potential to yield information about the Hawaiian Pre-Contact Period, Kornbacher considered the complex as potentially eligible for the National Register of Historic Places and the Hawaiʻi Register of Historic Places (Kornbacher 1992:12).

In 1993, the International Archaeological Research Institute, Inc. (Kornbacher 1993) conducted an archaeological survey of Kaʻāpahu Subdivision Remnant Lots 5, 6, and 7 and the Hāna Highway Corridor, Kīpahulu, Hāna, Maui, Hawaiʻi. During the survey, State Site #s 50-50-16-1129, -1130, and -1492 were relocated. Several new sites were also identified: SIHP Site #50-50-16-3140, a large rockshelter located 5.0m above the beach. A pictograph was noted on the second face of the cave overhang (Kornbacher 1993:22); SIHP Site #50-50-16-3141, an "alluvial sedimentary deposit with an exposure of approximately 2.3 meters" located on the east side of Alelele Stream (Kornbacher 1993: 23); SIHP Site #50-50-16-3145, a series of disturbed "wall segments, linear rock alignments, and retaining walls" (Kornbacher 1993:28); and SIHP Site #50-50-16-3146, two rockshelters. No historic artifacts were observed, and no modern use was noted. All sites were interpreted to be associated with the Pre-Contact Period.

Robert J. Hommon (1994) conducted a Cultural Resource Assessment of Kaʻāpahu Ahupuaʻa for the superintendent of Haleakala National Park in 1994. Small portions of the 1,409 acre parcel had limited or large-scale, non-intensive survey work completed (Hommon 1994); areas included the valleys of Alelele, Lelekēa, and Kukuiʻula. Many of the sites discussed above are mentioned, including rockshelters, loʻi (irrigated terraces for taro), the Lelekēa Complex, and the Kālepa Complex.

Xamanek Researches (Fredericksen and Fredericksen 2001) conducted an archaeological inventory survey in Kālepa Ahupuaʻa in 2001. The survey was conducted mostly along the coast, specifically just mauka (north) of Mokuia Point. No sites were identified and only one artifact, an isolated basalt flake, was encountered. Although no archaeological sites of significance were identified during the survey, Mokuia Point, adjacent and south of the project area, was designated as State Site

59-50-16-5058, because of its importance as a traditional Hawaiian fishing area (Fredericksen and Fredericksen 2001: 15).

In 2007, SCS (Morawski and Spear 2007) conducted an archaeological inventory survey of an area known as 'Three Arches," located east of Kālepa Stream and on the slope below Piʻilani Highway in Kālepa Ahupuaʻa, District of Hāna, Island of Maui [TMK: (2) 1-6-010 and 1-7-001]. The survey identified SIHP Site #50-50-15-6272, which consisted of three areas of stacked rock terracing under Piʻilani Highway and Hāna Belt Road. The features are located in close proximity to each other and were constructed during the construction of Hāna Belt Road.

Several archaeological investigations have been conducted in the project area prior to slope stabilization project. Table 1 lists these projects and the results of each, as interpreted by the authors of the respective projects. Please note that several of these interpretations have been altered, based on the research outlined in Hoerman et al. (2008).

In 2008, SCS (Hoerman et al. 2008) conducted an archaeological inventory survey for the Kaupō-Kīpahulu Rockfall project, in the Ahupuaʻa of Kaʻāpahu and Kukuiʻula, Kīpahulu District, Island of Maui [TMK: (2) 1-6-010:006 and 007]. The project area was located along Kālepa and Alelele slopes, adjacent to Hāna Highway. The survey identified portions of two previously identified sites: State Site 50-50-16-1638, the Hāna Belt Road, which links East Maui with the rest of the island; and State Site 50-50-16-3143, the King's Trail, a paved trail encircles the Island of Maui. Construction was initiated by the aliʻi Piʻilani and completed by his son, Kihaapiilani. The survey also resulted in the identification of two newly identified sites: SIHP Site #50-50-16-6438, a three-sided terrace located on the on the west side of Kālepa Stream, which, may have functioned as a habitation or ceremonial site, and SIHP Site #50-50-16-6439, a rockshelter, containing human skeletal remains, located along the western slope of Alelele Valley, within the boundaries of Haleakalā National Park.

In 2009, SCS (Armstrong and Dega 2009) conducted archaeological monitoring during the Kaupō-Kīpahulu Rockfall Project, located in the Ahupuaʻa of Kaʻāpahu, Kīpahulu District, Island of Maui [TMK: (2) 1-6-010: 06 and 007]. During the program of archaeological monitoring, two sites were identified: SIHP Site #50-50-16-6486, a human burial comprised of a single adult individual (MNI=1) interred in a rockshelter. Based on context, positioning, and the absence of modern or historic cultural materials, the burial ins interpreted as a traditional, Pre-Contact interment containing an individual of Polynesian ancestry; and SIHP Site #50-50-16-6577, a trail with an adjacent stacked stone terrace. Located on a steep slope, it roughly follows the ridge contours, running parallel to a cliff face.

Table 1: Previously Identified Historic Properties in the Vicinity of the Current Project Area.

State Site Number	Originally Identified By	Location	Form and Function	Time Period
50-50-16-1492; A25-1	Thrum 1907; Soehren 1963	Lelekēa	Lelekēa Complex – agricultural complex and Paokahi Heiau	Pre-Contact
50-50-16-1129; A25-5	Soehren 1963	Alelele	Alelele Stream Terraces – agricultural	Pre-Contact
50-50-16-1130; A25-6	Soehren 1963	Kālepa	Kālepa Complex – terraces, fishing shrine	Pre-Contact
A26-1	Soehren 1963	Kālepa	Fragmentary Walls – possible house site	Pre-Contact
A26-2	Soehren 1963	Kālepa	Rectangular Enclosures – agricultural	Pre-Contact
50-50-17-3147; A25-2 and A25-3	Soehren 1963	Kukuiʻula	Kukuiʻula Complex – cemetery and agriculture (*loʻi*)	Pre-Contact
50-50-16-3142	Keau and Mitchell 1982	Alelele	Rockshelter – burial cave	Pre-Contact
50-50-16-3144	Keau and Mitchell 1982	Kaʻāpahu	2 Rockshelters – possible burial cave	Pre-Contact
50-50-16-3140	Kornbacher 1993	Kālepa	Rockshelter – possible temporary habitation	Pre-Contact
50-50-16-3141	Kornbacher 1993	Alelele	Alluvial Deposit	Pre-Contact
50-50-16-3145	Kornbacher 1993	Kaʻāpahu	Disturbed Walls/Rock Alignment – undetermined function	Pre-Contact
50-50-16-3146	Kornbacher 1993	Kaʻāpahu	Rockshelters – possible habitation	Pre-Contact
50-50-06-1638	National Register of Historic Places 2004	Discontinuous throughout project area	Hāna Belt Road	Historic-Modern use
50-50-16-3143		Discontinuous throughout project area	King's Trail	Pre-Contact with Historic re-use
50-50-16-6438	Hoerman et al .2008	Kālepa	Three - sided platform	Pre-Contact
50-50-16-6439	Hoerman et al 2008	Alelele	Rockshelter - burial loci	Undetermined
50-50-16-6486*	Armstrong and Dega 2009	Alelele	Rockshelter – burial loci	Pre-Contact
50-50-16-6577*			Trail	Pre-Contact

* Site identified during work associated with Armstrong and Dega (2009).

CONSULTATION

The consultation process was conducted via telephone, e-mail, the U.S. Postal Service, and virtually. Information pertaining to cultural resources and traditional cultural practices conducted within the project area or within Kaʻāpahu Ahupuaʻa was sought from the forty-six (46) individuals and organizations listed in Table 2. The initial letters of inquiry, an example of which is presented in Appendix B, were mailed between March 3, 2021 and June 15, 2021.

The follow-up letters of inquiry (see Appendix C) were mailed via e-mail and USPS between March 17, 2021 and June 14, 2021. Follow-up letters were mailed as reminders to all the above-listed individuals and organizations, with the exception of those individuals and organizations that submitted responses to SCS prior to the mailing of the follow-up letters.

A Cultural Impact Assessment Notice was published in the March 2021 issue of the OHA newsletter, Ka Wai Ola (see Appendix D). This notice stated that Scientific Consultant Services, Inc. is seeking information on cultural resources and traditional cultural activities in the area of the proposed project and the surrounding ahupuaʻa, and provided locational information (i.e., the ahupuaʻa, traditional and modern names of the District, Island, State, and property Tax Map Key designation).Scientific Consultant Services, Inc. conducts in-person interviews, whenever possible. Due to the current COVID-19 pandemic, no in-person interviews were conducted for this CIA. For everyone's health and safety, SCS conducted one virtual interview, via ZOOM, and one telephone interview during the consultation for the current CIA. The signed information release form is presented in Appendix E.

Table 2: List of Cultural Contacts.

Name	Affiliation	Recommended by:
Kai Markell	Compliance Manager Office of Hawaiian Affairs	
Thelma Shimaoka	Community Outreach Coordinator III Office of Hawaiian Affairs	
Roy Newton	Office of Hawaiian Affairs	
Chris "Ikaika" Nakahashi	Cultural Historian State Historic Preservation Division	
Andrew "Kealana" Phillips	Burial Sites Specialist State Historic Preservation Division	
Keʻeaumoku Kapu, Chair	Maui Poʻo- Moku O Kahekili Aha Moku Advisory Council	
Blossom Feiteira	Maui Mokupuni Council	
Keʻeaumoku Kapu, CEO	Aha Moku o Maui	Chris "Ikaika" Nakahashi
Keʻeaumoku Kapu, Chairperson	Native Hawaiian Historic Preservation Council	
Leimana DaMate, Executive Director	Aha Moku Advisory Committee State of Hawaiʻi Department of Land and Natural Resources	
Albert Perez, Executive Director	Maui Tomorrow Foundation	
Lucienne de Naie, Vice President	Maui Tomorrow Foundation	
Maui Sierra Club		
Dane Maxwell, Chair	Maui/ Lānaʻi Island Burial Council	
Annella Amaral, President	Association of Hawaiian Civic Clubs	
Dr. Scott Fisher	Chief Conservation Officer, Hawaiʻi Land Trust; Maui/Lānaʻi Burial Council Representative; and Former Associate Director of Conservation, Hawaiian Islands Land Trust	

Dr. Fern P. Duvall II	Maui Nui Program Manager, Native Ecosystems Protection and Management Division of Forestry and Wildlife, Hawaii Department of Land and Natural Resources	
Native Hawaiian Plant Society		
Jade "Alohalani" [Helekunihi] Smith	Generational ties to Kaupō, Kaupō Moku Representative Aha Moku O Maui	
Torrie Nohara	Na Ala Hele Program Department of Land and Natural Resources Division of Forestry and Wildlife	Dr. Fern Duvall
Robert W. Hobdy	Environmental Consultant	Lucienne de Naie
Kyle Nakanelua	Maui Poʻo- Moku O Kahekili Aha Moku Advisory Council	
Patty Nishiyama	Nā Kupuna O Maui	
John Lind	Community member and husband to Tweety Lind	Lucienne de Naie, Robert W. Hobdy, Scott Crawford
Shane Sinenci	Hāna Representative, Maui Poʻo- Moku O Kahekili, Aha Moku Advisory Council and Hāna Representative, Maui County Council	
Tweety Lind	Cultural practitioner and community member and wife to John Lind	Lucienne de Naie, Robert W. Hobdy, Scott Crawford
Dr. Janet Six	Principal Archaeologist, County of Maui	Lucienne de Naie
Moana Rowland, Abstractor	Na Ala Hele Program Department of Land and Natural Resources Division of Forestry and Wildlife	Torrie Nohara
Nalani Tukuafu, Executive Director	Holani Hana Inc. and cultural practitioner	Oliveira-Medeiros on behalf of Councilman Shane Sinenci

Mavis Oliveira-Medeiros	Hana District Council Office on behalf of Councilman Shane Sinenci, Hāna District Representative	
Guy Aina	Community member	Lucienne de Naie
Sam Kaʻai	Community member	Lucienne de Naie
Helen Nielsen	Long-time resident	Lucienne de Naie Dr. Scott Fisher
Jonathan Starr	Long-time resident	Lucienne de Naie Dr. Scott Fisher
Keahi Lind	Kipahulu Representative Maui Poʻo- Moku O Kahekili Aha Moku Advisory Council	Jade "Alohanui" Smith
Kipahulu ʻOhana	Community members	Chris "Ikaika" Nakahashi
Skippy Hau	DLNR Division of Aquatic Resources	Chris "Ikaika" Nakahashi
Robert Carroll	Former East Maui Representative, Maui County Council	Skippy Hau
Sam Akoi	Hāna District Representative Aha Moku o Maui	
Dr. Andrew Walmisley	Kaupō Historian, Theologian, Scholar, Researcher	Dr. Scott Fisher
Tama Starr	Long-time Hāna resident	Dr. Scott Fisher
Kyle "Soot" Bredhoff	Former Kaupō Ranch Manager, long-time Hāna resident, and Dr. Scott Fisher's Uncle	Dr. Scott Fisher
Kimokeo Kapahulehua	Cultural practitioner	Lucienne de Naie
Timothy Bailey	Kula Mauka Poʻo Representative, ʻAha Moku O Maui	Lucienne de Naie
Rachel Hodara Nelson, M.A.	Archeologist/Cultural Resources Program Manager Haleakalā National Park	Dr. Scott Fisher

RESULTS

The consultation process for the Hāna Highway Repairs at Kālepa Point project resulted in SCS receiving written responses from fifteen (15) individuals via e-mail and conducting two interviews. One interview was conducted by telephone and one interview was conducted virtually via ZOOM.

WRITTEN RESPONSES

The fifteen written responses received by SCS are presented in this section of the report.

MR. ANDREW "KEALANA" PHILLIPS, BURIAL SITES SPECIALIST, STATE HISTORIC PRESERVATION DIVISION

Mr. Phillips responded via an email dated March 10, 2021:

Aloha Cathy,

Will forward to the Maui burial council members. Kealana

Concerns: Mr. Phillips did not express any concerns in his email dated March 10, 2021.

MR. CHRIS "IKAIKA" NAKAHASHI, CULTURAL HISTORIAN, STATE HISTORIC PRESERVATION DIVISION

Mr. Nakahashi responded via an email dated March 23, 2021:

Aloha Cathy,

Mahalo for contacting me regarding the Cultural Impact Assessment for the proposed Hāna Highway at Kālepa Point Road Repairs project area in the ahupuaʻa of Kaʻāpahu, Kīpahulu on Maui, TMK: (2) 1-6-010:999.

I recommend SCS to utilize the media (e.x. OHA's Ka Wai Ola, Maui News, Maui Times, etc.) to solicit additional information for this CIA.

I recommend SCS minimally to meet with:

- Kipahulu ʻOhana
- Keʻeaumoku Kapu – ʻAha Moku o Maui Inc.
- Skippy Hau – DLNR Division of Aquatic Resources

I recommend SCS minimally to meet with any native tenants and people that currently live or previously lived in the ahupua‘a listed above on Maui for information about the cultural resources and cultural practices for this CIA.

Koe nae ke kuleana o na kanaka ma loko = reserving the rights of native tenants.

Please let me know if I can assist with anything else.

A hui hou,

Christopher “Ikaika” Nakahashi, M.S.
Cultural Historian
Department of Land & Natural Resources
State Historic Preservation Division

Concerns: No concerns were expressed by Mr. Nakahashi in his email dated March 23, 2021.
Note: Scientific Consultant Services, Inc. contacted the Kipahulu ‘Ohana. Ke‘eaumoku Kapu was contacted in his capacity as CEO of Aha Moku o Maui Inc., Maui Po‘o or Chair of Moku O Kahekili Aha Moku Advisory Council, and as Chair of the Native Hawaiian Historic Preservation Council, Skippy Hau, DLNR Division of Aquatic Resources in the consultation process for this CIA and the remaining individuals and organizations listed in Table 2. Their written responses are presented below.

KIPAHULU ‘OHANA

SCS contacted the Kipahulu ‘Ohana and received the following response from Mr. Scott Crawford, Executive Director, in an email dated, May 6, 2021:

Aloha Cathy,
sorry for not responding sooner.
Auntie Tweetie and Uncle John Lind are the ones to talk with about this, but they don’t do email, so I forwarded your email to their son to share with them, but I would recommend calling them… Ask for Auntie Tweetie and then you can explain what you’re looking for and see if she can help.

Mahalo,

Scott Crawford
Executive Director

Concerns: Mr. Crawford did not express any concerns in his email.

KE‘EAUMOKU KAPU, CEO, ‘AHA MOKU O MAUI INC., MAUI PO‘O [CHAIR] OF MOKU O KAHEKILI AHA MOKU ADVISORY COUNCIL, CHAIR OF THE NATIVE HAWAIIAN HISTORIC PRESERVATION COUNCIL

SCS contacted Mr. Kapu, who responded via an email dated March 6, 2021:

> Aloha Cathy,
>
> Mahalo for reaching out again, I will be putting you in touch with the moku rep for Hana his name is Sam akoi. I will also reach out to him to assure he also gets in touch with you.
>
> Mahalo nui again.
>
> Ke‘eaumoku Kapu

Concerns: Mr. Kapu did not mention any concerns in his email.

MR. SKIPPY HAU, DLNR DIVISION OF AQUATIC RESOURCES

SCS contacted Mr. Hau at the request of Mr. Chris “Ikaika” Nakahashi, SHPD cultural Historian , who indicated Mr. Hau was knowledgeable about cultural resources and traditional cultural practices. Mr. Hau responded to SCS via an email dated March 23, 2021:

> Dear Cathy,
>
> Alelele Stream is one of our priority streams that people fish and gather ‘o‘opu, hihiwai, and prawns. We’ve conducted stream surveys and consider it to be an excellent example of a healthy ecosystem. While we’ve occasionally checked the stream, I believe you would like to know more about the gathering of opihi and fishing along the coast.
>
> I was shown the trail to hike from Kālepa Stream to Alelele Stream by Forester Bob Hobdy many years ago. He has since retired from the State.
>
> I have no objection and strongly support repairing the road for public access and safety on the South shore.
>
> I would recommend Mr. Robert Carroll, retired councilman for a resident’s perspective. He told me that Alelele is popular for camping by boy scouts, and residents.

I do not know how much visiting tourists or residents who want to camp and fish use Kālepa Point and the surrounding area.
Skippy

Concerns: Mr. Hau did not express any concerns in his email dated March 23, 2021. However, he did identify fishing and gathering as on-going traditional cultural practices and the associated cultural resources and the historic trail still used to access Alelele Stream.

Note: SCS contacted retired Councilman Mr. Robert Carroll via emails dated May 6, 2021 and May 25, 2021. Mr. Carroll did not respond.

MS. LUCIENNE DE NAIE, VICE PRESIDENT

Ms. de Naie provided comments March 17, 2021 and June 5, 2021. She also was interviewed by SCS and the summary of the interview is presented in the Interview section of this document. Ms. de Naie's emails are presented below in the order they were received by SCS:

On March 17, 2021, she wrote:

I would recommend contacting:

Helen Nielsen and Jonathan Starr who live part time along Kālepa Gulch in the area and know some of the Hawaiian families.

John and Tweety Lind

Bob Hobdy

Guy Aina and his 'ohana who are associated with Huialoha church.

I walked the area with Sam Ka'ai many years ago, and he knew stories of the area. Noelani Ahia is usually in touch with Sam.

I have personal knowledge of the old trail that starts at Kālepa gulch,(have hiked on it,) and have walked in the areas mauka of the road and observed archaeological sites and native plants when the national Park was in the process of purchasing the land.

On June 5, 2021, Ms. de Naie provided the following information:

Expanding the Park [from: https://www.nps.gov/hale/don-reeser.htm]:

> During his tenure at Haleakalā NP, Reeser increased park land holdings from 28,000 to 34,000 acres, expanding the park's Kīpahulu section on the eastern side of Maui. In 1998, Reeser was able to add the Puhilele and Ka'āpahu parcels to the Kīpahulu section. Kīpahulu has been home to Native Hawaiians for hundreds of years and remains an integral part of the thriving Native Hawaiian culture. This section of the park is also home to rare Native Hawaiian plant and animal species found nowhere else in the world.
>
> Before Reeser retired, he was able to obtain a federal appropriation for the purchase of the Nu'u section. Nu'u, which is located on the southeastern side of Maui in Kaupō moku (ancient district) was eventually purchased in 2008. This seemingly barren landscape is rich in Native Hawaiian natural and cultural resources.

Another very interesting reference (you may already have)
[from: https://kaupomaui.com/posts/heleipawa]:

> Hawaiian historian David Malo, who wrote a history of the islands in the 1840s-1850s, described Heleipawa this way:
>
> "Hele-i-pawa was a chief who was born at Lelekea, Ka'apahu, in Kipahulu on the island of Maui. He died at Poukela, and his bones were deposited at Ahulili."
>
> Here, Poukela is a shoreline area with a heiau (temple) west of Mokulau. Ahulili is a remote hill at the top of Manawainui Valley, 4,600 feet above sea level.
>
> While this excerpt provides a tantalizing glimpse of the early chief, in 1869, Samuel Kamakau, another native historian, provides a longer chant about Heleipawa. Kamakau gives a detailed itinerary of

Heleipawa's funeral procession, and this chant is a valuable source of Kaupo place names.

Kamakau's chant, published in the newspaper Ke Au Okoa on Oct. 21, 1869, is presented below, along with an English translation, on the right from, the book Tales and Traditions of the People of Old.

