
DRAFT ENVIRONMENTAL ASSESSMENT & ANTICIPATED FINDING OF NO SIGNIFICANT IMPACT, CALTECH SUBMILLIMETER OBSERVATORY DECOMMISSIONING



PREPARED FOR:
California Institute of Technology

PREPARED BY:



P L A N N I N G
S O L U T I O N S

JULY 2021

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION.....	1-1
1.1 OVERVIEW OF THE PROPOSED ACTION	1-4
1.2 PURPOSE OF THE PROPOSED ACTION	1-4
1.3 NEED FOR THE PROPOSED ACTION	1-5
1.4 PURPOSE OF THIS ENVIRONMENTAL ASSESSMENT	1-5
1.5 PERMITS AND APPROVALS.....	1-5
1.6 ORGANIZATION OF THE ENVIRONMENTAL ASSESSMENT	1-6
CHAPTER 2: DESCRIPTION OF PROPOSED ACTION.....	2-1
2.1 DESCRIPTION OF THE PROPOSED ACTION	2-1
2.1.1 Description of Existing Facilities	2-1
2.1.2 CSO Deconstruction and Removal Methodology	2-3
2.1.3 Site Restoration Methodology	2-19
2.1.4 Funding of Future Shared Infrastructure Removal	2-23
2.1.5 Restoration Effectiveness Monitoring	2-25
2.2 PRELIMINARY SCHEDULE FOR THE PROPOSED ACTION	2-25
2.3 PROJECT BUDGET	2-26
CHAPTER 3: PROJECT ALTERNATIVES	3-1
3.1 FRAMEWORK FOR CONSIDERATION OF ALTERNATIVES	3-1
3.2 IDENTIFICATION OF FEASIBLE ALTERNATIVES	3-2
3.3 ALTERNATIVES FOR DETAILED CONSIDERATION.....	3-3
3.3.1 ALT-1: No Action	3-3
3.3.2 ALT-2: Complete Facility and Infrastructure Removal with Full Restoration.....	3-3
3.3.3 ALT-3: Complete Facility and Infrastructure Removal with Moderate Restoration.....	3-4
3.3.4 ALT-4: Facility Removal, Infrastructure Capping, and Moderate Restoration.....	3-6
3.4 ALTERNATIVES CONSIDERED BUT REJECTED	3-10
3.4.1 Reduced Scale Alternative.....	3-10
3.4.2 Delayed Action Alternative	3-10
3.4.3 Alternative Location	3-11
CHAPTER 4: EXISTING ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION.....	4-1
4.1 ARCHAEOLOGY	4-1
4.1.1 Context.....	4-1
4.1.2 Prior Studies	4-4
4.1.3 Fieldwork and Findings	4-8
4.1.4 Potential Impacts	4-10
4.1.5 Mitigation Measures	4-10
4.2 CULTURAL IMPACT ASSESSMENT	4-10
4.2.1 Context.....	4-10

4.2.2	Cultural Overview	4-11
4.2.3	Consultation.....	4-12
4.2.4	Potential Impacts	4-16
4.2.5	Mitigation Measures	4-18
4.3	BIOLOGY	4-18
4.3.1	Context.....	4-18
4.3.2	Existing Conditions	4-18
4.3.3	Potential Impacts	4-23
4.3.4	Mitigation Measures	4-25
4.4	VISUAL AND AESTHETIC RESOURCES	4-25
4.4.1	Existing Conditions	4-26
4.4.2	Potential Impacts	4-27
4.4.3	Mitigation Measures	4-27
4.5	GEOLOGY AND TOPOGRAPHY	4-29
4.5.1	Context.....	4-29
4.5.2	Existing Conditions	4-33
4.5.3	Potential Impacts	4-34
4.5.4	Mitigation Measures	4-34
4.6	HYDROLOGY	4-34
4.6.1	Existing Conditions	4-35
4.6.2	Potential Impacts	4-49
4.6.3	Mitigation Measures	4-54
4.7	SOLID AND HAZARDOUS WASTE	4-54
4.7.1	Existing Conditions	4-54
4.7.2	Potential Impacts	4-56
4.7.3	Mitigation Measures	4-56
4.8	TRAFFIC	4-57
4.8.1	Existing Conditions	4-57
4.8.2	Potential Impacts	4-59
4.8.3	Mitigation Measures	4-61
4.9	NOISE	4-62
4.9.1	Context.....	4-62
4.9.2	Existing Conditions	4-63
4.9.3	Potential Impacts	4-63
4.9.4	Mitigation Measures	4-65
4.10	AIR QUALITY	4-65
4.10.1	Existing Conditions	4-65
4.10.2	Potential Impacts	4-66
4.10.3	Mitigation Measures	4-67
4.11	NATURAL HAZARDS	4-67
4.11.1	Existing Conditions	4-67
4.11.2	Potential Impacts	4-69
4.11.3	Mitigation Measures	4-71
4.12	PUBLIC SERVICES	4-71
4.12.1	Existing Conditions	4-71

4.12.2	Potential Impacts	4-72
4.12.3	Mitigation Measures	4-72
4.13	CUMULATIVE IMPACTS.....	4-73
4.13.1	Archaeological Resources	4-74
4.13.2	Cultural Resources.....	4-75
4.13.3	Biological Resources	4-75
4.13.4	Visual and Aesthetic Resources.....	4-76
4.13.5	Geology and Topography	4-76
4.13.6	Water Resources	4-76
4.13.7	Solid and Hazardous Waste Management	4-77
4.13.8	Traffic	4-77
4.13.9	Noise.....	4-77
4.13.10	Air Quality	4-78
4.13.11	Socioeconomic Conditions	4-78
4.14	MITIGATION MEASURES.....	4-79
CHAPTER 5: CONSISTENCY WITH LAND USE PLANS, POLICIES, AND CONTROLS		5-1
5.1	COUNTY OF HAWAI‘I.....	5-1
5.1.1	County General Plan.....	5-1
5.1.2	Hāmākua Community Development Plan (2018).....	5-3
5.2	STATE OF HAWAI‘I	5-4
5.2.1	Hawai‘i State Plan, HRS Chapter 226	5-4
5.2.2	State Land Use Law, HRS Chapter 205	5-6
5.2.3	Coastal Zone Management Program, HRS 205A.....	5-7
5.2.4	Consistency with Master Lease and Sublease	5-12
5.2.5	Mauna Kea Comprehensive Management Plan (2009)	5-13
5.3	FEDERAL LEGISLATION	5-15
5.3.1	National Historic Preservation Act.....	5-15
5.3.2	Clean Air Act (42 U.S.C. §7506(C))	5-15
5.3.3	Clean Water Act (33 U.S.C. §1251, et seq.).....	5-15
5.3.4	Coastal Zone Management Act (16 U.S.C. §1456(C)(1))	5-15
5.3.5	Endangered Species Act (16 U.S.C. §§1531-1544).....	5-16
5.3.6	Flood Plain Management (42 U.S.C. §4321, Executive Order No. 11988).....	5-16
CHAPTER 6: ANTICIPATED DETERMINATION.....		6-1
6.1	SIGNIFICANCE CRITERA.....	6-1
6.2	FINDINGS.....	6-1
6.2.1	Irrevocable Loss or Destruction of Valuable Resource	6-2
6.2.2	Curtails Beneficial Uses	6-2
6.2.3	Conflicts with Long-Term Environmental Policies or Goals	6-2
6.2.4	Substantially Affects Economic or Social Welfare	6-2
6.2.5	Public Health Effects	6-2
6.2.6	Produce Substantial Secondary Impacts.....	6-2
6.2.7	Substantially Degrade the Environment	6-3
6.2.8	Cumulative Effects or Commitment to a Larger Action.....	6-3

6.2.9	Effects on Rare, Threatened, or Endangered Species	6-3
6.2.10	Affects Air or Water Quality or Ambient Noise Levels	6-3
6.2.11	Environmentally Sensitive Area	6-3
6.2.12	Affects Scenic Vistas and View Planes	6-3
6.2.13	Requires Substantial Energy Consumption	6-3
6.3	ANTICIPATED DETERMINATION	6-4
CHAPTER 7: CONSULTATION AND DISTRIBUTION		7-1
7.1	SCOPING PERIOD CONSULTATION	7-1
CHAPTER 8: REFERENCES.....		8-1

LIST OF APPENDICES

APPENDIX A.	SITE DECOMMISSIONING PLAN
APPENDIX B.	AN ARCHAEOLOGICAL ASSESSMENT FOR THE CALTECH SUBMILLIMETER OBSERVATORY DECOMMISSIONING PROJECT ON MAUNAKEA, TMK: (3) 4-4-015:009 (POR.), KA'OHE AHUPUA'A, HĀMĀKUA DISTRICT, ISLAND OF HAWAI'I
APPENDIX C.	CULTURAL IMPACT ASSESSMENT FOR THE CALTECH SUBMILLIMETER OBSERVATORY DECOMMISSIONING PROJECT ON MAUNA KEA, TMK: (3) 4-4-015:009 (POR.), KA'OHE AHUPUA'A, HĀMĀKUA DISTRICT, ISLAND OF HAWAI'I
APPENDIX D.	BIOLOGICAL SETTING ANALYSIS: CALTECH SUBMILLIMETER OBSERVATORY DECOMMISSIONING
APPENDIX E.	HYDROGEOLOGICAL AND GEOLOGICAL EVALUATION FOR THE DECOMMISSIONING OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY SUBMILLIMETER OBSERVATORY
APPENDIX F.	TRANSPORTATION MANAGEMENT PLAN FOR CALIFORNIA INSTITUTE OF TECHNOLOGY SUBMILLIMETER OBSERVATORY DECOMMISSIONING, MAUNA KEA, HAWAI'I
APPENDIX G.	SCOPING MESSAGE AND BACKGROUND SUMMARY
APPENDIX H.	SITE RESTORATION EFFECTIVENESS MONITORING PLAN
APPENDIX I.	BEST MANAGEMENT PRACTICES PLAN
APPENDIX J.	ARCHAEOLOGICAL MONITORING PLAN

LIST OF FIGURES

Figure 1-1	Location of CSO in MKSR.....	1-2
Figure 1-2	Extent of CSO Site and Existing Layout	1-3
Figure 1-3	Caltech Submillimeter Observatory.....	1-4
Figure 2-1	Plan View of Existing Facilities on the CSO Site.....	2-3
Figure 2-2	ALT-2 Scope of Work	2-4
Figure 2-3	Conceptual Plan View of Overall Deconstruction Staging.....	2-5
Figure 2-4	Plan View of Deconstruction Staging Area 1	2-10
Figure 2-5	Conceptual Plan View of Deconstruction Staging Area 2.....	2-11
Figure 2-6	Photograph of CSO’s Aluminum Panel Skin.....	2-14
Figure 2-7	Photograph of Internal Structure During Construction.....	2-15
Figure 2-8	Photograph of Foundation During Construction.....	2-16
Figure 2-9	Cross-Section Drawing Illustrating a Portion of CSO’s Foundation.....	2-16
Figure 2-10	CSO Site Prior to Construction.....	2-20
Figure 2-11	Pre-Construction Topographical Survey of Site (1982)	2-21
Figure 2-12	Comparison of Pre-Construction and 2016 Topographical Surveys	2-22
Figure 2-13	ALT-2 Post-Decommissioning Site Conditions	2-24
Figure 2-14	Shared Infrastructure in the MKSR	2-25
Figure 3-1	ALT-3 Scope of Work	3-5
Figure 3-2	ALT-3 Post-Decommissioning Site Conditions Example	3-6
Figure 3-3	ALT-4 Scope of Work Example	3-8
Figure 3-4	ALT-4 Post-Decommissioning Site Conditions Example	3-9
Figure 4-1	CSO Decommissioning Project Direct Effect Study Area	4-2
Figure 4-2	Direct Effects Study Area and Visual Effects Study Area with nearby Historic Properties	4-3
Figure 4-3	Direct Effects Study Area Relative to the Mauna Kea Summit Region Historic District Boundary and the Extent of Traditional Cultural Properties	4-5
Figure 4-4	Direct Effects Study Area Relative to the Archaeological-Historic Properties and Traditional Cultural Properties in the MKSR and Mauna Kea Ice Age Natural Area Reserve.....	4-7
Figure 4-5	View from Site No. -16164 and Simulated View Without CSO	4-9
Figure 4-6	Flora Locations	4-20
Figure 4-7	CSO Facility Viewshed.....	4-28
Figure 4-8	Fill Material Analysis Sample Locations.....	4-31
Figure 4-9	Lithological Test Hole Locations.....	4-32
Figure 4-10	Sample Locations and Classified Lavas on Maunakea per Wolfe et al. 1997 ...	4-33
Figure 4-11	Historic Conceptual Model of Groundwater Occurrence and Flow in the State of Hawai‘i.....	4-35
Figure 4-12	Conceptual Model of Groundwater Systems for Hawai‘i Island.....	4-36

Figure 4-13	Geology of Hawai‘i Island with Locations of Scientific Borings.....	4-38
Figure 4-14	Conceptual Model of Stacked Freshwater Bodies	4-39
Figure 4-15	Water Budget Schematic for Hawaii Island.....	4-40
Figure 4-16	Geologic Map with Cross-Section A-A’ and Locations	4-42
Figure 4-17	Cross-Section from CSO to Hilo (and other locations)	4-43
Figure 4-18	Surface Water.....	4-45
Figure 4-19	Photo of Lake Waiau Taken dated November 9, 2018.....	4-46
Figure 4-20	Watersheds and Surface Water Flowpaths in Summit Area	4-47
Figure 4-21	As-Built Plan View of Cesspool on CSO Site	4-49
Figure 4-22	As-Built Section View of Cesspool on CSO Site	4-50
Figure 4-23	Existing Traffic Volumes.....	4-60
Figure 4-24	Hurricane Tracks, 1950 to 2012.....	4-69
Figure 7-1	CSO Decommissioning Project in the Hawai‘i Tribune-Herald.....	7-4

LIST OF TABLES

Table 1.1	Permits and Approvals	1-5
Table 2.1	BMPs Required by the CMP (2009).....	2-6
Table 2.2	Preliminary Schedule for the Proposed Action.....	2-26
Table 2.3	Estimated Project Budget.....	2-26
Table 3.1	Summary of Infrastructure Removal and Restoration Options.....	3-2
Table 3.2	Matrix of Feasible Potential Alternatives	3-3
Table 4.1	AIS Reports for the Maunakea Summit Region	4-4
Table 4.2	Historic Sites within the Visual Effects Study Area.....	4-8
Table 4.3	Individuals and Organizations Sent Consultation Request Letters for CIA	4-13
Table 4.4	Organizations Sent Second Round Consultation Request Letters for CIA.....	4-15
Table 4.5	Arthropods Found near CSO during OMKM Invasive Species Facility Monitoring (2013-2017).....	4-21
Table 4.6	Arthropods Recorded Within the CSO Site, November/December 2018.....	4-22
Table 4.7	Groundwater Velocity and Travel Time Estimates for Components of Regional Groundwater System Between CSO and Hilo	4-52
Table 4.8	Solid Waste Associated with CSO Decommissioning.....	4-54
Table 4.9	Avg. 24-Hour Traffic Volumes for Affected Roadways	4-59
Table 4.10	Hawai‘i Administrative Rules §11-46 Noise Limits	4-62
Table 4.11	Construction Equipment Noise Emissions Levels.....	4-64
Table 4.12	Summary of Damaging Earthquakes on Hawai‘i Island.....	4-68
Table 4.13	Summary of Mitigation Measures	4-80
Table 7.1	Parties Consulted in Early Scoping.....	7-2

LIST OF ACRONYMS

AA	Archaeological Assessment
ACM	Asbestos-containing material
AIS	Archaeological Inventory Survey
AFONSI	Anticipated Finding of No Significant Impact
AMP	Archaeological Monitoring Plan
bgs	Below ground surface
BLNR	Board of Land and Natural Resources
BMP	Best Management Practice
BSA	Biological Setting Analysis
CAA	Clean Air Act
CAB	Clean Air Branch
CDP	Community Development Plan
CFHT	Canada-France-Hawai‘i Telescope
CFR	Code of Federal Regulations
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permit
CIA	Cultural Impact Assessment
CMP	Comprehensive Management Plan
CMS	Center for Maunakea Stewardship
CS	Caltech’s Sublease
CSO	Caltech Submillimeter Observatory
CWRM	Commission on Water Resource Management
CZM	Coastal Zone Management
DEM	Department of Environmental Management
DKI	Daniel K. Inouye Highway
DLNR	Department of Land and Natural Resources
DP	Decommissioning Plan
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMS	Emergency medical services
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
FEA	Final Environmental Assessment
FONSI	Finding of No Significant Impact
GP	Hawai‘i County General Plan
HAR	Hawai‘i Administrative Rules
HCDP	Hāmākua Community Development Plan

HCFD	Hawai‘i County Fire Department
HCPD	Hawai‘i County Police Department
HDOH	Hawai‘i State Department of Health
HDOH-WB	Planning and Design Section, Wastewater Branch
HDOH-ES	Environmental Services
HDOT	State of Hawai‘i, Department of Transportation
HEPA	Hawai‘i Environmental Policy Act
HIOSH	Hawai‘i Occupational Safety and Health Division
HRS	Hawai‘i Revised Statutes
HSDP	Hawaiian Scientific Drilling Project
HVAC	Heating, ventilation, and cooling
IfA	University of Hawai‘i at Mānoa Institute for Astronomy
IPCC	Intergovernmental Panel on Climate Change
ISMP	Invasive Species Management Plan
JCMT	James Clerk Maxwell Telescope
LBP	Lead-based paint
LCP	Lead-containing paint
LEI	Lehua Environmental Inc.
MCL	Maximum contaminant level
MEP	Mechanical, Electrical, and Plumbing
mgd	Million gallons per day
MKMB	Mauna Kea Management Board
MKOs	Maunakea Observatories
MKSR	Mauna Kea Science Reserve
MKSS	Mauna Kea Observatory Support Services
ML	Master Lease
MMIS	Modified Mercalli Intensity Scale
MP	Master Plan
msl	Mean sea level
NAAQS	National Ambient Air Quality Standards
NAR	Natural Area Reserve
NFPA	National Fire Prevention Association
NHPA	National Historic Preservation Act
NHRP	National Register of Historic Places
NHS	National Highway System
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places

OCCL	Office of Conservation and Coastal Lands
OEQC	Office of Environmental Quality Control
OHA	Office of Hawaiian Affairs
OMKM	Office of Mauna Kea Management
OSDA	Operating and Site Development Agreement
OSHA	Occupational Safety and Health Division
PHRI	Paul H. Rosendahl, Ph.D., Inc
PTA	Pōhakuloa Training Area
PWS	Public water systems
RCRA	Resource Conservation and Recovery Act
REC	Recognized environmental conditions
SAAQS	State Ambient Air Quality Standards
SDP	Site Decommissioning Plan
SDRP	Site Deconstruction and Removal Plan
SHPD	State Historic Preservation Division
SIHP	State Inventory of Historic Places
SOP	Standard Operating Procedure
SRGII	Sustainable Resources Group International, Inc.
SRP	Site Restoration Plan
SWD	Solid Waste Division
SWPPP	Storm Water Pollution Prevent Plan
TCP	Traditional Cultural Property
TMK	Tax Map Key
TMP	Transportation Management Plan
TMT	Thirty-Meter Telescope
UH	University of Hawai‘i
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
VIS	Visitor Information Station
VPD	Vehicles per day
WSU	Washington State University
XRF	X-ray fluorescence

CHAPTER 1: INTRODUCTION

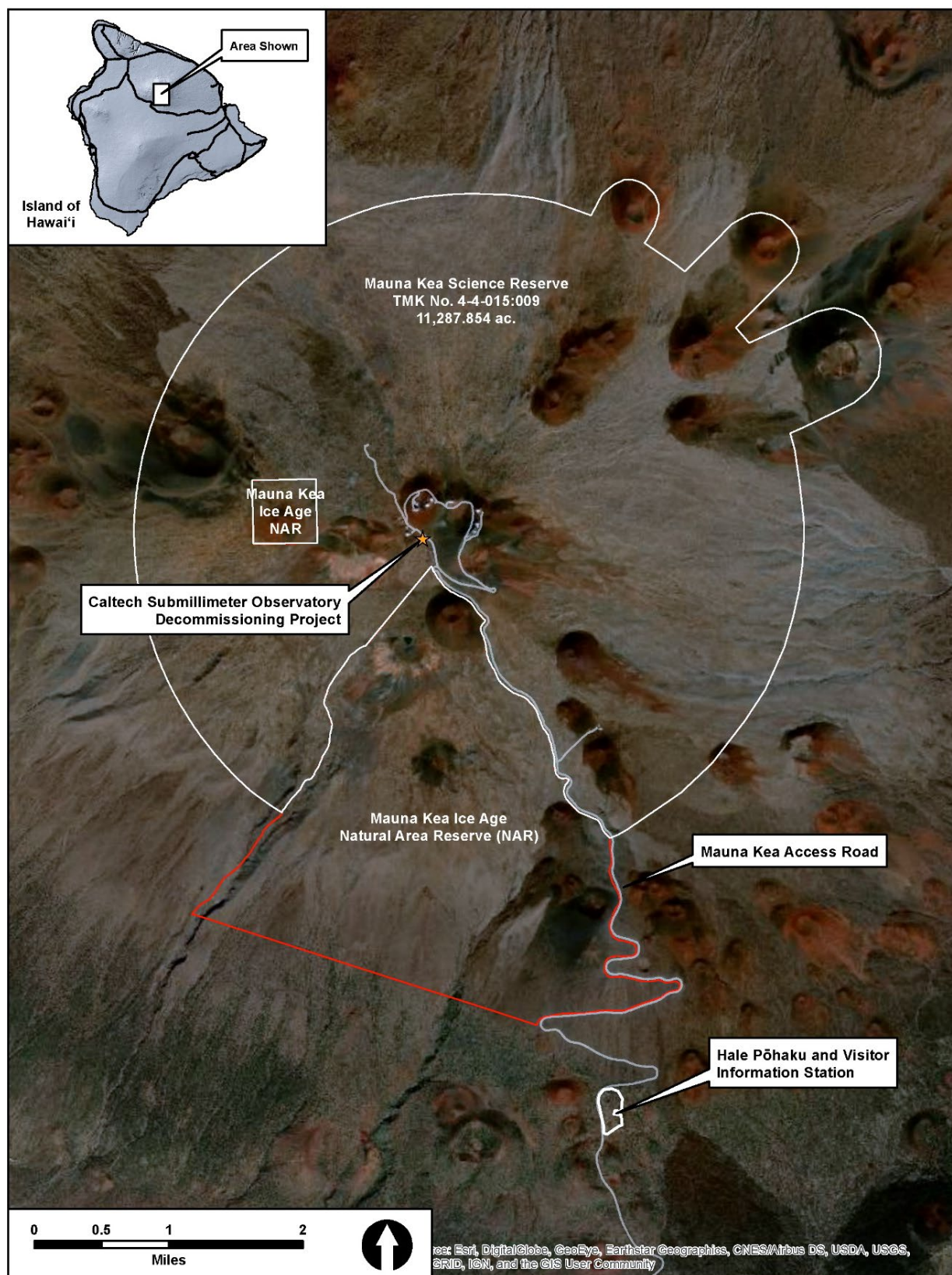
The Caltech Submillimeter Observatory (CSO) facility is located on a small portion of TMK No. 4-4-015:009, which is known as the Mauna Kea Science Reserve (MKSR), near the summit of Maunakea in the Hāmākua District on the Island of Hawai‘i (see Figure 1-1). This facility is owned and operated by the California Institute of Technology (henceforth referred to as “Caltech”) on land subleased from the University of Hawai‘i (UH), which leases the MKSR from the State of Hawai‘i, Department of Land and Natural Resources (DLNR). The “CSO Site” is defined as the sublease area and other minor adjacent areas that were disturbed during the original construction or will be disturbed during the decommissioning of the CSO (Figure 1-2). The CSO Site is roughly 1.3 acres.

CSO is a 10.4-meter (34 foot) diameter telescope that was engaged in astronomical observations in the terahertz radiation band (submillimeter wavelengths) from its first light in 1986 until it ceased operation 29 years later on September 8, 2015. Caltech formally tendered its Notice of Intent (NOI) to decommission the CSO to the UH Office of Mauna Kea Management (OMKM, now the Center for Maunakea Stewardship or CMS) on November 18, 2015, which was the first step in the decommissioning planning process. The current state of the CSO facility is shown in Figure 1-3.

The OMKM (now transitioning to CMS) manages the MKSR according to the terms of the Board of Land and Natural Resources (BLNR)-approved *Comprehensive Management Plan* (CMP, 2009). One component of the CMP is the *Decommissioning Plan for the Mauna Kea Observatories* (DP, 2010). The DP provides a framework for observatories on Maunakea, to ensure that the DLNR as landowner, the UH as Lessee and permittee, and the observatories as sublessees all have clear expectations of the observatory decommissioning process and can plan appropriately for it. In principle, the DP: (i) defines decommissioning and the steps necessary to achieving it; (ii) outlines the terms of decommissioning contained in UH’s Master Lease and existing subleases; (iii) provides information on financial planning for decommissioning; and (iv) offers guidance for the practical course of action needed to implement decommissioning.

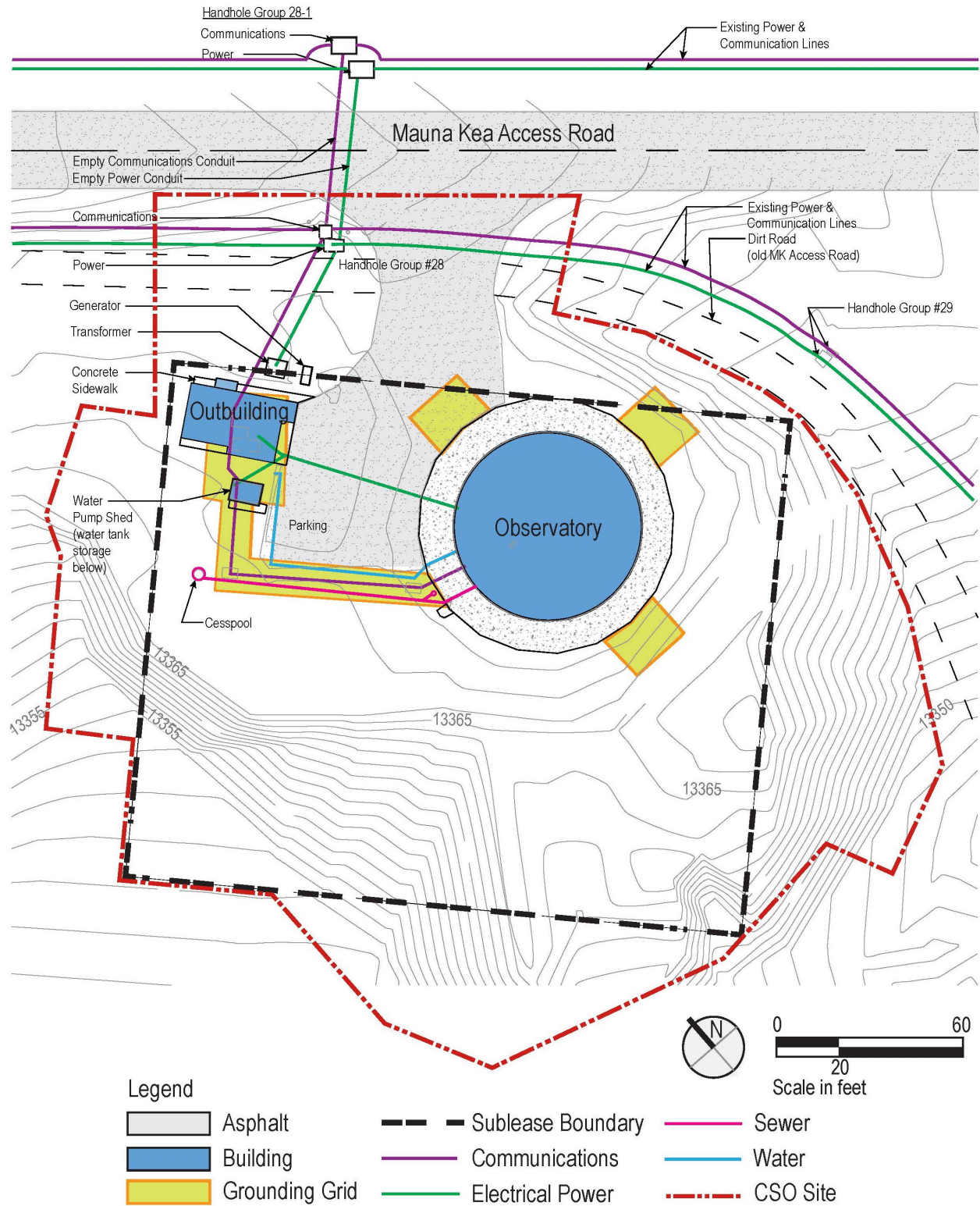
In addition, the CMP and DP both stipulate a series of management actions related to site recycling, decommissioning, demolition, and restoration activities by the observatories, including Caltech. The specific CMP management actions that apply are SR-1 and SR-2. SR-1 requires that the observatories develop detailed plans to recycle or demolish facilities; SR-2 requires that the observatories develop site restoration plans in association with decommissioning. Caltech is complying with these requirements for the CSO through the development of the Site Decommissioning Plan (SDP), which is attached in Appendix A, and this Environmental Assessment (EA).

Figure 1-1 Location of CSO in MKSR



Source: Planning Solutions, Inc. (2020)

Figure 1-2 Extent of CSO Site and Existing Layout

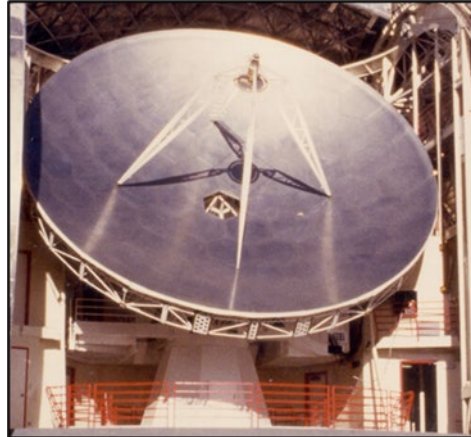


Source: M3 Engineering and Technology (2020)

Figure 1-3 Caltech Submillimeter Observatory



The CSO stands beside the Mauna Kea Access Road.
Source: Caltech (2019)



The CSO with dome open.

1.1 OVERVIEW OF THE PROPOSED ACTION

Caltech's proposed action is the decommissioning of the CSO facility pursuant to its *Site Decommissioning Plan for the Caltech Submillimeter Observatory* (SDP, see Appendix A). The SDP was prepared pursuant to the DP and describes the two primary components of decommissioning: (i) removal of the improvements within the CSO Site, and (ii) restoration of the CSO Site, as closely as practicable, to its pre-construction condition. The decommissioning is also described in detail in Chapter 2.

Because the CSO Site is located in the State of Hawai'i's Conservation District, a Conservation District Use Permit (CDUP) is required before the decommissioning can begin. The approval of a CDUP is an action by the State of Hawai'i. Typically, demolition of existing structures in the Conservation District are addressed under Hawai'i Administrative Rules (HAR) §13-5-22, wherein, "demolition, removal, or minor alteration of existing structures, facilities, land, and equipment," requires a Site Plan Approval by the DLNR, Office of Conservation and Coastal Lands (OCCL). Site Plan Approvals are typically administrative approvals, signed by the Chair of DLNR or a designated representative, and do not require preparation of an Environmental Assessment (EA). However, OCCL, in a letter to OMKM (now CMS) dated February 19, 2016 (Ref. No. HA-16-118), stated that decommissioning of the CSO would require a Conservation District Use Application (CDUA) to be reviewed and approved, subject to conditions, by the BLNR and an EA. This EA, which has been prepared according to the requirements of Hawai'i Revised Statutes (HRS) Chapter 343 and its implementing regulations contained in HAR §11-200.1 is intended to fulfill that requirement and inform the BLNR's decision-making on the CDUA.

1.2 PURPOSE OF THE PROPOSED ACTION

The purpose of the CSO Decommissioning project is to enable Caltech to conclude its use of the site and surrender its sublease while satisfying its obligations, via subleases and other agreements, to UH and the State of Hawai'i related to the CSO facility through the permitting and then implementation of the preferred alternative in this EA (Chapter 2) and the SDP (Appendix A).

1.3 NEED FOR THE PROPOSED ACTION

The proposed action is needed in order for Caltech to vacate the CSO Site and, per the terms and conditions of its sublease agreement, relinquish its sublease to UH. *The Sublease Agreement among the California Institute of Technology, the University of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, Sublease H09176* (CSO Sublease, 1983) offers four options on termination or expiration of the sublease:

1. Sale to UH.
2. Surrender with concurrence of UH.
3. Sale to a third party acceptable to UH.
4. Remove the property and restore the site to even grade at the expense of Caltech.

Consistent with the guidance contained in the DP (2010) and with its own NOI, Caltech has prepared an SDP which states that Caltech's intent and preferred alternative is complete removal of structures and infrastructure on the CSO Site and full restoration of the CSO Site (i.e., consistent with the fourth option for termination of the lease, plus additional restoration) followed by surrender of the sublease to UH.

1.4 PURPOSE OF THIS ENVIRONMENTAL ASSESSMENT

The purpose of this EA is to provide detailed information and analysis to inform relevant organizations, agencies, and individuals regarding the potential impacts of implementation of the SDP and its decommissioning alternatives, including the preferred alternative of complete removal of all aboveground and underground structures and infrastructure and full restoration of the CSO Site. It is also intended to fulfill the requirement by OCCL that Caltech prepare an EA, meeting all of the content and process requirements of HRS, Chapter 343 and its implementing regulations contained in HAR §11-200.1, in support of its CDUA for the decommissioning process.

1.5 PERMITS AND APPROVALS

In addition to the requirement imposed by OCCL for a CDUP issued by the BLNR noted in Section 1.1, the proposed action will require several other permits and approvals. The permits and approvals required for the CSO Decommissioning Project which have been identified to date are summarized in Table 1.2 below.

Table 1.1 Permits and Approvals

<i>Permit or Approval</i>	<i>Approving Agency</i>
Conservation District Use Permit	Board of Land and Natural Resources
HRS §6E Historic Preservation Review	State Historic Preservation Division
State Highways Permit	Hawai'i Department of Transportation
Construction Permit	County of Hawai'i Department of Public Works
Grading Permit	County of Hawai'i Department of Public Works
Right of Entry	Board of Land and Natural Resources
Source: Compiled by Planning Solutions, Inc. (2020)	

1.6 ORGANIZATION OF THE ENVIRONMENTAL ASSESSMENT

The remainder of this EA is organized as follows:

- Chapter 2 describes the proposed action in detail.
- Chapter 3 outlines the alternatives analyzed in this EA, as well as other alternatives that were initially considered but ultimately rejected, from further evaluation.
- Chapter 4 describes the existing environment and analyzes the potential impacts on natural, cultural, and socioeconomic resources. It also outlines strategies for minimizing and mitigating unavoidable adverse effects.
- Chapter 5 discusses the consistency of the proposed action with relevant plans, policies, and controls at local, regional, state, and federal levels.
- Chapter 6 provides the justification for the determination of a Finding of No Significant Impact (FONSI) by considering each individual significance criterion with respect to the proposed action.
- Chapter 7 summarizes the parties consulted during the preparation of this EA.

CHAPTER 2: DESCRIPTION OF PROPOSED ACTION

2.1 DESCRIPTION OF THE PROPOSED ACTION

The proposed action and preferred alternative consist of (i) BLNR awarding Caltech a CDUP for the decommissioning of the CSO as described in this chapter, and (ii) Caltech then implementing the decommissioning of the CSO as described in this chapter. The decommissioning of the CSO is described in detail in the SDP included in Appendix A and this chapter and would broadly consist of the following:

- Removal of all aboveground and belowground CSO components within the roughly 1.3 acre CSO Site (Figure 1-2), including, but not limited to, the observatory, outbuilding, foundations, cesspool, utilities, and grounding grid.
- Site restoration of the CSO Site as follows:
 - The topography would be returned to its pre-construction condition to the greatest extent possible. This would be achieved by removing fill placed on the lava flow during construction to the greatest extent possible. Cavities in the lava flow, where excavation occurred during construction (e.g., the cesspool), would be filled with a portion of the fill placed on the lava flow during construction, which is native to Maunakea.
 - The habitat would be restored to accommodate arthropod fauna to the greatest extent possible. In areas where cavities in the lava flow have been filled, rocks would be piled instead of attempting to recreate the flow. This would return the entire CSO Site to a condition consistent with the surrounding environment.
- Caltech would provide funds to UH to support the future decommissioning of shared infrastructure. Shared infrastructure consists of utility improvements shared by multiple Maunakea observatories and other uses. Such infrastructure cannot be removed until all uses that it serves have been decommissioned.
- Monitoring to characterize the effectiveness of restoration efforts would occur for three years.

Upon completion of the removal, restoration, and funding elements, Caltech would surrender its sublease to UH. The remainder of this chapter describes: (i) the observatory infrastructure present on the CSO Site; (ii) the methods that would be used to implement the proposed action, and (iii) implementation schedule and budget.

2.1.1 DESCRIPTION OF EXISTING FACILITIES

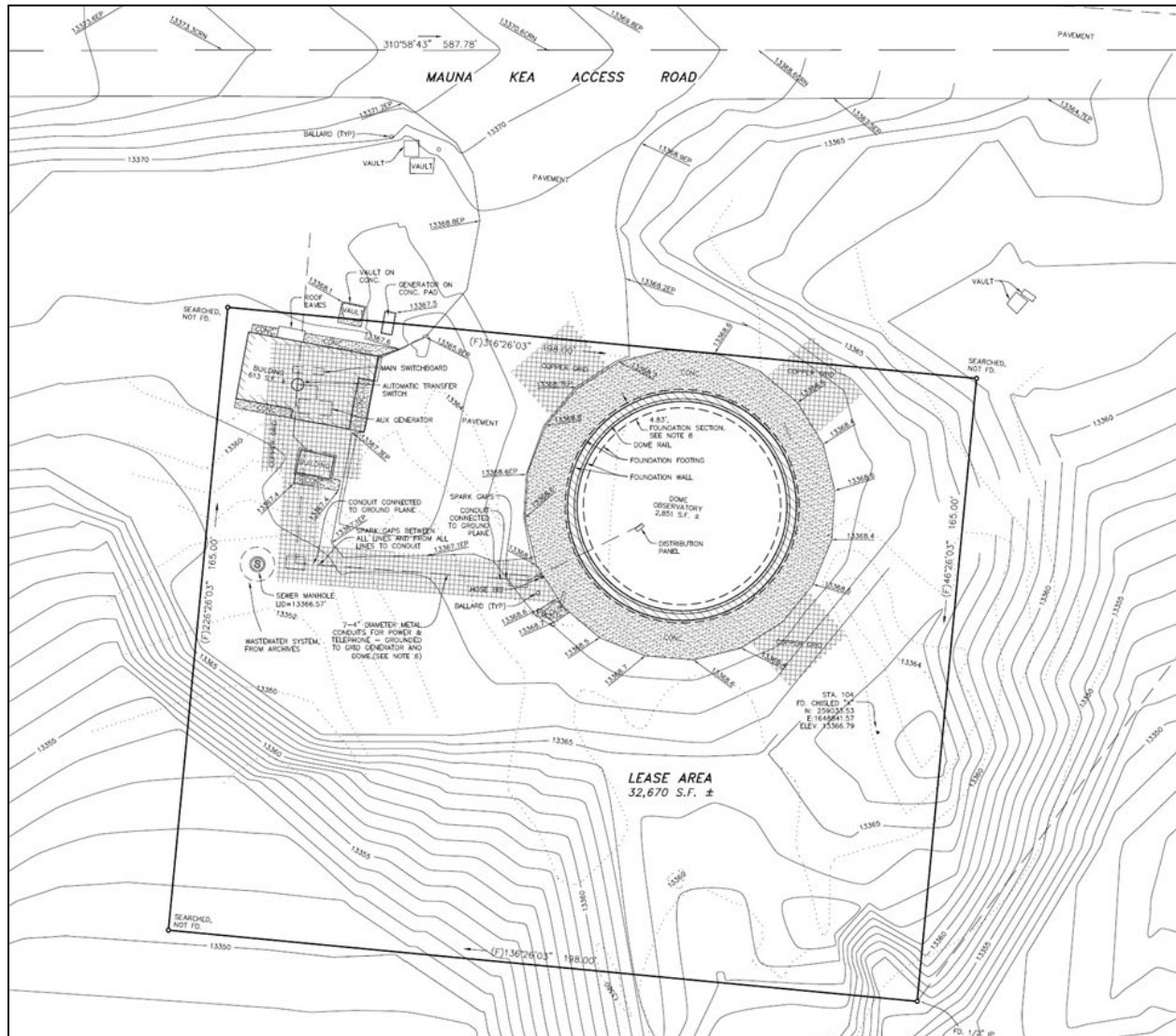
Construction of the CSO began in 1983 and was completed in 1986; the observatory closed 29 years later on September 8, 2015. The telescope, enclosed in a corotating dome, consists of a 10.4 meter (34 feet) diameter radio telescope with a reflector constructed of aluminum panels supported by a tubular steel truss. The weight of the reflector is 10,500 pounds and is attached to a dual-axis steel mounting structure that allows the reflector to be pointed in any skyward direction. The approximate total weight of the telescope is 43 tons (86,000 pounds).

The corotating dome is a steel structure clad with aluminum sheets. It is approximately hemispherical, 60 feet in diameter and 52 feet high. It has a two-shutter bay door that opens to expose the telescope to the sky. To allow it to follow the motion of the telescope, the entire dome structure rotates on a rail. Inside the dome, there are several laboratories and other rooms on three levels with various equipment and furnishings. The approximate total weight of the dome is 150 tons (300,000 pounds). Together, the telescope and dome rest on a concrete foundation, surrounded by a sidewalk, with an overall diameter of approximately 80 feet.

Fifty feet to the north of the CSO is a utility outbuilding (see Figure 1-2). This is a single-story building with metal framing, built on a concrete slab, with an adjoining concrete sidewalk. The original outbuilding houses the main electrical switchgear for the CSO; it was also used as an occasional workshop and for storage. The outbuilding was extended in 1990, and that extension currently stores emergency equipment used by the Maunakea Rangers. Adjacent to the outbuilding is a transformer in a metal cabinet and a backup electrical generator. Both are mounted on a concrete pad. The backup generator is fueled with propane from portable tanks stored in the outbuilding. All interconnecting fuel lines are underground.

Other on- or below-grade infrastructure at the CSO Site include a: (i) water tank; (ii) water pump housed in a shed mounted on a concrete pad; (iii) cesspool with a manhole for access; (iv) small concrete pad adjacent to the dome with plumbing fixtures for the water tank and cesspool; (v) ¾-inch copper water line to the tank; (vi) 4-inch sewer line to the cesspool; (vii) electrical lines between the Hawaiian Electric service point, the transformer, the outbuilding, the generator, and the dome; (viii) conduits for communications cables; between connection boxes near the access road, the outbuilding, and the dome; and (ix) copper grid for electrical grounding. Finally, the parking area between the dome and the outbuilding is paved with asphalt, which interconnects the CSO Site to the adjacent branch of the Mauna Kea Access Drive. There are also four ½-inch diameter survey markers at the four corners of the sublease area, and a fifth benchmark near the center of the CSO Site. Figure 2-1 provides a detailed plan view of existing facilities on the CSO Site.

Figure 2-1 Plan View of Existing Facilities on the CSO Site

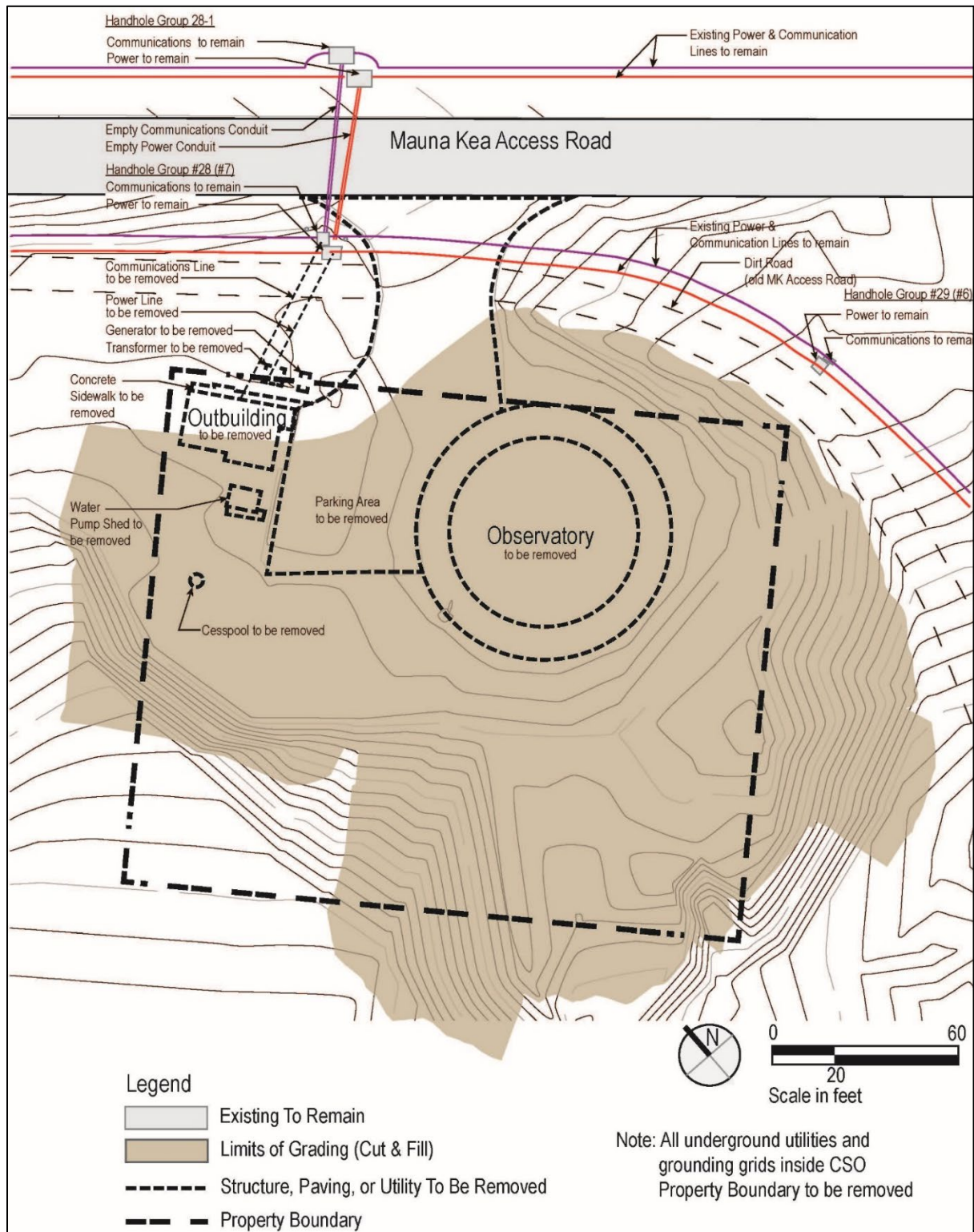


Source: dlb & Associates (2020)

2.1.2 CSO DECONSTRUCTION AND REMOVAL METHODOLOGY

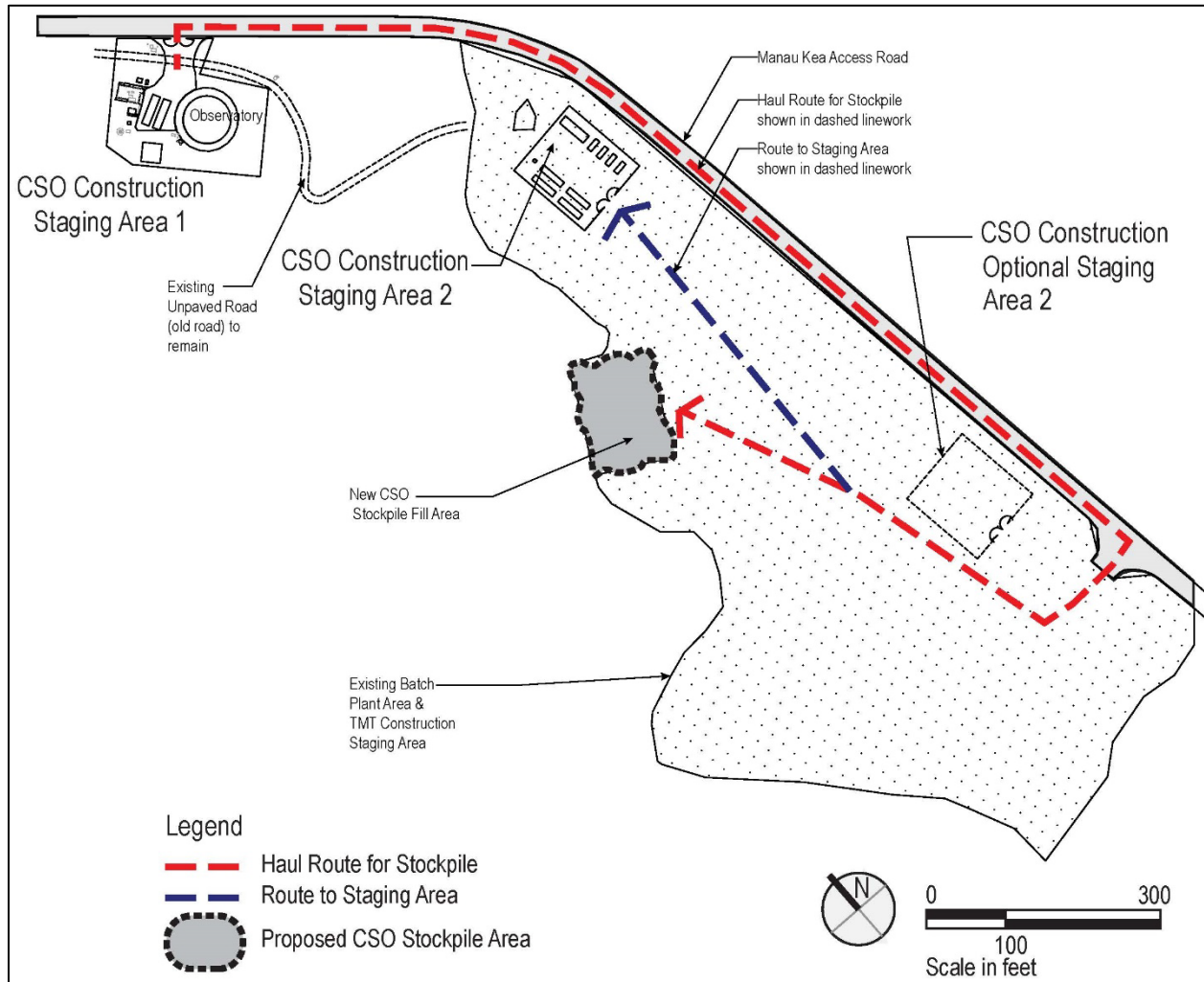
The following subsections outline the deconstruction and removal activities required to implement the proposed action. The deconstruction and removal process is laid out in detail and includes numerous precautions and protocols for safe and sensitive work by the contractor. Figure 2-2 illustrates the scope of work. Figure 2-3 provides a plan view of deconstruction staging.

Figure 2-2 ALT-2 Scope of Work



Source: M3 Engineering and Technology (2020)

Figure 2-3 Conceptual Plan View of Overall Deconstruction Staging



Source: M3 Engineering and Technology (2020)

2.1.2.1 Best Management Practices and Monitoring

All general contractors, subcontractors, and suppliers will be required to adhere to: (i) Best Management Practices (BMPs); (ii) permit conditions; and (iii) all applicable federal, state, and county statutes, regulations, and standards. The principal purpose of these BMPs and other commitments is to identify the safety, environmental, and resource protection requirements and constraints related to these activities. The BMPs will include measures to comply with applicable aspects of the CMP and other guidance. The CMP management actions that directly apply to the proposed project are the Construction Guidelines in Section 7.3.2 and summarized in Table 7-12 of the CMP. The construction guideline management actions are designated with codes C-1 through C-9 and are summarized in Table 2.1 along with where the requirements are addressed in this EA.

Table 2.1 BMPs Required by the CMP (2009)

<i>CMP Management Action No.</i>	<i>Management Action Description in CMP Table 7-12</i>	<i>Where Addressed in this EA</i>
C-1	General requirement: Require an independent construction monitor who has oversight and authority to ensure that all aspects of ground-based work comply with protocols and permit requirements.	Section 2.1.2.1.2
C-2	BMP: Require use of <i>Best Management Practices Plan for Construction Practices</i> .	Section 2.1.2.1.3
C-3	BMP: Develop, prior to construction, a rock movement plan.	Appendix I
C-4	BMP: Require contractors to provide information from construction activities to CMS for input into CMS information database.	Section 2.1.2.1.4
C-5	BMP: Require on-site monitors (e.g., archaeologist, cultural resources specialist, entomologist) during construction, as determined by the appropriate agency.	Section 2.1.2.1.2
C-6	BMP: Conduct required archaeological monitoring during construction projects per SHPD-approved plan.	Section 2.1.2.1.2
C-7	BMP: Education regarding historical and cultural significance.	Section 2.1.2.1.1
C-8	BMP: Education regarding environment, ecology, and natural resources.	Section 2.1.2.1.1
C-9	BMP: Inspection of construction materials.	Section 2.1.2.1.3
Source: Office Mauna Kea Management, <i>Comprehensive Management Plan</i> (2009)		

2.1.2.1.1 Education and Training

As the CMP management actions C-7 and C-8 require, all project personnel, monitors, contractors, and subcontractors will receive an educational orientation regarding the historic, cultural, and natural resources present in the summit region of Maunakea. Each individual will be required to complete the orientation prior to proceeding above Halepōhaku. It is anticipated that this orientation will be provided via the orientation video available on-line at: <http://www.malamamaunakea.org/about-us/maunakea-orientation> when the project begins. Because the proposed project is anticipated to take less than a year to complete, each person will only need to complete the orientation once. Should the project take more than a year to complete for a currently unexpected reason, each person will complete the orientation at least once a year.

Contractor and subcontractor personnel will receive additional information from the independent, archaeological, cultural, and invasive species monitors regarding the resources present, the protections they are afforded, and ways to reduce impacts to them when specific tasks are undertaken. These refreshers will be provided at weekly tailgate meetings or as warranted.

2.1.2.1.2 Construction Monitors

As the CMP management actions C-1, C-5, and C-6 require, several monitors will oversee the proposed project and have the authority to: (i) ensure that all aspects of the ground-based work comply with protocols and permit requirements, and (ii) stop activities if protocols and permit requirements are not being followed, unknown resources are encountered, or impacts to resources may occur. The monitors will consist of the following:

- *Decommissioning Manager.* A fulltime decommissioning manager, independent of the general contractor, will act as an independent construction monitor. Consistent with

CMP management action C-1, the decommissioning manager will ensure that BMPs and other commitments are being implemented throughout the decommissioning process. The decommissioning manager will work with archaeological, cultural, and invasive species monitors required at varying times during deconstruction.

