2016 FONR IMPACT ASSESSMENT AND HABITAT AND RARE PLANT SPECIES SURVEY RESULTS OPERABLE UNIT 1 FORMER FORT ORD, CALIFORNIA

Prepared for:

U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814-2922

Contract No. W912DY-10-D-0023
Delivery Order CM08

Prepared by:

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January 2017

HGL
HydroGeoLogic, Inc

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACL	aquifer cleanup level
COC	contaminants of concern
DD&A	Denise Duffy and Associates, Inc.
FDA	Fire Drill Area
FONR	Fort Ord Natural Reserve
GIS	geographic information system
GPS	global positioning system
GWETS	groundwater extraction and treatment system
HGL	HydroGeoLogic, Inc.
HLA	Harding Lawson Associates
HMP	Habitat Management Plan
LTM	long term monitoring
NWTS	Northwest Treatment System
OU	operable unit
ROD	Record of Decision
RTE	rare, threatened, or endangered
TCE	trichloroethene
UCNRS	University of California Natural Reserve System
UCSC	University of California at Santa Cruz
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

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2016 FONR IMPACT ASSESSMENT AND HABITAT AND RARE PLANT SPECIES SURVEY RESULTS OPERABLE UNIT 1 FORMER FORT ORD, CALIFORNIA

1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) was contracted by the U.S. Army Corps of Engineers (USACE), Sacramento District, to conduct a Fixed-Price Remediation with Insurance scope of work for Operable Unit (OU)-1 at the former U.S. Army Base Fort Ord located in Monterey County, California. The ongoing work was contracted by the USACE, Omaha District, under Contract Number W912DY-10-D-0023 Delivery Order CM08, and was administered through the USACE, Sacramento District. The overall goal of this effort is to achieve the primary remediation objectives specified in the Record of Decision (ROD) signed in July of 1995 by the U.S. Army, U.S. Environmental Protection Agency, and the California Environmental Protection Agency (U.S. Army, 1995). Those remediation goals are as follows:

- Establish hydraulic control and contain contaminated groundwater.
- Extract and treat groundwater exceeding aquifer cleanup levels (ACLs).

A groundwater extraction and treatment system (GWETS) was constructed in 1988 to remediate trichloroethene (TCE) and other groundwater contaminants.

A key factor affecting the design and implementation of the groundwater cleanup is that the area including and surrounding the OU-1 contaminant plume is part of the University of California Natural Reserve System (UCNRS), which is designated as the Fort Ord Natural Reserve (FONR). The FONR area potentially affected by the construction of OU-1 remediation facilities and activities is approximately 130 acres. Therefore, the project has the additional constraint that activities undertaken to achieve the OU-1 cleanup adequately protect and maintain the critical habitat and protected species found within the FONR. The FONR is managed by staff at the University of California at Santa Cruz (UCSC).

Figure 1.1 illustrates the location of Former Fort Ord and the OU-1 source area. The source area was the former Fort Ord Fritzsche Army Airfield Fire Drill Area (FDA). Activities conducted at the FDA between 1962 and 1985 resulted in contaminants being released to soils and groundwater. Although 10 volatile organic compounds have been identified as contaminants of concern (COCs) in groundwater underlying the FDA, TCE is the contaminant detected at the highest concentrations and across the greatest extent of the affected aquifer. Sampling results from September 2014 onward showed that all COC concentrations were less than the cleanup targets specified in the ROD.

The Installation-Wide Multispecies Habitat Management Plan (HMP) (U.S. Army, 1997) established the guidelines for conservation and management of the plant species and wildlife that largely depend on the land within the former Fort Ord for survival. The overall goal of the HMP is to provide for, at a minimum, no net loss of populations or important habitat for any of the subject species. The U.S. Army consulted with the U.S. Fish and Wildlife Service (USFWS) in

1998 to assess potential impacts to the sand gilia (*Gilia tenuiflora ssp. arenaria*) and Monterey spineflower (*Chorizanthe pungens var. pungens*) populations resulting from groundwater investigation and remediation activities within the FONR. On 30 March 1999, USFWS issued a Biological and Conference Opinion which described minimization measures to guide remediation and other activities conducted in habitat areas, including OU-1. That opinion is consistent with the HMP. The Army consulted the USFWS again in 2002 and 2007 to address impacts to Monterey spineflower critical habitat and the California tiger salamander (*Ambystoma californiense*) (USFWS, 2002 and 2007). In 2015 USFWS issued a Programmatic Biological Opinion that supersedes all previous biological opinions in which various mitigation measures were identified and are implemented before, during, and after work within the FONR (USFWS, 2015).

Annual biological surveys were conducted within the OU-1 area by others from 1998 through 2003. Since 2004, HGL conducted annual biological surveys focusing on mapping the extent and population of federally protected rare, threatened, or endangered (RTE) plant species within the FONR. The 2006 through 2015 rare plant surveys were conducted by Denise Duffy and Associates (DD&A) under subcontract to HGL. These surveys included mapping the endangered sand gilia and the threatened Monterey spineflower. The findings of these surveys were submitted in the following reports:

- Appendix A of the *Draft Remedial System Modification Plan, Operable Unit 1, Fritzsche Army Airfield Fire Drill Area, Former Fort Ord, California* (HGL, 2004a)
- *Results of 2004 Monterey Spineflower and Sand Gilia Surveys, OU-1, Former Ft. Ord, California* (HGL, 2004b)
- *Results of 2005 Monterey Spineflower and Sand Gilia Surveys, OU-1, Former Ft. Ord, California* (HGL, 2005)
- *Final 2006 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2007a)
- *2007 FONR Impact Assessment and Habitat and Rare Plant Survey Results* (HGL, 2008a)
- *2008 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2009a)
- *2009 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2009b)
- *2010 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2011a)
- *2011 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2012)
- *2012 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2013a)
- *2013 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2013b)
- *2014 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2014b)

- *2015 FONR Impact Assessment and Habitat and Rare Plant Species Survey Results* (HGL, 2015)

From 2007 through 2013, HGL engaged the UCSC to perform weed control activities in selected areas of the FONR. The overall objective of the weed control activities was to prevent or reduce potential negative impacts to the Monterey spineflower and sand gilia populations from expansion of non-native plants within that portion of the FONR affected by OU-1 remediation activities. During 2015, UCSC surveyed selected areas that were included in the 2007 through 2013 weed control activities and evaluated the effectiveness of those activities. Based on the results of the 2015 survey, no UCSC surveys or weed control activities were performed in 2016.

This document presents the results of the 2016 rare plant survey and discusses the potential impact on those plants from OU-1 remediation activities conducted since 2004. The following information also is included in this report:

- A description of the FONR site and overview of past activities
- Descriptions of the actions taken and site management protocols implemented to minimize adverse impacts to the FONR habitat
- A summary of the site activities conducted by HGL during 2016 and planned future activities
- Results of the 2016 rare plant survey and interim impact assessment
- Results from previous rare plant surveys for locations surveyed in 2016
- Recommendations for future work

1.1 SITE DESCRIPTION

Fort Ord was established in 1917 as a military training base for infantry troops. In January 1991, the U.S. Secretary of Defense announced the downsizing/closure of the base. In August 1994, portions of the property were transferred to UCSC, and the FONR was established in June 1996.

The former Fort Ord is located near Monterey Bay, approximately 80 miles south of San Francisco. The base consists of approximately 28,000 acres near the cities of Seaside, Sand City, Monterey, Del Rey Oaks, and Marina. Monterey Bay marks the western boundary of the former Fort Ord. Toro Regional Park borders the base to the southeast and land use to the east is primarily agricultural.

OU-1 occupies approximately 590 acres of the FONR in the southwestern corner of the former Fritzsche Army Airfield, west of Imjin Road and north of Reservation Road. The dominant habitats within the OU-1 portion of the FONR are coast live oak woodland, coastal scrub, maritime chaparral and annual grassland. The maritime chaparral is considered a rare habitat by the California Department of Fish and Wildlife. The overall former Fort Ord area contains large areas of maritime chaparral habitat.

Several federally protected RTE species are known or suspected to be present within the FONR. These include the federally endangered and state threatened sand gilia, the federally threatened

Monterey spineflower, the federally endangered Yadon's piperia, and the federally and state threatened California tiger salamander. Several plant and animal HMP species are also present in the FONR. Other plant HMP species include the following:

- Coast wallflower (*Erysimum ammophilum*)
- Eastwood's ericameria (*Ericameria fasciculata*)
- Monterey ceanothus (*Ceanothus cuneatus var. rigidus*)
- Sandmat manzanita (*Arctostaphylos pumila*)
- Toro manzanita (*Arctostaphylos montereyensis*)
- Yadon's piperia (*Piperia yadonii)*

The California black legless lizard (*Anniella pulchra nigra*), and the Monterey ornate shrew (*Sorex ornatus salarius*) are animal HMP species.

The northern and northeastern boundaries of OU-1 are adjacent to a large expanse of privately or municipally owned, non-native grassland. Transmission of non-native grass species into OU-1 is accelerated by the prevailing southern winds, which blow the seeds into the OU-1 area (Fusari, 2004). Non-native grasses and weedy forbs are already present throughout much of the OU-1 area. The significant expansion of these non-native grasses could potentially cause federally listed plant populations to decline.

Sand gilia appears to be less tolerant of competing plant cover than the Monterey spineflower. This hypothesis is based on the observation that numerous small Monterey spineflower populations were identified within the dense grassland habitat bordering the main FONR habitat to the east and north or on the roadways bordering this grassland in the initial 1998 survey. Subsequent rare plant surveys conducted between 2004 and 2007 also observed Monterey spineflower in this region. Although sand gilia was not detected in this region during the 1998 through 2007 surveys, sand gilia population patches were observed in 2007 at open areas within a small zone of grassland species inside the more extensive oak woodland habitat near the OU-1 plume source area (sand gilia patches 20 through 22 appear on Figure A3.4 in Appendix A of the 2007 FONR Impact Report [HGL, 2008a]). The small open area in which the sand gilia population was observed is approximately 300 feet east of the source area and is bordered by grasses that are surrounded by oak woodland and understory habitat. Several Monterey spineflower populations also were observed thriving within dense patches of non-native grasses in the same vicinity.

1.2 OVERVIEW OF OU-1 REMEDIATION ACTIVITIES WITHIN THE FONR

Numerous wells and soil borings were constructed within the FONR as part of the investigative effort to define the extent of environmental contamination and remediate contamination. Table 1.1 lists the wells that were installed within the OU-1 portion of the FONR. Table 1.2 lists the soil borings that were drilled since 2004 within the FONR portion of OU-1 without constructing a well. Table 1.2 also lists the wells within the FONR portion of OU-1 that have been destroyed. Figure 1.2 illustrates the OU-1 well and soil boring locations. No new wells or soil borings have been constructed by HGL within the FONR since 2006. In September 2011, 55 wells were destroyed within the FONR. In June 2014, 18 wells were destroyed within the FONR. Figure 1.3

illustrates the layout and components of the OU-1 groundwater remediation system within the FONR as of June 2015.

Note that typical well identification formats—"MW-" prefix for monitoring wells, "EW-" prefix for extraction wells, and "IW-" prefix for injection wells—do not correspond to well function in all cases. The boundaries of the contaminated groundwater zone in OU-1 were refined as the remedial design progressed. The initial system performance pilot test and other field tests provided data that described potential pumping rates for several wells. This data was used during design of the FONR component. Formulating and evaluating design alternatives showed that the most effective OU-1 remedy required that some wells be used for different purposes than originally intended. Consequently, some wells that were intended and named as monitoring wells (MW-OU1-46-AD, MW-OU1-85-A, and MW-OU1-87-A) became extraction wells. Conversely, numerous wells with the EW- prefix have been used only for monitoring groundwater quality. Only the following EW- prefix wells have been used for groundwater extraction:

EW-OU1-60-A	EW-OU1-63-A	EW-OU1-71-A
EW-OU1-62-A	EW-OU1-66-A	

Several wells were named as potential injection well sites but only two (IW-OU1-73-A and IW-OU1-74-A) were connected to the Northwest Treatment System (NWTS) for this purpose. The rest of the "IW-" prefix wells have been used only for monitoring groundwater quality, with one exception: well IW-OU1-10-A was converted to an extraction well in October 2010.

1.3 SUMMARY OF SITE ACTIVITIES

In 1987, about 4,000 cubic yards of contaminated soils were excavated and replaced with clean fill. The OU-1 ROD (U.S. Army, 1995) indicated that remediation of the contaminated soils at the FDA was complete. The ROD also defined groundwater extraction and treatment as the selected remedy for OU-1 groundwater. A GWETS was constructed in 1988 to remediate TCE and other related groundwater contaminants. The 1988 GWETS consisted of extraction wells EW-OU1-17-A and EW-OU1-18-A and was located a short distance downgradient (north) of the FDA. Extracted groundwater was piped to a treatment facility located at the former FDA, where dissolved organic compounds were removed using granular activated carbon vessels. The treated effluent was spray-irrigated in the southern portion of the FDA.

Despite a steady overall decline in contaminant levels within the groundwater capture zone of the 1988 GWETS, COCs were subsequently detected at concentrations above ACLs in groundwater downgradient from the capture zone. Additional wells installed between 1997 and 2001 (MW-OU1-21-A through MW-OU1-46-A) revealed that TCE exceeded the ACL as far as 2,100 feet downgradient from the existing capture zone. Groundwater modeling showed that contaminated groundwater north and west of extraction well EW-OU1-17A was not captured by the extraction system (AHTNA, 2003).

HGL began performing remediation activities in December 2003. A draft design to expand the original GWETS was presented in the *Draft Remedial System Modification Plan* (HGL, 2004a). New wells were installed and aquifer testing began in 2004 and continued through 2007. The draft GWETS expansion design was adjusted as data from the newly installed wells and aquifer testing

was processed. The final design was issued in the three-volume Final Engineering Design Report in 2006 (HGL, 2006a; 2006b; and 2006c).

In 2006, the first component of the GWETS expansion, the Hydraulic Control Pilot Project, was constructed (HGL, 2006d). Four additional extraction wells (the FONR system) were constructed from July through September 2007 to further expand the GWETS. These construction activities are described in detail in the *Final Hydraulic Control Pilot Project Construction Report* (HGL, 2007b) and the *Draft FONR System Construction Report* (HGL, 2008b). Additional details concerning the GWETS expansion and a summary of OU-1 site activities conducted during 2007 relating to habitat monitoring and impacts were provided in the *2007 FONR Impact Assessment and Habitat and Rare Plant Survey Results* (HGL, 2008a).

During 2010, HGL conducted sampling activities and constructed an underground pipeline and underground power line within the FONR habitat area. The underground pipeline and power line connected IW-OU1-10-A to the terminus of the existing remediation system (at extraction well MW-OU1-87-A). The underground piping was laid within the existing roadway to minimize environmental impacts to the surrounding habitat. Converting IW-OU1-10-A to an extraction well accelerated the overall groundwater cleanup. The design parameters for this expansion are described in the Remediation System Expansion Design Technical Memorandum (HGL, 2010). The 2010 construction activities and associated environmental monitoring are described in the *IW-OU1-10-A System Expansion Construction Report* (HGL, 2011b).

Previous results from the groundwater quality monitoring program showed that cleanup targets within the capture zone of the original GWETS extraction wells (Figure 1.3) were achieved during 2005. Groundwater pumping and treatment from the existing GWETS area was suspended in February 2006 as part of the rebound evaluation. A rebound evaluation to assess whether the improved groundwater quality could be sustained without additional remediation was completed during 2007. The *Draft Rebound Evaluation Report* (HGL, 2007c) was submitted for regulatory review and it was agreed that the groundwater sampling frequency in this region can be greatly reduced. Sampling from selected groundwater monitoring wells in this region continued for some wells at a reduced frequency into 2011. Sampling results confirmed that groundwater quality meets the ACLs and all wells within this area were destroyed in September and October 2011. In total, HGL destroyed 55 OU-1 monitoring wells, 53 of which were located within the FONR, in 2011. These well destruction activities are described in the Well Destruction Report (HGL, 2011c). COC concentrations in groundwater have continued to improve. In 2014, HGL destroyed another 18 monitoring wells that were located within the FONR and no longer needed to support remediation efforts. The 2014 well destruction activities are described in the *Well Destruction and Former OU-1 Treatment Plant Decommissioning Completion Report* (HGL, 2014a).

HGL typically conducts the following activities annually within the FONR habitat area:

- Collect performance monitoring samples from selected extraction wells and from the NWTS. However, no sampling was performed in 2016 because pumping and treatment operations were suspended in October 2014 after the cleanup targets were met.
- Collect samples from the wells composing the OU-1 groundwater long term monitoring (LTM) network. No sampling was performed in 2016 because the attainment monitoring

samples from May, July, October, and December 2015 showed that the remediation effort is complete.

- Survey rare plants at locations where well construction or destruction has occurred within the previous 3 years.

Only light-duty vehicles (pickup trucks or sedans) are used for sampling activities and travel routes are limited to established roadways.

The following sections describe the 2016 activities and the 2016 rare plant survey.

1.3.1 2016 Rare Plant and Habitat Surveys

Field observations at the reference area and within the FONR showed a relatively early blooming period in 2016 (it is typically from late April to early May). Survey dates were determined through communications with UCSC natural resource staff and by observing Monterey spineflower and sand gilia populations in the reference area near the FONR. Due to atypical weather, surveys for sand gilia and Monterey spineflower were split into two survey efforts, approximately four weeks apart. DD&A conducted surveys for sand gilia on 28 and 29 March 2016, and Monterey spineflower on 25 April and 04 May 2016. The timing of the surveys was intended to correspond with the observed peak blooming period for each species.