O Heleipawa o ke alii o Kipahulu,	Heleipawa, the chief of Kī-pahulu,
I hanau i Lelekea,	Was born at Lelekea;
O Pieleku ke ewe,	At Pielekū the placenta,
O Paokahi ka piko,	At Paokahi [heiau] the navel cord,
I Hekeu i Kuai ka aa,	At Hekeu, by Kuaʻi, the caul,
I ka Kahaleikalale kahua.	Ka-hale-i-kalalea the [house] site.
I ka piina i Keahuala i Makaaoa	Along the ascending path to Keahualā on Makaʻaoa
I Kaapahu mauna i ka lani,	In Kaʻapahu, the mountain in the sky,
I Kaloiki la i Kalonui,	To Kaloiki, to Kalonui,
I ke alahaka i Manokiai,	Along the rough road to Manokiaʻi,
I ke ala hoolewa i Nahunonapuunalu,	Along the funereal path to āhunonapuʻunalu,
I ke alahauiki a Kana,	Along the trail of Hauiki-a-Kana,
I ke Anawao i Kālepa,	By the inland cave in Kālepa,
I Waiahole la i Hualele,	Through Waiāhole, through Huʻalele,
I Puualaea i Nuanualoa,	Through Puʻualaea, to Nuʻanuʻaloa;
I Puolokalina i Kalaeoaihe,	To Puʻolokālina in Kalae-o-ʻaihē;
I Mikimiki la i Maalo,	Through Mikimiki, through Maʻalo;
I Kahuwai i Popoiwi,	Through Kahuwai to Popoiwi,
I Punahoa i Kanemalohemo	To Punahoa, to Kānemalohemo
Mokulau la i Muliwai,	At Mokulau; to Muliwai,
I Poukela i Loaloa i Puumakaa,	To Poukela, to Loʻaloʻa, to Puʻumakaʻā,
I Kaakaukawa i Kawahaohinau,	To Kaʻakaukawa, to Kawahaohinau,
I Nakukuioolu i Paliakoae;	To Nākukuiʻoʻolu, to Pali-a-koaʻe;
I Kaheka ilalo,	To Kāheka below,
I uliuli mauna iluna;	To the dark-hued mountain above;
I Helaniku i ke poo o Kauhau	At Helanikū, on the top of Kauhau
I Ahulili, waiho no o Heleipawa.	On ʻAhulili, Heleipawa was laid away.

> In total, 26 places in Kaupo are mentioned, starting with Kālepa at the boundary of Kaupo and Kipahulu. However, one of these places, Kauhau (a ridge west of Manawainui Valley), is only mentioned to provide context for the location of Helaniku. According to the chant, Heleipawa‘s body was taken through 24 places in Kaupo before being placed at the 25th, Ahulili.

Concerns: Ms. de Naie did not mention any concerns in either of her emails;

Note: SCS contacted John and Tweety Lind, via telephone, on June 15, 2021 and left a message. However, neither John or Tweety Lind returned SCS’s call. In addition, SCC contacted Guy Aina and Noelani Ahia in an effort to reach Sam Ka‘ai. However, SCS did not receive a response from either gentleman.

MS. HELEN NIELSEN, COMMUNITY MEMBER

Ms. Nielsen is a community member who was recommended to SCS as individual knowledgeable about cultural resources and traditional cultural practices in the Kālepa area by Ms. Lucienne de Naie, Vice President, Maui Tomorrow Foundation. Ms. Nielsen provided the following comments below via an email dated May7 2021:

> I received your request and will put some thought into it. I live just mauka, between Kālepa and Nuanuloa gulches, for over 30 years.
>
> Kupuna most familiar with this area are gone but I will ask a couple of others if they would like to contribute to this.
>
> I am happy to help, if I can.
>
> Best,
> Helen

Concerns: Ms. Nielsen did not express any concerns in her email.

ROBERT W. HOBDY, ENVIRONMENTAL CONSULTANT ENVIRONMENTAL

Mr. Hobdy is a renowned Hawaiian botanist and environmental consultant. He was recommended to SCS as individual knowledgeable about cultural resources and traditional cultural practices in the Kālepa area by Ms. Lucienne de Naie, Vice President, Maui Tomorrow Foundation. Mr. Hobdy provided his comments via an email dated March 6, 2021.

> Aloha Cathy,
>
> I am very familiar with the Kālepa Point Road Repairs Project on the southern edge of Kipahulu Moku in the Ahupuaʻa of Kaʻapahu. The Piʻilani Highway here hugs the base of the sea cliff between Kālepa Valley and Alelele Valley. This stretch of road between Kaupo and Kipahulu was constructed for vehicular use some time in the 1930s or 1940s. Prior to that the route was the Alanui o Piʻilani which was a foot trail. In 1921 Kenneth Emory and Thomas Maunupau were documented traveling this trail by horseback to visit Kaupo. The Alanui in this area ascended from sea level up switchbacks from Lelekeʻa Valley to the ridgetop to an elevation of 500 feet where it crossed Alelele Stream just above the 400 foot tall waterfall and then descended along switchbacks to near sea level at Kālepa Stream. This foot trail is still intact but is overgrown. The present highway in the project area was carved out of the base of the sea cliff and is narrow and vulnerable to high surf.
>
> The area between Kālepa Stream and Kukuiula in Kipahulu is not inhabited. Nearby sites include the Paokahi Heiau in Lelekeʻa Valley and the puʻukaua Fort high on the western ridge above Lelekeʻa. Both of these are remote from the project area. I don't have any direct contacts with knowledge of these sites, but for general information about the area you might contact John and Tweety Lind who live in Kikoʻo, Kipahulu.
>
> Bob Hobdy

Concerns: Mr. Hobdy did not express any concerns in his email dated March 6, 2021. However, Mr. Hobdy did identify the proposed project area as an historic section of roadway, which is made "vulnerable to high surf", the historic trail, and two sites in the general area of Ka: Paokahi Heiau, in Lelekeʻa Valley, and the puʻukaua Fort high on the western ridge above Lelekeʻa.

Note: SCS contacted John and Tweety Lind, via telephone, on June 15, 2021 and left a message. However, neither John nor Tweety Lind returned SCS's call.

RACHEL HODARA NELSON, ARCHEOLOGIST/CULTURAL RESOURCES PROGRAM MANAGER HALEAKALĀ NATIONAL PARK

Ms. Nelson was contacted at the suggestion In an email dated June 18, 2021, Ms. Nelson provided the following information:

Dear Cathy,

Thank you for your inquiry regarding Scientific Consultant Services, Inc. (SCS) Cultural Impact Assessment to collect information about cultural resources and traditional, previously or on-going, cultural activities within or near the proposed Hana Highway at Kālepa Point Road Repairs project area. In reviewing the project area, and the NPS commissioned report "An Archeological Inventory Survey of Five Stream Area, Kaʻāpahu, Haleakalā National Park, Kaʻāpahu Ahupuaʻa, Kīpahulu District, Maui TMK (2) 1-6-010:001, 006-008 (Portions, All), Tomonari-Tuggle, M.J., Rieth, T.M., and Murakami, G., 2015, prepared for National Park Service," the following sites referenced in the report are in the vicinity of the project area:

Kālepa Shrine: a terrace interpreted as a shrine (A25-6, now Site 50-50-16-1130) (referenced in Soehren, 1963, Connolly 1973a,b, Keau and Mitchell 1982, Hoerman et al 2008)

Soehren (1963:81) described Site -1130 as a well-built terrace of waterworn beach stone with cobble and pebble paving. The site was relocated during the 1973 Statewide Inventory and was assigned the current State site number; the site form states (Connolly 1973a):

"Kālepa shrine is a rectangular platform, measuring 9.1 x 8.5 m. It is in good condition although the platform surface is covered with grass. On the E side, there is a growth of young pandanus trees which will undoubtedly cause some deterioration unless they are removed. The platform is of multiple-stacked construction, built with water-worn basalt boulders. It ranges from 0.9 to 1.5 m in height on the S end and is level with the ground on the N. The N and part of the W boundaries are fairly indistinct, although a few rocks that probably are part of the platform are visible."

Kālepa rockshelter: (Site 50-50-16-3140)
(referenced in Kornbacher 1993, Hoerman et al. 2008)
During Kornbacher's (1993) survey of the mouth of Kālepa Valley, she recorded a rockshelter (Site -3140). The rockshelter did not appear to contain any cultural material or include modifications, with the exception of a possibly modern pictograph.

During the current survey (Tomonari-Tuggle et al. 2015) the two previously recorded sites, -1130 and -3140, were not re-located. "The area below Kālepa Bridge and the highway where the sites are located is covered in almost impenetrable cane grass and mature pandanus trees clustered in small, scattered groves" (Tomonari-Tuggle et al. 2015: 68).

Stratified Cultural Deposit: (Site 50-50-16-7611)
New site recorded by Tomonari-Tuggle (2015: 59)

"Site 50-50-16-7611 is a stratified cultural deposit exposed in a stream bank on the seaward side of Kālepa Bridge. The deposit is estimated to cover less than 30 m2. This area is heavily braided with numerous deep drainage cuts and remnant surfaces. The portion of the stream bank that was cleared is the west side of a long, narrow "island" created by two drainages that converge about 12 m seaward of the mapped profile; this remnant surface is 4 m wide. A cluster of pandanus trees is on the remnant surface above and seaward of the stream bank exposure; the stream is severely undercutting the surface and a dense concentration of exposed pandanus roots obscures the stream profile. Inland of the profile, vegetation is primarily dense cane grass."

"The mapped profile is 7.4 m long and 90 to 135 cm high. It includes three stratified cultural deposits: a charcoal-enriched cultural layer with two shallow, basin-shaped hearths (Layer VI); a cultural deposit with three pits (Layer V); and a boulder pavement and overlying deposit (Layer IV). These deposits represent four distinct occupation events. Two natural, culturally sterile /deposits (Layers VIII and VII) underlie the cultural strata, with three natural, culturally sterile deposits (Layers III, II, and I) overlying the strata."

Radiocarbon dating from the lowest cultural deposit indicate cultural activities began AD 1591-1779 and likely continued into the 19th or early 20th centuries. Multiple hearths and buried pavement indicate use of the site for habitation.

I have also pulled out the background section of the report and attached it for you here in case there is anything in there that you have not yet captured in your CIA.

Mahalo,

Rachel

Rachel Hodara Nelson
Archeologist/Cultural Resources Program Manager
Haleakalā National Park

Concerns: Ms. Nelson did not mention any concerns in her email. However, she did identify historic properties in the vicinity of the proposed project area.

MR. DANE MAXWELL, CHAIR, MAUI/ LĀNA‘I ISLAND BURIAL COUNCIL

Mr. Dane Maxwell, Chair, Maui/ Lāna‘i Island Burial Council responded via an email dated March 23, 2021;

Aloha e Cathy,

Kala mai for the late response, I will send this out to the MLIBC Hāna member now.

Mahalo,

Dane Maxwell

Concerns: Chair Maxwell did not express any concerns in his email.

DR. FERN P. DUVALL II, MAUI NUI PROGRAM MANAGER, NATIVE ECOSYSTEMS PROTECTION AND MANAGEMENT

Dr. Fern Duvall responded via an email dated March 8, 2021:

Dear Cathy Dagher:

I am nor an appropriate audience for your questions. Try Na Ala Hele program's Torrie Nohara (ccd). Also Janet Six is wholly appropriate.

Mahalo a me ke aloha mai Maui Nui

Dr. Fern P. Duvall II

Concerns: Dr. Duvall did not express any concerns in hi email.

Note: SCS contacted Dr. Janet Six, Principal Archaeologist, County of Maui, via email. However, Dr. Six was unable to provide comments. SCS was able to reach Torrie Nohara (Na Ala Hele Program, Department of Land and Natural Resources, Division of Forestry and Wildlife) and her comments are provided below.

TORRIE NOHARA, NA ALA HELE PROGRAM, DEPARTMENT OF LAND AND NATURAL RESOURCES, DIVISION OF FORESTRY AND WILDLIFE

Ms. Nohara provided the comments below via an email dated March 8, 2021:

Hi, Cathy. We are doing well. I hope all is well with you. I've forwarded your request to Moana Rowland our abstractor. She will respond. The only thing over there that I know of is the trail mauka (way mauka) at that point. Glad to see they're finally fixing the road through there. Stay well. Aloha!

In a subsequent email, also dated March 8, 2021, Ms. Nohara stated that the historic trail located mauka (north) of Kālepa Point, is "…part of the Ke Ala La Loa O Maui and managed by the National Park. We refer to it as the Kaapahu Trail at that point."

Concerns: Ms. Nohara did not mention any concerns in her email. However, Ms. Nohara did identify the historic trail in the area.

Note: Although Ms. Nohara reached out to Moana Rowland on several occasions, Ms. Rowland did not respond.

DR. SCOTT FISHER, CHIEF CONSERVATION OFFICER, HAWAIʻI LAND TRUST; MAUI/LĀNAʻI BURIAL COUNCIL REPRESENTATIVE; AND FORMER ASSOCIATE DIRECTOR OF CONSERVATION, HAWAIIAN ISLANDS LAND TRUST

Dr. Fisher responded via an email dated March 5, 2021, in which he indicated he would like to participate in the consultation process.

> Aloha Cathy,
>
> Yes, I'm happy to help in any way I can. Let me know when you'd like to talk.
>
> Mahalo

Concerns: Dr. Fisher did not express any concerns in his email. However, he did ,express concerns during his interview, which is summarized in the Interview section of this document.

TAMA STARR, LONG-TIME HĀNA RESIDENT

Dr. Scott Fisher, in his interview (see Interview section of this document), suggested SCS include Ms. Starr in the current consultation process. Ms. Starr kindly responded via an email dated June 14, 2021:

> Dear Cathy:
>
> We are delighted to hear that a plan is taking shape to repair that terribly dangerous section of road.
>
> I cannot see how anything of archaeological interest might be found there. It is a sheer cliff which was artificially created by cutting into the mountainside in the 1930s when the road was built. There are no caves. Any historic settlements would have been farther inland, up inside the gulch, a good distance away.
>
> I hope this is helpful.
>
> Best,
>
> Tama Starr

Concerns: Ms. Starr did not mention any concerns in her email. However, she did identify the project area as an historic section of the roadway corridor.

DR. ANDREW WALMISLEY

SCS contacted Dr. Walmisley at the suggestion of Dr. Scott Fisher. Dr. Walmisley is a freelance historian who has spent most of his life as an Episcopal priest and an international educator, culminating in five years at Seabury Hall, Maui. In addition to theology and history, his academic degrees focus on the impact of US colonialism in East Maui in the nineteenth century, as seen through the eyes of one illustrious Kaupō native: Elia Helekūnihi. His research has mostly been on the districts of Kaupō and Hāna. He is currently working on the publication of his dissertation, "The Betrayal of Elia Helekūnihi," and he has begun research on a comprehensive history of Maui utilizing Hawaiian language primary sources.

In an email dated June 22, 2021, Dr. Walmisley provided historical background information, in the form of photos and an historic letter, which provides a glimpse of life in and travel through this area in the early 1800s (Figures 9 through 14). These photos include photos include recent photos Dr. Walmisley recently took of the "old government road" that runs considerably mauka [northeast] of the current highway. Dr. Walmisley suggests this trail "is likely the "Hoapili Highway", built in the 1830s on the site of the more ancient Piʻilani Highway" (see Figures 10 through 12). In addition, Dr. Walmisley supplied SCS with an historic "letter written by Louis Mitchell, pastor of Kaupō describing the difficulties of getting his family from Kīpahulu to Kaupō in the early 20th century (see Figures 13 and 14). Dr. Walmisley pointed out that Louis Mitchellʻs "wife (who feared the pali trail and went by canoe) was first cousin to King Kalākaua and Queen Liliʻuokalani."



Figure 9: An Early Photograph of Nuanualoa not far to the west of Kaʻāpahu Ahupuaʻa. (From the Baker collection in the State Archives; provided courtesy of Dr. Andrew Walmisley).



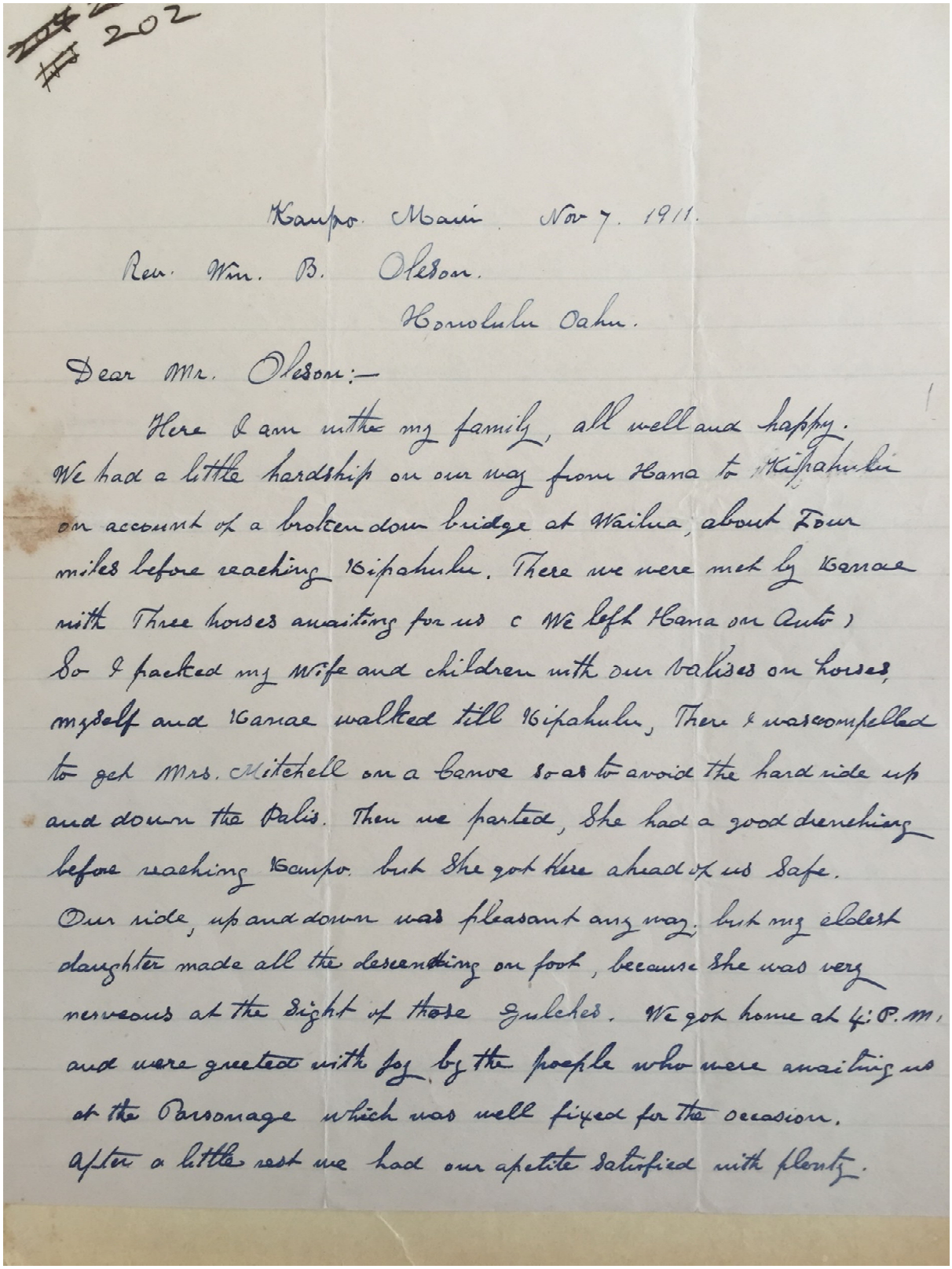
Figure 10: Photograph of the "Old Government Road" (Provided courtesy of Dr. Andrew Walmisley).



Figure 11: Photograph of the "Old Government Road" (Provided courtesy of Dr. Andrew Walmisley).



Figure 12: Photograph of the "Old Government Road" (Provided courtesy of Dr. Andrew Walmisley).



Kaupo. Maui Nov 7. 1911.

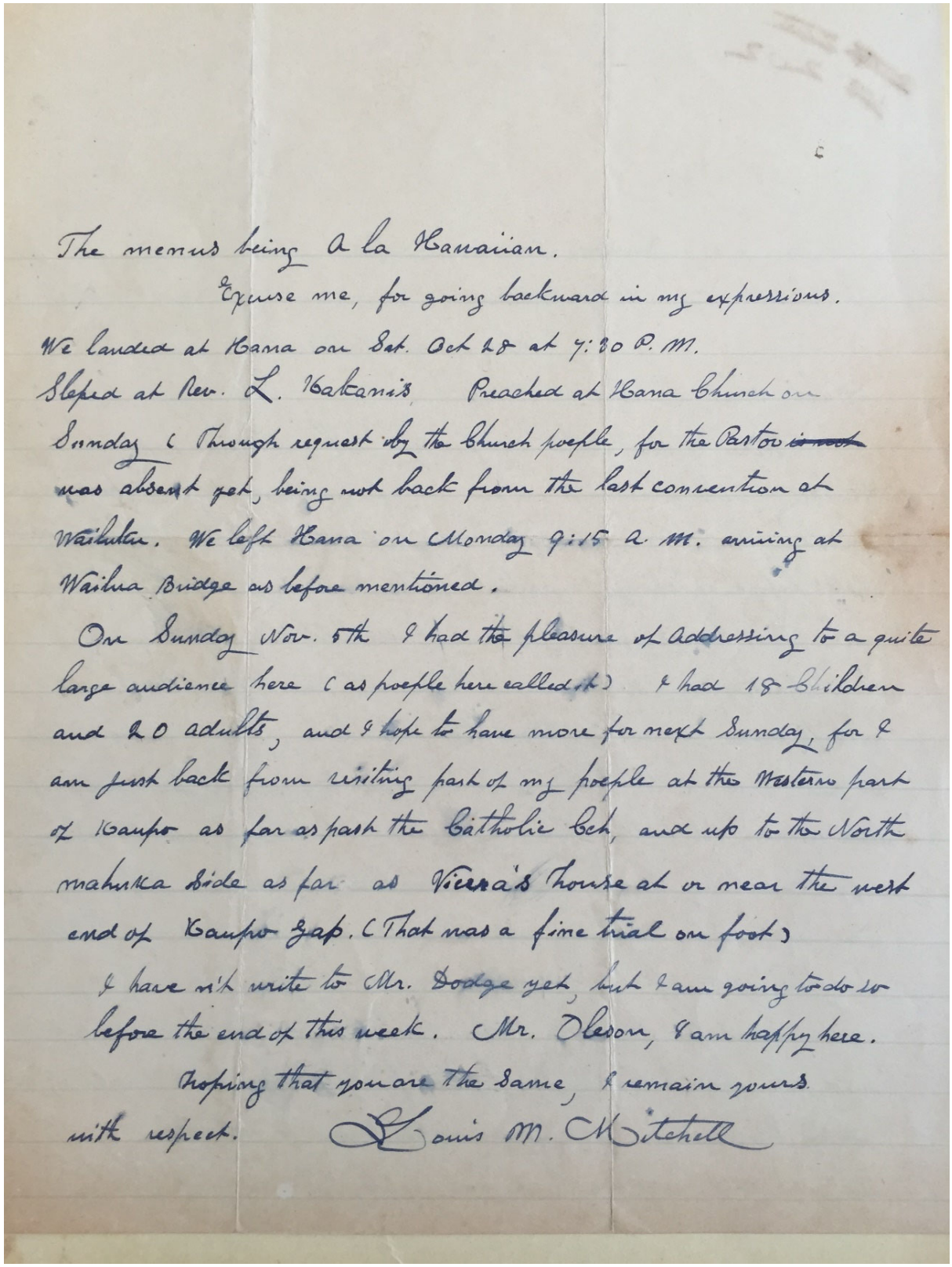
Rev. Wm. B. Oleson.