- *Archaeological Monitor.* As recommended in the Archaeological Assessment (AA) prepared for the proposed project (ASM, 2018) and per CMP management action C-6, an Archaeological Monitoring Plan (AMP) will be prepared in accordance with HAR Chapter 13-279 and approved by SHPD prior to deconstruction activities starting. A draft of the AMP is included in Appendix J. Per the AMP and CMP management actions C-5 and C-6, the archaeological monitor will be present during ground-altering activity (e.g., digging trenches, removal of underground foundations and utilities, and removal of existing fill material).
- *Cultural Monitor.* As recommended in the Cultural Impact Assessment (CIA) prepared for the proposed project (ASM, 2020) and per CMP management action C-5, a cultural monitor will be present during ground-altering activity. The AMP (Appendix J) includes a cultural component. At the discretion of the selected cultural monitor, a more detailed cultural monitoring plan may be developed.
- *Invasive Species Monitor.* As recommended in the Biological Setting Analysis (SRGII, 2019) and per CMP management action C-5, an invasive species monitor will conduct monthly surveys for non-native species throughout the deconstruction process in order to identify any such introductions and formulate a response if necessary. Invasive species monitoring will address other components of the invasive species prevention and control program, such as vehicle and material inspections, throughout the deconstruction process. A draft Invasive Species Monitoring Plan that incorporates recommendations in the BSA is included in Appendix I.

All third-party construction monitors will participate in regularly scheduled deconstruction meetings led by the general contractor to keep abreast of the progress of deconstruction activities and schedule monitoring efforts. The independent monitors will interface with the general contractor to confirm that deconstruction activities follow the established protocols. It is also anticipated that each of the monitors will contribute to the project's worker orientation program. Among other benefits, archaeological and cultural monitoring will help to ensure that natural, archeological, historic, or cultural resources are not negatively impacted during site decommissioning.

2.1.2.1.3 Best Management Practices

As the CMP management actions C-2 and C-9 require, the proposed project will implement a Best Management Practices Plan that covers a range of topics and incorporates sustainable practices. The plan will include BMPs for:

- Water use
- Vehicle use, ride sharing, and traffic
- Material and waste management, including spill prevention
- Disturbance of ground surface and dust generation

- Erosion and water quality measures
- Invasive species prevention and control program
- Safety and accident prevention
- Inspection of equipment and materials

A draft of the Best Management Practices Plan is provided in Appendix I. All BMPs will be implemented during both the deconstruction and removal phase and the site restoration phase.

2.1.2.1.4 Coordination and Reporting

Beyond the requirements of CMP management action C-4, Caltech will conduct regular communications with CMS and other parties. This will be achieved through construction meetings and notices and other tools. Caltech believes this will increase the likelihood that the project is successfully completed in a safe and environmentally sensitive manner while maintaining normal public access to the mountain. The lines of communications will include: (i) the general contractor, (ii) CMS' decommissioning manager, (iii) third party monitors, (iv) CMS, (v) Maunakea Rangers, and (vi) representatives of the other observatories.

In addition, the project will provide to CMS all field logs, laboratory analyses (if any), and other construction documents that contain information on the biotic and abiotic environmental variables at the CSO Site.

2.1.2.2 Deconstruction Mobilization and Staging

Prior to commencement of deconstruction, proper installation of support infrastructure and procedures will promote safe and efficient conduct. The initial phase of deconstruction will consist of:

- The installation of temporary construction fencing around the perimeter of the work and staging areas.
- Implementation of BMPs, including the placement of dust and erosion control barriers at appropriate locations established in the Storm Water Pollution Prevention Plan (SWPPP), which will be a component of the National Pollutant Discharge Elimination System (NPDES) general construction permit. The BMPs outlined in the SWPPP will not use any biological material or non-native rock or cinder. BMPs will be maintained and the SWPPP updated as appropriate throughout the deconstruction period.
- Installation of portable office trailers and portable toilets within the nearby Batch Plant at CSO Construction Staging Area 2 and a portable toilet at the CSO Site (i.e., Staging Area 1).

The temporary construction fencing is intended to visually define the spatial extent of deconstruction activity and to limit access to the CSO Site and staging areas to authorized individuals only. The perimeter fencing can be expanded or contracted, within established limits, during the course of the decommissioning process as the work area changes in extent. This fencing will also serve dust and erosion control functions. The requirement for fencing will be included in the deconstruction specifications distributed as part of the bidding process for general

contracting firms. These specifications will require that the general contractor provide calculations for securing the fencing against wind loads at the project site as determined by the applicable building code.

As originally constructed, the CSO facilities were primarily built on or in fill from other locations on Maunakea. The fill will be removed and transported to an approved alternative location in the “Batch Plant” area (Section 2.1.2.16). Appropriate BMPs related to dust and erosion control will be prioritized from the outset. Figure 2-3 depicts the planned staging and haul routes during deconstruction. All vehicle and foot traffic will follow that route along the Mauna Kea Access Road; the dirt road will not be utilized.

As shown in Figure 2-3, the staging will be partitioned into three areas:

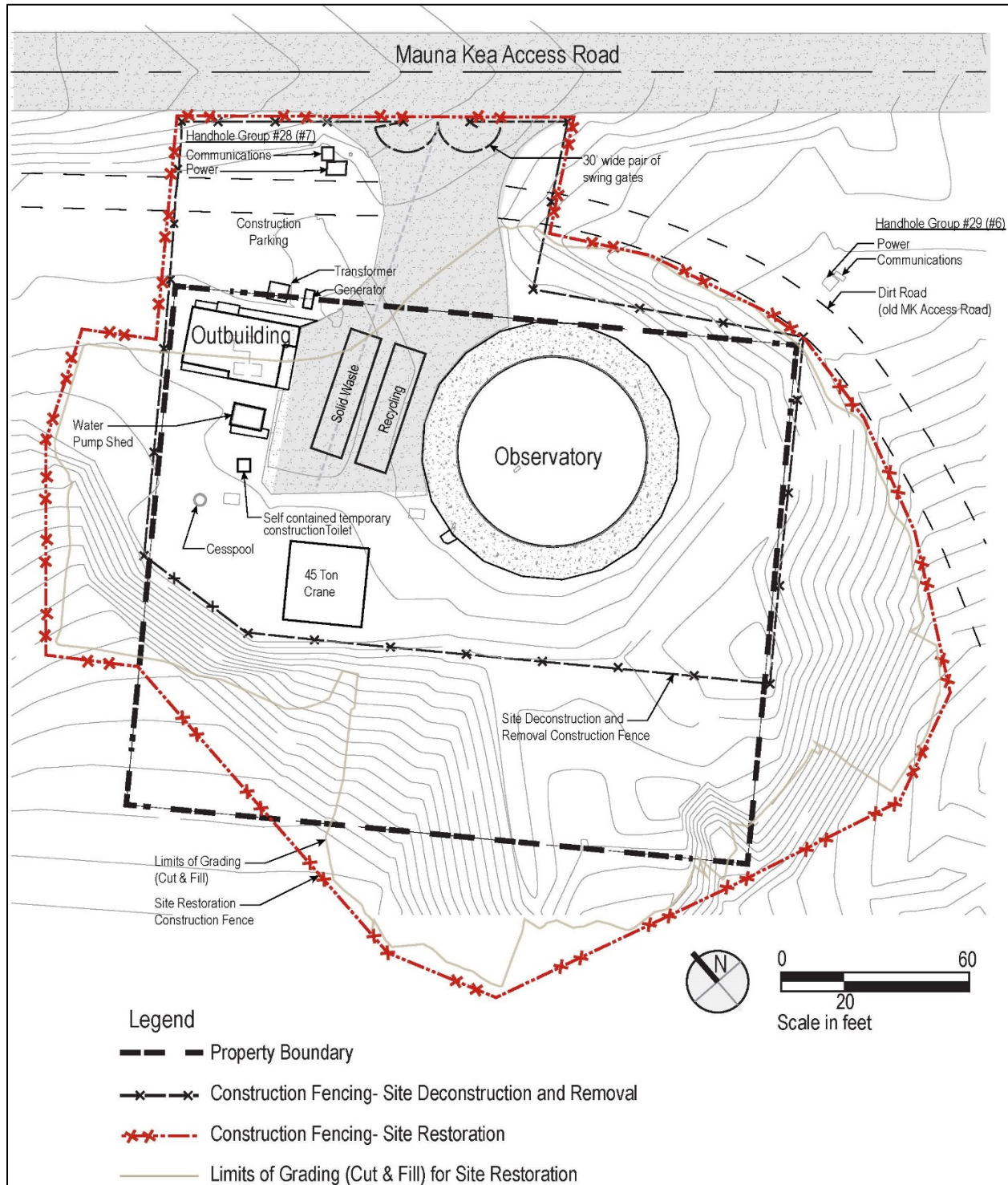
1. Staging Area 1 on the CSO Site;
2. Staging Area 2 within the Batch Plant adjacent to the Mauna Kea Access Road, it will be roughly 110 by 120 feet and roughly 0.3 acre; and
3. The 135 by 100 foot, roughly 0.3 acre, CSO fill stockpiling area also within the Batch Plant.

Figure 2-4 depicts a conceptual plan view of the Staging Area 1 on the CSO Site; Figure 2-5 provides a conceptual plan view of Staging Area 2. No grading of the Batch Plant will be required prior to establishing the staging areas. Once temporary construction fencing is emplaced, additional dust and erosion control BMPs will be placed around the perimeter of the CSO Site and Staging Areas 1 and 2.

An office trailer will be stationed at Staging Area 2 throughout the decommissioning process (see Figure 2-4). The trailer will be provided by the general contractor, with space provided for an independent decommissioning manager on-site daily. It will also afford adequate space for third-party archaeological, cultural, and invasive species monitors who will be present, as appropriate, during the site deconstruction and restoration phases of the project (see Section 2.1.2.1.2).

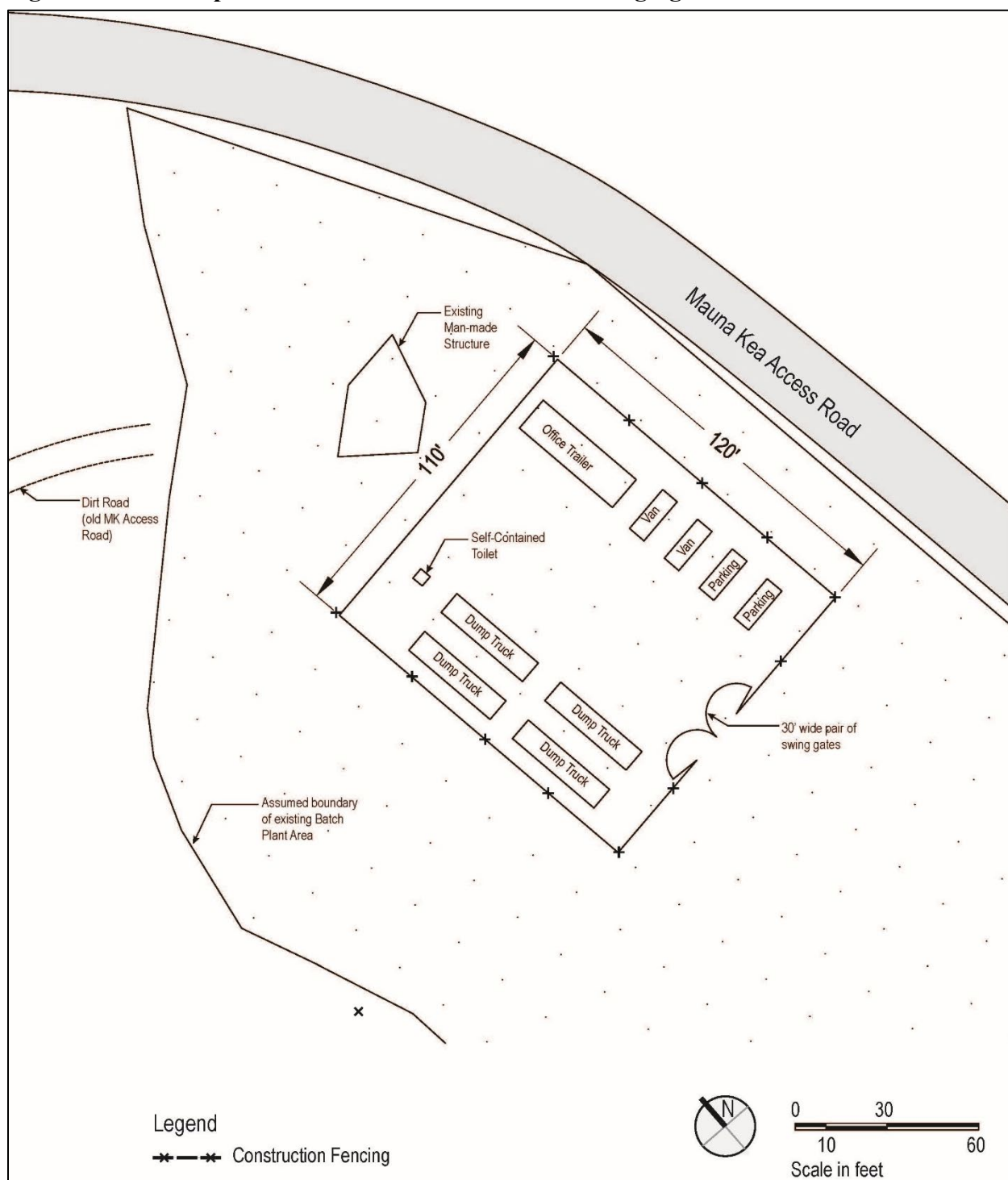
Temporary power interconnections, provided by Hawaiian Electric, for all deconstruction activities will also be put in place during mobilization and staging. Electrical power will be drawn from the closest remaining power source. For the CSO Site, the nearest available power source will be handhole group 28 (see Figure 2-4). There may be a period during which on-site generators supply power at the CSO Site and Staging Area 2. Water for deconstruction purposes will be provided via the existing tank and pump (see Figure 1-2) before being removed during latter stages of the deconstruction and removal process and/or a temporary aboveground water tank at Staging Area 2. Self-contained toilet facilities will be provided in the construction supervision trailer or through the use of portable toilets temporarily stationed on the CSO Site and Staging Area 2.

Figure 2-4 Plan View of Deconstruction Staging Area 1



Source: M3 Engineering and Technology (2020)

Figure 2-5 Conceptual Plan View of Deconstruction Staging Area 2



Source: M3 Engineering and Technology (2020)

2.1.2.3 Demolition Preparation and Fire Prevention

Once the site has been secured and staged, the first deconstruction task will be to prepare the existing structures for demolition. All power and plumbing lines serving the observatory will be

taken out of service by deenergizing or capping the lines, respectively, at the nearest point of remaining service. For the proposed action, this will be at the Handhole No. 28. Caltech anticipates that this modest task can be carried out in a single day with a limited crew of subcontractors.

The Hawai‘i County Fire Department (HCFD) is the primary agency responsible for fire prevention, fire control, and emergency medical services in the County of Hawai‘i. Caltech has been in communication with the HCFD regarding the CSO decommissioning and will continue to coordinate with them during its implementation. The National Fire Prevention Association’s (NFPA) NFPA 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations (2004) notes:

“A.5.4.1 Failure to remove scrap and trash accumulations provides fuel for the rapid expansion of a fire that might otherwise be confined to a small area. These accumulations also provide a convenient fuel source for malicious fires.”

The HCFD has indicated that during deconstruction, Caltech and its contractors may stage trailers to sort and deposit aluminum, steel, and deconstruction waste on-site. Caltech anticipates using roll-off trailers or similar container that can be securely covered, brought to the site, and stationed there during demolition. The contractor will be responsible for sorting and depositing deconstruction waste in the appropriate on-site container. HCFD has also stated that:

- Up to four locations may be designated on-site for deconstruction material sorting and collection, and that up to three roll-off trailers may be used, as appropriate, at any time during deconstruction.
- A truck may deliver an empty roll-off container up to a designated open location and haul away the full container while still complying with the total limit of three roll-off containers noted above.
- Recyclable material and deconstruction waste will be properly separated at all times during the deconstruction process.

2.1.2.4 Lead Paint and Mold

Between January 22 and 23, 2019, Lehua Environmental Inc. (LEI) performed site reconnaissance to identify and inventory: (i) asbestos-containing material (ACM), (ii) lead-containing paint (LCP), (iii) lead-based paint (LBP), and (iv) mold-impacted areas of the CSO Site. This survey is provided in the SDP included in Appendix A.

LEI recommended the following:

1. Manage and/or remove and dispose of hazardous and regulated materials in accordance with applicable local, state, and federal regulations, prior to renovation and/or demolition activities that may disturb these materials.
2. Remove and dispose of all loose and flaking (i.e., poor condition) LCP and LBP that may be disturbed during renovation/demolition activities in accordance with applicable local, state, and federal regulations.

3. Spot remove and dispose of LCP and LBP in areas that have the potential to become airborne or otherwise create dust (e.g., from sanding, drilling, friction, etc.) during renovation/demolition activities.
4. Any remediation and demolition contractor(s) must take appropriate measures to comply with applicable Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA) and Hawai'i Occupational Safety and Health Division (HIOSH) regulations pertaining to the handling of lead-containing materials and worker protection. Note that OSHA and HIOSH regulate activities that disturb paint which contain any detectable concentration of lead and that detectable levels of lead in the paint were found throughout the CSO Site.
5. Have air monitoring conducted for airborne lead by qualified personnel during any lead paint disturbance and general renovation activities of areas that were determined to contain this contaminant.
6. Conduct multi-incremental sampling of soils surrounding the CSO Site prior to and after any exterior lead paint disturbance activities.
7. Previously water damaged ceiling tiles located throughout the CSO Site should be removed. These tiles may be identified by water staining and/or discoloration.

Caltech will direct appropriately trained personnel to implement all seven recommendations prior to starting demolition of the buildings. The fifth and sixth recommendations will also be implemented during certain tasks outlined below, through structure demolition (Section 2.1.2.9), as deemed appropriate by trained personnel after the first five recommendations have been completed as part of this task.

2.1.2.5 Telescope Demolition

Caltech has been and continues to actively pursue the possibility of reusing the existing CSO telescope for further scientific research at an astronomical site other than Maunakea. If this effort is successful, the removal of the telescope will occur prior to the deconstruction activities presented in this EA. However, at the time this EA was prepared, no candidate site for relocation had yet been funded. If no relocation is funded prior to deconstruction, demolishing and removing the telescope will occur as part of the decommissioning of the CSO Site. The steel telescope structure will be cut using cutting torches and saws into transportable pieces and recycled as scrap material. All the support equipment that remained on-site is specific to the CSO telescope and will be disposed of appropriately if the telescope is subject to demolition.

2.1.2.6 Mechanical, Electrical, and Plumbing (MEP) Demolition

General demolition work will begin with the removal of interior building components. The demolition of observatory mechanical, electrical, and plumbing (MEP) building systems will be first and will include removal of all power, lighting, water, waste, and communication lines integrated throughout the observatory facility and outbuildings.

Removing these “guts” of the facility will be mostly performed by means of individuals utilizing various handheld cutting equipment. All MEP material removed from the facility will be placed in the appropriate on-site container to be trucked off-site to the designated landfill or recycled.

2.1.2.7 Partition/Built-In Demolition

To complete the interior demolition and prepare for the removal of the outer shell itself, all interior partitions, ceilings, and built-in units will be disconnected from the structure and removed. Working within the tightly confined shell of the observatory structure will require that the majority of interior demolition work be done by means of individuals utilizing appropriate cutting equipment. All material is to be considered waste and placed in the appropriate on-site container for later removal off-site to the designated landfill.

2.1.2.8 Skin Removal

The enclosure skin of the outer shell of the observatory consists of individual thin triangular aluminum panels fastened to the supporting steel tube structure (see Figure 2-6). During deconstruction, the panels of the skin will be cut into manageable pieces using saws and cutting torches, and removed with the use of a crane and lift.

Figure 2-6 Photograph of CSO's Aluminum Panel Skin



Source: Caltech (2020)

It is anticipated that the individual facets will be removed on a one-by-one basis rather than through simultaneous removal of multiple panels by multiple workers. All aluminum panels are considered recyclable material and will be placed in the appropriate on-site container for removal off-site to the designated recycling center.

2.1.2.9 Structure Demolition

With the building interiors, including MEP, and exterior skin removed, the structural skeleton of the observatory will be ready for dismantling (see Figure 2-7). The dismantling process will be performed with a manlift for cutting steel members into manageable pieces using cutting torches and saws and a crane for lifting these pieces from the structure to a flatbed truck for removal off-site. All steel deconstruction waste is planned to be recycled.

2.1.2.10 Paving Removal

To prepare for subsurface demolition and removal work, the existing paving will be removed. Demolished paving will be loaded onto a dump truck for removal to a designated off-site landfill.

Figure 2-7 Photograph of Internal Structure During Construction



Source: Caltech (1985)

2.1.2.11 Foundation and Grounding Grid Removal

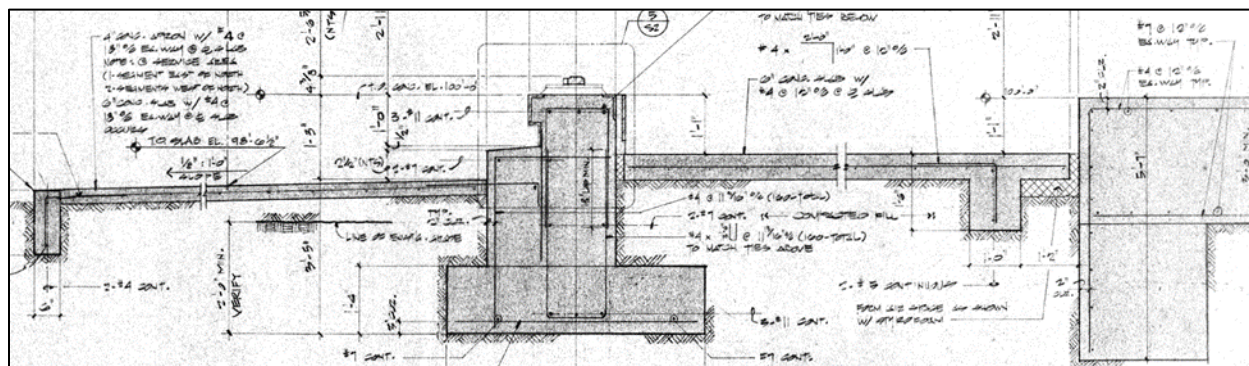
The CSO does not have a basement level and the structural footings underpinning the observatory consist of shallow spread footings. For this reason, total foundation removal is included in all alternatives. The CSO's foundations can be seen in Figure 2-8 and Figure 2-9, with the latter showing how the depth and thickness of the foundation varies from the center to the apron.

Figure 2-8 Photograph of Foundation During Construction



Source: Caltech (1985)

Figure 2-9 Cross-Section Drawing Illustrating a Portion of CSO's Foundation



Source: H. Robert Hogan & Associated, *CSO Foundation Plan* (1983)

The reinforced concrete foundation will be broken or cut, removed from the ground, and placed in roll-off bins. The portions of the grounding grid near the CSO foundation will be removed during this phase. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping or grounding mats, which will be transported to a designated recycling center.

2.1.2.12 Cesspool

As part of the decommissioning of the CSO Site, the cesspool will be closed. Caltech, in preparation for this closure, has consulted with the State of Hawai‘i Department of Health, Planning and Design Section, Wastewater Branch (HDOH-WB), to identify alternative courses of action for closure and backfilling of the cesspool. As part of this consultation, HDOH-WB provided information from *General Backfilling Scenarios for an Injection-Well Cesspool* (2004), summarized as follows:

- Backfilling and permanently abandoning an injection-well cesspool constitutes an injection well closure.
- Prior to any method of backfilling, each injection-well cesspool should be cleared to its original constructed depth, and all sediments, sludge, and organic materials in the cesspool should be removed and disposed of properly.
- Backfilling with a cement mixture or flowable fill may stop short of reaching the ground surface in order to accommodate topsoil, landscaping, grading, underground utilities, or foundation considerations.
- All backfilling methods should not leave behind a depression in the ground. The final ground surface should be shaped or graded to prevent tripping or falling, as well as water ponding.
- An official injection well closure indicates that the injection well has been cleaned out and permanently filled and sealed with an inert material having stability and physical strength.

Because backfilling the cesspool with cement would permanently leave CSO infrastructure material on-site, contrary to its stated intention to totally remove all infrastructure and fully restore the site, CSO has explored other options for closure of the cesspool that would return the area more closely to its pre-construction condition. On March 1, 2018, Caltech representatives met with Sanitarian Amy Cook of HDOH’s Environmental Services Division to discuss options for the closure of the CSO cesspool, including whether excavation below the cesspool was warranted or if fill from the CSO Site, rather than cement, was an acceptable fill alternative. In that meeting, HDOH-ES acknowledged Caltech’s intention to remove all manmade structures from the site and stated that they were not aware of any instances of excavating below or beyond a cesspool base, except to enlarge a cesspool. In addition, HDOH-ES indicated that use of natural material from the CSO Site to fill the cavity left by removal of the cesspool was acceptable. (Amy Cook, pers. comm., March 1, 2018).

Based on its consultation with HDOH-WB and HDOH-ES, for all action alternatives Caltech now plans to: (i) pump out all sludge remnants in the cesspool, (ii) test the sludge for potential contaminants and dispose of it properly, (iii) trench around the outer perimeter of the concrete cesspool cylinder to its depth; (iv) remove the concrete cesspool structure and dispose of it properly; and then (v) use structural fill from the CSO Site¹ to fill the void to a depth even with the surrounding native lava flow surface and compact the fill during the backfilling process to

¹ This structural fill to be used is the fill placed on the lava flow during CSO construction and is native to Maunakea (Intera, 2019).

minimize settling in the future. CSO will continue to coordinate with the HDOH and comply with the instructions provided by it during closure of the cesspool.

2.1.2.13 Phase II Environmental Site Assessment (ESA)

It is believed that small hydraulic fluid leaks may have occurred at the CSO Site when it was being built in 1984, and a small hydraulic fluid release was reported and addressed in 2009. These leaks, response actions taken to date, and other relevant information were identified in the *Phase I Environmental Site Assessment* (ESA), which is provided in Appendix B of the SDP (Appendix A), and is summarized in Section 3.2.1 of the SDP.

Per DP guidance, a *Phase II Sampling and Analysis Plan* (Phase II SAP) was prepared to address the findings of the Phase I ESA. The Phase II SAP is provided in Appendix C of the SDP (Appendix A), and is summarized in Section 3.3 of the SDP.

Following removal of the underground concrete slab (see Section 2.1.2.11) and cesspool (Section 2.1.2.12), Caltech will perform sampling and analysis per the Phase II SAP, which is attached to the SDP (Appendix A). The actions outlined in the Phase II SAP will address the past hydraulic fluid release. Contaminated soil, if any, would be removed and disposed of properly based on the results of sampling outlined in the Phase II SAP.

2.1.2.14 Outbuilding and Secondary Aboveground Infrastructure

Under the proposed action, the outbuilding, a smaller nearby building housing a water pump, a generator mounted on a concrete pad, a transformer mounted on a concrete pad, and all other secondary aboveground infrastructure will be removed.

All building materials, including concrete pads and slabs, will be deconstructed and placed in roll-off bins. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping, if any, which will be transported to a designated recycling center.

2.1.2.15 Remaining Underground Infrastructure

Underground improvements to be demolished include: (i) utility lines, (ii) water tank, and (iii) remaining grounding grid and other ancillary subsurface infrastructure. Under the proposed action, all the utility conduits from handhole group #28, which provides service to CSO and throughout the CSO Site will be removed. In concert with these activities, the remaining grounding grid will be removed.

All building materials, including conduit and tank, will be removed from the ground and placed in roll-off bins. All material removed will be designated as deconstruction waste material and will be removed from the CSO Site and transported to an approved landfill, with the exception of recyclable material such as copper piping and wire (including the grounding grid), which will be transported to a designated recycling center.

2.1.2.16 Backfill and Finish Grading

Following the removal of all infrastructure, removal of remaining fill material will take place using heavy, medium, and small equipment and hand tools. The temporary construction fencing will be repositioned (Figure 2-4) to surround the site restoration work area prior to this fill removal activity. As the fill is removed, a quantity of roughly five cubic yards of fine ash material and small rocks, consistent with the size and material of the rocks scattered in the nearby undisturbed areas, will be segregated using a screen or similar method and stockpiled on site or at the staging area until needed for restoring the arthropod habitat (Section 2.1.3). The stockpiles left at the Batch Plant will be approximately five feet in height and cover an area of approximately 100' x 135' (Figure 2-3) and tightly arrayed in overlapping piles.

No fill or aggregate material will be imported from a non-Maunakea source to the CSO Site or Staging Area 2.

Once all the excess fill material has been removed, the reserved fine ash and small rocks will be layered on top of summit-native rock to leave a visual appearance consistent with the original condition of the Site. Because the CSO Site is located on a lava flow, it will not be possible to fully reconstruct the preexisting flow in excavated areas. Rather, restoration will use rocks and fill, compacting as necessary for long-term stability, to return those areas to a natural condition consistent with the surrounding topography.

2.1.2.17 Demobilization

Upon completion of the backfill and the site restoration processes (see Section 2.1.2.16 and 2.1.3) that can be completed with the temporary construction fence in place, the general contractor will remove the fencing, soil erosion and dust control BMPs, and other items from the CSO Site for its final restoration.

2.1.3 SITE RESTORATION METHODOLOGY

Once deconstruction and removal of the CSO is complete, site restoration will take place, per the guidance of Caltech's *Site Restoration Plan* (SRP), a component of their SDP (Caltech, 2021; see Appendix A), which was prepared to comply with the DP's guidance:

"The purpose of a Site Restoration Plan is to present specific targets for site restoration and to describe the methodology for restoring disturbed areas after the demolition/construction activities described in the Site Deconstruction and Removal Plan are completed. Each SRP shall be specific to the site and consider cultural, biological, and physical aspects of site restoration. Each SRP shall include a provision for effectiveness monitoring to characterize success and/or failure of restoration efforts."

It also goes on to provide definitions for three levels—minimal, moderate, and full—of site restoration which can be considered; Caltech, as part of its proposed action, will implement full restoration of the former CSO Site. Full restoration entails returning the CSO Site as closely as possible to its pre-construction condition, including topography and arthropod habitat. Figure 2-10 depicts the condition of the CSO Site prior to the facility's construction in the 1980s.

Figure 2-10 CSO Site Prior to Construction



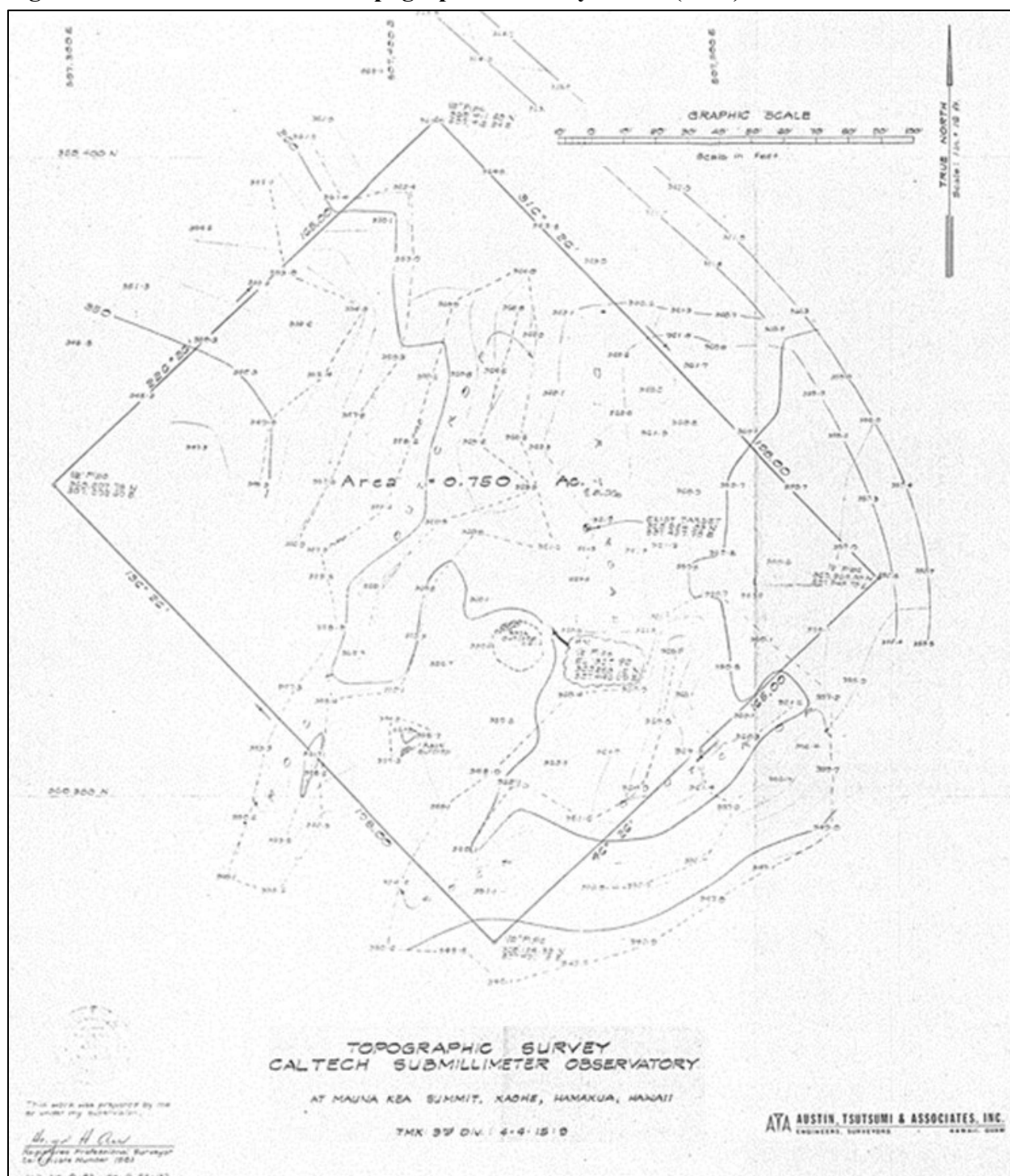
Note: The “CIT” label refers to the California Institute of Technology and identifies the CSO Site.



Source: Caltech (1985)

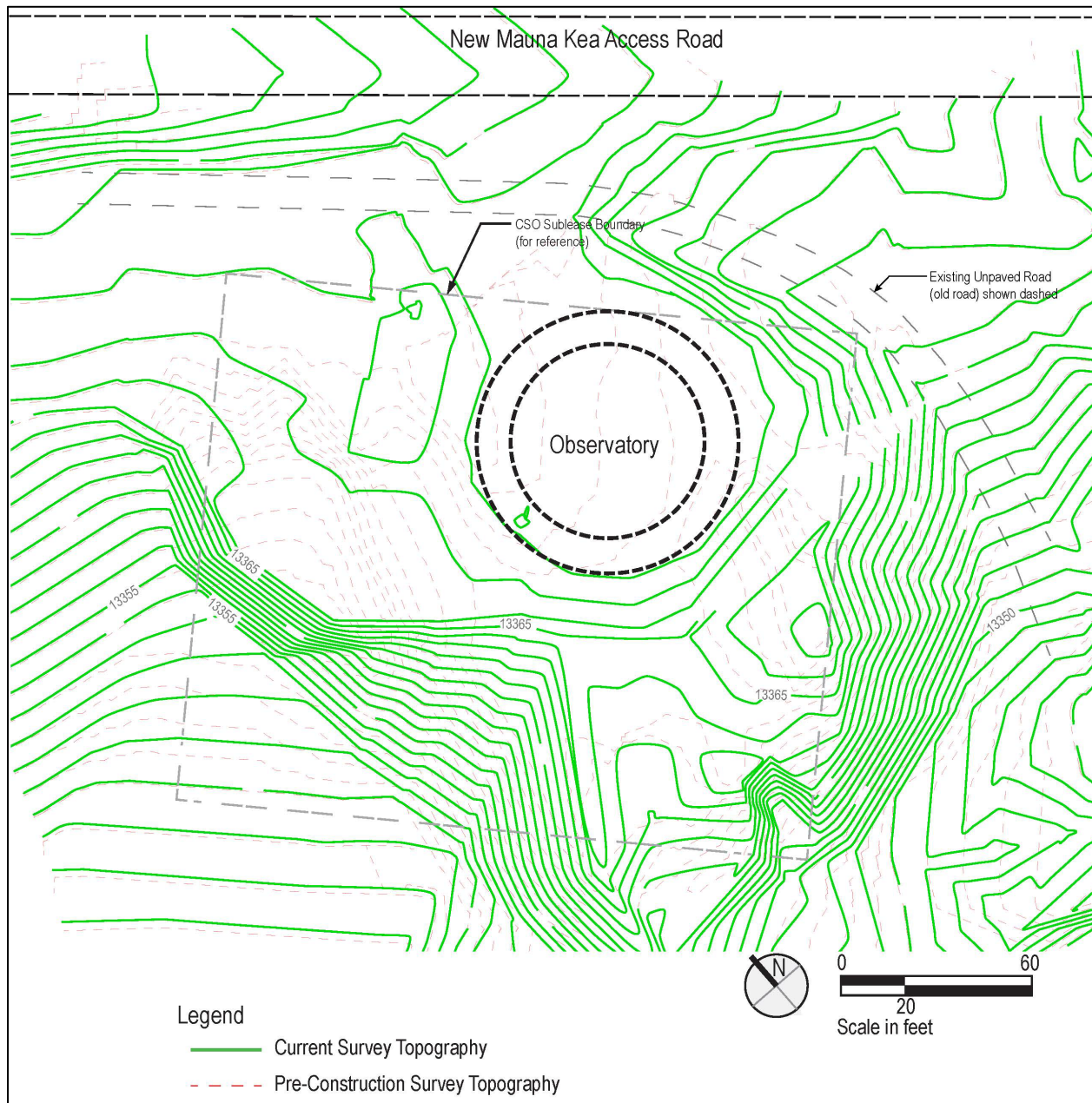
Austin, Tsutsumi & Associates, Inc, undertook a pre-construction site topographical survey, presumably prepared in 1982-1983 and noted as received January 21, 1983; the survey is provided in Figure 2-11. M3 Engineering and Technology, Caltech’s decommissioning planning contractor, digitized this prior survey and overlaid it with an updated site survey performed by dlb & Associates in 2016 (see Figure 2-12), with corrections for relative calibrations, to determine topographical discrepancies between the two and to calculate cut and fill requirements.

Figure 2-11 Pre-Construction Topographical Survey of Site (1982)



Source: Austin, Tsutsumi & Associates, Inc (1982)

Figure 2-12 Comparison of Pre-Construction and 2016 Topographical Surveys



This figure reproduces information not legible in the 1982 pre-construction topographical conducted by Austin, Tsutsumi and Associates, Inc.
Source: dlb & Associates (2016)

A comparison of the two surveys indicates that:

- Pre-construction grading and excavation cut approximately 495 cu. yds. of material from the site and filled with approximately 2,830 cu. yds. material, yielding a net fill of 2,335 cu. yds.;
- The maximum depth of the fill is about 10 feet, on the downhill side of the facility;
- The deepest foundation, under the telescope, is about 4 feet below grade and entirely in fill; and

- The cesspool extends approximately 13.5 feet below grade, with the upper 9 feet in fill and the lower 4.5 feet in the pre-construction topography.

Because restoration of the pre-construction topography would primarily require removal of fill from the site, with only modest excavation and backfill for the cesspool, there appear to be no engineering obstacles to full restoration of the pre-construction topography.

Following removal of fill placed on the site during construction and grading (see Section 2.1.2.16) to restore topography, active arthropod habitat restoration will consist of scattering fine ash material and small rocks stockpiled during fill removal using medium to small equipment (e.g., a mini loader) and hand tools in an attempt to provide the naturalistic appearance and niche habitat for native species of plants and arthropods.

Figure 2-13 illustrates the anticipate CSO Site conditions post site restoration.

2.1.4 FUNDING OF FUTURE SHARED INFRASTRUCTURE REMOVAL

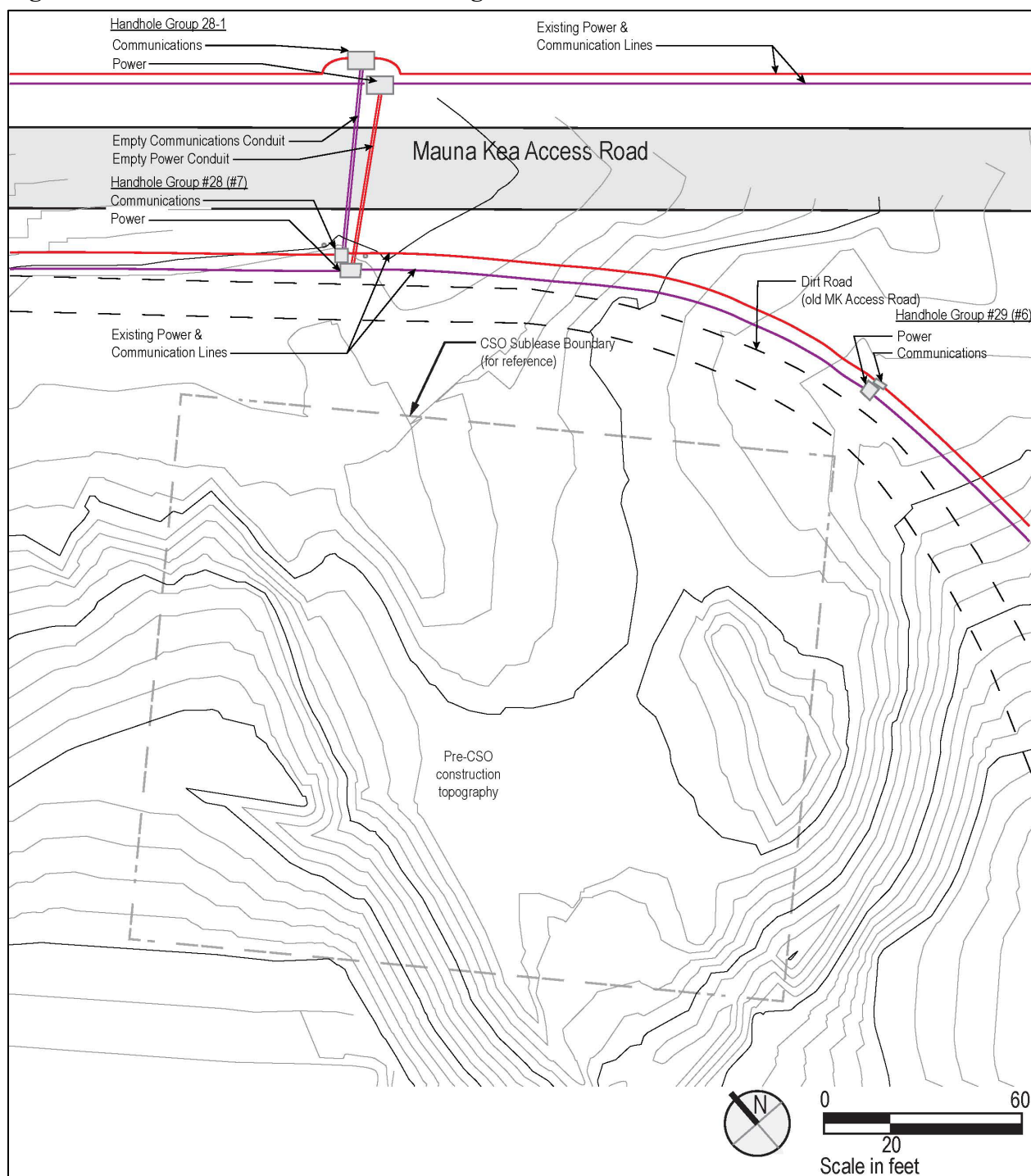
Infrastructure within the MKSR that CSO relies on and is shared with other uses in the summit region cannot be decommissioned until the other uses that rely on it also cease. Therefore, Caltech will not remove those shared facilities as part of the proposed action, but will provide funds to UH so that they can be decommissioned at a later date. The only shared infrastructure within the CSO Site is: (i) the electric and communication utilities along the dirt road (former Mauna Kea Access Road) that extend from near the Batch Plant, through handhole group #28, to JCMT; and (ii) the empty conduits that extend from handhole group #28, under the Mauna Kea Access Road, to handhole group 28.1 (Figure 2-13 and Figure 2-14).

Caltech would provide funds to UH for the future decommissioning of the shared infrastructure based on a weighted pro-rata share of the facilities it has utilized. Caltech has been assessed by UH to have a pro-rata interest in the following:

- The electrical and communication service that extends from near the lower portion of the Batch Plant, through handhole group #28, and on to JCMT (red line on Figure 2-14).
- The empty conduit between handhole group #28 and #28.1 (white line on Figure 2-14).
- Electric line from the lower portion of the Batch Plant to east side of Mauna Kea Access Road (short purple line on Figure 2-14).
- Communication service that extends from near the lower portion of the Batch Plant to near the upper part of the Batch Plant (a roughly 700 linear foot section of the pink line on Figure 2-14).
- Communication service that extends from near the upper portion of the Batch Plant to near the UH 2.2 observatory and “summit lunch room” (blue line on Figure 2-14).

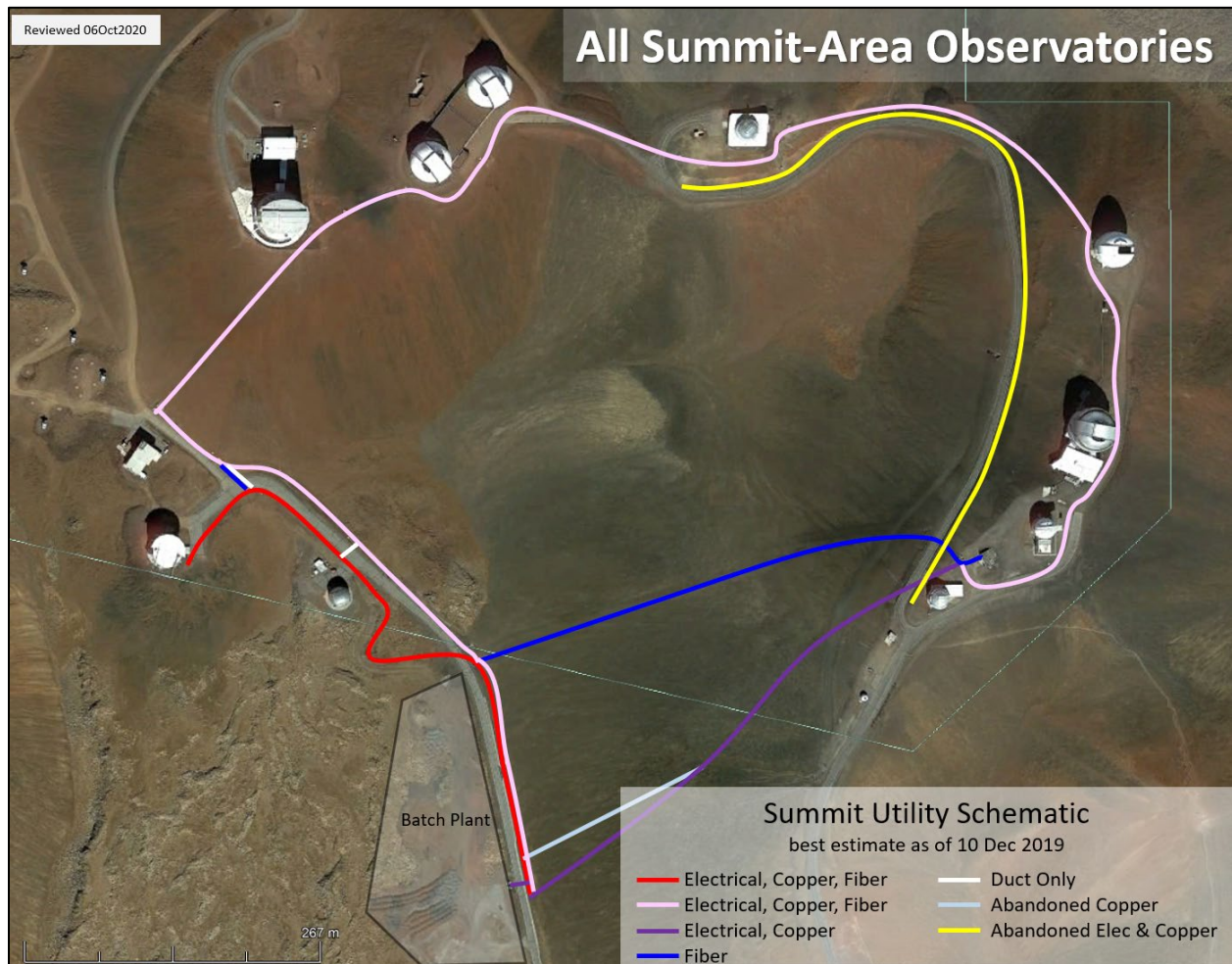
In 2020 UH estimated that CSO’s weighted pro-rata share to decommission the shared infrastructure was roughly \$525,000. Caltech will provide an inflation-adjusted sum equivalent to this 2020 estimate to UH prior to the termination of its sublease.

Figure 2-13 ALT-2 Post-Decommissioning Site Conditions



Source: M3 Engineering and Technology (2020)

Figure 2-14 Shared Infrastructure in the MKSR



Source: University of Hawai'i (2020)

2.1.5 RESTORATION EFFECTIVENESS MONITORING

Caltech will fund and ensure that restoration effectiveness monitoring is conducted for a period of three years post project completion.² The principle goal of the monitoring is to assess the recolonization of the restored habitat by native biota already established in the area, including arthropod species. A secondary goal of the monitoring is to evaluate the presence of invasive arthropod species in the area. The monitoring will be conducted as outlined in Appendix H.

2.2 PRELIMINARY SCHEDULE FOR THE PROPOSED ACTION

Caltech fully intends to complete all phases of the decommissioning process, including deconstruction and site restoration, as expeditiously as practical. The major project-related tasks, and their preliminary schedule for completion, are presented in Table 2.2 below.

² A monitoring period of three years is required per the *Decommissioning Plan for the Maunakea Observatories* (SRGII 2010).

Table 2.2 Preliminary Schedule for the Proposed Action

<i>Task</i>	<i>Estimated Start Date</i>	<i>Estimated Completion Date</i>
Pre-Assessment Scoping	11/8/2017	5/1/2018
Site Surveys	5/1/2018	7/31/2019
Site Decommissioning Planning	8/1/2019	12/2021
Environmental Assessment and Conservation District User Permit	11/15/2020	12/2021
Other Permitting, Construction Bidding, and Contractor Selection	Winter 2022	Spring 2022
Deconstruction and Removal	Summer 2022	Fall 2022
Site Restoration	Fall 2022	Winter 2022
Shared Infrastructure Funding	2022	2022
Surrender of CSO Sublease	n/a	Early 2023
Restoration Monitoring	2023	2025
Source: M3 Engineering and Technology (2020)		

2.3 PROJECT BUDGET

Caltech is responsible for the decommissioning of the CSO. Caltech will cover all decommissioning costs from their general funds; no federal funds would be involved in the decommissioning. The estimated total cost of the proposed action is summarized in Table 2.3.

Table 2.3 Estimated Project Budget

<i>Item</i>	<i>Cost</i>
Deconstruction and Restoration	
Material	n/a
Labor	\$1,134,420
Other Direct	\$622,750
Contractor Costs	\$924,310
Contingency	\$807,180
Shared Infrastructure	\$525,380
Restoration Monitoring	\$20,000
TOTAL	\$4,034,040
Source: M3 Engineering and Technology (2020)	

CHAPTER 3: PROJECT ALTERNATIVES

3.1 FRAMEWORK FOR CONSIDERATION OF ALTERNATIVES

Title 11, Chapter 200.1, HAR contains the HDOH environmental review rules. HAR §11-200.1-9 deals with applicant actions such as the CSO Decommissioning Project. It requires that, for actions not exempt, the applicant must consider the environmental factors and available alternatives and disclose those in an EA or Environmental Impact Statement (EIS). HAR §11-200.1-18 establishes the process for the preparation and content of an EA. Among the requirements listed, HAR §11-200.1-18(d)(7) requires the identification and analysis of impacts of alternatives considered during project planning.

In accordance with those requirements, Caltech has considered a number of alternatives before determining that the proposed action described in Chapter 2 is its preferred alternative, allowing it to meet its purpose and need as defined in Sections 1.2 and 1.3. As can be seen in those sections, Caltech's purpose is to comply with the DP, as well as the end-of-sublease conditions identified in the sublease between Caltech and UH for the CSO.

The *Sublease Agreement among the California Institute of Technology, the University of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, Sublease H09176* (CSO Sublease 1983) offers four options on termination or expiration of the sublease:

1. Sale to UH.
2. Surrender with concurrence of UH.
3. Sale to a third party acceptable to UH.
4. Remove the property and restore the site to even grade at the expense of Caltech.

Caltech is also committed to addressing applicable CMP management actions, specifically those detailed in the DP. The DP:

- Outlines two removal options: (i) complete (or total or full) removal, and (ii) infrastructure capping.
- Outlines three restoration levels: (i) minimal, (ii) moderate, and (iii) full (or total).
- States that, “For decision making purposes, the starting point for determining the scope and extent of removal shall be total removal,” and, “The starting point for determining the level to which a site is to be restored shall be total restoration to the pre-construction condition.”

The preferred alternative, detailed in Chapter 2, consists of complete removal and full restoration. Thus, it is consistent with, but goes beyond, option 4 in the sublease and is the same as the “starting point” for decision-making identified in the DP.

3.2 IDENTIFICATION OF FEASIBLE ALTERNATIVES

This section identifies a long list of potential alternatives based on the sublease conditions, the scenarios contained in the DP, as well as the specific examples of alternatives recommended for inclusion in EAs and EISs contained in HAR § 11-200.1-24.

Of the four end-of-sublease options outlined in the CSO Sublease, only the fourth, removal and restoration, is considered feasible because: (i) UH has indicated they are not interested in purchasing the property in its entirety from Caltech, (ii) no third party has indicated an interest in buying the property in its entirety from Caltech, and (iii) although UH has not explicitly stated it, Caltech assumes that UH would not approve the surrender of the property in its entirety.³

Per the DP (2010), Table 3.1 summarizes the options for removal and levels of site restoration that can be considered.

