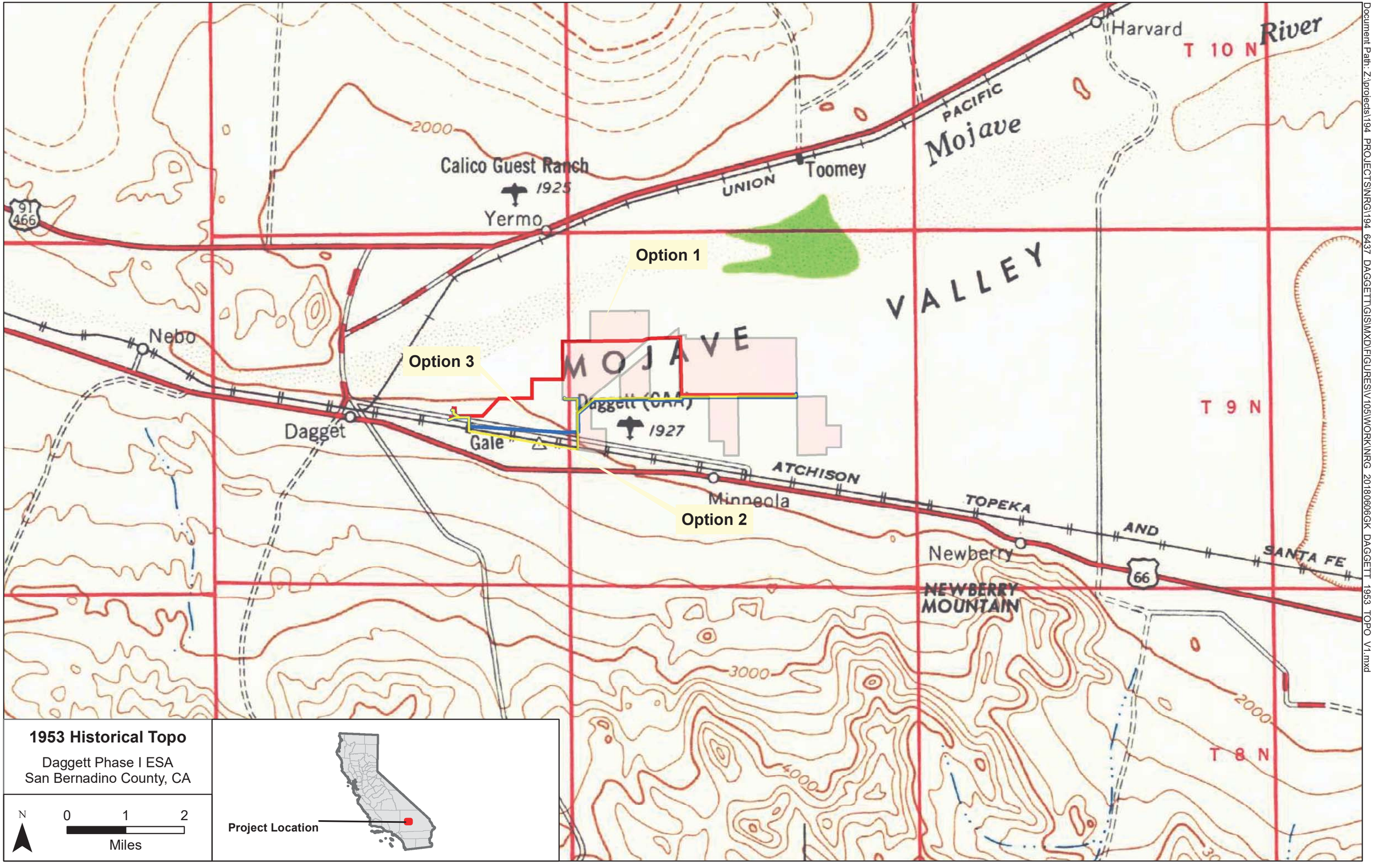


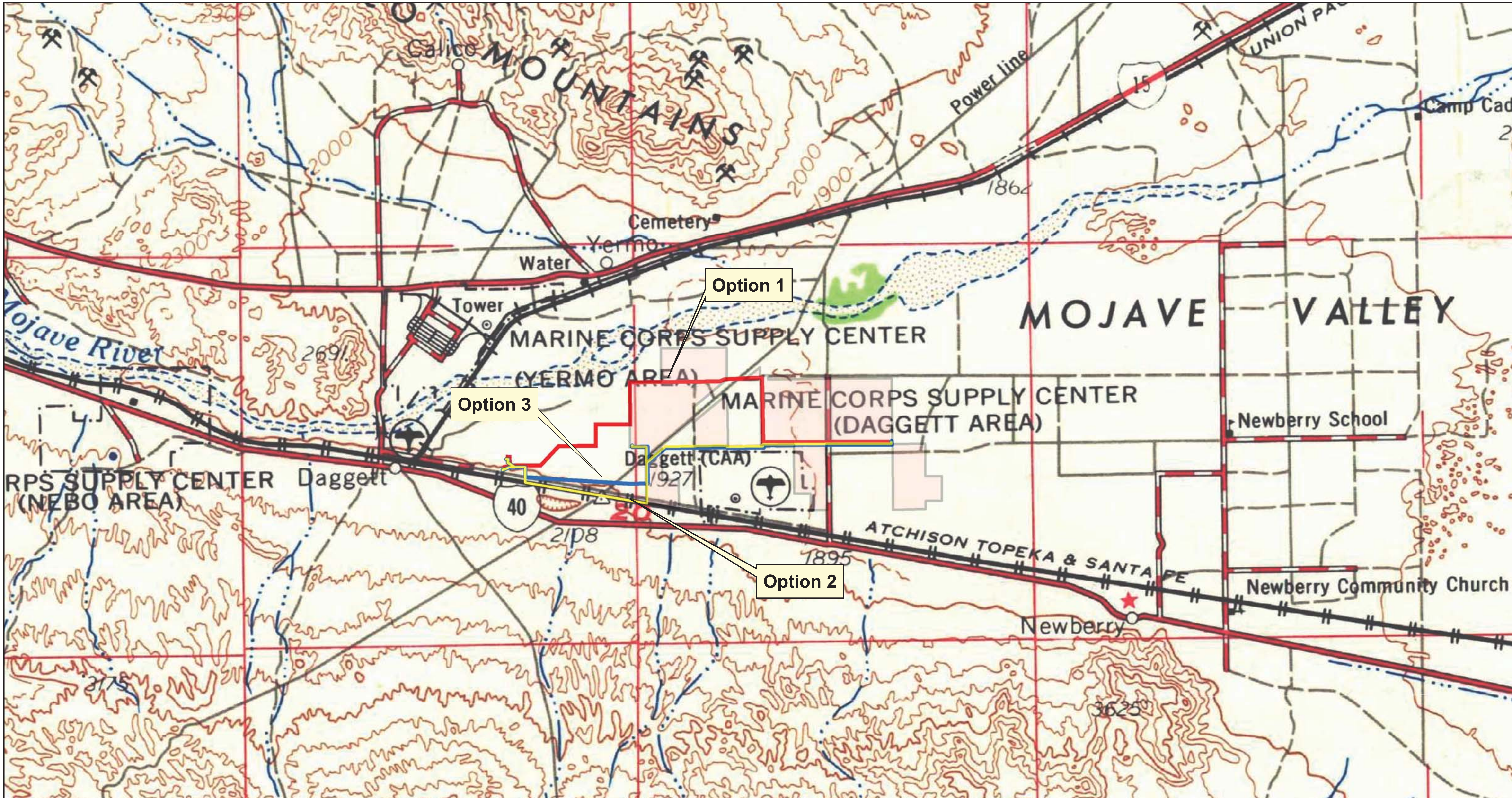
1953 Historical Topo

Daggett Phase I ESA
San Bernadino County, CA

N

0 1 2

Miles



Calico
MOUNTAINS
Power line
UNION PA
15
Camp Cady
Cemetery
Yermo
Water
Tower
Option 1
MARINE CORPS SUPPLY CENTER
(YERMO AREA)
MOJAVE
VALLEY
Mojave River
Option 3
MARINE CORPS SUPPLY CENTER
(DAGGETT AREA)
Newberry School
RPS SUPPLY CENTER
(NEBO AREA)
Daggett
Daggett (CAA)
1927
40
2108
ATCHISON TOPEKA & SANTA FE
1895
Option 2
Newberry Community Church
Newberry
1862
2691
3175
3625
4064
4882
5094

1966 Historical Topo

Daggett Phase I ESA
San Bernadino County, CA

N

0 1 2

Miles

Document Path: Z:\projects\194 PROJECTS\NRG\194 6437 DAGGETT\GIS\MXD\FIGURES\V105\WORK\NRG 20180606GK DAGGETT 1953 TOPO V1.mxd

Option 1

Option 2

Option 3

1977 Historical Topo

Daggett Phase I ESA
San Bernadino County, CA

N

0 1 2

Miles

Project Location

Appendix D—Resumes of Environmental Professionals

Experience Summary

Ms. Miller has 16 years of experience in the preparation, coordination, and management of Environmental Assessments (EAs), Environmental Impact Statements (EISs), and Categorical Exclusion (CatEx) documents conducted under the National Environmental Policy Act (NEPA) documents for proposed roads, energy projects, federal facilities, and federally funded projects. During the last five years, her duties have also included the siting, permitting, and obtaining various environmental clearances for utilities and energy projects such as substations, transmission lines, and energy generation.