Honolulu Oahu.

Dear Mr. Oleson:—

Here I am with my family, all well and happy. We had a little hardship on our way from Hana to Kipahulu on account of a broken down bridge at Wailua, about Four miles before reaching Kipahulu. There we were met by Kanae with Three horses awaiting for us (We left Hana on Auto) So I packed my Wife and children with our Valises on horses, myself and Kanae walked till Kipahulu, There I was compelled to get Mrs. Mitchell on a Canoe so as to avoid the hard ride up and down the Palis. Then we parted, She had a good drenching before reaching Kaupo. but She got here ahead of us Safe. Our ride, up and down was pleasant any way, but my eldest daughter made all the descending on foot, because She was very nervous at the sight of those Gulches. We got home at 4: P. M. and were greeted with joy by the people who were awaiting us at the Parsonage which was well fixed for the occasion. After a little rest we had our apetite satisfied with plenty.

Figure 13: Page 1 of Letter written by Louis Mitchell, pastor of Kaupō, Dated November 11, 1911 (Provided courtesy of Dr. Andrew Walmisley).



The menus being A la Hawaiian.

Excuse me, for going backward in my expressions.

We landed at Kana on Sat. Oct 28 at 7:30 P. M.
Sleped at Rev. L. Kakani's Preached at Kana Church on
Sunday (Through request by the Church people, for the Pastor ~~is not~~
was absent yet, being not back from the last convention at
Wailuku. We left Kana on Monday 9:15 A. M. arriving at
Waihua Bridge as before mentioned.

On Sunday Nov. 5th I had the pleasure of addressing to a quite
large audience here (as people here called it) I had 18 Children
and 20 adults, and I hope to have more for next Sunday, for I
am just back from visiting part of my people at the Western part
of Kaupo as far as past the Catholic Sch, and up to the North
makaha side as far as Vierra's House at or near the west
end of Kaupo Gap. (That was a fine trial on foot)

I have n't write to Mr. Dodge yet, but I am going to do so
before the end of this week. Mr. Oleson, I am happy here.

Hoping that you are the same, I remain yours
with respect. Louis M. Mitchell

Figure 14: Page 2 of Letter written by Louis Mitchell, pastor of Kaupō, Dated November 11, 1911 (Provided courtesy of Dr. Andrew Walmisley).

And in a subsequent email dated June 23, 2021, Dr. Walmisley provided the following comments:

Aloha Cathy,

My sense is that the borderlands of all the moku of Maui were generally marginal territories. We see that clearly on both sides of Kaupō district, particularly towards Kahikinui. However, it is important to point out that you don't go far at all until you reach densely populated ahupuaʻa and the fact that these ahupuaʻa are often quite tiny indicates that they were populous. By 1841, as you know, the population had already been decimated, yet there was still a school at Naopuʻu (very close to the west of Kālepa) with 37 children. Nuanualoa was well-populated until late in the century and had a thriving ʻalaea clay industry. Not far away in Pualaea (where there was another school) missionary Dwight Baldwin of Lāhainā had an orange grove. In other words, to the west of Kālepa there was a thriving community, which in earlier times would have been even more populated. I believe there were loʻi kalo up Kālepa Stream as well.

Warmly,
Andrew

Concerns: Dr. Walmisley did not mention any concerns in his emails.

MS. JADE "ALOHALANI" SMITH, KAUPŌ MOKU REPRESENTATIVE, AHA MOKU O MAUI

Ms. Smith provided the following comments d via an email dated March 6, 2021:

Aloha Cathy,

Thank you for sending us information regarding the Assessment for Kālepa Point Road repairs. I had the opportunity to work with Janod Construction in 2007 - 2009 and understood the sensitivity of the Iwi buried within the cliffs on the mauka side, to which you probably have the details. Besides that, there isn't any other concerns but that the road needs repairs for the safety of the public. It is well overdue for repairs. Thank you for including us in for input. If I can assist you further, let me know.

J. Alohalani Smith

Concerns: Ms. Smith expressed concerns about the human burials in the cliff face above Kālepa Point and the proposed project area. She also suggested SCS contact Keahi Lind, Kipahulu Representative, Maui Poʻo- Moku O Kahekili, Aha Moku Advisory Council. Unfortunately, neither Ms. Smith nor SCS were able to obtain contact information for Mr. Lind.

NALANI TUKUAFU, EXECUTIVE DIRECTOR, HOLANI HANA INC. AN CULTURAL PRACTITIONER

The office of Councilman Shane Sinenci, through Mavis Oliveira-Medeiros, was kindly reached out to the Kālepa community on behalf of SCS, and Nalani Tukuafu, Executive Director of Holani Hana Inc. and a cultural practitioner, thoughtfully provided the comments below, via an email dated March 12, 2021:

> After sitting down and thinking about everything I realized I actually have a lot to say. Hahaha- I hope this helps. Let me know if I need to revise or revisit some information here so that it fits what you need.
>
> There are a few points that I would like to include on a cultural and historical standpoint regarding the area of Kaʻāpahu- Alelele- and Kālepa in Kipahulu.
>
> Our family has been here for more than 7 generations- in the ahupuaʻa of kapuaʻikini which is a few ahupuaʻa down from Kaʻapahu. Kaʻapahu/ lelekea bay is the only bay that is canoe accessible near us, and has long been the place where our family stores our canoe, and fishes for our family. Our family has many stories about this place. The two streams that flow into the bay are precious to us, and provide our family with food. We also utilize and share a relationship with Alelele stream and bay, where for many years we've used the fresh water stream and ocean to gather food. Alelele is considered a sacred place to us- the water is full of minerals that we utilize in laʻaulapaʻau, and the cliff sides are ancient burial sites. The cliffs and mountains between these areas hold iwi kupuna, native plants, and native animals. Disruption of these places - their cliff sides, caves, and ridges should be avoided, and maintenance of the road must be perpetuated with the utmost care.
>
> When the current cliff side fencing system was installed- in 2005 or 2006, my mother, grandmother, and other kupuna helped the county with iwi kupuna that had been exposed. My grandmother knew the names of those that were buried there, and never shared them with us- or anyone- on the grounds that the information was too sacred. That being said- we do know that there are iwi kupuna present throughout these areas- even though we don't know who or exactly where.
>
> Another historical reference that should be included is that Alelele was occupied and farmed by a small village of its own. Before the road was put in - there was still a family living there - who traveled by use of the donkey trail. There are records from sailors journals that describe Alelele as an extremely well farmed cliff side cove... with kalo blowing in the wind all along the soiled cliffs. Before the road and bridge were put there the pond opened up and filled the whole cove on the makai side, my grandma used to tell me stories about how they would walk

over and swim in the huge pond. Knowing this small bit of history tells me a couple things about the impact the road has had on the place. 1. Because of the highway cutting through - and colonialism in general - the family that cared for this place for generations moved away and there has been an amazing amount of neglect with regards to the native plants of this specific place. If the cliff side was filled with native kalo and other native plants before- and is now currently filled with Christmas berry - then there's been a disruption to how the cliff erodes due to the deeper roots now penetrating the mountain. Unfortunately goats have overrun the cliffs as well- causing a dangerous amount of erosion, so dangerous that many locals don't feel comfortable going up to the waterfall on most days due to falling rocks. 2. Since the smart phone began geo mapping pictures that people take - tourist have had an unprecedented impact on the space. I haven't counted- but if I go to Hanawi on any given day- and spend a couple hours there - there will be a constant flow of tourist parking and walking up the trail. I'd say at least 200 people an hour. It's frustrating - since this place is so special to us- so witness them claiming the space for tourist adventurism. They leave trash, clothing, shoes, and a residue of oils and lotions in the water. They trample up the trail where unmarked historical sites exist including but not limited to old hale (house) foundations.

Because of the impact that traffic has had on the place in the last 20 years, we're headed down a dangerous road that may not be amendable if we don't take some actions to preserve what we have left. I don't know how this influences how the road will be fixed in that spot - but I hope this perspective and brief history can help that work in a way that makes the current situation there better for the land, water, and native people.

I would admonish anyone working on the area to proceed with caution and respect. I plead with the state and county not to allow any desecration within the duration and scope of this project.

Mahalo!
Nalani Tukuafu

Concerns: Ms. Tukuafu describes the historical; and cultural significance and sacredness of the area. She also describes the relationship the families who have been living in the area for generations have with the plants, animals, and the surrounding environment, which provides food, water, and medicine. Ms. Tukuafu mentions the traditional burials in the cliff face. Ms. Tukuafu requests that the cliff sides, caves, and ridges should be avoided, and maintenance of the road must be perpetuated with the utmost care.

INTERVIEWS

The consultation process resulted in SCS conducting two interviews. As stated elsewhere in this report, under normal circumstances, the SCS CIA interviews are conducted in person, whenever possible. In an effort to keep everyone safe and healthy, due to the current COVID-19 pandemic, no in person interviews were conducted during the consultation process for this report. The interview with Dr. Scott Fisher was conducted virtually via ZOOM and the interview with Ms. Lucienne de Naie was conducted by phone. Summaries of these interviews are presented below.

DR. SCOTT FISHER, CHIEF CONSERVATION OFFICER, HAWAIʻI LAND TRUST; MAUI/LĀNAʻI BURIAL COUNCIL REPRESENTATIVE; AND FORMER ASSOCIATE DIRECTOR OF CONSERVATION, HAWAIIAN ISLANDS LAND TRUST

Dr. Fisher is the Chief Conservation Officer of the Hawaiʻi Land Trust (HILT), where he formerly served as Chief Conservation Officer. The mission of HILT, a state-wide conservation organization, focuses on sustainability in an effort to protect the lands for current and future generations. He also is serving a second term as a representative on the Maui/Lānaʻi Islands Burial Council (MLIBC). Dr. Fisher's family is from Maui. Dr. Fisher grew up in Kula, which is where he and his family currently live. During his youth, his mother worked as the bookkeeper for Kaupō Ranch for a few years. Dr. Fisher's "uncle", Kyle "Soot" Bredhoff, who is in his late 80s now, was the manager of Kaupō Ranch from 1968 to 1982. In addition, Dr. Fisher is very involved with Kaupō through his work at the Hawaiʻi Land Trust. Dr. Fisher participated in a ZOOM interview conducted by Cathleen Dagher, B.A., on June 3, 2021. The interview is summarized below.

> In 2007 or 2008, after the earthquake on the Big Island, screening was placed over the cliff face above the Hāna Highway as a protective measure to keep the boulders from impacting the cars and roadway below. Dr. Fisher remembers Les Kuloloio [now deceased, former cultural practitioner, and former MLIBC representative] expressing, at that time, a high degree of concern because in that area; i.e., in the cliffs above the highway at Kālepa Point, were iwi kupuna.
>
> In addition, along that whole area, the cliffs are the habitat for the koaʻe kea, the white-tailed tropicbird (*Phaethon rubricauda* and *P. lepturus*). The area is a high quality habitat for these sea birds. In fact, all over Kaupō, you can see the tropicbirds and they are mainly coming from the area around the Kālepa Point area. Traditionally, their feathers were used.

Putting the area in the context of history, Kālepa Ahupuaʻa was the boundary between the Districts of Kīpahulu and Kaupō. In addition, in the late 18th century, Kaʻāpahu Ahupuaʻa formed the political boundary between the Islands of Maui and Hawaiʻi. At that time, the Districts of Hāna and Kīpahulu belonged to the Big Island. It is important to know that Kaʻāpahu Ahupuaʻa has the added significance of being a major political boundary. The Kīpahulu side of Kaupō was the home of Kamehameha I's brother, Keliʻimaikaʻi.

From what we know right now about the area, the Kaupō District contained a 25-mile wide dryland agricultural field system - possibly the largest dryland agricultural field system on Maui. While it is possible the Kula field system is larger, this has yet to be determined. The upper- Kīpahulu side of Kaupō had quite an extensive dryland taro field system. What made Kaupō so culturally rich were the agricultural practices which were based in the nutrient-rich soils of the Naholuku colluvial fan. In addition to agriculture, traditionally, the people living in the area relied heavily on marine resources.

Kaupō District starts at Pāhihi Gulch on the west and extends to Kālepa Gulch, on the east. This is a fairly large district containing approximately eighteen ahupuaʻa and approximately 60 known heiau. The three most important heiau are Loʻaloʻa Heiau, which was located at approximately 1,500 ft amsl on the eastern edge of the field system; Kou Heiau, was a very, very substantial heiau located right on the coast on the Kīpahulu (western) side of Kaupō. According to Hawaiian scholar Dr. Patrick Kirch, Kou Heiau is significant because, although it is a luakini class heiau, it had an agricultural function. Kou Heiau is directly aligned with the rising of the sun on the morning of October 24, 1700, which Kirch suggests is important for knowing the time to begin planting. The third significant heiau is located on the coast in Nuʻu Ahupuaʻa and was used well-after the ʻai noa. This heiau may have even been built after the ʻai noa because when Bishop Museum anthropologist Kenneth P. Emory and his native Hawaiian guide Thomas K. Maunupau visited the site in the early 1920s, they talked to the kahuna whose name was Kenui. Kenui, who was the last kahuna of the heiau, told Emory and Maunupau that his grandfather had built it. Emory estimated Kenui to be in his 60s at the time of his visit, calculated Kenui's grandfather to have been alive in the 1890, at the time of the ʻai noa. Fishing played a large role in Kaupō life. Kenui used to sleep in the heiau in order to receive visions on where to fish. "The point is, cultural practices in Kaupō remain intact in many ways, even to this day. Even with cattle ranching and all of the changes that have happened, there are still people who practice much of their traditional cultural practices, including fishing."

Hunting is seen as a cultural practice. It is still very important and in some ways has replaced small-scale agriculture as a cultural activity. Hunting of deer is very recent and goat hunting has a longer history goats, as they were introduced to the Hawaiian Islands in the mid-1800s.

Economically, agriculture and fishing were conducted traditionally. Early on, in the Historic Period, ranching became important and played huge role in the economy of Kaupō, with the forming of the Kaupō Ranch who was the largest employer.

According to Kaupō historian Dr. Andrew Walmisley, around 1910, the Japanese came in and harvested a huge amount of koa [*Acacia koa*]. There used to be extensive koa forests in Kaupō. Ecologically, goats have done a lot of damage in Kaupō, where there is currently a large feral goat population. Kaupō was extremely culturally rich. At one point, it was the fourth most populous district on the Island, following Lahaina, Hāna, and Wailuku. Both pre- and post-Contact, Kaupō had a fairly substantial population. During the Historic Period, Kaupō had five schools. After World War I [1914-1918], people began to move out. On April 1, 1946, at least in Nu‘u, the 1946 tsunami really moved everyone out. The population at Nu‘u really seemed to disappear.

During the course of the interview, Dr. Fisher suggested SCS contact Tama Starr long-time resident and Jon’s sister; Jonathon Starr long-time resident; Helen Nielsen, Jon’s partner and long-time resident; Dr. Andrew Walmisley, Kaupō historian, theologian, scholar, researcher; Kyle “Soot” Bredhoff, former Kaupō Ranch manager, long-time Hāna resident; Sam Aina; Rachel Hodara, M.A., Archeologist/Cultural Resources Program Manager, Haleakalā National Park; and Alohalani [Helekulani] Smith.

Concerns: Dr. Fisher reasserted Leslie Kuloloio’s concern that traditional native Hawaiian burials are located in the cliff face above Hāna Highway at Kalepa Point.

Note: Dr. Fisher provide written approval and permission to include the above interview summary in this report in an email dated September13, 2021. Please also note, SCS included Tama Starr, Jonathon Starr, Helen Nielsen, Dr. Andrew Walmisley, Kyle “Soot” Bredhoff, Sam Aina; Rachel Hodara, and Alohalani [Helekulani] Smith in the CIA consultation process.

LUCIENNE DE NAIE, VICE PRESIDENT, MAUI TOMORROW FOUNDATION

Lucienne de Naie currently is the Vice President of the Maui Tomorrow Foundation and a long-time resident of Huelo, in East Maui. She is an historical researcher, author, and a long-time member of the Sierra Club, where she has served in a several capacities. In addition, Ms. de Naie is founding member of Maui Cultural Lands, Inc., a non-profit land trust which has restored cultural sites in Honokōwai Valley, and of the Maui Coastal Land Trust, now known as Hawaii Island Land Trust. Ms. de Naie participated in a telephone interview conducted by Cathleen Dagher, B.A., on June 5, 2021. The interview is summarized below.

> Kālepa Valley does seem to have been a place of some importance because the King's Trail could be accessed there from the coast. There was a coastal trail that winds around through Nuʻu, Kaupō, and the area where Loʻaloʻa Heiau is. The modern Hāna Highway probably overlays portions of the trail that extends along the coast; a portion of which extends further inland. During the 1990s, Ms. de Naie hiked a portion of the inland section of this trail with Donald Reeser, during his tenure as Superintendent of Haleakalā National Park, when he was working to expand the park. She stated the trail was paved with waterworn and unmodified basalt cobbles embedded in the dirt with spaces between them. She could not recall if there were curbstones along the edges of the trail. The trail crossed threes valleys within Kaʻāpahu Ahupuaʻa: Kālepa Valley, Alelele Valley, and Lelekēa Valley (see Figure 6).
>
> Ms. de Naie accessed the trail from the ridge on the east side of Kālepa Valley, followed the ridge separating Kālepa Valley from Alelele, dropped down into Alelele Valley, passed through an old Hawaiian village, and crossed Alelele Stream. Alelele Stream is famous for its waterfalls and pools. It is also known as one of the healthiest streams on Maui. It has complete stream life in it, it has never been diverted, and it is a completely natural stream that must be spring-fed from way above. Ms. de Naie stated, " It was like seeing time untouched." The trail crossed Alelele Stream, extended across Alelele Valley above the big waterfall, continued up the east side of Alelele Valley, into Lelekēa Valley. Within Lelekēa Valley, the trail turned, and headed back down to the coast.
>
> On a subsequent occasion in the 1990s, Ms. de Naie walked the area with Sam Kaʻai., who shared his knowledge with her. During this trip, Ms. de Naie observed a single loulu [*Pritchardia* spp.]. the native palm tree, growing on Lelekēa Valley. Mr. Kaʻai told her, at the time, that particular tree was over a hundred years old and that it used to be surrounded by others. Over time these trees, which grow in dry areas, died off and rats ate the seeds. These trees used to be very common, but now, are an endangered species. Mr. Kaʻai also told Ms. de Naie that there was a heiau in Lelekēa Valley Mr. Kaʻai also mentioned there

were habitation sites in Kālepa Valley, as there were in Alelele. Ms. de Naie also recounted that koa [*Acacia koa*] once grew abundantly in the area, as well, and it still grows in the upper portions of the Kalepa Valley.

Ms. de Naie mentioned that David Dodds, the previous owner of the land before the National Park acquired it, had an actual permit to log koa out of the upper parts of Kalepa and Alelele Valleys using helicopters.

All of these valleys were populated until the early 1900s, when there was a tidal wave that hit the East Maui coast from Hāna to Keʻanae. As a result, the streams within these low-lying valleys flooded the valley floors. The residents who were forced to leave their homes did not return.

The ocean in the area immediately adjacent and south of the project area is a very popular fishing site native Hawaiians continue to frequent to conduct the traditional practice cultural of fishing and collecting/gathering cultural resources, including ʻopihi [*Cellana* spp.] and laʻau.

During the course of the interview, Ms. de Naie suggested SCS contact Kimokeo Kapahulehua, cultural practitioner and the Haleakalā National Park staff. Mr. Kaphalehua had accessed the Kalepa Valley to harvest a koa tree for a canoe a number of years ago, after being given permission by the Starr family to access their land in Kaupō. Ms. de Naie happened to be in Kaupō, visiting Nuʻu pond, when Mr. Kapahulehua and his crew of helpers drove through with the log strapped to the bed of a vehicle. Mr. Kapahulehua explained to the party at Nuʻu (who were there for a Sierra Club hike, that he and other cultural practitioners, had visited the koa forest in Kalepa, above the Starr's property earlier in the year to offer appropriate cultural protocols and pray for guidance to select a tree for the future canoe.

After this was all complete, the party came back, guided by the propitious time in the Hawaiian moon cycle, as Ms. de Naie recalled, to complete the harvest and the transport of the koa log. Mr. Kapahulehua is well known as a traditional Hawaiian waʻa or canoe paddler and builder who serves as a kumu (teacher) for many novice canoe paddlers.

Concerns: Ms. de Naie is concerned that the road repair project may impact access to the ocean and the cultural practice of gathering and collecting of cultural resources (i.e., plants, near-coastal and marine resources) used for traditional (food, medicine, and for ceremonial) purposes.

CULTURAL IMPACT ASSESSMENT SUMMARY

This Cultural Impact Assessment was prepared in accordance with the Guidelines for Assessing Cultural Impacts (OEQC 1997:11-13). The Guidelines recommend that a CIA consult relevant individuals/organizations, conduct ethnographic interviews and archival and historical research, identify cultural resources and practices located within the project area or in proximity, and finally, assess the impact of the proposed action and its mitigation measures on the cultural practices or resources identified.

In the case of the current undertaking, letters of inquiry were sent to forty-six individuals and organizations, via the U.S. Postal Service and e-mail, that may have knowledge or information pertaining to the collection of cultural resources and/or practices currently in Kaʻāpahu Ahupuaʻa of Kīpahulu District. Written responses received from fifteen individuals and two interviews identified valued cultural, historical, or natural resources in close proximity to the proposed project area and adjacent environs.

Background and supporting information was obtained from historical and cultural source materials provided by scholars such as Samuel Kamakau, Martha Beckwith, Jon J. Chinen, Lilikalā Kameʻeleihiwa, R. S. Kuykendall, Marion Kelly, E. S. C. Handy and E.G. Handy, Elspeth P. Sterling, and Mary Kawena Pukuʻi and Samuel H. Elbert and continue to contribute to our knowledge and understanding of Hawaiʻi, past and present. The works of these and other authors were consulted and incorporated in the report where appropriate. Land use document research was supplied by the Waihona ʻAina Database (2021) and the Office of Hawaiian Affairs Kipuka Database (2021).