Table 3.1 Summary of Infrastructure Removal and Restoration Options

<i>Task</i>	<i>Level</i>	<i>Description</i>
Deconstruction and Removal	Infrastructure Capping	Infrastructure capping (also referred to as “partial removal”) involves removal of aboveground facilities, with or without utilities, and leaves all or part of the underground portion of the facility in place. Under this option, varying degrees of infrastructure removal and capping can be considered.
	Complete Removal	Complete infrastructure removal (also referred to as “total removal” or “full removal”) involves removal of the entire facility, including underground utilities, pilings, and foundation to the extent practicable under normal engineering deconstruction practices.
Site Restoration	Minimal	Minimal restoration is the removal of all man-made materials and grading of the site, leaving the area in safe condition.
	Moderate	Moderate restoration goes beyond minimal to include enhancing the physical habitat structure to benefit the native arthropod community.
	Full	Full restoration (also referred to as “total restoration”) would return the site to its original pre-construction topography, as well as restoring arthropod habitat.
Source: Office of Mauna Kea Management, Decommissioning Plan (2010)		

On behalf of Caltech, M3 Engineering and Technology (M3), which specializes in observatory engineering and architecture, has evaluated the feasibility of complete infrastructure removal and full restoration of the CSO Site. M3’s analysis indicated, with a high level of confidence, that complete removal of all infrastructure and full restoration of the site is feasible, and they have developed a plan to do so. As a result of this finding, the full range of removal and restoration alternatives may be considered technically feasible, from complete infrastructure removal and full restoration at one end of the spectrum (i.e., the “starting point” identified in the DP and the preferred alternative in Chapter 2) to infrastructure capping and minimal restoration at the other end. Table 3.2 presents a matrix of the potential alternatives for removal and restoration which are, in theory, possible.

³ Surrendering is akin to the No Action alternative (ALT-1), except that it requires UH’s approval.

Table 3.2 Matrix of Feasible Potential Alternatives

<i>Removal</i>	<i>Restoration</i>
No Action	No Action
Complete Removal	Full Restoration
Complete Removal	Moderate Restoration
Complete Removal	Minimal Restoration
Infrastructure Capping	Full Restoration
Infrastructure Capping	Moderate Restoration
Infrastructure Capping	Minimal Restoration
Source: Compiled by Planning Solutions, Inc. (2020)	

Section 3.3 details the reasonable alternatives that Caltech has determined merit full consideration and analysis in this EA. Section 3.4 discusses those alternatives that were considered during preliminary planning for the CSO Decommissioning Project but were ultimately rejected from further consideration.

3.3 ALTERNATIVES FOR DETAILED CONSIDERATION

From the full range of feasible alternatives shown in Table 3.2, Caltech further reduced this range of options to a reasonable set of alternatives for detailed consideration in this EA.

3.3.1 ALT-1: NO ACTION

Under the “No Action” Alternative (henceforth, “ALT-1”) nothing would change from the existing state of the site. No effort would be made to remove the improvements and infrastructure (the observatory, outbuilding, driveway, foundation, cesspool, utilities, etc.) and no effort would be made to restore any part of the site.

The No Action Alternative does not address the purpose and need for the CSO Decommissioning Project. It is considered here pursuant to the content recommendations contained in HRS Chapter 343 and to provide a baseline for comparison and contrast with the action alternatives.

3.3.2 ALT-2: COMPLETE FACILITY AND INFRASTRUCTURE REMOVAL WITH FULL RESTORATION

This alternative (henceforth, “ALT-2” or “preferred alternative”) represents Caltech’s preferred alternative and is the proposed action detailed in Chapter 2 and is only summarized here for completeness. ALT-2 is consistent with the purpose (see Section 1.2), the project need (Section 1.3), and Caltech’s intent as stated in the NOI. Under this alternative, Caltech would commit to the following:

- Complete removal of the CSO observatory, outbuilding, and all other above- and underground facilities, using the methods described in Section 2.1.2;
- Full restoration of the CSO Site to its pre-construction condition to the greatest extent practicable using the methods described in Section 2.1.2.16, including: removal of construction fill except where needed to fill cavities in the lava substrate caused by infrastructure removal; and, restoration of arthropod habitat;

- Restoration monitoring to characterize success or failure of physical, biological, and cultural restoration efforts; and
- Providing funds to UH to support the planned, future decommissioning of shared infrastructure.

Figure 2-2 illustrates the scope of work for ALT-2; Figure 2-13 illustrates the anticipated site conditions following implementation of ALT-2's removal and restoration activities.

3.3.3 ALT-3: COMPLETE FACILITY AND INFRASTRUCTURE REMOVAL WITH MODERATE RESTORATION

This alternative (henceforth, "ALT-3") addresses a potential circumstance under which Caltech embarks with the intent to implement ALT-2, but, due to unanticipated factors that only become evident after removal and restoration operations commence, determines that full restoration of the CSO Site is not possible. If such unanticipated factors or conditions are encountered, Caltech would coordinate with construction monitors (Section 2.1.2.1), CMS, and the Institute for Astronomy (IfA). Caltech, in consultation with CMS and IfA, would select the appropriate course of action.⁴

Under this alternative, Caltech would apply for a CDUP to implement ALT-2, receive such a permit before the start of work, and begin deconstruction and restoration with the intent of completing the work per ALT-2, including full restoration. ALT-3 does not start with an intent to conduct moderate restoration, but because full restoration across the entire CSO Site would not be achievable, the level of restoration would be considered moderate (see Table 3.1). Even though only moderate restoration would be achieved on a portion of the CSO Site, Caltech would perform full restoration over the maximum extent of the site achievable. For example, if 40 percent of the CSO Site cannot be fully restored for some currently unknown reason, Caltech would conduct moderate restoration on that 40 percent and full restoration over the remaining 60 percent.

Under ALT-3, Caltech would intend to implement ALT-2 but complete the following:

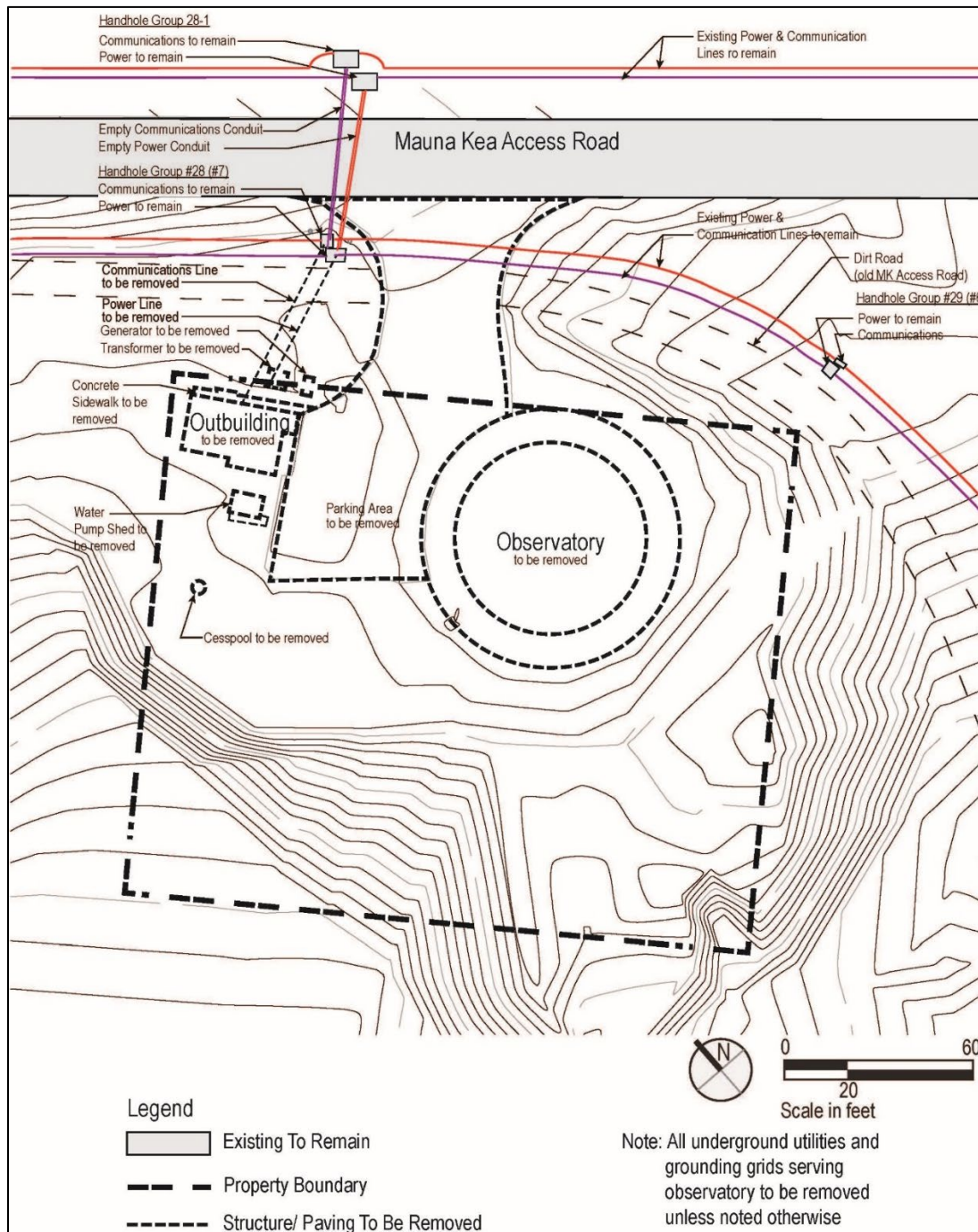
- Complete removal of the CSO observatory, outbuilding, and all other above- and underground facilities, using the methods described in Section 2.1.2;
- Full restoration of the portion of the CSO Site, if any, to the greatest extent practicable to its pre-construction topography using the methods described in Section 2.1.3;
- Moderate restoration of the remaining portion of the CSO Site that could not be fully restored, including (i) grading the area in a safe condition, but without matching the pre-construction topography, and (ii) restoring arthropod habitat to the greatest extent possible;
- Restoration monitoring to characterize success or failure of physical, biological, and cultural restoration efforts; and

⁴ The appropriate course of action will depend on the factor or condition encountered. Possible courses of action include, but are not limited to, (i) identifying a remedy that allows for complete removal and full restoration, (ii) implementing ALT-3, or (iii) implementing ALT-4.

- Providing funds to UH to support the planned, future decommissioning of shared infrastructure.

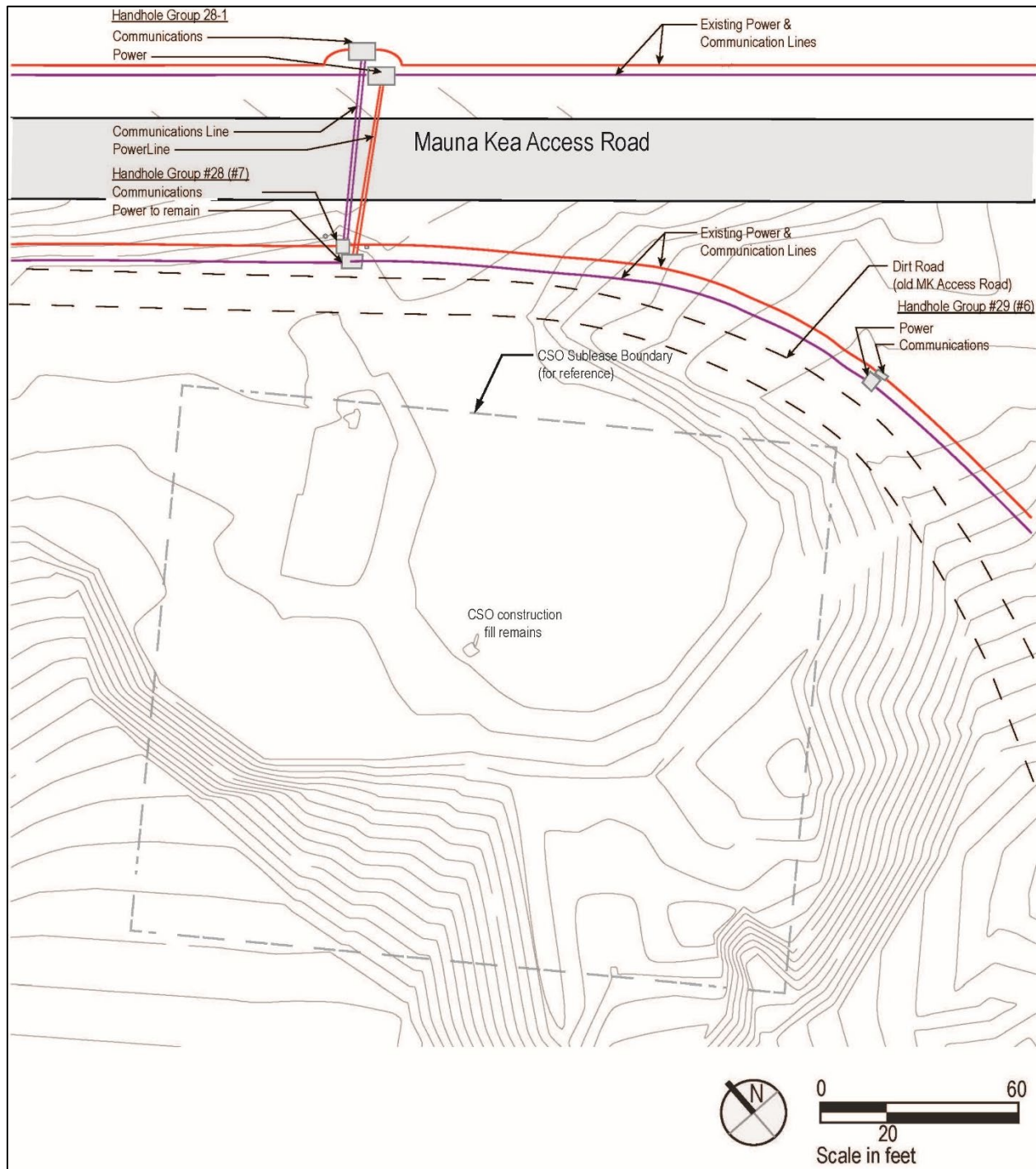
Figure 3-1 illustrates the scope of work for ALT-3, which is identical to the ALT-2 scope of work. Figure 3-2 illustrates one possible site condition following implementation of ALT-3's removal and restoration activities; it illustrates moderate restoration (i.e., no topographic restoration) across the entire CSO Site.

Figure 3-1 ALT-3 Scope of Work



Source: M3 Engineering and Technology (2020)

Figure 3-2 ALT-3 Post-Decommissioning Site Conditions Example



Source: M3 Engineering and Technology (2020)

3.3.4 ALT-4: FACILITY REMOVAL, INFRASTRUCTURE CAPPING, AND MODERATE RESTORATION

This alternative (henceforth, “ALT-4”) addresses a potential circumstance under which Caltech embarks on its intention to implement ALT-2, but due to unanticipated factors that only become

evident after removal and restoration operations commence, complete removal and full restoration of the CSO Site is not possible. Similar to ALT-3, if such unanticipated factors or conditions are encountered during deconstruction activities, Caltech would coordinate with construction monitors (Section 2.1.2.1), CMS, and the IfA. Caltech, in consultation with CMS and IfA, would select the appropriate course of action.⁵

Under ALT-4, Caltech would apply for a CDUP to implement ALT-2, receive such a permit before the start of work, and begin deconstruction with the intent of completing the work per ALT-2, including full restoration. ALT-4 does not start with an intent to conduct cap infrastructure and conduct moderate restoration, but because complete removal would not be achievable, the removal would be considered “infrastructure capping,” and because full restoration across the entire CSO Site would not be achievable, the restoration would be considered moderate (see Table 3.1). Even though some infrastructure would be capped and left in place, Caltech would remove infrastructure to the maximum extent practicable. Similarly, even though only moderate restoration would be achieved on a portion of the CSO Site, Caltech would perform full restoration over as much of the site as possible.

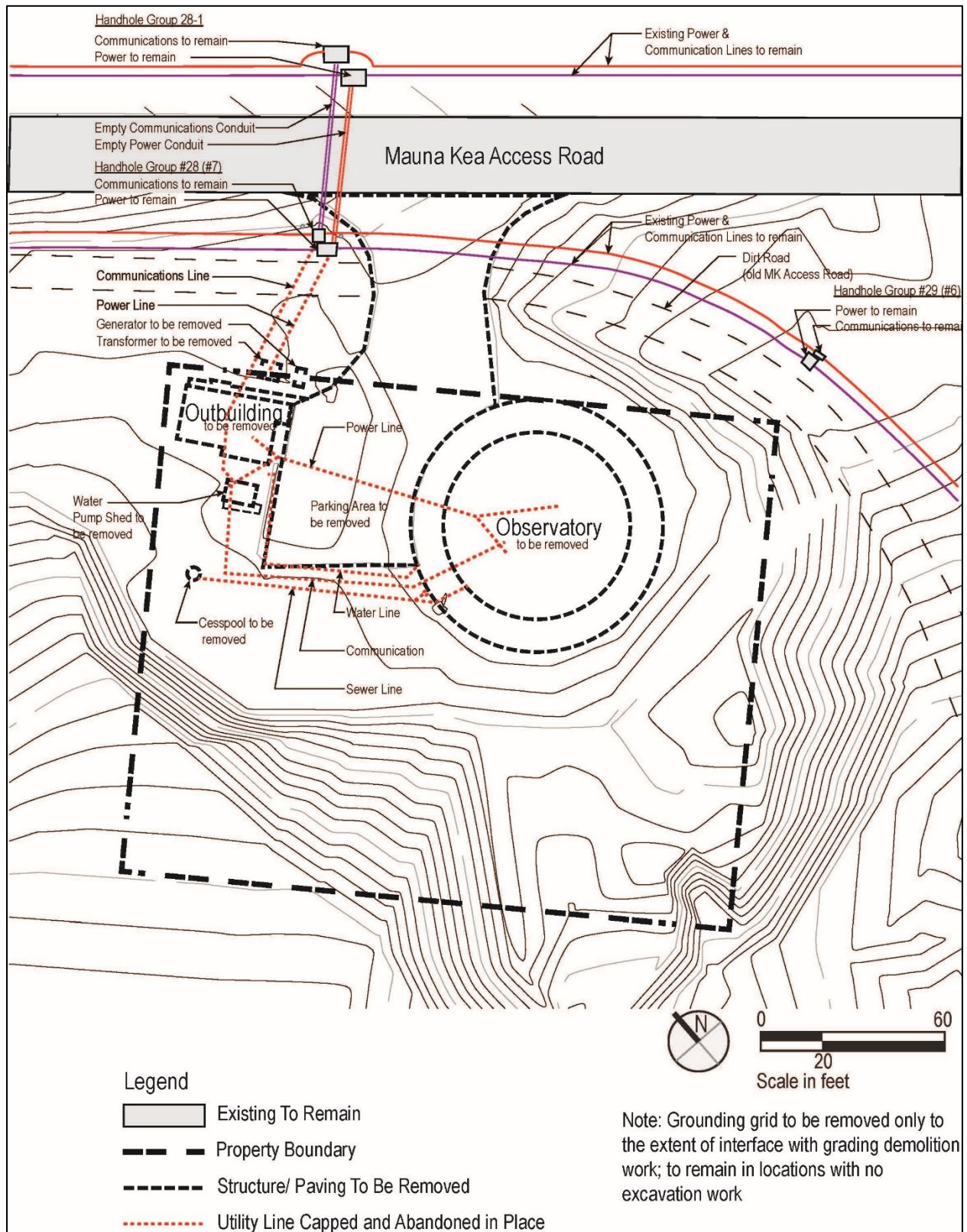
Under ALT-4, Caltech would intend to implement ALT-2 but complete the following:

- Complete removal of the CSO observatory, outbuilding, and all other aboveground facilities, using the methods described in Section 2.1.2;
- Removal of the CSO observatory and outbuilding foundations, cesspool, and other underground infrastructure to the maximum extent achievable, using the methods described in Section 2.1.2, but some portions would be capped and not removed;
- Full restoration of as much of the CSO Site as possible to its pre-construction condition to the greatest extent practicable, using the methods described in Section 2.1.3;
- Moderate restoration of the remaining portion of the CSO Site that could not be fully restored, including (i) grading and leaving the area in a safe condition, but without matching the pre-construction topography, and (ii) restoring arthropod habitat to the greatest extent practicable;
- Restoration monitoring to characterize success or failure of physical, biological, and cultural restoration efforts; and
- Providing funds to UH to support the planned, future decommissioning of shared infrastructure.

Figure 3-3 illustrates an example of the scope of work for ALT-4. Readers should note that it is only an example because it is not known which infrastructure components would not be removable due to unanticipated factors. Figure 3-4 illustrates one possible site condition following implementation of ALT-4’s removal and restoration activities; it illustrates some infrastructure capped and left in place and moderate restoration (i.e., no topographic restoration) across the entire CSO Site.

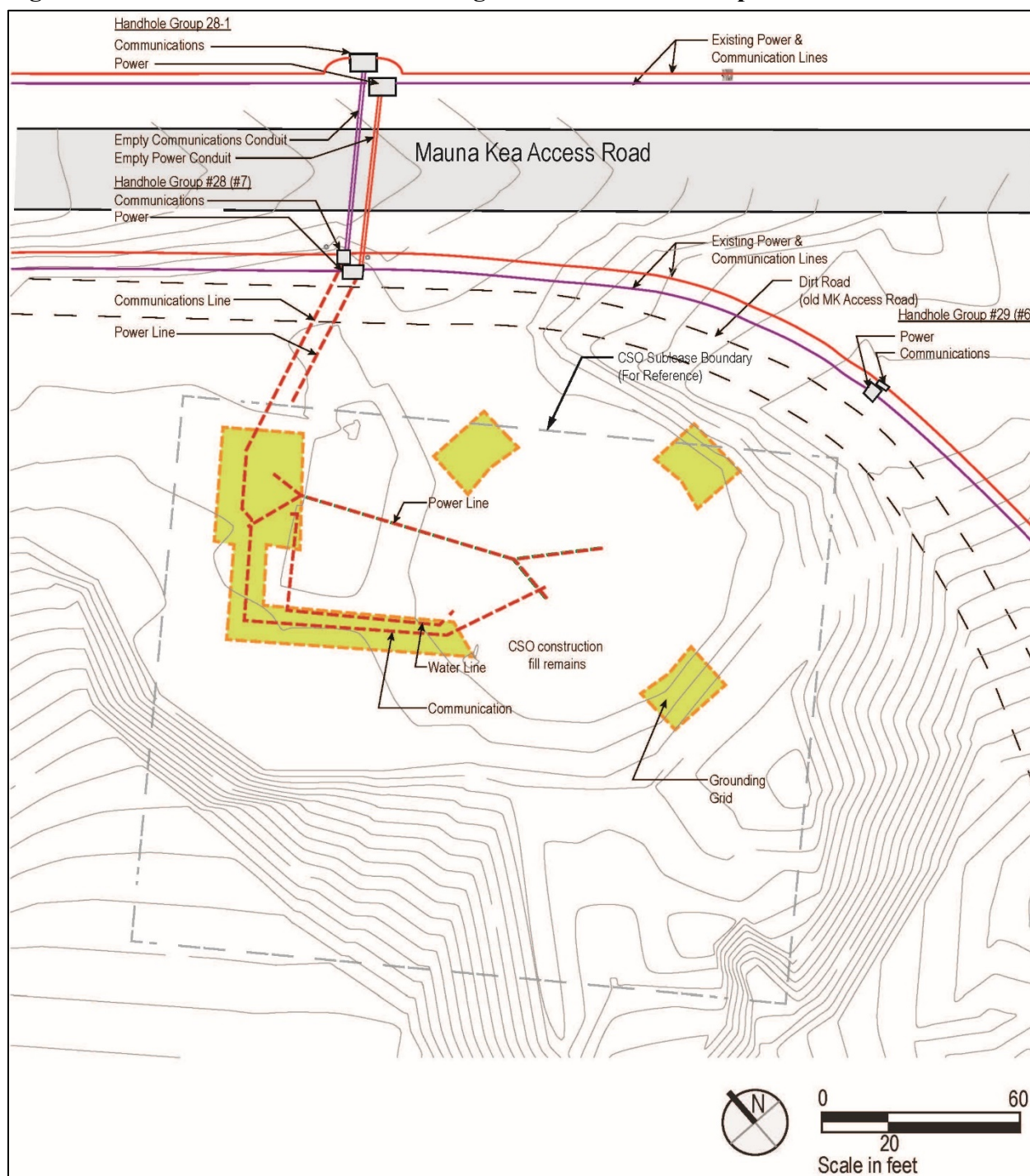
⁵ The appropriate course of action will depend on the factor or condition encountered. Possible courses of action include, but are not limited to, (i) identifying a remedy that allows for complete removal and full restoration, (ii) implementing ALT-3, or (iii) implementing ALT-4.

Figure 3-3 ALT-4 Scope of Work Example



Source: M3 Engineering and Technology (2020)

Figure 3-4 ALT-4 Post-Decommissioning Site Conditions Example



Source: M3 Engineering and Technology (2020)

3.4 ALTERNATIVES CONSIDERED BUT REJECTED

3.4.1 REDUCED SCALE ALTERNATIVE

Several alternatives were considered feasible (see Section 3.2) but ultimately were screened out and are not analyzed in detail in this EA. The reduced scale alternatives fall into this group and include alternatives that involved the retention and repurposing of the outbuilding on the CSO Site and/or reductions in the level of facility removal and site restoration. Briefly, they were:

- Starting with the intent to conduct complete facility and infrastructure removal with moderate restoration.
- Complete facility and infrastructure removal with minimal restoration (this alternative most closely parallels the CSO Sublease fourth option).
- Starting with the intent to conduct infrastructure capping with moderate restoration.
- Infrastructure capping with minimal restoration.
- Partial facility removal (outbuilding retention), infrastructure capping, and full restoration over about 80% of the CSO Site.
- Partial facility removal (outbuilding retention), infrastructure capping, and moderate restoration over about 80 percent of the Site.
- Partial facility removal (outbuilding retention), infrastructure capping, and minimal restoration over about 80 percent of the Site.

These alternatives were screened out because, although they address the purpose and need to varying degrees, they are not consistent with Caltech's intent, as clearly stated in the NOI that was reviewed and accepted by UH and DLNR. In addition, early consultation with stakeholders regarding the inclusion of these potential alternatives indicated limited support for or interest in them.

Specific to the three alternatives that envisioned retention of the outbuilding to support safety-related goals in the CMP (i.e., those that include "partial facility removal"), UH has indicated that they believe those CMP goals can be satisfied through other management actions. Contributing factors to the screening out of alternatives that included outbuilding retention included (i) the outbuilding never had and is inappropriate to retrofit with restroom or water facilities, and (ii) the outbuilding was designed to house specific equipment, not for human occupancy. Furthermore, technical assessments developed during the planning of the CSO Decommissioning Project indicate that the benefits of the proposed action would be notably curtailed if the outbuilding were retained.

In view of the foregoing, Caltech has concluded that a reduced scale alternative to the proposed action is not desirable and has eliminated the listed potential alternatives from further evaluation in this EA.

3.4.2 DELAYED ACTION ALTERNATIVE

HAR §11-200.1 recommends the consideration of a variety of alternatives, including those of a substantially different nature than the proposed action, to include alternative locations, scales, and

timing. Despite this, Caltech believes that a delayed action alternative may be dismissed out of hand because it would prolong adverse cultural, biological, physical, and financial impacts without any scientific benefit. This is particularly true because CSO suspended operations on September 8, 2015, and no entity has expressed a desire to restart scientific operations. Delay would in fact inflate the negative cultural impact by continuing to incur that impact without any countervailing benefit(s). Therefore, although Caltech could theoretically delay action until near the end of its sublease agreement, which is valid through 2033, they have determined that a delayed action alternative is not a viable option and eliminated it from further consideration in this EA.

3.4.3 ALTERNATIVE LOCATION

HAR §11-200.1 recommends the consideration of alternative locations. Such alternatives are not germane to the proposed project because the CSO is located at a single discrete location and the proposed decommissioning can only take place at that location.

Caltech has developed a partnership to move the telescope only (i.e., not the enclosure, outbuilding, or any other infrastructure) and has been actively engaged in identifying funding for this purpose. It is not certain funds will be obtained in time, and so the telescope may be removed and disposed of instead.. More importantly, while operating the CSO telescope at an alternative location would reduce the scale of Caltech's facilities on Maunakea, it would not address: (i) Caltech's responsibility to remove its remaining facilities and restore the site; or (ii) meet the terms laid out in its NOI. For these reasons, Caltech has determined that an alternative location is not a reasonable option and therefore eliminated it from further consideration in this EA.

CHAPTER 4: EXISTING ENVIRONMENT, POTENTIAL IMPACTS, AND MITIGATION

This chapter describes the potential environmental effects of the CSO decommissioning alternatives (ALT-1, ALT-2, ALT-3, and ALT-4), described in Chapter 2 and Chapter 3. This chapter is organized by resource category (e.g., water quality, air quality, noise, etc.). The discussion under each topic includes: (i) an overview of existing conditions on the project site; (ii) the potential environmental impacts that may occur as a result of implementation of one or more of the alternatives considered in this EA; and, where appropriate (iii) any mitigation measures that Caltech will take to avoid, minimize, or mitigate potential adverse effects. The scale of the discussion and analysis is commensurate with the potential for impacts. Where appropriate, the larger environmental context (e.g., Hāmākua District) is discussed, and in other cases the focus is narrower (e.g., the CSO Site). The discussion of impacts also distinguishes between short-term impacts (e.g., those occurring when equipment and personnel are actively implementing the deconstruction and restoration) and those that may result over the long-term as a result of the CSO Decommissioning Project. As the proposed project will not result in the development of any new facilities or long-term operations, most of the discussion focuses on short-term, “construction phase” impacts.

4.1 ARCHAEOLOGY

4.1.1 CONTEXT

At the request of Caltech, ASM Affiliates conducted an archaeological survey for the CSO Decommissioning Project on Maunakea. The resulting report, *An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea, TMK: (3) 4-4-015:009 (por.), Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i* (ASM 2018), provided the basis for the information and analysis in the following subsections and is provided in Appendix B. Although the CSO Site was included in a prior State Historic Preservation Division (SHPD)-accepted Archaeological Inventory Survey (AIS) (McCoy et al. 2010), the current Archaeological Assessment (AA) was conducted to account for the passage of time, to validate the findings of the prior AIS, and to identify any new find spots⁶ that might be present.

The current study includes:

- A “direct effects study area” where ground disturbance may be anticipated to occur during the decommissioning process. This includes the CSO Site, the Batch Plant, and adjacent roads and is outlined in yellow on Figure 4-1 and Figure 4-2. The entire direct effects study area has previously been disturbed by construction activities.
- A larger “visual effects study area” that includes the viewshed of the CSO facility and is shown as green shading Figure 4-2. It includes large areas of undisturbed land as well as roads and observatories.

⁶ ASM Affiliates Archaeological Assessment defines “find spots” as “anthropogenic features that are either obviously modern (e.g., camp sites with tin cans, pieces of glass and other modern material culture items), or features that cannot be classified with any level of confidence as historic sites because of their uncertain age and function (e.g., a pile of stones on a boulder) (McCoy 1999).” See Sec 4.1.2.1 for further discussion.

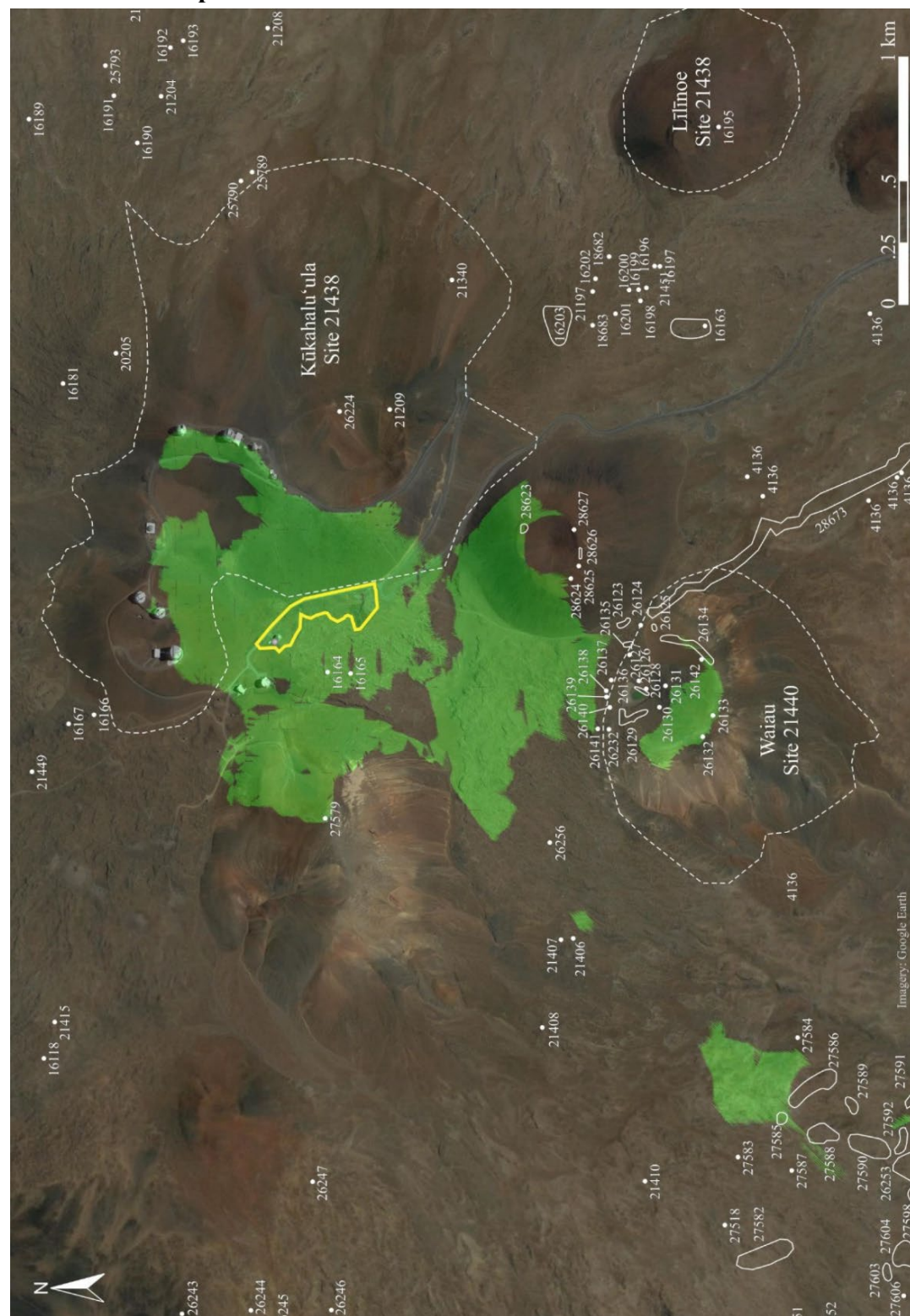
Figure 4-1 CSO Decommissioning Project Direct Effect Study Area



Note: Location of the CSO Decommissioning Project's direct effect study area is shown in yellow.

Source: ASM, *An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea, TMK: (3) 4-4-015:009 (por.), Ka'ohe Ahupua'a, Hāmākua District, Island of Hawai'i* (2018)

Figure 4-2 Direct Effects Study Area and Visual Effects Study Area with nearby Historic Properties



Note: Direct Effects Study Area outlined in yellow; Visual Effects Study Area shown in shaded green.

Source: ASM, *Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea*, TMK: (3) 4-4-015:009 (por.), Ka 'ohe Ahupua'a, Hāmākua District, Island of Hawai'i (2020)

4.1.2 PRIOR STUDIES

The direct effects study area was examined during three prior archaeological surveys (McCoy 1982a; McCoy and Nees 2010; McCoy et al. 2010) and by ASM Affiliates in 2018. The visual effects study area was surveyed in the same three studies, and also two other archaeological inventory surveys (McCoy and Nees 2009, 2013) and by ASM Affiliates in 2018. Results of these surveys and summaries of prior archaeological studies were presented in four AIS reports (Table 4.1).

Table 4.1 AIS Reports for the Maunakea Summit Region

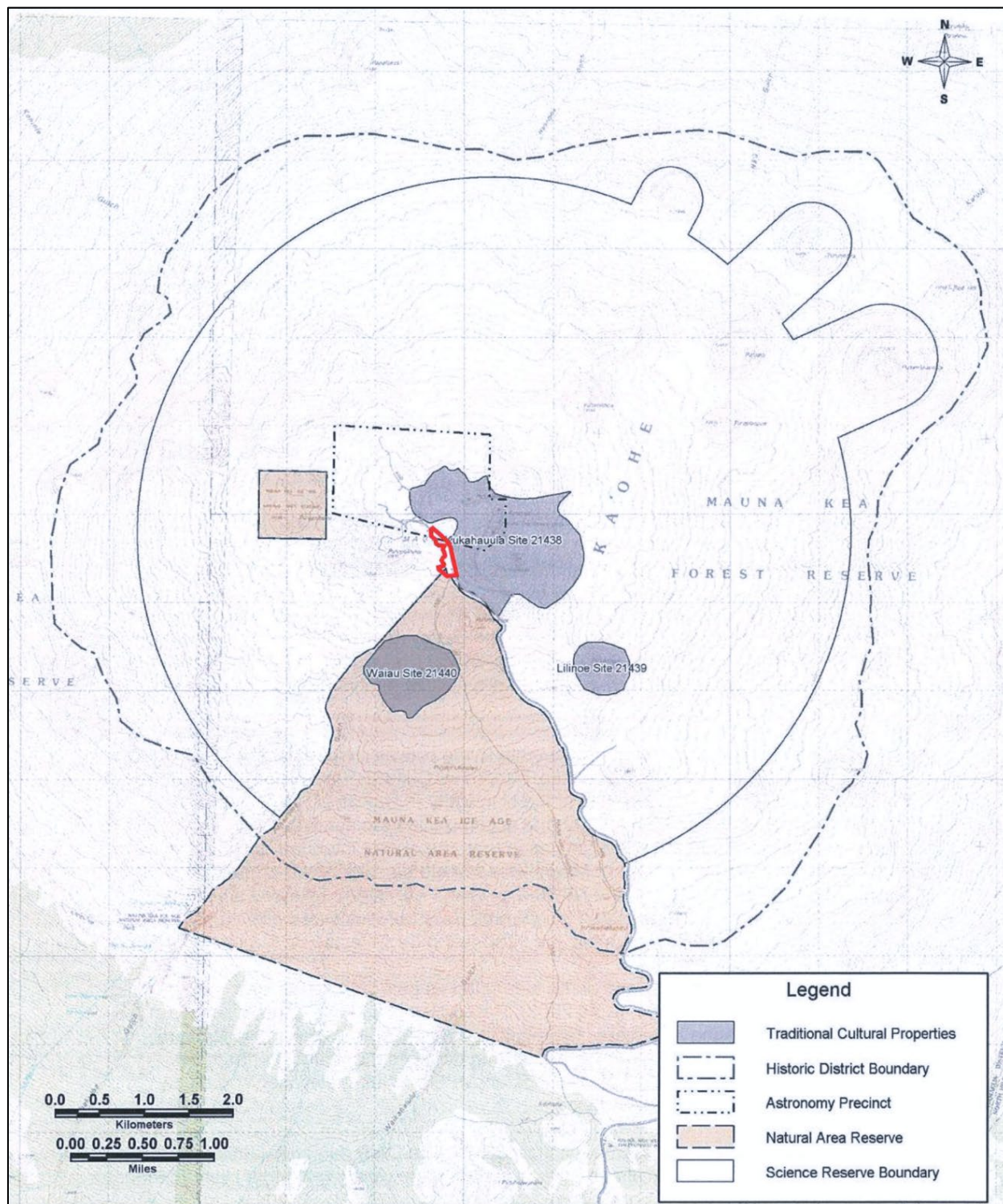
<i>Year</i>	<i>Author(s)</i>	<i>Scope</i>	<i>No. of Historic Properties</i>
2009	McCoy and Nees	Lake Waiau	41 sites, 1 TCP ¹
2010	McCoy et al.	Astronomy Precinct	6 sites, 1 TCP
2010	McCoy and Nees	Mauna Kea Science Reserve (MKSr)	263 sites, 2 TCP ²
2013	McCoy and Nees	Mauna Kea Ice Age Natural Area Reserve	109 sites, 1 TCP ³
Notes: 1. Traditional Cultural Property (TCP) 2. Includes McCoy et al. (2010) findings. 3. Includes McCoy and Nees (2009) findings.			
Source: ASM, <i>Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i</i> (2020)			

The CSO site was also subject to an archaeological survey by the B. P. Bishop Museum (McCoy 1982a) in support of the observatory's EIS.

4.1.2.1 Mauna Kea Summit Region Historic District

The Mauna Kea Summit Region Historic District (State Inventory of Historic Places (SIHP) Site No. 50-10-23-26869), which encompasses the extent of the glacial moraines and crest of the relatively pronounced change in slope that create the impression of a summit plateau (Figure 4-3), was designated by SHPD during the preparation of a draft Historic Preservation Plan for the MKSR. While the draft plan was never finalized, elements of the plan were incorporated into the *Mauna Kea Science Reserve Master Plan* (Group 70 International 2000). The district was initially proposed in the cultural impact assessment for the *Mauna Kea Science Reserve Master Plan* (PHRI 1999) and was later discussed in a SHPD review of the *Draft Environmental Assessment for the Keck Outrigger Telescope Project* and the *Final Environmental Impact Statement for the Keck Outrigger Telescope Project* (NASA 2005). The archaeological inventory surveys conducted (Table 4.1) indicated that the district is eligible for listing in the National Register of Historic Places (NHRP) under Criteria A, B, C, and D, and was also determined to be historically significant under Criteria a, b, c, d, and e of HAR §13-275-6 as a result of the McCoy et al. (2010) AIS.

Figure 4-3 Direct Effects Study Area Relative to the Mauna Kea Summit Region Historic District Boundary and the Extent of Traditional Cultural Properties



Note: Location of the CSO Decommissioning Project's direct effect study area is shown in red.

Source: ASM, *An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea*, TMK: (3) 4-4-015:009 (por.), Ka'ōhe Ahupua'a, Hāmākua District, Island of Hawai'i (2018)

The archaeological surveys conducted (Table 4.1) recorded 263 historic properties in the MKSR and 109 historic properties in the Mauna Kea Ice Age Natural Area Reserve (Figure 4-4). Most, but not all, of these historic properties are within the historic district's boundaries; all those within the boundary are considered to be contributing elements to the district. Combined, these sites include: (i) three SHPD-designated Traditional Cultural Properties (TCPs), (ii) 151 shrines, (iii) 139 sites comprising the Mauna Kea Adze Quarry Complex, (iv) five burial features and 56 possible burial features, (v) 23 stone markers or memorials, (vi) four Historic campsites, (vii) three temporary shelters, (viii) three trails, (ix) one Historic dump, (x) one Historic transportation route, (xi) one petroglyph, and (xii) three sites of unknown function.

The TCPs comprise three pu'u (Figure 4-4): (i) Site No. 21438 Kūkahau'ula; (ii) Site No. 21440 Pu'u Waiau; and (iii) Site No. 21439 Pu'ulilīnoe, that were determined to be eligible for inclusion in the National Register of Historic Places (NRHP) based on consultation begun by Langlas (1999) with knowledgeable kūpuna, or elders. The Kūkahau'ula TCP is adjacent to the direct effects study area and portions of the Kūkahau'ula and Pu'u Waiau TCPs are within the visual effects study area (Figure 4-2).

The Mauna Kea Adze Quarry Complex, located near Pōhakuloa Gulch on the southern slope of Maunakea, is partially in both the MKSR and the Mauna Kea Ice Age Natural Area Reserve; it is not within the direct effects study area or the visual effects study area. This complex contains 141 sites that include the quarry, workshop locations used for manufacturing and/or ritual activities, and one habitation rock-shelter located outside of the quarry proper.

In addition to archaeological sites and other historic properties, archaeological surveys conducted on the summit since 1997 have been recording "find spots" (called "locations" in early reports). During the MKSR AIS (McCoy and Nees 2010), 339 find spots were recorded, and approximately 313 find spots were recorded during the Mauna Kea Ice Age Natural Area Reserve AIS (McCoy and Nees 2013). The placement of objects and features classified as "find spots" by cultural practitioners and other visitors to the summit is understood to be ongoing, and management policies regarding construction of new Hawaiian cultural features and constructions considered to be "find spots" is governed by the CMP (2009).

4.1.2.2 Historic Properties in the Study Areas

The entirety of the studies areas (direct and visual) were surveyed during one or more of the previous archaeological surveys (Table 4.1). The entire direct effect study area is within the Mauna Kea Summit Region Historic District (Figure 4-3); however, no individual historic properties have been previously reported in the direct effects study area. The two closest historic archaeological sites are two shrines (Site Nos. 50-10-23-16164 and -16165) located 188 meters and 250 meters, respectively, to the south-southwest of CSO (Figure 4-2).

The entire visual effects study area (Figure 4-2) is also within the Mauna Kea Summit Region Historic District (Figure 4-3). Eleven previously identified historic properties lie within the visual effects study area (Table 4.2, Figure 4-2).

Figure 4-4 Direct Effects Study Area Relative to the Archaeological-Historic Properties and Traditional Cultural Properties in the MKSR and Mauna Kea Ice Age Natural Area Reserve



Table 4.2 Historic Sites within the Visual Effects Study Area

<i>Site No.</i>	<i>Type(s)</i>	<i>No. of Features</i>	<i>Type of Features</i>	<i>Location Relative to CSO</i>
16164	Shrine	2	5, possibly 6, uprights	188 meters (m) SSW
16165	Shrine	1	2 uprights	250 m SSW
21438	Kūkahau‘ula	1	Maunakea Summit as TCP	149 m E
21440	Pu‘u Waiau	1	Pu‘u as TCP	1,280 m S
26132	Possible Burial	2	Alignments	1,550 m SSE
26133	Cairn	1	Cairn	1,545 m SSE
26134	Possible Burials, Possible Shrine, Marker/Memorial	17	1 terrace, 1 mound/terrace, 4 pavements, 9 mounds, 2 rock piles	1,530 m S
26142	Workshop	1	Lithic scatter	1,510 m S
27579	USGS Marker	1	1 USGS marker	630 m W
27585	Workshop	1	4 adze manufacturing workshops, flakes, hammerstones, cores	2,530 m SW
28623	Possible Burial	4	4 mounds	930 m SE
Source: ASM, Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i (2020)				

4.1.3 FIELDWORK AND FINDINGS

The Principal Investigator for the AA (ASM 2018) was Benjamin Barna, Ph.D and the fieldwork was conducted by Theodore Bibby, Ph. D. and Benjamin Barna, Ph.D., on May 10, 2018. During the archaeological field survey, the entire ground surface of the direct effects study area was visually inspected by walking transects oriented parallel to the study area boundaries and spaced no more than 15 meters apart. No subsurface testing was conducted because the entire direct effects study area was previously disturbed by construction activities, covered in some places with recently dumped cinder fill, and known to overlie bedrock. No archaeological resources of any kind were identified within the direct effects study area. No find spots were observed within the current study area.

In addition to the pedestrian survey of the direct effects study area, an assessment of the potential visual impacts of the removal of the CSO dome and facilities was made by photographing the CSO facility site from the nearest historic property within the visual effects study area (Site No. -16164, a shrine located approximately 188 meters south-southwest of the CSO facility). Removal of the CSO facility was simulated by digitally erasing the telescope superstructure from the photographs taken from Site No. -16164 (see Figure 4-5).

Figure 4-5 View from Site No. -16164 and Simulated View Without CSO



View northeast of CSO, at center left, with Site No. 16164 in foreground.



Simulated view northeast from Site No. 16164 after full removal of CSO.

Source: ASM, *Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea*, TMK: (3) 4-4-015:009 (por.), Ka'ohe Ahupua'a, Hāmākua District, Island of Hawai'i (2020)

4.1.4 POTENTIAL IMPACTS

Given that no archaeological resources were identified within the direct effects study area, ASM and Caltech have concluded that CSO Decommissioning Project action alternatives (ALT-2, ALT-3, and ALT-4) will have no direct effect on any historic properties. With respect to indirect effects, the eleven previously-recorded significant historic properties (Table 4.2; Figure 4-2) within the viewshed of the CSO facility and the Mauna Kea Summit Region Historic District will experience overall beneficial effects from the removal of the CSO facilities. For those sites and the district, the removal of the aboveground facilities will partially restore the appearance of the summit as it was prior to the construction of the CSO. This will result in an enhancement of the integrity of setting, feeling, and association of the 11 sites as well as the historic district; Figure 4-5 provides a comparison of the view toward the CSO from Site No. -16164. Therefore, because this effect is not “harmful,” the determination of effect for the proposed project in accordance with HAR §13-284-14(a) and (b) is “no historic properties affected.”

The No Action Alternative (ALT-1) does not have the potential to cause any further impact to archaeological or historic properties. However, it would perpetuate the ongoing impact related to the visibility of the CSO within its viewshed as discussed above.

With respect to the historic preservation review process of the Department of Land and Natural Resources–State Historic Preservation Division (DLNR-SHPD), no further historic preservation assessments or surveys need to be conducted within the CSO facility project area prior to project implementation.

4.1.5 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will entail:

- All construction personnel being educated regarding the historic resources in the project area as required by CMP management action C-7.
- Archaeological monitoring per CMP management action C-6 and an Archaeological Monitoring Plan (AMP) prepared in accordance with HAR §13-279. A draft AMP is provided in Appendix J and will be approved by DLNR-SHPD prior to project implementation. Among other roles, the AMP will ensure protection of Site No. -21438 (Kūkahau‘ūla), which is on the opposite side of the Mauna Kea Access Road from the direct effects study area, and as a contingency for the discovery of unanticipated archaeological resources.

4.2 CULTURAL IMPACT ASSESSMENT

4.2.1 CONTEXT

As discussed in Section 1.1, the issuance of a CDUP by the BLNR for the CSO Decommissioning Project subjects this action to the requirements of the Hawai‘i Environmental Policy Act (HEPA), as codified in HRS, Chapter 343. Among those requirements is the preparation of a Cultural Impact Assessment (CIA), intended to inform this EA, and prepared pursuant to Act 50 and in accordance with the Office of Environmental Quality Control’s (OEQC) *Guidelines for Assessing*

Cultural Impacts, adopted by the Environmental Council of the State of Hawai‘i on November 19, 1997 (OEQC, 1997). Act 50, which was signed into law by the Governor on April 26, 2000, specifically acknowledges the State of Hawai‘i’s responsibility to protect native Hawaiian cultural practices. The OEQC guidelines identify several possible types of cultural practices and beliefs that are subject to assessment. These include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs. The guidelines also identify the types of potential cultural resources, associated with cultural practices and beliefs, that are subject to assessment. Essentially, these are natural features of the landscape and historic sites, including traditional cultural properties.

Act 50 further states that, “environmental assessments...should identify and address effects on Hawai‘i’s culture, and traditional and customary rights,” and that, “native Hawaiian culture plays a vital role in preserving and advancing the unique quality of life and the ‘aloha spirit’ in Hawai‘i.” Further, Articles IX and XII of the *Constitution of the State of Hawai‘i* impose on government agencies a duty to promote and protect the cultural beliefs, practices, and resources of Native Hawaiians and other ethnic groups.

Pursuant to this requirement, Caltech had ASM Affiliates (ASM) prepare a CIA assessing the potential cultural impacts of the proposed action and its alternatives (see Chapter 2 and Section 3.3). The resulting report, a *Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i* (ASM, 2020), provides the basis for the information and analysis summarized in the following subsections. The complete CIA is included as Appendix C.

4.2.2 CULTURAL OVERVIEW

An extensive body of literature describing the significance of Maunakea and the summit region has been developed over the past three decades (Kanahele and Kanahele 1997; Lang and Byrne 2013; Langlas 1999; Langlas et al. 1999; Maly 1998, 1999; Maly and Maly 2005, 2006; McCoy et al. 2009; McEldowney 1982; PHRI 1999; Simonson and Hammatt 2010). Through archival research and a compilation of native traditions, historical accounts, and oral-historical interviews, a detailed cultural history of Maunakea has been presented that documents a wide range of cultural knowledge and practice associated with the mountain, and more specifically with the summit region and its association with Hawaiian deities. These studies have also recognized Maunakea as a “cultural landscape” that continues to be sacred to contemporary cultural practitioners. The cultural landscape is not merely a sum of specific, identifiable resources; it represents the combined works of nature and cultural practitioners and the values attributed to the landscape by Native Hawaiians.

The numerous studies also indicate that Native Hawaiians performed what would today be considered industrial activities on the upper slopes of Maunakea. This is evident from the extensive Mauna Kea Adze Quarry Complex, known as Keanakāko‘i, within the NAR. Sites associated with the quarry also occur within the UH Management Area. Evidence indicates that the quarry was utilized for centuries and there were multiple routes or corridors connecting it to the entire island. Fine-grained basalt obtained within the quarry were used by craftspeople to make adze, octopus lure sinkers, and other items. Researchers have indicated that “[t]he basic difference between this indigenous use of the mountain’s sacred summit area for a lithic industry [adze

quarry], and the modern day use of the summit for the study of the stars by astronomers is the issues of appropriate protocol and respect” (PHRI 1999).

Linking the traditional with the contemporary are the numerous historically documented excursions to Maunakea undertaken by Hawaiian ali‘i during the nineteenth century. Citing various accounts (Desha 2000; Kamakau 2001; Korn 1958; NASA 2005, de Silva and de Silva 2006) note that several ali‘i ascended Maunakea for ceremonial purposes. Kamehameha I went to Lake Waiau to pray and leave an offering of ‘awa, and Ka‘ahumanu made the same journey in 1828 in an unsuccessful attempt to retrieve the iwi of her ancestress Līlinoe. Waiau was also visited by Kauikeaouli in 1830, Alexander Liholiho in 1849, and Peter Young Ka‘eo in 1854. In October, 1882, Queen Emma Kaleleonālani and her royal party ascended Maunakea, “to demonstrate her lineage and godly connections, and to perform a ceremonial cleansing in the most sacred of the waters of Kane in Lake Waiau,” (Maly and Maly 2005). Her journey to the summit was commemorated in several mele, or songs, and in the names of descendants of its participants, and also physically on the mountain in the form of a pillar of stones observed ten years later by members of a scientific expedition led by W.D. Alexander and E.D. Preston (Maly and Maly 2005). Kanahale and Kanahale (1997) also relate that, “Emma went to the top of Mauna Kea to bathe in the waters of Waiau. The ceremony was to cleanse in Lake Waiau at the piko of the island.”

The cultural-historical background information that has been generated for Maunakea as a result of the numerous detailed studies clearly demonstrates the sanctity of Maunakea and Maunakea’s summit region. The compiled oral-historical information provides further specific details about the cultural importance of the summit’s viewplanes, the traditional significance of individual pu‘u, and the importance of proper cultural protocol. It is also clear from the oral-historical information that current-day Hawaiian cultural practices on Maunakea are perceived by the practitioners of those activities to be an exercise in, and extension of, traditional and customary practices.

4.2.3 CONSULTATION

In an effort to solicit input from concerned Native Hawaiian practitioners and community members, a public notice was published in the August 2018 edition of Ka Wai Ola o OHA; no responses were received. In addition, consultation invitation letters, dated June 8, 2018, were mailed and emailed to 23 individuals and organization, all of whom filed as intervenors in the recent TMT contested case hearing. The full text of the consultation invitation letter is provided in Appendix C of this report. Table 4.3 identifies the parties to whom a consultation letter was provided. Four responses were received to the letter and only one individual, Harry “Hank” Fergerstrom, gave their consent to participate.