This year, all surveys included Yadon's piperia in addition to Monterey spineflower and sand gilia. However, the surveys were not conducted within the appropriate blooming period for Yadon's piperia and none of that species were observed. Baseline Realignment and Closure biologists stated that they would follow-up during the appropriate blooming period and identify the piperia species, if present.

The 2016 rare plant survey covered the reference area near the intersection of Reservation Road and Imjin Parkway, the former fence line around the original OU-1 groundwater treatment facility, and those well sites within the FONR habitat area where wells were destroyed in 2014 as noted below and shown on Appendix A, Figures A3.1 through A3.6:

- MW-OU1-22-A
- MW-OU1-24-AR
- MW-OU1-40-A
- PZ-OU1-46-AD2
- MW-OU1-23-A
- MW-OU1-25-A
- MW-OU1-51-A

The PZ-OU1-46-AD2 well location was adjacent to existing well MW-OU1-46-A and near existing well MW-OU1-46-AD. These three wells are considered to be a single location when evaluating rare plant survey results.

The wells listed below were also destroyed in 2014 but were not included in the rare plant survey because they are located in grassland areas or along roadway bordering grassland area outside of the FONR habitat:

- EW-OU1-43-A
- EW-OU1-47-A
- MW-B-10-A
- MW-OU1-56-A
- MW-OU1-64-A1
- MW-OU1-64-A2

- MW-OU1-29-A
- MW-OU1-41-A
- MW-OU1-45-A
- MW-OU1-65-A
- MW-OU1-ERD-08-A

The fence surrounding the GWETS location was removed in 2014 after the rare plant survey had been completed for that year. The fence surrounded the original contaminant source area in which contaminated native soils had been removed in 1987 and replaced with clean, non-native soils. No intrusive activities had been conducted along or near the fence line since 2004 or earlier and this area was not explicitly included in rare plant surveys after 1998. Because some wells were constructed in the vicinity in 2004 and 2005, the 2004 baseline and subsequent post-construction rare plant surveys triggered by those activities extended over the northern half of the fence perimeter. In 2014, the GWETS treatment facility and the fence were destroyed and the entire fence line was within the boundary of the post-destruction rare plant survey.

Section 2.0 of this report presents an overview of the biological survey results, and Appendix A provides a detailed description.

1.3.2 2016 Field Activities

In September 2014, the LTM results showed that the OU-1 groundwater cleanup targets had been met and the remediation system was placed in standby mode. In 2015, groundwater samples were collected at 8 wells during 4 monitoring events and water level measurements were taken at the others to determine if the remediation and monitoring efforts were complete. The regulatory agencies concurred that no further sampling or cleanup was needed. The schedule for closeout activities will be determined in the future. No intrusive activities (such as drilling, aquifer testing, construction, or well demolition) are planned within the FONR during 2016.

1.4 IMPACT PREVENTION AND MITIGATION MEASURES

Activities conducted within the FONR are limited to those that are essential to achieving the remediation goals for the project. The remedial actions and ongoing operation of the remedial system have been and will continue to be consistent with the HMP and biological opinion(s). Compliance with these measures reduces or avoids impacts to RTE species of concern on the project site. In May 2015, the USFWS issued a programmatic biological opinion to address anticipated effects to federally protected species on the former Fort Ord and associated critical habitat as a result of the Army's activities. This May 2015 biological opinion supersedes all previous biological opinions regarding former Fort Ord. Consequently, guidance for the OU-1 remedial action(s) are as follows:

- Installation-Wide Multispecies Habitat Management Plan (U.S. Army, 1997)
- The 28 May 2015 Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (8-8-09-F-74) (USFWS, 2015)
- Site-specific guidance and direction from UCNRS staff for locations within the FONR

The Army tries to avoid OU-1 construction activities within the FONR between November 1 and June 1 to allow Monterey spineflower and sand gilia to set seed and to minimize impact to the FONR during ecologically sensitive periods. All construction or demolition activities are sequenced to avoid this time frame as much as possible within the overall project constraints. For example, the final FONR system construction began in July 2007 and was completed in September 2007 before the seasonal rains began. Likewise, well destruction and road repair activities have been initiated and completed before the rainy season began.

In addition to complying with the guidance listed above, beginning in 2007, HGL subcontracted with UCSC to implement manual and mechanical weed control measures at selected locations within the OU-1 portion of the FONR. The weed control program was renewed annually and implemented by UCSC through 2013. The areas where weed control activities were performed in 2013 and earlier are shown on Figure 1.4. Each area included in the weed control program received between one and three treatments (using a weed-eater and/or hand pulling) depending on site-specific phenology, observed response to past treatments, and species composition. UCSC staff also surveyed well sites to identify the composition of the plant population in the immediate vicinity of the wells. The effectiveness of the 2007 through 2013 weed control activities was evaluated by UCSC and HGL based on UCSC surveys conducted in 2007 and 2015 (HGL, 2015). Based on the evaluation results, weed control activities were not performed in 2016 and future weed control activities are not planned.

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2.0 OVERVIEW OF 2016 RARE PLANT SURVEY RESULTS

The objectives of the 2016 rare plant survey and habitat inventory were to accomplish the following:

1. Identify locations and estimate populations of selected rare plant species at the OU-1 reference site, selected FONR well destruction sites, and near the GWETS fence line, as described in Section 1.3.1.
2. Map Monterey spineflower, sand gilia, and Yadon's piperia populations for comparison to past surveys and / or to facilitate planning if future construction, destruction, or maintenance activities are needed.

The reference site encompasses approximately 0.5 acre located approximately 3,000 feet southeast of the former OU-1 source area (Appendix A, Figure A1.2). DD&A biologists have used this site since 2010 to identify the peak of the blooming period for Monterey spineflower and sand gilia. The time to initiate the rare plant surveys at former Fort Ord and other locations has been partly based on observations of plants within the reference area to ensure that such surveys are conducted at appropriate times.

Coast live oak woodland is the dominant habitat in the reference area. Grassland and coast live oak woodland is adjacent to the reference site on the northwestern boundary. All other sides of the reference area are bordered by developed roads (Reservation Road, Mbest Drive, and University Drive). Non-native grasses and weedy forbs were already present throughout much of the reference area when the surveys began in 2010.

The 2016 rare plant survey was conducted at the reference site, at 7 former well sites within OU-1, and along the former GWETS fence line. This section presents a summary of the key findings from those surveys. The complete survey report is presented in Appendix A.

A DD&A biologist and a DD&A technician conducted surveys for sand gilia on 28 and 29 March 2016, and Monterey spineflower on 25 April and 4 May 2016 using a global positioning system (GPS). Yadon's piperia was included in all surveys, but was not found at any location. Consequently, Yadon's piperia is not further discussed in this report. The survey was timed to coincide with the peak blooming period insofar as possible for Monterey spineflower and sand gilia. The peak blooming period was determined through communications with UCSC FONR natural resource management staff and by observing a known occurrence of sand gilia at the Fort Ord reference site near the FONR.

Each rare plant survey was conducted along existing or proposed roadways and access routes. The width of the survey area was approximately 10 feet beyond the edge of the roadway on either side. If a rare plant was identified, the survey in that area was extended to the boundary of the population encountered.

2.1 RARE PLANT SURVEY METHODS

Large areas of Monterey spineflower and sand gilia were mapped as polygons using a Trimble Pathfinder ProXH GPS unit. Smaller plant groups and individuals were mapped as points with

attributes to identify the number of individuals at each location. When a rare plant was identified, the survey in that area was extended to the boundary of the population encountered.

Individual counts were made for all sand gilia populations whether they were mapped as points (population less than or equal to five) or polygons (population greater than five). The polygon boundary was drawn to include all plants identified as a distinct population. However, Monterey spineflower was only counted as individuals when groups of less than five were mapped. For larger populations, Monterey spineflower was mapped as polygons and characterized according to the percent of cover; specifically, the percentage of the polygon covered by the Monterey spineflower divided by the total area enclosed within the polygon. The cover classes are defined as follows:

- Very Sparse (corresponding to an absolute cover of less than 3 percent)
- Sparse (3 to 25 percent)
- Medium Low (26 to 50 percent)
- Medium (51 to 75 percent)
- Medium High (76 to 97 percent)
- Very High (greater than 97 percent)

GPS data was exported to shapefile format for use in a geographic information system (GIS) (ESRI ArcGIS) and mapped on high-resolution aerial photography. These maps are presented in Appendix A (Figures A3.1 through A3.6).

2.2 SAND GILIA SURVEY RESULTS

Sand gilia was observed and mapped at 6 locations within the DD&A reference site and at 6 locations within or along the former GWETS fence line. Although sand gilia was present along secondary access routes, it was not observed at any of the well locations surveyed. A total of 12 populations (6 points and 6 polygons) of sand gilia were mapped within the 2016 survey area (see Appendix A, Attachment A-1 and Figures A3.5 and A3.6). A total of 1,090 individual plants were mapped at the 12 populations.

2.3 MONTEREY SPINEFLOWER SURVEY RESULTS

A total of 26 populations (13 points and 13 polygons) of Monterey spineflower were mapped at the reference site, at 2 of the 7 well sites (MW-OU1-40-A and MW-OU1-46-AD) within the FONR, and the area within or along the former GWETS fence line (see Appendix A, Figures A3.1 through A3.5). Of the 13 populations of Monterey spineflower that were mapped as polygons, one population was identified as Medium (51 to 75 percent cover), 6 populations were identified as Medium Low (26 to 50 percent cover), and 6 populations were identified as Sparse (3 to 25 percent cover).

3.0 DISCUSSION OF 2016 SURVEY RESULTS

The Army will assess whether the success criteria listed in the 2015 programmatic biological opinion have been met at the end of the 3rd year of monitoring (2017) for the most recently disturbed well sites. The annual reference plot rare plant survey was initiated in 2010. Table 3.1 summarizes the survey results at the reference plot. Table 3.2 summarizes the results for all rare plant surveys conducted at the 2016 rare plant survey sites since 1998.

During well construction or destruction activities, the work area and drill rig footprint is approximately 30 feet in diameter and centered on the well borehole. Discussions comparing survey results in this report assume that a plant population or polygon is attributed to a given well site if any part of the population or polygon is within the potentially disturbed area. In some cases, observation wells were constructed within approximately 30 feet of an existing well. For the purpose of this impact assessment, these paired well locations are considered and counted as a single location and data point.

Numerous environmental factors affect the growth of the rare plants monitored in this survey (Fox et al. 2006). Precipitation is an important factor for Monterey spineflower, and herbivory for sand gilia (Fox 2007). The annual rare plant surveys are timed to coincide with the peak blooming season and are typically performed in April or May. The total precipitation for the October 2015 through March 2016 period (8.68 inches) preceding the annual rare plant survey is provided in Table 3.3 for reference in subsequent discussions. The total precipitation of 21.50 inches during the October 2015 through March 2016 period was the largest amount for that period since 2005; it also far exceeds the 7.35 inches to 8.78 inches observed during the previous 3 years and is the maximum amount since the annual reference area surveys began in 2010.

This section compares the results of the 2016 rare plant survey within the DD&A reference area and the 7 well locations on the OU1 FONR property with the results of previous surveys. The 2016 survey is the second of three annual surveys to be conducted after well destruction at these locations in accordance with 28 May 2015 Programmatic Biological Opinion.

3.1 SAND GILIA

3.1.1 Reference Area

The reference area is located on property that is relatively undisturbed by anthropogenic activities. As seen in Table 3.1, sand gilia populations in the reference area have varied tremendously from one year to the next. Population counts ranged from a low of 70 individuals in 2012 to a maximum of 1,086 individuals in 2010. The rare plant survey results for 2016 showed the third highest population count (946 individual plants) since the reference area survey began in 2010. Sand gilia populations fluctuate from year to year because of natural variation in rainfall, temperature, and other factors. The interrelationship between these variables is complex, as illustrated by the comparison of total population to the total amount of precipitation in the preceding rainy season:

- The total population of sand gilia dropped from 1,086 in the 2010 survey to 318 in the 2011 survey although total precipitation—16.85 inches versus 17.29 inches, respectively—was very similar.

- The total population of sand gilia in 2015 was nearly identical to that observed in 2010 (1,078 versus 1,086) although total precipitation—8.68 inches versus 16.85 inches, respectively—was almost 50 percent lower and represents the third consecutive year of significantly below-average annual precipitation.

The data from the reference area surveys provides a frame of reference for assessing the variability observed at well sites within the FONR where remediation activities have been conducted over the years.

3.1.2 FONR Well Locations

In 2016, sand gilia was not detected at any of the 7 well locations (Table 3.2) surveyed. This is consistent with past survey results. Except at well MW-OU1-40-A (installed in 1999), sand gilia has not been observed at any of these 7 locations in any previous survey (see Table 3.2). Sand gilia was observed at or near MW-OU1-40-A during the 2001 survey (HLA, 2001) but was not seen in the annual surveys from 1998 through 2005 or in the subsequent three surveys that included this well.

3.1.3 Former GWETS Fence Line

The 2016 survey results showed 3 sand gilia polygons and 9 individual plants at 3 locations within the fenced area in the southern half of the previously enclosed area—the total number of sand gilia plants observed in 2016 was 144. No wells were located along the fence line. There were no intrusive activities along the fence line since it was installed until the fence was removed in 2014. Consequently, rare plant surveys from 2005 through 2007 and from 2012 through 2014 included only portions of the fence line that were incidental to surveys conducted at nearby newly installed or destroyed well locations. No rare plant surveys were conducted in the vicinity of the GWETS fence line from 2008 through 2011.

Sand gilia was observed in the 1998 and 2004 baseline surveys at locations along the northwest section of the GWETS fence line. Sand gilia was also observed at locations along the fence line in annual surveys completed in 2001, 2002, 2003, 2007, and 2015. The 2016 observed populations were less extensive than either the 1998 or 2004 baseline surveys and were located at the southern limit of the 1998 and 2004 observations., The 2016 survey also showed a population of 105 sand gilia plants within the fenced area; the 2015 survey showed a larger population (295 plants) and bigger area in this same location (Figure 3.1). The 2015 survey was the first survey within the fenced area since 1998. As shown in Table 3.1, the sand gilia population also decreased in the reference area. In total, sand gilia has been observed along or within the fence line in 9 of the 15 rare plant surveys performed in area since 1998.

3.2 MONTEREY SPINEFLOWER

Previous rare plant surveys conducted by DD&A indicate that populations of Monterey spineflower were often observed in areas with sparse to moderately abundant non-native annual grass cover, which suggests that this species may be somewhat more tolerant of annual grass cover variations and environmental factors than sand gilia. As with sand gilia, there are several environmental factors that affect the amount of Monterey spineflower that blooms in a given year

and the interrelationship between these variables is complex. For example, variations in the total area of observed Monterey spineflower in comparison to the total amount of precipitation in the preceding rainy season are illustrated in Table 3.4:

- The total population area of Monterey spineflower varied by approximately 1 percent in the reference area in 2010 versus 2013 and in 2011 versus 2013; however, precipitation varied by nearly 50 percent in both comparisons.
- The total population area of Monterey spineflower varied by nearly 25 percent in the reference area in 2013 versus 2015 although precipitation varied only by approximately 1 percent.

As with sand gilia, these results illustrate the range of variability in plant populations under natural conditions unaffected by remediation activities.

3.2.1 Reference Area

Table 3.1 summarizes the reference area survey results for Monterey spineflower. The reference area has shown relatively few populations of Monterey spineflower and the population densities have primarily been Sparse. In 2015, the first Monterey spineflower population with Medium density was observed. In 2016, this Medium density population expanded in area and overlapped the Sparse population observed in 2015. The Medium Low density population observed in 2015 also greatly expanded in size in 2016. The total area of Monterey spineflower in 2016 (3,241 square feet) increased by more than 50 percent when compared to last year and is the largest area since annual reference surveys began in 2010 (Appendix A, Figure A3.6).

3.2.2 FONR Well Locations

Monterey spineflower was found at 2 of the 7 well locations (MW-OU1-40-A and PZ-OU1-46-AD2) in 2016. Well locations PZ-OU1-46-AD2, MW-OU1-46-A, and MW-OU1-46-AD are considered a single location. These wells have been included in 15 surveys from 1998 through 2016; Monterey spineflower was observed in 9 of those surveys since these wells were installed. Monterey spineflower observations during all surveys from 1998 through 2015 at the other 6 well locations surveyed in 2016 are summarized below and presented in detail in Table 3.2:

- MW-OU1-22-A. Monterey spineflower was detected in 6 of the 7 annual surveys conducted from 1998 through 2004 (absent in 1998) but was not detected during 5 surveys at this location between 2005 and 2016.
- MW-OU1-23-A. Monterey spineflower was detected only in the 1998 rare plant survey but not in the subsequent 9 surveys conducted between 1999 and 2016.
- MW-OU1-24-AR. Monterey spineflower was detected in 4 (1998 through 2000 and in 2006) of the 12 rare plant surveys conducted between 1998 and 2016.
- MW-OU1-25-A. Monterey spineflower was detected in 3 (1998 through 2000) of the 10 rare plant surveys conducted between 1998 and 2016.

- MW-OU1-40-A. Monterey spineflower was detected in 5 of the 6 surveys conducted from 1998 through 2003 but was not detected during 4 subsequent surveys at this location between 2004 and 2015. A total of 3 plants were detected at 2 locations in the 2016 survey.
- MW-OU1-51-A. This location was included in 11 separate surveys but Monterey spineflower was detected only in the 1999 survey.