IDENTIFED CULTRAL RECOURCES AND CULTURAL PRACTICES

The purpose of a Cultural Impact Assessment is to identify the possibility of on-going cultural activities and resources within a project area, or its vicinity, and then assessing the potential for impacts on these cultural resources. As stated elsewhere in this report, the Hawaii State Office of Environmental Quality Control (OEQC 2012:11), states the geographical extent of the CIA study area should be greater than the area over which the proposed project extends to ensure that cultural practices that occur outside of the project area, but which may still be affected, are included in the assessment. Thus, for the purpose of this CIA study, the entire ahupuaʻa is the project area.

During the consultation process, numerous cultural practices and cultural resources were identified in the proposed project area and adjacent environs, are briefly described below.

BURIALS

Hawaiian mortuary practices include interring the dead in "pits, coffins, crypts, cairns, cists, or other structural monuments" (Han et al. 1986: 11). "Structural monuments" include lava tubes, blisters, and caves, which are known to be located in cliff face immediately above the project area, some of which have been documented, including SIHP Site #50-50-16-6486 (Armstrong and Dega 2009). Many individuals who participated in the consultation process mentioned these burials and wanted to make sure that all parties involved with this project were aware of their presence. One individual with generational ties to the area, stated that her grandmother knew the names of the individuals who were buried in the cliffs and never shared that information with anyone because that information was too sacred.

FLORA AND FAUNA

The landscape adjacent to the proposed project area provides a wide variety of natural resources that were previously and continue to be used in cultural practices. Numerous native plants grow in the surrounding area, many of which continue to be used for traditional purposes including medicinal, ceremonial, and as a source of food.

The koaʻe kea, the white-tailed tropicbird (*Phaethon rubricauda* and *P. lepturus*), is also a cultural resource associated with the cliffs above Kālepa Point area, as pointed out by Dr. Scott Fisher in his interview. According to Malo (1951:40), these birds have "long tail feathers which are used to make kahili" (feather standard, symbolic of royalty) "and [it] is fit for food."

At one time, koa trees (*Acacia koa*) were abundant throughout the area. Traditional uses of this particular tree includes canoes (Malo 1951:126), ceremonial purposes (Malo 1951:174), and as surfboards (Malo 1951:223).

FRESHWATER, COASTAL, AND MARINE ENVIRONMENT RESOURCES

The coastal area continues provide cultural resources for subsistence and ceremonial purposes. Families continue supplement their diet with a variety freshwater and coastal fish, snails, and mollusks found in Alelele Stream, Kaʻāpahu/ Lelekēa Bay, and in the area below the Hāna Belt Highway and the proposed project area - marine resources include deep sea and off-shore fishing areas. In addition, one person mentioned that her family continues the cultural practice of storing canoes in Kaʻāpahu/ Lelekēa Bay

TRAILS

According to Kirch (1985:266-267), overland trails "form an important component of [traditional] settlement landscapes ...[forming]…linkages between individual communities …particularly along the leeward coasts" of the Hawaiian Islands. Trails in Kīpahulu extend parallel to the coastline or mauka-makai between the upland and the coast (see Figure 6). The Hāna Belt Highway follows an earlier trail, the Alanui o Pi'ilani (King's Trail, ala nui), which was a foot trail. These trails continue to be used for travel in the area, to access cultural resources, and ceremonial areas, including burials.

HISTORIC PROPERTIES

Hāna Belt Highway, which is the proposed project area, is considered a cultural resource and an historic property, as it was constructed over 50 years ago. As explained in the National Register of Historic Places Nomination Form (see Appendix A):

> The road's alignment dates to its construction in the 1920s. The Belt Road is the only overland automobile route that connects East Maui communities with the rest of the island. The period of significance is circa 1900 when Mauians began calling for an improved road and a rudimentary wagon road was constructed near Nahiku, to 1947 when the last bridge was built to service the Hana Belt Road.

Hāna Highway (also known as the Hana Belt Road, Hāna Road, Hāna Highway, Pi'ilani Highway), including the project area corridor, has been designated State Inventory of Historic Properties (SIHP) Site #50-50-15-1638 and is listed on the National Register of Historic Places as 01000615 (Appendix A). As stated elsewhere in this report, prior to the construction of the Hāna Belt Highway, travel was conducted via the Alanui o Pi'ilani (King's Trail), which was a foot trail.

CONCLUSION AND RECOMMENDATIONS

The findings of the current Cultural Impact Assessment identified the Hāna Belt Highway roadway corridor (SIHP Site #50-50-15-1638), the proposed project area, as a cultural resource/historic property. The Hāna Belt Highway roadway corridor (SIHP Site #50-50-15-1638) was constructed over 50 years ago, has been recognized as significant under multiple criteria in accordance with Hawaii Administrative Rules (HAR) § 13-284, and has been nominated for the National Record of Historic Places (see Appendix A). No additional cultural resources or cultural practices were identified within this segment of the Hāna Belt Highway roadway corridor. However, valued cultural and natural resources have been identified in the surrounding environment: human burials, including the rockshelter and human burial designated as SIHP Site #50-50-16-6486 (see Armstrong and Dega) and those human burials reported to be in the cliff face above the proposed project area by the cultural contacts during the current consultation process; the freshwater, near-coastal, and marine resources; native flora and fauna; minerals; and wildlife. Fishing and the procurement of freshwater, near-coastal, and marine resources; native flora and fauna; minerals; and wildlife) for food, medicine, and ceremonial purposes are the traditional cultural practices identified during the consultation process.

Therefore, it is recommended that consultation with the State Historic Preservation Division be conducted prior to the commencement of ground altering activities to determine appropriate mitigation measures to protect historic properties from impacts throughout the duration of the proposed project. It is further recommended that measures be in place to protect cultural resources identified through the consultation process and to allow native Hawaiians to continue conducting cultural activities by providing alternative access to identified cultural resources throughout the duration of the project.

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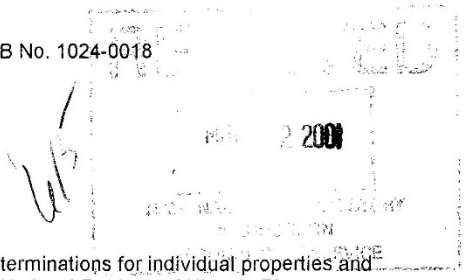
APPENDIX A: NATIONAL REGISTER OF HISTORIC PLACES NOMINATION FORM FOR THE HĀNA BELT HIGHWAY

NPS Form 10-900
(Rev. 10-90)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
REGISTRATION FORM



This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in How to Complete the National Register of Historic Places Registration Form (National Register Bulletin 16A). Complete each item by marking "x" in the appropriate box or by entering the information requested. If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions. Place additional entries and narrative items on continuation sheets (NPS Form 10-900a). Use a typewriter, word processor, or computer, to complete all items.

1. Name of Property

historic name Hāna Belt Road
other names/site number Belt Road, Hāna Road, Hāna Highway, Pi'ilani Highway

2. Location
street & number Hāna Highway (State Rte. 360), Pi'ilani Highway (Rte. 31) not for publication __
city or town Makawao District to Hāna District
vicinity Ha'ikū, Ke'anae, Nāhiku, Hāna, Kīpahulu
state Hawai'i code HI county Maui code 009 zip code __

3. State/Federal Agency Certification
As the designated authority under the National Historic Preservation Act of 1986, as amended, I hereby certify that this ____ nomination ____ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ✓ meets ____ does not meet the National Register Criteria. I recommend that this property be considered significant ___ nationally ✓ statewide ___ locally. (___ See continuation sheet for additional comments.)

4-20-01
Signature of certifying official Date

State or Federal agency and bureau

In my opinion, the property ____ meets ____ does not meet the National Register criteria.
(___ See continuation sheet for additional comments.)

Signature of commenting or other official Date

State or Federal agency and bureau

4. National Park Service Certification

I, hereby certify that this property is: Signature of Keeper Date of Action

√ entered in the National Register
√ See continuation sheet. Sarah D. Pope 6/15/01

___ determined eligible for the National Register
__ See continuation sheet. _____

___ determined not eligible for the National Register

___ removed from the National Register

____ other (explain): _____

5. Classification
Ownership of Property
(Check as many boxes as apply)

__ private

_x_ public-local

_x_ public-State

___ public-Federal

Category of Property
(Check only one box)

___ building(s)

_x_ district

___ site

___ structure

___ object

Name of related multiple property listing
(Enter "N/A" if property is not part of a multiple property listing.)

N/A

Number of Resources within Property

Contributing	Noncontributing	
____	_____	buildings
____	_____	sites
73	1	structures (bridges and culverts)
_____	_____	objects
73	1	Total

Number of contributing resources previously listed in the

National Register N/A

6. Function or Use

Historic Functions (Enter categories from instructions)

Cat: Transportation Sub: road-related

Current Functions (Enter categories from instructions)

Cat: Transportation Sub: road-related

7. Description

Architectural Classification
(Enter categories from instructions)

Other: OTHER: roadways; bridges: reinforced concrete, girder, flat slab, masonry (basalt or lava rock)

Materials
(Enter categories from instructions)

foundation _____

roof _____

walls _____

_____

other asphalt, concrete, masonry (lava rock)

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing)

__X__ A Property is associated with events that have made a significant contribution to the broad patterns of our history.

____ B Property is associated with the lives of persons significant in our past.

__X__ C Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

____ D Property has yielded, or is likely to yield information important in prehistory or history.

Criteria Considerations

(Mark "X" in all the boxes that apply.)

Property is:

____ A owned by a religious institution or used for religious purposes.

____ B removed from its original location.

____ C a birthplace or a grave.

____ D a cemetery.

____ E a reconstructed building, object, or structure.

____ F a commemorative property.

____ G less than 50 years of age or achieved significance within the past 50 years.

Areas of Significance
(Enter categories from instructions)

Engineering _____

Social History _____

Transportation _____

Commerce _____

Period of Significance

circa 1900 to 1947

Significant Dates

circa 1900 to 1947

Significant Person
(Complete if Criterion B is marked above)

Cultural Affiliation

Architect/Builder

County engineers, including Hugh Howell, Paul Low, and A. H. Wong; builders were county employees, prison labor, and private contractors. Private contractors included Wilson and McCandless, Hugh Howell Engineering Company, and Moses Akiona, Ltd. Designers also included William D'Esmond, architect; Joseph Matson, and D. Kapohakimohewa.

9. Major Bibliographical References Bibliography (Cite the books, articles, and other sources used in preparing this form on one or more continuation sheets.)

Previous documentation on file (NPS)

___ preliminary determination of individual listing (36 CFR 67) has been requested

___ previously listed in the National Register

___ previously determined eligible by the National Register

___ designated a National Historic Landmark

___ recorded by Historic American Buildings Survey

_____

___ recorded by Historic American Engineering Record

_____

Primary Location of Additional Data

___ State Historic Preservation Office

_X_ Other State agency

___ Federal agency

___ Local government

___ University

___ Other

Name of repository:

State of Hawai'i Department of Transportation

10. Geographical Data Acreage of Property _ _____

UTM References
(Place additional UTM references on a continuation sheet)

	Zone	Easting	Northing		Zone	Easting	Northing
1	04	787810	2314160	3	04	789510	2312640
2	04	788850	2313440	4	04	789860	2312530

_X_ See continuation sheet.

Verbal Boundary Description
(Describe the boundaries of the property on a continuation sheet.)

The boundaries of the nominated district are delineated by the course of the Hāna Belt Road. The right-of-way is approximately 40' wide and is variable along the entire length of the road. The historic district begins .2 miles west of Mile Marker 3 on the Hāna Highway, State Route 360, near Huelo, and ends on the south end of Koukou'ai Bridge near Kīpahulu on Route 31.

Boundary Justification
(Explain why the boundaries were selected on a continuation sheet.)

The boundaries are coterminus with the Hāna Belt Road's historic right-of-way. The beginning and end points were selected to encompass the portion of the Hāna Belt Road that retains the greatest historic integrity and character. This section of roadway is relatively unaltered and is the most spectacular portion of Maui's historic belt road system, both in its scenery and its historic character. The boundaries include the highest concentration of stylistically consistent historic bridges in the State of Hawai'i.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 10 Geographical Data Page 2

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

UTMs continued:

	zone/easting	northing	
5	04/790890	2311540	
6	04/791260	2311740	
7	04/791400	2311610	
8	04/792250	2310930	
9	04/793400	2310360	
10	04/793620	2310280	points 5-17: Ke'anae, Hawai'i quad
11	04/794270	2309800	
12	04/794310	2309020	
13	04/795250	2309060	
14	04/796560	2309440	
15	04/796790	2309280	
16	04/797770	2308430	
17	04/797540	2306640	
18	04/797580	2305320	
19	04/797800	2305090	
20	04/798000	2304760	
21	04/798680	2304860	
22	04/798890	2304800	
23	04/799550	2304630	points 18-32: Nāhiku, Hawai'i quad
24	04/799760	2304420	
25	04/799920	2304330	
26	04/800000	2304410	
27	04/800520	2304260	
28	04/800880	2304190	
29	04/801930	2303950	
30	04/802190	23033830	
31	04/		
32	04/	2303830	

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 10 Geographical Data Page 3

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

UTMs continued:

	zone/easting	northing	
33	04/803810	2303440	
34	04/803910	2303270	
35	04/804000	2303160	
36	04/804170	2303130	
37	04/804290	2303000	
38	04/804900	2303020	points 33-47: Hāna, Hawai'i quad
39	04/805350	2303020	
40	04/805650	2302900	
41	04/806060	2302760	
42	04/807160	2302510	
43	04/807630	2302290	
44	04/812440		
45	04/812960	2295650	
46	04/812960	2293760	
47	04/812580	2292900	
48	04/811030	2290640	
49	04/810240	2290700	
50	04/809900	2290260	
51	04/809480	2290260	
52	04/809190	2290300	
53	04/809070	2290210	points 48-60: Kīpahulu, Hawai'i quad
54	04/808730	2289420	
55	04/808500	2289330	
56	04/808210	2289200	
57	04/808000	2289200	
58	04/807770	2288590	
59	04/807680	2288060	
60	04/805910	2286630	

11. Form Prepared By

name/title Dawn E. Duensing, historian
organization Maui County Cultural Resources Commission date 1/13/01
street & number P.O. Box 888 telephone (808)572-6583
city or town Makawao state HI zip code 96768

Additional Documentation. Submit the following items with the completed form:

Continuation Sheets

Maps

A USGS map (7.5 or 15 minute series) indicating the property's location.

A sketch map for historic districts and properties having large acreage or numerous resources.

Photographs

Representative black and white photographs of the property.

Additional items
(Check with the SHPO or FPO for any additional items)

Property Owner(Complete this item at the request of the SHPO or FPO.)

name State of Hawai'i, Department of Transportation
street & number 869 Punchbowl Street telephone (808)587-2150
city or town Honolulu state Hawai'i zip code 96813

name County of Maui, Department of Public Works & Waste Management
street & number 200 S. High Street telephone (808)270-7845
city or town Wailuku state Hawai'i zip code 96793

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

The Hāna Belt Road is coterminous with its historic right-of-way. The Hāna Highway portion of the "belt road" traverses approximately fifty-one miles along Maui's north and east coast from Kahului in central Maui to the remote East Maui community of Hāna. After Hāna, the road continues as the Pi'ilani Highway and circles back around East Maui's south side, a distance of thirty-seven miles. Together, these East Maui roads were part of Maui's "belt" road system around the entire island. The proposed historic district includes approximately forty-two miles of road from .2 miles west of Mile Marker 3 on the Hāna Highway near Huelo to Koukou'ai Bridge on Pi'ilani Highway near the Kīpahulu section of Haleakalā National Park. The narrow road winds around more than 600 curves and over fifty-nine bridges. The Hāna Belt Road is famous for its one-lane bridges with sharp approaches and encompasses the highest concentration of unaltered and stylistically consistent historic bridges in Hawai'i. The Belt Road to Hāna is notable for its breathtaking scenery as it passes waterfalls, v-shaped valleys, and small villages, often hugging the precipitous sea cliffs on Maui's rugged coastline. The roadway width varies from less than 16' wide along the sea cliffs and other rugged terrain to approximately 22' wide through level topography and residential areas. Along most of the roadway, there is no shoulder or a very narrow shoulder. The road's alignment dates to its construction in the 1920s. The Belt Road is the only overland automobile route that connects East Maui communities with the rest of the island. The period of significance is circa 1900 when Mauians began calling for an improved road and a rudimentary wagon road was constructed near Nāhiku, to 1947 when the last bridge was built to service the Hāna Belt Road.

TOPOGRAPHY AND EARLY ROAD

The Hāna Belt Road traverses through some of Hawai'i's most rugged topography and rainiest climate. The island of Maui is comprised of two shield volcanoes joined by an isthmus, which constitutes east and west Maui. East Maui, where the Hāna Belt Road is located, is the immense Haleakalā, a dormant volcano more than 10,000' in elevation. In earlier times, lava flows poured into the ocean to create the jagged coastline along which the road is aligned. Centuries of stream erosion from the wet, tradewind climate on Haleakalā's windward (northeastern) slope cut a rugged terrain of great sea cliffs and v-shaped valleys. The wet climate allowed

dense forests to grow over the rough terrain and helped make the Hāna District in East Maui one of Hawai'i's most isolated and inaccessible areas.

Prior to 1450 A.D., Maui was divided into two separate kingdoms, one with a court at Lahaina, the other with a court in Hāna. The East Maui coastal area was well populated in ancient times, but had little contact with the rest of Maui due to its isolated location. Traditionally, Hawaiians preferred to rely on their highly-developed navigational skills and traveled by canoe. As a result, Hāna was often politically tied to the more accessible communities across the channel on the island of Hawai'i. In the sixteenth century, Maui's King Pi'ilani conquered East Maui and pulled Hāna into his political sphere. Pi'ilani was notable for his public works projects, including the *Alaloa*, or main road, which began in West Maui.[1]

The predecessor trail to the Hāna Belt Road was built by Pi'ilani's son, Kihapi'ilani, in the sixteenth century. The trail was paved with hand-fitted basalt (lava) rocks. The 1848 account of Moses Manu noted, "This road was treacherous and difficult for the stranger, but when it was paved by Kihapi'ilani this road became a fine thing." When completed, the road was 4' to 6' wide, 138 miles long, and encircled the entire island. With the completion of Kihapi'ilani's East Maui trail, known as the King's Highway, Maui became the only island in the Hawaiian chain to have a "belt" road that completely encircled it.[2] In 1828, missionaries noted that the trail was "paved" and extended over thirty miles. They reported that it was a great help in ascending and descending the steep mountains and cliffs in the area. The early trail's switchbacks over the mountains near Honomanū were still visible in the 1940s.[3] Today, intact portions of the King's Highway remain, although most of the road has been obliterated by agriculture or paved over by modern roadways, including the Hāna Belt Road.

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[1] Gail Bartholomew, *Maui Remembers: A Local History*. (Honolulu: Mutual Publishing), 1994, 2.

[2] Bartholomew, *Maui Remembers*, 2; Trust for Public Land and Bay Pacific Consulting, *East Maui Resource Inventory*, Prepared for the Rivers, Trails, and Conservation Assistance Program, National Park Service, U.S. Department of the Interior (Honolulu: 1998), 9.

[3] E. E. Pleasant, "Maui 100 Years Ago: The Old Trail to Hāna." *The Maui News*, June 13, 1942.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 3

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

THE HĀNA BELT ROAD

The modern history of the Hāna Belt Road began in the 1870s when fifteen miles of unpaved road was built from central Maui into East Maui's rain forest to facilitate the construction of the Hāmākua Ditch, which was completed in 1878. The ditch was an extraordinary nineteenth century engineering marvel built to ensure the economic success of sugar by bringing water from rainy East Maui to central Maui's arid plantations. In 1900, Mauians began considering the necessity of extending a good wagon road through to Hāna, which would be part of the island's "belt" (around-the-island) road system. That year, a rudimentary road was built from Ke'anae to Nāhiku to service the Nāhiku Rubber Company. Construction through this country was difficult due to the terrain and climate. The road was surfaced with cinder, but was not adequate for automobile traffic. In 1905, the Superintendent of Public Works reported that the road in East Maui traversed through very rough country and as a result, was built "as narrow as possible in order to construct, with the money available, the maximum length of road."[4] Overland travel continued by horse and many travelers followed the trails along the irrigation ditches. Steamer remained the preferred mode of transportation for travel along the Hāna Coast.[5]

By the early 1900s, Maui leaders began planning for an improved route to Hāna. Beginning in 1908 and reaching a peak in 1911, numerous concrete bridges were built along the Hāna Coast in anticipation of road improvements.[6] In 1914, the Maui County Board of Supervisors lobbied the Territory of Hawai'i Legislature for funding to extend the road from Kailua to Ke'anae. Territorial Governor Pinkham was adamantly opposed to the Hāna Belt Road and blocked most of its funding. Despite the governor's opposition, money was appropriated and the Wilson and McCandless firm completed a "several-mile" section of road between Ke'anae and Nāhiku in

[4] Bartholomew, *Maui Remembers*, 161; Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, prepared for the State of Hawai'i, Department of Transportation, Highways Division. Draft. (Honolulu), 1996, IV 12.
[5] "Raymond Adds Ginger To Loan Fund Meeting," *The Maui News*, May 23, 1914.
[6] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 12.

1914. *The Maui News* reported that this "fine piece of road" was of "practically no benefit" since it ended in a forest reserve miles from any habitation. The newspaper noted that one section of road closely traversed along the mountainside a few thousand feet above sea level, with other sections following the Ko'olau Ditch. The road was praised for passing through some of the most spectacular scenery in the islands. Although money had been pledged to carry the road all the way into Ke'anae, Governor Pinkham refused to approve the appropriation and Maui was left with an inaccessible stretch of road.[7]

By 1920, the belt road from central Maui to Kailua was suitable for modern automobile traffic. Parts of the road were paved with macadam to ensure that it was passable during the rainy season. Keeping the road open was essential as it was the primary transportation route into Maui's pineapple country and muddy roads had periodically shut down pineapple operations. Maui County stretched funding as far as it could by using convict labor on the belt road projects.[8] Territorial funding to extend and complete the coastal highway to Hāna, however, continued to be a problem and was not resolved until Wallace Farrington became governor. Major sections of the Hāna Coast remained inaccessible to automobile traffic, namely the region between Kailua and Nāhiku, the area with the most challenging topography. With Governor Farrington's strong backing, the major portion of today's Hāna Highway was constructed in two separate construction projects between 1923 and 1926. The road between Kailua and Ke'anae was built from 1923 to 1925. Immediately thereafter, a road between Wailua and Nāhiku that connected with the route into Hāna was constructed and opened to the public in 1926.