Table 4.3 Individuals and Organizations Sent Consultation Request Letters for CIA

<i>Name</i>	<i>Responded</i>	<i>Consented</i>
Joseph Kualii Lindsey Camara	No	n/a
B. Pualani Case	No	n/a
Clarence Kukauakahi Ching	No	n/a
Harry Fergerstrom	Yes	Yes
Flores-Case 'Ohana (E. Kalani Flores)	Yes	No
William Freitas	No	n/a
Cindy Freitas	No	n/a
KAHEA (Yuklin Aluli, Esq.)	Yes	No
Tiffnie Kakalia	No	n/a
Kalikolehua Kanaele	No	n/a
C. M. Kaho'okahi Kanuha	No	n/a
Brannon Kamahana Kealoha	No	n/a
Mehana Kihoi	No	n/a
Glen Kila	No	n/a
Maelani Lee	Yes	No
Paul K. Neves	No	n/a
Kealoha Pisciotta	No	n/a
PUEO (Lincoln Ashida)	No	n/a
J. Leina'ala Sleightholm	No	n/a
Stephanie-Malia Tabbada	No	n/a
The Temple of Lono (Lanny Alan Sinkin)	No	n/a
Dwight J. Vicente	No	n/a
Crystal F. West	No	n/a
Source: ASM, Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i (2020)		

Hank Fergerstrom initially responded via email, which motivated a follow-up telephone conversation in which he provided his mana'o concerning the CSO decommissioning process. First and foremost, Hank was emphatic that every element of the CSO facility, above and below ground level, should be removed for the project to be pono. He expressed concern about too much activity taking place within sacred space and suggested that only one project at a time should occur in the summit region, and that the extent of activity for that project should be kept to a minimum. Hank further recommended that cultural protocols be developed in consultation with practitioners to act as a guide for behavior and activity during the decommissioning process.

On July 5, 2019, Robert B. Rechtman, Ph.D. was contacted by Jimmy Medeiros, Sr., who had responded to an earlier invitation to consult on this project. Mr. Medeiros indicated that he was a recognized descendant for burial sites in Ka'ohē Ahupua'a, Hāmākua and that he has long been involved in such issues. When asked about his thoughts on the CSO Decommissioning Project, he was clear that all of the extant elements of the observation facility should be "completely gone." With respect to restoration of the land following removal, he stated that the, "place should be restored as much as can." Mr. Medeiros suggested that the demolition and restoration work should be subject to cultural monitoring, and he requested to be kept informed as he wanted to, "stay involved as the process moves forward." A second, in-person consultation was conducted with Mr. Medeiros on July 17, 2019, in which he reiterated that the entire aboveground expression of the observatory, and as much of the subsurface infrastructure as possible, should be removed. He

stated that the ground surface should be restored as much as possible to pre-observatory conditions. He expressed concern that all contaminated ground material that may be identified should be removed from the mountain. He again requested that he be included in the decommissioning process as it moves forward, offering his services as a cultural monitor.

The Office of Hawaiian Affairs (OHA) West Hawai‘i branch was contacted for consultation and the office coordinator, Shane Palacat-Nelsen, explained that, in his OHA capacity, he had no comment as OHA was engaged in a lawsuit with UH with respect to the management of Maunakea. He also indicated that he was a member of Kahu Kū Mauna Council and his comments on the project were, and continue to be, delivered through that committee. Mr. Palacat-Nelson referred ASM to contact Keola Lindsey at the main OHA office on O‘ahu for official comments. Mr. Lindsey was contacted and related that, if OHA was interested in consulting, they would get back to ASM. As of the time this EA was written, no response from OHA had been received.

On December 11, 2018, Robert B. Rechtman Ph.D. attended a meeting of Kahu Kū Mauna at which proposed decommissioning alternatives were presented. While all members agreed that total removal and restoration would be the best option, they did leave open the possibility for considering retaining the CSO outbuilding, to be repurposed to support OMKM (now CMS) emergency operations; currently there is no such dedicated facility available to the Ranger staff in the summit area, and reusing or repurposing an existing structure would be preferable to new construction.

Peter Young (of Ho‘okuleana, LLC) met with Pua Kanahele and Noe Noe Wong Wilson on February 7, 2020, to discuss the decommissioning of CSO. Pua Kanahele and Noe Noe Wong Wilson have been identified as among the leadership of the Ku Kia‘i Mauna on Maunakea; however, both noted that they were speaking of their own personal positions and not speaking on behalf of the Ku Kia‘i Mauna. In the meeting, potential project alternatives were discussed, and without hesitation and with firm conviction, both noted that any alternative that retains the outbuilding was not acceptable and that the only viable alternative from a cultural perspective is for the total removal of all man-made improvements and the full restoration of the site. Alika Desha, a Nā Ali‘i with the Royal Order of Kamehameha I, was present during the meeting, and while mostly silent, he was in agreement with their position.

In a follow-up meeting with Kahu Kū Mauna on February 12, 2020, Kahu Kū Mauna stressed the importance of acknowledging that, “there is a diversity of perspectives regarding the sacredness of Maunakea and some Native Hawaiians do not view Maunakea as sacred.” Native Hawaiians are not monolithic in their views and there are a multitude of opinions regarding the sanctity of Maunakea. However, for the purposes of the CIA for the CSO Decommissioning Project, it was the mana‘o from individuals and organizations who are familiar with traditional cultural resources and practices, and regard such as sacred or significant, that informed the identification and assessment process. In the hope of better assessing the diversity of viewpoints in the Hawaiian community, Kahu Kū Mauna requested that a “wider net” be cast to obtain additional consultation.

A second round of consultation letters were sent to the 14 Native Hawaiian organizations listed in Table 4.4 below on July 7, 2020.

Table 4.4 Organizations Sent Second Round Consultation Request Letters for CIA

<i>Name</i>	<i>Responded</i>	<i>Consented</i>
Kohala Hawaiian Civic Club	Yes	Yes
Waimea Hawaiian Civic Club	No	n/a
Hawaiian Civic Club of Laupāhoehoe	No	n/a
Nā Wahine O Kamehameha	No	n/a
Queen Lili‘uokalani Trust	No	n/a
Kailapa Community Association	No	n/a
Pi‘ihonua Hawaiian Homestead Community Association	Yes	No
La‘i‘ōpua 2020 Association	Yes	Yes
South Kohala Hawaiian Civic Club	No	n/a
Kona Hawaiian Civic Club	No	n/a
Hawaiian Civic Club of Ka‘ū	No	n/a
Royal Order of Kamehameha, Māmalahoa	No	n/a
Waimea Hawaiian Homesteaders’ Association	No	n/a
Keaukaha Community Association	No	n/a
Source: ASM, Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i (2020)		

Three responses were received from this second round of attempted consultation. On July 20, 2020, Ronald Kodani of the Pi‘ihonua Hawaiian Homestead Community Association called the ASM office and related that his organization had no cultural input to offer. Velda “Napua” Akamu, President of the Kohala Hawaiian Civic Club, responded in the affirmative to the request for consultation in an email dated July 13, 2020, and on July 17, 2020, participated in a telephone interview.

Mrs. Akamu was raised on Hawai‘i Island in the Kohala area, and as a youth in the 1960s would travel to Maunakea as part of school field trips, where they “would walk up the mountain.” It was during those visits that she developed her spiritual and cultural attachment to the Mauna that she now shares with her son as they visit Maunakea. She considers the mountain sacred space and it is her tradition to request assistance from kūpuna through chant and prayer when in that space. When presented with the various alternatives to the removal and restoration of the observatory she responded that the only viable option, from a cultural perspective, is complete removal and restoration of the landscape. When asked specifically about the removal activities, Napua indicated that care should be taken to not harm any other cultural assets and recommended that guidance be sought from within the group of “protectors” with respect to cultural protocols to be implemented during the decommissioning activities.

On September 5, 2020, Kawehi Inaba, President of La‘i‘ōpua 2020, responded by email expressing an interest in participating in the consultation process, and a telephone consultation ensued that same day. Similar to others who were consulted, Mrs. Inaba expressed that the only acceptable option from her cultural perspective would be the complete removal of the observatory facility and as much environmental restoration as would be feasible.

Those consulted and CIA research did not identify any specific ongoing traditional, customary, or contemporary cultural practices occurring within or associated with the CSO Site or direct effects study area, nor did it identify any resources used for traditional and customary cultural practices that are present on the CSO Site. No CIA participants or past studies suggest that the CSO Site or

direct effect study area is used to access locations where traditional and customary cultural practices are conducted or cultural resources are gathered.

4.2.4 POTENTIAL IMPACTS

It was a conclusion of the companion archaeological study (Section 4.1; Barna 2018; Appendix B) that the CSO Decommissioning Project action alternatives will have no direct effect on any historic property; and, with respect to indirect effects, the 11 historic properties within the viewshed of the CSO facility and the Mauna Kea Summit Region Historic District will experience overall beneficial effects from the removal of the CSO facilities. For these sites, the removal of the aboveground facilities will partially restore the appearance of the summit area as it was prior to the construction of the CSO, resulting in an enhancement of the integrity of setting, feeling, and association of the sites as well as of the historic district.

The CIA begins its analysis of impacts of site decommissioning as follows (Appendix C):

“...there is no disputing that the decommissioning of an observatory facility within the Astronomy Precinct on Mauna Kea would have a positive cultural impact. What is up for review and discussion in this analysis is the identification of those aspects of the decommissioning that could diminish or reverse the positive impact, and the measures that can be taken to avoid or mitigate any potential negative effects.”

The CIA analyzes the impact of CSO decommissioning associated with its goals and intents on the cultural landscape as follows:

“What has been expressed by several cultural practitioners in prior and current interviews is that the goal of decommissioning from their perspective would be to ultimately clear the summit of Mauna Kea of “Western” intrusions and return the landscape as best as possible to its pre-development condition. While this ideal is not necessarily achievable given the existing roadways and associated infrastructure, it is the assessment of the current study that any decommissioning proposal that leaves behind physical remnants of a facility, whether above or below the current ground surface, would result in a negative cultural impact with respect to the proposed action [with the proposed action being removal and restoration to the fullest extent possible].”

From this point of view, the presence of the current CSO facilities, including any invisible underground infrastructure, has a negative impact on the cultural landscape, and the greater the degree of removal and restoration, the proportionately greater the potential positive impact on that resource would be. However, while the above discussion suggests simply that greater levels of removal and restoration have greater benefit, the CIA (ASM Affiliates, 2020) follows immediately with a statement regarding targets and desires created by the DP (2010) and how the restoration outcome may or may not align with them:

“As stated in the Decommissioning Sub-Plan, “Ideally, the target for all sites is restoration to the site’s historical condition prior to construction of the facility.” (Sustainable Resources Group Int’l, Inc. 2010:23). If this is DLNR and the University’s position, adopted through approval of the CMP (and its sub-plans),

then as stated in the CMP, the “[d]esired outcome to the extent possible, [is to] reduce the area disturbed by physical structures ... by upgrading and reusing buildings and equipment at existing locations, removing obsolete facilities, and restoring impacted sites to pre-disturbed condition” (Ho‘akea 2009:7-53; emphasis [added]). Both the CMP and the Decommissioning Sub-Plan indicate that the decommissioning starting point is for the observatories to do their utmost to completely remove all structures and fully restore the site, and based on what was said during consultation, doing less than that could be perceived as improper and culturally offensive.”

Thus, a negative impact to the cultural landscape may arise if the removal option and restoration level employed at the CSO Site is less extensive than the DP’s “starting point” (e.g., complete removal and full restoration) when the greater extent was technically feasible. The CIA provides the following statements and recommendations related to decommissioning:

With the understanding that some negative impacts may result from decommissioning, these impacts would not completely erase the overall positive impact. However, a perception exists that anything short of an attempt at complete facility removal and full environmental restoration would result in a disingenuous decommissioning effort, as well as be an affront to cultural sensibilities. Therefore, it is recommended that the complete facility (above and below ground) be removed and the affected environment be restored to the fullest extent possible. Following this, and the other above-offered recommendations, will help to ensure that the proposed decommissioning will not result in impacts to any traditionally valued cultural or historical resources nor any traditional cultural practices or beliefs.

These two passages indicate, in the view of the authors of the CIA and based upon the sentiments expressed during the consultation process, that removal and restoration of the CSO Site to the greatest extent possible would result in a qualitatively better outcome for the cultural landscape than other options. By extension, these two quotes also suggest that anything less than an attempt at total removal and full site restoration could have a negative impact, compounding the ongoing adverse impact caused by the presence of the CSO.

Consequently, remaining committed to Caltech’s intent to completely remove the CSO infrastructure and fully restore the site (e.g., the preferred alternative and proposed action, Chapter 2) will maximize the beneficial effects, and prevent negative impacts, of decommissioning on the cultural landscape. This benefit is based on repeated statements, both in the DP (2010) and by Caltech, regarding total removal and full restoration being the starting point and the desired goal of the decommissioning process. ALT-2, ALT-3, and ALT-4 all reflect Caltech’s intent, but under ALT-3 and ALT-4 that intent would not be fully realized, despite being attempted, due to unanticipated factors beyond Caltech’s control. Thus, ALT-2 would provide the largest beneficial effect and ALT-3 and ALT-4 would provide a quantitatively lesser, but qualitatively comparable, benefit if complete removal and full restoration could not be achieved.

Based on the studies conducted, Caltech has concluded that there will be no direct effect on any cultural resources or practices as a result of the CSO Decommissioning Project and, provided its intent remains intact, that any resulting indirect effects will be entirely positive. Nevertheless,

Caltech will implement the mitigation measure suggested by those that participated in the CIA and discussed in Section 4.2.5.

Finally, to the extent that the No Action Alternative (ALT-1) would retain all the structures present on the CSO Site, it would at minimum perpetuate—and potentially exacerbate—the negative impact on the cultural landscape its presence causes.

4.2.5 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will entail:

- All construction personnel being educated regarding the historic resources in the project area as required by CMP management action C-7.
- Archaeological monitoring per CMP management action C-6 and an Archaeological Monitoring Plan (AMP) prepared in accordance with HAR §13-279. A draft AMP is provided in Appendix J and will be approval by DLNR-SHPD prior to project implementation.
- A Cultural Monitoring Plan will be developed and reviewed by the Kahu Kū Mauna Council and approved by the CMS Director prior to project implementation. Caltech will ensure that both an archaeological monitor and a cultural monitor are present during ground-altering activity.

4.3 BIOLOGY

4.3.1 CONTEXT

In order to characterize the existing biological resources, assess potential impacts of implementing the CSO Decommissioning Project, and identify any needed mitigation measures, Caltech retained the services of Sustainable Resources Group International, Inc. (SRGII) to prepare a Biological Setting Analysis (BSA). The report: (i) describes the existing environment with regard to biological resources, (ii) outlines the restoration scenarios that may occur as part of the decommissioning process, (iii) describes the potential effects on biological resources for the deconstruction and restoration scenarios, and (iv) recommends protocols and mitigation measures for the protection of biological resources. The *Biological Setting Analysis: Caltech Submillimeter Observatory Decommissioning* (SRGII 2019) is provided in Appendix D and provides the basis for the information and analysis provided in the following subsections.

4.3.2 EXISTING CONDITIONS

The CSO Site was disturbed by grading and construction of the CSO in the mid-1980s. Other construction in the area during the same period included erection of the James Clerk Maxwell Telescope (JCMT) and a branch of the Mauna Kea Summit Access Road. These activities resulted in fill being deposited on the natural lava flow ground surface and the sites being leveled.

The CSO Site is located in the alpine stone desert ecosystem, which occurs above roughly the 11,150-foot elevation on Maunakea. The alpine stone desert is characterized by low precipitation,

high rates of evaporation, high wind speeds, high solar radiation, regular freezing and thawing cycles, and a porous substrate. These characteristics limit the development of the plant and animal communities in this zone (Aldrich 2005). The CSO site is located on a lava flow composed mainly of basalt and covered with fill native to the summit of Maunakea.

4.3.2.1 Flora

The plant community in the alpine stone desert consists of species of lichens and mosses with sparsely distributed vascular plants.⁷ Lichens are the dominant species present. About half of the lichens recorded on Maunakea have not been identified to the species level and thus are of unknown origin. Twenty-three species of lichen and approximately twelve species of moss known to occur within the Maunakea alpine stone desert have been identified to the species level (Berryman and Smith 2011, Smith et al. 1982). All lichen and moss species identified on Maunakea to date are native to the Hawaiian Islands.

Vascular plants grow mainly at the base of larger rocks where soil and water accumulate and are protected from the wind (Char 1999). The most abundant vascular species in Maunakea's alpine stone desert are two grass species, Hawaiian bentgrass (*Agrostis sandwicensis*) and pili uka (*Trisetum glomeratum*), and two fern species, 'iwa'iwa (*Asplenium adiantum-nigrum*) and Douglas' bladderfern (*Cystopteris douglasii*). Of these four species, Hawaiian bentgrass is the most common in the alpine stone desert.

To determine the presence, abundance and composition of lichens, mosses, and vascular plants the survey involved walking transects and recording species presence within and just outside of the site (Appendix A, Medeiros 2019). The survey report details the sparse nature of lichens and vegetation and their locations. Eleven clumps of lichens were observed. Species observed included: (i) the lichen *Lecanora polytropa*; (ii) 'iwa'iwa; and (iii) pili uka. The most abundant vascular plant in and near the survey site was the endemic grass pili uka. Most pili uka clumps were growing on topographically disturbed areas and one individual was found growing in a pavement driveway crack (Figure 4-6). Several individual 'iwa'iwa ferns were found in the CSO site between the east-to-south boundary of the subleased area and the dirt road, and none were found within the subleased area (Figure 4-6). No other plant species were recorded.

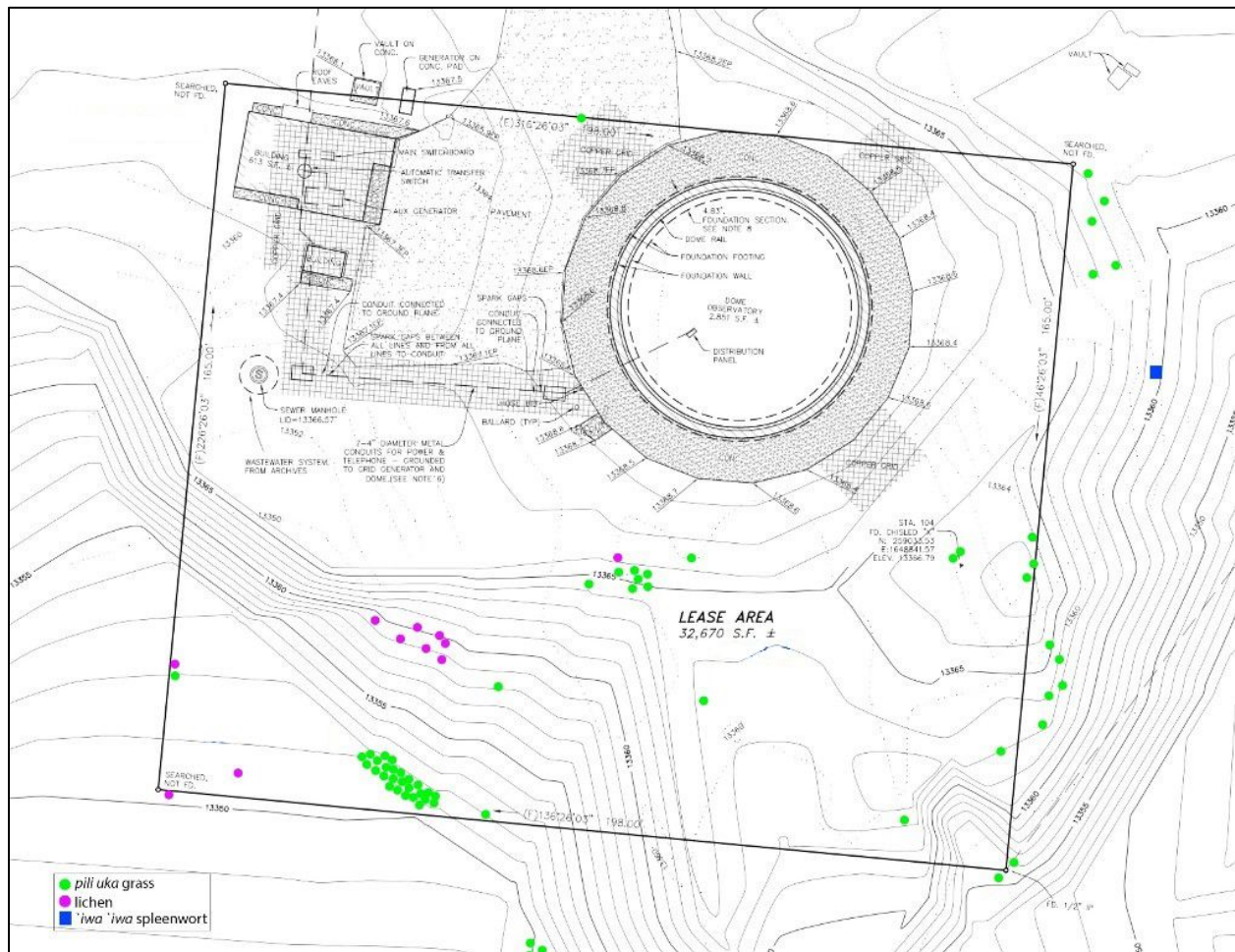
4.3.2.2 Fauna

4.3.2.2.1 Arthropods

Arthropods are the most common fauna present in the alpine stone desert ecosystem. Both native and non-native arthropods are known to inhabit the region. Surveys typically distinguish between resident arthropod species, which are cold-adapted species that occur and survive on the mountain at higher elevations, and non-resident arthropod species, which are those that are brought to the summit by the aeolian drift process (i.e. blown up by the wind) or are inadvertently transported through human activity. Non-resident species die in the cold weather and provide an important food source for resident species.

⁷ All discussion on the plant community in general includes lichens. Although lichens are not plants they are often grouped into the vegetative community by land managers for consideration of species presence and effects of management activities.

Figure 4-6 Flora Locations



Source: BSA (SRGII 2019).

While the diversity of resident native arthropod species present in the summit region is low, arthropod surveys and invasive species monitoring has indicated that the abundance of resident native arthropods is much higher than resident non-natives (SRGII 2009, Kirkpatrick and Klasner 2015, and OMKM unpublished data). Native resident species include the wēkiu bug (*Nysius weikiuicola*), a noctuid moth (*Agrotis kuamauna*), a hide beetle (*Dermestes maculatus*), the Hawaiian wolf spider (*Lycosa hawaiiensis*), a bark louse (*Palistreptus inconstans*), and a centipede (*Lithobius* sp.) (Medeiros et al. 2019, Howarth and Stone 1982). Some taxa recorded in the summit region have not been identified to species level, and because both native and non-native species from these families are known to occur in Hawai'i, the origin is unknown. These include two sheet-web spiders (*Erigone* spp.), an unidentified linyphiid sheet-web spider (Family *Linyphiidae*), two slender springtails (Family *Entomobryidae*), and two species of mites (Families *Anystidae* and *Eupodidae*) (Howarth and Stone 1982).

Invasive species monitoring is conducted by CMS (formerly OMKM) annually at various locations at the summit and quarterly at all observatories (facility monitoring) with the goal of detecting new invasive species threats. Invasive arthropod monitoring at observatories involves placing traps within and around the facilities and retrieving them approximately seven days later. Hand searches around the perimeter of each observatory are also conducted. Specimens are identified to the

lowest taxa necessary to determine if the arthropod represents a potential threat as an invasive not currently present in the summit region. CMS staff are responsible for identification. Identification may entail sending specimens to the Bishop Museum staff, Hawai‘i Ant Lab staff, or Department of Land and Natural Resources Division of Forestry and Wildlife (DLNR-DOFAW) entomologist for consultation. Most invasive species found in perimeter searches or traps outside of observatories are already dead and believed to be products of aeolian drift. If live specimens of invasive species are detected outside of the observatories, further monitoring is done to determine the extent of the population and the potential for eradication. Rapid response protocols and plausible control methods by taxa are detailed in the Maunakea Invasive Species Management Plan (ISMP) (Vanderwoude et al. 2015). Table 4.5 lists arthropods found in and around the CSO during a five year period (2013-2017) of invasive species monitoring. None of the species found warranted response actions.

Table 4.5 Arthropods Found near CSO during OMKM Invasive Species Facility Monitoring (2013-2017)

<i>Order</i>	<i>Family</i>	<i>Scientific Name</i>	<i>Common Name</i>	<i>Origin</i>
Acari	Unknown	Unknown	mites	Native & Non-native
Araneae	Unknown	Unknown	spiders	Native & Non-native
Coleoptera	Coccinellidae	<i>Harmonia conformis</i>	ladybird beetle	Non-native
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i>	ladybird beetle	Non-native
Coleoptera	Scarabaeidae	<i>Onthophagus nigriventris</i>	dung beetle	Non-native
Diptera	Various	Various	Flies	The majority of fly species are either non-native or of unknown origin.
Diptera	Calliphoridae	Unknown	blow flies	Non-native
Diptera	Sphaeroceridae	Unknown	dung flies	Native & Non-native
Diptera	Syrphidae	Unknown	hover flies	Non-native
Hemiptera	Aphididae	<i>Aphis</i> sp.	Aphids	Non-native
Hemiptera	Lygaeidae	<i>Nysius palor</i>	seed bug	Non-native
Hemiptera	Pentatomidae	<i>Bagrada hilaris</i>	shield bug	Non-native
Hemiptera	Psyllidae	Unknown	jumping plant louse	Native & Non-native
Hymenoptera	Braconidae	Unknown	braconid wasp	Native & Non-native
Lepidoptera	Pieridae	<i>Pieris rapae</i>	cabbage butterfly	Non-native
Psocoptera	Psocidae	Unknown	bark lice	Native & Non-native
Source: BSA (SRGII 2019)				

An assessment of the arthropod fauna present at the CSO Site was conducted prior to construction of the observatory as part of its EIS (Group 70 1982). Two species of springtails and four species of mites were found in the soil, and Hawaiian wolf spiders (*Lycosa hawaiiensis*) and an anystid mite were found under rocks at the CSO Site.

An arthropod survey conducted as part of the proposed decommissioning project involved sampling by trapping, hand searches, and specimen collection from ice on the north side of the CSO Observatory (see Table 4.6, Appendix D). The majority of species recorded, with the exception of three, were not native to the alpine stone desert on Maunakea. One native spider

species (*Lycosa hawaiiensis*) and one native moth species (*Agrotis kuamauna*) were recorded, along with one fly species from an unknown origin (*Bradysia* sp.). Arthropods from the Aphis genera were found in the traps but could not be identified to the species level. All Aphis species in Hawai‘i are non-native. Aphis species have been previously recorded in the alpine stone desert on Maunakea. One member of the survey team who samples arthropods regularly in the UH Management Areas reported previously noting native spiders and caterpillars at or near the CSO Site, although they were not common in this survey (Jesse Eiben, pers. comm. 2018).

Table 4.6 Arthropods Recorded Within the CSO Site, November/December 2018

<i>Order</i>	<i>Family</i>	<i>Scientific Name</i>	<i>Common Name</i>	<i>Origin</i>
Araneae	Lycosidae	<i>Lycosa hawaiiensis</i>	Hawaiian lycosid wolf spider	Endemic
Araneae	Trachelidae	<i>Meriola arcifera</i>	spider	Non-native
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i>	convergens ladybird beetle	Non-native
Coleoptera	Dytiscidae	<i>Rhantus gutticollis</i>	diving beetle	Non-native
Dermaptera	Forficulidae	<i>Forficula auricularia</i>	European earwig	Non-native
Diptera	Agromyzidae	<i>Phytomyza plantaginis</i>	leaf miner fly	Non-native
Diptera	Calliphoridae	<i>Eucalliphora latifrons</i>	blue bottle fly	Non-native
Diptera	Ephydriidae	<i>Hydrellia</i> sp.	ephydrid fly	Non-native
Diptera	Phoridae	<i>Diplonevra peregrina</i>	humpbacked fly	Non-native
Diptera	Sciaridae	<i>Bradysia</i> sp.	darkwinged fungus gnat	Unknown
Diptera	Syrphidae	<i>Allograpta exotica</i>	hover fly	Non-native
Hemiptera	Aphididae	<i>Aphis</i> sp.	Aphids	Non-native
Hemiptera	Psyllidae	<i>Acizzia uncatoides</i>	jumping plant louse	Non-native
Heteroptera	Lygaeidae	<i>Neacoryphus bicrucis</i>	whitecrossed seed bug	Non-native
Heteroptera	Lygaeidae	<i>Nysius palor</i>	seed bug	Non-native
Heteroptera	Miridae	<i>Coridromius variegatus</i>	plant bug	Non-native
Heteroptera	Nabidae	<i>Nabis capsiformis</i>	pale damsel bug	Non-native
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	braconid wasp	Non-native
Hymenoptera	Braconidae	<i>Biosteres</i> sp.(?)	braconid wasp	Non-native
Hymenoptera	Ichneumonidae	<i>Diadegma insulare</i>	Ichneumon wasp	Non-native
Hymenoptera	Ichneumonidae	<i>Pristomerus spinator</i>	Ichneumon wasp	Non-native
Lepidoptera	Noctuidae	<i>Agrotis kuamauna</i>	noctuid moth	Endemic
Orthoptera	Gryllidae	<i>Metioche vittaticollis</i>	cricket	Non-native
Thysanoptera	Thripidae	<i>Frankliniella</i> sp.	Thrip	Non-native
Source: BSA (SRGII 2019)				

Wēkiu bugs are normally not found on lava flows, such as the CSO Site, or in areas dominated by compacted ash/silt as the habitat is considered unsuitable (Stephenson et al. 2017, UH Hilo 2010, Englund et al. 2007, Porter and Englund 2006). While wēkiu bugs have not been found in the lava flow habitat around the CSO, they are found in the area called the Poi Bowl, which is to the east of the CSO on the other side of the Mauna Kea Access Road. The Poi Bowl is considered prime habitat for the wēkiu bug and will not be subject to disturbance during CSO deconstruction and restoration activities.

None of the arthropods identified during this study or known to occur in the alpine stone desert are listed as threatened or endangered species.

4.3.2.2.2 *Birds and Mammals*

Two endangered birds, ‘ua‘u (*Pterodroma sandwichensis* or Hawaiian petrel) and ‘akē‘akē (*Oceanodroma castro* or band-rumped storm petrel), may utilize the alpine shrubland ecosystem on Maunakea, which is well below the CSO Site in the elevation range from roughly 9,800 to 11,150 feet. There have been no recorded detections of birds or burrows in the vicinity of the CSO Site. Although there are records of pigs and sheep occurring in the alpine stone desert, feral ungulates are not common as there are very few plants to browse. CMS personnel report that mice are regularly encountered and are believed to actively reproduce in the summit region. The endangered ‘ōpe‘ape‘a (*Lasiurus cinereus semotus* or Hawaiian hoary bat) has not been detected in the vicinity of the CSO Site or summit region, but may occur at high elevations.

4.3.3 POTENTIAL IMPACTS

Under the No Action Alternative (ALT-1), there would be no negative or positive biological impact relative to status quo, and negative biological impacts relative to the pre-construction conditions (e.g., the presence of structures and hardscape displacing habitat) would endure. Resources would remain unimpacted by any decommissioning activities, and both native and non-native species would continue to occupy the project footprint. While Caltech retained its lease, they would maintain the facility, but thereafter the facility would begin to deteriorate. As the facility deteriorated over the years, the site would gradually re-naturalize and biological resources would continue to expand into the developed portions of the CSO Site as the pili uka grass in the pavement crack demonstrate. However, the no action alternative could never achieve the level of restoration and biological benefit that the action alternatives can.

Potential effects on biological resources would be similar for all the Action Alternatives and are described in the sections below.

4.3.3.1 ALT-2 Effects

Vegetation. Lichens, mosses, and vascular plants present within the CSO Site would be subject to disturbance and possible mortality during deconstruction. Adverse impacts include being crushed, buried, or covered in dust. Due to the sparse nature of lichens, mosses, and plants within the affected area and the presence of the same species on adjacent lands, the loss of some individuals during deconstruction does not represent a threat to the continued presence of these species on Maunakea. It is expected that lichens, mosses, and vascular plants would recolonize the site after it is restored, as has been the case in other disturbed areas in the summit area. Due to extreme environmental conditions, recolonization of the restored site will likely take longer than it would at a lower elevation. Overall, the reduction in hardscape, increase in natural habitat, and recolonization of that habitat by species already established in the area represents an environmental benefit.

Arthropods. As with vegetation, there would be some temporary impacts to native and endemic arthropods during deconstruction. Some mortality to arthropods would occur due to use of heavy equipment and moving of materials around the CSO Site and the Batch Plant. However, the level of arthropod mortality associated with deconstruction activity on 1.3 acres of the roughly 23,000-acre alpine stone desert ecosystem is unlikely to significantly affect the metapopulation of any single native arthropod species within the ecosystem. Arthropod surveys in areas around the

summit have recorded the presence of native arthropods in many previously disturbed areas, including around observatory structures, indicating a high likelihood of arthropods recolonizing the site after restoration. Removal of the CSO would have no effect on the process of aeolian drift, which operates on a scale of thousands of feet of elevation, and thus would not diminish the food supply for resident arthropods. No adverse effects on wēkiu bugs would be anticipated as a result of the deconstruction and restoration activities as lava flows are not wēkiu bug habitat, and restoration activities would not require fill material to be taken from current wēkiu bug habitat. Overall, the reduction in hardscape via deconstruction, increase in natural habitat via restoration, and recolonization of that habitat by species already established in the area represents an environmental benefit.

Invasive Species. The threat of importing new species of invasive plant, arthropods, or other types of species must be considered. There are several factors that minimize the likelihood of invasive species becoming established in connection with the proposed action. Although the proposed project involves bringing heavy machinery and other equipment up to the summit that could harbor invasive species if not properly cleaned, there would be no building materials or aggregate transported from lower elevations on which invasive species could “hitchhike” to the site. As discussed in Section 4.3.4, the project will comply with the CMP and implement invasive species prevention protocols (e.g., inspection and cleaning) that will reduce the likelihood of invasive species being introduced and control them if they are found. Significant adverse effects related to the establishment of invasive species are not anticipated due to mitigation measures and extreme environmental conditions. Finally, the extreme environmental conditions at the summit are not conducive for the establishment of most species not already present and, should a new species become established, the conditions would limit its movement and potentially its reproduction, providing opportunity for eradication.

Organic Compounds & Inorganic Chemicals. There is the potential for biological organisms to be exposed to organic compounds (i.e. solids from cesspool) and inorganic chemicals (i.e. metals from cutting the observatory structure during deconstruction). Project protocols will detail how to avoid these impacts including implementing BMPs to, for example, (i) contain any spills; (ii) properly store, maintain, and use materials and equipment; and (iii) properly store, recycle, and dispose of wastes. In the event that residue is inadvertently left on-site, it would be subject to decomposition, albeit very slowly due to the characteristics of the alpine ecosystem. Due to project protocols that will be followed, no significant adverse impacts to biological organisms due to exposure to organic and inorganic chemicals is anticipated

Native Birds & Mammals. Adverse effects on native birds or mammals are highly unlikely, as none are known to frequent the CSO Site or summit region.

4.3.3.2 ALT-3 Effects

Under ALT-3, full restoration would occur over as much of the CSO Site as possible, but some portion would undergo only moderate restoration due to currently unforeseen circumstances (Section 3.3.3). In this scenario, that portion of the site would be graded and left in a safe condition, but without matching the pre-construction topography. The only difference between ALT-2 effects (Section 4.3.3.1) and ALT-3 effects would be associated with the portion of the CSO Site not fully restored. Flora and fauna would recolonize both the fully and moderately restored areas, but the diversity and density of recolonization may differ between the two areas. Assuming the

fully restored areas are more advantageous to the native species, ALT-3 would result in a slightly less beneficial outcome than ALT-2, but it would remain a beneficial effect relative to no action.

4.3.3.3 ALT-4 Effects

Under ALT-4, where unforeseen circumstances encountered during deconstruction require it, some infrastructure capping would occur (Section 3.3.4). Leaving quantities of inert infrastructure in place would not have an impact on biological resources. In the event that it is unfeasible to remove some portion of cesspool solids or hydraulic fluid impacted soil, any residue present, and/or a portion of the cesspool structure, would be buried underneath native material used to restore the site. The only biological organisms likely to come in contact with the cesspool structure or residue are invertebrates. Given that every effort will be made to remove as much material as possible and that any remaining material would occupy a very small amount of invertebrate habitat, if any (depending on depth), they would not represent a significant adverse impact.

The overall ALT-4 project impacts would be similar to those outlined for ALT-3 in Section 4.3.3.2 because ALT-4 would also result in a portion of the CSO Site not being fully restored. In addition, the benefit may be slightly diminished relative to ALT-3 due to the residual subsurface materials that could not be removed.

4.3.4 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Consistent with CMP management actions C-5 and C-9 and as recommended in the Biological Setting Analysis (SRGII, 2019), a biologist/entomologist will implement an Invasive Species Monitoring Plan (ISMP) approved by the CMS Director and DLNR. A draft of the ISMP is included in Appendix I. The plan includes an invasive species prevention and control program and is consistent with and incorporates Standard Operating Procedures (SOPs) from OMKM's Invasive Species Management Plan (ISMP) (Vanderwoude et al. 2015).
- Implement a BMP Plan that complies with other CMP requirements and will avoid or minimize impacts to biological resources through protocols such as minimizing habitat disturbance, avoiding dust generation, and managing construction waste effectively. A draft BMP Plan is included in Appendix I.

4.4 VISUAL AND AESTHETIC RESOURCES

This section: (i) describes the existing visual conditions on the Island of Hawai'i and Maunakea summit region, (ii) discusses the visual impacts the CSO Decommissioning Project may have, and (iii) identifies how the deconstruction and removal of the CSO Observatory mitigates its potential visual impacts.

4.4.1 EXISTING CONDITIONS

The Island of Hawai‘i’s landscape and visual resources are varied. On the northern tip, the coast is rugged, covered in dense vegetation and dotted with waterfalls and rivers. Inland, around the town of Waimea, at an elevation of 4,000 feet, the landscape is comprised of rolling pastures used for cattle ranching. The western side of the island consists of popular resorts and beaches, but lacks dense vegetation along the coast. The southern and southeastern portions of the island experience high rainfall and are covered with lush vegetation; Volcanoes National Park is located in this area. The eastern portion of the island consists of steep terrain with dramatic views of the rainforest and cliffs along the coast.

The *Hawai‘i County General Plan* (GP; County of Hawai‘i, 2005) includes a chapter on natural beauty that recognizes the importance of preserving the island’s natural and scenic beauty. The chapter includes goals, policies and standards to identify and protect scenic vistas and viewplanes. One goal is to, “Protect scenic vistas and viewplanes from becoming obstructed.” The GP also provides guidelines for designating sites and vistas of extraordinary natural beauty to be protected, and includes the standard, “Distinctive and identifiable landforms distinguished as landmarks, e.g. Mauna Kea, Waipi‘o Valley.” Around the Island of Hawai‘i, the following views of Maunakea have been identified as sites of profound natural beauty:

- Views of Maunakea and Maunaloa from Pahoa-Kea‘au, Volcano-Kea‘au Roads, and various Puna subdivisions;
- Views of Hilo Bay with Maunakea in the background; and
- Mauna Kea State Recreation Area.

In addition, the *South Kohala Development Plan* (County of Hawai‘i, 2008) includes a policy to preserve Waimea’s sense of place. It includes a recommended strategy to, “protect the pu‘u of Waimea that have cultural, historical and visual importance,” and which have, “grand views of Mauna Kea.”

In contrast to the lush coastal areas of the Hāmākua District, the summit of Maunakea is an alpine desert ecosystem. The lands of Maunakea’s summit region are characterized by their isolation, high elevation, cool temperatures, and the relative lack of moisture. Above the tree line, at approximately 9,500 feet above sea level, vegetation is comprised of low shrubs, and above 11,150 feet in elevation the vegetation is generally limited to lichens, moss, low ferns, and small clumps of native grass (see Section 4.3.2). A small alpine lake, Lake Waiau, is situated on the upper southern flank of the mountain. Views of the summit of Maunakea from lower elevations (e.g., Honoka‘a, Hilo, and Waimea) are often obscured by clouds and/or vog, a volcanic smog formed when sulfur dioxide and other volcanic gasses emitted by Kīlauea mix with oxygen, moisture, and sunlight. The levels of vog can fluctuate over time. There was a particularly thick period from 2008 through 2018, when vog dramatically increased, in the decade prior to Kīlauea’s March 2018 eruption.

Currently, there are 13 astronomy facilities, with one additional astronomy facility permitted but not yet built; some of these facilities are visible from locations around the island including Honoka‘a, Hilo, and Waimea. During planning for the TMT Project, UH Hilo worked with their planning consultant, Parsons Brinckerhoff, Inc. to prepare a viewshed analysis of existing

observatories, accounting for their visual attributes including their elevation, dome height, and dome color (UH Hilo, 2010) and identifying the viewshed, expressed as a percentage of the Island's total area, from which each observatory is visible. The conclusion of that study was that the CSO facility is 13,362 feet above sea level, the dome is 63 feet high, metallic silver in color, and visible from just five percent of the island. The five percent is primarily in uninhabited areas on the upper slopes of Mauna Loa (Figure 4-7). This indicates that the CSO facility is not visible from any of the scenic vistas and viewplanes identified in the GP (County of Hawai'i, 2005).

More recently, as part of their analysis of potential impacts to historic properties as a result of the CSO Decommissioning Project, ASM conducted a visual effects review, based on the relationship of the observatory site to nearby archaeological features (see Section 4.1.2). As part of that study, they used Google Earth™ visual analysis software to identify areas within the MKSR from which the CSO is visible; the result of that analysis is shown in Figure 4-2. Per the findings of that analysis, ASM concluded that the CSO facility could be seen from 11 contributing elements (see Table 4.2) of the Mauna Kea Summit Region Historic District (Figure 4.4).

4.4.2 POTENTIAL IMPACTS

Pursuant to the significance criteria contained in HRS, Chapter 343, the CSO Decommissioning Project would result in significant impact(s) to visual and aesthetic resources if it substantially affects scenic vistas and viewplanes identified in the GP, Hawai'i State Plan, or other related studies. A substantial effect could occur if any aspect of the proposed action or its alternatives were to obstruct views of an identified scenic resource or create a new visual presence which is incongruous with an existing scenic vista or viewplane. However, because all of the action alternatives (ALT-2, ALT-3, and ALT-4) consist of varying levels of CSO deconstruction, removal, and site restoration, no such impact will occur. Thus, no significant impact to visual resources will occur.

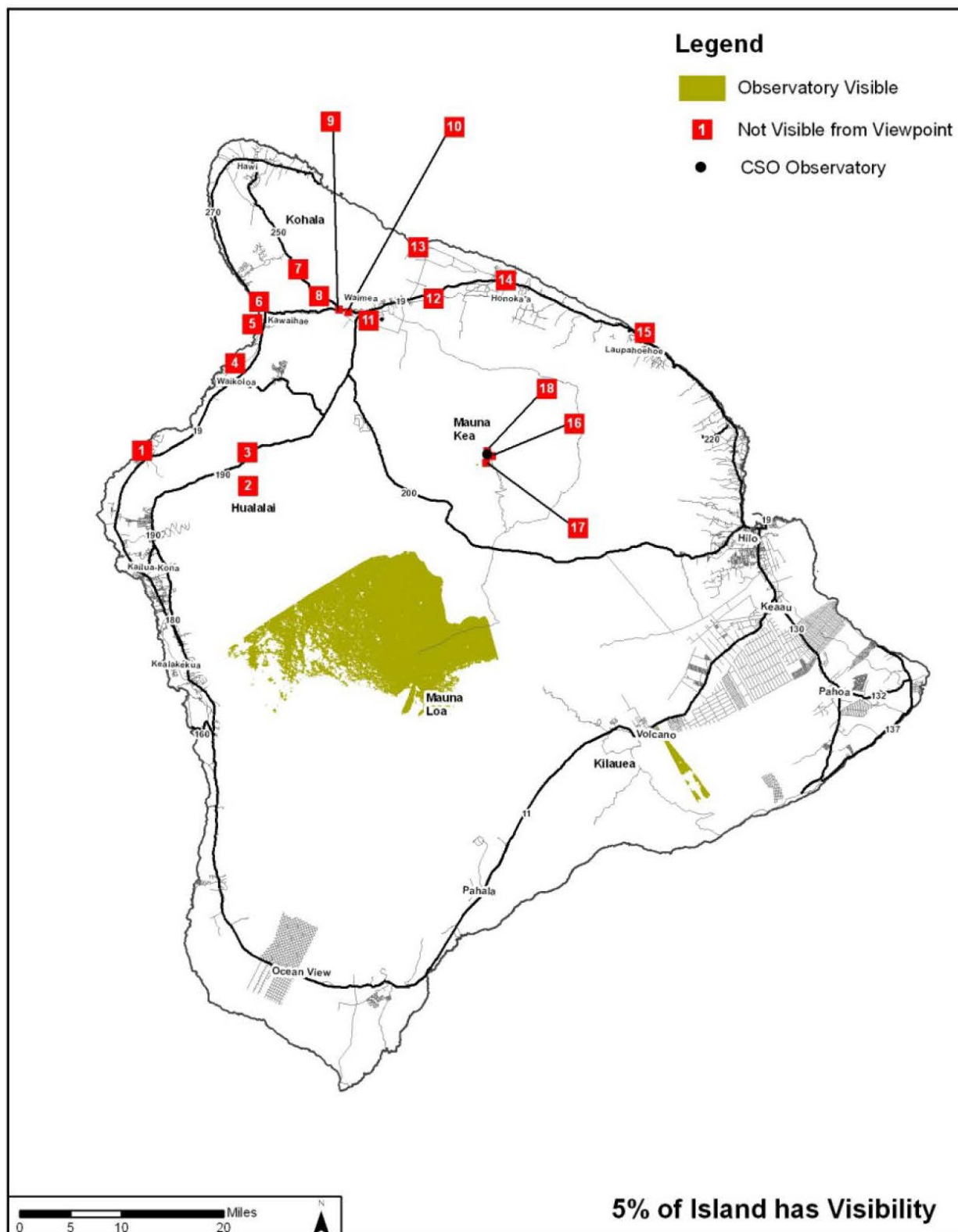
With respect to the visual effects within the CSO viewshed, including the 11 historic properties and the Mauna Kea Summit Region Historic District, these areas and resources will experience overall beneficial effects from the removal of the CSO facilities. For those areas, the removal of all aboveground facilities, as called for under all of the action alternatives evaluated in this EA, will partially restore the appearance of the summit as it was prior to the construction of the CSO. This will result in enhancement of the integrity of the setting, feeling, and associate of the historic sites and district.

The No Action Alternative would not produce any beneficial effects to visual and aesthetic resources as the CSO facilities would remain. Once Caltech's sublease lapsed, and they were no longer able to maintain the facility, it would fall into disrepair and its adverse visual impact within its viewshed would gradually increase.

4.4.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. However, no specific mitigation efforts are proposed as all of the action alternatives evaluated in this EA will result in a reduction in visually intrusive structures and equipment and have beneficial effect.

Figure 4-7 CSO Facility Viewshed



Source: TMT EIS (2010)

4.5 GEOLOGY AND TOPOGRAPHY

4.5.1 CONTEXT

In order to assess the potential impacts of implementation of the action alternatives assessed in this EA, Caltech has assembled information regarding the pre-construction topography of the CSO Site based on documents and other evidence that were accumulated at the time the observatory was constructed. It also conducted later analysis of post-construction conditions, including an analysis by Intera, Inc. of the fill material placed on the site at the time of construction. The resulting report, *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (Intera, Inc. 2019) forms the basis for some of the information and analysis in the following subsections and is included as Appendix E. The following subsections present these findings, followed by discussion of potential impacts and mitigation measures.

4.5.1.1 Pre-Construction Geological Analysis (1982)

Prior to construction of the CSO in 1982, Dames & Moore was retained to conduct a biological study of the proposed telescope site and its environs; their report was appended to the Final EIS for the CSO (Dames & Moore 1983) as Appendix B. While the focus of their report was biology, their analysis and findings noted in part that:

“The rocks of Mauna Kea have evolved through the typical phases of Hawaiian volcanism to a relatively mature stage. The most recently erupted rocks possess higher alkali and silica contents than the basalts which comprise the main mass of the volcano. This so-called alkalic cap phase of volcanism typically marks the waning of eruptive activity.

Mauna Kea has been dormant for at least 3,600 years although occasional weak seismicity and the general evolutionary characteristics do not preclude future eruptions. The subaerial portion of Mauna Kea has been dated at least 315,000 ± 50,000 years (Porter et al, 1977). Buried parts of the mountain are no doubt older. At least four periods of glaciation have accompanied eruptive activity at Mauna Kea, the last occurring about 20,000 years ago. Eight periods of eruptive activity have been identified. Post glacial eruptive activity has apparently been confined to the south rift of the mountain below elevation 10,000 feet.

Thus, the deposits in the site area (Elevation 13,300 ft) erupted prior to, or during the last glacial episode. Some lavas have erupted through or adjacent to the glaciers and display features characteristic of subglacial eruptions.

The principal rock type of the summit area of Mauna Kea is hawaiiite which commonly forms clinkery aa lava flows or cinder cones up to 600 feet high with ejecta fragments up to 10 feet in size. These hawaiiites range from non-vesicular and dense to extremely vesicular and less dense.

The surfaces of lava flows are frequently striated (which signify overriding glacier movement) and inter stratified with glacial debris (characterized by loose rock fragments), which in turn are interlayered with cinder, ash and other volcanic pyroclastic materials.

Based on available photographs and interviews with University of Hawaii researchers, the proposed site is interpreted to be an aa lava flow which vented in the vicinity of the site (probably from one of the summit cones) and flowed primarily northwest with one lobe extending to the south. From the existing topography, the southern lobe of this flow appears to have moved about 2,000 feet downhill from the site --approximately 80% of the distance to Lake Waiau.

However, the flow surface has been subject to subsequent glaciation and the original flow paths of the lava are obscured. This aa flow overlies a slightly older flow (possibly part of the same eruption period) which also moved to the south and southwest -- surrounding Lake Waiau and filling the area between Puu Waiau, Puu Poliahu and Puu Hau Kea and partially covered the north and west rim of Puu Waiau."

With respect to the then-anticipated site work required to build the CSO, Dames & Moore noted the following in their report:

"The proposed earthwork for the site is minimal — limited to minor levelling, removal of lava fragments, and footing excavations up to 4 feet deep at the telescope site. Estimated total excavation is only about 100 cubic yards. The excavated lava rock will be utilized mostly for footing backfills."

In addition to this information, several pre-construction surveys have helped Caltech identify the original topography of the site prior to CSO-related earthwork. Figure 2-11 presents a detailed site survey prepared by Austin Tsutsumi & Associates, Inc. dated January 21, 1983.

4.5.1.2 Fill Material Methodology, Analysis, and Results

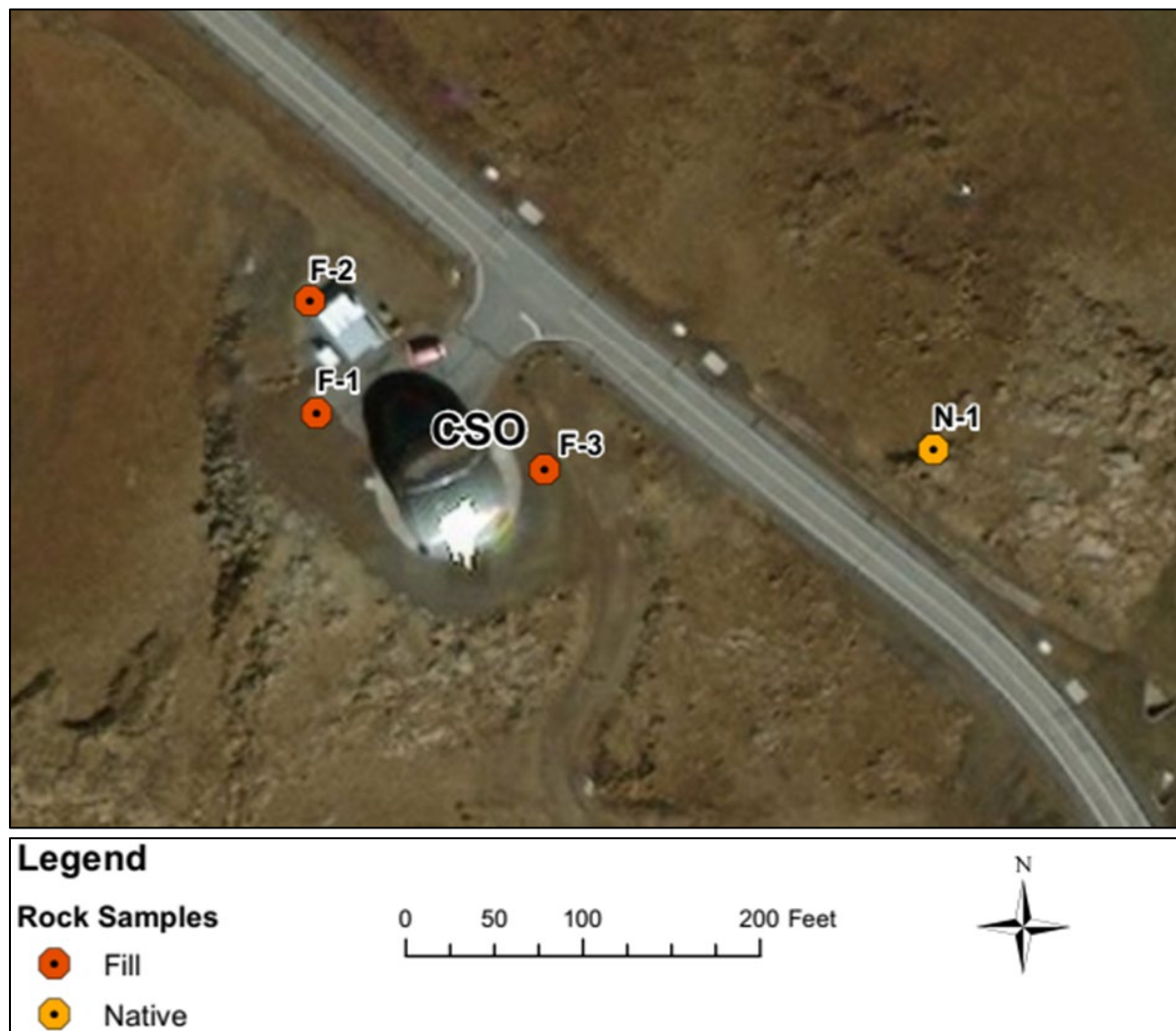
The origin of the fill material used on the CSO Site was not documented at the time of construction. In order to better understand the source of the fill material present on the CSO Site, Caltech retained a geotechnical engineering firm, Intera, Inc. to obtain and analyze fill samples and assess whether the fill was native to Maunakea or from some other source. Intera, Inc. obtained four samples for geochemical analysis; three samples were from the CSO Site itself and the fourth sample was from a lava flow immediately adjacent to the CSO Site, intended to provide additional compositional data on the Laupāhoehoe Volcanics. The locations where the four samples were taken is shown in Figure 4-8.