Thirteen (13) polygons totaling 9,523 square feet were mapped within the 2016 FONR survey area. The 13 Monterey spineflower polygons included 6 Sparse, 6 Medium–Low, and 1 Medium population density categories. As shown in Table 3.5, the total area of Monterey spineflower polygons was more than four times greater than that observed in 2015. All survey results are summarized in Table 3.2 and presented in detail in Appendix A.

3.2.3 Former GWETS Fence Line

The rare plant survey history for the fence removed in 2014 was described in Section 3.1.3. The 2016 survey results showed 5 Monterey spineflower polygons (4 Sparse and 1 Medium Low densities) and a total of 7 individual plants at 5 locations within the fenced area. The overall polygon area increased from 2015 to 2016 as 2 of the 2015 Medium Low density areas and one of the point populations merged into a single, larger Medium Low density area. The survey results are shown on Appendix A Figure A.5.

Monterey spineflower was observed in the 1998 baseline along part of the eastern fence line and at a small area north of the fence (Figure 4.3). A larger Monterey spineflower population was also found at the northern location in the 2004 baseline survey, but the eastern area was not surveyed. Monterey spineflower populations were observed along portions of the fence line in 12 of the 15 rare plant surveys performed in the area since 1998.

4.0 IMPACT ASSESSMENT

Construction and groundwater monitoring efforts were undertaken by HGL during 2004 through 2015 to remediate contaminated groundwater within the OU-1 portion of the FONR. Construction activities included the following:

- Drilling soil borings
- Constructing extraction, injection, and monitoring wells
- Installing water conveyance pipelines
- Installing infiltration trenches
- Constructing a groundwater treatment facility
- Converting IW-OU1-10-A from a monitoring well to an extraction well
- Destroying a total of 73 wells within the OU-1 area during 2011 and 2014
- Repairing road to address ruts created by heavy equipment traffic and erosion

Figure 4.1 illustrates the areas in which construction occurred during 2004 through 2015. The locations of OU-1 wells destroyed in 2011 and 2014 are shown on Figure 4.2.

A critical concern throughout the project has been the protection of the rare plant species within the FONR. To that end, direct impacts of construction activities within the footprint of known populations of Monterey spineflower or sand gilia were minimized by using the results of the 1998 rare plant survey (HLA, 1998). The results of the 1998 rare plant survey are provided on Figure 4.3. In addition, a pre-construction survey was conducted in the spring of 2004 (HGL, 2004b) to delineate population locations. The survey results were used to adjust the location of remediation facilities to avoid previously identified rare plant locations wherever possible. As discussed below, this strategy enabled the construction activity to mostly avoid overlapping known rare plant populations. The few exceptions to this approach are described later in this section.

UCSC staff responsible for managing the FONR expressed a significant concern that construction activities would cause indirect impacts to the rare plant species by altering the habitat in the work areas. They were concerned that the practice of clearing existing native vegetation to enable equipment access for well or pipeline construction may provide a pathway for non-native, invasive plant species from the surrounding areas to encroach farther into the FONR. The UCSC concern is that such encroachment may result in declining rare plant populations as the non-native newcomers outcompete the existing plants and come to dominate the overall species distribution. To address this concern, HGL contributed funds to support manual and mechanical weed control efforts by UCSC from 2007 through 2013. The weed abatement efforts removed large portions of the invasive weed seed source for the growing seasons (HGL, 2008a; 2009a; 2009b; 2011a; 2012; 2013a; 2013b). UCSC, HGL, and the Army evaluated the effectiveness of the previous weed control efforts based on field surveys conducted during the first half of 2015. The Army suspended weed control activities based on those evaluation results.

HGL has conducted annual rare plant surveys from 2004 through 2016 (through subcontractors) to satisfy the requirements of the Biological Opinions (USFWS, 2002; 2007; 2015). The data resulting from these surveys is evaluated annually and has not shown evidence of overall negative

impact to rare plant populations. Table 3.2 summarizes the rare plant populations observed at the OU-1 sites surveyed in 2016.

4.1 ORIGINAL GWETS FENCE LINE

The native soils within the GWETS fence line were removed in 1987 as part of the source area remediation effort and the area was used to treat extracted OU-1 groundwater (U.S. Army, 1995). The treated water was returned to the A-Aquifer through a spray irrigation system. The GWETS fence line was not explicitly surveyed in any of the annual efforts conducted from 2004 through 2014 and only partially covered in the 2004 through 2007 surveys because the remediation activities in that time period were limited to sampling existing wells and did not disturb the habitat.

Monterey spineflower was observed within 30 feet of the fence line in at least one location in 1998 and in every subsequent rare plant survey except the 2001, 2002, and 2006 efforts. As shown in Table 3.2, Monterey spineflower was observed in 12 of the 15 surveys conducted in this area since 1998. Because the fence was constructed before the earliest rare plant survey in 1998, it is not possible to make "before and after" comparisons.

Sand gilia was observed in both the 1998 and 2004 baseline surveys within 30 feet of the fence line and in 9 of the 15 surveys overall. As with Monterey spineflower, it is not possible to make "before and after" comparisons because the fence was constructed before the earliest rare plant survey (in 1998).

4.2 2016 RARE PLANT POPULATIONS AT THE WELLS DESTROYED IN 2014

This section summarizes the 2016 survey results for the sites of the 7 wells destroyed in 2014 that were located within the FONR habitat area. Sand gilia was not detected at any of these well sites in 2016 or in any previous survey, except for a single occurrence at well MW-OU1-40-A in 2001 (see Table 3.2). Consequently, the 2016 survey results show no new sand gilia colonizations of the surveyed areas.

As shown in Table 3.2, Monterey spineflower was detected only at MW-OU1-40-A and MW-OU1-46-AD in 2016.

Existing monitoring wells MW-OU1-46-A, MW-OU1-46-AD, and destroyed well PZ-OU1-10-AD2 are considered one survey point because they are located within 30 feet of one another. These three wells were constructed in 2001, 2004, and 2005, respectively. In previous surveys, Monterey spineflower was detected in the 1998, 1999, 2002, and 2003, but not in the 2004 pre-construction survey. It was not observed in the annual surveys from 2005 through 2007, but was present in 2008 through 2010, 2015, and 2016. Overall, Monterey spineflower has been observed in 9 of the 15 surveys conducted at this location.

Monterey spineflower was detected only once in any previous survey at wells MW-OU1-23-A (in 1998) and MW-OU1-51-A (in 1999). Thus, the 2016 Monterey spineflower survey results at these wells are consistent with the past surveys.

MW-OU1-22-A was constructed in 1997. Monterey spineflower was detected at this location in each annual survey conducted from 1999 through 2004 (absent in 1998). It has not been detected within 30 feet of this well in the last 5 surveys from 2005 onward.

MW-OU1-24-AR was constructed in 2003 as a replacement for vandalized well MW-OU1-24-A. The replacement well was constructed at the same location as well MW-OU1-24-A (constructed in 1997) and both wells are evaluated as a single location. Monterey spineflower was detected at this location in each survey from 1998 through 2000, but was not detected from 2001 through 2005. It was observed in one of 7 post-construction surveys (2006).

MW-OU1-25-A was constructed in 1998. Monterey spineflower MS was detected at this location in 3 (1998 through 2000) of the 10 rare plant surveys conducted between 1998 and 2016.

MW-OU1-40-A was constructed in 1999. Monterey spineflower was detected at this location in 5 of the 6 surveys conducted from 1998 through 2003, but was not detected during 4 subsequent surveys at this location between 2004 and 2015. The 2016 detections are the first since 2005.

4.3 SUMMARY

The 2016 rare plant survey results were compared with all previous rare plant surveys (conducted between 1998 and 2015) to assess construction impacts on the FONR rare plant populations. Five impact categories have been defined in previous Annual Rare Plant Survey and Habitat Impact Reports:

1. Rare plant species not detected in any survey
2. Rare plant species detected before but not after well construction
3. Rare plant species detected before and after well construction
4. Rare plant species detected only after well construction
5. Well was constructed before earliest rare plant survey in 1998

Well sites included in categories 1 and 5 do not provide data that can be used to compare before and after construction rare plant populations.

As noted earlier, sand gilia was not detected in 2016 or in any previous survey at 6 of the 7 well sites monitored in 2016—well sites MW-OU1-22-A, MW-OU1-23-A, and MW-OU1-24-AR and the GWETS fence line were constructed before the earliest survey in 1998 and fall into category 5 as defined above. Well locations MW-OU1-25-A, PZ-OU1-46-AD2, and MW-OU1-51-A fall into category 1. At well MW-OU1-40-A, sand gilia was detected just once (in 2001) in the 9 post construction surveys that included this location. Well location MW-OU1-40-A falls into category 4.

The survey results for Monterey spineflower at three of the 4 well sites that were constructed after the initial survey in 1998 (MW-OU1-25-A, PZ-OU1-46-AD2, and MW-OU1-40-A) fell into category 3—the population has been observed before and after well construction. MW-OU1-51-A was constructed in 2004 and Monterey spineflower was observed at this site only in 1999. Monterey spineflower was not observed in 1998 at this location although exceptionally favorable

conditions for Monterey spineflower were present that year (Fusari, 2004). Also, Monterey spineflower was not seen at MW-OU1-51-A in the 2000 and 2004 surveys before well construction or in the 2005 through 2009 annual surveys performed after well construction. These results are consistent with the findings presented in the 2015 OU-1 habitat impact and rare plant survey report (HGL, 2015).

5.0 RECOMMENDATIONS AND FUTURE WORK

In 2014, 7 wells at 7 locations were destroyed within the FONR. These wells are:

MW-OU1-22-A	MW-OU1-23-A	MW-OU1-24-AR	MW-OU1-25-A
MW-OU1-40-A	PZ-OU1-46-AD2	MW-OU1-51-A	

The second year of the 3-year monitoring requirement specified in the 2015 Biological Opinion (USFWS, 2015) was performed in 2016 for these wells. The conservation measures specified in the 2015 Programmatic Biological Opinion (USFWS, 2015) states, "Following groundwater remediation, monitoring of HMP annuals and/or their habitat will be conducted where HMP annuals were present prior to remediation and will be monitored for 3 years following the completion to assess the reestablishment of the HMP annual plant populations (Monterey gilia and Monterey spineflower) unless otherwise coordinated with the Service. The exception for this 3-year monitoring schedule will be in the University of California Natural Reserve, where monitoring will be suspended at sites where HMP annuals have not been documented during baseline surveys nor in the first year of follow-up surveys. Additionally, surveys for HMP annuals will not be conducted in areas considered low quality habitat for these species (Service 2013)".

Monterey spineflower was not detected in the baseline surveys of 1998 and 2004 or in the first year (2015) of follow-up surveys after well demolition (see Table 3.2) at well MW-OU1-51-A. As noted in Section 4.3, Monterey spineflower has been detected only once in 11 surveys and sand gilia not at all at well MW-OU1-51-A. The Army consequently recommended in 2015 (HGL, 2015) that the 3-year monitoring schedule be suspended in accordance with the 28 May 2015 Programmatic Biological Opinion guidance at well MW-OU1-51-A. However, this well was inadvertently included in the 2016 survey and will also be included in 2017.

The 2015 Programmatic Biological Opinion lists general conservation measures "to minimize disturbance to natural resources, in particular, HMP species". These include conducting employee environmental awareness training programs, developing Habitat Checklists prior to all activities within non development parcels, minimizing footprint of work areas, utilizing existing roads, and mapping and flagging HMP plant species to avoid unnecessary disturbances. The Army will continue to employ the above measures to limit disturbance to HMP species, as well as conducting the required 3 year follow up monitoring of HMP annuals.

The Army will assess whether the success criteria listed in the 2015 programmatic biological opinion have been met at the end of the 3rd year of monitoring of the well sites that were destroyed in 2014. The proposed recommendation for 2016 and 2017 habitat related activities are as follows:

- Continue to implement the conservation measures specified in the 2015 Programmatic Biological Opinion during OU-1 remediation activities.
- Continue the 3-year rare plant monitoring program at the well sites located within the FONR that were destroyed in 2014.

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TABLES

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Table 1.1
Wells Within the Fort Ord Natural Reserve

Wells Installed/Sampled Before 2004				Wells Installed for Enhanced Reductive Dechlorination Pilot Study		Wells Installed 2004 through 2006			
Identification	**Year Installed**	**Identification**	**Year Installed**	**Identification**	**Year Installed**	**Identification**	**Year Installed**	**Identification**	**Year Installed**
MW-B-10-A	1976	*MW-OU1-24-A*	1997	*IW-OU1-ERD-01-A*	2002	*IW-OU1-01-A*	2004	PZ-OU1-10-A1	2005
MW-OU1-01-A	1986	MW-OU1-24-AR	2003	*MW-OU1-ERD-01-A*	2002	IW-OU1-02-A	2004	PZ-OU1-46-AD2	2005
MW-OU1-02-A	1986	MW-OU1-25-A	1998	*IW-OU1-ERD-02-A*	2002	PZ-OU1-02-A1	2004		
MW-OU1-03-A	1986	MW-OU1-26-A	1998	*MW-OU1-ERD-02-A*	2002	*IW-OU1-05-A*	2004		
MW-OU1-04-A	1986	MW-OU1-27-A	1998	*IW-OU1-ERD-03-A*	2002	IW-OU1-10-A	2004	EW-OU1-60-A	2006
MW-OU1-05-A	1986	*MW-OU1-28-A*	1998	*MW-OU1-ERD-03-A*	2002	*IW-OU1-13-A*	2004	MW-OU1-61-A	2006
MW-OU1-06-A	1986	MW-OU1-29-A	1998	*IW-OU1-ERD-04-A*	2002	*IW-OU1-24-A*	2004	EW-OU1-62-A	2006
MW-OU1-07-A	1986	*MW-OU1-30-A*	1998	*MW-OU1-ERD-04-A*	2002	*IW-OU1-25-A*	2004	EW-OU1-63-A	2006
MW-OU1-08-A	1986	*MW-OU1-32-A*	1998	*MW-OU1-ERD-05-A*	2002	MW-OU1-46-AD	2004	MW-OU1-64-A1	2006
MW-OU1-09-A	1986	*MW-OU1-33-A*	1998	*MW-OU1-ERD-06-A*	2002	EW-OU1-47-A	2004	MW-OU1-64-A2	2006
MW-OU1-10-A	1987	*MW-OU1-34-A*	1998	*MW-OU1-ERD-07-A*	2002	*EW-OU1-48-A* *	2004	MW-OU1-65-A	2006
MW-OU1-11-SVA	1986	*PZ-OU1-35-A*	1998	MW-OU1-ERD-08-A	2002	EW-OU1-49-A	2004	EW-OU1-66-A	2006
MW-OU1-12-A	1988	*MW-OU1-36-A*	1999			PZ-OU1-49-A1	2004	MW-OU1-67-A	2006
PZ-OU1-13-A	1988	*MW-OU1-37-A*	1999			MW-OU1-50-A	2004	MW-OU1-68-A	2006
PZ-OU1-14-A	1988	*MW-OU1-38-A*	1999			MW-OU1-51-A	2004	EW-OU1-71-A	2006
PZ-OU1-15-A	1988	*MW-OU1-39-A*	1999			EW-OU1-52-A	2004	EW-OU1-72-A	2006
PZ-OU1-16-A	1988	MW-OU1-40-A	1999			EW-OU1-53-A	2004	IW-OU1-73-A	2006
EW-OU1-17-A	1987	MW-OU1-41-A	2001			*EW-OU1-54-A*	2004	IW-OU1-74-A	2006
EW-OU1-18-A	1987	MW-OU1-43-A	2001			*EW-OU1-55-A*	2004	MW-OU1-82-A	2006
MW-OU1-19-A	1993	*MW-OU1-44-A*	2001			MW-OU1-56-A	2004	MW-OU1-83-A	2006
MW-OU1-20-A	1993	MW-OU1-45-A	2001			MW-OU1-57-A	2004	MW-OU1-84-A	2006
MW-BW-10-A	1997	MW-OU1-46-A	2001			MW-OU1-58-A	2004	MW-OU1-85-A	2006
MW-OU1-21-A	1997	*MW-OU1-01-180*	2000			MW-OU1-59-A	2004	MW-OU1-86-A	2006
MW-OU1-22-A	1997	*MW-OU1-02-180*	2000					MW-OU1-87-A	2006
MW-OU1-23-A	1997	*MW-OU1-03-180*	2000					MW-OU1-88-A	2006

Notes:

Well name in *italics* indicates that well has been destroyed.
ERD - enhanced reduction dechlorination
EW - extraction well
IW - injection well
MW - monitoring well
OU1 - Operable Unit 1
PZ - piezometer
SVA - Salinas Valley Acquiclude