Other duties and assignments have focused on documentation, evaluation, and mitigation of environmental resources, including hazardous and contaminated materials, water resources, soils/geology, wetlands, social and economic characteristics, land use, and recreational resources in relation to potential project impacts. As necessary, mitigation actions and permitting activities were coordinated, reviewed, and implemented.

As a project manager and resource specialist, she interacts and coordinates with numerous state, federal, and local agencies. Environmental evaluations include documentation of standards, applicable regulations and guidelines, and conformity with various plans and local programs.

Prior to employment with Tetra Tech, she performed similar NEPA and permitting consulting work for 12 years, and was Superfund Unit Chief with the Kansas Department of Health and Environment (KDHE) for 8 years prior to that. Her work at KDHE involved individual management oversight of investigation and remediation projects, staff oversight, coordination with other agencies, negotiation of legal contracts with responsible parties, U.S. Environmental Protection Agency (EPA) grant management, and management of the state Superfund program.

As a project and program manager, Ms. Miller has coordinated and led project teams; produced, updated, and prioritized project scopes of work, schedules, and contracts, including cost spreadsheets; and provides clients with consistent and effective communication including verbal and written progress reports. Her successful management style is performed through attention to detail, quality assurance/ quality control methods, prioritization of tasks to meet deadlines, and efficiency in team assignments and oversight.

Education

MS, Water Resources Science, University of Kansas, 1987
BS, Geology, University of Kansas, 1980

Registrations/Certifications

Registered Professional Geologist, WY, Number PG-3367, Updated 1/1/13

Corporation Project Experience

Deputy Project Manager/Senior Environmental Planner, August 2011–Present
Xcel Energy, West Main Relocation Project, Larimer County, Colorado

Tetra Tech is conducting route analyses, biological and cultural resource analyses, and 1041 and Areas and Activities of State Interest permit applications for Boulder and Larimer counties, for Xcel Energy. Public Service Company of Colorado, an Xcel Energy Company, proposes to install an upgrade to its facilities along existing or new easements from the Boulder-Larimer County line to a terminus north of the town of Wellington. These facilities range in size from 4-inch, 6-inch, and 16-inches and generally serve as transmission facilities typically operating at high pressure. Tetra Tech is conducting route analyses, resource analyses, Areas and Activities of State Interest permit applications for Boulder and Larimer counties, Colorado, and public involvement activities to support the project. In addition to

permit services, Tetra Tech is also providing construction biological and environmental monitoring services and assisting Public Service Company with agency and local government consultation.

Responsibilities include assisting the project manager in the identification of permitting requirements and drafting the permit application. Ms. Miller conducted regulatory, environmental, and community research for and prepared the Larimer County Location and Extent Permit Application and 1041 Permit Application. Document lead for the city of Fort Collins Natural Areas Department (NAD) Easements or Rights of Way Permit Application Document lead; conducted research (regulatory, environmental, and community) for and prepared the Boulder County 1041 Permit Application and the draft South Larimer 1041 Permit Application. Follow-up project support work will include responding to referral comments and preparation of supporting permit applications.

Document Lead/Senior Environmental Planner
Jordan Cove LNG Terminal and Pacific Connector Gas Pipeline, May 2013–Present
Tetra Tech is preparing a Federal Energy Regulatory Commission (FERC) EIS for the construction and operation of an LNG terminal and a new 231.82-mile, 36-inch diameter interstate natural gas transmission system and related facilities. The proposed system would extend from the proposed Jordan Cove, Oregon to interconnect with two interstate natural gas pipelines near Malin, Oregon. Ms. Miller provides review of geology and groundwater resource reports and submitted supporting documents and writes the related EIS sections for the proposed project.

Document Lead/Senior Environmental Planner
Lavaca Bay LNG Project, March 2013–Present
Tetra Tech is preparing FERC Resource Reports for the proposed development, construction, and operation of liquefied natural gas (LNG) terminal facilities to be located on a parcel of land on the South Peninsula of Point Comfort within the Port of Port Lavaca-Point Comfort, Texas, along the Gulf of Mexico; and an approximately 29-mile-long, 42-inch-diameter pipeline header system (pipeline) to transport natural gas from existing pipeline systems to the LNG terminal facilities. Ms. Miller prepared the soils and geology resources reports and continues to address FERC and agency comments regarding the reports and supporting information.

Document Lead/Senior Environmental Planner
Columbia Gas Transmission, LLC East Side Expansion Project, August 2013–Present
Tetra Tech is preparing a FERC EA for the construction and operation of two natural gas looping pipelines and related facilities in Chester County, Pennsylvania, and Gloucester County, New Jersey, as well as lesser areas in New York and Maryland. The project schedule includes initiation of construction in November 2014 and to place the facilities in-service by September 2015. Ms. Miller is providing review of Resource Report and supporting information submittals, and will write the geology and groundwater EA sections.

Project Lead/Senior Environmental Planner, March 2013–August 2013
Phase I Environmental Site Assessments – NextEra Minco III Wind Farm (Caddo, Canadian, and Grady Counties, Oklahoma) and Xcel Energy Rocky Flats Natural Gas Pipeline Replacement (Jefferson County, Colorado)
Ms. Miller coordinated and completed the work for two Phase I ESAs including project coordination, background research, document preparation, property owner interviews, and site reconnaissance activities.

Senior Environmental Planner, August 2011–August 2012
Tri-State Generation and Transmission Association, Inc., Carey Substation, Weld County, Colorado
Tetra Tech prepared the resource analyses, environmental assessment for the Rural Utility Service, and the Areas and Activities of State Interest permit application for Weld County, Colorado to support a new electrical substation proposed by Tri-State Generation and Transmission Association. Tetra Tech conducted a biological resources assessment and conducted informal consultation for the project with the US Fish and Wildlife Service and the Colorado Division of Parks and Wildlife.

Document Lead/Senior Environmental Planner
Cherokee Pipeline, June 2011–August 2012
Public Service Company of Colorado is proposing to construct approximately 34 miles of new 24-inch steel natural gas transmission pipeline between the Cherokee Generating Station in Adams County, Colorado and terminating at the Fort Lupton Metering Facility in Weld County, Colorado. Construction is expected to begin in 2013 and the pipeline is expected to be in operation by October 2014. Tetra Tech is preparing the route selection study, land use and environmental permit applications, and environmental documentation required for approval of the project. Tetra Tech prepared the pipeline route selection study and is developing four land use permit applications, three state permit applications, one federal permit application, and numerous additional local permit applications.

Ms. Miller conducted regulatory, environmental, and community research for and prepared the Adams County 1041 Permit Application. Follow-up work included responding to referral comments and preparing supporting permit applications.

Document Lead/Senior Environmental Planner
Cherokee Station June 2011–August 2012
Public Service Company of Colorado is converting the Cherokee Station coal-fired power plant to natural gas in response to Colorado's 2010 Clean Air-Clean Jobs legislation. Cherokee Station is located north of downtown Denver, Colorado, adjacent to the South Platte River. Tetra Tech was selected to conduct the environmental resource analyses and Areas and Activities of State Interest (1041)/Conditional Use Permit applications required by Adams County, Colorado to support the Cherokee Generating Station Repowering Project. Tetra Tech conducted economic, biological, cultural, and transportation impact analyses for the permit applications.

Ms. Miller conducted regulatory, environmental, and community research for and prepared the Adams County 1041 Permit Application. Follow-up work included responding to referral comments and preparation of supporting permit applications."

Senior Environmental Planner/Resource Specialist, May 2011–Present
Cogentrix Energy, LLC, Quail Brush Power Project, City of San Diego, California
Cogentrix proposed construction of approximately a 100 megawatt natural gas-fired peaking facility near the eastern boundary of the city of San Diego, California. Project facilities include the peaking plant, a transmission line, switchyard, and natural gas pipeline.

Ms. Miller's responsibilities include task lead and resource specialist for the following CEC AFC sections: socioeconomics and transportation.

Senior Environmental Planner, May 2011–Present
PSCo Cherokee Station–Adams County Permitting
Public Service Company of Colorado is converting the Cherokee Station coal-fired power plant to natural gas in response to Colorado's 2010 Clean Air-Clean Jobs legislation. Cherokee Station is located north of downtown Denver, Colorado, adjacent to the South Platte River. Tetra Tech was selected to

conduct the environmental resource analyses and Areas and Activities of State Interest (1041)/ Conditional Use Permit applications required by Adams County, Colorado to support the Cherokee Generating Station Repowering Project. Tetra Tech conducted economic, biological, cultural, and transportation impact analyses for the permit applications

Senior Environmental Planner, December 2010–Complete
Lucky Corridor
Lucky Corridor, LLC has proposed construction of approximately 130 miles of new 500-kilovolt transmission line in northern New Mexico to better link renewable energy and gas resources with energy export markets. Tetra Tech is preparing Standard Form 299 Permit applications for the project for rights-of-way across federal lands.