The general lithology of the fill material was determined with observations from six randomly located holes dug to various depths, ranging from 0.8 to 1.5 feet below the top of the fill surface. Fill-clast lithology was described using terminology consistent with Compton (1985) and Wentworth and MacDonald (1953). The location of the lithological test holes is shown in Figure 4-9.

The four samples were shipped to the Washington State University (WSU) GeoAnalytical Lab in Pullman, Washington. XRF analysis was conducted to get percent composition (by weight) for 29

elements.⁸ The results of Intera, Inc.’s investigation, which compared the elemental compositions of the three fill samples to that of the lava flow adjacent to the CSO Site, found that the fill samples were consistent with the Laupāhoehoe Volcanics. As shown in Figure 4-8, the “F” samples are from the CSO Site fill and the “N” sample is from the adjacent lava flow. The results show that N1, F1, and F2 are very similar and are probably from the same flow. F3 was also drawn from Laupāhoehoe Volcanics but is likely from a cinder cone. To illustrate the samples’ relationship to the area’s geology, Figure 4-10 superimposes the sample locations on a diagram from Wolfe et al. (1997) that compositionally classifies the lavas of Maunakea.

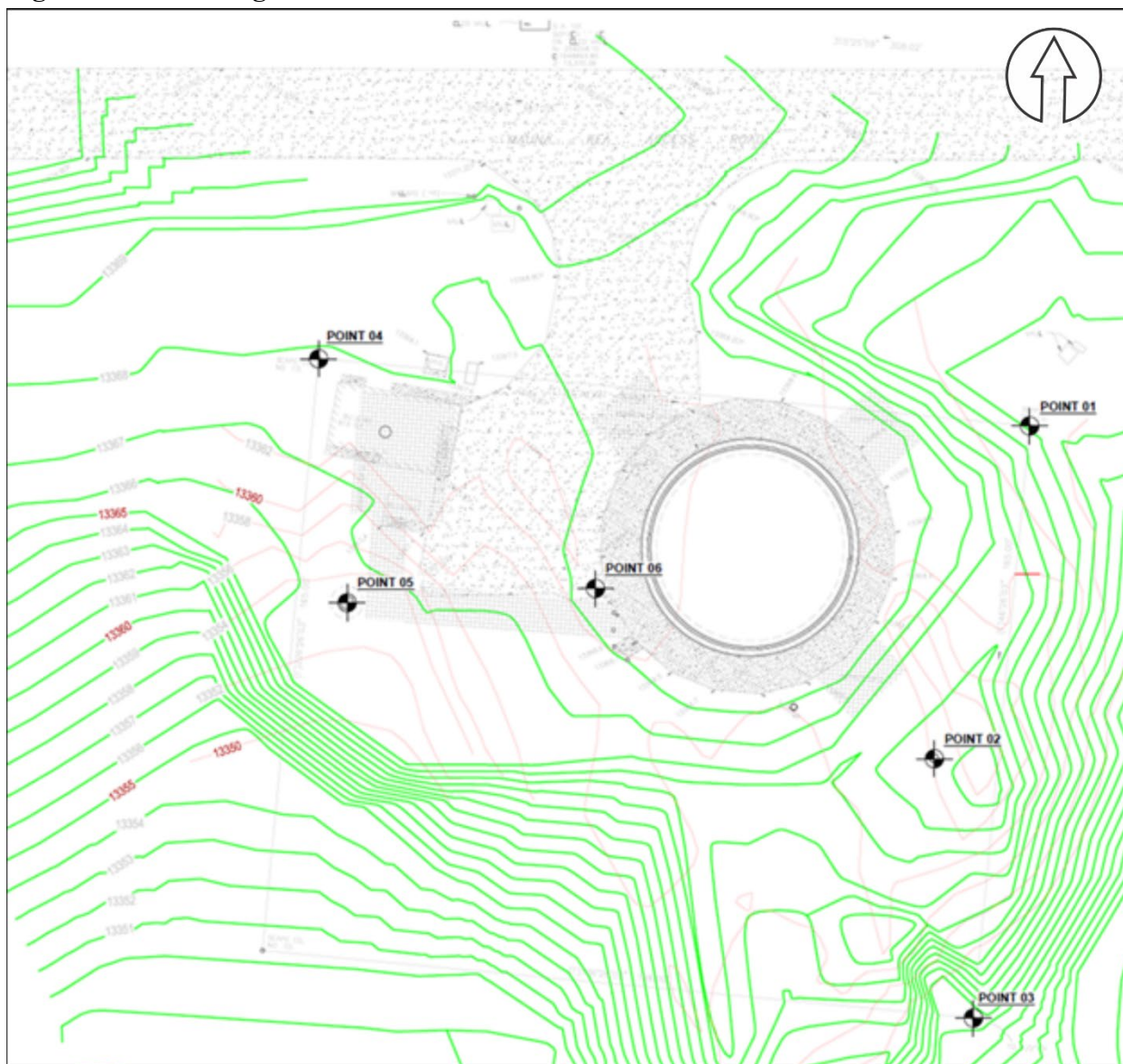
Figure 4-8 Fill Material Analysis Sample Locations



Source: Intera, Inc. (2019)

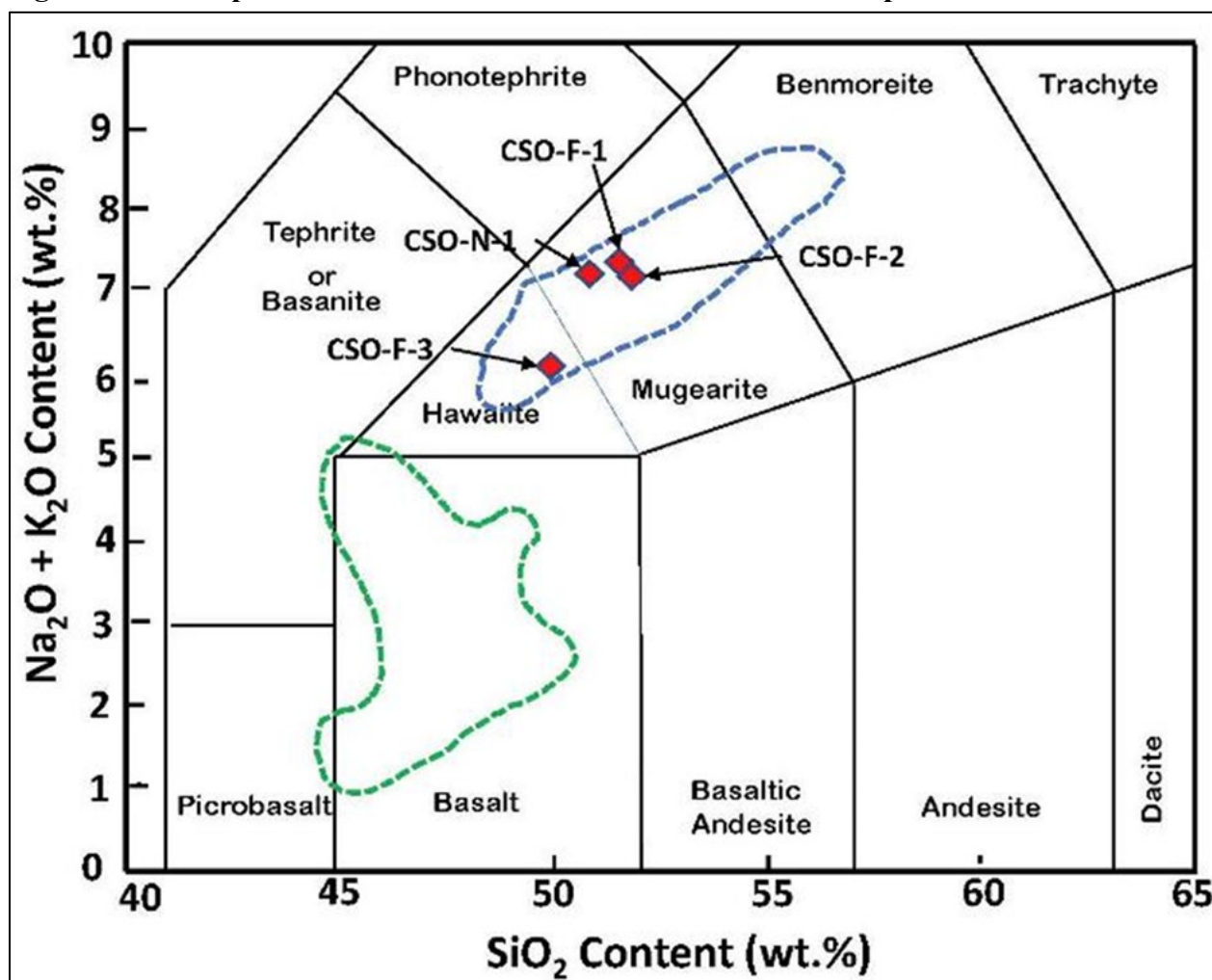
⁸ The elements were: silicon, aluminum, titanium, iron, manganese, calcium, magnesium, potassium, sodium, phosphorus, scandium, vanadium, nickel, chromium, barium, strontium, zirconium, yttrium, rubidium, niobium, gallium, copper, zinc, lead, lanthanum, cesium, thorium, neodymium and uranium.

Figure 4-9 Lithological Test Hole Locations



Source: Intera, Inc. (2019)

Figure 4-10 Sample Locations and Classified Lavas on Maunakea per Wolfe et al. 1997



Note: The green dashed line denotes the approximate extent and range of geochemically analyzed older Hāmākua Volcanics and the blue dashed line denotes the approximate extent and range of geochemically analyzed younger Laupāhoehoe Volcanics

Source: Intera, Inc. (2019)

4.5.2 EXISTING CONDITIONS

As noted in Section 2.1.3, Austin Tsutsumi & Associates, Inc. prepared a pre-construction site topographical survey (1982); that survey is shown in Figure 2-11. During preparation of the SDP and this EA, M3 Engineering and Technology, Caltech's decommissioning engineering and design contractor, digitized this prior survey and overlaid it with an updated site survey performed by dlb & Associates in 2016 (see Figure 2-12), with corrections for relative calibrations, to determine topographical discrepancies between the two and to calculate cut and fill requirements.

A comparison of the two surveys indicates that approximately 495 cubic yards of material were cut and approximately 2,830 cubic yards of fill were emplaced on the CSO Site during construction of the CSO facility in the 1980s. The maximum depth of the fill currently on the site is approximately 10 feet deep on the downslope, southeast side of the CSO Site. As previously discussed in Section 4.5.1.2, the origin of the fill currently on the CSO Site was not documented, but has been determined to be consistent with the Laupāhoehoe Volcanics found in the vicinity of

the CSO Site and likely to be native to Maunakea's summit area. Much or all of the CSO Site fill is believed to have been sourced from an excavation in a Laupāhoehoe lava flow during widening of the Mauna Kea Summit Access Road and possibly tephra from one of the nearby Laupāhoehoe cinder cones.

4.5.3 POTENTIAL IMPACTS

The No Action Alternative (ALT-1) would not involve any earthwork and will have no impact on the geology, topography, or soils of the CSO Site or elsewhere.

For all action alternatives (ALT-2, ALT-3, and ALT-4), restoration of the CSO Site will entail changing the topography from its developed condition to as close to its natural, pre-construction condition as feasible. Those topographic modifications are considered beneficial effects in this case even though, during deconstruction, stormwater runoff may be affected and the site will be made less easy to walk on. The impacts would remain beneficial under ALT-3 and ALT-4 because, even though a portion of the site's topography would not be fully restored to the pre-construction topography, it would be left in a safe condition.

For all action alternatives, only modest quantities of backfilling will be required for site restoration, primarily related to backfill after the cesspool vault is removed, and all wastes and non-native materials will be removed. All of the fill material used will be native to the Maunakea summit region and is already present on the CSO Site. The use of this native fill for backfill during decommissioning does not represent a hazard or an adverse impact to geologic resources. The removal of all wastes and non-native materials ensures that the geologic resources of the region will not be adversely affected by the proposed project.

4.5.4 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will entail:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- A Rock Movement Plan (Appendix J) will be observed as required by CMP management action C-3.
- Implement a BMP Plan that covers a range of topics, including stormwater management, and incorporates sustainable practices as required by CMP management actions C-2 and C-9 (Appendix I).

4.6 HYDROLOGY

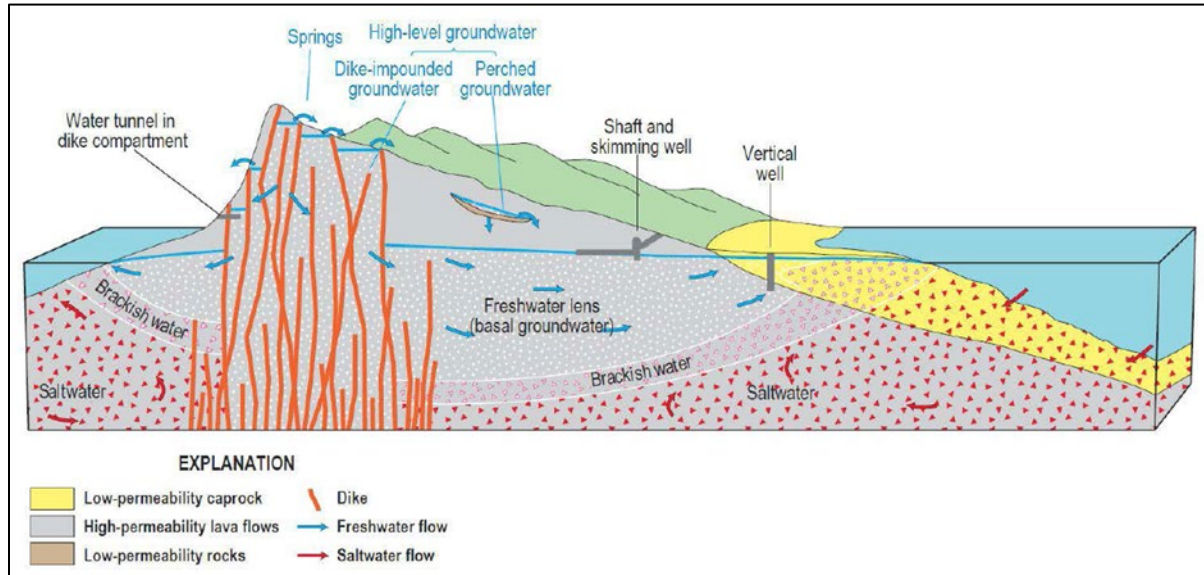
Caltech retained the services of geosciences and engineering consulting firm, Intera, Inc., to assess the hydrological conditions near the CSO Site and the potential water resource impacts of the action alternatives. The resulting report, *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (Intera, Inc. 2019) forms the basis for the information and analysis in the following subsections and is included as Appendix E.

4.6.1 EXISTING CONDITIONS

4.6.1.1 Islandwide Context

Historically, groundwater in the State of Hawai‘i has been conceptualized in four categories: (i) basal groundwater, (ii) high-level or impounded groundwater, (iii) perched groundwater; and (iv) sedimentary or caprock groundwater. Figure 4-11 illustrates this concept.

Figure 4-11 Historic Conceptual Model of Groundwater Occurrence and Flow in the State of Hawai‘i



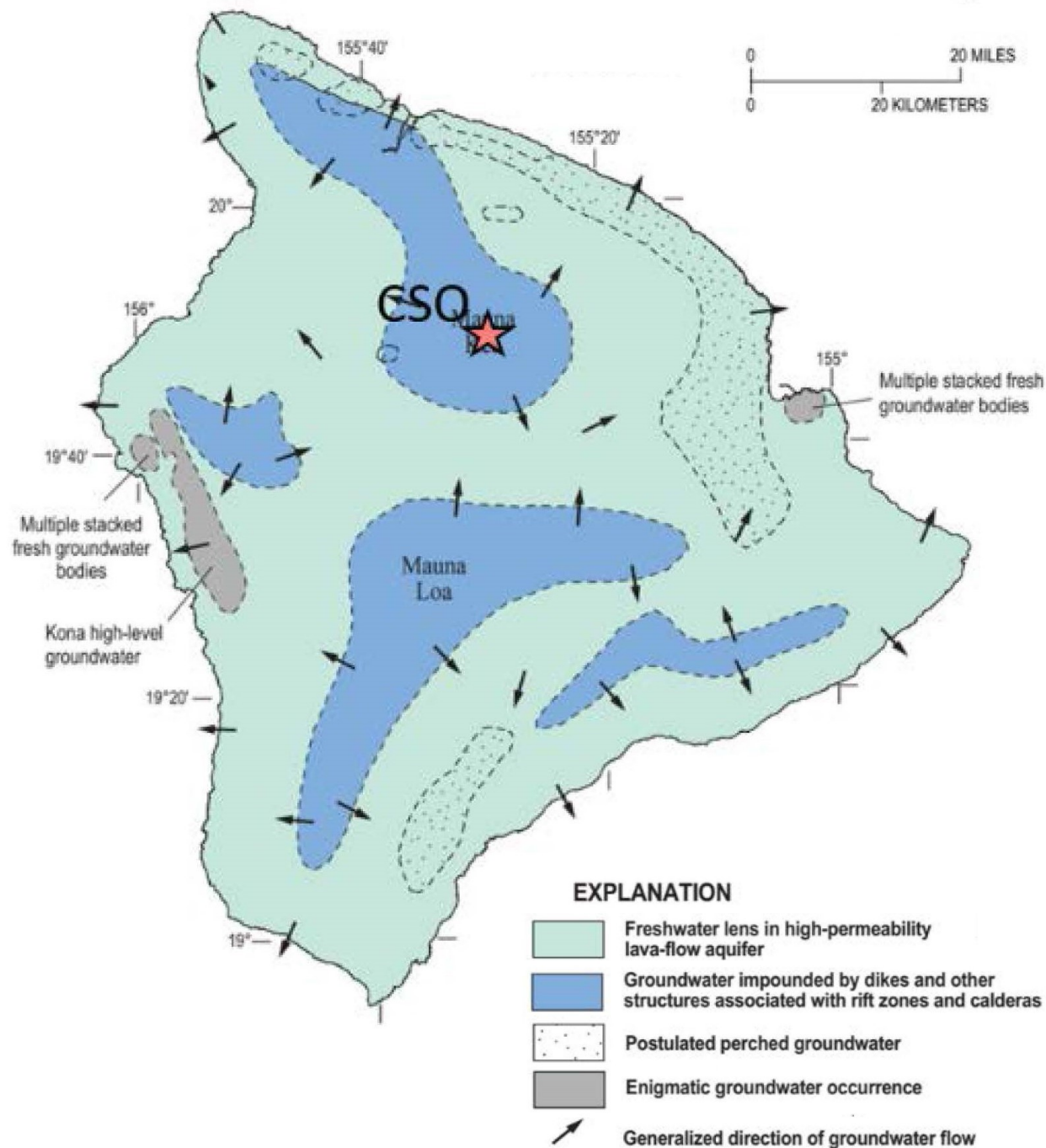
Source: Intera, Inc., Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory (2019); from Izuka et al., 2018.

The hydrology of the Island of Hawai‘i is unusual relative to the older Hawaiian Islands due to the presence of active volcanoes, little weathering, and the absence of sedimentary caprock deposits that provide for the fourth type of groundwater listed above (shown in yellow in Figure 4-11). Research and core samples conducted over the past 25 years have shown that the historic model may not be fully applicable to Hawai‘i Island, and possibly other islands as well (Thomas et al., 1996; Stolper et al., 2009; Thomas, 2016). Researchers have discovered deep freshwater aquifers in Hilo and Kona that do not fall into the four general categories noted above. Hawai‘i Island’s hydrogeology as categorized by Izuka et al. (2018) based on these new discoveries departed from the historic model somewhat and identified four principal groundwater settings (Figure 4-12):

- Freshwater lens in highly permeable lava flows, which is largely analogous to basal groundwater;
- Groundwater impounded by dikes and other structures associated with rift zones and calderas, which is analogous to high-level or impounded groundwater;
- Perched groundwater associated with sediment or tephra deposited in between lava flows (“postulated perched groundwater” on Figure 4-12), which is similar to perched groundwater in the historic model; and

- Stacked freshwater bodies located below sea level (“enigmatic groundwater occurrence” on Figure 4-12) (detailed in Figure 4-14), which is an entirely new classification.

Figure 4-12 Conceptual Model of Groundwater Systems for Hawai‘i Island



Source: Adapted from Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019), from Izuka et al., 2018.

Groundwater basal aquifers, also called freshwater lens systems, are an important source of drinking water in Hawai‘i. Hawai‘i basal aquifers can occur in basalt and other igneous rocks as

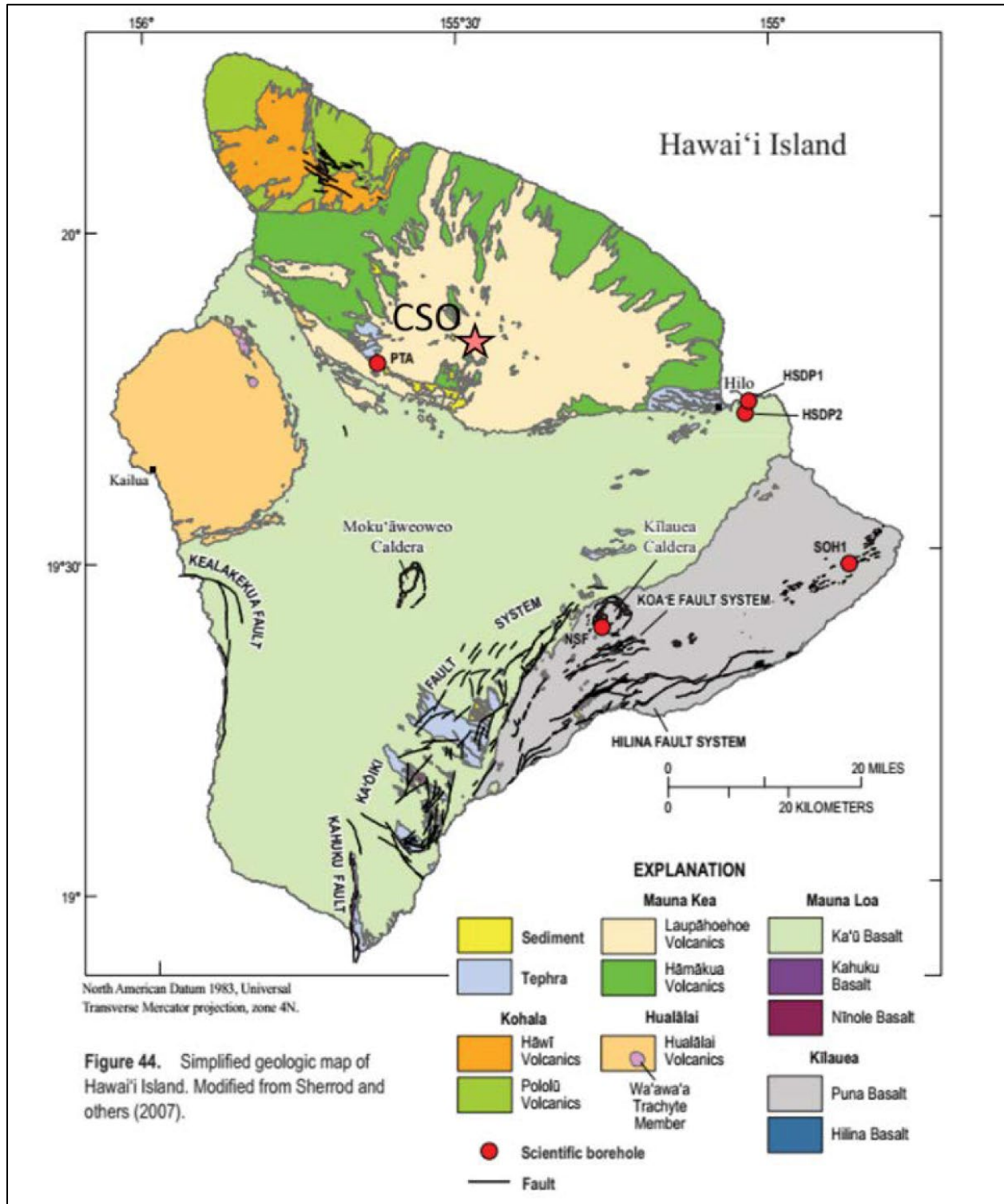
well as in sedimentary formations, locally known as caprock, if present. In a basal aquifer, lower density (lighter) fresh water can be thought of as floating on higher density (heavier) salt water. The fresh water and salt water are separated by a mixing or transition zone where salinity gradually increases from near-fresh to seawater concentrations (i.e., brackish, see Figure 4-11). The behavior of basal groundwater is a function of the geologic properties of the rock, groundwater recharge, the dynamics of the transition zone and groundwater pumping. The water level in feet above sea level of basal aquifers is generally less than 50 feet. Basal groundwater that is not pumped out of the ground ultimately discharges into the ocean as seeps and/or springs.

Some groundwater is retained behind dikes on the upper slopes of the volcanoes or along rift zones. Dike-impounded water is also called high-level water because groundwater can be impounded several thousand feet above sea level. There are no mapped dikes in the study area, but this is not surprising because dikes are subsurface features that are exposed by mass wastage or fluvial erosion and Maunakea is only slightly eroded. It is nearly certain that dikes occur in Maunakea's subsurface (blue areas in Figure 4-12). There is no direct information on the regional groundwater table below the summit of Maunakea; based on evidence from Pōhakuloa Training Area (PTA) and extrapolation from other Hawai'i summit areas, Intera Inc. assumed the average depth to groundwater below the summit area is 3,000 feet below ground surface (bgs) (e.g., groundwater elevation is roughly 10,000 feet above mean sea level [msl]). The dike-impounded groundwater discharges or "leaks" into deeper or neighboring dike groundwater bodies, the basal groundwater, or, in cases where erosion has occurred to expose the dikes, into streams. Researchers believe that the dike-impounded aquifers below the CSO Site discharge into the stacked freshwater aquifers discussed below.

Perched water in Hawai'i generally refers to relatively small aquifers situated on restrictive layers of weathered ash or soil above the basal or high-level aquifers. Perched groundwater can occur thousands of feet above sea level. Perched aquifer systems either leak downward, slowly, through the restrictive layers or discharge laterally to underlying basal or dike-impounded aquifers, or discharge to streams and springs. An example of perched groundwater, with a surface expression, is Lake Waiau, which is discussed in Section 4.6.1.3).

The hydrogeologic framework of Hawai'i is not understood as well as the other islands due to the relatively large size of the island and the uneven distribution of lithological and hydrological data from wells that are generally clustered near the coastline (Mink and Lau, 1993; Whittier et al., 2004). Because of these data gaps, island-wide groundwater elevation contours cannot be made. A few scientific exploratory wells (i.e., Pōhakuloa Training Area, and the deep Hawaiian Scientific Drilling Project (HSDP) drill holes near Hilo, HSDP1 and HSDP2; see Figure 4-13) and geophysical studies (Zohdy and Jackson, 1969; Pierce and Thomas, 2009; Thomas, 2016) provide some subsurface information, but little or no subsurface hydrogeological data exists at the high-altitude interior, including beneath Maunakea.

Figure 4-13 Geology of Hawai'i Island with Locations of Scientific Borings

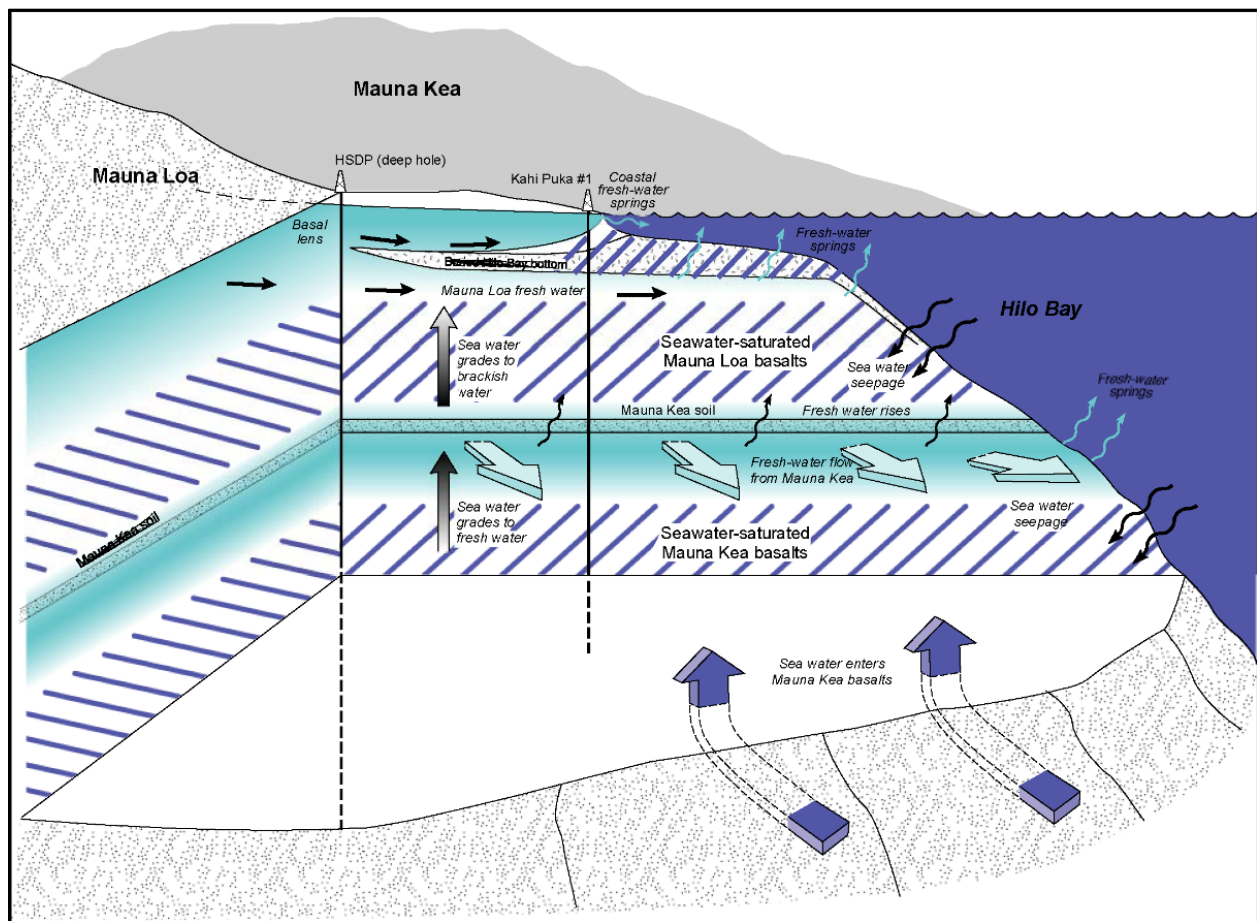


Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

This recent research on the Island of Hawai'i indicates that, contrary to the historic model that assumed a monolithic basal lens (Figure 4-11), there are multiple stacked bodies of freshwater

thousands of feet below sea level separated by seawater-saturated basalts (Thomas et al., 1996; Stolper et al., 2009) (Figure 4-14). The deep HSDP drill holes near Hilo, HSDP1, and HSDP2 (Figure 4-13), revealed upper and lower freshwater-saturated aquifers (enigmatic groundwater on Figure 4-12, Thomas et al., 1996). They found a freshwater body about 400 feet thick, confined below a soil layer at 900 feet bgs that marked the transition from Maunakea lavas below and younger overlying Mauna Loa lavas above in the HSDP1 borehole. The second, deeper HSDP2 borehole encountered this same deep freshwater aquifer at about 1,000 feet bgs, as well as several, much deeper, freshwater-saturated aquifers extending from a depth of about 6,500 feet bgs to more than 9,900 feet bgs (Stolper et al., 2009). This clearly diverges from the monolithic basal lens concept and indicated stacked freshwater bodies, as illustrated in Figure 4-14. Similar stacked freshwater bodies have been observed on the west side of the island in Kona (see enigmatic groundwater on Figure 4-12).

Figure 4-14 Conceptual Model of Stacked Freshwater Bodies



Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

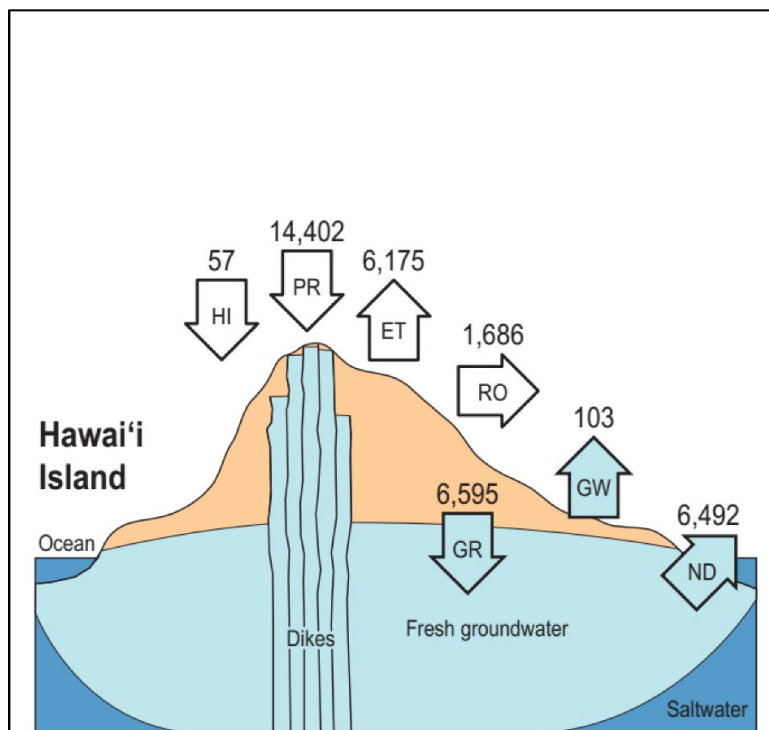
Thomas et al. (1996) considered these stacked freshwater bodies as part of a deep groundwater system that receives water from approximately 7,000 feet elevation on the slopes of Maunakea, based on stable isotope ratios and carbon-14 age dating. Stolper et al. (2009) estimated these fresh groundwater bodies account for as much as one third of the rainfall recharge from the windward, mid-altitude slopes of Maunakea. Based on the distance between the 7,000 foot elevation and the HSDP drill holes (18 miles), it was estimated that groundwater in the lower portion of the stacked

freshwater aquifer was flowing roughly 44 feet/year because the water is roughly 2,200 years old. Scientists continue to investigate these systems.

4.6.1.2 Maunakea Groundwater

The regional groundwater body below the summit of Maunakea is probably a dike-impounded high-level aquifer (Figure 4-15; Izuka et al., 2018). It is “probable” because there is no direct confirmation of high-level water from drilling. Groundwater hydrologic units have been established by the Commission on Water Resource Management (CWRM) to provide a consistent basis for managing groundwater resources (CWRM, 2008). The five aquifer systems that connect to the peak of Maunakea are: (i) Honoka‘a, (ii) Pa‘aulo, (iii) Hakalau, (iv) Onomea, and (v) Waimea. There are also an unknown number of relatively small perched water bodies associated with buried glacial deposits and deposits of weathered ash or sediment. Lake Waiau is the surface expression of a shallow perched aquifer (Leopold et al., 2016).

Figure 4-15 Water Budget Schematic for Hawaii Island



Note: PR = precipitation, HI = human inputs, ET = evapotranspiration, RO = runoff, GR = groundwater recharge, GW = groundwater use, ND = discharge.

Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

There are several factors affecting the vulnerability of an aquifer. They include potential flow pathways of groundwater recharge, the occurrence of potential contaminating activities, and physical and geochemical conditions in the vadose zone⁹ that may affect contaminant transport (Whittier et al., 2010; Eberts et al., 2013). Contaminant transport is affected by attenuation factors, including adsorption, biological action, chemical action (cation and anion exchange or

⁹ The vadose zone is the unsaturated sediment and rock between the ground surface and the top of the underlying aquifer's phreatic (saturated) zone.

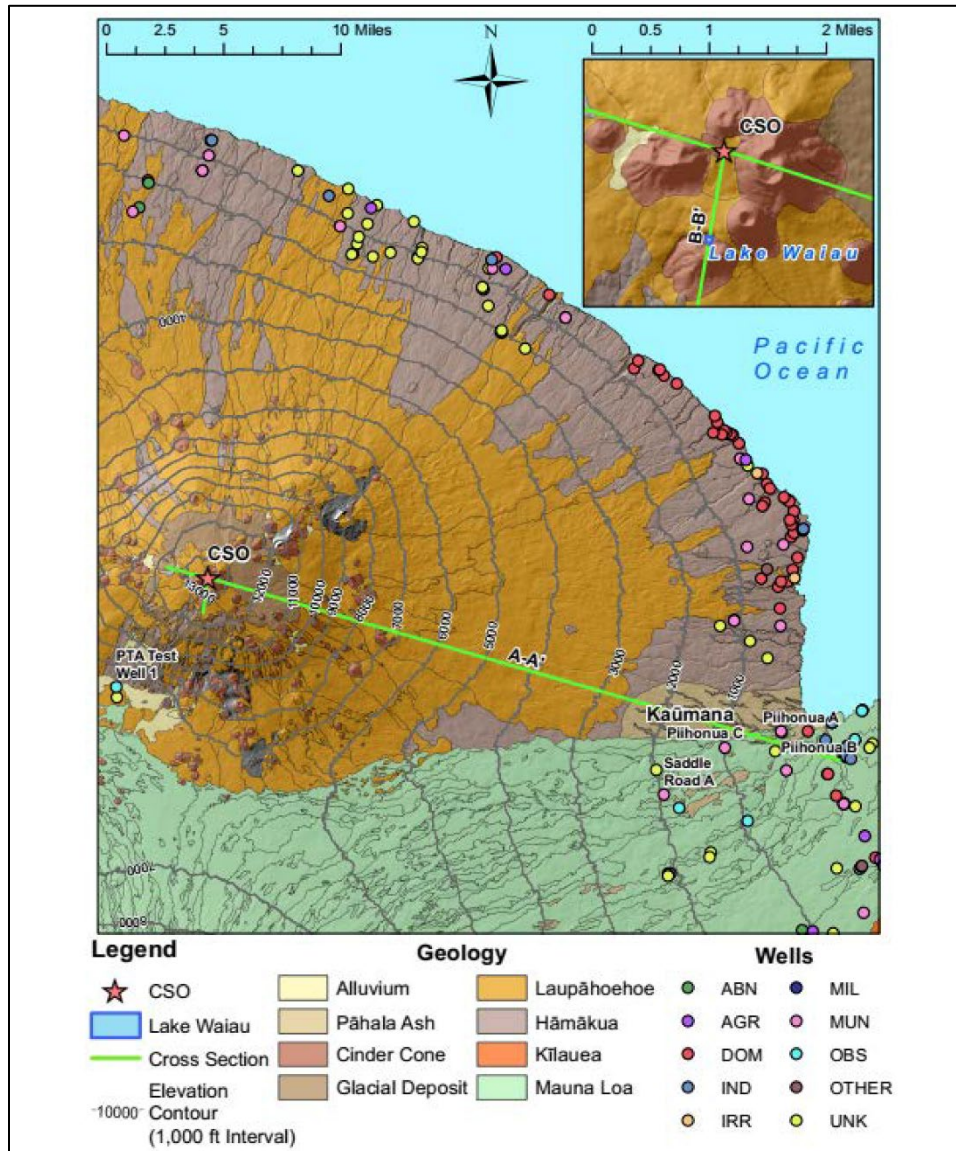
precipitation), filtration, and dilution. These natural geochemical and physical conditions also influence the viability and transport of bacteria. For example, slightly elevated temperatures may increase biological activity and accelerate alteration of organic contaminants and nutrients. Other important factors in the phreatic zone (the saturated zone below the vadose zone) include travel time and dilution. Dilution of contaminants will be greater in areas with high groundwater recharge. Travel time is a function of groundwater velocity and distance between recharge areas and discharge areas. There is more potential for attenuation during longer travel times.

The primary purpose of Intera, Inc.'s report (2019) was to assess the potential for groundwater pollution from the on-site cesspool to occur (see Section 2.1.2.12). Intera prepared a conceptual groundwater model of Maunakea's summit region; this conceptual model is a simplified graphic representation of the relevant geology and hydrology of the CSO Site and its environs.

The depth to groundwater is important in determining possible recharge flow pathways. There is no direct information on the regional groundwater table below the summit of Maunakea, but data exist at the PTA in the saddle between Maunakea and Mauna Loa from the scientific boring at PTA Test Well 1 (Figure 4-16) (Thomas and Haskins, 2013). Perched groundwater was encountered at two depth intervals in the PTA Test Well 1: 500-540 and 700-1,181 feet bgs. The regional water table was encountered at 1,806 feet bgs, or at about 4,500 feet above msl. Geophysical surveys have also indicated elevated groundwater levels at the lower slopes of the eastern flank of Maunakea (Pierce and Thomas, 2009; Thomas, 2016). Zones of low resistivity observed in magneto-telluric surveys collected about the eastern flank of Maunakea suggest the frequency and extent of perched or high-level groundwater bodies is higher than previously anticipated (Thomas, 2016).

This information indicates that the regional groundwater level below Maunakea is at the deepest 9,000 feet bgs (4,500 feet-msl). If known water levels in other Hawai'i summit areas are extrapolated, the regional water level below the summit is probably significantly higher. Intera have assumed an average depth to groundwater below the summit area of 3,000 feet bgs (10,000 feet-msl). The regional groundwater below the summit is probably dike-impounded, so water levels will vary, perhaps significantly, in different dike compartments.

Figure 4-16 Geologic Map with Cross-Section A-A' and Locations



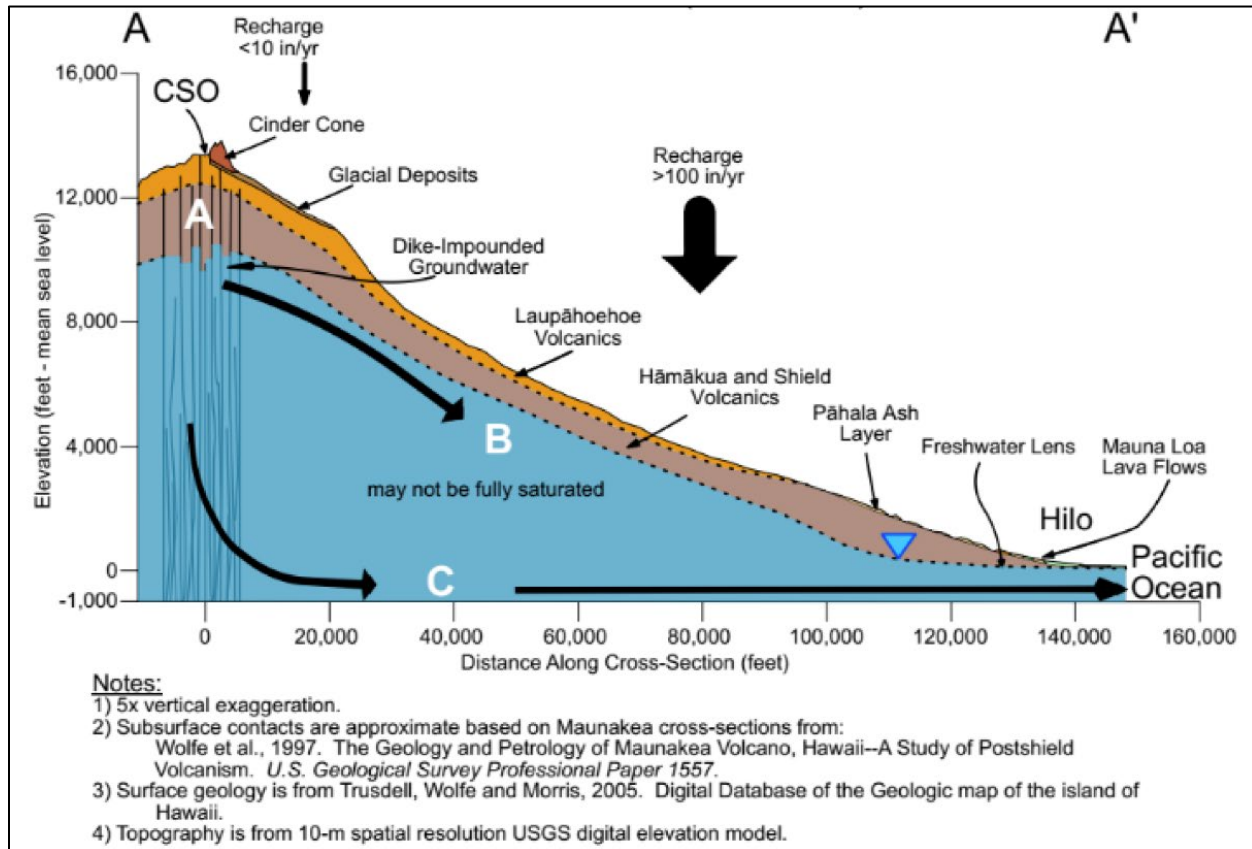
Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

Groundwater travel time is also a factor in assessing aquifer vulnerability. As discussed in Section 4.6.1.1, it is estimated that water in the lower portion of the stacked freshwater aquifer flows roughly 44 ft/year. It is likely that groundwater originating near the peak of Maunakea enters that lower flow system. These findings suggest it would take at least 3,000 years for groundwater to travel from the summit area of Maunakea to the shoreline of Hilo (Thomas 2018a).

Based on these and other data, the Maunakea groundwater system is represented by Cross Section A-A' on Figure 4-17. Cross Section A-A' depicts the groundwater system for approximately 24 miles between the CSO near Maunakea's summit and Hilo. The Laupāhoehoe Volcanics are assumed to extend approximately 1,000 feet bgs in the summit area and become a thinner veneer downslope. The Hāmākua Volcanics are lumped with the shield volcanics because they have similar hydrogeological properties (i.e., relatively high hydraulic conductivity), while the

Laupāhoehoe Volcanics have distinctly lower hydraulic conductivity. Groundwater levels in the dike-impounded zone beneath the CSO are thought to vary around an average of 10,000 ft-msl in the 3-mile wide rift zone.

Figure 4-17 Cross-Section from CSO to Hilo (and other locations)



Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

Intera, Inc. depicted two major flow paths for regional groundwater flow originating in the summit area. The upper arrow depicts overflow or spill from the dike compartments. This water would flow through other high-level aquifers in areas that are potentially not fully saturated. The lower arrow shows a flow path for water discharging at or below sea level from the dike compartments and flowing as basal or lower portion of the stacked freshwater aquifer towards the ocean. Recharge at higher elevations will be pushed to deeper levels in the saturated zone by recharge occurring at lower elevations. This will result in deeper groundwater flow paths for higher elevation recharge. Contaminants transported in groundwater from higher elevations will also tend to be pushed deeper in the aquifer.

The dike-impounded groundwater beneath the summit of Maunakea is a leaky system that flows radially in all directions away from the summit and CSO. This distribution of flow directions means a contaminant that is introduced to the dike-impounded groundwater system could be transported radially, in several directions from the Maunakea summit area. The “may not be fully saturated” labeled zone between 20,000 and 100,000 ft (horizontal) on Figure 4-17 is in a zone where extensive perching likely exists with alternating saturated and unsaturated zones (Thomas,

2018). If high level water discharges into this zone, the flow would be both saturated and unsaturated.

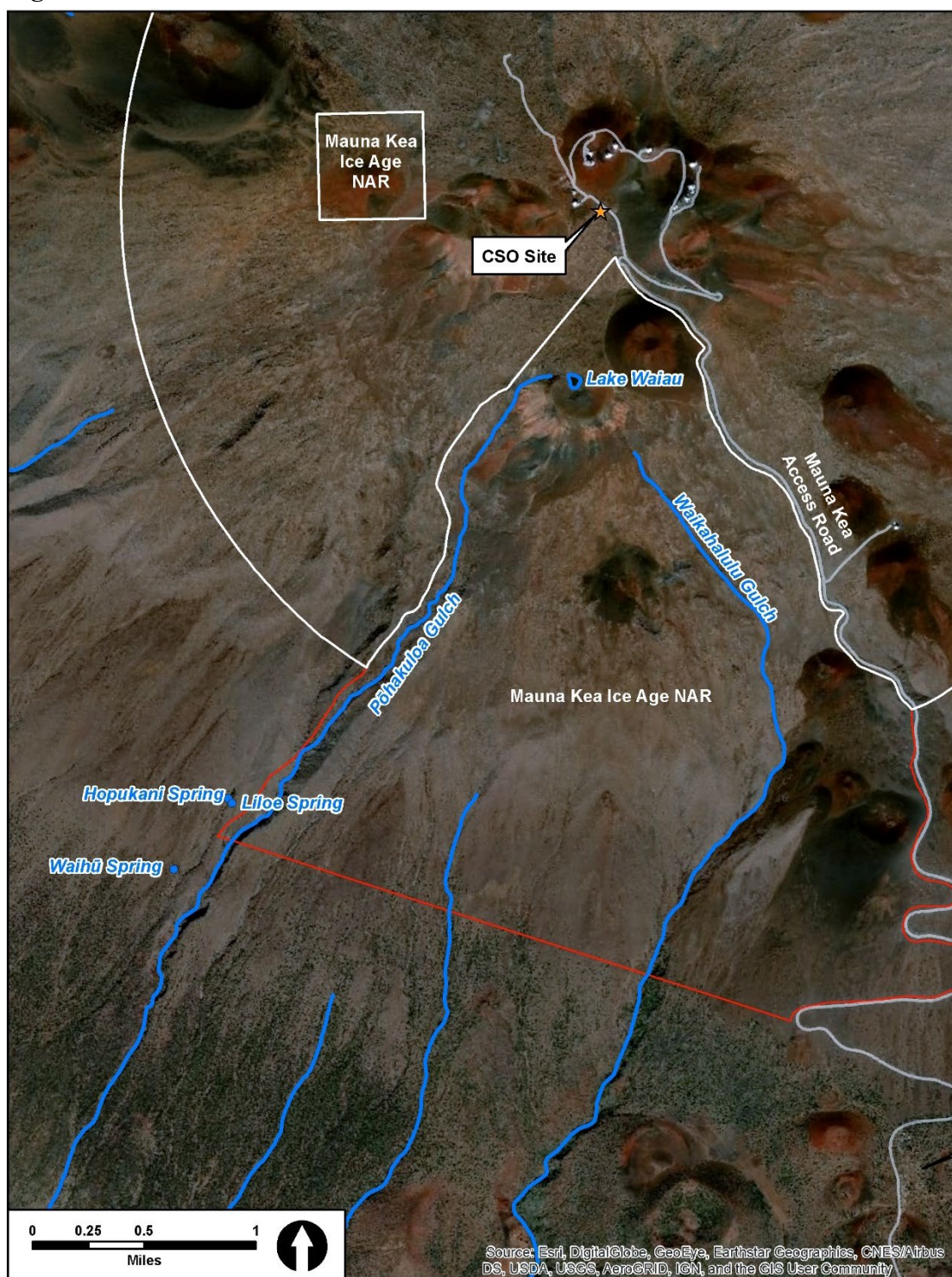
4.6.1.3 Surface Water

A map showing the surface water in the summit region of Maunakea is shown in Figure 4-18. The only continuous surface water in the summit area is Lake Waiau, which is roughly 4,000 feet to the south of the CSO Site. The Pōhakuloa and Waikahalulu Gulches are the most highly developed gulches on the upper mountain slopes (Figure 4-18), but only have surface flow during and for a brief period after storm events. Over three miles south of the CSO Site there are three known springs near Pōhakuloa gulch: the Hopukani, Waihū, and Liloe Springs (collectively “Pōhakuloa Springs”). The highest of these three springs is at an elevation of roughly 10,440 feet and thus not in the summit area.

Pōhakuloa Gulch originates on the southwest side of Maunakea. The watershed includes the CSO Site and Lake Waiau. The gulch likely formed due to scouring from melting glaciers (Macdonald et al., 1983; Lockwood, 2000; Porter, 2005). These melt waters are thought to have contributed to the initial filling of Lake Waiau (Sherrod et al., 2007).

During fieldwork, Intera, Inc. personnel visited Lake Waiau and walked the upper portion of the Pōhakuloa Gulch watershed on November 9, 2018. As illustrated in Figure 4-19, the lake was filled and overflowing into the gulch. The watershed around the lake is mostly rock rubble, red weathered lava rock, and slightly weathered lava flows; the CSO Site is not within the lake’s watershed (Figure 4-20). Occasional tufts of grass grew in the weathered material. The lake was pigmented green from algae, and the perimeter of the lake was surrounded by grass. Although the lake was overflowing, the soil was dry and there was no indication of recent precipitation or surface water inflows, indicating that the lake is an expression of perched groundwater.