Table 1.2
Soil Borings and Wells Destroyed Within the Fort Ord Natural Reserve

Identification	Year Boring Abandoned or Well Destroyed	Identification	Year Boring Abandoned or Well Destroyed	Identification	Year Boring Abandoned or Well Destroyed
Soil Borings and Wells Destroyed 2004 - 2013. Post Destruction Rare Plant Monitoring Complete.					
SB-OU1-2004-I	2004	MW-OU1-01-180	2011	MW-OU1-32-A	2011
SB-OU1-2004-J	2004	MW-OU1-01-A	2011	MW-OU1-33-A	2011
SB-OU1-2004-K	2004	MW-OU1-02-180	2011	MW-OU1-34-A	2011
SB-OU1-2004-L	2004	MW-OU1-02-A	2011	MW-OU1-36-A	2011
SB-OU1-2004-M	2004	MW-OU1-03-180	2011	MW-OU1-37-A	2011
SB-OU1-46-AD1	2005	MW-OU1-03-A	2011	MW-OU1-38-A	2011
SB-OU1-60-A	2005	MW-OU1-04-A	2011	MW-OU1-39-A	2011
EW-OU1-48-A	2006	MW-OU1-05-A	2011	MW-OU1-42-A	2011
EW-OU1-17-A	2011	MW-OU1-06-A	2011	MW-OU1-44-A	2011
EW-OU1-18-A	2011	MW-OU1-07-A	2011	MW-OU1-ERD-01-A	2011
EW-OU1-54-A	2011	MW-OU1-08-A	2011	MW-OU1-ERD-02-A	2011
EW-OU1-55-A	2011	MW-OU1-09-A	2011	MW-OU1-ERD-03-A	2011
IW-OU1-01-A	2011	MW-OU1-10-A	2011	MW-OU1-ERD-04-A	2011
IW-OU1-05-A	2011	MW-OU1-11-SVA	2011	MW-OU1-ERD-05-A	2011
IW-OU1-13-A	2011	MW-OU1-12-A	before 2003	MW-OU1-ERD-06-A	2011
IW-OU1-24-A	2011	MW-OU1-19-A	2011	MW-OU1-ERD-07-A	2011
IW-OU1-25-A	2011	MW-OU1-20-A	2011	PZ-OU1-13-A	2011
IW-OU1-ERD-01-A	2011	MW-OU1-21-A	2011	PZ-OU1-14-A	2011
IW-OU1-ERD-02-A	2011	MW-OU1-24-A	2003	PZ-OU1-15-A	2011
IW-OU1-ERD-03-A	2011	MW-OU1-28-A	2011	PZ-OU1-16-A	2011
IW-OU1-ERD-04-A	2011	MW-OU1-30-A	2011	PZ-OU1-35-A	2011
MW-BW-10-A	2011	MW-OU1-31-A	2011		
Wells Destroyed in 2014					
EW-OU1-43-A	2014	MW-OU1-25-A	2014	MW-OU1-56-A	2014
EW-OU1-47-A	2014	MW-OU1-29-A	2014	MW-OU1-64-A1	2014
MW-B-10-A	2014	MW-OU1-40-A	2014	MW-OU1-64-A2	2014
MW-OU1-22-A	2014	MW-OU1-41-A	2014	MW-OU1-65-A	2014
MW-OU1-23-A	2014	MW-OU1-45-A	2014	MW-OU1-ERD-08-A	2014
MW-OU1-24-AR	2014	MW-OU1-51-A	2014	PZ-OU1-46-AD2	2014

Notes:

A - A-Aquifer
EW - extraction well
MW- monitoring well
PZ- piezometer
SVA - Salinas Valley Aquiclude
ERD - enhanced reductive dechlorination
IW- injection well
OU1- Operable Unit 1
SB - soil boring

Table 3.1
Rare Plant Survey Results for Reference Plot - 2010 through 2016

Sand Gilia

Year Surveyed	Number of Point Populations	Number of Individuals at Point Populations	Number of Polygon Populations	Number of Individuals at Polygon Populations	Total Number of Individuals	Area of Polygons (square feet)
2010	7	18	7	1,068	1086	1,715
2011	12	40	4	278	318	1,410
2012	12	21	4	49	70	210
2013	7	17	13	719	736	1,281
2014	2	5	2	92	97	370
2015	4	8	7	1,070	1078	1,512
2016	3	3	3	943	946	1,498

Monterey Spineflower

Year Surveyed	Number of Populations with < 5 Individual Plants	Total Number of Individual Plants	Number of Populations with > 5 Individual Plants	Plant Cover Density Summary for Areas With > 5 Individual Plants					Area of Polygons (square feet)
				Sparse	Medium-Low	Medium	Medium-High	Very High	
2010	0	0	2	1	1	0	0	0	2,846
2011	1	4	1	0	1	0	0	0	2,865
2012	1	4	2	2	0	0	0	0	1,494
2013	0	0	7	6	1	0	0	0	2,813
2014	1	4	6	6	0	0	0	0	1,119
2015	1	3	3	1	1	1	0	0	2,114
2016	0	0	2	0	1	1	0	0	3,241

Monterey Spineflower Plant Cover Density Categories Based on Percentage of Plant Cover of Total Ground Area

Very Sparse (less than 3 percent)
Sparse (3 to 25 percent)
Medium Low (26 to 50 percent)
Medium (51 to 76 percent)
Medium High (76 to 97 percent)
Very High (greater than 97 percent)

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Table 3.2
Rare Plant Survey Results Relative to OU-1 Well Locations

Well Identification	Year Installed	Appendix A Figure #	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				Harding Lawson Associates Surveys																	
Wells Installed Before 1998																					
MW-OU1-22-A**	1997	A3.4	N	MS	MS	MS	MS	MS	MS	N	N	N	--	--	--	--	--	--		N	N
MW-OU1-23-A**	1997	A3.4	MS	N	N	N	N	N	N	--	--	--	--	--	--	--	N	--	--	N	N
MW-OU1-24-AR[(2)]**	2003	A3.3	MS	MS	MS	N	N	N	N	N	MS	N	--	--	--	--	--	--	--	N	N
Wells Installed from 1998 - 2001																					
MW-OU1-25-A[(4)]**	1998	A3.3	MS	MS	MS	N	N	N	N	--	--	--	--	--	--	--	N	--	--	N	N
MW-OU1-40-A**	1999	A3.4	MS	MS	MS	SG	MS	MS	N	N	--	--	--	--	--	--	N	--	--	N	MS
MW-OU1-46-A[(1)]	2001	A3.2	MS	MS	N	N	MS	MS	N	N	N	N	MS	MS	MS	--	--	--	--	MS	MS
Wells Installed in 2004 After the Rare Plant Survey																					
MW-OU1-46-AD[(1)]	2004	A3.2	MS	MS	N	N	MS	MS	N	N	N	N	MS	MS	--	--	--	--	--	MS	MS
MW-OU1-51-A**	2004	A3.2	N	MS	N	--	--	--	N	N	N	N	N	N	--	--	--	--	--	N	N
Wells Installed in 2005 After the Rare Plant Survey																					
PZ-OU1-46-AD2[(1)]**	2005	A3.2	MS	MS	N	N	MS	MS	N	--	N	N	MS	N	--	--	--	--	--	MS	MS
Fence Installed Around Original Groundwater Extraction and Treatment System (GWETS)																					
GWETS Fence[(3)]	1988	A3.5	MS, SG	MS	MS, SG	SG	SG	MS, SG	MS#006[100]; SG#82[100]; SG#259[50]; SG#80[80];	MS#213[VS]	N	MS, SG	--	--	--	--	MS	MS	MS	MS,SG	MS, SG

Table 3.2
Rare Plant Survey Results Relative to OU-1 Well Locations

Well Identification	Year Installed	Appendix A Figure #	Remarks Regarding Results for Given Year												
			2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wells Installed Before 1998															
MW-OU1-22-A**	1997	A3.4	MS#90[1000]; extends far beyond well												
MW-OU1-23-A**	1997	A3.4													
MW-OU1-24-AR(2)**	2003	A3.3			MS#59[VS]										
Wells Installed from 1998 - 2001															
MW-OU1-25-A(4)**	1998	A3.3													
MW-OU1-40-A**	1999	A3.4													MS#11[1];#12[2]
MW-OU1-46-A(1)	2001	A3.2					MS#34[VS]	MS#27[M]						MS#36[S]	MS#32[ML]
Wells Installed in 2004 After the Rare Plant Survey															
MW-OU1-46-AD(1)	2004	A3.2					MS#34[VS]	MS#27[M]						MS#36[S]	MS#32[ML]
MW-OU1-51-A**	2004	A3.2													
Wells Installed in 2005 After the Rare Plant Survey															
PZ-OU1-46-AD2(1)**	2005	A3.2					MS#4[1]							MS#36[S]	MS#32[ML]
Fence Installed Around Original Groundwater Extraction and Treatment System (GWETS)															
GWETS Fence(3)	1988	A3.5	MS#006[100]; SG#82[100]; SG#259[50]; SG#80[80];	MS#213[VS]	N	SG#23[50]; MS#45[VS]	--	--	--	--	MS#84[S]; MS#103[ML]; MS#43[3]	MS#123[S]	MS#48[2]; MS#49[3]	MS#19[4]; MS#20[1]; MS#21[4]; MS#32[S]; MS#33[S]; MS#34[ML]; MS#35[ML]; SG#1[2]; SG#2[1]; SG#7[18]; SG#8[295]	SG#1[3]; #2[2]; #3[4]; #20[105]; #21[20]; #22[10] MS#15[1]; #16[1]; #19[3]; #27[S]; #30[S]; #35[ML]

(1) MW-OU1-46-A, MW-OU1-46-AD, and PZ-OU1-46-AD2 considered to be one location.
(2) MW-OU1-24AR replaced MW-OU1-24-A, so they're considered to be one location. Because MW-OU1-24-A was installed in 1997, MW-OU1-24AR is grouped with the wells installed before 1998.
(3) Survey included approximately only the northern half of the fence perimeter in 2004 through 2014.
(4) MW-OU1-25-A was installed in August 1998, after the spring 1998 rare plant survey. Accordingly, the 1998 rare plant survey is applicable as a baseline for MW-OU1-25-A.

No new wells have been installed since 2006.
*This well was abandoned in 2011.
**This well was abandoned in 2014.
-- not surveyed
EW - extraction well
FONR - Fort Ord Natural Reserve
HCCP - Hydraulic Control Pilot Project
ID - identification
IW - injection well
MD - medium high
ML - medium low
MS - Monterey spineflower
MS#49[VS] - population ID # [density category or number of plants]
MW - monitoring well
N - area was surveyed; but no rare plants were detected.
OU1 - operable unit 1
PZ - piezometer
RP/HS - rare plant/habitat survey; population ID# & segment identification refers to Figures A3.1 through A3.3 in Appendix A.
#49 - indicates population ID number assigned in corresponding annual rare plant survey; [13] indicates number of plants.
S - sparse
SG - Sand gilia
SG#26[13] - population ID # [number of plants]
SG^1 - Given map scale, it is possible that the observed sand gilia population was just outside the northwest boundary of the staging area.
VS - very sparse

Table 3.3
Fort Ord Precipitation Data - 1998-2016

Year	October - March Rainfall (inches)
1998	22.36
2004	10.32
2005	21.73
2006	14.18
2007	7.88
2008	9.71
2009	11.89
2010	16.85
2011	17.29
2012	11.3
2013	8.78
2014	7.35
2015	8.68
2016	21.5
Average	**13.56**

Notes:
Precipitation information obtained from
http://met.nps.edu/~ldm/renard_wx/

Table 3.4
Monterey Spineflower Populations for Reference Plot versus Precipitation

Year Surveyed	Area of Monterey Spineflower Polygons (square feet)		October - March Rainfall (inches)	
	By Year	Variation Between Years (%)	By Year	Variation Between Years (%)
2010	2,846	1.2%	16.85	47.9%
2013	2,813		8.78	
2011	2,865	1.8%	17.29	49.2%
2013	2,813		8.78	
2013	2,813	24.8%	8.78	1.1%
2015	2,114		8.68	

Table 3.5
Rare Plant Survey Results for OU1 FONR Survery Area - 2014 through 2016

Sand Gilia*					
Year Surveyed	**Number of Populations**	**Individual Plants**	**Number of Point Populations**	**Number of Polygon Populations**	**Area of Polygons (square feet)**
2014	54	921	44	10	3,629
2015	5	331	2	3	81
2016	12	1,090	6	3	1,964

Monterey Spineflower*							
Year Surveyed	**Number of Populations**	**Number of Point Populations**	**Number of Polygon Populations**	**Polygons Per Density Class**			**Area of Polygons (square feet)**
				Sparse	**Medium-Low**	**Medium**	
2014	21	8	13	10	3	0	2,841
2015	18	9	9	6	3	0	3,468
2016	26	13	13	6	6	1	9,523

Monterey Spineflower Plant Cover Density Categories Based on Percentage of Plant Cover of Total Ground Area
Sparse (3 to 25 percent)
Medium Low (26 to 50 percent)
Medium (51 to 76 percent)

* Results include all observed populations, including those found at more than 30 feet from any well.

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FIGURES

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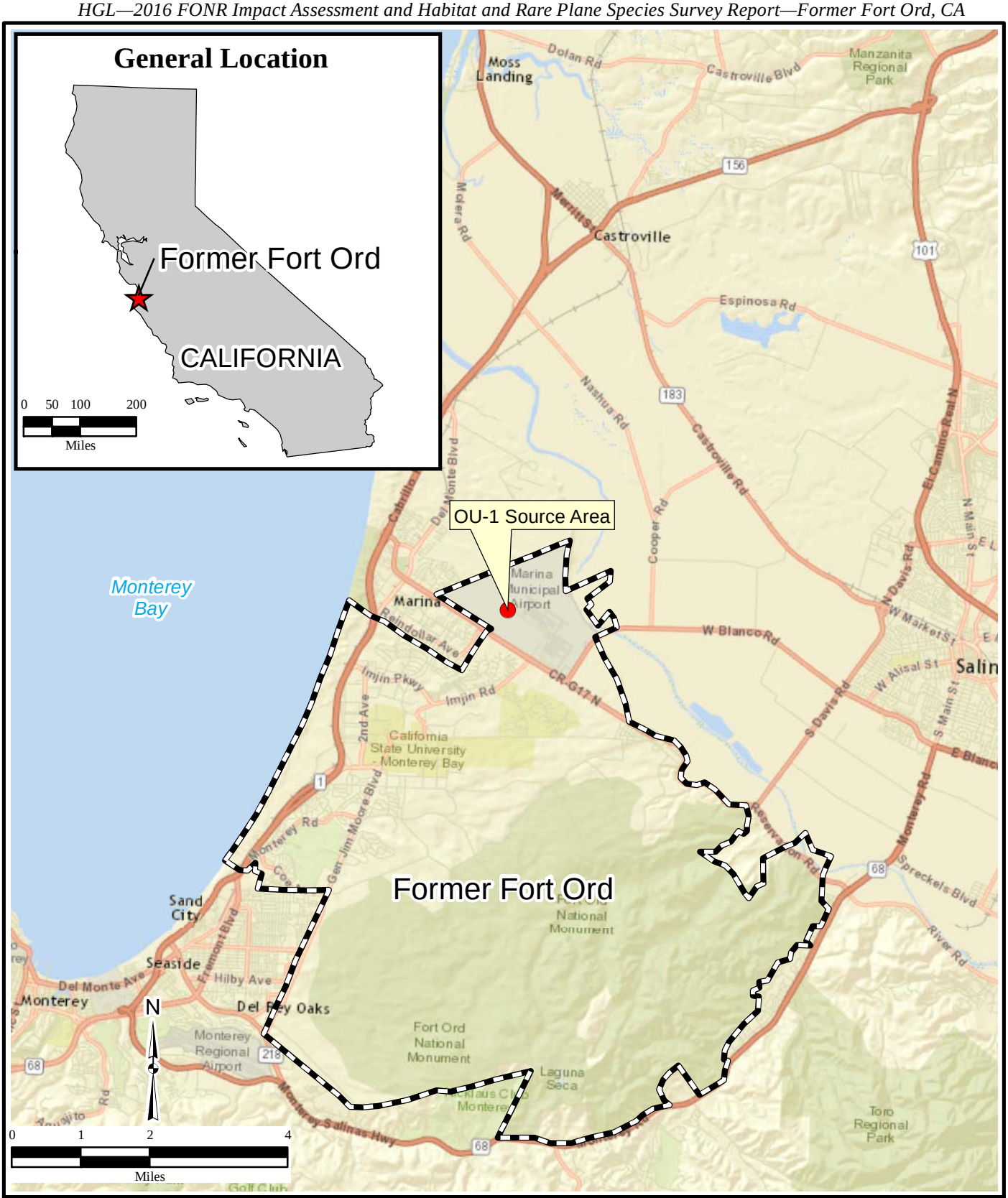