Senior Environmental Planner/Resource Lead, April 2010–November 2011
Edwards to Meadow Mountain
Public Service Company of Colorado built a new natural gas transmission pipeline to meet rapidly growing needs in the Avon/Eagle-Vail region. The Edwards-Meadow Mountain Gas Pipeline Project was a system upgrade that replaced the existing 60-year-old, six- , eight-, and 12-inch natural gas pipelines located in Eagle County, Colorado, underneath the eastbound lane of U.S. Highway 6 with a new high-pressure pipeline. Tetra Tech completed the following permit applications for the Project: Eagle County Special Use Permit; Eagle County Permit to Construct in the Public Right-of-Way; Town of Avon 1041 Permit; Air Pollution Emission Notice and Construction Permit; CDOT Utility Permit; and consultation with the U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, State Historic Preservation Office, and Colorado Division of Wildlife.

Ms. Miller's involvement in the project has included acting as the resource lead for water resources, soils, geologic hazards, hazardous materials, and transportation, as well as assisting in the overall organization and preparation of local and federal permit applications.

Deputy Project Manager/Senior Environmental Planner, January 2010–January 2012
Saguache Solar Energy
The Saguache Solar Energy Project is a proposed 200-megawatt solar thermal facility site in Saguache County, Colorado, proposed by the applicant, to be a project company formed by SolarReserve. The project will be developed within approximately 6,200 acres of privately owned land being optioned by SolarReserve in Saguache County, in south-central Colorado. The project site is located in the San Luis Valley, where the state's best solar resources exist. The San Luis Valley is identified as one of two solar power generation development areas in the state of Colorado. Tetra Tech is providing support services for approval of the project through the Saguache County 1041 permitting process.

Responsibilities include assisting the project manager with the budget, invoices, add services, scheduling, project meetings, coordination with SolarReserve and Saguache County, review of documents (1041 permit requirements and other deliverables), and with production of draft and final project deliverables.

Senior Environmental Planner/Resource Specialist, December 2009–Present
Shell WindEnergy, Inc., Hermosa West Wind Energy Project, Albany County, Wyoming
The Hermosa West Wind Energy Project, located in Albany County, Wyoming, is being developed by Shell WindEnergy on an 11,125-acre site near the town of Tie Siding. The Project would consist of up to 200 wind turbines with a combined generating capacity of up to 300 megawatts. Shell WindEnergy is requesting to interconnect the Project with the existing Craig to Ault 345-kilovolt transmission line owned and operated in part by Western Area Power Administration. Tetra Tech is preparing the environmental impact statement and conducting public involvement activities for the Project.

Responsibilities include task lead and resource specialist for the following EIS sections: environmental justice, socioeconomics, and geology, minerals, and soils.

Senior Environmental Planner/Resource Specialist, December 2009–October 2010
NextEra Energy Resources, LLC, Black Canyon Solar Energy Project, Alamosa County, Colorado
Project consists of a 30-megawatt photovoltaic solar energy-generating facility and associated 1.5-mile transmission line in Alamosa County, Colorado. Tetra Tech prepared a Critical Issues Analysis, Phase I Environmental Site Assessment, and Areas and Activities of State Interest Permit (1041 Permit) application. Tasks included development of the 1041 permit application, engineering support, visual simulations, coordination with the Colorado Division of Wildlife and U.S. Fish and Wildlife Service, preparation for and attendance at a community meeting, preparation for and attendance at a Board of County Commissioners hearing for the project, and coordination with Alamosa County.

Responsibilities include task lead and resource specialist for the following 1041 permit application sections: socioeconomics and geology, minerals, and soils.

Deputy Project Manager, November 2009–January 2011
BP Wind Energy North America, Inc., Cedar Creek II Wind Farm Project, Weld County, Colorado
Tetra Tech provided a variety of local (1041 permit) and state permitting and transportation services and also performed biological and cultural surveys to BP Wind Energy Services for the Cedar Creek II Wind Farm Project, a 300-megawatt wind energy generation facility in Weld County, Colorado. Tetra Tech also assisted BP with the development and evaluation of site alternatives of wind facilities, and consultation with Weld County planning officials and state agencies regarding environmental concerns and post-construction environmental and cultural monitoring. Tetra Tech also sited and permitted a 14-mile 230-kilovolt transmission line and interconnection substation. Ancillary services included GIS mapping; analysis of impacts to environmental and social resources; analysis of impacts related to the temporary batch plant; protocol level field surveys for wetlands and cultural and historic resource assessment; Phase I Environmental Site Assessment for the Project area and transmission line; sampling of a water well; preparation of drainage reports, traffic studies, and meteorological tower applications; and preparation and attendance at Weld County hearings.

Responsibilities include assisting the project manager with the budget, invoices, add services, scheduling, project meetings, coordination with BP and Weld County, review of documents (1041 permit requirements and pre-construction deliverables), and with production of draft and final project deliverables.

Document Lead/Senior Environmental Planner, 2012 - Present
Xcel Larimer–Boulder Counties, CO
Public Service Company of Colorado proposes to install an upgrade to its facilities along existing or new easements from the Boulder–Larimer County line to a terminus north of the town of Wellington. These facilities range in size from 4-inch or 6-inch to 16-inches and generally serve as transmission facilities typically operating at high pressure. Tetra Tech is conducting route analyses, resource analyses, Areas and Activities of State Interest permit applications for Boulder and Larimer counties, Colorado, and public involvement activities to support the project.

Ms. Miller conducted regulatory, environmental, and community research for and prepared the Larimer County Location and Extent Permit Application and 1041 Permit Application. Document lead for the city of Fort Collins Natural Areas Department (NAD) Easements or Rights of Way Permit Application Document lead; conducted research (regulatory, environmental, and community) for and prepared the draft Boulder County 1041 Permit Application. Follow-up project support work includes responding to referral comments and preparation of supporting permit applications.

Senior Environmental Planner, August 2011 – August 2012
Tri-State Generation and Transmission Association, Inc., Carey Substation, Weld County, CO
Tetra Tech prepared the resource analyses, environmental assessment for the Rural Utility Service, and the Areas and Activities of State Interest permit application for Weld County, Colorado to support a new electrical substation proposed by Tri-State Generation and Transmission Association. Tetra Tech conducted a biological resources assessment and conducted informal consultation for the project with the US Fish and Wildlife Service and the Colorado Division of Parks and Wildlife.

Select Project Experience

Project and Program Management
Organized and managed projects for clients as well as projects and programs for the state of Kansas. Activities included grant applications and grant management and tracking budgets and program performance. Ms. Miller has worked with numerous public and private entities to implement and achieve program goals. Her creative approach to setting up and scheduling projects has received enthusiastic feedback from her supervisors and clients. Public involvement activities have consisted of formal presentations, question/answer sessions, surveys, and formal comment–response documents.

Permitting for Renewable Energy Generation Projects
Ms. Miller has managed and acted as the document and resource lead for NEPA requirements and local permitting solar, wind, electric transmission lines, and natural gas pipeline projects in Colorado, Arizona, Texas, and Oklahoma.

Resource and Task Lead Support for Energy Projects
Ms. Miller has performed essential resource and task lead duties (water resources, socioeconomics, geology and soils, hazardous materials, environmental justice) associated with numerous small and large-scale projects (electric transmission lines, natural gas pipelines, and substations) in Colorado, Wisconsin, Michigan, Oklahoma, Texas, Oregon, Pennsylvania, New Jersey, and Idaho.

Previous Experience

Project and Program Management
Organized and managed projects for clients as well as projects and programs for the state of Kansas. Activities included grant applications and grant management and tracking budgets and program performance. Ms. Miller has worked with numerous public and private entities to implement and achieve program goals. Her creative approach to setting up and scheduling projects has received enthusiastic feedback from her supervisors and clients. Public involvement activities have consisted of formal presentations, question/answer sessions, surveys, and formal comment–response documents.

Regulatory Oversight Projects—Ms. Miller performed regulatory project management oversight duties for the following short list of environmental remediation project sites:

Pester Burn Ponds National Priorities List (NPL) Site—This Remedial Investigation/Feasibility Study (RI/FS) project refinery site is located in El Dorado, Kansas. The project included innovative cleanup technologies for the remediation of refinery sludge ponds that were contaminating area groundwater and a nearby stream.

Fort Riley NPL DOE Site, Fort Riley, Kansas—This project included work with EPA and DOE as the state leads for the RI/FS process for hundreds of individual contaminated areas within this military

installation, including underground storage tank areas, equipment maintenance areas, and ordinance/ bombing range areas.

FMC Fertilizer Plant, Lawrence, Kansas—This state voluntary cleanup project involved remediation of fertilizer-contaminated alluvial groundwater and ongoing monitoring and evaluation using groundwater modeling of the river/groundwater interface hydrological system.

Texaco Refinery, El Dorado, Kansas—This state voluntary cleanup site involved monitoring and cleanup of hydrocarbon-contaminated groundwater in and surrounding the refinery.