Figure 4-18 Surface Water



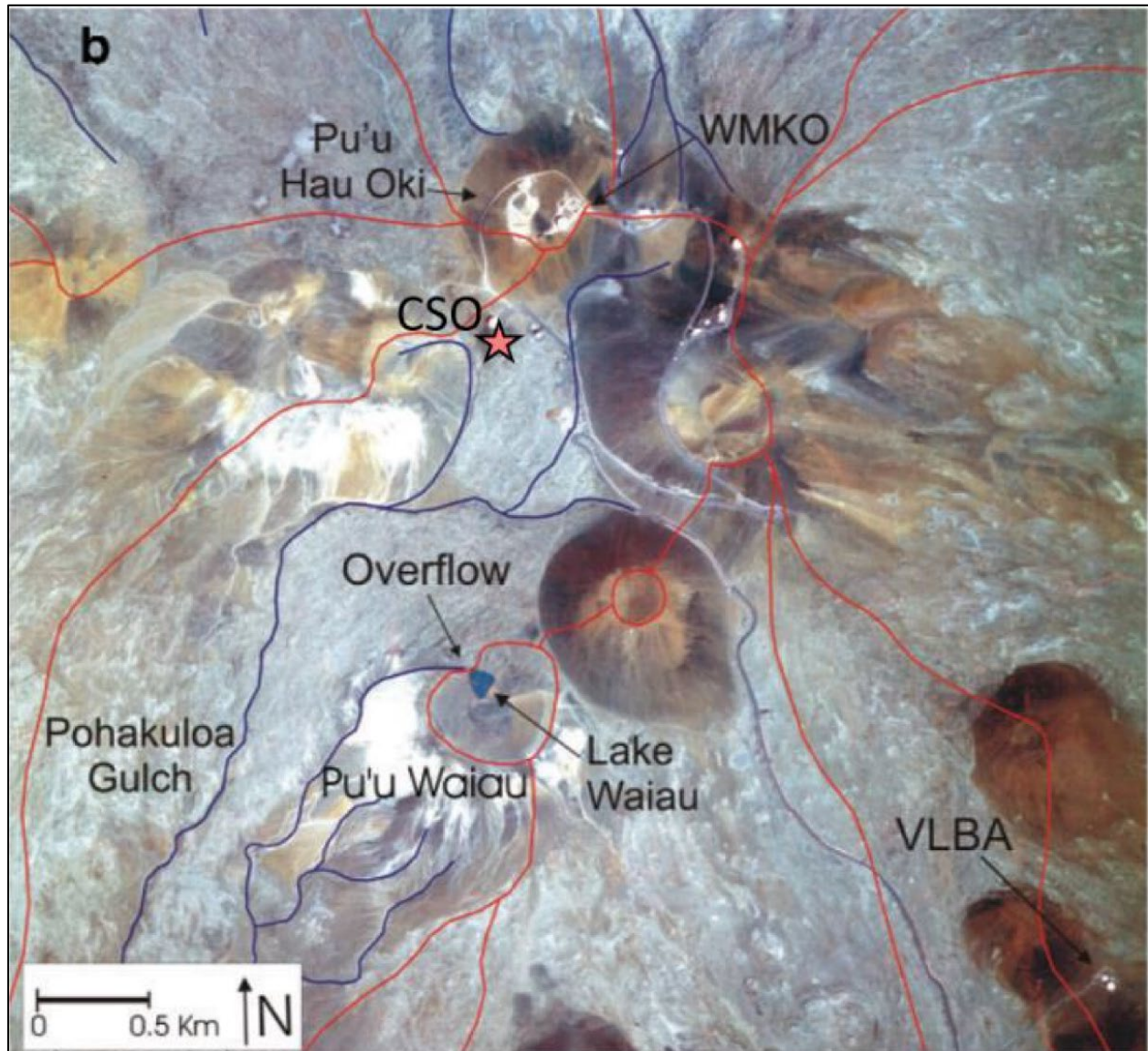
Source: PSI (2021)

Figure 4-19 Photo of Lake Waiau Taken November 9, 2018



Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

Figure 4-20 Watersheds and Surface Water Flowpaths in Summit Area



Note: Flow lines are shown in blue, watershed boundaries are shown in red.

Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

Intera, Inc. personnel noted that there are green algae in the lake; this implies the presence of nutrients. Nutrients and algae have been documented in Lake Waiau in 1977 to 1978 before the CSO was constructed (Laws and Woodcock, 1982). Laws and Woodcock noted that there were hypereutrophic conditions in the lake and found elevated levels of chlorophyll a in the lake during a drought. Patrick and Kauahikaua (2015) also noted that the lake was green during a period of low water levels in September 2013.

Lake Waiau (Figure 4-19) fluctuates in size with precipitation; it has been observed to shrink (Patrick and Delparte, 2014) and then regain its full volume. It is a perennial body of water in the crater of a cinder cone that was occupied by ice during past glaciations. Water remains in the lake despite being situated atop porous volcanics due to a fine-grained ash or glacial till layer that

perches groundwater (Leopold et al., 2016). A study by Woodcock (1980) indicated that Lake Waiau water is similar to the water discharging at the Pōhakuloa Springs.

Ehlmann et al. (2005) concluded that Lake Waiau is fed by a small 135,000 square meter circular basin and is isolated from the surface drainage of the telescopes. They concluded that precipitation within that basin is sufficient to fill and sustain the lake. There is no indication that the small aquifer and watershed that feeds Lake Waiau are hydraulically connected to the CSO Site via surface water or groundwater.

4.6.1.4 Wastewater

The CSO facility includes a small wastewater system that, when the facility was in use, disposed of waste from two toilets and a few sinks. The initial Conservation District Use Application (CDUA) for the CSO submitted June 10, 1982, notes:

“It is estimated that when the telescope becomes operational an average of five to seven persons will be present on the mountain at one time, operating in two shifts per day at the telescope site. The additional personnel are expected to generate an additional 1,100 to 1,500 gallons per month (gal/mo) of liquid sewage.”

Consistent with these prior estimates and review of a sampling of water delivery to the CSO over the years, it appears that the average monthly water delivery to CSO was 1,250 gal/mo. An as-built figures of the CSO cesspool are shown on Figure 4-21 and Figure 4-22 (Stolper, 2015). The cesspool is 7 feet in diameter, 10 feet tall and the discharge occurs through the bottom perforations.

The EIS (Caltech, 1982), prepared prior to the construction of CSO, notes that:

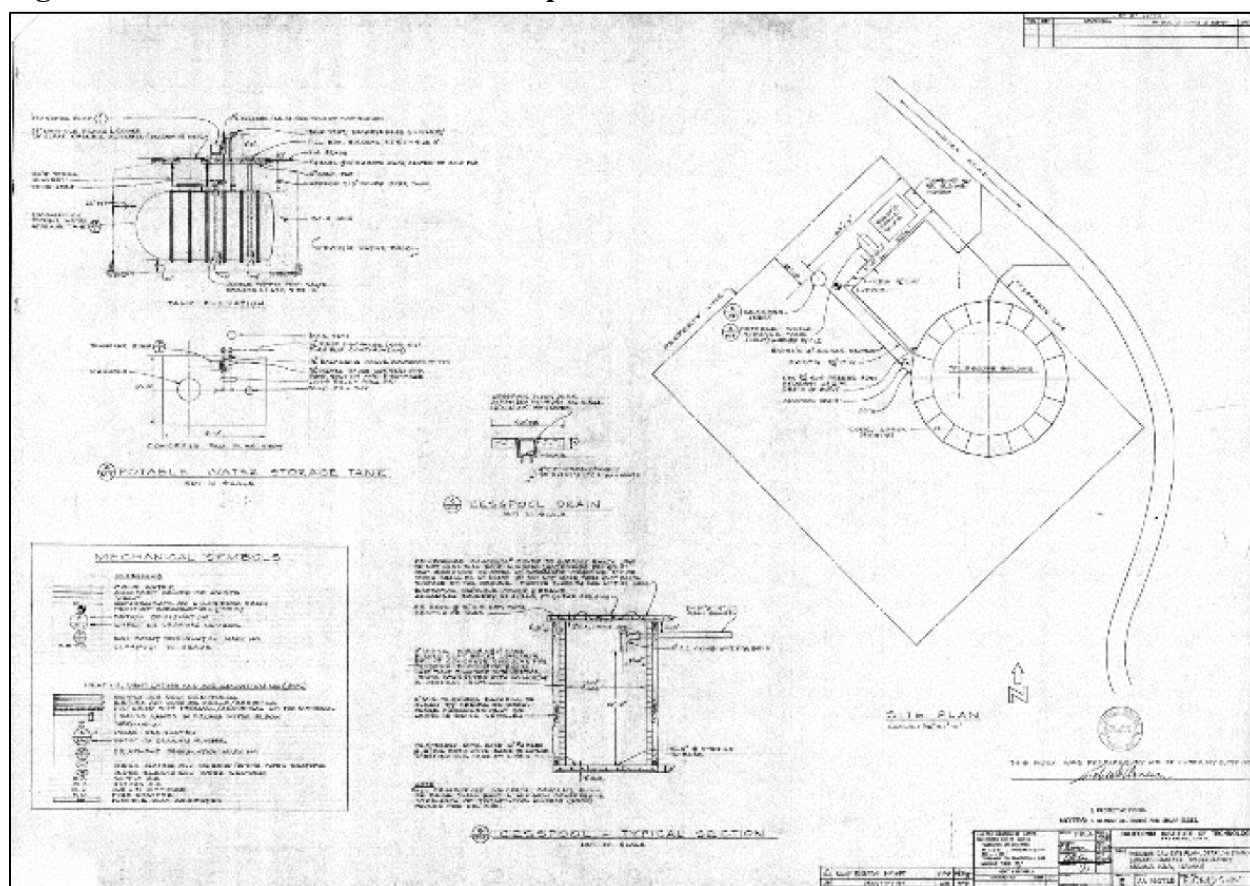
“Disposal of 1,100-1,500 gal/mo of liquid sewage into an 850-gallon septic tank is not expected to impact the hydrology of the area or pollute Lake Waiau.”

The EIS (1982) further noted:

“The combined factors of relatively low effluent flow, evaporation losses from the cesspool tank, storage within the underlying lava rock or permafrost, probable downward dispersion (in event of a deep permafrost layer) and estimated negligible flow rate combined with significant purification within a few hundred feet of the source—lead to the conclusion of no impact on Lake Waiau.”

Intera estimated that during operation, the CSO effluent had an average nitrogen concentration of 87 mg/L and, based on that and the flow rate of 1,250 gal/mo, calculated an average nitrogen loading rate of 0.41 kg/month for the CSO cesspool. This is much lower than the average effluent and nitrate loading rate for a single cesspool in the Kaūmana area above Hilo, which is 20,100 gallon/month and 4.5 kg/month, respectively. The nitrogen loading rate at the CSO is significantly lower than a typical cesspool because of the low total effluent discharge.

Figure 4-21 As-Built Plan View of Cesspool on CSO Site



Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

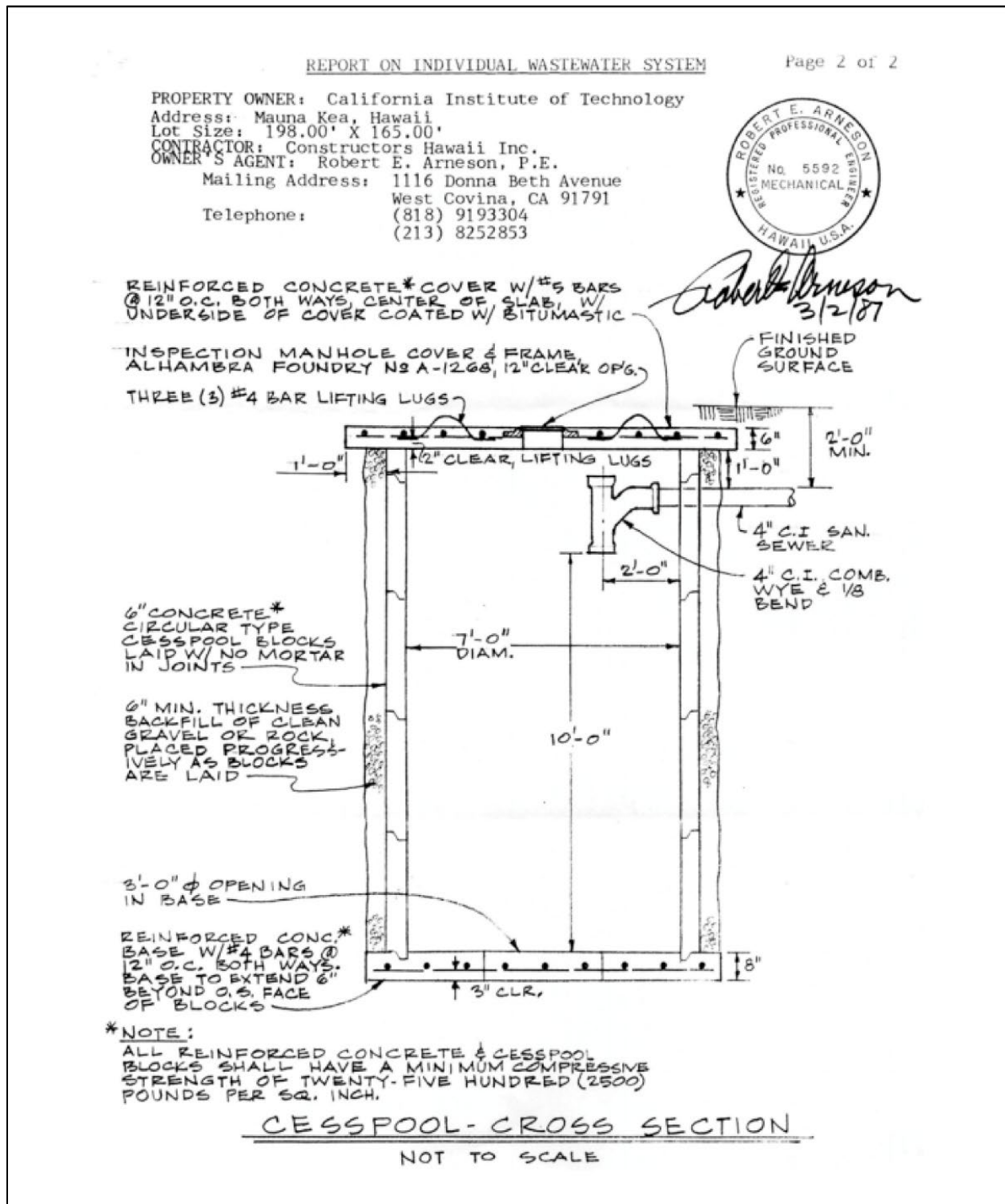
4.6.2 POTENTIAL IMPACTS

4.6.2.1 Potential Impacts to Groundwater

No long-term impacts to groundwater are anticipated due to the proposed action because the proposed action would result in the removal of facilities, including the cesspool, and the restoration of the CSO Site so that no residual potential contaminants remained.

During scoping effort, the public voiced concern regarding the roughly 30 year operation of the cesspool at the CSO Site. Although the cesspool structure would be removed as part of the proposed action, the 30 years of wastewater leachate cannot be removed. Community members are concerned that the leachate will contaminate aquifers in the future. This concern is addressed in the following subsections, the first of which address groundwater flow toward Hilo and the second address groundwater flow toward Waimea.

Figure 4-22 As-Built Section View of Cesspool on CSO Site



Source: Intera, Inc., *Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory* (2019)

4.6.2.1.1 Modelled Travel Time from CSO to Drinking Water Wells

Figure 4-17 shows a diagram of the conceptual flow system from the CSO to Hilo or other locations, including Pa‘auilo, Waimea, and Waikoloa. Intera, Inc. used the graphical software package VS2DI to model the vertical flow of leachate through the unsaturated zone, estimated to be roughly 3,000 feet thick and indicated by “A” on Figure 4-17. VS2DI simulates fluid flow and solute or energy transport through variably saturated porous media (USGS, 2000). Intera, Inc. constructed a conservative model that:

- Did not account for low permeability zones that would slow flow. This is a conservative approach because if the flow slowed, travel time would increase, providing additional time for contaminants to attenuate.
- Did not simulate any saturated zones, although they may be present. This is also a conservative approach because saturated zones would also slow the flow.
- Did not simulate dispersion or attenuation factors that in reality are certainly reducing the concentrations of pathogens and nutrients.
- Simulated 35 years of CSO operation with the cesspool discharge leachate at a rate of 1,250 gal/mo throughout. This is conservative because it is longer than the actual operation period.
- Assumed groundwater recharge of <8 inches/year at the summit of Maunakea.
- Incorporated several conservative assumptions regarding porosity, hydraulic conductivity, residual moisture, and other parameters.

The results indicate the leachate plume would travel downward through the vadose zone to the dike-impounded groundwater level 3,000 feet below ground surface in 34 years (see “A” on Figure 4-17). This equates to a vertical velocity of about 88 feet/year. Leachate that percolates to the dike-impounded groundwater table(s) would become part of the dike-impounded aquifer system below Maunakea (Figure 4-12 and Figure 4-17).

Estimation of the travel time through the unsaturated zone is the first step. Next, the travel time through the saturated or phreatic zone was evaluated. Figure 4-17 illustrates two flow paths (B and C) through the saturated zone. The estimated travel time for leachate from the CSO cesspool to the basal aquifer beneath the Hilo-Kaūmana area via the less likely shallow pathway (“B” on Figure 4-17) is estimated to range between 72 years to 412 years, based on the sum of travel times through Components A and B (Table 4.7). Regarding the more likely deep aquifer flow path (Component C from Figure 4-17 and Table 4.7), the groundwater travel time is estimated to be roughly 3,000 years from the peak of Maunakea to Hilo based on the age dating of groundwater from Thomas et al. (1996).

Table 4.7 Groundwater Velocity and Travel Time Estimates for Components of Regional Groundwater System Between CSO and Hilo

<i>Component</i>	<i>Groundwater Velocity</i>			<i>Travel Distance (feet)</i>	<i>Travel Time (years)</i>		
	<i>Mean</i>	<i>Min.</i>	<i>Max.</i>		<i>Mean</i>	<i>Min.</i>	<i>Max.</i>
A – Vadose Zone	88	--	--	3,000	34	--	--
B – Basal Aquifer	1,747	318	3,176	120,000	208	38	378
C– Deep Aquifer	50	--	--	120,000	3,000	--	--
Notes: Source for basal aquifer is Lau and Mink (2006); Liu (2007); Whittier (2018b). Source for deep aquifer is Thomas et al. (2016).							
Source: Intera, Inc., <i>Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory</i> (2019)							

Thus, the earliest estimated arrival time for effluent from CSO to Hilo is 72 years. In other words, the Intera model estimates that no effluent from the cesspool, even in miniscule amounts, has reached Hilo; in fact, only a small portion of it has reached the dike-impounded aquifer beneath the summit region. The shortest modelled travel time (72 years) is significantly less than the roughly 2,200 years old groundwater encountered in the HSDP boring near Hilo, indicating the models are very conservative in nature.

Intera, Inc. also considered the travel time to other drinking water sources in the area around Maunakea. Groundwater flow emanates radially from Maunakea and is as likely to flow toward Waiki‘i, Waikoloa, and Waimea as Hilo. The cross section and flow paths would be analogous (Figure 4-17). Based on the basal groundwater velocities presented in Table 4.7, Intera, Inc. estimated the minimum groundwater travel times from the CSO Site to the public water supply wells serving Waikoloa and Waimea to be in the range of 70 to 400 years (similar to the Hilo travel times).

Waiki‘i Ranch is located about 12 miles from the CSO Site. Based on the basal groundwater velocities presented in Table 4.7, Intera, Inc. estimated the minimum groundwater travel times from the CSO to drinking water wells serving that community to be in the range of 55 to 240 years.

4.6.2.1.2 Contaminant Fate

Contaminants from cesspools are typically assessed by nitrate (as nitrogen). Nitrate (as nitrogen) in samples from public drinking water wells serving Waiki‘i, Waikoloa, Waimea, Pa‘auilo, and Hilo has consistently been between 1 and 2 mg/L, well below the Maximum Contaminant Level (MCL) of 10 mg/L. These nitrate levels are also lower than the Hawai‘i natural background level of 3 mg/L. Based on this information, there is no indication of impacts from the CSO cesspool or other cesspools and other wastewater disposal systems on the drinking water wells.

It is extremely unlikely that any pathogens from the CSO cesspool will reach the regional aquifer system. Pathogens from wastewater have been known to degrade by 10^{-5} (five orders of magnitude) within 92 days of travel time (Crockett, 2007). This means that the unit concentration of pathogens would be 0.00001 after 92 days due to attenuation factors including adsorption, biological action, dispersion, chemical action (cation and anion exchange or precipitation), filtration, and dilution. Thus, the 87 mg/L concentration of nitrate in the CSO discharge would be reduced to 0.00087 mg/L, which is three orders of magnitude below the MCL. Leachate transport through the 3,000 feet of unsaturated volcanics separating the CSO cesspool from the dike-impounded groundwater is modelled to take a minimum of 34 years. This travel time is 134 times

longer than the 92 days during which wastewater pathogens have been shown to degrade by five order of magnitude.

If contaminants remain in the leachate when it enters the dike-impounded groundwater, they would have to travel 12 to 24 miles, estimated to take another 21 to 3,000 years, before entering a drinking water well. During that travel time, they would continue to be subject to the attenuation factors mentioned above.

To put the potential for the CSO cesspool operation to impact drinking water resources into context, Intera compares the CSO to the cesspools at residential properties in the Kaūmana area above Hilo that are upgradient of drinking water wells (Pi'ihonua #1 A & B). Based on HDOH records and estimates, there are about 1,000 cesspools with 680,000 gallons/day of effluent for a nitrate loading rate of 155 kg/day of nitrogen (a loading rate more than 10,000 times the CSO cesspool's). Most of the cesspools in the Kaūmana area upgradient of the wells are on residential properties that have an elevation of 400 to 1,000 feet MSL. Therefore, their effluent percolates through a thinner vadose zone than the CSO effluent did (less than 1,000 feet vs. roughly 3,000 feet). As the Kaūmana effluent nitrates move through the subsurface they are subject to attenuation processes discussed above. Despite this much greater nitrate load, sourced much closer to the drinking water wells than the CSO cesspool, the nitrate level in groundwater extracted from those wells have consistently been under 0.5 mg/L.

4.6.2.1.3 Conclusion

As discussed in Section 2.1.2.12, based on its consultation with HDOH-WB and HDOH-ES, for all action alternatives Caltech now plans to: (i) pump out all sludge remnants in the cesspool, (ii) test the sludge for potential contaminants and dispose of it properly, (iii) trench around the outer perimeter of the concrete cesspool cylinder to its depth; (iv) remove the concrete cesspool structure and dispose of it properly; and then (v) use structural fill from the CSO Site to fill the void to a depth even with the surrounding native lava flow surface and compact the fill during the backfilling process to minimize settling in the future. CSO will continue to coordinate with the HDOH and comply with the instructions provided by it, including *General Backfilling Scenarios for an Injection-Well Cesspool* (2004), during closure of the cesspool.

By relying on these procedures, and based on the analysis and evidence outlined in the sections above, Intera concludes (Appendix E) that there is virtually no potential for CSO cesspool leachate to impact the drinking water supplies of Hilo or other communities around Maunakea. This confirms that the CSO cesspool effluent will have no to a negligible impact on groundwater quality and drinking water quality.

Similarly, all workers will use portable toilets brought to and from the project site; thus, activities associated with the proposed project are not expected to have an impact on groundwater quality.

4.6.2.2 Potential Impacts to Surface Water

There is virtually no potential for cesspool leachate to impact Lake Waiau or the Pōhakuloa Springs based on the lack of hydraulic connection between these water bodies and the CSO Site.

Prior to implementation of the proposed project, Caltech will obtain a National Pollutant Discharge Elimination System (NPDES) permit and will implement the BMPs outlined in the Site-Specific

Stormwater Pollution Prevention Plan (SWPPP), which will be prepared when the NPDES permit application is prepared. These protections will prevent the project from having a significant effect on stormwater runoff and surface water quality.

4.6.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Implement a Best Management Practices Plan that covers a range of topics, including stormwater management, and incorporates sustainable practices as required by CMP management actions C-2 and C-9 (Appendix I).

In addition, regarding the closure of the cesspool, Caltech will comply with applicable provisions of the *General Backfilling Scenarios for an Injection-Well Cesspools* and other directives from HDOH-WB.

4.7 SOLID AND HAZARDOUS WASTE

This section addresses the solid and hazardous waste and materials management practices associated with the action alternatives considered in this EA. During consultation and scoping conducted during the preliminary planning for the CSO Decommissioning Project, many individuals repeatedly stated that Caltech should make every effort to reuse and/or recycle as much of the deconstruction material as possible rather than discard it as waste, including the CSO telescope itself (see Section 2.1.2.5). These suggestions align with Caltech's intent. Caltech's goal is to reuse and/or recycle as much of the telescope and facility as reasonably practicable during implementation of the CSO Decommissioning Project.

4.7.1 EXISTING CONDITIONS

4.7.1.1 Deconstruction Waste

The estimated amount of solid waste which will result from the CSO deconstruction are provided in Table 4.8.

Table 4.8 Solid Waste Associated with CSO Decommissioning

<i>Type of Solid Waste</i>	<i>Quantity</i>
Aluminum	5 tons
Concrete	350 tons
Copper Grounding Mesh	0.26 tons
Miscellaneous ¹	350 tons
Steel	150 tons
TOTAL	855.26 tons
Note 1: Includes wood, drywall, ceilings, piping, etc.	
Source: M3 Engineering and Technology (2020)	

There is no reason to expect that any of these wastes are hazardous wastes. Minor amounts of these wastes were found to have lead-containing paint (LCP) or lead-based paint (LBP) on them. As discussed in Section 2.1.2.4, loose and flaking LCP and LBP that may be disturbed during deconstruction will be removed and disposed of in accordance with applicable regulations prior to these materials become wastes themselves. Wastes with residual (not loose or flaking) LCP and LBP will be managed so that lead-containing dust is not generated during deconstruction and will be disposed of with the unpainted wastes.

On February 2, 2018, representatives of Caltech met with the Hawai‘i County Department of Environmental Management (DEM) as part of the scoping and pre-assessment consultation that has taken place during the preliminary planning for the CSO Decommissioning Project. A second, follow-up discussion was held on January 23, 2020, with the Division Chief of the DEM’s Solid Waste Division (SWD), which is tasked with: (i) municipal wastewater management; (ii) maintenance of the Island’s five municipal wastewater system; (iii) solid waste disposal; (iv) landfill operation and management; (v) vehicle disposal; and (vi) all other environmental management and recycling programs conducted by the County.

While the SWD indicated their preference that Caltech reuse or recycle as much material as possible, the Chief indicated that all deconstruction material, including aluminum, steel, concrete foundation rubble, etc. are eligible to be deposited at the West Hawai‘i Pu‘u Anahulu Landfill. No permit is required to do so. In addition, SWD noted that Caltech should coordinate large deliveries of solid waste with the West Hawai‘i Pu‘u Anahulu Landfill so that personnel could be scheduled to open earlier or close later, as needed.

On February 22, 2018, representatives of Caltech met with the DEM’s Recycling Coordinator who indicated that Caltech could, with minimal additional effort, separate and recycle metals (e.g., steel frames, aluminum paneling, copper grounding mesh, etc.). In addition, recycling vendors on the Island may be able to accept and recycle that material, although some may have preconditions associated with accepting them. DEM also suggested that there may be options to recycle and/or reuse concrete rubble resulting from the CSO Decommissioning Project. Based on this feedback, Caltech is currently exploring opportunities to recycle some or all of the material which will accumulate from the deconstruction and removal process.

4.7.1.2 Other Waste

Other wastes consist of (i) small quantities of glycol, hydraulic oil, any other remaining liquid, and any other packaged materials (i.e., cleaning products) that remain in the facility, (ii) LCP and LBP removed prior to deconstruction, (iii) petroleum-impacted soil, if any, associated with historic hydraulic fluid leaks, and (iv) residual material within and around the cesspool.

The small quantities of glycol, hydraulic oil, any other liquid materials, and other packaged materials will be removed prior to the start of deconstruction activities by a trained professional (Section 2.1.2.4). These materials and wastes are not hazardous wastes. These materials will be recycled or disposed of in accordance with applicable local, state, and federal regulations prior to deconstruction activities that may disturb them.

LCP and LBP will be removed from painted surfaces prior to deconstruction by trained professionals (Section 2.1.2.4). They will collect all the removed LCP and LBP, conduct a

hazardous waste determination according to HAR Chapter 11-261, and dispose of the waste in accordance with applicable local, state, and federal regulations.

Per the Phase II SAP, soil beneath the CSO's concrete slab and material within and around the cesspool will be segregated from other deconstruction waste and assessed (Section 2.1.2.13 and Appendix A). These wastes will be sampled and assessed prior to disposal, but there is no reason to believe that they will be hazardous wastes. Once characterized, these wastes will be disposed of in accordance with applicable local, state, and federal regulations.

4.7.2 POTENTIAL IMPACTS

The No Action Alternative (ALT-1) will produce no solid waste of any kind that would be recycled or disposed in the near term. Once Caltech's sublease had terminated and it was no longer able to access the site, it would result in the CSO materials gradually degrading and eventually becoming waste that others (e.g., Rangers and UH) would have to pick up and dispose of as it blew away or became a hazard. It would likely result in the LCP and LBP continuing to degrade and gradually becoming dust that impacts the area downwind. It would also result in the residual hydraulic oil impacted soil, if any, and the cesspool residue remaining in the subsurface, where it would gradually degrade.

The action alternatives would all result in the removal of all wastes, including the small quantity of wastes that could potentially be hazardous wastes. They will also remove the residual petroleum-impacted soil and other organic wastes (e.g., cesspool residue) to the maximum extent practicable.

While the total quantities of solid waste will vary marginally between alternatives, all of the action alternatives discussed in this EA (ALT-2, ALT-3, and ALT-4) will produce substantial amounts of waste (see Table 4.8). Caltech will work with Hawai'i Island-based vendors to see that as much material as possible is reused or recycled. Much of the solid waste will be deposited in the West Hawai'i Pu'u Anahulu Landfill, per coordination with the County of Hawai'i DEM. However, all of the material is appropriate for disposal at that location and will not substantially affect the public health, involve a substantial degradation of environmental quality, and/or detrimentally affect air or water quality in the Maunakea summit area or the broader region.

Mandatory compliance with existing regulations and requirements and the implementation of the mitigation measures proposed in this section will ensure that the deconstruction and removal of the CSO Observatory will not result in a significant impact due to its solid and hazardous waste management.

4.7.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.

- Caltech will have experts in the appropriate fields implement LCP/LBP operations and perform the tasks outlined in the HDOH-approved Phase II SAP (attached to the SDP in Appendix A).
 - As outlined in Section 2.1.2.4, items 5 and 6, monitoring will be conducted to assess employee safety and capture methods during the removal of LCP and LBP.
 - The sampling and assessment of the soil and residual material below the cesspool per the Phase II SAP is not required by applicable regulations. It is a mitigation measure that Caltech has incorporated into the proposed project to address community concerns.
- Implement a Best Management Practices Plan that covers a range of topics, including waste management, and incorporates sustainable practices as required by CMP management actions C-2 and C-9 (Appendix I).

4.8 TRAFFIC

During the preliminary planning for the CSO Decommissioning Project, Caltech requested the assistance of Austin, Tsutsumi & Associates, Inc. to better understand, and possibly reduce, potential impacts to area transportation corridors as a result of deconstruction and site restoration operations. The resulting report, *Transportation Management Plan for California Institute of Technology Submillimeter Observatory Decommissioning, Mauna Kea, Hawai‘i* (TMP) (Austin, Tsutsumi & Associates, Inc.; 2019) provides the basis for the information and analysis contained in the following subsections. The complete report is included as Appendix F of this report.

4.8.1 EXISTING CONDITIONS

Daniel K. Inouye Highway (DKI, Route 200, aka Saddle Road) connects Hilo with central and western portions of the island via the saddle between Maunakea and Mauna Loa. Primary access to the summit region of Maunakea is via Mauna Kea Access Road from its intersection at mile 19.9 of DKI. DKI also provides access to: (i) Hilo Solid Waste Recycling and Transfer Station, located approximately 45 miles east of CSO; (ii) West Hawai‘i Pu‘u Anahulu Landfill, located approximately 56 miles west of CSO; (iii) Kawaihae Harbor, located approximately 62 miles west of CSO; and (iv) Hilo Harbor, located approximately 45 miles east of CSO. Mauna Kea Access Road also provides access to Halepōhaku, where the Visitor Information Station (VIS) and other facilities are located.

4.8.1.1 Roadway Characteristics

This section provides descriptions of the existing roads that may be impacted by the CSO Decommissioning Project alternatives. The roadway conditions reflect the existing conditions at the time the TMP was prepared (2019).

- Mauna Kea Access Road is generally a north-south, two-way, two-lane undivided road with a posted speed limit of 25 to 40 miles per hour (mph) with steep slopes. This roadway provides access to the summit region of Maunakea and is mostly paved except for a roughly four mile segment above Halepōhaku.

- Daniel K. Inouye Highway (DKI) (aka “Saddle Road”) is generally an east-west, two-way, two to four lane undivided, minor arterial with a posted speed limit of 60 mph in the vicinity of its intersection with Mauna Kea Access Road. DKI is a state roadway (Route 200) that begins at the outskirts of Hilo and travels west before terminating at its intersection with Māmalahoa Highway near Waimea.

The following roadways provide access from CSO to the West Hawai‘i Pu‘u Anahulu Landfill and Kawaihae Harbor:

- Mauna Kea Access Road and DKI (Route 200 – Saddle Road), described above.
- Māmalahoa Highway (Highway 190 – the upper road) is generally a north-south, two-way, two-lane, undivided State roadway between Waimea and Kailua-Kona. Māmalahoa Highway is a minor arterial with a posted speed limit of 55 mph, near the intersection with DKI.
- Waikoloa Road is generally an east-west, two-way, two-lane, undivided roadway that connects Māmalahoa Highway and Queen Kaahumanu Highway. The roadway has a posted speed limit of 35 mph near Waikoloa Village, but the posted limit increases to 45 mph near Queen Kaahumanu Highway and 55 mph near Māmalahoa Highway.
- Queen Ka‘ahumanu Highway (Route 19) is generally a north-south, two-way, two-lane, undivided roadway with a posted speed limit of 45 mph, near the intersection with Waikoloa Road. This roadway travels between Kawaihae and Kailua-Kona. West Hawai‘i Pu‘u Anahulu Landfill is off this highway, just south of the Waikoloa Road intersection.
- ‘Akoni Pule Highway (Route 270) is generally a north-south, two-way, two-lane, undivided roadway with a posted speed limit of 35 mph near Kawaihae Harbor. The roadway travels between Kawaihae and Pololū Valley. Kawaihae Harbor is off this highway, just north of the Queen Ka‘ahumanu Highway intersection.

The following roadways provide access from CSO to Hilo Solid Waste Recycling & Transfer Station and Hilo Harbor:

- Mauna Kea Access Road and DKI (Route 200 – Saddle Road), described above.
- Puainako Street (Route 2000) is generally an east-west, two-way, two-lane, undivided major collector that connects DKI and Māmalahoa Highway (Highway 11) in Hilo. Puainako Street is a state roadway with a posted speed limit of 35 mph and 55 mph east and west of Komohana Street, respectively.
- Māmalahoa Highway (Route 11) is generally a north-south, two-way, two to three-lane, divided principal arterial with a posted speed limit of 35 mph near Leilani Street. This roadway travels between Hilo and Kailua-Kona.
- Leilani Street is generally an east-west, two-way, two-lane, undivided roadway with a posted speed limit of 30 mph. Leilani Street provides access to the Hilo Solid Waste Recycling & Transfer Station.
- Kalaniana‘ole Avenue (Route 19) is generally an east-west, two-way, two-lane, undivided roadway with a posted speed limit of 35 mph, near Hilo Harbor.

- Kūhiō Street (Route 19) is generally a north-south, two-way, two-lane, undivided roadway with a posted speed limit of 25 mph. This roadway provides access to the Port of Hilo.

4.8.1.2 Existing Traffic

During preparation of their TMP, Austin, Tsutsumi & Associates, Inc. obtained the latest available data on traffic volumes from the State of Hawai‘i, Department of Transportation (HDOT) and prior traffic studies conducted in the region. Based on their review of available data, there are approximately 30 to 40 vehicles per day (VPD) traveling along Mauna Kea Access Road, but there can be up to 200 VPD on particularly busy days, such as when there is a snowfall on the summit. Table 4.9 summarizes available traffic volume data for affected roadways. Figure 4-23 depicts the locations and volumes identified in Table 4.9.

Table 4.9 Avg. 24-Hour Traffic Volumes for Affected Roadways

<i>Roadway</i>	<i>Reference Location</i>	<i>Avg. 24-Hour Traffic Volume (VPD)</i>
Mauna Kea Access Road	Above Halepōhaku	30 to 40
Daniel K. Inoue Hwy.	East of Ua Nahele St.	4,500
Daniel K. Inoue Hwy.	East of Māmalahoa Hwy.	4,600
Māmalahoa Hwy.	South of Daniel K. Inoue Hwy.	5,200
Waikoloa Rd.	East of Paniolo Ave.	4,800
Waikoloa Rd.	East of Queen Ka‘ahumanu Hwy.	9,000
Queen Ka‘ahumanu Hwy.	South of Waikoloa Rd.	17,600
‘Akoni Pule Hwy.	North of Kawaihae Rd.	6,000
Puainako St.	West of Komohana St.	6,900
Puainako St.	West of Māmalahoa Hwy.	18,700
Kalaniana‘ole Ave.	East of Māmalahoa Hwy.	15,600
Kūhiō St.	North of Kalaniana‘ole Hwy.	2,500
Source: Austin, Tsutsumi & Associates, Inc., <i>Transportation Management Plan for California Institute of Technology Submillimeter Observatory Decommissioning, Mauna Kea, Hawai‘i</i> (2019)		

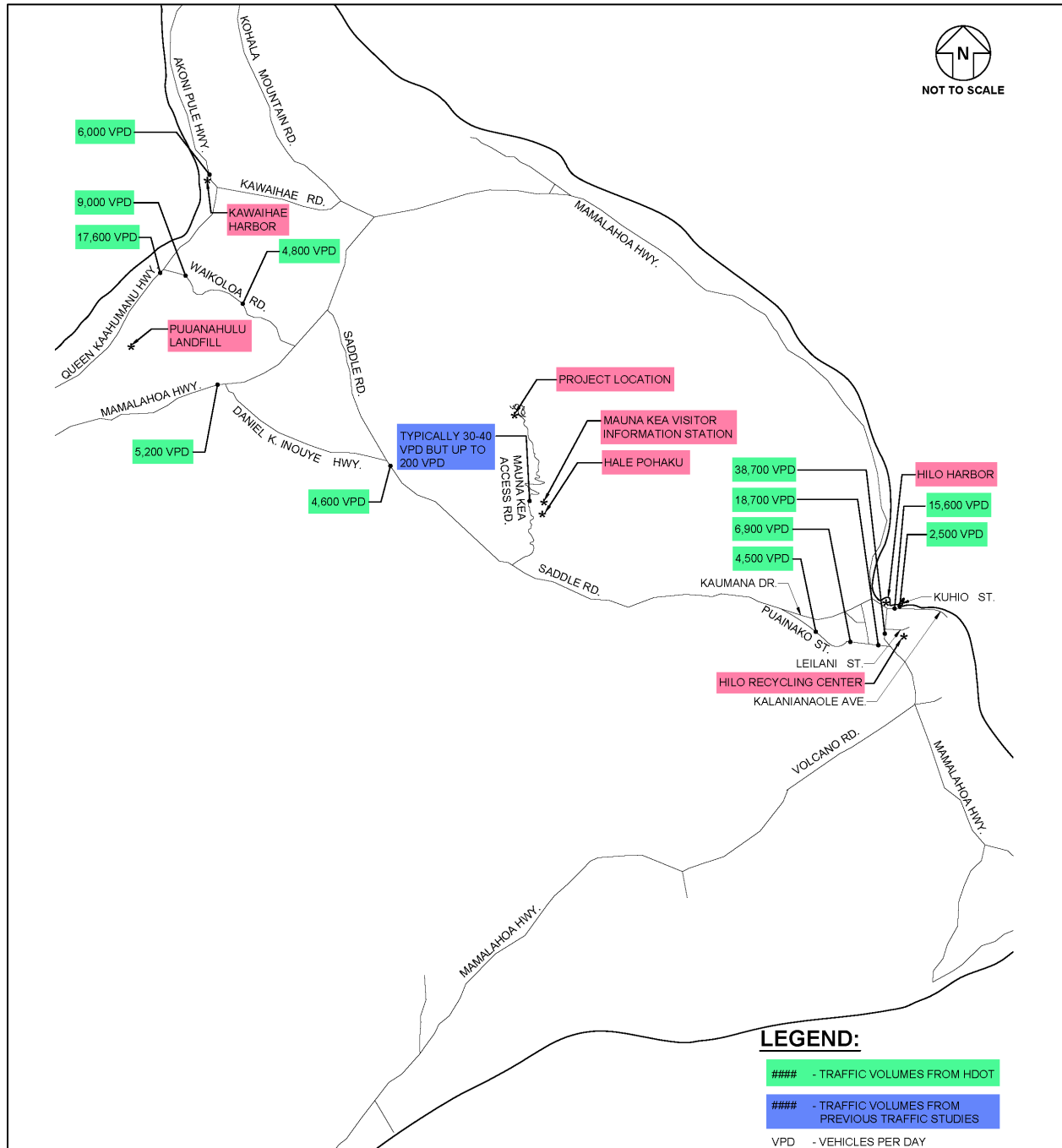
4.8.2 POTENTIAL IMPACTS

The standard threshold for determining whether an action has a significant impact is 1,000 passenger cars per lane, per hour (PC/PL/PH). The three action alternatives are sufficiently similar in scope and schedule that their traffic impacts would be imperceptibly different. Per the TMP all of the action alternatives are expected to produce 36 construction-related VPD on roads beyond the CSO Site and staging areas. Applying the 1,000 PC/PL/PH standard, there would be no significant impacts to traffic as a result of implementing any of the action alternatives considered in this EA (ALT-2, ALT-3, and ALT-4).

The construction personnel trips will likely occur during the AM and PM peak hours of traffic, while the construction vehicle trips may occur at any time during construction work hours. A work schedule is still in development for the CSO Decommissioning Project, but typical construction work hours are between 7:00 AM and 4:00 PM. Depending on construction crew size, they will either: (i) drive individually each day to Halepōhaku and then vanpool to the CSO Site; (ii) drive individually each day and park in the Batch Plant staging area; or (iii) drive individually each day to a designated site in Hilo or elsewhere, then vanpool to the CSO Site. For the first and second

options, Mauna Kea Access Road would experience a higher increase in traffic volume, as all construction-related traffic would travel along this roadway, when compared with the third option. However, regardless of the commute option selected for construction crews, the impact to existing traffic is expected to be minimal.

Figure 4-23 Existing Traffic Volumes



Source: Austin, Tsutsumi & Associates, Inc., *Transportation Management Plan for California Institute of Technology Submillimeter Observatory Decommissioning, Mauna Kea, Hawai'i* (2019)

Peak periods of traffic throughout the day along Mauna Kea Access Road generally align with various activities on the summit, including commercial tours for sunrise viewing, observatory workers commuting to/from in the mornings and afternoons, and both independent and commercial tours for sunset viewing. Assuming all construction-related traffic will travel along Mauna Kea Access Road, traffic would double with the additional construction-related trips, but the total volume would be less than 100 VPD. If all 36 construction-related trips occurred on the busiest days, there would be roughly 230-240 VPD, or 23 to 24 vehicles during the PM peak hour (i.e., 10 percent), which is still considerably less than the 1,000 PC/PL/PH threshold described above. Since the existing volumes on Mauna Kea Access Road are low, the potential increase in construction traffic on that corridor is not anticipated to have more than a minimal impact.

Temporary road closures will be limited to Mauna Kea Access Road during the mobilization and demobilization of the crane and office trailer (see Section 2.1.2). However, the duration of the temporary closures will be very brief and scheduled during off-peak hours; thus, the impact of these short closures is not expected to be more than a minor inconvenience for the few on the road during that brief off-peak period.

Since construction personnel will travel from various origins and construction trips will be split between West Hawai'i Pu'u Anahulu Landfill, Hilo Solid Waste Recycling and Transfer Station, Hilo Harbor, and Kawaihae Harbor, the remaining roadways will only serve a portion of the additional construction-related vehicle trips. As a conservative evaluation, if all 36 daily vehicle trips are added to the remaining roadways identified in Table 4.9, the additional construction traffic would account for less than one percent of the average daily volume for each roadway. Thus, the increase in construction traffic would not have a significant impact on traffic.

The No Action Alternative (ALT-1) would produce no additional traffic of any kind.

4.8.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, the BMP Plan (Appendix I) will include:

- A number of work area strategies to mitigate potential impacts to area traffic flow in the summit region as a result of the CSO Decommissioning Project. They include employing as appropriate: (i) temporary signage; (ii) changeable message boards; (iii) channelizing devices; (iv) flaggers and uniformed traffic control officers; (v) barricades; (vi) portable barriers; and (vii) escort vehicles.
- The construction manager or designee responsible for discharging the terms of the TMP will monitor all phases of construction work and shall document any problems, issues, or recommendations for remediation and for use by future decommissioning projects.
- Ride-sharing and/or vanpooling by workers, when appropriate, to and from the summit region.

In addition, should MKSS find that additional road maintenance is necessary due to CSO decommissioning activities, Caltech would reimburse CMS for additional road maintenance costs incurred.

4.9 NOISE

4.9.1 CONTEXT

Hawai‘i Administrative Rules, Title 11, Chapter 46, Section 4 (HAR §11-46-4) defines the maximum permissible community sound levels in dBA. These differ according to the kind of land uses that are involved, as defined by zoning district, and time of day (i.e., daytime or nighttime). These limits are shown in Table 4.10. Definitions of two technical terms used in this discussion are as follows:

- *A-Weighted Sound Level (dBA)*. The sound level, in decibels, read from a standard sound-level meter using the “A-weighted network.” The human ear is not equally sensitive in all octave bands. The A-weighted network discriminates against the lower frequencies according to a relationship approximating the auditory sensitivity of the human ear.
- *Decibel (dB)*. This is the unit that is used to measure the volume of a sound. The decibel scale is logarithmic, which means that the combined sound level of ten sources, each producing 70 dB will be 80 dB, not 700 dB. It also means that reducing the sound level from 100 dB to 97 dB requires a 50 percent reduction in the sound energy, not a 3 percent reduction. Perceptually, a source that is 10 dB louder than another source sounds about twice as loud. Most people find it difficult to perceive a change of less than 3 dB.

The maximum permissible sound levels specified in HAR §11-36-4(b) apply to any excessive noise source emanating from within the specified zoning district. They are measured at or beyond the property line of the premises from which the noise emanates. Mobile noise sources, such as construction equipment or motor vehicles are not required to meet the 70 dBA noise limit. Instead, construction noise levels above these limits are regulated using a curfew system whereby noisy construction activities are not permitted during nighttime periods, on Sundays, and on holidays, unless the project obtained a “noise variance.”

Table 4.10 Hawai‘i Administrative Rules §11-46 Noise Limits

<i>Zoning District</i>	<i>Noise Limit (in dBA)</i>	
	<i>Daytime (7:00 a.m. to 10:00 p.m.)</i>	<i>Nighttime (10:00 p.m. to 7:00 a.m.)</i>
Class A: Areas equivalent to lands zoned residential, conservation, preservation, public space, open space, or similar type.	55	45
Class B: All areas equivalent to lands zoned for multi-family dwellings, apartment, business, commercial, hotel, resort, or similar type.	60	50
Class C: All areas equivalent to lands zoned agriculture, country, industrial, or similar type.	70	70
Source: Hawai‘i Administrative Rules §11-46 <i>Community Noise Control</i>		

Pursuant to HAR 11-46-3, areas such as the CSO Site that is within the State Conservation District is in Class A, the most restrictive for the purposes of noise limits. A maximum L₁₀ noise level of 55 dBA during daytime hours (7:00 a.m. to 10:00 p.m.) and 45 dBA during nighttime hours (10:00 p.m. to 7:00 a.m.) is allowed, as measured from the property lines of a parcel in a Class A District

(i.e., the MKSR parcel boundary).¹⁰ Noise levels from stationary sources are not to exceed the maximum permissible L_{10} levels within any twenty-minute period, except by permit or variance.

4.9.2 EXISTING CONDITIONS

Noise sensitive sites near the CSO Site are limited to areas where outdoor use is common in the MKSR. The summit region of Maunakea is removed from urban areas and generally experiences low ambient noise levels. No one resides in the summit region and the scientists and staff that visit the summit region will retire to the Halepōhaku dormitories or other lower elevation locations, while other visitors leave the summit after sunset and prior to nightfall. The primary activities on the summit of Maunakea which produce noise above the natural background level include:

- *Vehicular Travel.* Traffic is discussed in Section 4.8. The existing astronomy facilities generate, on average, approximately 36 vehicle trips a day, and there are approximately additional 52 vehicle trips a day related to visitors, rangers, etc.
- *Observatory Operations.* Observatories are generally quiet facilities with all operations occurring indoors during the day. Most of the existing observatories utilize heating, ventilation, and cooling (HVAC) systems to keep the interior of the observatory domes in equilibrium with the outside temperature when they open in the evening. The HVAC systems and/or their exhaust vents are the primary sources of noise at the observatories.
- *Construction Operations.* Periodically, construction operations occur in the summit region. Most are related with observatory upgrades and improvements. Roadway work is another source of construction noise.

Other potential contributors to noise levels on the summit of Maunakea are: (i) the Army's Pōhakuloa Training Area; (ii) Bradshaw Army Airfield; and (iii) local and regional air traffic. However, nothing has been documented in literature indicating that military-related noise is an issue within the MKSR. While no noise study was conducted during the planning of this project, based on measurements made for nearby projects, ambient noise levels during regular trade wind weather is probably near 55 dBA. Noise levels during periods of calm winds and no traffic are probably less than 45 dBA.

4.9.3 POTENTIAL IMPACTS

Audible construction noise, while intermittent and temporary, will be an unavoidable result of deconstruction, removal, and site restoration activities under all of the action alternatives considered in this report (ALT-2, ALT-3, and ALT-4). Deconstruction, excavation, transport and other activities will also entail the use of heavy equipment including a crane, lift, heavy trucks with backup alarms, and excavators (e.g., backhoes which generate up to 84 dBA at a distance of 50 feet) to dig and fill the trenches necessary during removal operations. As depicted in Table 4.11, some of this equipment is inherently noisy. Because the nearest places where non-construction personnel work or congregate are hundreds of feet away, the most noticeable sources

¹⁰ L_{10} is the noise level exceeded for 10 percent of the time of the measurement duration. This is often used to give an indication of the upper limit of fluctuating noise, such as that from road traffic and takes account of any peaks in noise.

of construction noise to them are likely to be related to transport of equipment, material, and personnel along Mauna Kea Access Road.

Table 4.11 Construction Equipment Noise Emissions Levels

Equipment	Typical Noise Levels (dBA) 50 ft., U.S. Dept. of Trans. Study (1979)	Average Noise Level (dBA) 50 ft., CA/T Project Study (1994)	Typical Noise Level (dBA) 50 ft., U.S. Dept. of Trans. Study (1995)	Lmax Noise (dBA) 50 ft., CA/T Project Spec. 721.560
Air Compressor	--	85	81	80
Backhoe	84	83	80	80
Chain Saw	--	--	--	85
Compactor	82	--	82	80
Compressor	82	--	82	80
Concrete Truck	--	81	--	85
Concrete Mixer	--	--	85	85
Concrete Pump	--	--	85	85
Concrete Vibrator	--	--	76	80
Crane, Derrick	86	87	88	85
Crane, Mobile	--	87	83	85
Dozer	88	84	85	85
Drill Rig	--	88	--	85
Dump Truck	--	84	--	84
Excavator	--	--	--	85
Generator	84	78	81	82
Gradall	--	86	--	85
Hoe Ram	--	85	--	90
Impact Wrench	--	--	85	85
Jackhammer1	--	89	88	85
Loader	87	86	85	80
Paver	80	--	89	85
Pile Driver, Impact	--	101	101	95
Pile Driver, Sonic	--	--	96	95
Pump	80	--	85	77
Rock Drill	--	--	98	85
Roller	--	--	74	80
Scraper	89	--	89	85
Slurry Machine	--	91	--	82
Slurry Plant	--	--	--	78
Truck	89	85	88	84
Vacuum Excavator	--	--	--	85
Note 1: There are 82 dBA at 7-meter rated jackhammers (90 lbs. class) available. This would be equivalent to 74 dBA at 50 ft. These are silenced with molded intricate muffler tools. Source: http://ops.fhwa.dot.gov/wz/workshops/accessible/Schexnayder_paper.htm				

Due to the location of the CSO Site, well removed from the MKSR boundaries, construction noise will not exceed 55 dBA at the property line. Caltech does not anticipate the need for a Construction Noise Permit. Caltech does not anticipate the need for a Noise Variance because decommissioning work will take place during normal work hours.

The No Action Alternative (ALT-1) will produce no additional noise of any kind.

4.9.4 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Implement a Best Management Practices Plan that covers a range of topics and incorporates sustainable practices as required by CMP management actions C-2 and C-9, including practices associated with noise directly or indirectly:
 - The total number of vehicle trips for workers, and thus the noise related to vehicular travel, will be minimized via ride-sharing and/or vanpooling, when appropriate.
 - Exterior gas- or diesel-powered generators will be properly maintained and only be used when needed.

4.10 AIR QUALITY

4.10.1 EXISTING CONDITIONS

Pursuant to the Clean Air Act (CAA), which is the primary federal law governing air quality, the EPA has established National Ambient Air Quality Standards (NAAQS) for six designated criteria air pollutants: (i) ozone (O₃), (ii) particulate matter (PM₁₀ and PM_{2.5}), (iii) carbon monoxide (CO), (iv) nitrogen dioxide (NO₂), (v) sulfur dioxide (SO₂), and (vi) lead (Pb). These standards establish the maximum safe concentrations of pollution considered to be acceptable, with an adequate margin of safety, to protect the public health and welfare. In accordance with the CAA, Section 176(c)(1), federal agencies are required to ensure that their undertakings conform to applicable implementation standards for achieving and maintaining NAAQS.

As required by the CAA, each state is required to provide a framework for regulating air quality and to develop plans to maintain and attain the NAAQS. The HDOH Clean Air Branch (CAB) has adopted State Ambient Air Quality Standards (SAAQS) that apply within the State of Hawai‘i, which in some cases are more stringent than national standards. The proposed CSO Decommissioning Project is in the County of Hawai‘i and is under the jurisdiction of the CAB. Under the provisions of the CAA, the County of Hawai‘i is classified as being in attainment with regard to all NAAQS.

Air quality is an important factor for astronomy facilities, as unique visibility conditions are required for astronomical observations. Although many studies have been performed to evaluate astronomical observing conditions, traditional air quality monitoring of the six criteria pollutants noted above has not been actively undertaken in the summit region of Maunakea. However, air quality monitoring has been performed at the Mauna Loa Observatory at an elevation of approximately 11,140 feet MSL since its construction in 1956. This monitoring station provides data most representative of conditions on Maunakea. The data gathered at this station indicate that the air quality at the Mauna Loa Observatory is excellent and well within attainment for both

NAAQS and SAAQS. Given the similarities between the two locations (Maunakea and Maunaloa), it may be inferred that overall air quality at the CSO Site is excellent as well.

Maunakea rises well above the atmospheric temperature inversions that occur at approximately 7,000 feet MSL. Particulates and aerosols like vog (volcanic gas), smog, dust, smoke, salt, and water vapor generated below the inversion level are “capped” by the temperature inversion, so they do not rise above the inversion layer and do not cause any interference with observatories on the summit. Periodically, anabatic winds can come up the slopes of Maunakea, penetrating the inversion layer, and bringing with them insects and relatively small volumes of air from lower elevations.¹¹ Locally generated contributors to air pollution above the inversion level include vehicle exhaust, chemical fumes from construction and maintenance activities, and fugitive dust from various sources, including vehicles traveling on unpaved surfaces, road grading, and construction or other activities conducted in unpaved areas. Rapid dispersion of pollutants is aided by strong winds in the summit region.

4.10.2 POTENTIAL IMPACTS

Under all of the action alternatives (ALT-2, ALT-3, and ALT-4) considered in this report, potential air quality effects will be short-term, construction related, and less than significant. During the deconstruction, removal, and site restoration process (see Section 2.1.2), the heavy construction equipment that will be used for implementation of the CSO Decommissioning Project (e.g., bulldozers, tractor trailers, excavators, etc.) will be powered by internal combustion engines that emit a variety of air pollutants. Construction equipment emissions result from the following sources and activities: (i) construction equipment engine exhaust; (ii) motor vehicle exhaust, brake, and tire wear; (iii) entrained dust from material delivery trucks; (iv) entrained dust from roadways; (v) entrained dust from construction worker vehicles; (vi) fugitive dust from bulldozing, grading, and scraping, and from the handling of excavated material, such as depositing excavated fill into haul trucks; and (vii) fugitive dust from wind erosion of disturbed areas.