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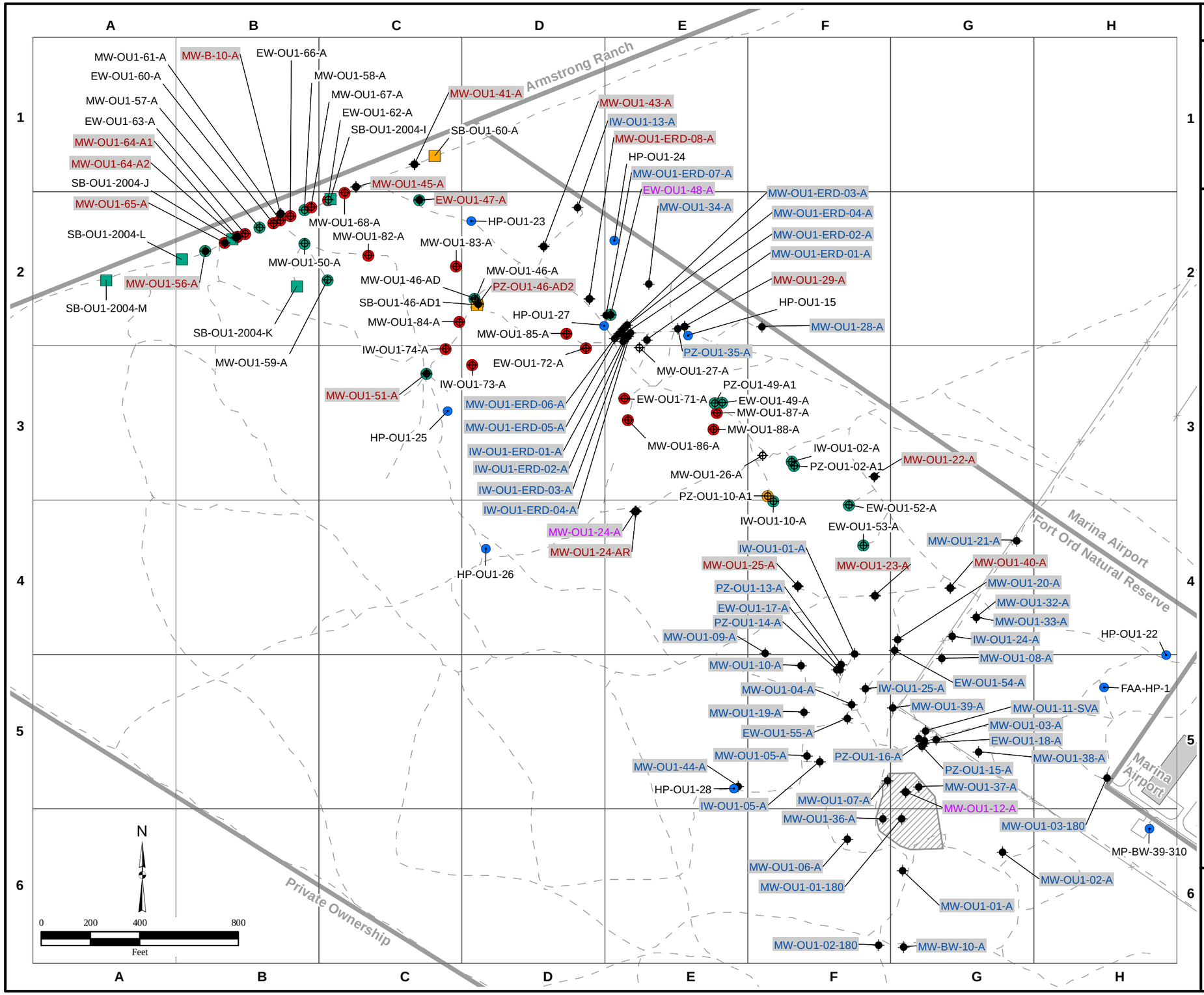
Legend

- OU-1 Source Area
- Former Fort Ord

Figure 1.1
Former Fort Ord

Figure 1.2
OU-1 Soil Borings, Wells, and Piezometers Constructed Within the FONR



Legend

- Well/Piezometer Drilled Before 2004
- Soil Boring Drilled Before 2004
- Well Destroyed
- 2004 Well/Piezometer
- 2004 Soil Boring
- 2005 Well/Piezometer
- 2005 Soil Boring
- 2006 Well/Piezometer
- MW-OU1-26-A — Well or Boring ID
- MW-OU1-12-A — Well Destroyed Before 2006
- MW-OU1-21-A — Well Destroyed September 2011
- MW-OU1-40-A — Well Destroyed 2014
- Trail/Unimproved Road
- Fence
- Property Boundary
- Building
- Former Fire Drill Area

Notes:
FONR=Fort Ord Natural Reserve
OU-1=Operable Unit 1

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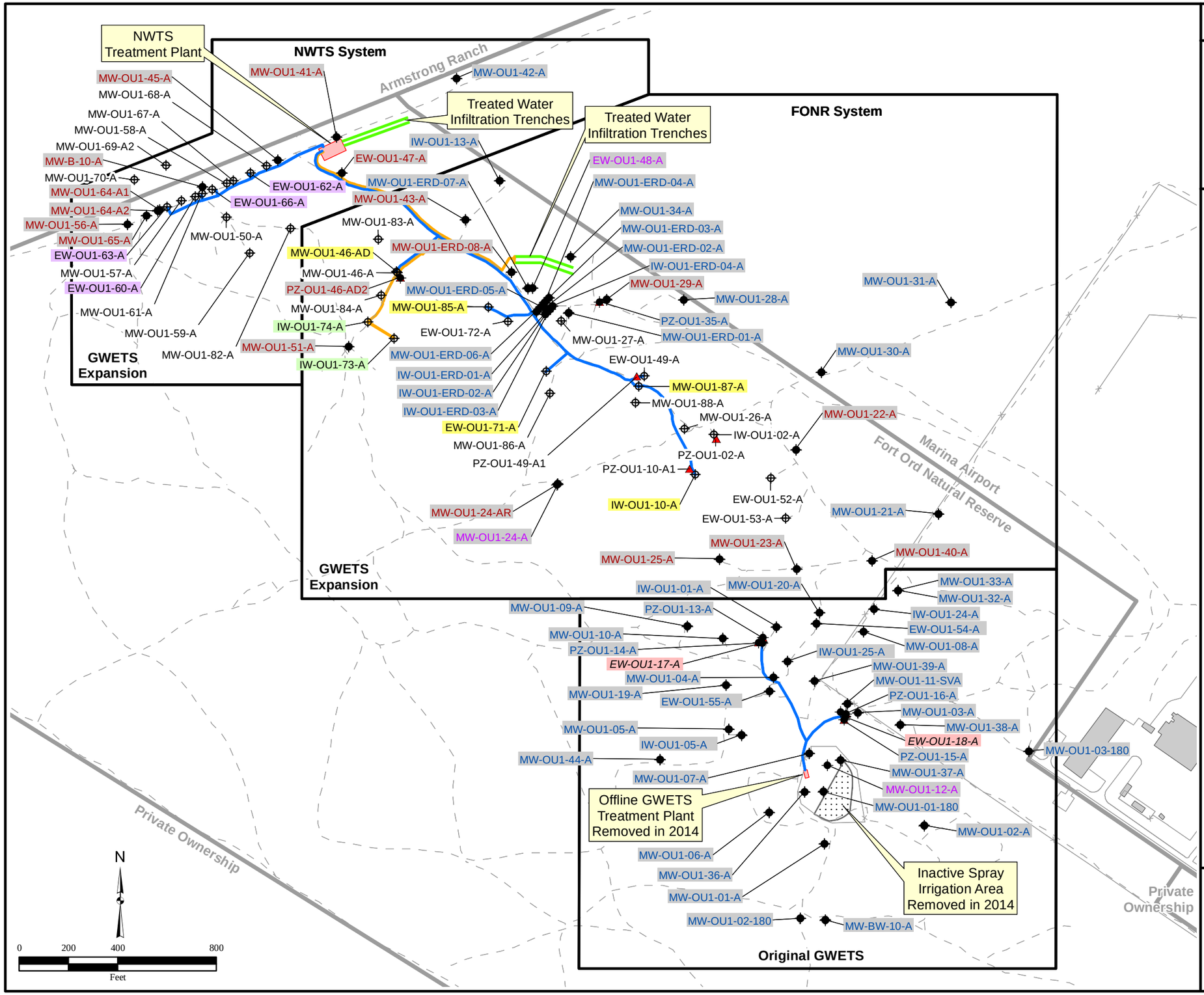
7/29/2016 ARW
Source: HGL

HydroGeoLogic, Inc

Figure 1.3
OU-1 Remediation System Areas Within the FONR



Legend

- Well
- Well Destroyed
- Piezometer
- MW-OU1-27-A — Well Identification
- EW-OU1-18-A — Original GWETS Extraction Well (Destroyed September 2011)
- IW-OU1-74-A — FONR Injection Well
- MW-OU1-46-AD — FONR Extraction Well
- EW-OU1-63-A — NWTS Extraction Well
- MW-OU1-12-A — Well Destroyed Before 2006
- MW-OU1-21-A — Well Destroyed September 2011
- MW-OU1-40-A — Well Destroyed 2014
- Trail/Unimproved Road
- Fence
- Extraction Pipeline
- Treated Water Pipeline
- Treated Water Infiltration Trench
- Property Boundary
- Treatment Plant
- Inactive Spray Irrigation Area
- Building

Notes:
The treated water and extraction water pipelines are located in separate trenches within or near the existing roadway. The separation shown in this figure is exaggerated for clarity.

FONR=Fort Ord Natural Reserve
GWETS=Groundwater Extraction and Treatment System
NWTS=Northwest Treatment System
OU-1=Operable Unit 1

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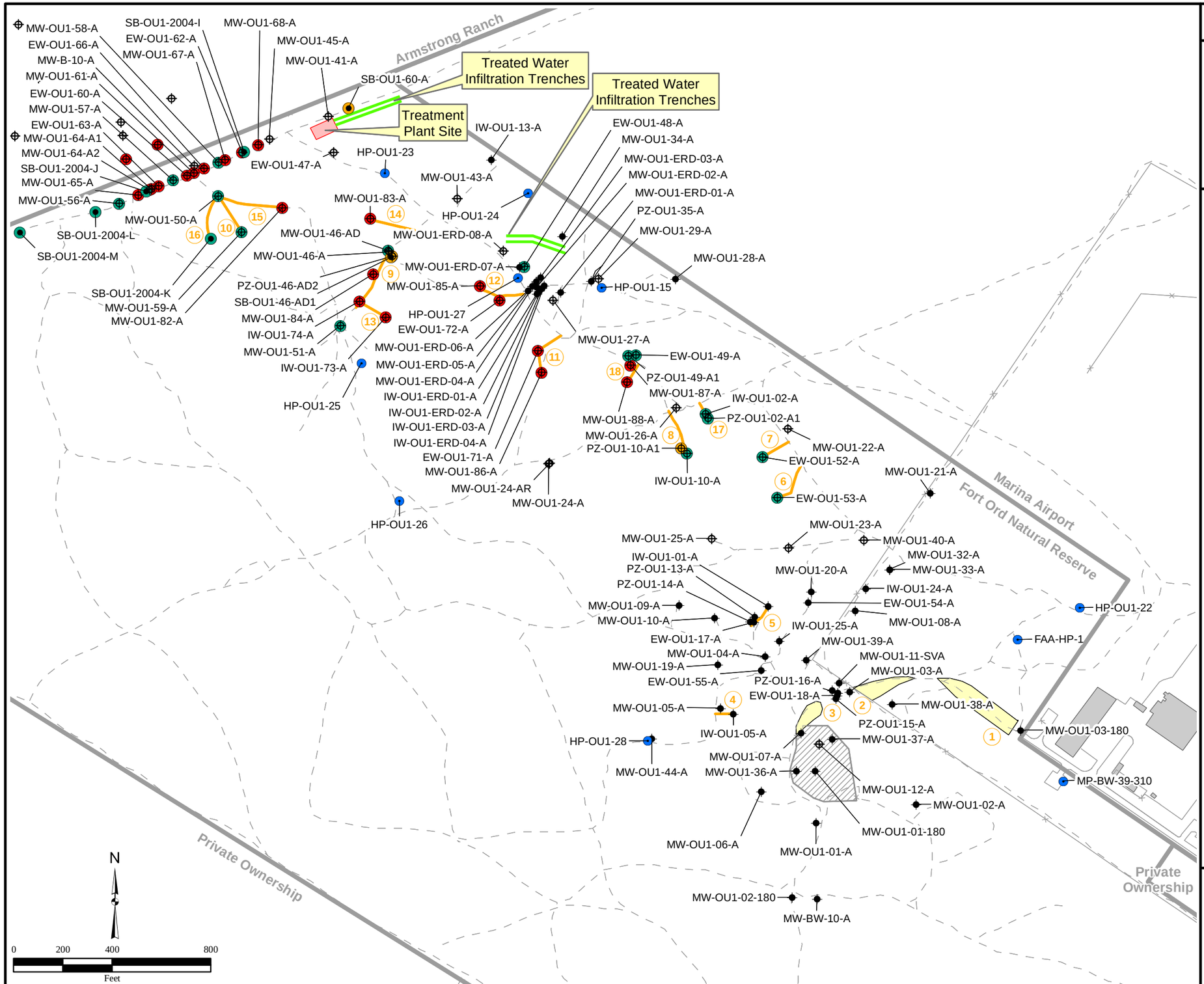
7/29/2016 ARW
Source: HGL

HydroGeoLogic, Inc

Figure 1.4
OU-1 Weed Control Segment Locations



Legend

- Well/Piezometer Drilled Before 2004
- Soil Boring Drilled Before 2004
- Abandoned Soil Boring
- Well Destroyed September 2011
- 2004 Well/Piezometer
- 2004 Soil Boring (abandoned)
- 2005 Well/Piezometer
- 2005 Soil Boring (abandoned)
- 2006 Well/Piezometer
- MW-OU1-21-A — Well or Boring ID
- Weed Control Segment
- 1 — Weed Control Segment Identification Number 2007-2013
- Trail/Unimproved Road
- Fence
- Treated Water Infiltration Trench
- Property Boundary
- Southern Staging Area in 2004
- Treatment Plant
- Building
- Former Fire Drill Area

Note:
OU-1=Operable Unit 1

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7/29/2016 ARW
Source: HGL

HydroGeoLogic, Inc

Figure 3.1
Sand Gilia
Near Former GWETS Fence Line
Baseline vs. 2015/2016

Legend

Fence

1998 Rare Plant Survey (UC Santa Cruz):

Sand Gilia Population

2004 Rare Plant Survey (CH2MHill*):

Sand Gilia Population

2015 Rare Plant Survey (DDA*):

Sand Gilia Point Population

Sand Gilia Polygon Population

2016 Rare Plant Survey (DDA*):

Sand Gilia Point Population

Sand Gilia Polygon Population

Notes:
*=performed under subcontract to HGL
DDA=Denise Duffy and Associates
GWETS=groundwater extraction and treatment system

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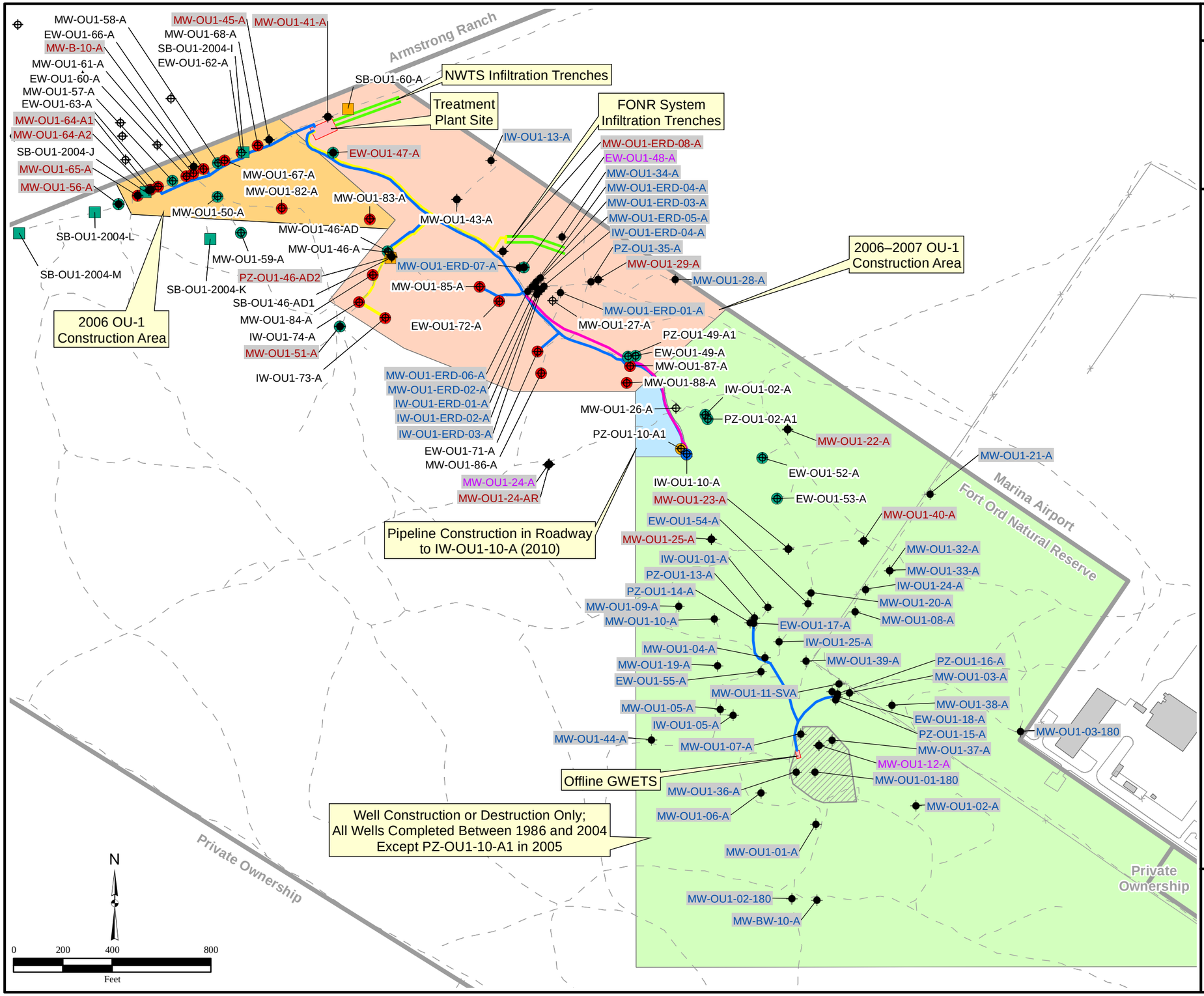
12/22/2016 JG
Source: HGL, CH2MHill, UC Santa Cruz ArcGIS Online Imagery

HydroGeoLogic, Inc

Figure 4.1
OU-1 Construction Activities
2004–2015



Legend

- Well/Piezometer Drilled Before 2004
- Well Destroyed
- 2004 Well/Piezometer
- 2004 Soil Boring
- 2005 Well/Piezometer
- 2005 Soil Boring
- 2006 Well/Piezometer
- Existing Well Modified in 2010
- MW-OU1-86-A — Well or Boring ID
- MW-OU1-12-A — Well Destroyed Before 2006
- MW-OU1-21-A — Well Destroyed September 2011
- MW-OU1-40-A — Well Destroyed 2014
- IW-OU1-10-A Pipeline Route
- Extraction Pipeline
- Infiltration Trench
- Treated Water Pipeline
- Trail/Unimproved Road
- Fence
- Property Boundary
- Treatment Plant
- Building
- Former Fire Drill Area

Notes:
The treated water and extraction water pipelines are located in separate trenches within or near the existing roadway. The separation shown in this figure is exaggerated for clarity.