Boeing Plant, Wichita, Kansas—This state voluntary cleanup site involved investigation, monitoring, and cleanup of solvent (volatile organic compounds) contaminated groundwater in and surrounding the airplane manufacturing plant.

Permitting for Renewable Energy Generation Projects

Ms. Miller was the project manager for Sempra Generation's proposed six-square-mile photovoltaic solar energy facility west of Phoenix, Arizona – Mesquite Solar Project. Duties have included consulting support for securing local (Maricopa County) and state (Arizona Corporation Commission) permits for land use amendments, drainage variances, special use permits, and the State Certificate of Compatibility for the transmission line.

Resource and Task Lead Support for Energy Projects

Ms. Miller has performed essential resource and task lead duties (water resources, socioeconomics, geology and soils, environmental justice) associated with numerous large-scale projects, including the CapX 2020 Transmission Line permitting process and the NextGen Environmental Evaluation. She performed similar duties for the Garmesa Pipeline EA (a U.S. Bureau of Land Management [BLM] project) and the Idaho Power transmission line and water pipeline project EA (another BLM project).

Permitting and Siting for Substations and Transmission Lines

Ms. Miller was the project manager for acquisition of the planning permit for Xcel's Spindle Hill Switching Station in the town of Frederick, Colorado. The permit process, which is almost complete, has involved detailed landscaping, grading, and drainage features as well as the approval of two waivers through a town board hearing. Other Colorado substation permitting projects have included Xcel's Kelim Substation (Johnstown) and Xcel's Ault Substation (Weld County). She was also involved in a permit process for new Xcel transmission lines in the city of Aurora, Colorado, which includes proposed tree removal and replacement according to city landscaping guidelines. Ms. Miller also assisted in the siting study for Xcel's Arrowhead Lake Substation in Greeley, Colorado. Ms. Miller conducted resource studies for the Project Power EA 115-kV transmission line and facilities in Santa Fe, New Mexico, for the Public Service Company of New Mexico. The lead agency for the project was Taos office of the BLM. Three final transmission line routes were evaluated in the EA.

I-70 Mountain Corridor Programmatic EIS (PEIS)

Ms. Miller performed an analysis of existing and future water supply requirements in the corridor for the evaluation of indirect impacts in relation to future corridor growth. She was also responsible for the preparation of the regulated and hazardous materials, social and economic values, land use, and water resources (including water quality) portions of the PEIS. Ms. Miller also worked with the U.S. Forest Service to formulate and implement a methodology for analysis of indirect impacts to recreation resources. Mine wastes from historical mining in the corridor have contaminated soil and streams along I-70. She assisted in coordination with the Colorado Department of Public Health and Environment, Colorado Department of Transportation (CDOT), and EPA for a Memorandum of Agreement that would address the handling of mine waste contamination in soil and groundwater. She assisted in the

creation of a land use and watershed-based methodology to evaluate cumulative impacts to environmental resources and community values that received positive comments from EPA. Ms. Miller was also a major participant in the categorization, organization, internal review, and response formation process associated with public comments received on the draft PEIS.

GSA NEPA Projects

Ms. Miller performed resource studies, due diligence studies, and project management duties for numerous GSA NEPA projects. She acted as the consulting project manager of an EA for a border station in Roosville, Montana, which resulted in a Finding of No Significant Impact (FONSI) for the replacement/upgrade of this aging rural border station. Her project management experience included completion of several GSA CatEx checklist reports following the GSA Public Buildings Service's NEPA desk guide. Ms. Miller completed various NEPA resource studies (geology, water resources, wetlands, floodplains, land use, and hazardous materials) for GSA projects in Salt Lake City, Utah; Helena, Montana (Federal Judicial Court Building); Sweetgrass, Montana; Fort Collins, Colorado (APHIS Research Building); and the Denver Federal Center (Building 25 Renovation CatEx). She also completed several Phase I and Phase II ESA studies for GSA, including border station projects in Sweetgrass and Roosville, Montana.

Powers Boulevard EA

Ms. Miller prepared a methodology for the analysis of water quality impacts in this highly urbanized and growing transportation corridor project in Colorado Springs, Colorado. Issues of concern included increased stormwater runoff from increased impervious surface areas, sedimentation, and subsequent changes to stream channels and surface water quality. The analysis used a long-range stormwater quality model to evaluate existing and future pollutant loads in numerous subbasins through the corridor using land use data and project design data. Numerous permanent best management practices (dry detention basins) are proposed that would collect runoff from the highway as well as from adjacent areas in the subbasins.

Over the River EA

Ms. Miller coordinated issue discussions and prepared the following EA sections for this controversial project: air quality, noise, floodplains, engineering safety, geology, soils, hazardous materials, water resources, wild and scenic rivers, farmlands, and hydrology and water rights. She also prepared public comment summaries based on public scoping meetings for the project.

Broadway Viaduct CatEx, Denver

Ms. Miller conducted an extensive environmental analysis of hazardous materials and water resources along a proposed roadway improvement corridor of I-25 for CDOT. Because the corridor is densely populated by industry and commercial business, researching of possible limitations for design options included a comprehensive search for potentially contaminated sites. She also completed the materials management plan used by the CDOT contractor during project construction.

Various NEPA

Ms. Miller has also contributed to numerous NEPA studies including U.S. Highway 34 EA and State Highway 402 EA, Loveland, Colorado; Rock Springs, Wyoming, viaduct replacement EA; Broomfield Flatirons/U.S. 36 Interchange EA (water resources, wetlands, environmental contaminants studies); Black Hawk, Colorado/SH-119 improvements (wetlands, environmental contaminants studies); and East Belt Interchange Corridor, Casper, Wyoming. Several of these projects included project management duties.

Discipline Codes

Project Manager, Primary

Hydrologist
Planner: Urban/Regional
Environmental Scientist
Geologist

Skill Set

NEPA
Environmental Assessments
Environmental Impact Studies
Environmental Geology
Environmental Permitting
Geologic Hazard Evaluations
Groundwater Sampling
Hydrology
Licensing of Power Projects
NEPA Assessments
NPDES Permitting
Permitting
CERCLA
RCRA
Sampling & Analysis Planning
State Programs
Borings and Wells—Monitoring Well Installation
Borings and Wells—Soil Classification/Logging
Dense Non Aqueous Phase Liquids (DNAPL)
Hydrogeology—Pump Test Analysis
Hydrogeology—Slug Test Analysis
Hydrogeology—Water Quality
Hydrogeology—Water Supply
Hydrology—Water Quality
Light Non Aqueous Phase Liquids (LNAPL)
Sampling—Groundwater
Sampling—Sediment
Sampling—Soil
Sampling—Water Level Measurements
Underground Storage Tanks/Refineries
Economics
Land Use
Planning
Public Involvement
Recreation
Siting
Socioeconomics
Stormwater

Professional References

Tricia Bernhardt, Senior Environmental Planner/Project Manager, Tetra Tech EC, 303-980-3727, tricia.bernhardt@tetratech.com
Tim Tetherow, Environmental Division Manager, J.F. Sato and Associates, 720-299-6651
Rick Bean, Remedial Section Chief, Kansas Department of Health and Environment, 785-296-1675

Related Company Information

Payroll Number: 527274
Employment Status: Part-Time
Preferred First Name: Rachel
Office Location: Lakewood, CO
Hire Date: 12/14/09
Years with Other Firms: 12
Years with Current Firm: 4
Total Years' Experience: 16
Supervisor: Stephanie Phippen, Senior Geoscientist
Office Phone: (303) 980-3600
Cell Phone: (303) 378-5836
Fax: (303) 980-3539
E-mail Address: rachel.miller@tetratech.com
Other E-mail Address (if any):
Resume Last Revised: 11/12/2013

Appendix E—Photo Log Documentation

Appendix E - Photographic Documentation
Daggett Solar Facility
Daggett, CA

Photo: 1 **Description:** View looking south towards Santa Fe Street.	

Photo: 2 **Description:** View looking southeast towards Santa Fe Street.	

Photo: 3 **Description:** View looking north.	

Photo: 4 **Description:** View of neighboring slag pit looking southwest.	

Photo: 5 **Description:** View of transmission line looking north.	

Photo: 6 **Description:** View of transmission line looking northeast.	

Photo: 7 **Description:** View of transmission line looking west.	

Photo: 8 **Description:** View looking northwest.	

Photo: 9 **Description:** View looking south.	

Photo: 10 **Description:** View of transmission line and east adjacent agricultural land looking northeast.	

Photo: 11 **Description:** View of existing agricultural looking northeast.	

Photo: 12 **Description:** View of neighboring solar facility looking west.	

Photo: 13 **Description:** View looking northeast.	

Photo: 14 **Description:** View looking south.	

Photo: 15 **Description:** View looking northwest, associated agricultural building pictured.	

Photo:16 **Description:** View looking north.	

Photo: 17 **Description:** View of transmission line looking east.	

Photo: 18 **Description:** View looking southwest.	

Photo: 19 **Description:** View of adjacent agricultural looking west.	

Photo: 20 **Description:** View looking south.	

Photo: 21 **Description:** View of Barstow-Daggett Airport looking southwest.	

Photo: 22 **Description:** View looking east.	