[7] "Raymond Adds Ginger To Loan Fund Meeting," *The Maui News*, May 23, 1914; "Belt Road Or Nothing Says Board," *The Maui News*, June 20, 1914; "Let's Have The Belt Road Money," *The Maui News*, June 20, 1914; "No Ke'anae Highway Says Governor," *The Maui News*, July 18, 1914; "Road Pau on Nāhiku Part Belt Road," *The Maui News*, November 14, 1914.

[8] "No Money For Belt Road For Two Years," *The Maui News*, May 7, 1920; "Convict Labor to Work on Belt Road," *The Maui News*, September 17, 1920.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 5

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Maui County Engineer Paul Low was credited with supervising "one of the most difficult and at the same time finest pieces of road engineering" on Maui.[9] In January 1923, Low presented his estimates to complete the Hāna road as two projects, the first of which was the roadway extension from Kailua to Ke'anae, a distance of 11.67 miles, which would require the excavation of 273,000 cubic yards of earth. The second phase of the project extended the road from Ke'anae to Wailuaiki near Nāhiku, a distance of 5.67 miles that called for almost 30,000 cubic yards of earth to be excavated. Low used earlier survey work done by engineers of the Maui Loan Fund Commission, which had been created by the Territorial Legislature to oversee special funds for Hawai'i's belt road systems. Low credited engineers Harvey and Howell with designing the original plans. (Hugh Howell also served as Maui County engineer between 1906 and 1914.) In addition to the earlier surveys, Low and a team of county surveyors scouted the route for the Hāna Belt Road, took field notes, and prepared plans and specifications. Low's 1923 estimates included engineering costs, excavation, fill, retaining walls, culverts, bridges, macadam pavement, and tunnels to relocate some ditches. The new road was to be built on a 16'-wide bench, with a pavement width of 12'-0".[10]

The Kailua to Ke'anae section of the belt road took two years to build. Crews worked from both ends of the project and met in May 1925. The road opened to the public on June 11, 1925. The new section of road was described as "serpentine" as it passed through a dozen gulches and wound around "mountain sides that dip into the ocean." Although the distance between the two communities was only four miles as the crow flies, the mileage needed to complete the road around the difficult topography was nearly twelve miles. In order to build the new road, workers were lowered by rope over the steep cliffs and gulches to dig a footing, set their drills, bore holes, and set the powder and fuses that would blast the new roadbed. The most spectacular piece of the road was also considered its most impressive engineering feat. This portion of road traversed down the mountainside (west) to the bottom of Honomanū Gulch,

[9] "Steam Shovels Meet Next Week," *The Maui News*, July 31, 1926.

[10] "Itemized Costs Proposed Belt Road Presented," *The Maui News*, January 19, 1923; "Estimate Made Belt Road Cost By Way Kailua," *The Maui News*, January 13, 1923; "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926.

where it crossed a bridge and proceeded up the other mountainside (east side of the gulch) to a peak on the Ke'anae side. Motorists had impressive views from both sides of the gulch, including a view of the road on the other side. Governor Farrington described the scene as a "gorgeous spectacle [with] the blue sea in many places hundreds of feet below you, the white surf beating against the shore line and these wonderful green hills, the many gulches and every playing light, shade and color on the sides of beautiful and majestic Haleakalā." *The Maui News* noted that the road was still rough in many places, unsurfaced, and in need of widening so that cars could pass each other at any point. The article pointed out the road opened up "marvelously beautiful scenery" that most Maui residents had never seen. As a piece of engineering, the editor claimed that there was nothing in the Territory of Hawai'i or perhaps the world quite like the new road to Ke'anae. A Los Angeles-based writer admired the landscape features, including bamboo thickets, mountain apple, and native kukui trees.[11]

Work began immediately on the final link of the Hāna Belt Road project. In 1925, Maui's road program received a substantial boost when President Calvin Coolidge approved a bond issue for the Territory of Hawai'i that included $150,000 to continue construction of the Hāna Belt Road. County Engineer Low reported that finishing work was being done on the newly completed section to Ke'anae, including top-dressing the road, finishing culverts, and improving bridge approaches. Stone masons were building wing walls on the bridges and retaining walls in the valleys. Crews with forty men each had started to build the last link of the road from both the Hāna and Ke'anae sides, which was a length of 3.5 miles. This section was benched at 16'-0" wide, although plans called for the road to eventually be widened to 20'-0" after it had settled. Several bridges near Wailua were also built during this phase, including the Waikani Bridge and the bridge at West Wailuanui. Construction of the last link of road was difficult as

[11] "First Car Runs Over Belt Road Kailua-Ke'anae," *The Maui News*, May 23, 1925; "Dream Of Thirty Years Ago About To Be Realized," *The Maui News*, June 6, 1925; "Hundreds Motor to Ke'anae: Maui Turns Out To See Opening Of Scenic Road," *The Maui News*, June 13, 1925; "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Maui's New Road," editorial, *The Maui News*, June 17, 1925; "Wonder And Charm Of Maui Scenery To Be Pictured And Told Hundreds Of Thousands Readers On Mainland," *The Maui News*, August 15, 1925.

Narrative Description (continued)

much of the work consisted of blasting the solid rock in the area. Shovels on both sides of the project failed due to the stresses of working on solid rock cuts and the necessity of removing hundreds of tons of rock along the right-of-way. At times, the steam shovels could not do the work without considerable blasting and hand work. Heavy rains disrupted the project as well, causing floods and undermining embankments. In November 1926, a flood in the Wailuanui Valley caused a landslide over the road, washed out the scaffolding on the Waikani Bridge, and carried away 600 bags of cement to be used on the bridge.[12]

The Hāna Belt Road was opened to the public on December 18, 1926. *Honiron*, a publication of Honolulu Iron Works, described the road as "spectacularly chiseled out of abrupt cliffs and precipitous valleys." It noted that miles of the roadway were nothing more than a 16'-wide shelf cut into the mountainside, with towering masses of rock above and sheer drops measuring hundreds of feet to the ocean below. When asked how the scenery of the new section of road compared to the Kailua-Ke'anae section, Low commented that there was no comparison. He admired the section of road above the Wailua Valley that traveled along a narrow ledge for about a mile and provided a lovely panorama of *taro* patches and rice fields in the quaint village of Wailua below. *The Maui News* noted that the newly completed Hāna Belt Road was the "great road making achievement in the Islands, fraught with tremendous difficulties in engineering and construction work" and completed by "dare-devil exploits." The paper claimed the road was the most scenic driveway in the world, with vistas of lofty mountains, the Pacific Ocean, wild canyons, cataracts, waterfalls, and luxurious tropical vegetation. Signs marked "bad turn" and "go slow" were installed to mark dangerous curves and other points in the road. The average speed for driving the Hāna Belt Road was 20 m.p.h. Although Low's

[12] "Coolidge Approves Proposed $2,590,000 Hawai'i Bond Issue," *The Maui News*, August 22, 1925; "Kailua-Kōpili'ula Road Work Making Headway, Says Low," *The Maui News*, March 13, 1926; "Workers Blast Tons Of Rock On Belt Road," *The Maui News*, May 15, 1926; "Builders Progress In Construction Of Belt Road Project," *The Maui News*, April 17, 1926; "Flood Threatens Belt Road Bridge," *The Maui News*, November 17, 1926.

Narrative Description (continued)

1923 estimates to complete the road to Hāna included pavement, the road was not paved when it was opened in 1926.[13]

Approximately six miles west of Hāna, near Upper Nāhiku, the Hāna Belt Road enters a coastal plain, which permits the alignment to run in a relatively straight path. The road passes over some minor gulches via a number of culverts and several bridges. Approximately four miles south of Hāna, the coastal plain ends and the road again passes through East Maui's challenging terrain. South of Ala'ala'ula Bridge, the road traverses through a series of rugged gulches similar to those near Ke'anae. South of Waikakoi Bridge, the road is benched into the high cliffs, around steep mountains and into the deep valley of Wailua Cove, before climbing back out of the valley. This portion of road is similar to the road near Honomanū Gulch near Ke'anae. Near Kīpahulu, the Hāna Belt Road passes through the scenic 'Ohe'o Gulch and Koukou'ai Gulch, which were spanned by concrete arch bridges in 1916 and 1911 respectively. It is uncertain when the belt road between Hāna and Kīpahulu was built, although it was being used for automobile traffic by the time the belt road was completed between Kailua and Hāna in 1926.[14]

BRIDGES and CULVERTS

The Hāna Belt Road includes fifty-nine bridges and numerous culverts constructed between 1908 and 1947. Sixteen of these bridges are located on the Hāna Belt Road south of Hāna (Pi'ilani Highway, Route 31) and forty-three on the Hāna Belt Road between Hāna and Huelo

[13] "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Honiron Tells Of Maui Road To Hāna," *The Maui News*, March 5, 1927; "Linking Up Maui," *The Maui News*, editorial, December 18, 1926; "Celebration Typical Of Maui," editorial, *The Maui News*, December 22, 1926.

[14] "Magnificent Scenery Unfolds Before Eyes of Travelers On Motor Trip Over New Road Leading To Hāna," *The Maui News*, December 22, 1926; "Maui Belt Road Circled," *The Maui News*, January 15, 1927.

Narrative Description (continued)

(Hāna Highway, Route 360). The narrowest bridges are approximately 12'-6" wide and the widest bridge is approximately 20'-6". More than half of the bridges are single span.

The majority of bridges in the district were constructed of reinforced cast-in-place concrete. County and territorial engineers utilized structural systems typical for the early twentieth century, including concrete arch, flat slab, girder, and simple tee-beam spans. Eighty percent of the concrete bridges were constructed between 1908 and 1929. Two unique bridges in the proposed historic district are rare surviving examples of masonry arch construction with basalt (lava rock). Many of the bridges have wingwalls, abutments, and piers constructed of concrete rubble masonry with basalt.

The majority of bridges featured two styles of parapet construction. Twenty-four bridges built between 1908 and 1915 had a solid-paneled, reinforced-concrete parapet with a peaked concrete rail cap. From 1916 to 1929, thirty-one bridges were built with a reinforced-concrete parapet of simple vertical concrete balusters and a square concrete rail cap.[15] The Pu'uhaoa Bridge, built in 1910, and the Waiokamilo Bridge, built in 1921, featured a more ornate open-rail parapet. Two bridges constructed in 1947, Kawaipapa and Wailua, are unique along the corridor, with concrete post-and-beam railings. Some of the bridges have construction dates inscribed on the parapets.

Masonry Arch Bridges

Two masonry arch bridges are located on the Hāna Belt Road south of Hāna, the Hāhālawe Bridge and Wai'ele Bridge. Constructed in 1910, both bridges utilized cut basalt blocks to build the abutments and arch rings. The bridges feature solid reinforced-concrete parapets with rail caps. "A.D. 1910" is inscribed on the outer parapet of each bridge. The bridge walls and rock abutments may date to different construction periods, with the concrete parapets being from a later date. The bridges retain their historic integrity, and feature fine craftsmanship and uncommon materials.[16]

[15] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191.
[16] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192.

Narrative Description (continued)

Concrete Arch Bridges

After 1904, concrete arch bridges were built in Hawai'i, often using standardized plans. Two types of concrete arch bridges were constructed in Hawai'i, solid and open spandrel. The solid-spandrel bridges were generally arch-deck bridges in which the traffic deck rested upon the arch. Between 1916 and 1926, several bridges of this type were built on Maui, including three bridges built along the Hāna Coast: 'Ohe'o Bridge, Hanawī Bridge, and Kūhiwa Bridge. The 'Ohe'o Bridge spans the scenic 'Ohe'o Gulch in Haleakalā National Park.

The open-spandrel concrete arch bridges demonstrated sophisticated engineering for their day and marked the evolution of concrete technology toward lighter, yet larger structures. Koukou'ai Bridge was the first open-spandrel arch bridge on Maui and is an excellent example of early twentieth century bridge construction in the Hawaiian Islands. Built in 1911, it spans a deep gorge just south of Haleakalā National Park. The other open-spandrel concrete arch bridge on the Hāna Coast is the Waikani Bridge, built in 1926 by the Akiona Contracting Company and designed by local architect William D'Esmond. The bridge dramatically crosses a deep gorge at the end of a long valley and is perhaps the most aesthetically pleasing bridge along the Hāna Belt Road.[17]

Concrete Deck Girder and Flat Slab Bridges

Concrete deck girder, including tee-beam spans and simple deck girder, were the most common types of bridge built along the Hāna Belt Road. Territorial and county engineers realized that these structures were both economical and strong over short spans. As a result, the government began using concrete deck bridges rather than arch or timber bridges after 1911. The majority of these bridges were built between 1911 and 1928. The 1912 Waikamoi Bridge is one of the earliest remaining examples of a concrete slab bridge in Hawai'i. Concrete slab bridges were cast on site using formwork built by local carpenters. The earlier bridges featured a solid-

[17] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192-194.

paneled reinforced-concrete parapet, with the later bridges utilizing simple vertical concrete balusters and a square concrete rail cap.[18] Three bridges date to the 1930s and two were built in 1947. The bridges constructed in 1947 utilized a post-and-beam design that is unique in the Hāna Belt Road corridor.

Culverts

Honolulu Iron Work's publication *Honiron* reported that numerous culverts along the Hāna Belt Road were necessary due to the to the demanding topography. During the 1920s, Calco Corrugated Culverts manufactured from Armco Ingot Iron were used in road construction.[19] Today, there are also culverts constructed of basalt, which are visible from the road. Many of the culverts are topped by lava rock walls on the road. Numerous culverts are not visible from the road and are covered by dense vegetation, which makes it difficult to establish an accurate count of culverts, both contributing and non contributing, along the Hāna Belt Road.

Many culverts along the Hāna Belt Road were built using concrete abutments, concrete slabs, and small concrete parapets. Example of this type of structure include: Culvert #1 between Nā'ili'ilihā'ele Bridge and 'O'opuola Bridge; Culverts #2, #3, and #4 near Ke'anae between Palauhulu Bridge and Waiokamilo Bridge; Culverts #9 and #10 located in the town of Hāna, south of Kawaipapa Bridge near the Hāna Fire Station; and Kalena Culvert north of Koukou'ai Bridge.

Four distinctive culverts (Culverts #5, #6, #7, and #8) constructed of concrete abutments, concrete slabs, and open parapets with simple vertical concrete balusters and concrete rail caps are located west of Hāna and east of Honomā'ele Bridge. These structures vary in span length from 5'-5" to 14'-7". Another distinctive culvert is located adjacent to (east of) Waiokamilo Bridge and spans the Hāna Highway at the "Y" intersection with Wailua Road. Its parapets were built to match those of the Waiokamilo Bridge. Two culverts with concrete abutments,

[18] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 195-198.

[19] "Honiron Tells Of Maui Road To Hāna," *The Maui News*, March 5, 1927.

concrete slabs, and solid parapets are Mo'omonui Culvert and Maluhiana'iwi Culvert. The construction dates are inscribed on each of these culverts.

To most observers, many of these culverts would be regarded as bridges, even though they are considered to be culverts by the State Department of Transportation. The State of Hawai'i Department of Transportation (DOT) considers a culvert to have a span of less than 10'-0" in accordance with Federal Highway Administration guidelines. Some of these structures measured longer than 10'.

VISTAS and VIEWS

There is hardly a place along the Hāna Belt Road where motorists are not rewarded with a variety of scenic views, including the ocean, mountains, sea cliffs, waterfalls, small villages, native and exotic vegetation, and traditional landscapes.

Although it is sometimes difficult to find pullouts along the narrow road, viewpoints are scattered throughout the Hāna Belt Road corridor. At most of the bridges, motorists can park on either side to view waterfalls and valleys. The most impressive waterfalls are located at the Waikani Bridge, 'Ohe'o Bridge, and Wailua Bridge. The Kīpahulu District of Haleakalā National Park includes the picturesque 'Ohe'o Gulch; its pools are a popular swimming spot. Elements of the East Maui Irrigation Company ditchworks can be seen at numerous bridges along the road, including the Kōpili'ula Bridge. Just after the Kōpili'ula Bridge, the Hāna Belt Road runs parallel to the irrigation ditch for a short distance. Scenic views are provided at Kaumahina State Wayside near Ke'anae and Wailua Valley Lookout Park above the village of Wailua. Pua'a Ka'a State Park is directly adjacent to the road near Nāhiku. Traditional cultural landscapes of taro patches are viewed in the villages of Ke'anae and Wailua. Native vegetation along the Hāna Belt Road includes hapu'u fern, ko'a, kukui, and pandanus forests. Most of the vegetation along the road, however, is exotic, with species such as bamboo and ginger impacting the landscape. On the coastal plain near the town of Hāna are large ranching areas that were formerly used for sugar cane cultivation.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 13

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

ALTERATIONS

Maintaining the Hāna Belt Road over the years has been no easy task. Since the earliest days, highway crews have struggled to keep up with damage caused by landslides, rocks, vegetation, downed trees, and floods. A journalist driving the road in 1940 referred to it as a "paved trail following the line of the ditch through the wild jungle."[20] The road was not completely paved until 1962. Over the years, lava-rock retaining walls and guardwalls were constructed in various locations along the road. These walls complement the historic character of the Hāna Belt Road.

In 1969, the State of Hawai'i transferred jurisdiction over the portion of the Hāna Belt Road between Hāna and Kīpahulu, which is now known as the Pi'ilani Highway, to the County of Maui. The Hāna Belt Road between Huelo and Hāna remained under the jurisdiction of the State of Hawai'i. The manner in which the road is maintained and preserved is significantly different between the two government agencies.

Although the state's portion of the Hāna Belt Road (Hāna Highway) between Huelo and Hāna retains its historic character and integrity, there have been alterations along the roadway. The most noticeable change to the state section of the Hāna Belt Road is the addition of w-beam and thrie-beam steel guardrails. It is unknown when the first guardrails were installed along the Hāna Belt Road. Concrete posts from earlier guardrails are still present along the roadside in some areas. Another change over the years has been road widening. There are still many segments of the road that are close to the original 16' width (especially on the cliffs near Ke'anae) and too narrow for cars to pass each other without yielding. The road, however, has been widened in most areas. In a few places where there is a more level topography, as through villages and near the beginning of the road near Huelo, the pavement is up to 22'-0" wide. In several locations, the Department of Transportation has used the new layers of asphalt during

[20] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 14.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 14

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

repaving projects to super-elevate curves, particularly in the area east of Wailua. On many bridges, added layers of asphalt have significantly shortened the height of the bridge parapets and asphalt often fills part of the openings between bridge railings. Other changes along the road include painting some bridges and lava rock walls white to increase nighttime visibility, installation of numerous cautionary signs ("one-lane bridge," "narrow road"), reflector signs, and reflectors in the pavement. There have been a few jersey barriers added to the road, usually in places where the roadbed is being undermined alongside a steep cliff.

In the mid 1990s, the road west of Ke'anae that traverses the steep mountainside on the east side of Honomanū Gulch was widened. Work included blasting and removing a large section of the mountain near the road's summit to relocate the damaged road (which was collapsing into the ocean) away from the cliff. A rock wall which does not match the character of the typical basalt parapets seen along the Hāna Belt Road was built between the mountain and the road to catch falling rocks. Concrete gutters were installed and wide shoulders were added. The state Department of Transportation has installed concrete gutters and new culverts in other locations along the road, especially in the area between Wailua and Nāhiku.

The bridges along the Hāna Belt Road retain their historic character. One notable exception is Kawaipapa Bridge. Constructed in 1947, the bridge was altered in 1991 when a new bridge was added to the to the west end of the original structure. The 1991 bridge expansion was modeled on the original bridge, with replications of the post-and-beam bridge walls. The consequence of the expanded bridge was that the original bridge lost its historic integrity and is a non-contributing structure.

The County of Maui section of the Hāna Belt Road, now called the Pi'ilani Highway, has been subjected to fewer changes than the state-maintained portion of the belt road. The county has widened the road in a few locations, but for the most part, the pavement is no widr than 18'-0" and often averages 15' to 16' wide. Some guardrails have been added, but not to the same extent as the state-maintained section of the Hāna Belt Road.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 15

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Although the Hāna Belt Road has been improved over the years, many of the bridges along the road have suffered from a lack of maintenance. Many of the bridge walls originally averaged 34" high. The walls are now shorter due to repeated layers of asphalt. In many cases, the additional asphalt is approximately 12" deep. The majority of the bridges in the Hāna corridor have weeds and vegetation growing in the concrete joints. A few bridge walls have been damaged by accidents. Many of the damaged walls were repaired to match the original design, although in a few cases, damage was not repaired neatly or was repaired with a non-matching element. An example of repaired bridge wall is the Waikani Bridge balustrades, which were severely damaged on the west end. Rather than restoring the end of the bridge wall, the repair consisted of building a rock wall in place of the balustrades. Another example of a bridge alteration that does not match the original structure is Nua'ailua Bridge. Altered in 1940, the *mauka* (mountain side) parapet was replaced with a non-matching concrete wall, most likely as a result of road widening.

The Hāna Belt Road retains its historic character and integrity. For the most part, the road is relatively unaltered. The road's alignment has not been changed since it was completed in 1926, although sections of the road on sea cliffs have collapsed into the ocean and necessitated reconstruction. The road retains its historic character and integrity in its rural location and narrow lanes. The bridges retain historic integrity with sharp and narrow approaches, original materials, and original design. Although a majority of the bridges are quite simple in appearance, several bridges are more elaborate and were designed and built by masters. The bridge designs and materials survive intact, with a few minor exceptions.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 16

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description
(Describe the historic and current condition of the property on one or more continuation sheets.)

Inventory of Contributing Bridges & Significant Culverts

Listed in geographical order east from Huelo:

Hōlua Bridge: constructed 1929; concrete tee-beam; one span, 48'-0"; total length 49'-0"; bridge width 16'-7"; approximate height above stream 28'-0".

Kailua Bridge: constructed 1929; concrete tee-beam; one span, 39'-0"; total length 40'-0"; bridge width 20'-6"; approximate height above stream 18'-0".

Na'ili'ilihā'ele Bridge: constructed 1930; concrete tee-beam; three spans, 21'-6"; total length 64'-0"; bridge width 20'-3"; approximate height above stream 20'-6". Designer: County Engineer Office.

Culvert #1: concrete, one span, approximate length 9'-0".

'O'opuola Bridge: constructed 1925, altered 1931; concrete tee-beam; one span, 29'-0"; total length 30'-0"; bridge width 19'-8"; approximate height above stream 18'-6". Designer: County Engineer Office.

Makanali Bridge: constructed 1928; concrete slab; one span, 18'-0"; total length 18'-0"; bridge width 16'-6". Designer/builder: Department of Public Works.

Ka'aiea Bridge: constructed 1928; concrete tee-beam; one span, 20'-0"; total length 22'-0"; bridge width 16'-6"; approximate height above stream 15'-0". Designer/Builder: Department of Public Works.