FONR=Fort Ord Natural Reserve
GWETS=Groundwater Extraction and Treatment System
NWTS=Northwest Treatment System
OU-1=Operable Unit 1

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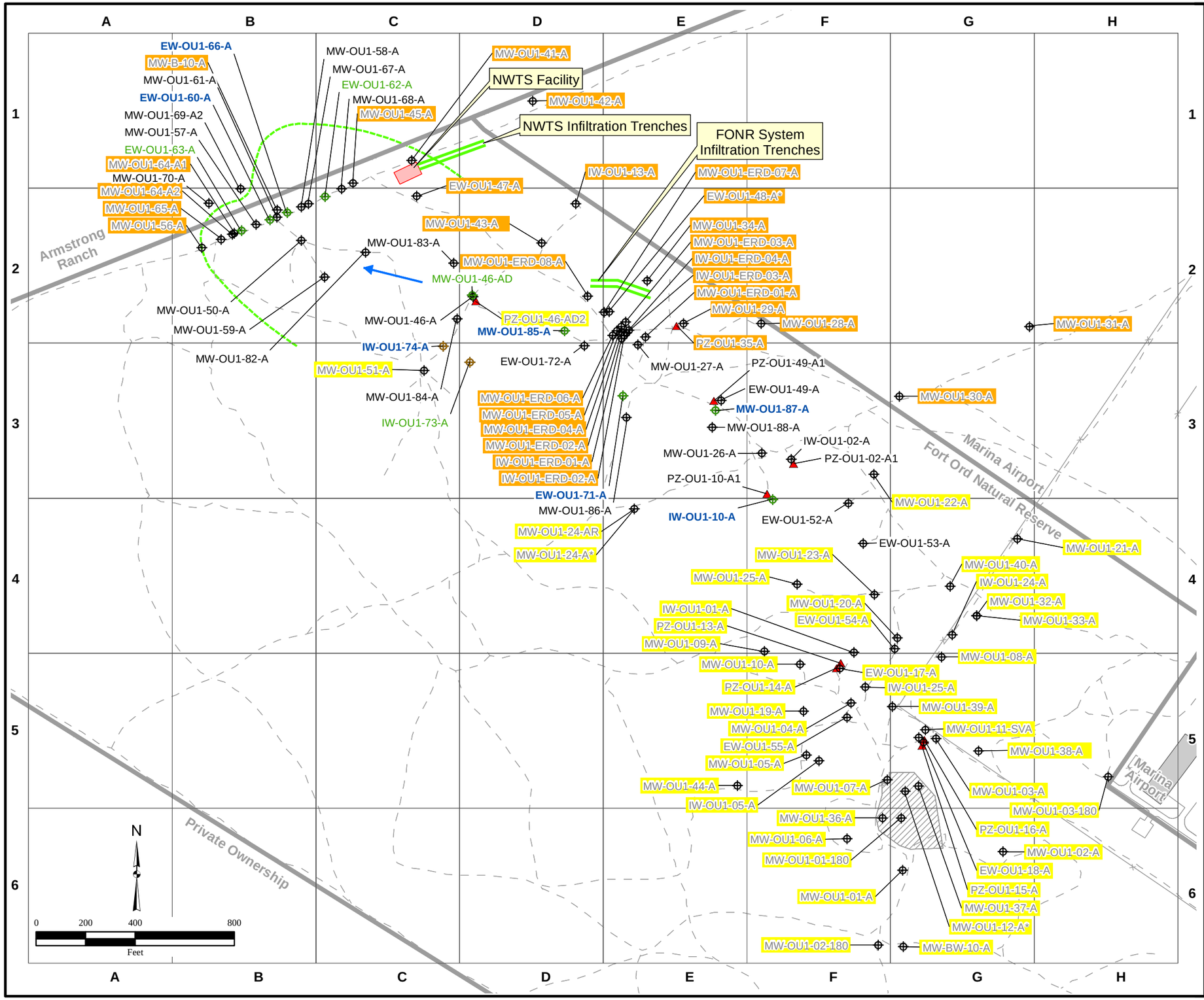
7/29/2016 ARW
Source: HGL

HGL HydroGeoLogic, Inc

Figure 4.2
OU-1 Wells Destroyed 2011 and 2014



Legend

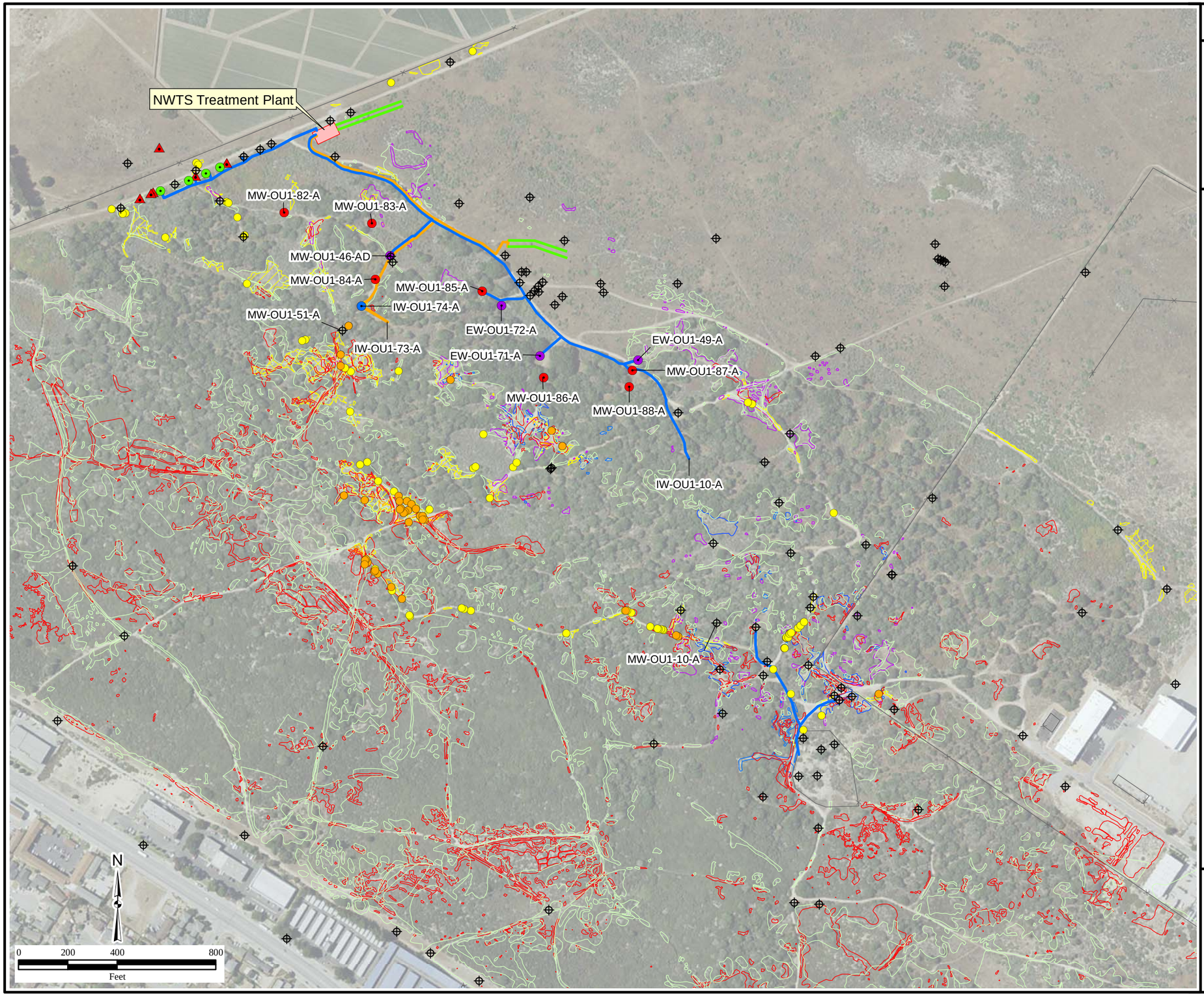
- Monitoring Well
- Extraction Well
- Injection Well
- Piezometer
- MW-OU1-88-A — Well ID
- MW-OU1-87-A — Active Well
- EW-OU1-62-A — Inactive Well
- MW-OU1-30-A — Well Destroyed in Grassland or Northwest Boundary Road
- MW-OU1-02-A — Well Destroyed Within FONR Habitat Area
- Trail/Unimproved Road
- Fence
- Treated Water Infiltration Trench
- Estimated Northwest Treatment System Capture Zone
- Groundwater Flow Direction
- Property Boundary
- Treatment Plant
- Building
- Former Fire Drill Area

Notes:
*=Well destroyed before 2006
FONR=Fort Ord Natural Reserve
NWTS=Northwest Treatment System
OU-1=Operable Unit 1

\\Gst-srv-01\hglgis\Ft_Ord_MSIW\IA_HRPSS_Report_2016\(4-02)wells_destroyed_2011.mxd
7/29/2016 ARW
Source: HGL

HydroGeoLogic, Inc

Figure 4.3
Summary of 1998, 2004, and 2005 Rare Plant Surveys Results



Legend

- Monitoring Well
- Northwest Treatment System Extraction Well
- Northwest Treatment System Performance Monitoring Well
- FONR OU-1 Monitoring Well
- FONR OU-1 Extraction Well
- FONR OU-1 Injection Well
- Extraction Pipeline Route
- Infiltration Trench
- Treated Water Pipeline Route
- Fence

1998 Rare Plant Survey (UC Santa Cruz):

- Sand Gilia
- Monterey Spineflower

2004 Rare Plant Survey (CH2MHill):

- Sand Gilia
- Monterey Spineflower

2005 Rare Plant Survey (CH2MHill):

- Sand Gilia
- Monterey Spineflower
- Sand Gilia
- Monterey Spineflower–High Density
- Monterey Spineflower–Medium Density
- Monterey Spineflower–Sparse Density
- Monterey Spineflower–Very Sparse Density

Notes:
FONR=Fort Ord Natural Reserve
NWTS=Northwest Treatment System
OU-1=Operable Unit 1

\\Gst-srv-01\hglgis\Ft_Ord_MSIW\IA_HRPSS_Report_2016\(4-03)98-05_Plant_Survey.mxd
7/29/2016 ARW
Source: HGL, CH2MHill, UC Santa Cruz ArcGIS Online Imagery

HGL HydroGeoLogic, Inc

APPENDIX A

RESULTS OF 2016 MONTEREY SPINEFLOWER AND SAND GILIA SURVEYS

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Acronym List

CDFW	California Department of Fish and Wildlife
CNDDB	California Natural Diversity Database
DD&A	Denise Duffy & Associates, Inc.
FDA	Fire Drill Area
FONR	Fort Ord Natural Reserve
GIS	geographic information system
GPS	global positioning system
GWETS	groundwater extraction and treatment system
HGL	HydroGeoLogic, Inc.
HMP	Habitat Management Plan
OU	operable unit
TCE	trichloroethene
UCNRS	University of California Natural Reserve System
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound

A1.0 Introduction

HydroGeoLogic, Inc. (HGL) is executing a groundwater remediation project at Operable Unit (OU1) at the former Fort Ord U.S. Army Base located in Monterey County, California (Figure A1.1). The U.S. Army Corps of Engineers (USACE)-Sacramento District under Contract Number W912DY-10-D-0023 awarded this work to HGL. Denise Duffy & Associates (DD&A) performed biological survey work described herein under subcontract to HGL.

Fort Ord was established in 1917 as a military training base for infantry troops. In January 1991, the Secretary of Defense announced the downsizing/closure of the base. In August 1994, portions of the property were transferred to the University of California and the Fort Ord Natural Reserve (FONR) was established in June 1996. The former Fort Ord is located near Monterey Bay approximately 80 miles south of San Francisco. The base consists of approximately 28,000 acres near the cities of Seaside, Sand City, Monterey, Del Rey Oaks, and Marina. Monterey Bay marks the western boundary, Toro Regional Park borders the base to the southeast, and land use to the east is primarily agricultural.

Activities conducted at the former Fort Ord Fritzsche Army Airfield Fire Drill Area (FDA) (the source area for OU1 contaminants) between 1962 and 1985 resulted in the release of contaminants to soils and groundwater. Although 10 volatile organic compounds (VOCs) were identified as contaminants of concern in groundwater underlying OU1, trichloroethene (TCE) is the contaminant that was detected at the highest concentrations and across the greatest extent of the affected aquifer. A groundwater extraction and treatment system (GWETS) began operation in 1988 to remediate TCE and other groundwater contaminants. In 2004 HGL assumed control of the remediation efforts, which included the construction of a new GWETS in 2006. The 1988 facility is referred to as the original GWETS and th e new facility is referred to as the Northwest Treatment System (NWTS).

A key factor that affected the design and implementation of the groundwater cleanup is the fact that the groundwater plume lies beneath a part of the University of California Natural Reserve System (UCNRS) designated as the FONR. The FONR area potentially impacted by the construction of OU1 remediation facilities is approximately 130 acres. Rare plant surveys are required by the Habitat Management Plan (USACE, 1997) (HMP) and the 2015 Programmatic Biological Opinion (United States Fish and Wildlife Service, 2015), in areas that are disturbed during construction activities associated with remediation efforts. Project activities undertaken to achieve the OU1 cleanup must protect and maintain the special-status species found within the FONR, specifically two listed plant species: the federally threatened Monterey spineflower (*Chorizanthe pungens* var. *pungens*) and the state threatened and federally endangered sand gilia (*Gilia tenuiflora* ssp. *arenaria*). DD&A also surveyed the disturbed areas for the federally endangered Yadon's piperia (*Piperia yadonii*). Yadon's piperia was included in the 2016 survey at the request of the Base Realignment and Closure (BRAC) office and in accordance with the 2015 Programmatic Biological Opinion. As part of the current remediation project, seven wells were destroyed in 2014, and the fencing around the original GWETS was removed. Rare plant surveys

were conducted in 2016 in the OU1 FONR area disturbed by the destruction of wells and the removal of the fence line in 2014. The well survey areas included the secondary access routes to the well locations, but did not include the main thoroughfares on the FONR property. Rare plant surveys are conducted as part of the overall objective of protecting the two special-status plant species in areas affected by construction activities. This report details the surveys completed in March, April, and May 2016.

A1.1 Survey Objectives

The objectives of the 2016 rare plant surveys were to:

1. Map Monterey spineflower and sand gilia at a DD&A reference site southeast of the FONR property (Figure A1.2);
2. Map Monterey spineflower, sand gilia, and Yadon's piperia at well locations destroyed in 2014 within the sensitive habitat portions of the FONR, secondary access routes associated with the destroyed well locations, and where the fencing around the original GWETS was removed (OU1 FONR survey area—Figures A1.3 & A1.4)

A1.2 Site Location and Description

The dominant habitats in the OU1 FONR survey area include coast live oak woodland, maritime chaparral, coastal scrub, disturbed/developed land, and annual grassland. Several special-status plant and wildlife species occur within the FONR, including federally threatened Monterey spineflower and federally endangered and state threatened sand gilia. The northern and eastern boundaries of OU1 are adjacent to a large expanse of non-native grassland. Transmission of non-native grass species into OU1 is accelerated by the prevailing southern winds, which blow seeds into the OU1 area (Fusari, 2004). Non-native grasses and weedy forbs are already present throughout much of the OU1 area. The spread of non-native, invasive species into newly disturbed areas may result in population declines of Monterey spineflower and sand gilia. Sand gilia is especially vulnerable to the encroachment of invasive species as it is less tolerant of competing plant cover than Monterey spineflower.

At the DD&A reference site coast live oak woodland is the dominant habitat type. Grassland and coast live oak woodland is adjacent to the DD&A reference site on the northwestern boundary. All other boundaries of the reference site are paved roadways (Reservation Road, MBEST Drive, and University Drive). Non-native grasses and weedy forbs are present throughout much of the reference site.