This equipment, powered by internal combustion engines, will emit a variety of air pollutants, all in small quantities and over a relatively limited period of time (i.e., several months). None of these equipment emissions will add substantively to the existing area sources of these pollutants, which consists principally of vehicles traveling along Mauna Kea Access Road. As a result, combustion emissions such as NO_x and diesel particulate matter from this equipment are not expected to have a significant effect on local or regional air quality.

Soil disturbance during deconstruction, removal, and site restoration activities will also have temporary effect on air quality, which may be more noticeable than emissions from engines. Activities such as the removal of the cesspool and copper grounding mesh will require disturbance of soil and generate fugitive dust, as will hauling excess fill from the CSO Site to the Batch Plant stockpiling area. Caltech will implement BMPs that reduce dust generation so that impacts to air quality, habitat, and astronomical facilities is negligible and less than significant. The potential for fugitive dust will continue until ground-disturbing activities are complete; once site restoration is complete no further potential for air quality impacts, however modest, exists.

¹¹ Anabatic winds are winds that blow up a steep slope or mountainside, driven by heating of the slope, typically during the daytime in calm, sunny weather.

The No Action Alternative does not have the potential to cause any impacts to local or regional air quality.

4.10.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Implement a Best Management Practices Plan that covers a range of topics and incorporates sustainable practices as required by CMP management actions C-2 and C-9, including practices associated with air quality directly or indirectly, including, but not limited to:
 - Require all vehicles and motorized equipment to be maintained in good working condition.
 - The total number of vehicle trips for workers, and thus the emissions related to vehicular travel, will be minimized via ride-sharing and/or vanpooling, when appropriate.
 - Exterior gas- or diesel-powered generators will only be used when needed.

4.11 NATURAL HAZARDS

4.11.1 EXISTING CONDITIONS

4.11.1.1 Fire

The Hawai'i County Fire Department is the primary agency responsible for the delivery of a variety of emergency services for the County of Hawai'i. Services include fire suppression, emergency medical services (EMS), land and sea rescues, vehicular and other extractions and hazardous materials mitigation. The county is divided into two battalion areas, East and West, with one Assistant Fire Chief for each battalion area.

There are 20 County fire stations and two Federal fire stations (Hawai'i Volcanoes National Park and PTA). PTA has a Mutual and Automatic Aid Agreement with the County of Hawai'i and provides first response to 911 calls for all fires, traffic accidents and other emergencies in its vicinity, including at a minimum, the area from Saddle Road Mile Post 17 to 46 and the summits of Maunakea and Mauna Loa.

4.11.1.2 Earthquakes and Geological Hazards

The potential for renewed volcanic activity in the Maunakea summit region is extremely remote. Maunakea last erupted approximately 4,600 years ago, and the volcano is classified as dormant, but not extinct. In 1997, Wolfe and others mapped a dozen separate post-glacial (i.e., less than 10,000 years ago) eruptive vents on Maunakea's middle flanks, but none younger than 40,000 years old were found in the summit area. These findings support the theory that future eruptions will likely occur well below the summit and will not pose any threat to the CSO Site.

The most significant geologic hazard is seismic activity. Hawai‘i Island is one of the most seismically active areas on Earth, and about two dozen earthquakes with a magnitude 6 or greater have been documented on Hawai‘i since the devastating earthquakes of 1868; those that caused damage are listed in Table 4.12. The approximate epicenter of those earthquakes and the predicted Modified Mercalli Intensity Scale (MMIS) seismic intensities are shown as well. In 2006, a VII intensity earthquake on the MMIS caused minor damage to the Keck, Subaru, UH 2.2m, and the Canada-France-Hawai‘i Telescope (CFHT) astronomical facilities. Some auxiliary equipment was damaged, but the telescopes’ mirrors and overall facility structural integrity were not affected. The summit of Maunakea will remain susceptible to seismic disturbance with intensities up to VII on the MMIS.

Table 4.12 Summary of Damaging Earthquakes on Hawai‘i Island

<i>Date</i>	<i>Epicenter Location</i>	<i>Max. MMIS</i>	<i>Mag.</i>	<i>Deaths</i>	<i>Damage</i>	<i>Repair Cost</i>
3/28/1868	South Hawai‘i	IX	7.0	0	Extensive throughout South Hawai‘i	Unknown
4/2/1868	South Hawai‘i	XII	7.9	81	>Homes destroyed by tsunami	Unknown
10/05/1929	Hualālai	VIII	6.5	0	Extensive in Kona	Unknown
8/21/1951	Kona	VIII	6.9	0	Extensive in Kona	Unknown
4/26/1973	North of Hilo	VIII	6.2	0	Extensive in Hilo	\$5.6M
11/29/1975	Kalapana	VIII	7.2	2	Extensive in Hilo	\$4.1M
11/16/1983	Ka‘oiki	IX	6.7	0	Extensive throughout South Hawai‘i	>\$6M
6/25/1989	Kalapana	VII	6.2	0	Southeast Hawai‘i	\$1M
10/15/2006	Kīholo Bay	VIII	6.0-6.7	0	Northwest Hawai‘i	>\$100M
5/4/2018	East Rift Zone	VIII	6.9	0	Moderate damage	Unknown
Source: USGS (2019)						

More recently, on Friday, May 4, 2018, a magnitude 6.9 earthquake occurred with an epicenter near Fern Acres in Pāhoā on the east side of the island. This quake, associated with the eruption of Kīlauea Volcano, caused moderate damage. Hawai‘i Electric Light Co., Inc. estimated that this quake temporarily knocked out electrical service to approximately 14,000 customers.

4.11.1.3 Flood Hazards and Tsunami Inundation

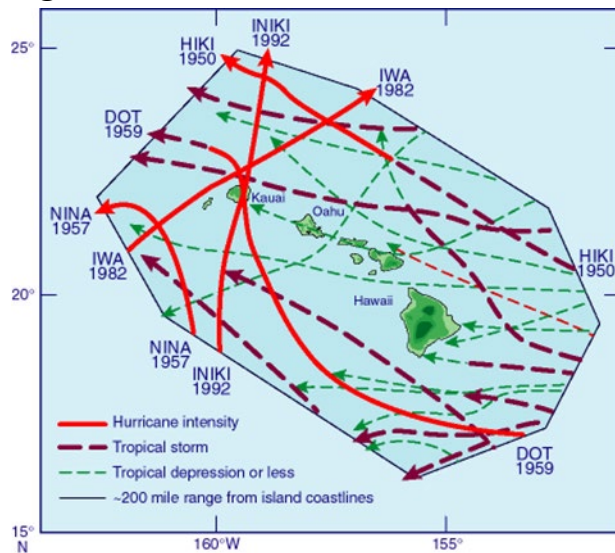
The Federal Emergency Management Area has designated the entire Maunakea summit region as being in Flood Zone X. This designation corresponds to areas that are subject to flooding from a potential 500-year flood or from a 100-year flood with flood levels of less than one foot. Areas designated as Zone X are outside of the 0.2 percent annual chance floodplain; because these areas are considered to have very low potential for flooding, no base flood elevations have been determined. There is no record of any flood occurring at or near the CSO Site.

The CSO Site is not located within a designated Flood Hazard Safety Area nor is it within a Tsunami Evacuation area (Pacific Disaster Center, 2018).

4.11.1.4 Hurricanes and Tropical Storms

While many hurricanes have passed near Hawai‘i Island during the last 50 years, none have directly affected the Island of Hawai‘i (Figure 4-24). However, on Friday, August 8, 2014, Tropical Storm Iselle landed on the eastern side of Hawai‘i Island. It was the strongest tropical system to make landfall on the island since reliable records began in 1950. The storm made landfall just prior to 3:00 AM HST with sustained winds near 60 mph and higher gusts. A gust of 66 mph was observed at Volcano National Park, and a gust to 72 mph occurred as far away as O‘ahu Forest National Wildlife Reserve (AccuWeather, 2014). Another tropical storm in 1958 reached sustained speeds of 35 mph with gusts of 52 mph near Hilo. In other areas of the island, as judged by damage, winds reached sustained speeds of at least 58 mph with gusts of 86 mph or more (CPHC, 2013).

Figure 4-24 Hurricane Tracks, 1950 to 2012



Source: UH School of Ocean and Earth Science and Technology (2014)

4.11.1.5 Climate Change and Sea Level Rise

The global community of climate scientists has concluded that sea levels are currently rising and that this trend is expected to continue for the foreseeable future. The Intergovernmental Panel on Climate Change (IPCC) has predicted (Church et al., 2013; IPCC, 2013) that the average temperature in the Hawaiian Islands is likely to increase by 0.5 to 1.5 C (0.9-1.7 F) by 2100, rainfall is likely to decrease by, at most 10 percent, and sea level could rise between 0.26 and 0.98 m (0.85 to 3.2 feet).

4.11.2 POTENTIAL IMPACTS

4.11.2.1 Potential Impacts from Fire

As discussed in Section 2.1.2.3, fire and fire prevention has been a focus of Caltech from the project's inception. As part of the early planning and scoping for the proposed CSO Decommissioning Project, a meeting was held between Caltech representatives and Chief Darren Rosario, Deputy Chief Lance Uchida, Battalion Chief Robert Perreira of the HCFD to discuss fire

and fire-response related issues associated with the project. The HCFD has indicated that during construction Caltech and its contractors may stage trailers to sort and deposit aluminum, steel, and deconstruction waste on-site. Caltech anticipates using roll-off trailers or similar containers, brought to the site, and stationed there during deconstruction. The contractor will be responsible for sorting and depositing construction waste in the appropriate on-site container. HCFD has also stated that:

- Up to four locations may be designated on-site for deconstruction material sorting and collection, and that up to three roll-off trailers may be used, as appropriate, at any time during deconstruction.
- A truck may deliver an empty roll-off container up to a designated open location and haul away the full container while still complying with the total limit of three roll-off containers noted above.
- Recyclable material and deconstruction waste will be properly separated at all times during the deconstruction process.

Caltech and its contractors will also comply with these stipulations along with all applicable standards and procedures of the NFPA's Uniform Fire Code (2006) and, specifically, *Code 241 Standards for Safeguarding Construction, Alteration, and Demolition Operations*. Per that guidance, Caltech or its contractors will develop, maintain, and keep on-site a written fire prevention, fire suppression, and emergency evacuation plan. In addition, Caltech and its contractors will continue to coordinate, as necessary, with HCFD throughout implementation of the CSO Decommissioning Project. With these measures in place, no significant impacts related to fire are anticipated as a result of any of the action alternatives evaluated in this report.

The No Action Alternative does not have the potential to cause impacts related to fire.

4.11.2.2 Potential Impacts from Earthquakes and Geological Hazards

Because CSO Decommissioning Project will not create any new structures or infrastructure, it is not susceptible to damage by seismic activity and will not increase the seismic vulnerability of the CSO Site or adjacent areas.

The No Action Alternative does not have the potential to have any effect on the seismic vulnerability of the CSO Site or adjacent areas.

4.11.2.3 Potential Impacts from Flood Hazards and Tsunami Inundation

The CSO Site is not located in an area with any history of flooding or tsunami inundation and the action alternatives under consideration for the CSO Decommissioning Project will not increase vulnerability of the area to these hazards in any way.

The No Action Alternative does not have the potential to cause or increase the vulnerability of the CSO Site or adjacent areas to flooding or tsunami inundation.

4.11.2.4 Potential Impacts from Hurricanes and Tropical Storms

The CSO Decommissioning Project will not create any buildings or aboveground structures which could be vulnerable to hurricane-force winds. Thus, the likelihood of impacts to the CSO Decommissioning Project from such storms is very low. In the event that a hurricane or tropical storm does occur during the roughly six month deconstruction and restoration effort, all work will cease and workers will vacate the summit region, secure equipment and materials left on site, and remove any vulnerable equipment and/or material prior to the storm.

The No Action Alternative does not have the potential to cause or increase the vulnerability of the CSO Site or adjacent areas due to hurricanes or tropical storms.

4.11.2.5 Potential Impacts from Climate Change and Sea Level Rise

The small predicted temperature change and modest decrease in rainfall would not significantly affect the CSO Decommissioning Project. Because the CSO site is located on the summit of Maunakea, well above sea level, a rise in average sea level of even 3.2 feet (1 m) would not affect any of the action alternatives.

The No Action Alternative does not have the potential to affect the climate, regional microclimate, or to contribute to climate change or sea level rise.

4.11.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Require all vehicles and motorized equipment to be maintained in good working condition.
- Caltech will prepare and abide by the terms of a fire prevention, suppression, and emergency evacuation plan in coordination with HCFD.
- Implement a Best Management Practices Plan that covers a range of topics and incorporates sustainable practices as required by CMP management actions C-2 and C-9.

4.12 PUBLIC SERVICES

4.12.1 EXISTING CONDITIONS

4.12.1.1 Hawai‘i County Police Department

The Hawai‘i County Police Department (HCPD) is the designated law enforcement agency for the Island of Hawai‘i. Its operations are separated into two areas of the island. Area I covers the eastern side of the island and includes the districts of: (i) Hāmākua, (ii) North Hilo, (iii) South Hilo, and (iv) Puna. It is home to the HCPD headquarters and four stations. Area II covers West

Hawai‘i, and includes the districts of: (i) North Kohala, (ii) South Kohala, (iii) Kona, and (iv) Ka‘ū, with five stations across these districts. Each of the two areas is run by a Commander, and each district in the County is headed by a police captain. The most recent data presented *County of Hawai‘i Data Book*, is for the year 2015, and lists the per capita ratio of resident population to police officers at 328 to 1; there is no further breakdown by district.¹²

4.12.1.2 Hawai‘i County Fire Department

As noted in Section 4.11.1.1, HCFD is the primary agency responsible for the delivery of a variety of emergency services, including responding to fires, EMS, land and sea rescues, vehicular extractions, and hazardous materials mitigation for the County of Hawai‘i. The County is divided into two battalion areas, East and West, with one Assistant Fire Chief in charge of each battalion area. There are twenty fulltime fire and medical stations and twenty volunteer fire stations, with over sixty pieces of heavy equipment available for a variety of emergencies that may occur on the island.

4.12.1.3 Schools

There are approximately 42 public, 12 charter, and 19 private schools located around the island; some serve grades kindergarten through 12th (K-12) grade, while others serve only certain grade levels. For the 2014-2015 academic year, total combined public and private enrollment for all grades K-12 was 30,046 students.

4.12.1.4 Recreational Facilities

There are various recreational facilities sponsored by the County of Hawai‘i on the island, including parks, pools, community- and senior-centers. Public school facilities are also available to the community as recreational facilities when school is not in session.

4.12.1.5 Medical Services

There are five major medical facilities on the Island of Hawai‘i: (i) Kohala Hospital, (ii) Hale Ho‘ola Hāmākua, (iii) Kona Community Hospital, (iv) Ka‘ū Hospital, and (v) Hilo Medical Center. These facilities offer varying services and levels of care, but all offer 24-hour EMS.

4.12.2 POTENTIAL IMPACTS

None of the action alternatives in this EA will create conditions which would impose additional pressure on HCFD, HCPD, area schools, recreational facilities, or medical services.

The No Action Alternative does not have the potential to affect any public services in any way.

4.12.3 MITIGATION MEASURES

The project will comply with all aspects of the CMP as outlined in Section 2.1.2.1 and elsewhere in this document. For example, this will include:

¹² This ratio is extrapolated from information contained in the 2015 *County of Hawai‘i Data Book*, which identified the population of the County at 196,428 and the number of HCPD officers as 599.

- All construction personnel being educated regarding the environment, ecology, and natural resources in the project area as required by CMP management action C-8.
- Caltech will prepare and abide by the terms of a fire prevention, suppression, and emergency evacuation plan in coordination with HCFD (see Section 4.11.2.1).
- Comply with NFPA's *Code 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations*.
- Implement a Best Management Practices Plan that covers a range of topics and incorporates sustainable practices as required by CMP management actions C-2 and C-9.

4.13 CUMULATIVE IMPACTS

During the preliminary planning process, Caltech has evaluated whether the CSO Decommissioning Project, while individually limited in scope, might contribute to significant impacts on the natural or human environment when considered cumulatively along with other projects in the Maunakea summit region. A cumulative impact is an impact on the environment which results from the incremental impact of a proposed action when added to other past, present and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. A cumulative impact occurs when the incremental environmental effects of the Project added to other past, present, and reasonably foreseeable future actions result in substantial significant impacts.

Cumulative impacts in the Maunakea summit region have been summarized in numerous environmental disclosure documents in the past, most recently the EIS for the TMT project in 2010. This EA accepts the findings of the analysis documented in that EIS and assesses the effects of the CSO Decommissioning Project and the effects of other foreseeable action in the summit region. The other foreseeable actions in the summit region are:

- The decommissioning of the Hōkū Ke‘a astronomy facility, which is foreseeable because UH Hilo submitted a NOI to OMKM on September 16, 2015. The NOI states that “UH Hilo intends to deconstruct and remove the telescope and observatory structure and restore the site. The deconstruction, removal, and restoration activities will be conducted pursuant to the Site Deconstruction and Removal Plan and a Site Restoration Plan, both of which will be developed and implemented in accordance with the Decommissioning Plan. Use of the site for astronomy purposes will be permanently ended; no astronomy re-use is contemplated.” Caltech has no further information regarding this foreseeable action. The decommissioning process and effort is likely to be very similar to that employed to decommission CSO (both are complying with the Decommissioning Plan); therefore, Caltech assumes the direct impacts associated with this project will be similar to those document in the sections above.
- The installation of a Chlorine Oxide (ClO) monitor at a facility in the summit region. This is foreseeable because a ClO monitor is located in the CSO outbuilding, which will be removed by the proposed action, and the ClO monitor operator, the Naval Research Laboratory, has indicated that they will seek a new location for the ClO monitoring instrument in the Maunakea summit region. Caltech understands that a new

CLO monitoring instrument will be installed within an existing facility and will require very little, if any, modifications to the facility that would be visible from its exterior. Based on that understanding, Caltech anticipates that direct impacts associated with this effort, if any, will be nominal.

- The storage of safety supplies and the regular parking of a vehicle at a facility other than the CSO is also foreseeable. Safety supplies utilized by the Rangers have historically been stored in the CSO's outbuilding; with the removal of that building as part of the proposed action, those supplies will have to be stored in another location in the summit region. In addition, a vehicle designated for emergency egress of injured, sick, or stranded people from the summit region has historically been parked at the CSO facility; with the decommissioning of the CSO facility, that vehicle will be parked outside another facility in the future. Caltech understands that space within an existing facility will be found for the storage of the safety supplies and that no modifications to the facility would be necessary. Caltech further understands that the vehicle will be parked within an existing parking area of an existing facility so that no new disturbance in the summit region is needed to accommodate this vehicle. Based on that understanding, Caltech anticipates that direct impacts associated with these adjustments, if any, will be nominal.

Although the TMT project has not been constructed, it is not treated as a foreseeable action in this analysis because that project's effects are accounted for in the EIS that this section uses as its starting point. The level of existing cumulative impact disclosed in this EA treats the TMT project as a past project, along with the development of access roads, trails, utilities, and the other astronomical facilities, including CSO.

The TMT EIS cumulative impact analysis concluded that:

- The existing level of cumulative impact to cultural, historic, biological, visual, and geologic resources is substantial, significant, and adverse.
- The existing level of cumulative impact to socioeconomic conditions and public services is substantial and beneficial.
- The existing level of cumulative impact to other resources is not substantial and is less than significant.

Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be countervailing, where the negative cumulative effect is less than the sum of the individual effects, or synergistic, where the net negative cumulative effect is greater than the sum of the individual effects. The following subsections consider whether the effects of the foreseeable projects listed above, when considered together with the CSO Decommissioning Project, may result in significant cumulative impacts to area resources.

4.13.1 ARCHAEOLOGICAL RESOURCES

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on archaeological and historic resources that is considered substantial, significant, and adverse.

Under any of the action alternatives considered in this report (ALT-2, ALT-3, and ALT-4), the removal of the CSO is anticipated to have beneficial effects on nearby archaeological and historic resources (Section 4.1.4). The decommissioning of the Hōkū Ke‘a facility is expected to have similar, if not greater, beneficial effects because it will remove a non-contributing feature from the historic district that is visible from a greater number of contributing features than the CSO. Furthermore, it is located on the TCP Kūkahau‘ula; that resource would directly benefit from its decommissioning. The other foreseeable actions are not anticipated to result in any effects on archaeological resources.

As such, the implementation of the proposed action and other foreseeable actions, in the context of the existing environment, would have a limited beneficial effect; however, the level of cumulative impact on archaeological and historic resources would continue to be substantial, significant, and adverse.

4.13.2 CULTURAL RESOURCES

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on cultural resources that is considered substantial, significant, and adverse.

Under any of the action alternatives considered in this report (ALT-2, ALT-3, and ALT-4), the removal of the CSO is anticipated to have varying degrees of beneficial effects on nearby cultural resources and Maunakea’s cultural landscape (Section 4.2.4). The decommissioning of the Hōkū Ke‘a facility is expected to have similar, if not greater, beneficial effects because it will remove a facility situated on the TCP Kūkahau‘ula. The other foreseeable actions are not anticipated to result in any effects on cultural resources.

As such, the implementation of the proposed action and other foreseeable actions would have a limited beneficial effect; however, the level of cumulative impact on cultural resources would continue to be substantial, significant, and adverse.

4.13.3 BIOLOGICAL RESOURCES

The TMT EIS concluded that, based on the information available at the time it was prepared in 2010, it was not possible to determine the magnitude or significance of past human activity on wēkiu bugs or other biological resources that inhabit the alpine stone desert ecosystem. The wēkiu bug was a candidate for listing as a threatened or endangered species at the time the TMT EIS was prepared. It is possible that a significance determination was not made because it was not known if the species would be listed, or not.

Since the TMT EIS was completed, the Department of Interior’s U.S. Fish and Wildlife Service determined that the wēkiu bug would not be listed as threatened or endangered.

The proposed action’s effect on biological resources and habitat are, under all of the action alternatives (ALT-2, ALT-3, and ALT-4), anticipated to be beneficial (Section 4.3.3). The decommissioning of the Hōkū Ke‘a facility is expected to have similar beneficial effects because, although it would restore a smaller area than the proposed action, the restored area may be utilized by wēkiu bugs. The other foreseeable actions are not anticipated to result in any effects on biological resources.

The limited beneficial effect of implementing of the proposed action and other foreseeable actions in the context of the existing environment combined with the knowledge that wēkiu bugs (and other species that depend on the alpine stone desert habitat) are not listed as threatened or endangered species has led Caltech to determine that the level of cumulative impact on the alpine stone desert ecosystem is and would continue to be adverse, but less than significant.

4.13.4 VISUAL AND AESTHETIC RESOURCES

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on visual resources that is considered substantial, significant, and adverse.

Implementing any of the action alternative considered (ALT-2, ALT-3, or ALT-4), will result in the removal of all aboveground structures from the CSO Site and a beneficial impact on the viewshed of the surrounding areas (Section 4.4.2). While effects to visual resources are, to some extent, subjective, the decommissioning of the Hōkū Ke‘a facility is expected to have similar, if not greater, beneficial effects because it will remove a facility that has a larger viewshed (15 percent of the island) than the CSO (5 percent of the island). The visual effects of the other foreseeable actions will be limited to the vehicle for emergency egress from the summit being parked in a different location that may be slightly more visible than it was at the CSO site. Because that vehicle will be parked within an existing parking lot where other vehicles are typically present, the visual effects are anticipated to be minimal.

As such, the implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a limited beneficial effect; however, the level of cumulative impact on visual resources would continue to be substantial, significant, and adverse.

4.13.5 GEOLOGY AND TOPOGRAPHY

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on geology and topography that is considered substantial, significant, and adverse. This determination was primarily due to the alteration of the cinder cone morphology in the summit region.

As discussed in Section 4.5—and regardless of which action alternative is implemented—the proposed action’s impacts will be positive. The decommissioning of the Hōkū Ke‘a facility is expected to have similar, and potentially greater, beneficial effects because it may restore some topography of a cinder cone. The other foreseeable actions are not anticipated to result in any effects on geology and topography.

Thus, the implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a limited beneficial effect; however, the level of cumulative impact on geology and topography would continue to be substantial, significant, and adverse.

4.13.6 WATER RESOURCES

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on water resources that is considered negligible and less than significant.

As discussed in Section 4.6.2, the proposed action would result in no long-term impacts to groundwater or surface water because it involves the removal of facilities. The decommissioning of the Hōkū Ke‘a facility is, similarly, not expected to have any effect on water resources. The other foreseeable actions are not anticipated to result in any effects on water resources.

Thus, the implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a negligible effect on water resources and the level of cumulative impact on water resources would continue to be negligible and less than significant.

4.13.7 SOLID AND HAZARDOUS WASTE MANAGEMENT

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact due to solid and hazardous materials and waste is small and less than significant.

Because of the nature of the proposed action, regardless of which action alternative is implemented, the proposed CSO Decommissioning Project will generate substantial quantities of waste, but only very limited volumes of that waste may be categorized as hazardous waste (Section 4.7). Overall, the proposed project will not result in a significant impact due to its solid and hazardous waste management. The decommissioning of the Hōkū Ke‘a facility is expected to similarly not result in significant impacts due to materials and wastes. The other foreseeable actions are not anticipated to result in any waste generation.

The implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a limited effect due to solid and hazardous materials and waste and the level of cumulative impact would continue to be small and less than significant.

4.13.8 TRAFFIC

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact that is less than significant as the existing roads are sufficient to handle the level of traffic, and that project does not represent a significant impact to the roads and level of traffic.

Because the nature of the proposed action, and regardless of which action alternative is implemented, the proposed CSO Decommissioning Project will temporarily generate a modest number of vehicle trips daily during the deconstruction and site restoration operations. As discussed in Section 4.8.2, the impact of the proposed project will be less than significant. The decommissioning of the Hōkū Ke‘a facility is expected to cause similar temporary traffic impacts. The other foreseeable actions are not anticipated to result in any traffic increases or impacts.

The proposed project and foreseeable actions will result in a long-term reduction in the number of daily astronomy-related trips to the summit region. As such, the implementation of the proposed action and other foreseeable actions would have a limited beneficial effect and the level of cumulative impact related to traffic would continue to be less than significant.

4.13.9 NOISE

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative noise impact that is less than significant.

The CSO Decommissioning Project—regardless of action alternative—will eliminate an existing source of periodic noise (the astronomy facility) and result in a temporary increase in noise related to deconstruction and restoration. The decommissioning of the Hōkū Ke‘a facility is expected to result in similar temporary noise impacts but also eliminate the source of periodic noise (the astronomy facility). The other foreseeable actions are not anticipated to result in any changes to the sonic environment.

The implementation of the proposed action and other foreseeable actions, in the context of the existing environment, would have a nominal long-term benefit on the sonic environment and the level of cumulative noise impact would continue to be less than significant.

4.13.10 AIR QUALITY

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a level of cumulative impact on air quality—primarily related to vehicle traffic-related emissions—that is less than significant.

As discussed in Section 4.10.2, the proposed project’s impacts on air quality will be less than significant. The decommissioning of the Hōkū Ke‘a facility is expected to have similar temporary and minimal impacts on air quality. The other foreseeable actions are not anticipated to result in any air quality impacts.

As such, the implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a limited beneficial effect (the elimination of long-term vehicle trips to the summit) and the level of cumulative impact on air quality would continue to be less than significant.

4.13.11 SOCIOECONOMIC CONDITIONS

As disclosed in the TMT EIS, the past actions in the summit region have resulted in a substantial and beneficial socioeconomic cumulative impact.

When the CSO facility ceased to operate in 2015, it eliminated some long-term, full-time jobs. The decommissioning of the facility will result in a limited number of short-term construction jobs. The discontinuation of the CSO facility will have a nominal adverse effect on the socioeconomic condition of Hawai‘i Island. The decommissioning of the Hōkū Ke‘a facility will have similar short-term construction effects, but because its long-term socioeconomic benefits are likely to be replaced by a new educational telescope at Halepōhaku, it would not have any long-term adverse effects on the island’s socioeconomic condition. The other foreseeable actions are not anticipated to result in any socioeconomic impacts.

As such, the implementation of the proposed action and other foreseeable actions in the context of the existing environment would have a nominal adverse effect (the elimination of a few long-term jobs) and the level of socioeconomic cumulative impact would continue to be substantial and beneficial.

4.14 MITIGATION MEASURES

This section summarizes the measures that Caltech will take that go beyond compliance with applicable rules, regulations, and statutory requirements, and are intended to reduce the potential for significant impacts to sensitive resources. The mitigation measures that have been identified in this EA have been developed to avoid, minimize, and rectify or mitigate the CSO Decommissioning Project's potential adverse impacts to the natural and human environment. Mitigation measures have been considered throughout the project planning process and will be incorporated into the project's deconstruction and restoration plans. Mitigation measures which are broadly intended to apply to all or nearly all activities include:

- Design all work to comply, or facilitate compliance with, applicable rules, regulations, and statutory requirements;
- Require: (i) archaeological; (ii) cultural; and (iii) invasive species monitors to be present during relevant and/or applicable activities;
- Prepare and implement: (i) cultural, (ii) natural resources, (iii) safety training for all on-site personnel and contractors; and
- Develop and institute: (i) invasive species monitoring; (ii) waste minimization, (iii) material storage and waste management, and (iv) spill prevention and response plans.

Table 4.13 provides a summary of the mitigation measures that Caltech will employ as part of the CSO Decommissioning Project, regardless of which action alternative (ALT-2, ALT-3, or ALT-4) is implemented, to ensure that potential impacts are less than significant.

Table 4.13 Summary of Mitigation Measures

Section	Resource	Mitigation
4.1	Archaeology	Archaeological monitoring per the terms of AMP.
4.2	Cultural Impact Assessment	Independent on-site cultural resources specialist monitor will be used while there is work performed during the deconstruction and restoration processes.
4.3	Biology	All persons involved with decommissioning activities, including planning, demolition, and site restoration, will participate in a mandatory training about the natural resources on Maunakea. In addition, Caltech will institute measures to: (i) minimize habitat disturbance; (ii) avoid introduction of non-native species; (iii) manage onsite material storage and disposal; and (iv) conduct invasive species monitoring.
4.4	Visual and Aesthetic Resources	n/a
4.5	Geology and Topography	BMPs including: (i) erosion and water quality measures; (ii) dust and debris management; and (iii) worker orientation regarding historic, cultural, ecological, and natural resources.
4.6	Hydrology	Follow or exceed HDOH-WB guidance including applicable provisions of <i>General Backfilling Scenarios for an Injection-Well Cesspool</i> (HDOH, 2004).
4.7	Solid and Hazardous Waste	Caltech will: (i) Prepare Phase II ESA assessing whether contaminants (i.e., hydraulic oil) are present in soil beneath the CSO and remediate, as necessary; (ii) train all construction personnel regarding environment, ecology, and natural resources of Maunakea; (iii) sort and properly recycle or dispose of construction waste; and (iv) implement a BMP Plan that covers waste management and incorporates sustainable practices as required by the CMP.
4.8	Traffic	Ridesharing will be implemented. In addition, will employ TMP guidance including: (i) temporary signage; (ii) changeable message boards; (iii) channelizing devices; (iv) flaggers and uniformed traffic control officers; (v) barricades; (vi) portable barriers; and (vii) escort vehicles. Caltech and its contractors will coordinate with CMS and MKOs to prevent conflicts between different operations (e.g., TMT construction) which may occur concurrently.
4.9	Noise	Adhere to HAR, Title 11, Chapter 46. Also, total number of vehicle trips for workers will be minimized via ride-sharing and/or vanpooling.
4.10	Air Quality	Follow BMPs related to: (i) erosion, (ii) dust, (iii) debris management; and (iv) requiring all vehicles and equipment to be maintained in good working condition.
4.11	Natural Hazards	Follow provisions of fire prevention, suppression, and emergency evacuation plan in coordination with HCFD, and adhere to NFPA's <i>Code 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations</i> .
4.12	Public Services	Follow provisions of fire prevention, suppression, and emergency evacuation plan in coordination with HCFD, and adhere to NFPA's <i>Code 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations</i> .
Source: Compiled by Planning Solutions, Inc. (2020)		

CHAPTER 5: CONSISTENCY WITH LAND USE PLANS, POLICIES, AND CONTROLS

This chapter discusses the relationship of the CSO Decommissioning Project to applicable land use plans, policies, and regulations at the County, State, and Federal level. Compliance with existing regulations and requirements, including via the implementation of mitigation measures discussed in Section 4.14, will help to ensure that the proposed action will not result in significant impacts on current land use policies and programs at the local, regional, or national level.

5.1 COUNTY OF HAWAI‘I

5.1.1 COUNTY GENERAL PLAN

The *Hawai‘i County General Plan* (GP) is a policy document expressing the broad goals and policies for the long-term development of the Island of Hawai‘i. The GP was adopted by ordinance in 1989 and revised in 2005. The GP itself is organized into thirteen broad domains, with policies, objectives, and standards for each, including: (i) economic, (ii) energy, (iii) environmental quality, (iv) flooding and natural hazards, (v) historic sites, (vi) natural beauty, (vii) natural resources and shoreline, (viii) housing, (ix) public facilities, (x) public utilities, (xi) recreation, (xii) transportation, and (xiii) land use.

There are also discussions of the specific applicability of each element to the nine judicial districts comprising the County of Hawai‘i. The GP notes:

“The summit area of Mauna Kea has the worldwide distinction as the best international center for observational astronomy. ... The astronomical facilities located atop Mauna Kea are also part of the Hāmākua District.

The facilities are located within the 11,228 acre Mauna Kea Science Reserve, which includes those lands situated above the 12,000 foot elevation, with the exception of areas within the Mauna Kea Ice Age Natural Area Reserve.”

The following sections of the GP contain the policies and goals most applicable to the CSO Decommissioning Project, followed by a discussion of their relationship to the proposed action; they are:

County General Plan Policies For Economic Goals - Chapter 2.2

Provide residents with opportunities to improve their quality of life through economic development that enhances the County’s natural and social environments.

Economic development and improvement shall be in balance with the physical, social, and cultural environments of the island of Hawaii.

Strive for diversity and stability in the economic system.

Provide an economic environment that allows new, expanded, or improved economic opportunities that are compatible with the County’s cultural, natural and social environment.

Strive for an economic climate that provides its residents an opportunity for choice of occupation.

Strive for diversification of the economy by strengthening existing industries and attracting new endeavors.

Strive for full employment.

Promote and develop the island of Hawaii into a unique scientific and cultural model, where economic gains are in balance with social and physical amenities. Development should be reviewed on the basis of total impact on the residents of the County, not only in terms of immediate short run economic benefits.

Discussion: While the CSO Decommissioning Project will result in some temporary employment and expenditures, it is modest in scope and will not make a significant impact on socioeconomic conditions within the County of Hawai'i. However, the proposed action is not inconsistent with the economic development goals identified above and will not obstruct or inhibit any other projects or industrial development. Further, the environmentally and culturally appropriate removal of the defunct observatory and restoration of the site will demonstrate that the scientific contributions of the CSO can be balanced with the cultural and environmental sensitivity of Maunakea's summit region in a careful and well managed way.

County General Plan Policies For Natural Beauty - Chapter 7.2 Goals

Protect, preserve and enhance the quality of areas endowed with natural beauty, including the quality of coastal scenic resources.

Protect scenic vistas and viewplanes from becoming obstructed.

Maximize opportunities for present and future generations to appreciate and enjoy natural and scenic beauty.

County General Plan Policies For Natural Resources and Shoreline - Chapter 8.2 Goals

(a) Protect and conserve the natural resources from undue exploitation, encroachment and damage.

(b) Provide opportunities for recreational, economic, and educational needs without despoiling or endangering natural resources.

(c) Protect and promote the prudent use of Hawaii's unique, fragile, and significant environmental and natural resources.

(d) Protect rare or endangered species and habitats native to Hawaii.

(e) Protect and effectively manage Hawaii's open space, watersheds, shoreline, and natural areas.

(f) Ensure that alterations to existing land forms, vegetation, and construction of structures cause minimum adverse effect to water resources, and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation, or failure in the event of an earthquake.

Discussion: By removing the existing structures and supporting infrastructure currently occupying the site, the CSO Decommissioning Project will uphold the natural resource goals of the Hawai‘i County General Plan. The deconstruction, removal, and site restoration process will return a portion of Maunakea’s summit region closer to its pre-construction condition and has the potential to serve as an important template for the decommissioning of other astronomical facilities as their organizations choose to cease operation. The native plant and arthropod habitat restoration that is a part of the project will also serve to protect important native habitat and the monitoring that will accompany it has the potential to provide valuable insights into how to protect and effectively manage restored habitat.

*County General Plan Policies For Land Use – Public Lands - Chapter 14.9.2
Goals*

(a) Utilize publicly owned lands in the best public interest and to the maximum benefit for the greatest number of people.

Discussion: The CSO Decommissioning Project is intended to demonstrate the pono disposition of publicly owned land following astronomy use by returning the site, as closely as possible, to its pre-development condition. The proposed action is consistent with what those consulted have indicated is in the public’s best interest at the CSO Site.

5.1.2 HĀMĀKUA COMMUNITY DEVELOPMENT PLAN (2018)

The *Hāmākua Community Development Plan* (HCDP) was adopted by the County of Hawai‘i as Ordinance No. 2018-78. The purpose of the HCDP is to: (i) establish County policy; (ii) direct County actions; (iii) help guide policies and actions of the State and Federal governments; and (iv) focus and guide community action in the Hāmākua District. The HCDP prioritizes natural and cultural resource protection, restoration, and enhancement and addresses land use and community infrastructure goals. While the document is necessarily far ranging, several of the provisions most directly applicable to the CSO Decommissioning Project are identified and discussed below.

4.9. Preserving Sacred Places: Waipi‘o Valley and Mauna Kea

4.9.1 Community Objective

This section of the CDP identifies Waipi‘o Valley and Mauna Kea as sacred places needing special attention. This section specifically addresses natural and cultural resource protections for both of these unique areas, but the section also addresses other elements of the CDP that are specific to these places.

Community Objective 1: *Protect, restore, and enhance watershed ecosystems, sweeping views, and open spaces from mauka forests to makai shorelines, while assuring responsible public access for recreational, spiritual, cultural, and sustenance practices.*

Community Objective 4: *Protect and nurture Hāmākua’s social and cultural diversity and heritage assets, including sacred places, historic sites and buildings, and distinctive plantation towns.*

Discussion: The CSO Decommissioning Project is intended to deconstruct and remove all structures and infrastructure from the site and then restore it, as closely as possible, to its pre-

construction condition. This process acknowledges the reverence that many have for Maunakea and is consistent with the HCDP's desire to protect, restore, and enhance sacred places for the recreational, spiritual, and cultural benefit of the people of Hawai'i.

4. 9. 8 Mauna Kea: Kokua Action

Kokua Action 43:

Collaborate with Observatories to develop a site decommissioning plan for each observatory, in accordance with the Decommissioning Plan for Mauna Kea Observatories.

Discussion: The purpose of the CSO Decommissioning Project is to fulfill the terms of Caltech's Site Decommissioning Plan (2021), which was prepared in accordance with the Decommissioning Plan (2010), thus upholding this action item of the HCDP.

4. 9. 8 Mauna Kea: Community Action

Kokua Action 36:

Provide natural and cultural resource preservation orientation training for tour operators, rangers, VIS staff, and volunteers in coordination with native practitioners who practice on Mauna Kea.

Discussion: As indicated in Section 2.1 and Table 2.1, and per the CMP, all personnel working on the CSO Decommissioning Project will complete the orientation training developed by OMKM and now administered by CMS. As part of the CSO Decommissioning Project, and as discussed in Section 4.2.5, a cultural monitor (in addition to archaeological and invasive species monitors) will provide cultural orientation, protocols, and guidance to individuals conducting on-site deconstruction and site restoration tasks so that the work can be carried out in a manner appropriate to its sensitive location.

5.2 STATE OF HAWAII

5.2.1 HAWAII STATE PLAN, HRS CHAPTER 226

Adopted in 1978 and last revised in 1991, the *Hawai'i State Plan* is intended to guide the long-range development of the State by:

- Identifying goals, objectives, and policies for the State and its residents;
- Establishing a basis for determining priorities and allocating resources; and
- Providing a unifying vision to enable coordination between the various counties' plans, programs, policies, projects and regulatory activities to assist them in developing their county plans, programs, and projects and the State's long-range development objectives.

The *Hawai'i State Plan* is a policy document. It depends on implementing laws and regulations to achieve its goals. While not all sections of the *Hawai'i State Plan* are directly applicable to the CSO Decommissioning Project, the most relevant are identified and discussed below.

§226-4: State Goals. In order to guarantee, for the present and future generations, those elements of choice and mobility that insure that individuals and groups may approach their desired levels of self-reliance and self-determination, it shall be the goal of the State to achieve:

(1) A strong, viable economy, characterized by stability, diversity, and growth, that enables the fulfillment of the needs and expectations of Hawaii's present and future generations.

(2) A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.

(3) Physical, social and economic well-being, for individuals and families in Hawai'i, that nourishes a sense of community responsibility, of caring, and of participation in community life.

Discussion: The CSO Decommissioning Project consists of the deconstruction and removal of all structures and infrastructure and the restoration of the site, as closely as possible, to its pre-construction condition. As such, it will enhance the beauty, cleanliness, quiet, and stability of the unique summit region of Maunakea. Caltech believes that in doing so, it will fulfill its responsibility to the community and uphold these goals of the Hawai'i State Plan.

§226-6: Objectives and Policies for the Economy in General.

(B) To achieve the general economic objectives, it shall be the policy of this State to:

(15) Promote and protect intangible resources in Hawai'i, such as scenic beauty and the Aloha spirit, which are vital to a healthy economy.

Discussion: It is Caltech's view that the timely implementation of the CSO Decommissioning Project will enhance the cultural and scenic beauty of the Maunakea summit region, consistent with this policy, via the deconstruction and removal of the observatory-related structures and infrastructure and the restoration of the site, as closely as possible, to its pre-construction condition. Thus, the proposed action is supportive of this policy.

§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 uses without generating costly or irreparable environmental damage.*
- (6) *Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii.*
- (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.*

Discussion: The CSO Decommissioning Project has been carefully planned and is intended to represent the prudent management of the site, shifting from an active astronomy facility to restored alpine stone desert ecosystem. With careful attention to the physical attributes of the site, Caltech is planning to restore and enhance the native habitat upon which native plants and animals of the alpine stone desert ecosystem depend; this is part of Caltech's broad commitment to the preservation of Hawai'i's natural resources. Finally, by serving as a well-managed example of the decommissioning process, the CSO Decommissioning Project may demonstrate the compatibility between scientific activities, facilities, and natural resources for other astronomical facilities.

5.2.2 STATE LAND USE LAW, HRS CHAPTER 205

Chapter 205, HRS established the State Land Use Commission and gives this body the authority to designate all lands in the State as Urban, Rural, Agricultural, or Conservation District. The counties make all land use decisions within the Urban District in accordance with their respective county general plans, development plans, and zoning ordinances. The counties also regulate land use in the State Rural and Agricultural Districts, but within the limits specified by HRS, Chapter 205.

The CSO Decommissioning Project is located in the State Conservation District. According to HAR §13-5-1, the intent of the Conservation District is to regulate land use within it:

“for the purpose of conserving, protecting, and preserving the important natural and cultural resources of the State through appropriate management and use to promote their long-term sustainability and the public health, safety, and welfare.”

The CSO was approved as a use within the Conservation District in 1982 by CDUP HA-1492. That permit places no conditions on the decommissioning of the CSO. The CSO Decommissioning Project is consistent with the range of land uses envisioned for the Conservation District and exemplifies the prudent management of conservation land by restoring its natural and cultural resources to the maximum extent practicable and promoting its long-term sustainability. A CDUP is being sought for the proposed project and this EA supports the application and informs the decision makers. The CDUA addresses the eight Conservation District use criteria. The proposed project will not commence until a permit is issued. The proposed action will contribute

to conservation, protection, and preservation of the Maunakea summit region; therefore, it is an appropriate land use in the Conservation District.

5.2.3 COASTAL ZONE MANAGEMENT PROGRAM, HRS 205A

The objectives of the Hawai‘i Coastal Zone Management (CZM) Program are set forth in Hawai‘i Revised Statutes, Chapter 205A. The program is intended to promote the protection and maintenance of valuable coastal resources. All lands in Hawai‘i are classified as valuable coastal resources. The State Office of Planning administers Hawai‘i’s CZM Program. A general discussion of the project’s consistency with the objectives and policies of Hawai‘i’s CZM Program follows.

5.2.3.1 Recreational Resources

Objective: Provide coastal recreational opportunities accessible to the public.

Policies:

- 1. Improve coordination and funding of coastal recreational planning and management; and*
- 2. Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*
- 3. Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;*
- 4. Requiring 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;*
- 5. Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
- 6. Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*
- 7. Ensuring 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;*
- 8. Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;*
- 9. Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and*
- 10. Encouraging 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; and crediting such dedication against the requirements of section 46-6.

Discussion: The proposed project will have no effect on coastal recreational resources. While some portion of the deconstruction, removal, and site restoration operations will be visible from nearby portions of the summit region, once complete, the restored site should be indistinguishable from adjacent areas and the project will not disrupt any ongoing use of the area or access to recreational opportunities.

5.2.3.2 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:

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

Discussion: The CSO Decommissioning Project is intended to restore, as closely as possible, the CSO Site to its natural, pre-construction condition. All work related to the project will occur in areas that have already been extensively disturbed. Section 4.1 describes the locations of historic resources in the project area, none of which are within the CSO Site. That section also outlines why it has been determined that no historic resources will be directly or adversely affected by the proposed project. The measures that Caltech will employ to protect and preserve historic resources, including those which could be inadvertently discovered during the decommissioning process, are also included in Section 4.1. SHPD will be sent a copy of this EA for review and their comments, if any, will be reproduced in the Final Environmental Assessment (FEA).

5.2.3.3 Scenic and Open Space Resources

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

Policies:

- 1. Identify valued scenic resources in the coastal zone management area;*
- 2. 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;*
- 3. Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and*
- 4. Encourage those developments that are not coastal dependent to locate in inland areas.*

Discussion: Coastal open space and scenic resources will not be adversely affected by the CSO Decommissioning Project. While the proposed deconstruction, removal, and site restoration operations will be visible from some public vantage points, this would be for only a brief time. Once restored, the site should be relatively indistinguishable from other unoccupied adjacent areas and with a much softer, more natural appearance than it has at the present time. The proposed action will require only modest alteration of natural landforms and is situated well away from public views of the shoreline.

5.2.3.4 Coastal Ecosystems

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

Policies:

1. *Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;*
2. *Improve the technical basis for natural resource management;*
3. *Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;*
4. *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*
5. *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 action will not interact with or affect coastal ecosystems or any other water body, as described in Section 4.6.2.

5.2.3.5 Economic Uses

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

Policies:

1. *Concentrate coastal dependent development in appropriate areas;*
2. *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*
3. *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:*

- i. Use of presently designated locations is not feasible;*
- ii. Adverse environmental effects are minimized; and*
- iii. The development is important to the State's economy.*

Discussion: The CSO Decommissioning Project is not a coastal development and would not lead to any changes in the concentration or location of coastal developments. The work would be conducted entirely within the MKSR at an elevation of roughly 13,350 feet above sea level and will have only a positive effect on the visual environment in Maunakea's summit region. While the proposed action will have only a minor impact on the State's economy, Caltech has instituted a series of mitigation measures summarized in Table 4.13 to ensure that the potential adverse environmental impacts of the project are minimized.

5.2.3.6 Coastal Hazards

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

Policies:

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

Discussion: Section 4.11.1.3 confirms that the project is outside the designated Special Flood Hazard Area and not within the County of Hawai'i's Tsunami Evacuation Zone. The proposed project will not cause or contribute to coastal flooding.

5.2.3.7 Managing Development

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

Policies:

- 1. Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;*
- 2. Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*
- 3. 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: Caltech has initiated contact (see Chapter 7) and continues to work cooperatively with all government agencies with oversight responsibilities to facilitate efficient processing of permits and informed decision making by the responsible parties. In addition, Caltech has, via public outreach and this EA, attempted to communicate the potential impacts of the CSO Decommissioning Project to the public in clear and understandable terms.

5.2.3.8 Public Participation

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

Policies:

1. *Promote public involvement in coastal zone management processes;*
2. *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*
3. *Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.*

Discussion: The public will have an opportunity to review and comment on the Draft EA, pursuant to the requirements of Hawai'i Administrative Rules §11-200.1. In addition to those requirements, Caltech plans to hold three public workshops during the Draft EA review period. Furthermore, the public participation objective will be addressed during the processing of the CDUA, which will include public notification and a public hearing.

5.2.3.9 Beach Protection

Objective: *Protect beaches for public use and recreation.*

Policies:

1. *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;*
2. *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*
3. *Minimize the construction of public erosion-protection structures seaward of the shoreline.*

Discussion: The project poses no risk to beaches. No structures are planned seaward of the shoreline, and no interactions with littoral processes would be involved.

5.2.3.10 Marine Resources

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

Policies:

1. *Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;*
2. *Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;*
3. *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;*
4. *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*
5. *Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.*

Discussion: The proposed project does not have the potential to affect marine resources.

5.2.4 CONSISTENCY WITH MASTER LEASE AND SUBLEASE

There are two layers of contractual agreements that have bearing on the CSO Decommissioning Project: (i) the Master Lease (ML); and (ii) Caltech's Sublease (CS).

5.2.4.1 Master Lease (ML)

An ML was made on June 21, 1968, between the State of Hawai'i, by its BLNR, Lessor, and the University of Hawai'i, Lessee, for the use of the MKSR. With respect to improvements, the leases notes (BLNR, 1968):

Improvements. The Lessee shall have the right during the existence of this lease to construct and erect buildings, structures and other improvements upon the demised premises; provided, that plans for construction and plot plans of improvements shall be submitted to the Chairman of the Board of Land and Natural Resources for review and approval prior to commencement of construction. The improvements shall be and remain the property of the Lessee, and shall be removed or disposed of by the Lessee at the expiration or sooner termination of this lease: provided, that with the approval of the Chairman such improvements may be abandoned in place. The Lessee shall, during the term of this lease, properly maintain, repair and keep all improvements in good condition. (Lease, 1968)

The ML expires on December 31, 2033; until then, it may be terminated at any time by the Lessee or for cause by the Lessor. Under the terms of the ML, DLNR's reserved rights include hunting and recreation, water, and trails and access. The lease allows for the construction of improvements (i.e., buildings, infrastructure and other improvements), with BLNR's explicit approval. Without a new lease or approval from the Chairman of BLNR to abandon them in place, permitted improvements within the MKSR must be removed prior to December 31, 2033. There is no specific provision in the ML related to decommissioning or site restoration.

5.2.4.2 Caltech Sublease (CS)

The CS was made on December 20, 1983, between the University of Hawai‘i, Sublessor, and California Institute of Technology, Sublessee, for the use of 0.75 acre area where the CSO was built. The CS states (CS, 1983):

“...upon the termination or expiration of this Sublease for any cause, Sublessee must select one of the following options:

- 1. Negotiate with Sublessor for sale of the property to Sublessor.*
- 2. With concurrence of Sublessor, peaceably surrender the demised premises and all or part of the property in place and good repair, order, and clean condition, reasonable wear and tear excepted. In the event that part of the property is removed, Sublessee shall restore the demised premises, or any portion affected thereby, to even grade to the extent that improvements are removed. and shall repair any damage done to the improvements in the event that equipment is removed.*
- 3. Sell the assets to a third party acceptable to Sublessor, which acceptance shall not be arbitrarily or capriciously withheld. Such sale shall be contingent upon the execution of a new Sublease and Operating and Site Development Agreement between the third party and Sublessor.*
- 4. Remove the property at the expense of Sublessee provided such removal is completed within Eighteen (18) months after termination or expiration of Sublease. unless otherwise agreed to in writing between Sublessor and Sublessee. In the event of such removal, Sublessee shall restore the property, or any portion affected thereby, to even grade to the extent that improvements are removed, and shall repair any damage done to the improvements in the event that equipment is removed. In the event Sublessee fails to remove such property or debris and restore the demised premises within the time specified above, such property may be removed and the land restored to its original condition by Sublessor at the expense of Sublessee.”*

5.2.4.3 Consistency with ML and CS

With the exception of the No Action Alternative (ALT-1), all of the action alternatives call for levels of deconstruction, removal, and site restoration, that exceed the requirements found in the ML and SL.

5.2.5 MAUNA KEA COMPREHENSIVE MANAGEMENT PLAN (2009)

The CMP (2009), previously introduced in Section 1.1 and approved in 2009 by the BLNR, applies to the proposed project because the project site is within the UH Management Areas. The CMP identifies 103 “management actions” that apply to various management, operation, planning, and construction activities. The following sections discuss the proposed project’s compliance with the management actions that apply to it.

5.2.5.1 Construction-Related Management Actions

CMP management actions C-1 through C-9 provide “construction guidelines” for projects within the UH Management Areas. The desired outcome of these guidelines is to “minimize adverse impacts to resources during all phases of construction, through use of innovative best management practices.” As detailed in Section 2.1.2.1, Caltech will implement BMPs and monitoring that fulfill the nine construction guideline management actions.

5.2.5.2 Decommissioning-Related Management Actions

CMP management actions SR-1 and SR-2 apply to existing observatories, including the CSO, once they decide to decommission. Management action SR-3, the only other management action in this category, does not apply to the proposed project because it only applies to future astronomy facilities. The desired outcome of these management actions, and the component Decommissioning Plan, is:

“To the extent possible, reduce the area disturbed by physical structures within the UH Management Areas by upgrading and reusing buildings and equipment at existing locations, removing obsolete facilities, and restoring impacted sites to pre-disturbed condition.”

In describing management actions SR-1 and SR-2, the CMP states that:

Each observatory has specific provisions in its agreement related to what is to become of the structure at the end of its term. Unless and until existing observatories revise their agreements, they need only comply with existing terms. It is possible that some observatories will be upgraded or demolished prior to the end of the term.

Demolition would be the responsibility of the terminating observatory. Observatories will be required to develop plans in coordination with IfA to be approved by CMS (identified as OMKM in the CMP) for site recycling, demolition and restoration. The plans are required to be in compliance with terms and conditions identified by CMS and the CMP, including all maintenance and construction management actions. In addition, the plans must consider the range of issues related to decommissioning including the impacts of demolition, waste management, substrate contamination, removal of underground storage tanks, habitat restoration, and cost.

Finally, the CMP stipulated that, in the event that an observatory considered decommissioning of their facility prior to the 2033 end of the lease, UH in consultation with DLNR and OMKM (now CMS) will initiate a discussion of a Site Decommissioning Plan and Site Restoration Plan to allow adequate time for decision-making, community input, and review.