Waikamoi Bridge: constructed 1912; concrete slab; two spans, 19'-0"; total length 41'-0"; bridge width 12'-9"; approximate height above stream 17'-0". Designer/Builder: Hugh Howell, Senior Engineer.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 17

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Puohokamoa Bridge: constructed 1912; concrete tee-beam; two spans, 25'-0"; total length 56'-4"; bridge width 15'-3", approximate height above stream 13'-0".

Haipua'ena Bridge: constructed 1912; concrete slab; two spans, 16'-0"; total length 34'-6"; bridge width 12'-9"; approximate height above stream 11'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Kōlea (Punala) Bridge: constructed 1911; concrete tee-beam; one span, 30'-0"; total length 34'-0"; bridge width 12'-8"; approximate height above stream 13'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Honomanū Bridge: constructed 1911; concrete tee-beam; two spans, 23'-0"; total length 48'-0"; bridge width 12'-8"; approximate height above stream 15'-0". Designer/Builder: Hugh Howell, Senior Engineer.

Nua'ailua Bridge: constructed 1911/altered 1940; concrete tee-beam; one span, 22'-0"; total length 35'-0"; bridge width 24'-0"; approximate height above stream 13'-0". Designer/Builder: Joseph Matson, Senior Engineer.

Pi'ina'au Bridge: constructed 1916; concrete tee-beam; one span, 27'-0"; total length 28'-5"; bridge width 19'-0"; approximate height above stream 19'-0".

Palauhulu Bridge: constructed 1916; concrete tee-beam; one span, 30'-0"; total length 31'-0"; bridge width 19'-10"; approximate height above stream 20'-6".

Culvert #2: concrete, one span, approximate length 10'-0".

Culvert #3: concrete, one span, approximate length 15'-0".

Culvert #4: concrete, one span, approximate length 13'-0".

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 18

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Waiokamilo Bridge: constructed 1921, altered 1937; concrete tee-beam; one span, 20'-0"; total length 24'-0"; bridge width 22'-1"; approximate height above stream 11'-0". Designer: D. K. Kapohakimohewa.

Waiokamilo Culvert: concrete, one span, approximate length 10'-3".

Waikani Bridge: constructed 1926; concrete arch, open spandrel; one span, 82'-6"; total length 108'-0"; bridge width 17'-7"; approximate height above stream 32'-0". Designer: William D'Esmond. Builder: Moses Akiona.

West Wailuaiki Bridge: constructed 1926, altered 1937; concrete tee-beam; three spans, 24'-6"; total length 62'-6"; bridge width 19'-7"; approximate height above stream 15'-0". Designer: A. H. Wong.

East Wailuaiki Bridge: constructed 1926; concrete tee-beam; one span, 31'-0"; total length 34'-5"; bridge width 18'-4"; approximate height above stream 16'-0". Designer/builder: A. P. Low, County Engineer.

Kōpili'ula Bridge: constructed 1926; concrete tee-beam; two spans, 34'-2"; total length 76'-7"; bridge width 14'-4"; approximate height above stream 6'-0".

Pua'aka'a (Waiohue) Bridge: constructed 1926; concrete tee-beam; one span, 19'-6"; total length 20'-2"; bridge width 22'-0"; approximate height above stream 7'-8".

Waiohue Bridge: constructed 1926, altered 1937; concrete tee-beam; two spans, 16'-7"; total length 40'-0"; bridge width 13'-2"; approximate height above stream 10'-0".

Waiohuolua Bridge: constructed 1920, altered 1970; concrete tee-beam; one span, 15'-0"; total length 19'-0"; bridge width 12'-9"; approximate height above stream 8'-0". One bridge wall was replaced by w-beam guardrail; the original bridge wall is in the stream below.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 19

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Bridge #2: constructed 1920; concrete tee-beam; one span, 16'-7"; total length 20'-0"; bridge width 12'-6"; approximate height above stream 8'-0".

Pa'akea Bridge: constructed 1920, altered 1937; concrete tee-beam; two spans, 16'-0"; total length 40'-0"; bridge width 12'-9"; approximate height above stream 8'-0".

Kapā'ula Bridge: constructed 1926; concrete tee-beam; two spans, 21'-0"; total length 49'-0"; bridge width 16'-0"; approximate height above stream 51'-0".

Hanawī Bridge: constructed 1926; concrete arch, solid spandrel; one span, 36'-0"; total length 61'-0"; bridge width 20'-4"; approximate height above stream 19'-0".

East Hanawī Bridge: constructed 1926; concrete tee-beam; one span, 18'-5"; total length 22'-10"; bridge width 15'-11"; approximate height above stream 15'-0".

East Hanawī Culvert: concrete, one span, approximate length 11'-8".

Makapipi Bridge: constructed 1926; concrete tee-beam; two spans, 22'-5"; total length 39'-10"; bridge width 16'-0"; approximate height above stream 12'-0".

Kūhiwa Bridge: constructed 1926; concrete arch, solid spandrel; one span, 36'-6"; total length 60'-0"; bridge width 16'-4"; approximate height above stream 35'-0". Builder: County Engineer's Office.

Kupukoi Bridge: constructed 1926; concrete tee-beam; one span, 21'-5"; total length 24'-7"; bridge width 16'-0"; approximate height above stream 15'-0".

Kahalaowaka Bridge: constructed 1926; concrete tee-beam; one span, 22'-4"; total length 24'-5"; bridge width 15'-0"; approximate height above stream 9'-0".

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 7 Page 20

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Description (continued)

Pupape-Manawaikeae Bridge: constructed 1926; concrete tee-beam; one span, 20'-8"; total length 24'-4"; bridge width 16'-2"; approximate height above stream 16'-0".

Kahawaihapapa Bridge: constructed 1922; concrete tee-beam; three spans, 17'-0"; total length 60'-0"; bridge width 16'-0"; approximate height above stream 15'-0". Builder: County Engineer's Office.

Kea'ā'iki Bridge: constructed 1921; concrete tee-beam; one span, 20'-10"; total length 22'-10"; bridge width 16'-1"; approximate height above stream 27'-0". Builder: County Engineer's Office.

West Waioni Bridge: constructed 1920; concrete tee-beam; one span, 24'-5"; total length 29'-5"; bridge width 16'-6"; approximate height above stream 15'-0".

Waioni Bridge: constructed 1920; concrete tee-beam; one span, 20'-7"; total length 24'-5"; bridge width 15'-11"; approximate height above stream 10'-0".

Lanikele Bridge: constructed 1917; concrete tee-beam; two spans, 22'-4"; total length 51'-6"; bridge width 16'-0"; approximate height above stream 13'-0".

Helele'ike'ōhā Bridge: constructed 1917; concrete tee-beam; one span, 23'-7"; total length 28'-6"; bridge width 16'-1"; approximate height above stream 12'-0".

'Ula'ino Bridge: constructed 1914; concrete tee-beam; two spans, 18'-10"; total length 39'-7"; bridge width 16'-0"; approximate height above stream 12'-0".

Mokulehua Bridge: constructed 1908; concrete tee-beam; three spans, 14'-0"; total length 48'-7"; bridge width 13'-11"; approximate height above stream 21'-0".

Oilowai Bridge: constructed 1914; concrete tee-beam; one span, 20'-7"; total length 22'-10"; bridge width 16'-2"; approximate height above stream 22'-0". Builders: Wilson & McCandless.

Narrative Description (continued)

Honomā'ele Bridge: constructed 1924; concrete tee-beam; two spans, 20'-4"; total length 38'-10"; bridge width 16'-1"; approximate height above stream 14'-0". Builders: County Engineer's Office.

Culvert #5: concrete, one span, approximate length 17'-6".

Culvert #6: concrete, one span, approximate length 12'-0".

Culvert #7: concrete, one span, approximate length 5'5".

Culvert #8: concrete, one span, approximate length 13'-0".

Culvert #9: concrete, one span, approximate length 14'-7".

Culvert #10: concrete, one span, approximate length 14'-0".

Mo'omonui Culvert: constructed 1911, concrete, one span approximate length 8'-3".

Haneo'o (Kaholopo) Bridge: constructed 1900, altered 1917; concrete slab; two spans, 10'-0"; total length 22'-6"; bridge width 15'-1".

Kapi'a (Kahawaiokapia) Bridge: constructed 1915, altered 1931; concrete slab; three spans, 17'-6"; total length 58'-4"; bridge width 14'-4"; approximate height above stream 17'-0". Designer/Builder: Wilson and McCandless.

Waiohonu Bridge: constructed 1915; concrete tee-beam; five spans, 18'-6"; total length 97'-6"; bridge width 15'-0"; approximate height above stream 14'-0". Designer/Builder: Wilson and McCandless.

Narrative Description (continued)

Papa'ahawahawa Bridge: constructed 1913; concrete tee-beam and concrete slab; two spans, 22'-0"; total length 40'-4"; bridge width 14'-5"; approximate height above stream 9'-0". Designer/Builder: County Engineer's Office.

Ala'ala'ula Bridge: constructed 1915; concrete slab; one span, 30'-0"; total length 54'-0"; bridge width 12'-6"; approximate height above stream 22'-0".

Waikakoi Bridge: constructed 1911; concrete slab; two spans, 14'-0"; total length 33'-6"; bridge width 15'-4"; approximate height above stream 18'-0".

Pa'ihi Bridge: constructed 1911; concrete slab; one span, 36'-6"; total length 42'-4"; bridge width 13'-9"; approximate height above stream 10'-0".

Wailua Bridge: constructed 1947; concrete tee-beam; one span, 60'-0"; total length 66'-1"; bridge width 14'-0"; approximate height above stream 17'-0".

South Wailua (Honolewa) Bridge: constructed 1911; concrete slab; two spans, 25'-0"; total length 57'-0"; bridge width 15'-2"; approximate height above stream 26'-0".

Pu'uhoao Bridge: constructed 1910; concrete tee-beam; one span, 20'-0"; total length 23'-2"; bridge width 12'-9"; approximate height above stream 13'-0".

Waiele (Paehala) Bridge: constructed 1910; masonry arch; one span, 20'-0"; total length 25'-0"; bridge width 12'-6"; approximate height above stream 7'-0".

Kakiweka (Mahalawa) Bridge: constructed 1910; concrete slab; one span, 28'-6"; total length 30'-10"; bridge width 13'-10"; approximate height above stream 16'-0".

Hāhālawe Bridge: constructed 1910; masonry arch; one span, 22'-0"; total length 25'-0"; bridge width 14'-9"; approximate height above stream 10'-0".

Narrative Description (continued)

Maluhiana'iwi Culvert: constructed 1910; concrete, one span, approximately 13'-9".

Pua'alu'u Bridge: constructed 1910; concrete slab; two spans, 15'-0"; total length 32'-10"; bridge width 14'-5"; approximate height above stream 10'-0".

'Ohe'o Bridge: constructed 1916; concrete arch, solid spandrel; one span, 58'-0"; total length 77'-0"; bridge width 14'-5"; approximate height above stream 44'-0".

Kalena Culvert: concrete, one span, approximate length 13'-5".

Koukou'ai (Kaukau'ai) Bridge: constructed 1911; concrete arch, open spandrel; one span, 31'-10"; total length 58'-0"; bridge width 15'-2"; approximate height above stream 34'-0".[21]

[21] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation,* prepared for the State of Hawai'i, Department of Transportation, Highways Division. Draft. (Honolulu), 1996, VI 196-198. All bridge widths and culvert span lengths were measured by Dawn Duensing as part of field work in December 2000.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 8 Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

Narrative Statement of Significance
(Explain the significance of the property on one or more continuation sheets.)

The Hāna Belt Road achieves state and local significance in the areas of engineering, transportation, commerce, and social history under criteria A and C. The construction of bridges and a road to Hāna between 1900 and 1947 was a major engineering achievement, as the County of Maui and private contractors benched a road into precipitous mountainsides and through the wilderness of East Maui. Fifty-nine of the bridges built between 1908 and 1947 remain along the route as an example of bridge engineering and construction in Hawai'i during the early twentieth century. The completion of an automobile route to Hāna in 1926 ended that community's isolation from the rest of Maui. The road opened East Maui to settlement, agricultural enterprises, and tourism. The Hāna Belt Road is the best remaining intact example of the old belt road system in Hawai'i. The Hāna Belt Road retains historic integrity in its original road alignment, narrow lanes, bridges, and spectacular setting along Maui's northeast coast.

Engineering

A 1905 Superintendent of Public Works report noted that road construction in the Hāna District was through "very rough country."[22] The plan for a belt road around East Maui was popular with Maui officials and businessmen, but took decades to complete due to high costs and construction difficulties. Building the Hāna Belt Road was an expensive and difficult proposition due to the challenging topography. Miles of road were blasted out of the mountainsides and numerous bridges were required to carry the road across streams and gulches. Construction was complicated by heavy vegetation, torrential rains, and landslides.

The majority of bridges in the Hāna District were built using construction methods and materials typical in Hawai'i during the early twentieth century. Most of the Hāna District bridges (eighty percent) were constructed prior to 1930. County and territorial engineers utilized common structural systems, including concrete arch, flat slab, girder, and simple tee-beam spans. The majority of bridges along the Hāna Belt Road were simple but functional, constructed with tee-beam spans and simple deck girders. The 1912 Waikamoi Bridge is one of

[22] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 12.

the earliest remaining examples of a concrete slab bridge in Hawai'i. Reinforced concrete was the most prevalent construction material due to the corrosive nature of the Pacific Ocean's salt air and the presence of wood-boring insects that made the use of steel and timber bridges less practical in Hawai'i than in the mainland United States. The Loan Fund Commission, established in 1911 to oversee belt road projects, decided that concrete would be used on Hawai'i's bridges rather than steel. The Commission observed that the concrete was more expensive in the beginning, but realized that the increased cost was justified due to concrete's durability as well as lower maintenance and repair costs. The use of reinforced concrete was an indication of the commitment of the Territory of Hawai'i and Maui County governments to building permanent public works improvements.[23]

Five concrete arch bridges on the Hāna Belt Road remain as excellent examples of early twentieth century bridge construction in the Hawaiian Islands. These bridges used the most modern engineering technology of their day. Today, the bridges make a significant statement regarding Maui's civic pride during the early twentieth century. The open-spandrel concrete arch bridges demonstrated sophisticated engineering and marked the evolution of concrete technology toward lighter yet larger structures. These bridges were constructed for their strength and permanence, although only a few remain in Hawai'i. Koukou'ai Bridge near Kīpahulu was the first open-spandrel arch bridge on Maui and one of the earliest to be built in Hawai'i. The 'Ohe'o Bridge, a solid spandrel concrete arch, spans the scenic 'Ohe'o Gulch in Haleakalā National Park and was declared eligible for the National Register of Historic Places in 1977 as part of the Kīpahulu Historic District (50-17-299). The open-spandrel Waikani Bridge was designed by Maui architect William D'Esmond and built by a well-known contractor, Moses Akiona.[24] D'Esmond designed Maui's County Office Building, built in 1927;

[23] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191, 195; V 10-12.

[24] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192-194.

Pā'ia School, 1926; St. Anthony's School, 1925; and numerous residences on Maui.[25]

Two unique bridges on the Hāna Belt Road are rare surviving examples of masonry arch construction with basalt, Hāhālawe Bridge and Wai'ele Bridge. Fewer than ten masonry arch bridges remain in the state of Hawai'i. Constructed in 1910, both bridges utilized cut basalt blocks for the abutments and arch rings. Basalt arch construction was common in Hawai'i prior to 1898. The bridge walls and rock abutments may date to different construction periods, with the concrete parapets being from a later date. The bridges retain their historic integrity, with each featuring fine craftsmanship and uncommon materials.[26]

The bridges along the Hāna Belt Road present a visual record and timeline of bridge construction technology and innovation on Maui and in Hawai'i. Many bridges are unique due to the use of vernacular materials (basalt). In addition to the masonry arch bridges, a number of bridges used basalt for the construction of abutments, piers and wingwalls. The majority of bridges, however, were built with the latest in construction technology, reinforced concrete. The bridges were built during a period when formal engineering expertise in bridge building was first introduced in Hawai'i and are good examples of the Territory of Hawai'i's progressive highway system. Each county in the territory had a County Engineer's Office, within which was a bridge design office. Many of the bridges on the Belt Road were designed by the County Engineer's Office and the engineers proved themselves to be not only technologically skilled, but also sensitive to aesthetics. In many cases, the bridges also demonstrate the work of skilled builders. The masonry arch and concrete arch bridges show a high degree of detailing and workmanship. Together, the bridges played a integral role in the development of belt roads on

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[25] *The Maui News*, December 4, 1926, section 8; "Drawings and Floor Plans of Proposed St. Anthony School Building," *The Maui News*, March 28, 1925; Dawn E. Duensing, *Historic Architectural Survey of Wailuku, Maui, Hawai'i*, prepared for the County of Maui Department of Planning, 1993, 20.

[26] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 192.

Narrative Statement of Significance (continued)

Maui as well as on other Hawaiian Islands. Today, the Hāna Belt Road bridges remain as the highest concentration of unaltered and stylistically consistent historic bridges in Hawai'i.[27]

Talented local engineers were responsible for the design and construction of the Hāna Belt Road. A substantial portion of the road and bridge design as well as the majority of engineering work was completed by County Engineer's Office. Hugh Howell, who was appointed Maui County engineer in 1906 and again in 1914, had served as an engineer with the Loan Fund Commission and participated in the early survey work for the Hāna Belt Road. He also designed several bridges on the Hāna Belt Road while serving as a county engineer. The Hugh Howell Engineering Company worked on Hāna Belt Road contracts once construction began. Paul Low was Maui County Engineer from 1918 until 1928 and was responsible for supervising the two major phases of Hāna Belt Road construction between 1923 and 1926. He and his county crews used Howell's earlier survey work as the basis for their road design and built the most spectacular sections of road between Kailua and Nahikū. During his tenure as county engineer, Low also supervised a number of Maui's other public works projects, including the County Office Building in 1924. A. H. Wong, who designed the West Wailuaiki Bridge, was appointed county engineer in 1928 to replace Low. After his service with the county, he worked on the construction of Haleakalā Highway and became an engineering supervisor with the Works Progress Administration project building Maui Airport.[28]

Notable local contractors built portions of the Hāna Belt Road and several bridges. The Honolulu firm Wilson and McCandless built the 1914 section of road near Nahikū and Oilowai Bridge. Another important local builder, Moses Akiona, was born in Ke'anae and established his contracting firm, Moses Akiona, Ltd., in 1920. In addition to Waikani bridge, Akiona's firm worked on other Maui projects, including Malulani Hospital, Kula Sanitarium, and the Lahaina

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[27] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, IV 7-9.
[28] Howell noted in *The Maui News*, January 10, 1914; January 9, 1915; and February 4, 1916. Low noted in *The Maui News*, February 15, 1918; October 3, 1928; in Duensing, *Historic Architectural Survey*, 35. Wong noted in *The Maui News*, October 17, 1928.

Courthouse. His business eventually grew to become one of the largest contracting firms in the territory. In the 1960s, Akiona and his sons built a section of the H-1 freeway on O'ahu.[29]

Transportation & Commerce

Belt road projects are a significant element in the transportation history of Maui. This road-building program was concurrent with the strategy of all the major Hawaiian Islands to develop belt road systems. By 1900, Mauians were concentrating on the Hāna section of the belt road, calling for a good wagon road to connect central Maui and Hāna. "What the Central Pacific was to California, and what the Panama Canal would be to the Islands," *The Maui News* emphasized in 1903, was "relatively what a good road all the way from Pā'ia to Hāna would mean to Maui." A road to Hāna was believed necessary for the economic development of East Maui and its success in sugar, minor industries, and small-scale farming.[30] Prior to the completion of a road from central Maui to Hāna, travel to East Maui villages was by steamship or an unpaved wagon and horse trail. The route along the Hāna Coast was often impassable due to heavy rain. Various sections of the coastal road were built by 1914, but the lack of a continuous road to Hāna was considered a nuisance. One Maui legislator complained that Maui was "the only island on which you cannot traverse by road around it."[31]

The improved transportation provided by the Hāna Belt Road was considered essential for Maui's commercial development. *Maui News* editorials noted that East Maui had plenty of fertile land and emphasized that a road to Hāna would open the area to settlement. Mauians predicted that a road through East Maui to Hāna would make homestead lands available and would also facilitate trade between East Maui and the rest of the island. Benefits to be obtained from improved transportation to Hāna included increased tax revenues, population, and

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[29] Spencer Mason Architects, *State of Hawai'i Historic Bridge Inventory and Evaluation*, VI 191, V 14.

[30] *The Maui News*, editorial, April 25, 1903.

[31] "Roads First Need View of Fassoth," *The Maui News*, February 11, 1921.

production. Roads connecting the various parts of the island, including Hāna, were viewed as essential to Maui as arteries were to the human body. Some Mauians believed that the Hāna Belt Road project was the most needed road in the territory and noted that Maui was ten years behind the other islands in its belt road construction.[32]

The opening of the Hāna Belt Road in 1926 was a major transportation milestone for Maui. *The Maui News* labeled it "the greatest road making achievement in the Island, one fraught with tremendous difficulties in engineering and construction work." The new road eliminated Hāna's reliance on the weekly steamer for its transportation and communication needs to the outside world. With the new road, the trip to Hāna could now be made overland on one's own timetable rather than by the schedule of a steamer or horse trip. Instead of a round-trip journey of a week, the trip was shortened to 3.5 hours each way.[33]

Another significant commercial aspect of the Hāna Belt Road was tourism. By the 1920s, Maui's businessmen and civic leaders recognized the importance of scenic roads and considered them to be commercial enterprises, without which Maui could not develop its tourism industry. As early as 1912, the Hāna Belt Road, as well as a proposed route to the summit of Haleakalā, were planned as the centerpieces of Maui's road-building projects. Mauians realized that building a road to Hāna would open up some of the finest scenery in the Hawaiian Islands and put Maui "on the tourist map." One civic group claimed that a magnificent scenic highway could be one of Maui's greatest assets. Local businessmen argued that tourism would not thrive on Maui unless the island had good roads to accommodate its visitors. One Mauian claimed that the mere mention of the term "horseback ride" scared tourists from visiting Maui. A businessman pointed out that tourists expected to travel comfortably by automobile and were not always willing to climb into the saddle to go sightseeing. Mauians realized that more tourists visited

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[32] *The Maui News*, editorials, June 28, 1902; November 15, 1902; December 27, 1902; March 7, 1903; July 4, 1903; "Advocates Belt Road: Maui is Ten Years Behind in Road Matters," *The Maui News*, November 6, 1909.