A1.2.1 Sand Gilia

Sand gilia is a small annual in the phlox family (*Polemoniaceae*). Plants range in height from two to six inches with a small, basal rosette of leaves. The lower branches of the stem are generally densely glandular. Plants typically bloom from April through June and have funnel-shaped flowers with narrow, purple to pinkish petal lobes and a purple throat. This species occurs in open sandy soils in dune scrub, coastal sage scrub, and maritime chaparral habitats. Sand gilia is endemic to Monterey Bay and the peninsular dune complexes. According to the California Natural Diversity Database (CNDDB) there are 31 occurrences

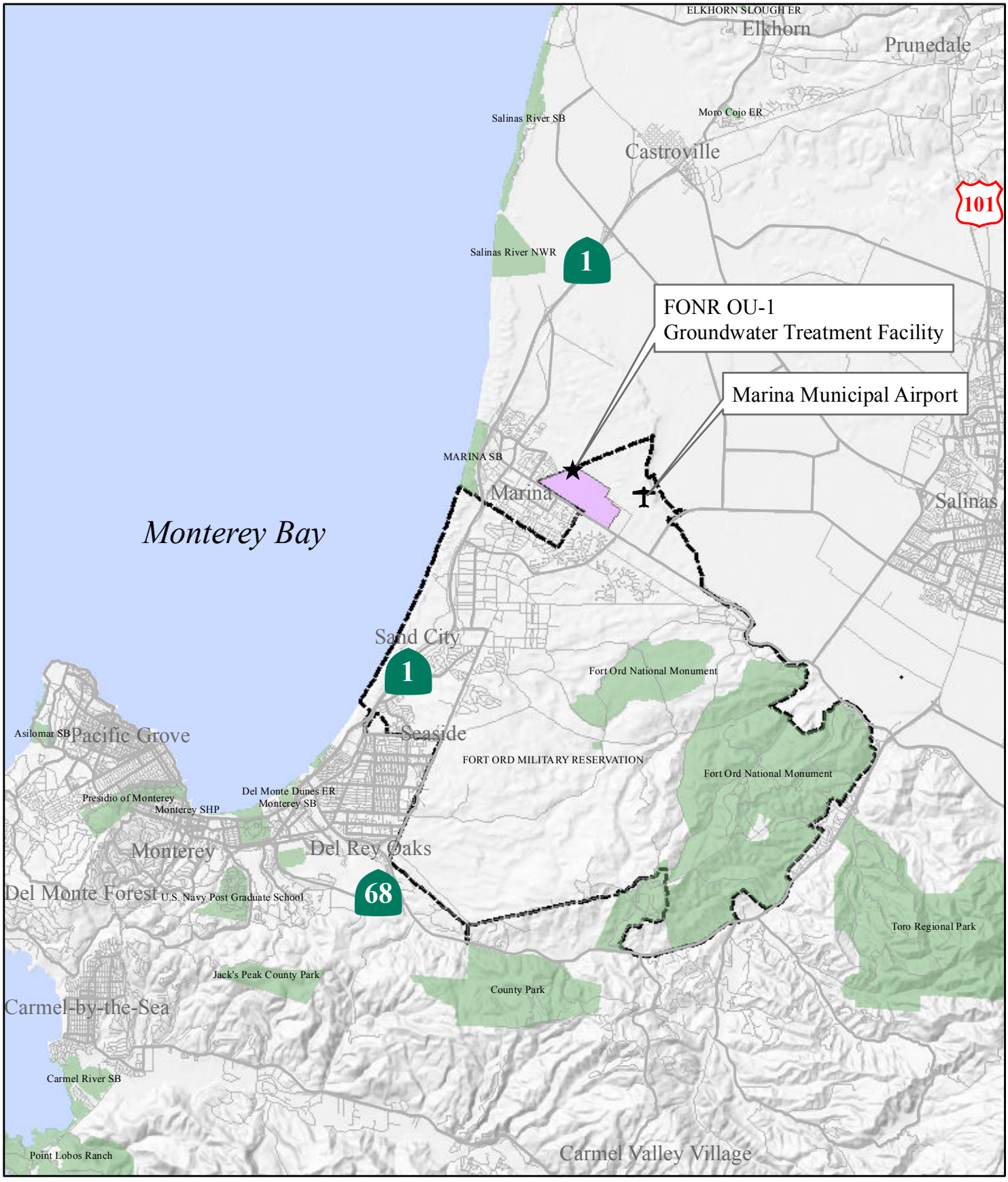
within Monterey County, including the occurrences at Fort Ord (CDFW, 2014). It is likely that some of these occurrences are no longer present and the exact number of extant (still in existence) occurrences are unknown.

A1.2.2 Monterey Spineflower

Monterey spineflower is a small, prostrate annual in the buckwheat family (*Polygonaceae*) that blooms from April to June. The white to rose floral tube of Monterey spineflower distinguishes it from the more common, but closely related diffuse spineflower (*Chorizanthe diffusa*), which has a lemon-yellow floral tube. This species typically occurs on open sandy or gravelly soils in coastal dune, coastal scrub, and maritime chaparral habitats. There are 47 records of Monterey spineflower within Monterey County in the CNDDB (CDFW, 2016); however, it is not known how many of these are extant.

A1.2.3 Yadon's Piperia

Yadon's piperia is a perennial herb in the orchid family (*Orchidaceae*) that blooms from May to August. The elongated spur of Yadon's piperia distinguishes it from the more common species of piperia that are found in the same habitat and range. This species typically occurs in coastal scrub, closed-cone pine forests, and maritime chaparral habitats. There are 29 records of Yadon's piperia within Monterey County in the CNDDB (CDFW, 2016); however, it is not known how many of these are extant.



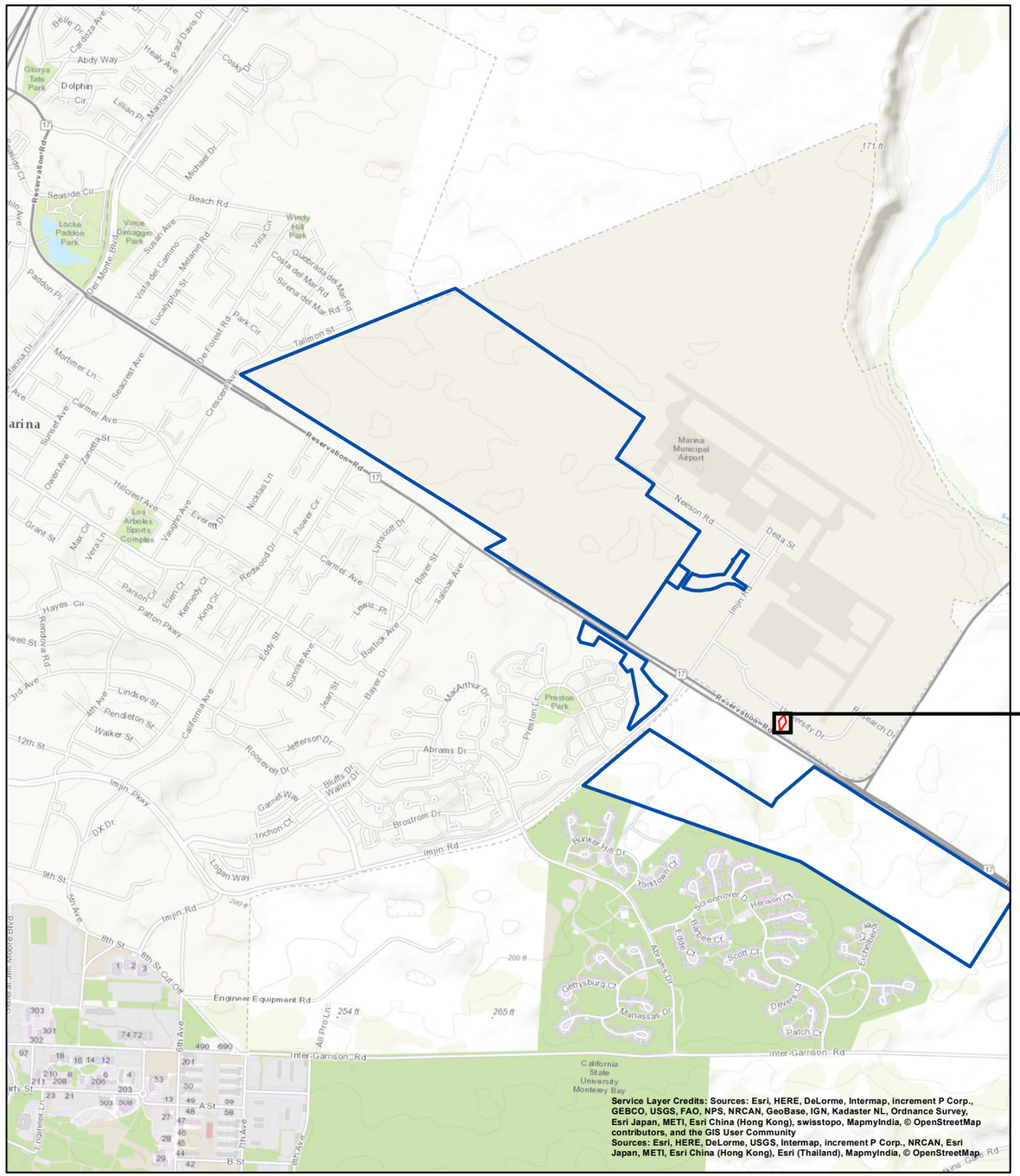
N

0 1.25 2.5 5 Miles

0 2.5 5 10 Kilometers

Figure A1.1

Project Vicinity Map



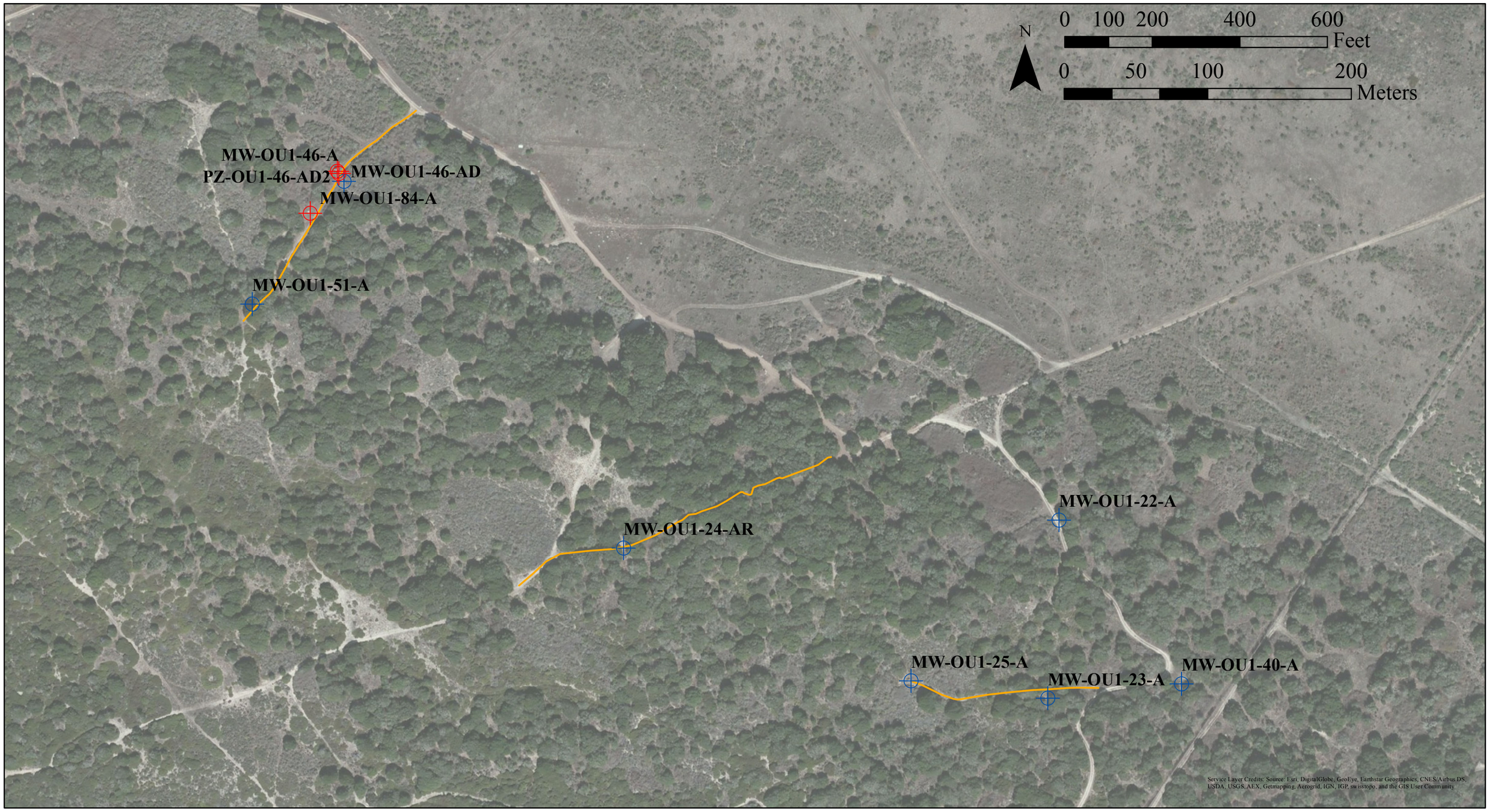
Reference Site

UC FONR Boundary

Figure A1.2

Date: 6/1/2016

2016 Survey Area DD&A Reference Site



Wells Surveyed in 2016 (Destroyed in 2014)

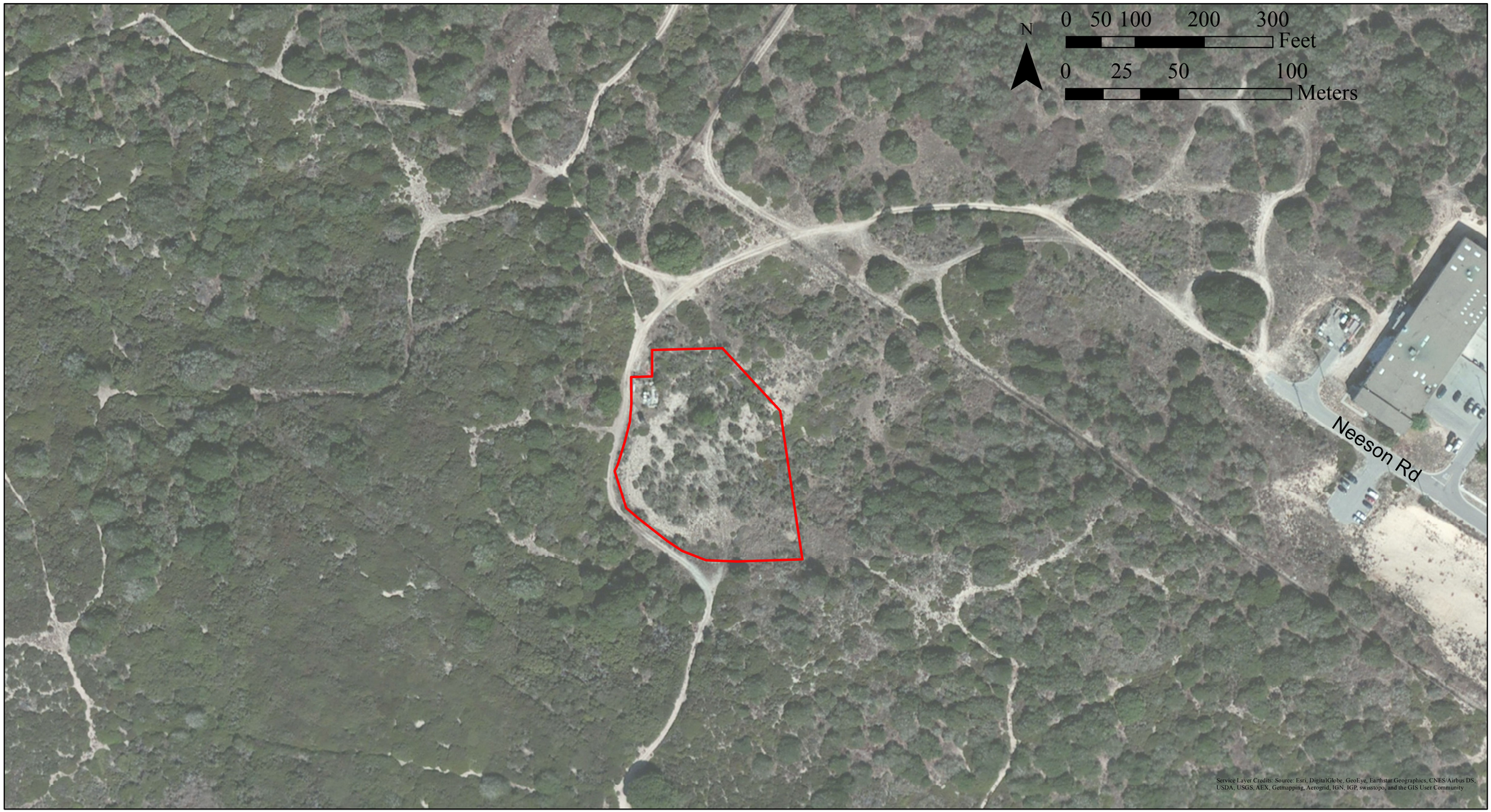
Wells Surveyed in 2016 (Not Destroyed)

Secondary Access Routes Surveyed in 2016

Date: 6/1/2016

Figure A1.3

OU1 FONR 2016 Wells Surveyed



Original GWETS Fence Line

Figure A1.4

OU1 FONR Original Groundwater Extraction and Treatment System (GWETS) Fence Line

Date: 6/1/2016

A2.0 Rare Plant Survey Methods

Rare plant surveys were conducted at a DD&A reference site (Figure A1.2) and the OU1 FONR survey area (Figures A1.3 & A1.4). These areas were surveyed for the three rare plants (i.e., Monterey spineflower, Yadon's piperia, and sand gilia) during four survey efforts. Due to atypical weather, surveys for sand gilia and Monterey spineflower were split into two survey efforts, approximately four weeks apart. Surveys for sand gilia were conducted on March 28 & 29, 2016, and surveys for Monterey spineflower were conducted on April 25, and May 4, 2016. Surveys were not conducted within the appropriate blooming period for Yadon's piperia. DD&A was tasked with surveying for all piperia within the disturbed areas and reporting the findings to the BRAC office. BRAC biologists planned to follow-up during the appropriate blooming period and identify the piperia species.