Photo: 23 **Description:** View of agricultural land looking southeast.	

Photo: 24 **Description:** View of agricultural land looking south.	

Photo: 25 **Description:** View of agricultural land looking north.	

Photo: 26 **Description:** View of agricultural land looking north.	

Photo: 27 **Description:** View looking north.	

Photo: 28 **Description:** View of single-family residence and agricultural land looking southwest.	

Photo: 29 **Description:** View looking northeast of agricultural building.	

Photo: 30 **Description:** View of adjacent building from Mineloa Road, looking south.	

Photo: 31 **Description:** View looking southeast, single-family residence and associated agricultural building pictured.	

Photo: 32 **Description:** View looking south.	

Photo: 33 **Description:** View of north adjacent single-family residence, looking north.	

Photo: 34 **Description:** View looking southwest.	

Photo: 35 **Description:** View looking southeast.	

Photo: 36 **Description:** View looking northeast.	

Photo: 37 **Description:** View looking west.	

Photo: 38 **Description:** View of north adjacent Koi Farm property, looking north.	

Photo: 39 **Description:** View of agricultural land, looking northwest.	

Photo: 40 **Description:** View of agricultural land, looking west.	

Appendix F—Relevant Documents

Appendix F—Relevant Documents

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132-5190

5090
Ser OPAE30.LW/151
July 31, 2017

Mary Aycock
Attn: SFD-8-2
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

Sue Hakim
Cal-EPA – Department of Toxic Substances
5796 Corporate Avenue
Cypress, CA 90630

Alonzo Poach
California Regional Water Quality Control Board - Lahontan Region
15095 Amargosa Road
Building 2, Suite 210
Victorville, CA 92392

SUBJECT: DRAFT FOURTH FIVE YEAR REVIEW REPORT, OPERABLE UNITS 1 THROUGH 7, MARINE CORPS LOGISTICS BASE BARSTOW, CALIFORNIA

Dear Ms. Aycock, Ms. Hakim, and Mr. Poach:

The Department of Navy is pleased to submit the Draft Fourth Five Year Review Report, Operable Units 1 through 7, Marine Corps Logistics Base Barstow, California for your review. Please provide your comments by October 2, 2017.

If you have any questions, please contact Ms. Lindsey White, Remedial Project Manager, at lindsey.e.white@navy.mil or (619) 532-4451.

Sincerely,

Theresa L Morley

THERESA MORLEY
By direction of the
Commanding Officer

Copy to: CO, MCLB Barstow (Attn: I&L Department, Environmental Division – Mr. James Debenedetti)

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DRAFT FOURTH FIVE YEAR REVIEW REPORT
OPERABLE UNITS 1 THROUGH 7
MARINE CORPS LOGISTICS BASE BARSTOW, BARSTOW, CALIFORNIA

DCN: OTIE-1818-0006-0001; Date: 31 July 2017

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DRAFT

FOURTH FIVE-YEAR REVIEW REPORT
OPERABLE UNITS 1-7
MARINE CORPS LOGISTICS BASE BARSTOW
Barstow, California

CONTRACT NUMBER: N39430-16-D-1818
CONTRACT TASK ORDER: 0006

DCN: OTIE-1818-0006-0001

PREPARED FOR:

Naval Facilities Engineering Command
ENGINEERING AND EXPEDITIONARY WARFARE CENTER

1220 Pacific Highway, Building 127
Room 112
San Diego, California 92132

PREPARED BY:

OTIE
An Oneida Nation Company

317 E. Main Street
Ventura, California 93001

31 JULY 2017

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DECLARATION OF ACCEPTANCE FOR
OUS 1 – 7 FOURTH FIVE-YEAR REVIEW REPORT – 2017
MARINE CORPS LOGISTICS BASE
BARSTOW, CALIFORNIA

Pursuant to the delegation of the authority in Sections 2(d) and 11(g) of the Executive Order 12580, and U.S. Department of Defense Instruction 4715.7 of 22 April 1996, the U.S. Department of the Navy is the approval authority for Comprehensive Environmental Response, Compensation, and Liability Act Five-Year Reviews conducted at sites under its jurisdiction, custody, or control.

Sekou S. Karega
Colonel, U.S. Marine Corps
Commanding Officer

Date

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EXECUTIVE SUMMARY

Introduction

This report presents the results of the Fourth Five-Year Review for seven operable units (OUs) located at the Marine Corps Logistics Base (MCLB) Barstow located near Barstow, California. This report has been prepared by the United States Department of the Navy (DON) in support of the Installation Restoration Program (IRP) being conducted at the MCLB Barstow. The IRP was developed by the Department of Defense (DOD) to clean up contamination at military facilities caused by past use, storage, handling, and disposal of hazardous and other potentially toxic substances. The review period of this report is October 2012 through September 2017, with a trigger review date of 11 December 2012.

Authority of Conducting Five-Year Reviews

The DON is the lead agency for conducting five-year reviews at the MCLB Barstow (the Base) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The DON has prepared this Five-Year Review pursuant to CERCLA Section (§)121(c) and the National Contingency Plan (NCP). In addition, the United States Environmental Protection Agency's (U.S. EPA's) Five-Year Review Guidance (U.S. EPA, 2001) and DON's policy for conducting CERCLA five-year reviews (DON, 2011) were extensively used in preparation of this Five-Year Review report. The Five-Year Review is required because hazardous substances, pollutants, or contaminants remain on Base above levels that allow for unlimited use and unrestricted exposure.

According to the NCP, Five-Year Review reports are to be completed and signed within five years of the trigger date for a site when, upon the completion of the Remedial Actions (RAs) at a site, hazardous substances, pollutants, or contaminants will remain above levels that allow for unlimited use and unrestricted exposure. The OUs 1 and 2 Record of Decision (ROD) (JEG, 1998a), signed 22 April 1998, required the first statutory Five-Year Review of these OUs to be completed by 22 April 2003. In accordance with DON's policy, the trigger date for the statutory Five-Year Review of OUs 3 and 4 was 9 September 1998. The trigger date for the statutory Five-Year Review of OUs 5 and 6 was 23 January 1998. To streamline and synchronize the five-year reviews of OUs 1 – 6, the First Five-Year Review was completed and signed on 30 December 2002. The trigger date for subsequent five-year reviews is the signature date of the prior five-year review. Hence the second Five-Year Review was signed on 19 December 2007 (DON, 2007), the Third Five-Year Review was signed on 11 December 2012 (DON, 2012), and the Fourth Five-Year Review is due in December 2017. The Fourth Five-Year Review will incorporate OU 7, for which the ROD was signed in December 2014. The Five-Year Review schedule is consistent with § 27.3 of the Federal Facility Agreement (FFA) between the DON, U.S. EPA Region 9, the California Department of Toxic Substances Control (DTSC), and the California Regional Water Quality Control Board - Lahontan Region (RWQCB-Lahontan Region).

Site Background and History

The MCLB Barstow is located in San Bernardino County, California, within the central Mojave Desert, approximately 135 miles northeast of Los Angeles. The MCLB Barstow consists of two areas: the Yermo Annex, which is 7 miles east of Barstow, California, between Interstates 15 and 40; and the Nebo Main Base, which includes the Rifle Range, is 3.5 miles east of Barstow and intersected by Interstate 40.

In November 1989, the Base was placed on the CERCLA National Priorities List (NPL) due to the presence of soil and groundwater contamination. Soil and groundwater at the MCLB Barstow are currently being cleaned up under the IRP. The MCLB Barstow IRP follows federal and state regulations in its investigation and cleanup of Base contamination. The DON is the lead DOD authority responsible for conducting the site investigation and cleanup at the MCLB Barstow. The DON's investigation and cleanup efforts are being conducted in conjunction with the U.S. EPA, the Regional Water Quality Control Board – Lahontan Region (RWQCB-Lahontan Region), and the State of California Environmental Protection Agency's Department of Toxic Substances Control (DTSC).

The IRP divides the Base (Yermo Annex and Nebo Main Base) into seven OUs. Each OU is divided into a number of CERCLA Areas of Concern (CAOCs). OUs 1 and 2 comprise groundwater contamination beneath the Yermo Annex and Nebo Main Base, respectively. Groundwater contamination is primarily due to dissolved volatile organic compounds (VOCs). OUs 3 and 5 comprise soil contamination sites at the Yermo Annex, and OUs 4 and 6 comprise soil contamination sites at Nebo Main Base. Soil contamination is primarily due to VOCs, metals, pesticides, polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs). OU 7 comprises soil, soil vapor, and groundwater contamination sites at Nebo Main Base and soil contamination sites at the Yermo Annex. Groundwater and soil vapor contamination are primarily due to VOCs, and soil contamination is primarily due to VOCS, semi-volatile organic compounds (SVOCs), metals, pesticides, PCBs, and PAHs. RODs were signed in 1997 for OUs 3 and 4; in 1998 for OUs 1 and 2 and OUs 5 and 6; and in 2014 for OU 7. Remedial actions are underway at both Yermo Annex and Nebo Main Base; land use controls/institutional controls (LUCs/ICs) have also been implemented at all seven OUs.