[33] "Linking Up Maui," *The Maui News*, editorial, December 18, 1926; "Maui Takes Day Off for Road Opening," *The Maui News*, December 22, 1926.

the Big Island of Hawai'i because that island's attractions, especially Kilauea Volcano, were accessible by automobile, while Maui's attractions remained almost inaccessible. The Hāna Belt Road was a significant piece of a road-building program that aimed to make Maui's scenic attractions easily available. Maui's plans to develop a tourist industry received a tremendous boost with the completion of the Hāna Belt Road in 1926 and the Haleakalā Highway in 1935.[34] These two roads were Maui's crowning achievements in transportation public works projects during the twentieth century. Both highways were important commercial enterprises and remain the island's most popular scenic drives today. The Hāna Belt Road has become an attraction in itself, with tourists driving the route to experience the narrow road and its historic bridges, not just the scenery. Motorists appreciate this unique route that is relatively unchanged from the 1920s and provides an opportunity to visit a rural area that is uniquely Hawaiian.

Social History

The immediate impact of opening the Hāna Belt Road was to end East Maui's centuries of isolation from the rest of Maui. Prior to the belt road's construction, many on Maui maintained that Hāna might as well be on another island.[35] Indeed, in ancient times, Hāna was more connected to communities on the island of Hawai'i that were more easily accessible by canoe. Until the Hāna Belt Road was completed, many Mauians had never seen the 'other side' of Maui, whether they lived in West Maui or East Maui.

The completion of the Hāna Belt Road is a testament to civic pride on Maui during the early twentieth century. The County Act in 1905 authorized the establishment of local governments

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[34] "No Ke'anae Highway Says Governor," *The Maui News*, July 18, 1914; "The Key to Progress," *The Maui News*, May 16, 1914; "Road to Ke'anae Now Maui's Best Bet To Draw Tourist Travel, *The Maui News*, October 7, 1925; Connect Maui Up," *The Maui News*, February 11, 1921; Duensing, Dawn E., *Haleakalā Highway, HAER No. HI-52.* [Washington D.C.], National Park Service, Historic American Engineering Record, 1999.

[35] "New Comer Doesn't Like Our Road Policy," *The Maui News*, August 14, 1915; "Connect Maui Up," *The Maui News*, February 11, 1921.

on Hawai'i's four major islands. On Maui, numerous public works projects during the next thirty years demonstrated residents' keen sense of civic awareness. Substantial public buildings were constructed in the county seat of Wailuku, including the Wailuku Courthouse (built in 1907), County Office Building (1924), Wailuku Library (1928), and Territorial Building (1931). In the Lahaina District, the courthouse was renovated and the Pali Highway was improved in 1925. Prominent schools were built, including the Wailuku Public School in 1905 and Maui High School in 1921, both designed by well-known architect C. W. Dickey. Many of the structures built during this intense period of civil works projects were designed by prominent architects, including Dickey, H. L. Kerr, and William D'Esmond.[36]

The Hāna Belt Road was part of this great, early twentieth century public works movement. First suggested in 1895, the Maui Board of Supervisors sought funding for the road as early as 1900. Although numerous bridges were constructed on the Hāna Belt Road starting in 1908, little money was available for road construction or improvement. Mauians lobbied Hawai'i's governors and legislators for decades before receiving funding to build the dream of an automobile road to Hāna. A 1923 estimate of $692,000 to complete the road was a substantial undertaking for an island with limited resources and a population of approximately 38,000, most of whom were agricultural laborers. Maui's leaders found ways to finance the Hāna Belt Road through the sale of territorial bonds and the savings gained from the use of public employees and prison labor rather than private contractors. In early 1923, the county government demonstrated its determination to go ahead with the project by purchasing a steam shovel and drill and assigning a gang of twenty men to begin work on the new road, even though the territorial legislature had not yet approved the sale of bonds for the project. The county established a prison camp in Kailua to house the fifty convicts expected to work on the road. Within months, leaders purchased another steam shovel and drill so that work could proceed from both ends of the road. Funding eventually was secured from the territorial and federal governments.[37]

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[36] Duensing, *Historic Architectural Survey*, 5-12, 19-20.

[37] "Belt Road Plans Further Advanced," *The Maui News*, February 10, 1923; "Belt Road Funds Knotty Problem Chamber Finds," *The Maui News*, March 9, 1923; "Belt Road Work Will Be

A number of bridges on the Hāna Belt Road were significant civic statements for Maui. Altogether, the concrete bridges along the road demonstrated the county's commitment to permanent and modern improvements. Several bridges were visually prominent both in style and location, and also demonstrated fine workmanship. Bridges such as Waikani, Koukou'ai, and 'Ohe'o indicated both the technical and aesthetic sophistication of the community in which they were built. Many of the bridges are examples of exceptional work by important local builders, including Johnny Wilson of Honolulu (in partnership with McCandless) and Moses Akiona. Waikani Bridge is one of the most aesthetically pleasing bridges along the road and was a collaboration of Akiona and D'Esmond. Many other bridges were not quite so grand, but also made pleasing visual statements, including Hanawī Bridge, Kūhiwa Bridge, Waiokamilo Bridge, and Pu'uhaoa Bridge.

The extent of economic development predicted by *Maui News* writers never happened, although many homes and small farms were built along the Hāna Belt Road corridor over the years as land became available and accessible. Census statistics indicate that the Hāna District was home to 3,100 residents in 1920 before the road opened. In 1930, population in the district declined to 2,436. Agriculture remained the dominant activity, with the communities of Ke'anae and Wailua noted for their production of *taro* and rice. Despite the improvements in transportation and the possibilities for more development, the Hāna District's population dwindled to 1,495 by 1950.[38]

The lack of road improvements over the past seventy years has not only preserved the historic character of the Hāna Belt Road, but has also helped to maintain the historic rural character of the Hāna District itself. The absence of an easily-traveled, high-speed traffic artery has served to impede substantial development, which has subsequently allowed Hāna and other communities in East Maui to remain rural. There are no fast food chains, chain stores, strip malls or

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Started By Maui County," *The Maui News*, March 10, 1923; "Belt Road Project Is To Go Forward At Once," *The Maui News*, May 26, 1923, Robert C. Schmitt, *Historical Statistics of Hawai'i*, Honolulu: The University Press of Hawai'i, 1977, 13.

[38] Robert C. Schmitt, *Historical Statistics of Hawai'i*, 13-14.

sprawling subdivisions along the Hāna Belt Road. Travelers along the Hāna Coast are served by the occasional roadside stand and must drive all the way to Hāna for conveniences such as groceries, gas, and restaurants. With a sizable population of residents of Hawaiian ancestry, Hāna is often cited as Maui's "most Hawaiian community." The Hāna community has worked together to "Keep Hāna Hawaiian," as a bumper sticker urges, and preserve its rural lifestyle and values. In the 1990s, residents rallied against the approval of major developments such as a golf course and an adjacent residential community. Many Hāna residents believe that the narrow, winding, and slow Hāna Belt Road is a means to "Keep Hāna Hawaiian."

Today, a trip along the Hāna Belt Road allows a motorist to see much of what would have been viewed in 1926 when the road opened: a spectacular thoroughfare chiseled out of cliffs, passing through huge gullies and past waterfalls, while always presenting stunning views of the Pacific Ocean and East Maui's natural features. Ke'anae still practices traditional ways, with *taro* being farmed and a Hawaiian lifestyle. A three-room rural school is still in operation in Ke'anae. The section of road above the Wailua Valley, which was admired by Engineer Paul Low, still travels along a narrow ledge for a mile, providing a panoramic view of *taro* patches in the quaint village of Wailua below. Along the way motorists view the historic irrigation ditches, weirs, and intakes still used for Maui's sugar industry. The journey to Hāna provides an opportunity to experience a rural way of life that is uniquely Hawaiian and also a way of life that is becoming more rare in the Hawaiian Islands.

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section 9 Page 1

Name of property Hāna Belt Road

County and State Maui County, Hawai'i

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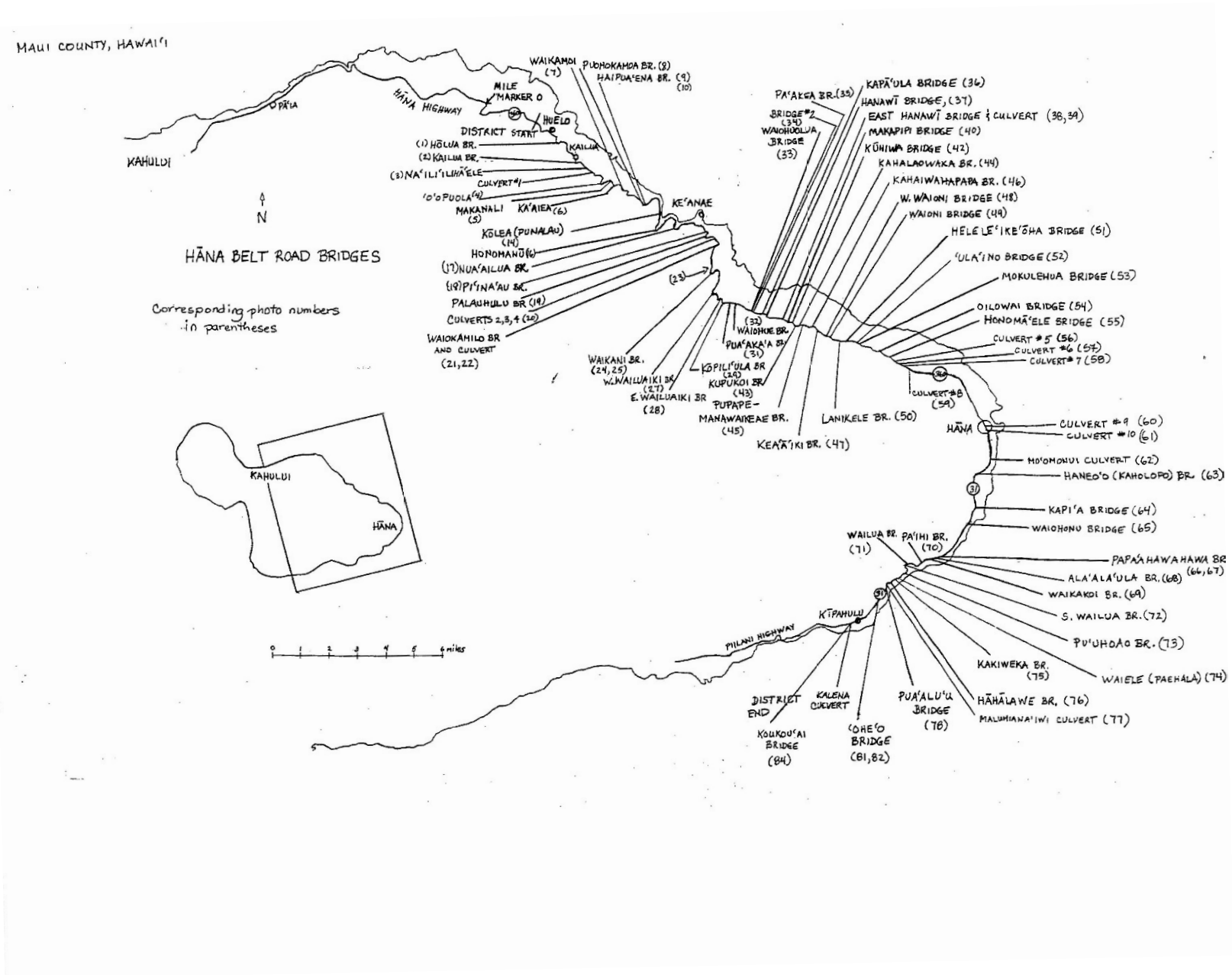
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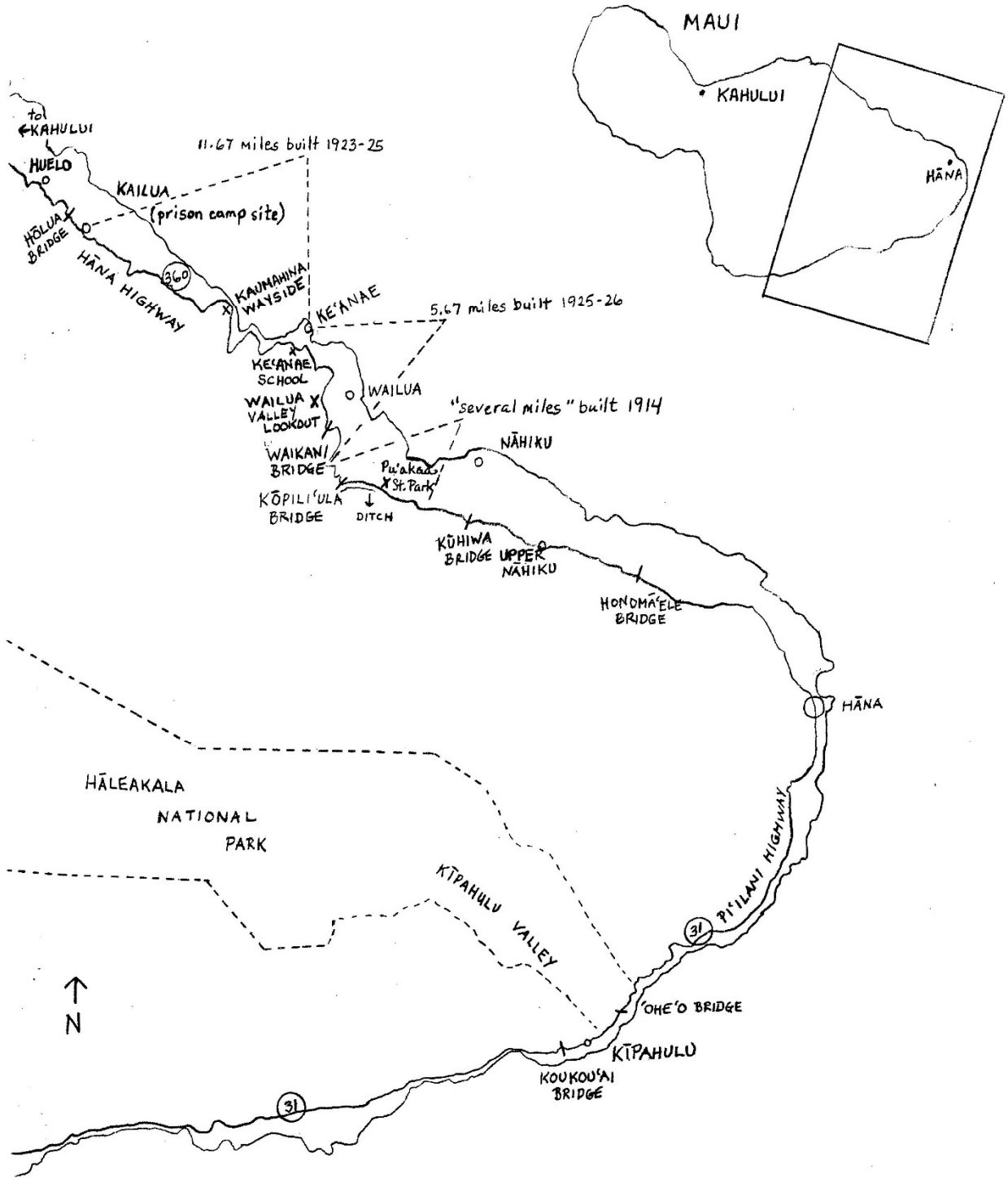
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The Maui News, 1900-1950.


MAUI COUNTY, HAWAI'I
KAHULUI
O PA'IA
HĀNA HIGHWAY
MILE MARKER 0
HUELO
DISTRICT START
KAILUA
(1) HŌLUA BR.
(2) KAILUA BR.
(3) NA'ILI'ILIHĀ'ELE
CULVERT #1
'O'OPUOLA (4)
MAKANALI (5)
KA'AIEA (6)
WAIKAMOI (7)
PUOHOKAMOA BR. (8)
HAIPUA'ENA BR. (9) (10)
KE'ANAE
KŌLEA (PUNALAU) (14)
HONOMANŪ (16)
(17) NUA'AILUA BR.
(18) PI'INA'AU BR.
PALAUHULU BR (19)
CULVERTS 2,3,4 (20)
WAIOKĀMILO BR AND CULVERT (21,22)
(23)
N
HĀNA BELT ROAD BRIDGES
Corresponding photo numbers in parentheses
WAIKANI BR. (24,25)
W. WAILUAIKI BR (27)
E. WAILUAIKI BR (28)
KŌPILI'ULA BR (29)
KUPUKOI BR (43)
PUPAPE-MANAWAIKEAE BR. (45)
PUA'AKA'A BR (31)
WAIOHUE BR. (32)
KEA'A'IKI BR. (47)
LANIKELE BR. (50)
PA'AKEA BR. (35)
BRIDGE #2 (34)
WAIOHUELUA BRIDGE (33)
KAPĀ'ULA BRIDGE (36)
HANAWĪ BRIDGE, (37)
EAST HANAWĪ BRIDGE & CULVERT (38,39)
MAKAPIPI BRIDGE (40)
KŪNIWA BRIDGE (42)
KAHALAOWAKA BR. (44)
KAHAIWAHAPAPA BR. (46)
W. WAIONI BRIDGE (48)
WAIONI BRIDGE (49)
HELE LE'IKE'ŌHA BRIDGE (51)
'ULA'INO BRIDGE (52)
MOKULEHUA BRIDGE (53)
OILOWAI BRIDGE (54)
HONOMĀ'ELE BRIDGE (55)
CULVERT #5 (56)
CULVERT #6 (57)
CULVERT #7 (58)
CULVERT #8 (59)
HĀNA
CULVERT #9 (60)
CULVERT #10 (61)
MO'OMONUI CULVERT (62)
HANEO'O (KAHOLOPO) BR. (63)
KAPI'A BRIDGE (64)
WAIOHONU BRIDGE (65)
PAPA'AHAWAHAWA BR (66,67)
ALA'ALA'ULA BR. (68)
WAIKAKOI BR. (69)
S. WAILUA BR. (72)
PU'UHOAO BR. (73)
WAIELE (PAEHALA) (74)
HĀHĀLAWE BR. (76)
MALUHIANA'IWI CULVERT (77)
PUA'ALU'U BRIDGE (78)
'OHE'O BRIDGE (81,82)
KALENA CULVERT
DISTRICT END
KŌUKOU'AI BRIDGE (84)
KĪPAHULU
PIILANI HIGHWAY
WAILUA BR. (71)
PA'IHI BR. (70)
KAKIWEKA BR. (75)
KAHULUI
HĀNA
0 1 2 3 4 5 6 miles

Hāna Belt Road
Maui County, Hawai'i



NPS Form 10-900-a
(8-86)

OMB Approval No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Section number ____ Page ____

SUPPLEMENTARY LISTING RECORD

NRIS Reference Number: 01000615 **Date Listed: 06/15/01**

Property Name: Hana Belt Road **County:** Maui **State:** HI

Multiple Name: N/A

This property is listed in the National Register of Historic Places in accordance with the attached nomination documentation subject to the following exceptions, exclusions, or amendments, notwithstanding the National Park Service certification included in the nomination documentation.

Sarah D Pope 6/15/01

(fax) **Signature of the Keeper** **Date of Action**

==========

Amended Items in Nomination:
The following amendments are hereby made to the documentation and confirmed with the HI SHPO:

Section 5, Classification
The road itself, not just the bridges and culverts, should be counted as a contributing structure. Therefore, the total number of contributing structures is changed to 74. The one (1) non-contributing structure remains the same.

Section 10, Geographical Data
The acreage of the property was not provided. The correct acreage of the district is 153 acres.

DISTRIBUTION:National Register property file;Nominating Authority

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 1

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

All photographs, with the exception of photograph #84 (Koukou'ai Bridge), were taken by Dawn E. Duensing. Dawn E. Duensing has all negatives except for that for #84, which is located at the State of Hawai'i Department of Transportation.