Mapping of the rare plant species was accomplished using a Trimble® Geo 7 Series global positioning system (GPS) with an external Zephyr Model 2 antenna. When Monterey spineflower, Yadon's piperia, or sand gilia was identified, the survey in that area was extended to the boundary of the population encountered. Large areas of Monterey spineflower and sand gilia were mapped as polygons, with attributes to identify number of individuals for sand gilia or percent absolute cover for Monterey spineflower. Smaller groups and individuals were mapped as points with attributes to identify the number of individuals at each location.

Individual counts were made for all sand gilia populations whether they were mapped using points (population ≤5) or polygons (population ≥6). However, Monterey spineflower were only counted as individuals when groups of five or less were mapped. Monterey spineflower populations consisting of greater than five individuals were mapped as polygons and characterized according to the percent of cover. The categories used were:

- Very Sparse (corresponding to an absolute cover of less than 3 percent),
- Sparse (3-25 percent absolute cover),
- Medium Low (26-50 percent absolute cover),
- Medium (51-75 percent absolute cover),
- Medium High (76-97 percent absolute cover), and
- Very High (>97-100 percent absolute cover).

Locations were mapped using GPS units and data defining the population boundaries and/or point location(s) were exported to shapefile format. Shapefiles were imported for use in the Geographic Information System (GIS) ESRI® ArcGIS 10.3 and overlaid on high-resolution aerial photography/satellite imagery. An overview of the FONR survey area results, the populations identified for each species within FONR, and the populations identified for each species within the reference site are discussed below.

A3.0 Rare Plant Survey Results

A3.1 Sand Gilia

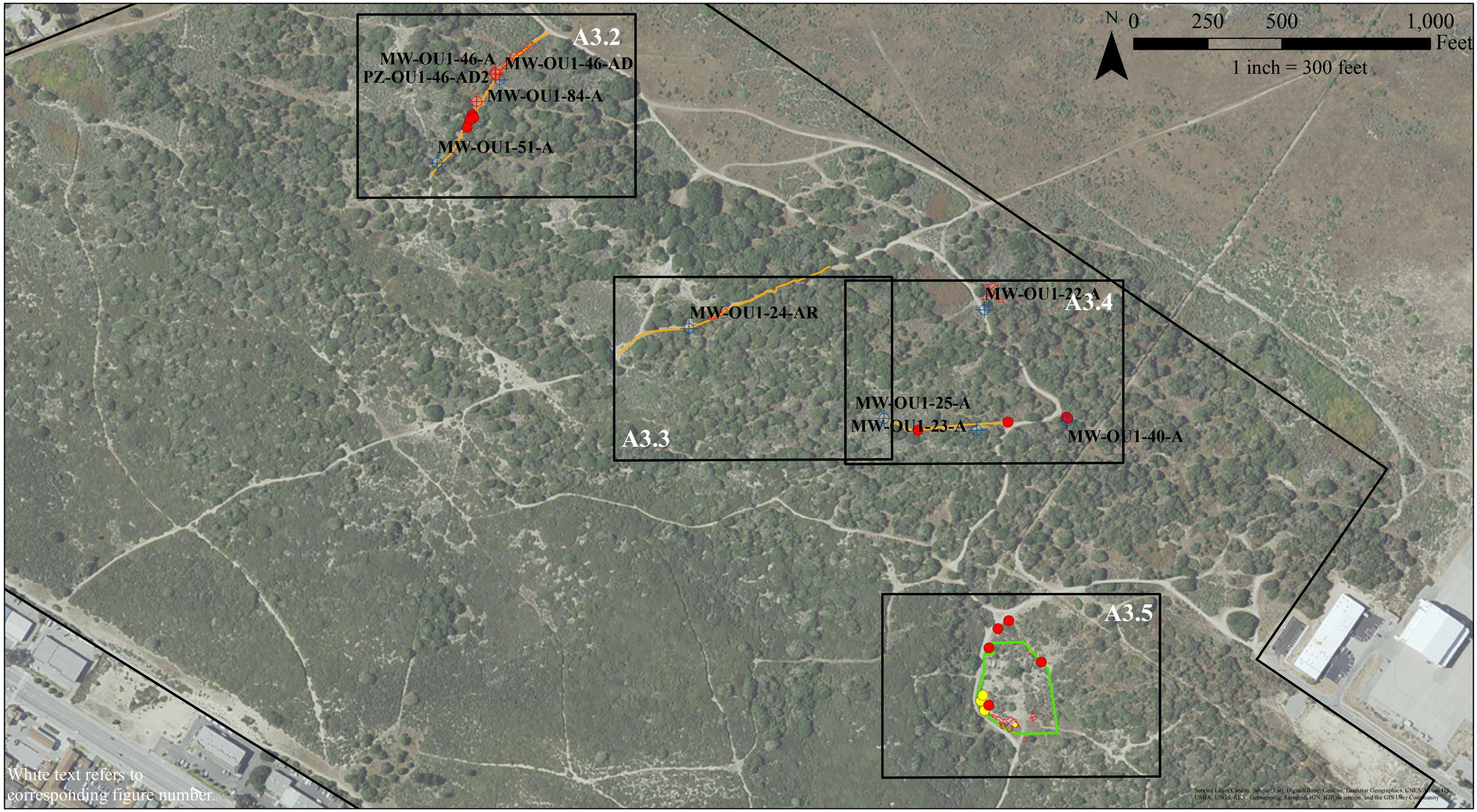
Sand gilia was observed and mapped at the DD&A reference site and OU1 FONR survey area (Figure A3.1 through Figure A3.6; Attachment A-1). Within the OU1 FONR survey area, sand gilia was present along secondary access routes and along the original GWETS fence line. In all, twelve populations (six points and six polygons) of sand gilia, totaling 2,910 individual plants were mapped within the DD&A reference site and OU1 FONR survey area.

A3.2 Monterey Spineflower

Monterey spineflower was observed and mapped at the DD&A reference site and OU1 FONR survey area (Figure A3.1 through Figure A3.6; Attachment A-1). Within the OU1 FONR survey area, Monterey spineflower was present at one of the seven destroyed well locations and two of the three existing well locations, along the secondary access routes, and along the original GWETS fence line. In all, 26 populations (thirteen points and thirteen polygons) of Monterey spineflower were mapped within the DD&A reference site and OU1 FONR survey area. Population size estimates for Monterey spineflower were not easily quantifiable; therefore, individual Monterey spineflower plants were not recorded within the GIS polygons. Populations of Monterey spineflower were categorized by percent cover based on visual estimation. Of the twelve populations of Monterey spineflower that were mapped as polygons, six populations were Sparse (5-25 percent cover), seven populations were Medium Low (26-50 percent cover), and two populations were Medium (51-75 percent cover).

A3.3 Yadon's Piperia

No piperia was observed or mapped within any of the survey areas during the 2016 survey effort. Due to the lack of observations, discussion of piperia, including Yadon's, will not be included in the remainder of this report.



Wells Surveyed in 2016 (Destroyed in 2014)

Wells Surveyed in 2016 (Not Destroyed)

Secondary Access Routes Surveyed in 2016

Original GWETS Fence Line

Sand Gilia Points

Monterey Spineflower Points

Sand Gilia Polygons

Monterey Spineflower Polygons

Sparse

Medium-Low

Medium-High

Date: 6/1/2016

DD&A

Figure A3.1

2016 Survey Area Rare Plant Population Locations Overview Map

N

0 50 100 200 Feet

1 inch = 70 feet

32

MW-OU1-46-AD

MW-OU1-46-A

PZ-OU1-46-AD2

MW-OU1-84-A

7

8

9

10

29

MW-OU1-51-A

White labels correspond with special-status plant population IDs from Appendices A & B

- Wells Surveyed in 2016 (Destroyed in 2014)
- Wells Surveyed in 2016 (Not Destroyed)
- Secondary Access Routes Surveyed in 2016
- Sand Gilia Points
- Monterey Spineflower Points
- Sand Gilia Polygons

Monterey Spineflower Polygons

- Sparse
- Medium-Low
- Medium-High

Date: 8/5/2016

DD&A

Figure A3.2

2016 OU1 FONR Well Survey - Rare Plant Locations

N

0 50 100 200 Feet

1 inch = 70 feet

MW-OU1-24-AR

36

MW-OU1-25-A

14

White labels correspond with special-status plant population IDs from Appendices A & B

Wells Surveyed in 2016 (Destroyed in 2014)

Secondary Access Routes Surveyed in 2016

Sand Gilia Points

Monterey Spineflower Points

Sand Gilia Polygons

Monterey Spineflower Polygons

Sparse

Medium-Low

Medium-High

DD&A

Figure A3.3

Date: 6/2/2016

2016 OU1 FONR Well Survey - Rare Plant Locations

N

0 50 100 200 Feet

1 inch = 70 feet

34

26

MW-OU1-22-A

MW-OU1-25-A

14

13

MW-OU1-23-A

11

MW-OU1-40-A

12

White labels correspond with special-status plant population IDs from Appendices A & B

Wells Surveyed in 2016 (Destroyed in 2014)

Secondary Access Routes Surveyed in 2016

Sand Gilia Points

Monterey Spineflower Points

Sand Gilia Polygons

Monterey Spineflower Polygons

Sparse

Medium-Low

Medium-High

DD&A

Figure A3.4

Date: 6/2/2016

2016 OU1 FONR Well Survey - Rare Plant Locations

N

0 50 100 200 Feet

1 inch = 70 feet

17 18 16 33 19 2 20 1 15 27 28 3 35 21 31 22 30

White labels correspond with special-status plant population IDs from Appendices A & B

Original GWETS Fence Line

Sand Gilia Points

Monterey Spineflower Points

Sand Gilia Polygons

Monterey Spineflower Polygons

Sparse

Medium-Low

Medium-High

Date: 6/2/2016

Figure A3.5

2016 OU1 FONR Original Groundwater Extraction and Treatment System Fence Line Survey - Rare Plant Locations

N

0 25 50 100 Feet

1 inch = 30 feet

25

24

38

5

6

23

4

37

Reservation Rd

Mbest Dr

White labels correspond with special-status plant population IDs from Appendices A & B

Reference Area

Sand Gilia Points

Monterey Spineflower Points

Sand Gilia Polygons

Monterey Spineflower Polygons

Medium Low

Medium

DD&A

Figure A3.6

Date: 8/5/2016

2016 DD&A Reference Site Survey - Rare Plant Locations

A4.0 Conclusions

A4.1 Rare Plant Populations

As required by the HMP and the 2015 Programmatic Biological Opinion, surveys are conducted for three years after the disturbance occurs in any area that is disturbed during the remediation effort. The 2016 survey is the second survey conducted following the disturbance associated with the removal of the original GWETS fence line and the destruction of wells in 2014. Rare plants observed within thirty feet of a well were considered to occur within the area impacted by the destruction of the well.

A4.1.1 DD&A Reference Site Sand Gilia Populations

The reference site is located in an area relatively undisturbed by anthropogenic activities. Natural variation in environmental factors, including rainfall and temperature, can influence the distribution and abundance of sand gilia within an area in a given year. In 2016, a total of 943 individual sand gilia plants were observed at the reference site (Table A4.1). In 2016, the largest individual population of sand gilia plants was observed at the reference site (476 individuals).

Table A4.1 Sand Gilia Population at DD&A Reference Site in 2016

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Area of Polygons (sq. ft.)
2016	6	946	3	3	1,498

A4.1.2 DD&A Reference Site Monterey Spineflower Populations

As with sand gilia, there are several environmental variables that can influence the distribution and abundance of Monterey spineflower in a particular year. In 2016, Monterey spineflower occupied approximately 3,241 square feet at the reference site (Table A4.2).

Table A4.2 Monterey Spineflower Population at the DD&A Reference Site in 2016. Polygon Density Class: Medium Low (26-50 percent cover) and Medium (51-75 percent cover)

			Polygons per Density Class		
Year	# of Populations	# of Points	Medium-Low	Medium	Total Area of Polygons (sq. ft.)
2016	2	0	1	1	3,241

A4.1.3 OU1 FONR Survey Area Sand Gilia Populations 2016

In 2016, DD&A surveyed for sand gilia along the original GWETS fence line, along secondary access routes, and at seven destroyed well locations in the OU1 FONR. Sand gilia was not present within thirty feet of any of the well locations surveyed. Six populations (3 points and 3 polygons), consisting of 144 individuals were found along the

original GWETS fence line (Figure A3.5 and Attachment A-1). The total sand gilia population observed in the 2016 was 1,090 plants (Table A4.3).

Table A4.3 Sand Gilia Population in OU1 FONR Survey Area in 2016

Year	# of Populations	Individual Plants	# of Points	# of Polygons	Area of Polygons (sq. ft.)	# of Wells Where Present	Well Location Where Present
2016	12	1,090	6	3	1,964	0	-

A4.1.4 OU1 FONR Survey Area Monterey Spineflower Populations 2016

In 2016, DD&A surveyed for Monterey spineflower along the original GWETS fence line, along secondary access routes, and at seven destroyed well locations in the OU1 FONR survey area. Monterey spineflower was found along the original GWETS fence line, along secondary access routes, and within 30 feet of one destroyed well locations (MW-OU1-40-A) (Table A4.4) and two existing well locations (MW-OU1-46-AD, MW-OU1-46-A) (Table A4.4).

Table A4.4 Monterey Spineflower Population at OU1 FONR Survey Area in 2016. Polygon Density Class: Sparse (5-25 percent cover), Medium-Low (26-50 percent cover), and Medium (51-75 percent cover)

Year	# of Populations	# of Points	Polygons per Density Class			Total Area of Polygons (sq. ft.)
			Sparse	Medium-Low	Medium	
2016	26	13	6	6	1	9,523

A5.0 References

[CDFW] California Department of Fish and Wildlife California Natural Diversity Database. 2016. Biogeographic Data Branch, Monterey County RareFind Report. Department of Fish and Wildlife.

Fusari, Margret, Ph.D., 2004. Director, University of California Santa Cruz Natural Reserves. Telephone conversations and e-mail correspondence with Amy Hiss, Gary Santolo, and Roy Evans regarding the federally listed species and noxious weeds. June, 2004.

[USACE] U.S. Army Corps of Engineers, Sacramento District. 1997. Installation-Wide Multispecies Habitat Management Plan for Former Fort Ord, California. April 1997. Sacramento, CA.

U.S. Fish and Wildlife Service [USFWS], 2015. Programmatic Biological Opinion for Cleanup and Property Transfer Actions Conducted at the Former Fort Ord, Monterey County, California (8-8-09-F-74) (2015 Biological Opinion). May 28. AR# BW-2747.

Attachment A-1. Sand Gilia Populations Identified During 2016 Survey

Population #	Number of Individuals	GIS Feature Type	Survey Date	Figure Number
1	3	Point	3/28/2016	**A3.5**
2	2	Point	3/28/2016	**A3.5**
3	4	Point	3/28/2016	**A3.5**
4	1	Point	3/29/2016	**A3.6**
5	1	Point	3/29/2016	**A3.6**
6	1	Point	3/29/2016	**A3.6**
20	105	Polygon	3/28/2016	**A3.5**
21	20	Polygon	3/28/2016	**A3.5**
22	10	Polygon	3/28/2016	**A3.5**
23	476	Polygon	3/29/2016	**A3.6**
24	457	Polygon	3/29/2016	**A3.6**
25	10	Polygon	3/29/2016	**A3.6**

Attachment A-2. Monterey Spineflower Populations Identified During 2016 Survey. Number of individual is provided for point features, and percent cover is provided for polygon features.

Population #	Number of Individuals or Percent Cover	Cover Class	GIS Feature Type	Survey Date	Figure Number
7	1	N/A	Point	4/25/2016	**A3.2**
8	1	N/A	Point	4/25/2016	**A3.2**
9	1	N/A	Point	4/25/2016	**A3.2**
10	1	N/A	Point	4/25/2016	**A3.2**
11	1	N/A	Point	4/25/2016	**A3.4**
12	2	N/A	Point	4/25/2016	**A3.4**
13	1	N/A	Point	4/25/2016	**A3.4**
14	4	N/A	Point	4/25/2016	**A3.4**
15	1	N/A	Point	4/25/2016	**A3.5**
16	1	N/A	Point	4/25/2016	**A3.5**
17	1	N/A	Point	4/25/2016	**A3.5**
18	1	N/A	Point	4/25/2016	**A3.5**
19	3	N/A	Point	4/25/2016	**A3.5**
26	10	Sparse	Polygon	4/25/2016	**A3.4**
27	10	Sparse	Polygon	4/25/2016	**A3.5**
28	10	Sparse	Polygon	4/25/2016	**A3.5**
29	15	Sparse	Polygon	4/25/2016	**A3.2**
30	15	Sparse	Polygon	4/25/2016	**A3.5**
31	25	Sparse	Polygon	4/25/2016	**A3.5**
32	30	Medium-Low	Polygon	4/25/2016	**A3.2**
33	30	Medium-Low	Polygon	4/25/2016	**A3.3**
34	35	Medium-Low	Polygon	4/25/2016	**A3.4**
35	35	Medium-Low	Polygon	4/25/2016	**A3.5**
36	40	Medium-Low	Polygon	4/25/2016	**A3.3**
37	50	Medium-Low	Polygon	5/4/2016	**A3.6**
38	75	Medium	Polygon	5/4/2016	**A3.6**

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