The DP further provides a framework for observatories on Maunakea to ensure that the DLNR as landowner, the UH as Lessee and permittee, and the observatories as sublessees all have clear expectations of the decommissioning process and can plan appropriately for it. In principle, the DP: (i) defines decommissioning and the steps necessary to achieving it; (ii) outlines the terms of decommissioning contained in UH’s ML and existing subleases; (iii) provides information on financial planning for decommissioning; and (iv) offers guidance for the practical course of action

needed to implement decommissioning. The DP, as a subplan of the CMP, is consistent with the information and management actions set forth in it.

Per the DP (2010), Section 3.2 and Table 3.1 summarize the options for removal and levels of site restoration that can be considered in an observatory's Site Deconstruction and Removal Plan (SDRP) and Site Restoration Plan (SRP). Finally, the DP (2010) notes that, if less than full restoration is implemented, the observatory may be required to undertake other mitigation measures; this analysis must be incorporated into the SRP.

The CSO Decommissioning Project, as presented in this EA, is articulated in Caltech's SDP, which was in turn developed, reviewed, and revised according to the DP's guidance (2010). All of the action alternatives considered herein (ALT-2, ALT-3, and ALT-4) are intended to conform to the requirements of the CMP and the DP. The SDP is provided in Appendix A and includes an SDRP, SRP, Cost-Benefit Analysis, Funding Plan, and other information to comply with the CMP and DP. Therefore, the proposed project has complied with the CMP management actions SR-1 and SR-2 to date and Caltech is committed to compliance throughout project planning, permitting, and implementation.

5.3 FEDERAL LEGISLATION

5.3.1 NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act is not applicable to the proposed project because it is not a federal undertaking.

5.3.2 CLEAN AIR ACT (42 U.S.C. §7506(C))

As discussed in Section 4.10, any emissions from construction vehicles or fugitive dust during the CSO Decommissioning Project are anticipated to be temporary and relatively minor. The contractors will employ BMPs to control fugitive dust emissions during the deconstruction, removal, and site restoration operations. Once these operations are complete, the restored former CSO Site will not produce any air emissions, will not alter air flow in the area, and will have no other measurable effect on the area's microclimate.

5.3.3 CLEAN WATER ACT (33 U.S.C. §1251, ET SEQ.)

The Clean Water Act, formally known as the Federal Water Pollution Control Act (33 U.S.C. §1251, et seq.) is the principal law governing pollution control and the water quality of the nation's waterways. The CSO Decommissioning Project, as discussed in Section 4.6, will not result in any impact to nearby surface waters or aquifers; consequently Caltech does not anticipate seeking any approvals from the U.S. Army Corps of Engineers under the Clean Water Act. Because the total disturbed area of the project is more than one acre, Caltech will obtain an NPDES permit (Section 1.5). In Hawai'i, the HDOH-CWB is authorized to issue NPDES permits.

5.3.4 COASTAL ZONE MANAGEMENT ACT (16 U.S.C. §1456(C)(1))

Enacted as Chapter 205A, HRS, the Hawai'i CZM Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The CZM area encompasses the entire

State of Hawai‘i, including all marine waters 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. Section 5.2.3 discusses the consistency of the CSO Decommissioning Project with the CZM Program’s ten policy objectives.

5.3.5 ENDANGERED SPECIES ACT (16 U.S.C. §§1531-1544)

The Endangered Species Act of 1973, as amended 1976-1982, 1984, and 1988 (16 U.S.C. §§1531-1544), provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the United States or elsewhere. The act is not applicable to the proposed project because it does not involve a federal action or the taking of a listed species (Section 4.3).

5.3.6 FLOOD PLAIN MANAGEMENT (42 U.S.C. §4321, EXECUTIVE ORDER NO. 11988)

This Executive Order is not applicable to the proposed project because it does not involve development or activities within a flood plain. As described in Section 4.11.1.3, the CSO Decommissioning Project lies within Flood Zone X and is outside any special flood hazard zone.

CHAPTER 6: ANTICIPATED DETERMINATION

6.1 SIGNIFICANCE CRITERIA

Hawai‘i Administrative Rule §11-200.1-14 establishes procedures for determining if an EIS should be prepared or if a Finding of No Significant Impact (FONSI) is warranted. HAR §11-200.1-14(d) provides that proposing agencies should issue an environmental impact statement preparation notice (EISPEN) for actions that it determines may have a significant effect on the environment. HAR §11-200.1-13(b) lists the following criteria to be used in making that determination.

In most instances, an action shall be determined to have a significant effect on the environment if it:

1. Involves an irrevocable commitment to loss or destruction of any natural or cultural resource;
2. Curtails the range of beneficial uses of the environment;
3. Conflicts with the State’s long-term environmental policies or goals as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders;
4. Substantially affects the economic or social welfare of the community or State;
5. Substantially affects public health;
6. Involves substantial secondary impacts, such as population changes or effects on public facilities;
7. Involves a substantial degradation of environmental quality;
8. Is individually limited but cumulatively has considerable effect on the environment or involves a commitment for larger actions;
9. Substantially affects a rare, threatened, or endangered species, or its habitat;
10. Detrimentially affects air or water quality or ambient noise levels;
11. Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters;
12. Substantially affects scenic vistas and viewplanes identified in county or state plans or studies; or,
13. Requires substantial energy consumption.

6.2 FINDINGS

The potential effects of the proposed CSO Decommissioning Project and its action alternatives, as described in Chapter 2 and Chapter 3, respectively, were evaluated relative to these thirteen

significance criteria. Caltech's findings with respect to each criterion are summarized in the following subsections.

6.2.1 IRREVOCABLE LOSS OR DESTRUCTION OF VALUABLE RESOURCE

The CSO Decommissioning Project consists of the demolition and removal of infrastructure present on the site and the restoration of the area to, as closely as possible, its pre-construction condition. It does not involve the loss of any significant or valuable cultural or natural resources and is intended to benefit the cultural and natural resources in the area.

6.2.2 CURTAILS BENEFICIAL USES

The development and operation of the CSO was deemed a beneficial use of the environment when it was permitted in 1982. Caltech, the facility developer, operated the facility until choosing to cease operation on September 8, 2015. The facility has not been operational since then. Thus, the deconstruction, removal, and site restoration operations which are part of all of the action alternatives considered in this EA will not curtail any existing beneficial use of the CSO, and will allow for beneficial use of the former CSO Site as public open space and natural area.

6.2.3 CONFLICTS WITH LONG-TERM ENVIRONMENTAL POLICIES OR GOALS

The CSO Decommissioning Project is consistent with all applicable plans, policies, and controls, as discussed throughout Chapter 5, including the *Hawai'i State Plan*, the *Hawai'i County General Plan*, and the BLNR-approved CMP. All of the action alternatives are consistent with the State's long-term environmental policies and goals as expressed in HRS, Chapter 344 and elsewhere in state law.

6.2.4 SUBSTANTIALLY AFFECTS ECONOMIC OR SOCIAL WELFARE

The proposed action will not have substantial effects on economic or social welfare. Its purpose is to allow Caltech to responsibly relinquish its sublease per the terms of that agreement and other applicable rules, regulations, and agreements.

6.2.5 PUBLIC HEALTH EFFECTS

The CSO Decommissioning Project will not adversely affect air or water quality, including water sources used for drinking or recreation. Neither will it generate other emissions that will have a significant adverse effect on public health.

6.2.6 PRODUCE SUBSTANTIAL SECONDARY IMPACTS

The proposed action will not produce substantial secondary impacts. The CSO Decommissioning Project will not foster population growth, promote economic development, or stress public facilities or services. Instead, it is intended to allow Caltech to responsibly relinquish its sublease per the terms of that agreement and other applicable rules, regulations, and agreements.

6.2.7 SUBSTANTIALLY DEGRADE THE ENVIRONMENT

The proposed action will not have substantial long-term environmental effects. The work will temporarily elevate noise levels and generate limited nuisance airborne dust during construction, but these impacts will be localized and of limited duration. Adequate measures will be taken to control the intensity of construction noise and dust, and the effects will be brief and minimal.

6.2.8 CUMULATIVE EFFECTS OR COMMITMENT TO A LARGER ACTION

The CSO Decommissioning Project does not represent a commitment to a larger action and is not intended to facilitate substantial economic or population growth. It is intended solely to remove the CSO, restore the site, and allow Caltech to responsibly relinquish its sublease per the terms of that agreement and other applicable rules, regulations, and agreements.

6.2.9 EFFECTS ON RARE, THREATENED, OR ENDANGERED SPECIES

No rare, threatened, or endangered species are known to utilize the CSO Site, and once restoration is complete the area will function as habitat for native flora and fauna. In addition, the proposed action will not utilize a resource or habitat needed for the protection of rare, threatened, or endangered species.

6.2.10 AFFECTS AIR OR WATER QUALITY OR AMBIENT NOISE LEVELS

Noise levels and airborne emissions will temporarily increase during deconstruction, removal and site restoration activities. BMPs will be implemented and any effects will be brief, relatively minor, and restricted to immediately adjacent areas. Once the CSO Decommissioning Project is completed, it will not produce airborne emissions, waterborne pollution, or noise.

6.2.11 ENVIRONMENTALLY SENSITIVE AREA

The CSO Site is not in a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters and will not have an effect on such areas. Further, the proposed action consists of deconstruction, removal, and site restoration activities that will restore the area, as closely as possible, to its pre-construction condition. Further, the CSO Decommissioning Project is not in any designated flood hazard or tsunami inundation zone.

6.2.12 AFFECTS SCENIC VISTAS AND VIEW PLANES

As discussed in Section 5.2.3.3, the proposed project is not visible from scenic vistas identified in county or state plans or studies and is not visible in viewplanes identified in county or state plans or studies; therefore, it will not substantially affect them.

6.2.13 REQUIRES SUBSTANTIAL ENERGY CONSUMPTION

The deconstruction, removal, and site restoration operations proposed as part of the CSO Decommissioning Project will require the use of some energy. However, once these relatively brief operations are complete, the site will not require the use of any energy.

6.3 ANTICIPATED DETERMINATION

In view of the foregoing, Caltech and DLNR have concluded that the proposed project will not have a significant adverse impact on the environment. Consequently, DLNR anticipates issuing a FONSI for the proposed action.

CHAPTER 7: CONSULTATION AND DISTRIBUTION

7.1 SCOPING PERIOD CONSULTATION

A critical component of the CSO Decommissioning Project planning effort was developing and implementing an outreach program to inform the public and obtain their input on the proposed project's purpose, scope, potential impacts, and recommended mitigation measures. Outreach was substantial and included a variety of activities. Prior to the pre-assessment public scoping process presentations were made to:

- OMKM's Environmental Committee on November 8, 2017;
- Kahu Kū Mauna Council on November 14, 2017; and
- MKMB on November 28, 2017.

Thereafter, the broader public scoping process commenced on December 4, 2017, with an email distribution to 238 recipients containing the summary background information. A copy of this scoping message and background summary are provided in Appendix G. In addition, media press releases were distributed at that time, resulting in a front page story in the December 5, 2017, edition of the *Hawai'i Tribune-Herald* inviting input related to the CSO Decommissioning Project and the EA process. Table 7.1 identifies the parties that were called or sent an email and/or letter during the scoping process informing them of upcoming public meetings and/or requesting that they contact the project team to discuss the project.. Figure 7-1 reproduces the *Hawai'i Tribune-Herald* article.

Consistent with applicable laws and regulations, extensive consultation was conducted during the first four months of 2018 with government agencies, organizations, and individuals. A series of individual and small group meetings were held. A two-page summary of the proposed project was prepared and given to discussion attendees; a copy of the two-page background summary is provided as Appendix G. In those discussions, attendees were also encouraged to visit Caltech's website for project updates.¹³ On January 14, 2018, a public presentation and discussion took place before the Hawai'i County Cultural Resources Commission. A PowerPoint presentation was provided to the audience, with background on the CSO and the decommissioning process as laid out in the CMP (2009) and DP (2010), followed by a question and answer period and a general discussion.

Feedback related to the CSO Decommissioning Project was generally consistent. The broad public outreach was appreciated, the removal of the telescope was received favorably, with most people feeling the project would have a positive effect. Many people providing input noted that the CSO Decommissioning Project was the first of its kind and that it had the opportunity to set a good example for other astronomy facility decommissioning projects to come. Principle concerns identified during outreach related to the handling of the closure and removal of the cesspool at the CSO Site and residual impact associated with the 2009 hydraulic fluid leak.

¹³ Found online at cso.caltech.edu.

Table 7.1 Parties Consulted in Early Scoping

Maunakea Observatories	
East Asian Observatory	Canada-France-Hawai‘i Telescope
Harvard Smithsonian Center for Astrophysics	Gemini Observatory
National Radio Astronomy Observatory	NASA Infrared Telescope Facility
Subaru Telescope	Smithsonian Submillimeter Array
UH 2.2 Meter Telescope	UH Hilo Hōkū Ke‘a
W.M. Keck Observatory	Very Long Baseline Array
Federal Agencies	
Environmental Protection Agency	National Oceanographic and Atmospheric Agency
National Resource Conservation Service	U.S. Army Pōhaku Loa Training Area
U.S. Fish and Wildlife Service	U.S. Geological Survey
U.S. National Park Service	
State Agencies	
Department of Agriculture	Department of Accounting and General Services
Department of Business, Economic Development, and Tourism	Department of Land and Natural Resources
Department of Hawaiian Home Lands	Department of Health
Department of Transportation	Edwin H. Mo‘okini Library
Environmental Center	Institute for Astronomy
Kauai Community College Library	Office of Environmental Quality Control
Office of the Governor	Office of Hawaiian Affairs
Office of Planning	Pāalamanui Campus Library
Thomas H. Hamilton Library	University of Hawai‘i
County Agencies	
Department of Environmental Management	Department of Parks and Recreation
Department of Public Works	Department of Research and Development
Department of Water Supply	Hawai‘i County Fire Department
Hawai‘i County Police Department	Office of the Mayor
Planning Department	
Elected Officials	
U.S. Senator Mazie Hirono	U.S. Senator Brian Schatz
U.S. Representative Colleen Hanabusa	U.S. Representative Tulsi Gabbard
State Senator Kai Kahele	State Senator Russell Ruderman
State Senator Josh Green	State Senator Lorraine Inouye
State Representative Mark Nakashima	State Representative Richard Onishi
State Representative Chris Todd	State Representative Joy San Buenaventura
State Representative Richard Creagan	State Representative Nicole Lowen
State Representative Cindy Evans	County Councilmember Valerie Poindexter
County Councilmember Aaron Chung	County Councilmember Maile David
County Councilmember Dru Kanuha	County Councilmember Karen Eoff
County Councilmember Sue Lee Loy	County Councilmember Eileen O’Hara
County Councilmember Jen Ruggles	County Councilmember Tim Richards

Community Organizations	
Arnott's Lodge and Hiking Adventures	Hawai'i Island Chamber of Commerce
Hawai'i Island Economic Development Board	Hawai'i Leeward Planning Conference
Hawaiian Eyes dba Hawaiian Haoles	'Imiloa Astronomy Center of Hawai'i
Jack's Tours	Japanese Chamber of Commerce
KAHEA	Kaneolehua Industrial Area Association
Kona-Kohala Chamber of Commerce	Mauna Kea Summit Adventure-Paradise Safaris
Meridian H.R.T.	PUEO
Robert's Hawai'i	Takikobo Hawai'i, Inc.
Individuals	
Michael Akau	Laura Aquino
Nick Agorastos	Rochelle Augustin-Beck
Kalepa Baybayan	Jackson Bauer
Mamo Bezilla	Cheryl Burghardt
Kualii Camara	Pua Case
Roberta Chu	Andrew Cooper
Greg Chun	Thomas Chun
Ian Cole	Susan Cordell
Kehaulani Costa	Donn Dela Cruz
Alika Desha	Jesse Eiben
Leningrad Elarinoff	Hank Fergerstrom
Kalani Flores	Heather Gallo
Grant Gerrish	Glennon T Gingo
Matthew Grauso	Richard Ha
Jay Hatayama	Clyde Hayashi
David Henkin	Nelson Ho
Wilma Holi	Stewart Hunter
Roger Imoto	Doug Ing
Wallace Ishibashi	Patrick Kahawaiolaa
Mike Kaleikini	CM Kaho'okahi Kanuha
Jim Kauahikaua	Springer Kaye
Moses Kealamakia, Jr.	Brannon Kealoha
Glen Kila	Jessica Kirkpatrick
Wendy Laros	Julie Leialoha
Bob Lindsey	George Martin
Joey Mello	Miles Miyasato
U'ilani Naipo	Sean Naleimaile
Christina Neal	Paul K. Neves
Max Newberg	Rob Pacheco
Shane Palacat- Nelsen	Cheyenne Perry
Kealoha Pisciotta	Brad Reil
Lukela Ruddle	Luis Salaveria
J. Leinaala Sleightholm	Hannah Springer
Heather Stever	Dale Suezaki
Craig Takamine	Anya Tagawa
Ron Terry	Donald Thomas
Marti Townsend	Mark Travalino
Cas Vanderwoude	Sage VanKralingen
Lehua Vincent	Dwight Vincente

Bill Walter	Deborah Ward
Keahi Warfield	Rick Warshauer
Brook Wilson	Ross Wilson
Joy S. Yoshina	Joan Yoshioka
Source: Compiled by Hookuleana, LLC (2020)	

Figure 7-1 CSO Decommissioning Project in the Hawai'i Tribune-Herald

Hawaii
Tribune Herald
Aloha Big Island

Tuesday, December 5, 2017 Proudly serving Hilo and the Big Island since 1923 75 cents

Preparing for removal

Caltech seeks feedback on dismantling of observatory atop Maunakea, site restoration

By TOM CALLIS
Hawaii Tribune-Herald

The California Institute of Technology is preparing to take removal of its submillimeter telescope atop Maunakea through the regulatory process.

The Caltech Submillimeter Observatory, which closed in 2015, will be the first to be dismantled under the Office of Maunakea Management's decommissioning subplan. No new telescopes will be built on the site.

The institute announced Monday it is starting a "public sooping period" to receive feedback on removal of the 10.4-meter telescope and site restoration. An environmental assessment and a conservation district use permit will be drafted.

Caltech said in a press release that it will consider different scenarios, and feedback on cultural, environmental and financial impacts will be incorporated into the plan.

See REMOVAL Page A9



The Caltech Submillimeter Observatory. The observatory closed in 2015 and officials now are starting the regulatory process for its removal from Maunakea.

Tribune-Herald file photo

REMOVAL From the front page

"We are grateful for the use of Maunakea for nearly three decades for astronomical research," said Sunil Gohwala, CSO director and Caltech physics professor, in a written statement. "We are undertaking the decommissioning process respectfully and look forward to working with OMKM, University of Hawaii at Hilo, and the community."

Opened in 1987, CSO observed light emitted between the infrared and radio wavelengths. That is suited for observing molecular gases and small solid dust particles

that fill dense regions where stars form, according to Caltech.

Caltech first announced its intent to remove the telescope in 2009.

At the time, it said the observatory was a cutting-edge facility for astronomical research and instrument development.

Contributions to science included detection of "heavy water" on comets and observation of "dusty planets," which optical telescopes are unable to see, Caltech said during the 2009 announcement.

It said then that the observatory was being closed because of the construction of the next-generation radio telescopes, such as the Cornell Caltech Atacama Telescope in Chile.

Final decommissioning plans will be approved by Caltech, the Maunakea Management Board, University of Hawaii and state Department of Land and Natural Resources.

Initially, Caltech anticipated the site would be returned to its natural state by 2018.

Planning, permitting and design is anticipated

to take about two years, according to Ashley Kierkiewicz, senior account executive with Hastings & Pleadwell, which is handling communications for Caltech.

That includes about one year to complete the environmental process and six months to one year to complete the conservation district use application. Decommissioning can begin once a CDUP is issued, she said.

Caltech also hired M3 Engineering and Ho'okuleana LLC to help it with the decommissioning process.

Comments can be submitted to Peter Young of Hookuleana LLC at PeterYoung@hookuleana.com by Jan. 15.

Public meetings are planned as part of the EA process,

Kierkiewicz said.

Caltech also is a partner with the W.M. Keck Observatory and Thirty Meter Telescope.

Email Tom Callis at tcalls@hawaiitribune-herald.com.

VIC Member Sale! Not a member? Not a problem! Join today, save today!
Christmas VIC Sale
Going on Now!
Lot of Store-Wide Christmas Savings!
Hurry in for Stocking Stuffers, Gift Certificates, Holiday Sewing and Crafting Needs!
Stop by the store or visit us online at
www.DiscountFabricWarehouse.com for more information!
DISCOUNT FABRIC WAREHOUSE
833 KANOELEHUA AVE • HILO 935-1234 • 74-5685 LUMIA ST. KONA 335-7474
MONDAY - SATURDAY 9AM-6PM • SUNDAY 10AM-4PM • SALE ENDS 12/24/17

Source: Hawai'i Tribune-Herald (2017)

Repeated attempts were made to meet with individuals and representatives of groups that were part of or associated with the intervenors with the TMT contested case. After repeated non-response, an unsigned, apparent copy of a certified letter addressed to Governor David Ige and dated April 23, 2018, was sent to Ho‘okuleana, LLC, Caltech’s consultant for public outreach related to the CSO Decommissioning Project. In part, that letter stated, relative to scoping and pre-EA consultation:

We appreciate the effort to reach out for comments. However, we believe its [sic] inappropriate for this to be happening at this time and we believe Caltech/CSO, and the University should wait until the legal questions including questions regarding the decommissioning and other agreements between the state’s BLNR, University of Hawai’i and the other International governments have been resolved.

The Court must be allowed to rule upon by those cases before the Court and before proceeding here. Because many of us are Plaintiffs in those Supreme Court Cases we wish to reserve our right to comment at a later date, when our comments are more appropriate and also when our comments cannot be used against us or our case.

CHAPTER 8: REFERENCES

- Aldrich, P. (2005). *Biological Information for Mauna Kea*. Prepared for the Office of Mauna Kea Management by Patrick Aldrich, Zoology Department, University of Hawai‘i, Honolulu, HI.
- ASM (ASM Affiliates).
- (2018). *An Archaeological Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Maunakea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i*.
- (2020). *Cultural Impact Assessment for the Caltech Submillimeter Observatory Decommissioning Project on Mauna Kea, TMK: (3) 4-4-015:009 (por.), Ka‘ohe Ahupua‘a, Hāmākua District, Island of Hawai‘i*.
- Austin, Tsutsumi & Associates, Inc. (2019). *Transportation Management Plan for California Institute of Technology Submillimeter Observatory Decommissioning, Mauna Kea, Hawai‘i. Prepared for the California Institute of Technology*.
- Berryman, S. and C.W. Smith. (2011). Lichen and Bryophytes of Mauna Kea Within the TMT Footprint and Impact Area Summit of Mauna Kea. December.
- Bryan, L. (1939). Lake Waiau of Hawaii. *Paradise of the Pacific* 51(2): 10–11.
- Caltech (1982). Final Environmental Impact Statement for a 10-Meter Telescope for Millimeter and Submillimeter Astronomy at Maunakea, Hāmākua, Hawai‘i. Prepared for the California Institute of Technology by Group 70.
- (1983). The Sublease Agreement among the California Institute of Technology, the University of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, Sublease H09176.
- (2021). *Site Decommissioning Plan for the Caltech Submillimeter Observatory*. Prepared for M3 Engineering and Technology Corporation and the California Institute of Technology by Planning Solutions, Inc.
- Char, W.P. (1999). *Botanical Resources, Mauna Kea Summit*. Appendix G of Mauna Kea Science Reserve Master Plan. Honolulu, HI.
- Church et al. (2013). *Climate Change 2013: The Physical Science Basis*. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
- Commission on Water Resource Management (CWRM). 2008. *Water Resource Protection Plan*. Prepared by the Wilson Okamoto Corporation. June..
- CMP (Comprehensive Management Plan). (2009). *Mauna Kea Comprehensive Management Plan, UH Management Areas*. Prepared for University of Hawai‘i by Ho‘akea, LLC dba Ku‘iwalu.
- Compton, R.R. (1985). *Geology in the Field*, John Wiley & Sons, New York.
- County of Hawai‘i.
- (2005). The Hawai‘i County General Plan.
- (2008). South Kohala Development Plan.

—— (2010). County of Hawai‘i Data Book.

County of Hawai‘i Civil Defense Agency in coordination with the Planning Department and Department of Data Systems with assistance from consultants Dr. George Curtis and Planner Brian Nishimura. (2005). Multi-Hazard Mitigation Plan: County of Hawai‘i.

Craig, C.R., Whittier, R.B., Dailer, M.L., Dulaiova, H., El-Kadi, A.I., Fackrell, J., Kelly, J.L., Waters, C.A., Sevadjan, J. (2013). Lahaina groundwater tracer study, Lahaina, Maui, Hawai‘i. Final Report. Prepared for State of Hawai‘i Department of Health, U.S. Environmental Protection Agency, U.S. Army Engineer Research and Development Center. June..

Crockett, C. S. (2007). The role of wastewater treatment in protecting water supplies against emerging pathogens. *Water Environmental Research*, vol. 79, no. 3, pp. 221-232.

Cultural Resources Plan. (2009). A Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island, State of Hawaii, A Sub-Plan of the Mauna Kea Comprehensive Management Plan. October 2009.

Cummings, M. and R. Babcock Jr. (2012). Condition assessment survey of onsite sewage disposal systems (OSDS) in Hawai‘i. University of Hawai‘i at Manoa. December.

Dames & Moore (1983). Appendix B: Geologic and Hydrologic Factors for the Environmental Impact Statement, Caltech Telescope Site, Mauna Kea Science Reserve. Prepared for California Institute of Technology by Dames & Moore.

de Silva, K., and M. de Silva (2006). E Ho‘i ka Nani i Mānā. *Kalenamanu*. http://apps.ksbe.edu/kaiwakiloumoku/kaleinamanu/he-aloha-moku-o-keawe/hoi_ka_nani, accessed June 11, 2018.

Delevaux, J.M.S., Whittier, R., Kostantinos, A.S., Bremer, L.L., Jupiter, S., Friedlander, A.M., Poti, M., Guannel, G., Kurashima, N., Winter, K.B., Toonen, R., Conklin, E., Wiggins, C., Knudby, A., Goodell, W., Burnett, K., Yee, S., Htun, T., Oleson, K.L.L., Wiegner, T. and T. Ticktin. (2018). A linked land-sea modeling framework to inform ridge-to-reef management in high oceanic islands. *PLoS ONE*, v. 13, no. 3.

Desha, S. (2000). *Kamehameha and his warrior Kekūhaupi‘o*. Translator Frances N. Frazier. Kamehameha Schools Press, Honolulu.

Eberts, S.M., Thomas, M.A., and Jagucki, M.L. (2013). The quality of our Nation’s waters—Factors affecting public-supply-well vulnerability to contamination—Understanding observed water quality and anticipating future water quality: U.S. Geological Survey Circular 1385, 120 p. Available online at <https://pubs.usgs.gov/circ/1385/>.

Ehlmann, B. L. Raymond E. Arvidson, Bradley L. Jolliff, Sarah S. Johnson, Brian Ebel, Nicole Lovenduski, Julie D. Morris, Jeffery A. Byers, Nathan O. Snider, and Robert E. Criss. (2005). Hydrologic and Isotopic Modeling of Alpine Lake Waiai, Mauna Kea, Hawai‘i. *Pacific Science* (2005), vol 59, no. 1:1-15, University of Hawai‘i Press.

Englund, R.A., A.E. Vorsino and H.M. Laederich. (2007). *Results of the 2006 Wekiu Bug (Nysius wekiuicola) Surveys on Mauna Kea, Hawai‘i Island*. Final Report. Prepared for Office of Mauna Kea Management. Hawaii Biological Survey Report 2007-03. Hawaii Biological Survey, Bishop Museum Honolulu, HI.

- Engott, J.A. (2011). A water-budget model and assessment of groundwater recharge for the Island of Hawai'i. U.S. Geological Survey, Scientific Investigations Report 2011-5078.
- EPA (Environmental Protection Agency).
- (1999). Final OSWER Directive “Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites (1999)
- (2012). Environmental Protection Agency, Citizen's Guide to Monitored Natural Attenuation (2012)
- <https://www.epa.gov/uic/cesspools-hawaii>
- n.d. Designated Sole Source Aquifers in EPA Region IX. http://www.epa.gov/safewater/sourcewater/pubs/qrg_ssamap_reg9.pdf
- Gerrish, G. (2013). *Botanical Baseline Survey (2011) of the University of Hawaii's Managed Lands on Mauna Kea*. Biology Department, University of Hawaii at Hilo. Prepared for Office of Mauna Kea Management.
- Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y. Y.-L. Chen, P.-S. Chu, J. K. Eischeid, and D. M. Delparte. (2013). *Online Rainfall Atlas of Hawai'i*. Bulletin of the American Meteorological Society 94(3): 313–316.
- Goodrich, J. (1833). Notices of some of the volcanos and volcanic phenomena of Hawaii, (Owyhee,) and other islands in that group, in a letter from Mr. Joseph Goodrich, missionary, dated Nov. 17, 1832. *American Journal of Science and Arts* 25: 199–203.
- Group 70. (1982). Final Environmental Impact Statement for A 10-Meter Telescope for Millimeter and Submillimeter Astronomy at Mauna Kea, Hāmākua, Hawai'i. Prepared for California Institute of Technology. Honolulu, Hawai'i.
- . (1983). Mauna Kea Science Reserve: Complex Development Plan Final Environmental Impact Statement, Maunakea, Hāmākua, Hawai'i. Prepared by Group 70 for the Research Corporation of the University of Hawai'i.
- Ho'akea, LLC dba Ku'iwalu (Ho'akea). (2009). *Mauna Kea Comprehensive Management Plan: UH Management Areas*. Prepared for University of Hawai'i.
- Ho'okuleana LLC. (2009). *‘Āina Mauna Legacy Program Implementation Work Plan*. Prepared for the Department of Hawaiian Home Lands.
- Ho'okuleana LLC. (2009). *‘Āina Mauna Legacy Program*. Prepared for the Department of Hawaiian Home Lands.
- Howarth, F.G. and F.D. Stone. (1982). An assessment of the arthropod fauna and aeolian ecosystem near the summit of Mauna Kea, Hawai'i. Prepared for Group 70, Honolulu, Hawai'i. 18 pp.
- Intera, Inc. (2019). Hydrogeological and Geological Evaluation for the Decommissioning of the California Institute of Technology Submillimeter Observatory. Prepared for the California Institute of Technology.
- Izuka, S.K., Engott, J.A., Rotzoll, K., Bassiouni, M., Johnson, A.G., Miller L.D., Mair, A. (2018). *Volcanic aquifers of Hawai'i—hydrogeology, water budgets, and conceptual models*. U.S. Geological Survey, Scientific Investigations Report 2015-5164 Version 2.

- Johnson, D. M., Hooper, P.R., and R.M. Conrey. (1999). *XRF Analysis of Rocks and Minerals for Major and Trace Elements on a Single Low Dilution Li-tetraborate Fused Bead*. GeoAnalytical Laboratory, Washington State University, Pullman, WA 99164. JCPDS International Centre for Diffraction Data, pp.843-867.
- Kanahele, P., and E. Kanahele. (1997). *A Social Impact Assessment: Indigenous Hawaiian Cultural Values of the Proposed Saddle Road Alignments*. Prepared for State of Hawai‘i, Department of Hawaiian Home Lands.
- Kamakau, S. (2001). *Ke Aupuni Mō‘ī: Ka Mo‘olelo Hawai‘i no Kauikeaouli keiki ho‘oilina a Kamehameha a me ke aupuni āna i noho mō‘ī ai*. Kamehameha Schools Press, Honolulu.
- Kim et al., 2010; Final Report On Hawaii’s Environmental Review System Prepared for the Hawaii State Legislature, October 2010
- Kirkpatrick, J. and F. Klasner. (2015). *2013 Invasive Species and Native Arthropod Monitoring Report*. Office of Maunakea Management.
- Korn, A. (1958). *The Victorian Visitors: An Account of the Hawaiian Kingdom, 1861-1866*. The University of Hawai‘i Press, Honolulu.
- Ku‘iwalu. (2009). *Mauna Kea Comprehensive Management Plan*. Prepared for University of Hawai‘i. April.
- Kumu Pono Associates LLC.
- (2001). *Malama Pono I Ka ‘Āina-An Overview of the Hawaiian Cultural Landscape*.
- (2002). “He Wahi Mo‘olelo No Ka ‘Āina A Me Na ‘Ohana O Waiki‘i Ma Waikōloa (Kalana O Waimea, Kohala), A Me Ka ‘Āina Mauna” (A Collection of Traditions and Historical Accounts of the Lands and Families of Waiki‘i and Waikōloa (Waimea Region, South Kohala), and the Mountain lands, Island of Hawai‘i).
- (2004). “Humu‘ula A Me Pi‘ihonua: He Mau ‘Āina Lei Ali‘i Ma Ka ‘Āina Mauna O Hawai‘i” (Humu‘ula and Pi‘ihonua: Lands that Adorn the Chiefs on the Mountain Lands of Hawai‘i), A Collection of Native Traditions, Historical Accounts, and Oral History Interviews.
- (2005). “He Mo‘olelo ‘Āina” A Cultural-Historical Study of the Upper Waiākea-Humu‘ula Mountain Lands: The Proposed Kīpuka ‘Āina Mauna Natural Area Reserve District of Hilo, Island of Hawai‘i.
- (2005). “Mauna Kea - Ka Piko Kaulana O Ka ‘Āina” (Mauna Kea-The Famous Summit of the Lands), A Collection of Native Traditions, Historical Accounts, and Oral History Interviews for: Mauna Kea, the Lands of Ka‘ohe, Humu‘ula and the ‘Āina Mauna on the Island of Hawai‘i.
- Lang and Byrne. (2013) *Mauna Kea: A Guide to Hawai‘i’s Sacred Mountain*. Watermark Press, Honolulu.
- Langlas, C. (1999). Supplement to Archaeological, Historical and Traditional Cultural Property Assessment for the Hawai‘i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project. In *The Saddle Road Corridor: An Archaeological Inventory Survey and Traditional Cultural Property Study for the Hawai‘i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project, Districts of South Kōhala, Hāmākua, North Hilo, and South Hilo, Island of*

- Hawai‘i. Paul H. Rosendahl, Ph. D., Inc. Report 1939-043099.* Prepared for Okahara & Associates, Kailua-Kona.
- Langlas, C., T. Wolforth, and J. Head. (1999). The Saddle Road Corridor: An Archaeological Inventory Survey and Traditional Cultural Property Study for the Hawai‘i Defense Access Road A-AD-6(1) and Saddle Road (SR200) Project, Districts of South Kōhala, Hāmākua, North Hilo, and South Hilo, Island of Hawai‘i. Paul H. Rosendahl, Ph. D., Inc. Report 1939-043099. Prepared for Okahara & Associates, Inc. Kailua-Kona.
- Lau, S.L. and J.F Mink. (2006). *Hydrology of the Hawaiian Islands*. University of Hawai‘i Press. Honolulu, HI, p. 129.
- Laws, E.A. and A.H. Woodcock. (1982). Hypereutrophication of a Hawaiian Alpine Lake. *Pacific Science* (1981), vol 35, no. 3. The University of Hawai‘i Press.
- Lease, 1968; General Lease S-4191 between State of Hawai‘i and University of Hawai‘i, June 21, 1968
- Leopold, M., Morelli, A., Schorghofer, N. (2016). Subsurface architecture of two tropical alpine desert cinder cones that hold water. *Journal of Geophysical Research: Earth Surface*, vol. 121, pp. 1148-1160.
- Liu, C.C.K. (2007). RAM2 modeling and the determination of sustainable yields of Hawai‘i basal aquifers. Water Resources Research Center University of Hawai‘i at Manoa.
- Lockwood, J.P. (2000). Mauna Kea Science Reserve Geologic Resources Management Plan – Appenxi “H” in Group 70, 2000, Mauna Kea Science Reserve Master Plan, Honolulu, HI.
- Macdonald, G.A., Abbott, A., Peterson, F.L. (1983). *Volcanoes in the Sea: The Geology of Hawai‘i*. University of Hawai‘i Press; 2nd Edition, July 1.
- Maly, K.
- (1998). “Mauna Kea - Kuahiwi Ku Ha‘o Malie.” A Report on Archival and Historical Documentary Research, Ahupua‘a of Humu‘ula and Ka‘ohe, Districts of Hilo and Hamakua, Island of Hawai‘i. Kumu Pono Associates, LLC.
- (1999). Mauna Kea Science Reserve and Halepōhaku Complex Development Plan Update: Oral History and Consultation Study, and Archival Literature Research, Ahupua‘a of Ka‘ohe (Hāmākua District) and Humu‘ula (Hilo District), Island of Hawai‘i. In *Mauna Kea Science Reserve Master Plan*. Prepared for University of Hawai‘i, Honolulu, HI.
- Maly, K., and O. Maly.
- (2005). Mauna Kea- Ka Piko Kaulana O Ka ‘Āina/Mauna Kea- The Famous Summit of the Land. Kumu Pono Associates Study HIMK67-OMKM (033005b). Prepared for The Office of Mauna Kea Management (University of Hawai‘i Hilo), Hilo, HI.
- (2006). Appendix A: Mauna Kea-“Ka Piko Kaulana o ka ‘Āina.” A Collection of Oral History Interviews Documenting Historical Accounts and Recollections of Mauna Kea and the Mountain Lands of Hāmākua, Hilo and South Kohala, on the Island of Hawai‘i.” Kumu Pono Associates Study HIMK67-OMKM (033005b). Prepared for The Office of Mauna Kea Management (University of Hawai‘i Hilo), Hilo, HI.
- McCoy, P.

- (1982a). *Archaeological Survey of the Proposed Site of the Caltech 10-Meter Telescope on Mauna Kea, Hawaii*. Department of Anthropology, B.P. Bishop Museum Ms. 080682. Prepared for Group 70 Inc., Honolulu, Hawaii.
- (1982b). Archaeological Reconnaissance Survey. In *Cultural Resources Reconnaissance of the Mauna Kea Summit Region*. Department of Anthropology, B. P. Bishop Museum, Honolulu.
- (1993). *Letter Report on the Inspection of Two Sites Located in the Vicinity of the Smithsonian Submillimeter Array*. Mountain Archaeology Research Corp. Submitted to the Smithsonian Institution Astrophysical Observatory.
- (1999). Mauna Kea Science Reserve Archaeological Site Inventory: Formal, Functional, and Spatial Attributes. In *Mauna Kea*.
- McCoy, P., S. Collins, S. Clark, and V. Park. (2009). A Cultural Resources Management Plan for the University of Hawaii Management Areas on Mauna Kea, Ka'ohē Ahupua'a, Hamakua Districts Hawaii Island, State of Hawaii. TMK: (3) 4-4-015: 09, 12. A Sub-Plan for the Mauna Kea Comprehensive Management Plan. Pacific Consulting Services, Inc. Prepared for Office of Mauna Kea Management, Hilo. Hilo.
- McCoy, P., and R. Nees
- (2009). *Archaeological Inventory Survey of Lake Waiau, Mauna Kea Ice Age Natural Area Reserve, Ka'ohē, Hāmākua, Island of Hawai'i*. Pacific Consulting Services, Inc. report. Prepared for Division of Forestry and Wildlife, Natural Area Reserves System, Department of Land and Natural Resources.
- (2010). Archaeological Inventory Survey of the Mauna Kea Science Reserve, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i TMK: (3) 4-4-015:09 (por.). Pacific Consulting Services, Inc. report. Prepared for Office of Mauna Kea Management.
- (2013). Archaeological Inventory Survey of the Mauna Kea Ice Age Natural Area Reserve Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i TMK: (3) 4-4-015:10, 11. Pacific Consulting Services, Inc. report. Prepared for Division of Forestry and Wildlife, Natural Area Reserves System, Department of Land and Natural Resources.
- McCoy, P., R. Nees, and S. Clark. (2010). Archaeological Inventory Survey of the Astronomy Precinct in the Mauna Kea Science Reserve, Ka'ohē Ahupua'a, Hāmākua District, Island of Hawai'i, TMK: (3) 4-4-015:09. Pacific Consulting Services, Inc. report. Prepared for Office of Mauna Kea Management, Hilo.
- McEldowney, H. (1982). Ethnographic Background of the Mauna Kea Summit Region. In *Cultural Resources Reconnaissance of the Mauna Kea Summit Region*. Department of Anthropology, B. P. Bishop Museum, Honolulu.
- Medeiros, M. (2019). Biological Inventory and Assessment Report, Fall 2018. Caltech Submillimeter Observatory, Maunakea, Hawaii. Prepared for Sustainable Resources Group International, Inc. January.
- Mink, J.F. and L.S. Lau. (1993). *Aquifer identification and classification for the island of Hawai'i: Groundwater protection strategy for Hawai'i*. University of Hawai'i, Water Resources Research Center Technical Report 191, 108 p.

- NASA (National Aeronautics and Space Administration). (2005). *Final Environmental Impact Statement for the Outrigger Telescopes Project*. National Aeronautics and Space Administration, Washington, D.C.
- NFPA. (2006). National Fire Protection Association - NFPA Uniform Fire Code 2006 Edition.
- NFPA 241. (2004). National Fire Protection Association - NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations 2004
- NOI. (2015). California Institute of Technology Notice of Intent Caltech Submillimeter Observatory, November 18, 2015
- OEQC (Office of Environmental Quality Control). (1997). *Guidelines for Assessing Cultural Impacts*, adopted by the Environmental Council of the State of Hawai‘i on November 19, 1997.
- OMKM (Office of Maunakea Management)
- Unpublished data 2014-2018. Standard Operating Procedure 10, *Invasive Invertebrate Early Detection Surveys of Facilities*.
- Unpublished data 2014-2018. Standard Operating Procedure 12, Maunakea Science Reserve Early Detection Arthropod & Vegetation Surveys.
- Oki, D.S. (1999). Geohydrology and numerical simulation of the ground-water flow system of Kona, Island of Hawai‘i. U.S. Geological Survey Water-Resources Investigations Report 99–4070, 49 p.
- Operating Agreement, 1983; Operating and Site Development Agreement between University of Hawai‘i and California Institute of Technology. December 20, 1983.
- Pacific Consulting Services, Inc. (PCSI). (2010). Architectural Inventory Survey of Halepōhaku Rest Houses 1 and 2 and Comfort Station, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island, Hawai‘i TMK: (3) 4-4-015: 12 (por.). Pacific Consulting Services, Inc. report. Prepared for Office of Mauna Kea Management, Hilo.
- Palacat-Nelson, S. (1982). Memorandum addressed to Robert B. Rechtman and Peter Young regarding February 12, 2020 meeting. Kahu Kū Mauna, Office of Maunakea Management, Hilo.
- Parker, P., and T. King. (1998). Guidelines for Evaluating and Documenting Traditional Cultural Properties. *National Register Bulletin 38*. Revised. U.S. Department of the Interior, National Park Service, Cultural Resources.
- Patrick, M.R. and D. Delparte. (2014). Tracking dramatic changes at Hawai‘i’s only alpine lake. *Eos*, v. 95, no. 14, p. 117–118.
- Patrick, M.R., and Kauahikaua, J. (2015). Satellite monitoring of dramatic changes at Hawai‘i’s only alpine lake—Lake Waiau on Mauna Kea volcano: U.S. Geological Survey Scientific Investigations Report 2015–5076, 16 p., <http://dx.doi.org/10.3133/sir20155076>.
- PHRI (Paul H. Rosendahl, Ph. D., Inc.). (1999). Cultural Impact Assessment Study: Native Hawaiian Cultural Practices, Features, and Beliefs Associated with the University of Hawai‘i Mauna Kea Science Reserve Master Plan Project Area. In Mauna Kea Science Reserve Master Plan, Appendix N. Prepared for the University of Hawaii Institute for Astronomy, Honolulu.

- Pierce, H.A. and D.M. Thomas. (2009). Magnetotelluric and Audiomagnetotelluric Groundwater Survey Along the Humu‘ula Portion of Saddle Road Near and Around the Pōhakuloa Training Area, Hawai‘i, USGS Open File Report 2009–1135, 160 p.
- Porter, S.C. (2005). Pleistocene snowlines and glaciation of the Hawaiian Islands. *Quaternary International*, vol. 138-139, pp. 118-128.
- Porter, S.C. and R.A. Englund. (2006). *Possible geologic factors influencing the distribution of the Wekiu Bug on Mauna Kea, Hawaii*. Hawaii Biological Survey Report 2006-031. Prepared for the Office of Mauna Kea Management by S.C. Porter and R.A. Englund, Hawaii Biological Survey, Bishop Museum Honolulu, HI.
- Rotzoll, K. and A.I. El-Kadi. (2008). Estimating hydraulic conductivity from specific capacity for Hawai‘i aquifers, USA. *Hydrogeology Journal*, v 16, p. 969–979
- Sherrod, D.R., Sinton, J.M., Watkins, S.E., Brunt, K.M. (2007). *Geologic map of the State of Hawai‘i*. U.S. Geological Survey, Open-File Report 2007-1089, version 1.0.
- Simonson, M. & H. Hammatt (2010). Cultural Impact Assessment for the Thirty Meter Telescope Observatory Project and Thirty Meter Telescope Mid-Level Facility Project, Maunakea, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island –TMK: [3] 4-4-015:001 por., 009, por. 012, por.. On file with Cultural Surveys Hawai‘i, Inc., Wailuku, HI.
- Skinner, J. (1934). Mauna Kea. *Paradise of the Pacific* 46(12):9.
- Smith, C.W., W.J. Hoe and P.J. O’Conner. (1982). *Botanical Survey of the Mauna Kea summit above 13,000 feet*. Prepared for Group 70. October.
- SRGII (Sustainable Resources Group Intn’l., Inc.
- (2009). Natural Resources Management Plan for the UH Management Areas on Mauna Kea. A Sub-Plan of the Mauna Kea Comprehensive Management Plan. September.
- (2010). Decommissioning Plan for the Mauna Kea Observatories. A Sub-Plan of the Mauna Kea Comprehensive Management Plan. January.
- (2019). *Biological Setting Analysis: Caltech Submillimeter Observatory Decommissioning*. November.
- State of Hawai‘i. (2002). Water System Standards (Domestic Consumption Guidelines separated by respective Counties)
- State of Hawai‘i, Department of Business, Economic Development and Tourism. (2010). *State of Hawai‘i Data Book*.
- State of Hawai‘i, Department of Hawaiian Home Lands.
- (2007). Humu‘ula/Pi‘ihonua Mauka Community Wildfire Protection Plan.
- (2007). Pasture Recommendations at Humu‘ula for Controlling Wildfire Fuels.
- (2007). Pi‘ihonua Mauka Conservation Management Proposal for the Department of Hawaiian Home Lands.
- (2007). Wildland Fire Management Plan Humu‘ula/Pi‘ihonua Mauka.
- State of Hawai‘i, Department of Land and Natural Resources.

- (2005). Hawai‘i’s Comprehensive Wildlife Strategy.
- (2010). DLNR’s on-line Flood Hazard Assessment Tool (FHAT).
- (2009). State Comprehensive Outdoor Recreation Plan (SCORP) Update.
- State of Hawai‘i, Department of Land and Natural Resources, Division of Aquatic Resources.
(2008). Atlas of Hawaiian Watersheds & Their Aquatic Resources, Island of Hawai‘i.
- State of Hawai‘i, Department of Land and Natural Resources, Division of Forestry and Wildlife.
—— (2003). Wao Akua “Sacred Source of Life”.
- (2006). Forestry Related Assistance Programs in Hawai‘i: Current Programs and Future Trends.
- (2007). A Survey of Koa Regeneration in Humu‘ula.
- (2007). Technical Report No. 07-01, Review of Methods and Approach for Control of Non-Native Ungulates in Hawai‘i.
- (2007). State of Hawai‘i Forest Stewardship Handbook.
- State of Hawai‘i, Department of Transportation, Highways Division & U.S. Department of Transportation, Federal Highway Administration, Central Federal Lands Highway Division.
—— (1999). Final Environmental Impact Statement, Saddle Road (State Route 200) Māmalahoa Highway (State Route 190) to Milepost 6, County of Hawai‘i, State of Hawai‘i, FHWA Project No. A-AD-6(1).
- (2010). Final Supplemental Environmental Impact Statement and Final 4(f) Evaluation, Saddle Road (State Route 200) Māmalahoa Highway (State Route 190) to Milepost 41, County of Hawai‘i, State of Hawai‘i, FHWA Project No. 200(00).
- Stearns, H.T., and Macdonald, G.A. (1946). *Geology and groundwater resources of the island of Hawai‘i*. Hawai‘i Division of Hydrography Bulletin, vol. 9, p. 363.
- Stieger, W. (2009). *A Brief History of the Caltech Submillimeter Observatory*. Caltech Submillimeter Observatory. http://www.cso.caltech.edu/cso_history/CSO_History, accessed May 22, 2018.
- Stolper, E.M. (2015). Notice of Intent to Decommission Caltech Submillimeter Observatory. November 18.
- Stolper, E.M., Depaolo, D.J. and D.M. Thomas. (2009). Deep drilling into a mantle plume volcano—The Hawai‘i Scientific Drilling Project. *Scientific Drilling*, vol. 4, pp. 4-14.
- Sublease, 1983; Sublease H09176 between University of Hawai‘i and California Institute of Technology, December 20, 1983
- Takasaki, K.J. (1993). Ground water in Kilauea volcano and adjacent areas of Mauna Loa volcano, island of Hawai‘i. U.S. Geological Survey Open-File Report 93–82, 28 p.
- Takasaki, K.J. and J.F. Mink. (1985). Evaluation of major dike-impounded ground-water reservoirs, Island of Oahu with a section on flow hydraulics in dike tunnels in Hawai‘i. U.S. Geological Survey Water-Supply Paper 2217. Prepared in cooperation with the Board of Water Supply City and County of Honolulu.

Thomas, D.M.

—(2016). Final Report on: Magnetotelluric and AudioMagnetotelluric Surveys on Department of Hawaiian Home Lands Mauna Kea East Flank.

—(2018). Interview conducted by Mr. Kevin Gooding of INTERA Incorporated with Dr. Donald Thomas, of the University of Hawai'i. Interview notes on file. INTERA Incorporated: Hawai'i. October 29.

—(2018a). Presentation: New Insights: Old Water Two Decades of Groundwater Research in Hawaii, Hawaii Institute of Geophysics and Planetology, Center for the Study of Active Volcanoes.

Thomas, D.M., Paillet, F.L., Conrad, M.E., (1996). Hydrogeology of the Hawai'i Scientific drilling project borehole KP-1—2. Groundwater geochemistry and regional flow patterns. *Journal of Geophysical Research*, vol. 101, pp. 11,683-11,694.

Thomas, D.M. and E. Haskins. (2013). *Analysis of the hydrologic structures within an ocean island volcano using diamond wireline core drilling*. Poster, American Geophysical Union 2013 Fall Meeting, San Francisco, USA.

Underwood, M.R., Meyer, W., and W.R. Souza. (1995). *Ground-water availability from the Hawai'i aquifer in the Kohala area, Hawai'i*. U.S. Geological Survey Water-Resources Investigations Report 95-4113, 57 p.

University of Hawai'i Hilo. (2010). Final Environmental Impact Statement Thirty Meter Telescope Project, Island of Hawai'i. May.

USFWS (U.S. Fish & Wildlife Service)

—(1999). *Review of Animal and Plant Taxa That are Candidates or Proposed for Listing as Endangered or Threatened*. Federal Register (64)205: 57534-57547. <https://www.govinfo.gov/content/pkg/FR-1999-10-25/pdf/99-27822.pdf>.

—(2010). Hakalau Forest National Wildlife Refuge Draft Comprehensive Conservation Plan and Environmental Assessment.

— (2011). *Species Assessment and listing priority assignment form: Nysius wēkiuicola*. <https://www.federalregister.gov/documents/2011/10/26/2011-27122/endangered-and-threatened-wildlife-and-plants-review-of-native-species-that-are-candidates-for>

USGS (United States Geological Survey).

— (1954). *Aerial Photograph 1HAI000050016*. Aerial Photograph. United States Department of Geology. <https://earthexplorer.usgs.gov/>, accessed December 20, 2017.

— (2000). VS2DI - A Graphical Software Package for Simulating Fluid Flow and Solute or Energy Transport in Variably Saturated Porous Media https://wwwbrr.cr.usgs.gov/projects/GW_Unsat/vs2di/.

van Genuchten, M. Th. (1980). A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Science Society of America Journal*. v. 44. pp. 892-898.

Vanderwoude, C., F. Klasner, J. Kirkpatrick, S. Kaye. (2015). *Maunakea Invasive Species Management Plan*. Prepared for the Office of Maunakea Management. February. <http://www.malamamaunakea.org/environment/invasive-species>

- Wentworth, C. (1935). Mauna Kea, the White Mountain of Hawaii. *Mid Pacific Magazine*.
- Wentworth, K.W. and G.A. Macdonald. (1953). Structures and forms of basaltic rocks in Hawai'i. U.S. Geological Survey—*Bulletin* 994, pp. 98.
- Whitter, R.B. (2018b). Interview (email) conducted by Mr. Kevin Gooding of INTERA Incorporated with Mr. Robert Whittier, of Hawai'i Department of Health, Safe Drinking Water Branch. Interview notes on file. INTERA Incorporated: Hawai'i. December 10.
- Whittier, R.B., Rotzoll, K., Dhal, S., El-Kadi, A.I., Ray, C., Chen, G., and D. Chang. (2004). Hawai'i source water assessment program report—Volume II, Island of Hawai'i source water assessment program report. Water Resources Research Center, University of Hawai'i at Mānoa, Honolulu, Hawai'i, 65 p.
- Whittier, R.B., Rotzoll, K., Dhal, S., El-Kadi, A.I., Ray, C., and D. Chang. (2010). Groundwater source assessment program for the state of Hawai'i, USA—Methodology and example application. *Hydrogeology Journal*, v. 18, no. 3, p. 711–723.
- Whittier, R.B. and A.I. El-Kadi. (2014). Risk-ranking of on-site sewage disposal systems for the Hawaiian Islands of Kauai, Molokai, Maui and Hawai'i. Prepared for State of Hawai'i Department of Health Safe Drinking Water Branch. September.
- Wolfe, E.W., Wise, W.S., Dalrymple, G.B. (1997). *The geology and petrology of Maunakea volcano, Hawai'i: a study of post shield volcanism*. U.S. Geological Survey, Professional Paper 1557: 129 p., 4 plates (maps) in slipcase.
- Woodcock, A.H.
- (1974). Permafrost and Climatology of a Hawai'i Volcano Crater, *Arctic and Alpine Research*, 6:1, 49-62
- (1980). Hawaiian alpine lake level, rainfall trends, and spring flow. *Pacific Science*. Vol. 24, no. 2. The University Press of Hawai'i.
- Zohdy, A.A.R, and D. B. Jackson. (1969). Application of Deep Electrical Soundings for Groundwater Exploration in Hawai'i. *Geophysics*, Vol. 34, No. 4, pp. 584-600.