1. Hāna Belt Road
2. Maui County, Hawai'i
3. Dawn E. Duensing
4. November 19, 2000
5. Dawn E. Duensing
6. Hōlua Bridge, view looking east
7. Photograph #1

4. November 19, 2000
6. Kailua Bridge, view looking east
7. Photograph #2

4. November 19, 2000
6. Nā'ili'ilihā'ele Bridge, view looking west
7. Photograph #3

4. November 19, 2000
6. 'O'opuola Bridge, view looking west
7. Photograph #4

4. November 19, 2000
6. Makanali Bridge, view looking west
7. Photograph #5

4. November 19, 2000
6. Ka'aiea Bridge, view looking west, with ditchworks in the background
7. Photograph #6

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 2

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 19, 2000
6. Waikamoi Bridge, view looking east
7. Photograph #7

4. November 19, 2000
6. Puohokamoa Bridge, view looking *makai* (towards the ocean)
7. Photograph #8

4. November 19, 2000
6. Haipua'ena Bridge, view looking *mauka* (toward the mountain or inland)
7. Photograph #9

4. November 19, 2000
6. Haipua'ena Bridge, view looking east
7. Photograph #10

4. November 19, 2000
6. View from road looking east, just east of Kaumahina State Wayside
7. Photograph #11

4. December 2, 2000
6. Aerial view of road on west side of Honomanū Valley.
7. Photograph #12

4. November 26, 2000
6. West side of Honomanū Valley portion of road as viewed from the road on Honomanū Valley's east side
7. Photograph #13

4. December 2, 2000
6. Kōlea (Punala) Bridge, looking *mauka*
7. Photograph #14

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 3

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. Hāna Belt Road through Honomanū Gulch, between Kōlea Bridge and Honomanū Bridge, looking east
7. Photograph #15

4. November 26, 2000
6. Honomanū Bridge, looking *mauka*
7. Photograph #16

4. November 26, 2000
6. Nua'ailua Bridge, looking east
7. Photograph #17

4. November 26, 2000
6. Pi'ina'au Bridge, looking west
7. Photograph #18

4. November 26, 2000
6. Palauhulu Bridge, looking *mauka*
7. Photograph #19

4. November 26, 2000
6. Culverts #2 & #3, looking west, culvert #4 is of similar construction.
7. Photograph #20

4. November 26, 2000
6. Waiokamilo Bridge, looking west
7. Photograph #21

4. December 2, 2000
6. Waiokamilo Bridge, *makai* wall. Waiokamilo Culvert, adjacent to bridge, has identical walls.
7. Photograph #22

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 4

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. View of road on cliff's edge above Wailua Village, after Wailua Valley lookout, looking west
7. Photograph #23

4. December 3, 2000
6. Waikani Bridge, looking *mauka* from west side of bridge
7. Photograph #24

4. November 26, 2000
6. Road view of Waikani Bridge, looking west
7. Photograph #25

4. December 3, 2000
6. View from road on east side of Wailuanui Valley, east of Waikani Bridge; overlooking Wailua Village, with Hāna Belt Road above Wailua visible on left
7. Photograph #26

4. November 26, 2000
6. West Wailuaiki Bridge, looking *mauka* from east side of bridge
7. Photograph #27

4. November 26, 2000
6. East Wailuaiki Bridge, looking east
7. Photograph #28

4. November 26, 2000
6. Kōpili'ula Bridge, looking east
7. Photograph #29

4. November 26, 2000
6. Ditch running alongside Hāna Belt Road after Kōpili'ula Bridge
7. Photograph #30

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 5

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. November 26, 2000
6. Pua'aka'a (Waiohue) Bridge, looking *mauka*
7. Photograph #31

4. November 26,2000
6. Waiohue Bridge, looking east/ *makai*
7. Photograph #32

4. November 26, 2000
6. Waiohuolua Bridge, looking east
7. Photograph #33

4. November 26, 2000
6. Bridge #2, looking east, Pa'akea Bridge is in background
7. Photograph #34

4. January 27, 2001
6. Pa'akea Bridge, with Bridge #2 in background, looking west
7. Photograph #35

4. December 2, 2000
6. Kapā'ula Bridge, looking west
7. Photograph #36

4. December 2, 2000
6. Hanawī Bridge, from west side of bridge looking *mauka*
7. Photograph #37

4. December 2, 2000
6. East Hanawī Bridge, looking east
7. Photograph #38

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 6

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 2, 2000
6. East Hanawī Culvert, looking east/ *mauka*
7. Photograph #39

4. December 2, 2000
6. Makapipi Bridge, looking *mauka*
7. Photograph #40

4. December 2, 2000
6. View of Hāna Belt Road east of Makapipi Bridge, looking east
7. Photograph #41

4. December 2, 2000
6. Kūhiwa Bridge, looking east
7. Photograph #42

4. December 2, 2000
6. Kupukoi Bridge, looking east
7. Photograph #43

4. December 2, 2000
6. Kahalaowaka Bridge, view looking *mauka*
7. Photograph #44

4. December 2, 2000
6. Pupape-Manawaikeae Bridge, view looking east
7. Photograph #45

4. December 2, 2000
6. Kahawaihapapa Bridge, looking east
7. Photograph #46

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 7

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 2 , 2000
6. Kea'ā'iki Bridge, looking east
7. Photograph #47

4. December 2, 2000
6. West Waioni Bridge, looking east
7. Photograph #48

4. December 2, 2000
6. Waioni Bridge, looking east
7. Photograph #49

4. December 2, 2000
6. Lanikele Bridge, looking west
7. Photograph #50

4. December 2, 2000
6. Helele'ike'ōhā Bridge, looking east
7. Photograph #51

4. December 2, 2000
6. 'Ula'ino Bridge, looking west
7. Photograph #52

4. December 3, 2000
6. Mokulehua Bridge, looking east
7. Photograph #53

4. December 3, 2000
6. Oilowai Bridge, looking east
7. Photograph #54

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 8

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Honoma'ele Bridge, looking west
7. Photograph #55

4. December 3, 2000
6. Culvert #5, looking west
7. Photograph #56

4. December 3, 2000
6. Culvert #6, looking *makai*
7. Photograph #57

4. December 3, 2000
6. Culvert #7, looking *makai*
7. Photograph #58

4. December 3, 2000
6. Culvert #8, looking west
7. Photograph #59

4. December 3, 2000
6. Culvert #9, looking *mauka*
7. Photograph #60

4. December 3, 2000
6. Culvert #10, looking west
7. Photograph #61

4. January 27, 2001
6. Mo'omonui Culvert, looking *mauka*
7. Photograph #62

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 9

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Haneo'o (Kaholopo) Bridge, looking *mauka*
7. Photograph #63

4. December 3, 2000
6. Kapi'a (Kahawaiokapia) Bridge, looking north
7. Photograph #64

4. December 3, 2000
6. Waiohonu Bridge, looking south
7. Photograph #65

4. December 3, 2000
6. Papa'ahawahawa Bridge, looking *mauka*
7. Photograph #66

4. December 3, 2000
6. Papa'ahawahawa Bridge, road view looking north
7. Photograph #67

4. December 3, 2000
6. Ala'ala'ula Bridge, looking *mauka*
7. Photograph #68

4. December 3, 2000
6. Waikakoi Bridge, looking north
7. Photograph #69

4. December 3, 2000
6. Pa'ihi Bridge, looking *mauka*
7. Photograph #70

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 10

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Wailua Bridge, looking north
7. Photograph #71

4. December 3, 2000
6. South Wailua (Honolewa) Bridge, looking *mauka*
7. Photograph #72

4. December 3, 2000
6. Pu'uhoao Bridge, looking north
7. Photograph #73

4. December 3, 2000
6. Waiele (Paehala) Bridge, looking north
7. Photograph #74

4. December 3, 2000
6. Kakiweka Bridge, looking *mauka*
7. Photograph #75

4. December 3, 2000
6. Hāhālawe Bridge, looking *mauka*
7. Photograph #76

4. December 3, 2000
6. Maluhiana'iwi Culvert, looking *mauka*
7. Photograph #77

4. December 3, 2000
6. Pua'alu'u Bridge, looking *mauka*
7. Photograph #78

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
CONTINUATION SHEET

Section Additional Documentation: Photographs Page 11

Name of property Hāna Belt Road
County and State Maui County, Hawai'i

4. December 3, 2000
6. Roadscape south of Pua'alu'u Bridge, looking north
7. Photograph #79

4. December 3, 2000
6. Roadscape north of 'Ohe'o Bridge, looking north
7. Photograph #80

4. December 3, 2000
6. 'Ohe'o Bridge, looking *makai*
7. Photograph #81

4. December 3, 2000
6. 'Ohe'o Bridge, looking *mauka*
7. Photograph #82

4. December 3, 2000
6. Roadscape south of 'Ohe'o Bridge in Haleakalā National Park, looking north
7. Photograph #83

3. August Riccio, Hawai'i Heritage Center
4. 1990
5. State of Hawai'i Department of Transportation
6. Koukou'ai (Kaukau'ai) Bridge, looking *mauka*
7. Photograph #84

APPENDIX B: EXAMPLE LETTER OF INQUIRY

Aloha kāua,

Scientific Consultant Services, Inc. (SCS) is seeking information about cultural resources and traditional, previously or on-going, cultural activities within or near the proposed Hana Highway at Kalepa Point Road Repairs project area. The project area is located in Kaʻāpahu Ahupuaʻa, Kīpahulu District, Island of Maui [TMK: (2) 1-6-010:999], within the Hāna Highway (State Route 360) corridor, near the transition to the Piʻilani Highway (County Route 31) at the Kālepa Bridge (Enclosures 1 through 3). The project is proposed by the County of Maui Department of Public Works, Engineering Division for the purpose of ensuring that Hāna Highway remains safe and passable by rehabilitating the county road and shore protection infrastructure.

The project involves the reconstruction of revetment, seawall, and roadway in the area of the Kālepa Gulch, 14 miles southwest of Hāna Town. An approximately 400 feet (121.92 meters) section of roadway was undermined by large waves during Hurricane Iselle. Hurricane Iselle was the 11th named storm of the 2014 hurricane season and made landfall on the Island of Hawaiʻi on August 7, 2014 as a tropical storm. Large waves hit the east shore of Hawaiʻi island, as well as that of Maui. Hurricane Iselle caused considerable damage to the Hāna Highway, as well as road protection structures, including the rock rubble revetment slopes and concrete masonry walls, on the makai (west) side of Piʻilani Highway. Hāna Highway (also known as the Hana Belt Road, Hāna Road, Hāna Highway, Plilani Highway), including the project area corridor, is an historic property designated State Inventory of Historic Properties (SIHP) Site # 50-50-15-1638 and is listed on the National Register of Historic Places as 01000615.

The purpose of this Cultural Impact Assessment (CIA) is to identify and understand the importance of any traditional Hawaiian and/or historic cultural resources or traditional cultural practices associated with the project area and the surrounding *ahupuaʻa.* In an effort to promote responsible decision-making, the CIA will gather information about the project area and its surroundings through research and interviews with individuals that are knowledgeable about the area in order to assess potential impacts to the cultural resources, cultural practices, and beliefs identified as a result of the proposed project. We are seeking your kōkua and guidance regarding the following aspects of our study:

- General history as well as present and past land use of the project area
- Knowledge of cultural resources which may be impacted by future development of the project area (i.e. historic and archaeological sites, as well as burials)
- Knowledge of traditional gathering practices in the project area, both past and ongoing Cultural associations of the project area, such as legends, traditional uses and beliefs
- Referrals of kūpuna or elders and kamaʻāina who might be willing to share their cultural knowledge of the project area and the surrounding ahupuaʻa

- Due to the sensitive nature regarding iwi kūpuna or ancestral remains discovered, manaʻo regarding nā iwi kūpuna will be greatly appreciated
- Any other cultural concerns the community has related to Hawaiian cultural practices within or in the vicinity of the project area.

The CIA is in compliance with the Hawaiʻi Revised Statute (HRS) Chapter 343 Environmental Impact Statements Law and in accordance with the State of Hawaiʻi Department of Health's Office of Environmental Quality Control (OEQC) *Guidelines for Assessing Cultural Impacts* as adopted by the Environmental Council, State of Hawaiʻi on November 19, 1997 (and revised in 2012).

According to the *Guidelines for Assessing Cultural Impacts* (Office of Environmental Quality Control 2012:12):

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs…The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural which support such cultural beliefs…

Enclosed are maps showing the location of the proposed project area. Please contact me within 30 days at (808) 597-1182 or via e-mail (cathy@scshawaii.com) with any information or recommendations concerning this Cultural Impact Assessment.

Sincerely yours,



Cathleen Dagher
Senior Archaeologist

Enclosures (3)

APPENDIX C: EXAMPLE FOLLOW-UP LETTER

Aloha kāua,

We are following up on our March 4, 2021, letter which was in compliance with the statutory requirements of the State of Hawai`i Revised Statute (HRS) Chapter 343 Environmental Impact Statements Law, and in accordance with the State of Hawai`i Department of Health's Office of Environmental Quality Control (OEQC) Guidelines for Assessing Cultural Impacts as adopted by the Environmental Council, State of Hawai`i, on November 19, 1997.

Scientific Consultant Services, Inc. (SCS) is seeking information about cultural resources and traditional, previously or on-going, cultural activities within or near the proposed Hana Highway at Kalepa Point Road Repairs project area. The project area is located in Kaʻāpahu Ahupuaʻa, Kīpahulu District, Island of Maui [TMK: (2) 1-6-010:999], within the Hāna Highway (State Route 360) corridor, near the transition to the Piʻilani Highway (County Route 31) at the Kālepa Bridge. The project is proposed by the County of Maui Department of Public Works, Engineering Division for the purpose of ensuring that Hāna Highway remains safe and passable by rehabilitating the county road and shore protection infrastructure.

The project involves the reconstruction of revetment, seawall, and roadway in the area of the Kālepa Gulch, 14 miles southwest of Hāna Town. An approximately 400 feet (121.92 meters) section of roadway was undermined by large waves during Hurricane Iselle. Hurricane Iselle was the 11th named storm of the 2014 hurricane season and made landfall on the Island of Hawaiʻi on August 7, 2014 as a tropical storm. Large waves hit the east shore of Hawaiʻi island, as well as that of Maui. Hurricane Iselle caused considerable damage to the Hāna Highway, as well as road protection structures, including the rock rubble revetment slopes and concrete masonry walls, on the makai (west) side of Piʻilani Highway. Hāna Highway (also known as the Hana Belt Road, Hāna Road, Hāna Highway, Plilani Highway), including the project area corridor, is an historic property designated State Inventory of Historic Properties (SIHP) Site # 50-50-15-1638 and is listed on the National Register of Historic Places as 01000615.

The project is proposed by the Department of Transportation, Airport Division. The proposed development consists of the replacement of the existing chain-link security fence at Port Allen Airport with a fence of similar size, height (approximately 4 feet), and in the same footprint. The existing security fence has deteriorated and must be replaced to comply with security requirements set forth by the Federal Aviation Administration. The project is seeking a Special Management Area Permit from the County.

It is the purpose of this outreach is to identify and understand the importance of any traditional Hawaiian and/or historic cultural resources or traditional cultural practices associated with the project area and the surrounding *ahupuaʻa.* In an effort to promote responsible decision-making, we are gathering information about the project area and its surroundings through research and interviews with individuals that are knowledgeable about the area in order to assess potential impacts to the cultural resources, cultural practices, and beliefs identified as a

result of the proposed project. We are seeking your kōkua and guidance regarding the following aspects of our study:

- General history as well as present and past land use of the project area
- Knowledge of cultural resources (i.e., historic and archaeological sites, as well as burials) that may be impacted by the fence replacement project
- Knowledge of traditional gathering practices in the project area, both past and ongoing Cultural associations of the project area, such as legends, traditional uses and beliefs
- Referrals of kūpuna or elders and kamaʻāina who might be willing to share their cultural knowledge of the project area and the surrounding ahupuaʻa
- Due to the sensitive nature regarding iwi kūpuna or ancestral remains discovered, manaʻo regarding nā iwi kūpuna will be greatly appreciated
-
- Any other cultural concerns the community has related to Hawaiian cultural practices within or in the vicinity of the project area.

According to the *Guidelines for Assessing Cultural Impacts* (Office of Environmental Quality Control 2012:12):

> The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs…The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural which support such cultural beliefs…

Please contact me within 14 days at (808) 597-1182 or via e-mail (cathy@scshawaii.com) with any information you would like to share about cultural resources or traditional cultural practices in the vicinity of the proposed project area, or with recommendations concerning this Cultural Impact Assessment.

Sincerely yours,



Cathleen Dagher
Senior Archaeologist

APPENDIX D: CIA NOTICE PUBLISHED IN KA WAI OLA, SEPTEMBER 2019

Input Needed on General Plan Update



By Cedric Duarte

The Department of Hawaiian Home Lands is in the process of updating its statewide General Plan and is seeking beneficiary input.

DHHL's General Plan is the first opportunity, within the Department's planning system, for beneficiaries to provide their input into future policies and strategies that are designed to guide the utilization of trust resources in the implementation of the Hawaiian Homes Commission Act.

In March, the DHHL will begin conducting its first beneficiary consultation meetings related to the General Plan. All beneficiaries are asked to watch for postcard invitations in the mail that will include meeting details.

As one piece of the planning framework, the General Plan provides a comprehensive policy that ensures coordinated, integrated, orderly social, physical, and economic development of Hawaiian Home Lands through the establishment of goals, objectives, and implementing actions. The General Plan is followed by detailed Island and Regional Plans that are crafted with further beneficiary consultation.

The General Plan process allows DHHL and its beneficiaries an opportunity to reflect on what has been accomplished, identify areas for improvement, and articulates a vision and direction for the Trust.

DHHL's planning process includes the involvement of an investigative committee formed with Commissioners of the Hawaiian Homes Commission pursuant to Hawai'i Revised Statutes Section 92-2.5 and Hawai'i Administrative Rules Section 10-2-16 (b) (1).

Commissioners Randy Awo, Russell Kaupu, Zachary Helm, and Chair William J. Aila, Jr. have been selected to serve on the HHC's investigative committee.

The General Plan is updated every 20 years with the last plan published in 2002. In that time, the Kaupe'a, Malu'ōhai, Kānehili, Ka'uluokaha'i, La'i 'Ōpua, Waiohuli, and Waiehu Kou homesteads are among the new subdivisions that were established.

To learn more about DHHL's planning process and statewide plans, visit dhhl.hawaii.gov/po. ■

Cedric R. Duarte is the Information & Community Relations Officer for the Department of Hawaiian Home Lands. He has worked in communications and marketing since 1999 and is a longtime event organizer. A product of the Kamehameha Schools and the University of Hawai'i at Mānoa, he resides in 'Aiea with his wife and two daughters.

CULTURAL IMPACT ASSESSMENT: NANAIKEOLA, WAIANAE DISTRICT, OAHU

Scientific Consultant Services, Inc. (SCS) is preparing a Cultural Impact Assessment (CIA) in advance of the proposed Nanaikeola Self-Help project, an 88 lot self-help housing subdivision affordable to low income families in Hawai'i. The subdivision will be located on a 12.388-acre property, owned by the Self-Help Housing Corp of Hawaii, known as Nanaikeola in Lualualei Ahupua'a, Wai'anae District, Oahu Island [TMK : (1) 8-7-008-076] (Enclosures 1 through 3). SCSis seeking information on cultural resources and traditional cultural practice, previously conducted or ongoing, within or near the proposed Nanaikeola Subdivision project area. Please respond within 30 days to Cathleen Dagher, Senior Archaeologist, at (808) 597-1182, or via email (cathy@scshawaii.com).

CULTURAL IMPACT ASSESSMENT: KA'ĀPAHU AHUPUA'A, KĪPAHULU DISTRICT, MAUI

Scientific Consultant Services, Inc. (SCS) is preparing a Cultural Impact Assessment (CIA) in advance of the proposed Hana Highway at Kalepa Point Road Repairs project area. The project area is located in Ka'āpahu Ahupua'a, Kīpahulu District, Island of Maui [TMK: (2) 1-6-010:999], within the Hāna Highway (State Route 360) corridor near the transition to the Pi'ilani Highway (County Route 31) at the Kālepa Bridge. The project is proposed by the County of Maui Department of Public Works, Engineering Division for the purpose of ensuring that Hāna Highway remains safe and passable by rehabilitating the county road and shore protection infrastructure. SCS is seeking information on cultural resources and traditional cultural practice, previously conducted or on-going, within or near the proposed project area. Hāna Highway (also known as the Hana Belt Road, Hāna Road, Hāna Highway, Piilani Highway), including the project area corridor, is an historic property designated State Inventory of Historic Properties (SIHP) Site # 50-50-15-1638 and is listed on the National Register of Historic Places as 01000615. If you have information to share, please respond within 30 days to Cathleen Dagher, Senior Archaeologist, at (808) 597-1182, or via email (cathy@scshawaii.com).

CULTURAL IMPACT ASSESSMENT: WAIAWA, O'AHU

Honua Consulting is preparing a Cultural Impact Assessment for the Waiawa Phase 2 Solar + Storage Project. The project area is comprised of Tax Map Keys: [1] 9-6-004:024, [1] 9-6-004:025, [1] 9-6-004:026, and [1] 9-4-006:036 in Waiawa on the Island of O'ahu. The CIA team is seeking consultation with practitioners, Native Hawaiian Organizations, stakeholders, and other individuals. Specifically, consultation is sought on historic or existing cultural resources that may be impacted by the proposed project, historic or existing traditional practices and/or beliefs that may be impacted by the proposed project, and/or identification of individuals or organizations that should be sought out for consultation on the CIA. Individuals or organizations may contact the CIA team at community@honuaconsulting.com or (808) 392-1617. Additional information about the project is available on the project website at https://aesdistributedenergy.com/waiawa-solar-homepage/.

CULTURAL IMPACT ASSESSMENT: WAI'ANAE, O'AHU

Honua Consulting is preparing a Cultural Impact Assessment for the Mountain View Solar + Storage Project. The project area is comprised of Tax Map Keys [1] 8-5-003:031, [1] 8-5-003:032, and [1] 8-5-019:035 in Wai'anae on the Island of O'ahu. The CIA team is seeking consultation with practitioners, Native Hawaiian Organizations, stakeholders, and other individuals. Specifically, consultation is sought on historic or existing cultural resources that may be impacted by the proposed project, historic or existing traditional practices and/or beliefs that may be impacted by the proposed project, and/or identification of individuals or organizations that should be sought out for consultation on the CIA. Individuals or organizations may contact the CIA team at community@honuaconsulting.com or (808) 392-1617. Additional information about the project is available on the project website at https://aesdistributedenergy.com/mountain-view-solar-homepage/.

BURIAL NOTICE: PUNALU'U AHUPUA'A, KO'OLAULOA DISTRICT, O'AHU

Notice to interested parties is hereby given that isolated, secondarily deposited human skeletal remains were discovered by International Archaeology, LLC. Approximately 25 complete or partial skeletal elements and 50 miscellaneous small bone fragments were identified. Based on the disposition of the remains, they were determined to be secondarily deposited and not an intact burial. The find was made during archaeological inventory survey excavations for Kamehameha Schools' proposed Punalu'u Habitat Bank and Stream Restoration Project at Punalu'u Ahupua'a, Ko'olauloa District, Island of O'ahu, TMK (1) 5-3-001:041 (portion). The ahupua'a of Punalu'u was awarded to William Pitt Leleiōhoku (LCA 9971). The find does not fall within a kuleana LCA. The SHPD has assigned a State Inventory of Historic Places number of 50-80-06-8882 to the area where the remains were found. Consolidation of the remains at a nearby location and subsequent preservation is proposed, and a final determination will be made by the O'ahu Island Burial Council in consultation with the SHPD and any identified lineal and/or cultural descendants. Individuals with information pertaining to the burial should contact Ms. Regina Hilo at the SHPD ([808] 692-8026, Regina.Hilo@hawaii.gov) or Ms. Leslie Iaukea ([808] 692-8023, Leslie.Iaukea@hawaii.gov) within thirty days of this notice. These individuals must provide information to the SHPD demonstrating lineal descent from these remains or descent from ancestors buried in Punalu'u Ahupua'a or Ko'olauloa District. ■

APPENDIX E: SIGNED INFORMATION RELEASE FORMS

INFORMATION RELEASE FORM

I, the undersigned, participated in a virtual interview, conducted via telephone, with Cathleen A. Dagher, B.A., Senior Archaeologist, Scientific Consultant Services, Inc., on June 5, 20121.

I understand that the information I have provided to Scientific Consultant Services, Inc., shall be submitted as part of a Cultural Impact Assessment report prepared in advance of the proposed Hāna Highway at Kālepa Point Road Repairs project. The project area is located in Kaʻāpahu Ahupuaʻa, Hāna (Kīpahulu) District, Island of Maui [TMK: (2) 1-6-010:999].

This information will be subject to publication which will be submitted to the public for general review. I have read the summary of the interview and the information is true and accurate to the best of my knowledge. By signing this release form, I am providing my approval for the release of the information to Scientific Consultant Services, Inc., for the purpose outlined above (i.e., making the contents of this interview available for publication to the general public).

Print Name: A. Lucienne de Naie

Signature: A. Lucienne deNaie

Release Dated: Oct 4, 2021