Five-Year Review Questions

The Fourth Five-Year Review evaluates the remedies implemented at each of the CAOCs at OUs 1-7 by answering the following questions:

Question A: Is the remedy functioning as intended by the RODs?

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and Remedial Action Objectives (RAOs) used at the time of the remedy selection still valid?

Question C: Has any other information come to light that could call in to question the protectiveness of the remedy?

Through the process of answering the review questions for each of the selected remedies, issues are identified and a determination is made if the remedies are protective of human health and the environment. Recommendations for follow-up actions, with milestone dates for implementation, are made to address identified concerns for short-term or long-term protectiveness of the remedies.

The following Five-Year Review Summary forms provide a synopsis of the OUs, remedies in place, previously-identified issues, protectiveness statements, and recommendations.

SITE IDENTIFICATION		
Site name (from WasteLAN) Marine Corps Logistics Base Barstow		
U.S. EPA ID (from WasteLAN) CA8170024261 (Nebo Main Base); CA8170090023 (Yermo Annex)		
Region: 09	**State:** CA	**City/County**: Barstow / San Bernardino County

SITE STATUS	
NPL status: ☒ Final ☐ Deleted ☐ Other (specify) _____	
Remediation status (choose all that apply): ☐ Under Construction ☒ Operating ☐ Complete	
Multiple OUs? ☒ YES ☐ NO	Construction completion dates: OU 1 (1998); OU 2 (1999 and 2007); OU3 (1999), OU4 (1999), OU 5 (2001), OU 6 (1999), OU 7 (in remedial design phase)
Has site been put into reuse? ☐ YES ☒ NO	

REVIEW STATUS	
Reviewing agency: ☐ U.S. EPA ☐ State ☐ Tribe ☒ Other Federal Agency: U. S. Department of the Navy	
Author name: Ms. Lindsey White, PE	
Author Title: Remedial Project Manager	**Author affiliation:** Naval Facilities Engineering Command, Southwest
Review period: October 2012 to September 2017	
Date(s) of inspection: 13 – 14 March 2017	
Type of review: ☒ Statutory ☐ Policy ☐ Post-SARA ☐ Pre-SARA ☐ NPL-Removal only ☐ Non-NPL Remedial Action Site ☐ NPL State/Tribe-lead ☐ Regional Discretion	
Review number: ☐ 1 (first) ☐ 2 (second) ☐ 3 (third) ☒ 4 (fourth) ☐ Other (specify) _____	
Triggering action: ☐ Actual RA On-site Construction at OU__ ☐ Construction Completion ☐ Other (specify)_____	☐ Actual RA Start at OU #_____ ☒ Previous Five-Year Review Report
Triggering action date: 12 / 11 / 2012	
Due date (five years after triggering action date): 12 / 11 / 2017	

FIVE-YEAR REVIEW SUMMARY FORM – OU 1 (Yermo Annex)

OU 1 consists of CAOC 37, which is the groundwater at Yermo Annex. The remedy for OU 1 was established in the OUs 1 and 2 ROD signed in 1998. The ROD addresses three groundwater VOC plumes identified as the CAOC 26, Yermo North, and Yermo South plumes, portions of which extend off Base. The ROD identified perchloroethylene (also called tetrachloroethene, perc, or PCE), trichloroethylene (TCE) and 1,1-dichloroethene (1,1-DCE) as contributing the most to estimated cancer risk and non-cancer health effects. The selected remedy is air sparging/soil vapor extraction (AS/SVE) to remove contaminant mass and groundwater extraction and treatment to provide hydraulic containment, and well-head treatment at two on-Base wells and two off-Base private residential wells. The implemented remedy includes the CAOC 26 AS/SVE and CAOC 16 AS/SVE systems, Groundwater Extraction and Treatment System (GETS), and granular-activated carbon (GAC) treatment to on-Base wells YDW-5 and YDW-6, and GAC treatment at the two off-Base residential wells. The GETS comprises 13 extraction wells, GAC treatment of extracted groundwater, and infiltration of treated water through two infiltration galleries. The remedial systems were installed during 1996 to 1998. The CAOC 26 AS/SVE system was shut down in 1998 after meeting remedial objectives; all surface remedial equipment was removed from this CAOC in 2015. The CAOC 16 AS/SVE system and GETS remain in operation. During the review period, only three extraction wells were operated to hydraulically contain the remaining OU 1 plume, called the "*Yermo North Plume*". A portion of the Yermo North plume remains off-site.

The OU 1 remedy also includes:

- Maintenance and monitoring of GAC treatment systems on two on-Base drinking water production wells and two off-Base private residential wells;
- Annual monitoring of groundwater VOCs at CAOCs 15/17, 16, 20, 23, 26, and 35;
- Groundwater monitoring to determine if dissolved metals, particularly chromium and nickel, are site-related contaminants in the CAOC 16 area;
- ICs/LUCs incorporated in the Base Master Plan to prevent use of Base groundwater within contaminated zones; and
- Notification of San Bernardino County regarding off-Base migration of contaminated groundwater.

Issues Identified during the Fourth Five-Year Review:

1. The OU 1 pump and treat remedy is not achieving containment of the off-Base contaminant plume. Data gaps in the off-base monitoring well network inhibit evaluation of plume dynamics, concentration distribution, and trends;
2. The long-term persistence of the Yermo North plume suggests the presence of a remaining contaminant mass at CAOCs 16, 15/17 and possibly 35. The existing soil vapor extraction (SVE) system may be located too far from the residual contaminant mass to effectively reduce vadose zone concentrations. The AS system has become ineffective due to declining water levels;
3. Off-site exposure to Base groundwater plume is not suspected, however the two off-base residential wells treatment systems are not currently in operation. The Yount private well went dry in May 2016 and the Hodges well appears to be inoperable based on inspections from the public right-of-way. The DON does not have a current access agreement to the Hodges property to perform direct inspection of the well and treatment system despite repeated attempts to contact the property owner who does not live on-site. An occasional resident/trespasser has

FIVE-YEAR REVIEW SUMMARY FORM – OU 1 (Yermo Annex)

been observed at the Hodges residence.

4. The CAOC 26 groundwater and vadose zone remedies are completed; no further monitoring is required; and
5. OU 1 groundwater chromium and nickel data indicate these metals are consistently below maximum contaminant levels and no further monitoring is required.

Recommendations and Follow-up Actions:

1. Perform a data gaps investigation of the Yermo North plume to improve delineation of the northern and off-site extent.
2. Investigate the residual contaminant mass in the vadose zone at CAOCs 16, 15/17, and 35; based on the results optimize the SVE system to ensure long-term effectiveness of the remedy. Turn off the AS portion of the remedy as it is no longer effective.
3. Maintain contact with Yount residence on status of their private well. Continue to pursue access agreement with off-Base Hodges property owner; the situation is being elevated to the DON legal counsel who will review and pursue options to gain access to the Hodges property to ascertain status of the well and GAC system, and to make necessary repairs (if the well is operable) to meet requirements of the ROD. Additionally, upon securing access to the property, the DON will provide notification to the occupants regarding potentially contaminated groundwater.
4. Document in the Administrative Record that the response action at CAOC 26 for vadose zone and groundwater is completed and no further monitoring is required; and
5. Document in the Administrative Record that detected metals in OU 1 groundwater do not require a response action or any further monitoring.

Protectiveness Statement:

The OU 1 (CAOC 37) groundwater remedy is protective of human health and the environment. Current protectiveness is not affected by the identified issues because of the ongoing operation of the remedial systems. Future protectiveness of the remedy would be better ensured through remedy optimization and addressing the existing data gaps in vadose zone and groundwater contaminant extent.

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 1 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 2 (Nebo Main Base)

OU 2 consists of CAOC 38, which is the groundwater at Nebo Main Base. CAOC 38 includes two dissolved VOC plumes identified as Nebo North and Nebo South. The selected remedy for the Nebo North plume is AS/SVE treatment of VOCs in the source area and natural attenuation to reduce contamination in groundwater downgradient of the source area. The Nebo North remedy included a "*fail-safe*" pump and

FIVE-YEAR REVIEW SUMMARY FORM – OU 2 (Nebo Main Base)

treat system (Nebo GETS) to prevent off-Base migration; however this system was no longer needed and was decommissioned in 2015. The Nebo North plume source area (former Building 50, CAOC 10.12) was treated with AS/SVE until RAOs were met and the system was shutdown with regulatory approval in April 2011. The AS/SVE system is maintained in standby-mode and periodically operated to address rebound in soil vapor concentrations in the former wash pad area as a protective measure for groundwater. The Nebo North plume area has decreased significantly with only one well exhibiting VOC concentrations above the MCLs during the review period.

The remedy selected for the Nebo South plume in the OU 2 ROD, signed in 2006, is AS/SVE to reduce soil vapor and groundwater VOC concentrations. A portion of the plume extended off-Base; however, off-Base groundwater concentrations have been below MCLs since at least 2003. The Nebo South plume has been significantly reduced in extent and concentration, but a small residual plume near the Base boundary persists.

The OU 2 remedy also includes:

- Monitoring associated with CAOC 7 Strata 1 and 2 (capped in-place wastes in the southern part of Nebo Main Base). Groundwater impacts related to CAOC 7 Stratum 1 are now under a cleanup remedy selected in the OU 7 ROD, which was signed in 2014;
- Monitoring for pesticides (specifically, dieldrin) in groundwater at CAOCs 1, 2, 3, and 14 in the northern part of Nebo Main Base; however, pesticide monitoring ceased in 2009 due to long-term monitoring results indicating no detectable concentrations; and
- ICs/LUCs that prevent installation of drinking water wells within the plume areas at Nebo North and Nebo South, and that restrict use of the area around Nebo South area; the Base Master Plan (BMP) incorporates these ICs/LUCs.

Issues Identified during the Fourth Five-Year Review:

1. Nebo North soil vapor VOC concentrations in a small area of the Former Building 50 source zone have been addressed with targeted SVE treatment; the rebounding concentrations are declining and continued targeted SVE is not warranted;
2. The Nebo North plume has attenuated except for a small residual groundwater PCE plume that appears to be related to former underground storage tanks (UST T-22A/B) and/or industrial operations at Warehouse 4 (CAOC 10.5) and/or Building 22. The PCE source area was not identified in the OUs 1 and 2 ROD. Groundwater concentrations of PCE are on an increasing trend at a monitoring well downgradient from UST T-22A/B; and
3. The Nebo South AS/SVE system prevents off-site migration and has reduced the extent of the VOC plume. The persistence of small residual plume areas indicates vadose zone source may be beyond the SVE radius of influence.

Recommendations and Follow-up Actions:

1. Nebo North: Discontinue further SVE in the former source area;
2. Nebo North: Perform a limited subsurface investigation to identify the source for the increasing PCE groundwater concentrations downgradient from UST T-22A/B. Prepare a Memorandum to File to add the UST T-22A/B source area to the OUs 1 and 2 ROD with an appropriate response action if necessary based on the additional data; and

FIVE-YEAR REVIEW SUMMARY FORM – OU 2 (Nebo Main Base)

3. Nebo South: Conduct a data gaps investigation to identify potential residual vadose zone source upgradient of the residual plume and optimize the AS/SVE remedy as necessary.

Protectiveness Statement:

The remedial actions at OU 2 (CAOC 38) Nebo North and Nebo South are currently protective of human health and the environment. Optimization measures to address the small residual but persistent plumes will ensure long-term protectiveness and effectiveness.

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 2 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 3 (Yermo Annex)

OU 3 consists of the shallow soils at Yermo Annex at CAOCs 18, 20, 23, and 34. The selected remedies under the OUs 3 and 4 ROD (signed 1997) include LUCs for CAOCs 18, 20, 23, and 34 and concrete caps constructed at portions of CAOCs 20 and 23. The LUCs are implemented through the Base Master Plan; the CAOC 20 and 23 caps are regularly maintained. Groundwater monitoring for CAOCs 20 and 23 is performed annually as part of the OU 1 long-term monitoring program. CAOC 20 groundwater samples are to be analyzed for the OU 1 COCs plus radiological parameters and four rounds of monitoring results evaluated to determine if this CAOC is a source of contaminants to groundwater.

Issues Identified during the Fourth Five-Year Review:

- CAOC 20: No issues for the ICs/LUCs portion of remedy. One additional round of groundwater radiological data is needed to complete the ROD-required assessment. VOCs were not detected in six rounds of downgradient groundwater monitoring; metals are consistently below maximum contaminant levels. Based on data evaluations in this five-year review, CAOC 20 is contributing neither metals nor VOCs contamination to groundwater at the site.

Recommendations and Follow-up Actions:

- CAOC 20: Collect one additional round of radiological data and evaluate per the ROD; report evaluation results in next annual groundwater monitoring report. Cease further monitoring for metals and VOCs.

Protectiveness Statement:

The OU 3 remedies at CAOCs 18, 20, 23, and 34 are currently protective of human health and the environment.

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 3 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 4 (Nebo Main Base)

OU 4 consists of the shallow soils at the Nebo Main Base at CAOCs 2, 5, 9, and 11. No further action (NFA) was selected for CAOC 9, and no further action with land-use controls were selected for CAOCs 2, 5, and 11.

Issues Identified during the Fourth Five-Year Review:

- None

Recommendations and Follow-up Actions:

- None

Protectiveness Statement:

The OU 4 remedy of LUCs only at CAOCs 2, 5, and 11 continue to be protective of human health and the environment.

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 4 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 5 (Yermo Annex)

OU 5 consist of the shallow soils at Yermo Annex at CAOCs 15/17, 16, 19, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 35, and 36. CAOC 25 was eliminated from the RI as not requiring additional investigation/remediation. Remedies selected in the OUs 5 and 6 ROD for OU 5 are:

- NFA for CAOCs 19, 22, 24, 27, 28, 29, 30, 31, 32, 35 Stratum 1 (east portion) and Stratum 2, and 36;
- LUCs/ICs only for CAOC 21
- LUCs/ICs for CAOCs 15/17and 26, with groundwater addressed under OU 1;
- LUCs for CAOC 16, consisting of preservation of the existing hardstand, with vadose zone and groundwater contamination addressed under OU 1;
- A cap and LUCs for CAOC 35 Stratum 1 Zone 1, which is an inactive Class III Landfill located in the northeastern portion of the Yermo Annex. Groundwater monitoring is performed under OU 1; and
- CAOC 32 (Stratum 2) was found during the 3rd Five Year Review to have a soil contaminant (Aroclor 1242) above a new risk-based screening level; therefore LUCs were implemented for this CAOC in a BMP Amendment published in 2015.

Issues Identified during the Fourth Five-Year Review:

- No issues identified.

FIVE-YEAR REVIEW SUMMARY FORM – OU 5 (Yermo Annex)

Recommendations and Follow-up Actions:

- None. (See recommendations made for the vadose zone and groundwater at CAOCs 16, 15/17, and 35 under OU 1.)

Protectiveness Statement:

The selected remedies at OU 5 are currently protective of human health and the environment because the ongoing maintenance of CAOC 16 hardstand and CAOC 35 Stratum 1 Zone 1 landfill cap prevents direct contact with subsurface contamination and landfill wastes.

Other Comments: The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 5 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 6 (Nebo Main Base)

OU 6 consists of the shallow soils at Nebo Main Base at CAOCs 1, 3, 4, 6, 7, 8, 12, 13, 14, and 33. Of these, CAOC 33 (at Rifle Range) was eliminated from the RI as not requiring further investigation. The selected remedies under the OUs 5 and 6 ROD for this OU include:

- NFA for CAOCs 4, 6, 8, 12, and 13; groundwater cleanup at CAOC 6 ("Nebo South" plume) is covered under OU 2 (CAOC 38);
- CAOCs 1, 3 and 14: LUCs consisting of modifications to the Base Master Plan to ensure Environmental Division review prior to land-use changes; and
- CAOC 7 Strata 1 and 2: Armored native soil cap, engineering controls, and LUCs; cap and ECs are regularly maintained; groundwater monitoring is performed annually or once every five years depending on analyte.

I**ssues Identified during the Fourth Five-Year Review:**

- None

Recommendations and Follow-up Actions:

- None. (See OU 7 for vadose zone and groundwater considerations at CAOC 7 Stratum 1.)

Protectiveness Statement:

The selected remedies at OU 6 continue to be protective of human health and the environment because the ongoing maintenance of caps and engineering controls at CAOC 7 Strata 1 and 2 and LUCs at the other OU 6 CAOCs. The long-term protectiveness of the remedy CAOC 7 Stratum 1 will be assured by implementation of the vadose zone and groundwater cleanup remedy under OU 7.

FIVE-YEAR REVIEW SUMMARY FORM – OU 6 (Nebo Main Base)

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 6 at the time of the remedy selection are still valid.

FIVE-YEAR REVIEW SUMMARY FORM – OU 7 (Yermo Annex, Nebo Main Base)

OU 7 comprises 18 sites including: CAOCs 9.60, 9.68, and Y-7 TA-12 at the Yermo Annex; and CAOCs 10, N-2 Area 1, 10.38/10.39 Units 1 - 7 (soils only), 10.38/10.39 Unit 7(groundwater), CAOC 7 Stratum 1 (soil vapor and groundwater), 10.12, 10.27, 10.35, 10.37, 10.3, 10.4, 10.5, 10.49, and 10.80, and NPZ-14 groundwater area at the Nebo Main Base. The selected remedies were:

- Monitored natural attenuation (MNA) with LUCs for groundwater at CAOC 10.38/10.39 Unit 7, NPZ-14, and CAOC 7 Stratum 1. SVE to remove contaminants from the vadose zone was also selected for CAOC 7 Stratum 1;
- Removal of lead-contaminated soil from CAOC 10 (in remedial design phase); LUCs including signage (implemented);
- Removal of lead shot and clay target debris, removal of PCB-contaminated soil from CAOC N-2 Area 1 (in remedial design phase). LUCs including signage (implemented);
- LUCs only for CAOCs 9.60, 9.68, 10.12, 10.27, 10.35, 10.37, 10.38/10.39 Units 1 through 6 (and Unit 7 soils), 10.3, 10.4, 10.5, 10.49, and 10.80; and
- NFA for Y-7 TA-12 (Yermo Annex).

Issues Identified during the Fourth Five-Year Review:

- Based on the available data for the three MNA sites, groundwater COC concentrations are not declining at a discernible rate; however, the MNA remedies are protective (no significant plume changes, no migration) at all three sites. A time-frame for MNA to meet the RAOs could not be established.
- The SVE portion of the remedy at CAOC 7 Stratum 1 is in the remedial design phase; implementation of SVE will ensure long-term effectiveness and protectiveness of the MNA groundwater remedy at this site.
- Data gaps in the monitoring well networks at CAOC 7 Stratum 1 and CAOC 10.38/10.39 Unit 7 lent some uncertainty to the MNA data evaluations for these two sites.
- The sources of groundwater contamination are not identified at CAOC 10.38/10.39 Unit 7 or the NPZ-14 groundwater area, lending uncertainty to the MNA data evaluations.

Recommendations and Follow-up Actions:

- Install additional monitoring well(s) at CAOC 7 Stratum 1 and CAOC 10.38/10.39 Unit 7 to improve the MNA monitoring network at these two sites; and
- Investigate the sources of groundwater contamination at CAOC 10.38/10.39 Unit 7 and NPZ-14 groundwater area.

FIVE-YEAR REVIEW SUMMARY FORM – OU 7 (Yermo Annex, Nebo Main Base)

Protectiveness Statement:

The OU 7 remedies are currently protective of human health and the environment. Long-term protectiveness will be better assured with improved understanding of the sources for the contaminated groundwater at two of the MNA sites (CAOC 10.38/10.39 Unit 7 and NPZ-14).

Other Comments:

The exposure assumptions, toxicity data, cleanup levels, and RAOs used for OU 7 at the time of the remedy selection are still valid.

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FIGURES

TABLES (AFTER TEXT)

APPENDICES

ACRONYMS AND ABBREVIATIONS

%	percent
§	Section
1,1-DCE	1,1-dichloroethene
µg/L	micrograms per liter
AGMR	Annual Groundwater Monitoring Report
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
AS/SVE	air sparging/soil vapor extraction
bgs	below ground surface
BMP	Base Master Plan
BEI	Bechtel Environmental, Inc.
BNI	Bechtel National, Inc.
CAOC	CERCLA Area of Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDHS	California Department of Health Services
CDPH	California Department of Public Health
CDWR	California Department of Water Resources
CFR	Code of Federal Regulations
COC	contaminants of concern
DOD	Department of Defense
DON	Department of the Navy
DTSC	Department of Toxic Substances Control
ER	Environmental Restoration
ERFA	Extended RFA
FFA	Federal Facility Agreement
FS	Feasibility Study
ft/ft	feet per foot
FWENC	Foster Wheeler Environmental Corporation
GAC	granular activated carbon
GETS	Groundwater Extraction and Treatment System
GEW	groundwater extraction well

ACRONYMS AND ABBREVIATIONS

GIS	Geographic Information System
HERO	California Department of Toxic Substances Control, Office of Human and Ecological Risk
HHRA	Human Health Risk Assessment
IC	institutional control
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IWTP	Industrial Wastewater Treatment Plant
JEG	Jacobs Engineering Group
LUC	land use control
MCL	maximum contaminant level
MCLB	Marine Corps Logistics Base
MDMC	Marine Depot Maintenance Command
MDAQMD	Mojave Desert Air Quality Management District
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAVFAC SW	Naval Facilities Engineering Command Southwest
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
NPL	National Priorities List
O&M	Operations and Maintenance
OCP	organochlorine pesticide
OEHHA	Office of Environmental Health Hazards Assessments
OHM	OHM Remediation Services Corporation
OTIE	Oneida Total Integrated Enterprises
OU	Operable Unit
PAH	polynuclear aromatic hydrocarbon
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene (perchloroethylene, perc)
pCi/L	picocuries per liter
PRG	Preliminary Remediation Goal

ACRONYMS AND ABBREVIATIONS

RA	remedial action
RAO	Remedial Action Objective
RAR	Remedial Action Report
RCRA	Resource Conservation and Recovery Act
RFA	RCRA facility assessment
RI	Remedial Investigation
ROD	Record of Decision
ROI	radius of influence
RPM	Remedial Project Manager
RSL	Regional Screening Level
RWQCB	Regional Water Quality Control Board
SAP	Sampling and Analysis Plan
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethene
TCRA	time-critical removal action
TEF	Technical and Economic Feasibility
TICs	tentatively identified compounds
TN&A	T N & Associates
TPH	total petroleum hydrocarbons
TPH-d	total petroleum hydrocarbons as diesel
TRPH	total recoverable petroleum hydrocarbons
TtEC	Tetra Tech EC, Inc.
TtFW	Tetra Tech FW, Inc.
URS	URS Corporation
USC	United States Code
U.S. EPA	U.S. Environmental Protection Agency
UU/UE	unlimited use/unrestricted exposure
VOC	volatile organic compound
WDR	waste discharge requirement

1.0 INTRODUCTION

1.1 OVERVIEW

The Department of the Navy (DON) is conducting environmental restoration activities at the Marine Corps Logistics Base, Barstow, California (the MCLB Barstow or the Base), as part of the Installation Restoration Program (IRP). The IRP was established by the Department of Defense (DOD) to identify, evaluate, and control the spread of contaminants from historical hazardous waste sites at military installations. The DON is the lead federal agency responsible for conducting the site investigation and cleanup at the MCLB Barstow. The DON's investigation and cleanup efforts are being conducted in conjunction with the U.S. Environmental Protection Agency (U.S. EPA), Region 9, Regional Water Quality Control Board – Lahontan Region (RWQCB - Lahontan Region), and the State of California Environmental Protection Agency's Department of Toxic Substances Control (DTSC) through a Federal Facility Agreement (FFA). All of these entities are collectively referred to as FFA Parties, and their representatives as FFA Remedial Project Managers (RPMs).

The MCLB Barstow is located in San Bernardino County, California, within the central Mojave Desert approximately 135 miles northeast of Los Angeles (Figure 1-1). The MCLB Barstow consists of two areas: the Yermo Annex, which is 7 miles east of Barstow between Interstates 15 and 40 (Figures 1-1 and 1-2); and the Nebo Main Base, which includes the Rifle Range, is 3.5 miles east of Barstow and intersected by Interstate 40 (Figures 1-1 and 1-3). Soil and groundwater at both Yermo Annex and Nebo Main Base have been impacted by contaminants and are being remediated under the IRP.

This Fourth Five-Year Review Report has been prepared by the Naval Facilities Engineering Command Southwest (NAVFAC SW) in accordance with the DON's Five-Year Review policy (DON, 2011) and U.S. EPA Comprehensive Five-Year Review Guidance (U.S. EPA, 2001). This report summarizes the status and evaluates the continued protectiveness of the remedies in place at the MCLB Barstow.

1.2 PURPOSE OF THE FOURTH FIVE-YEAR REVIEW REPORT

The purpose of this Fourth Five-Year Review Report is to evaluate the implementation and performance of the remedies in place at the MCLB Barstow and to verify whether the remedies continue to remain protective of human health and the environment. This Report includes the methods, findings, and conclusions of the Fourth Five-Year Review Report. In addition, issues found during the review are identified, and recommendations to address them are presented in this Report. This Report also discusses how the issues identified during the Third Five-Year Review have been addressed.

Consistent with Executive Order 12580, the Secretary of Defense is responsible for ensuring that Five-Year Reviews are conducted at all qualifying DOD cleanup sites. The DON has prepared this Fourth Five-Year Review Report pursuant to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA §121 states:

> If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in

> accordance with Sections 104 or 106, the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.

The NCP, 42 United States Code (USC), §9621(c), implementing regulations at 40 Code of Federal Regulations (CFR) Part 300.430(f)(4)(ii), provides:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.

According to the *Navy/Marine Corps Policy for Conducting Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Five-Year Reviews* (DON, 2011):

> a. A Five-Year Review shall be conducted at an Environmental Restoration (ER) site (Installation Restoration and Munitions Response) if the remedial action objectives (RAO) selected for a remedial action will result in any hazardous substances, pollutants, contaminants, or munitions and explosives of concern (MEC) remaining at the site above levels that allow for unlimited use/unrestricted exposure (UU/UE).
>
> b. If a remedial action will result in UU/UE, but the response action will not be completed within five years (if the first remedial site on an installation) or before the next Five-Year Review for other sites on the installation, then DON will conduct Five-Year Reviews during the remedial action operations (RAO) phase, as appropriate. When UU/UE is achieved, it will be documented in one subsequent Five-Year Review.

A Five-Year Review is required at the MCLB Barstow because hazardous substances, pollutants, or contaminants remain on Base above levels that allow for UU/UE. This is the Fourth Five-Year Review Report for the MCLB Barstow.

1.3 REVIEW INITIATION AND COMPLETION

The trigger for the MCLB Barstow Five-Year Review is the date of the prior Five-Year Review signing (December 11, 2012). The Fourth Five-Year Review period is October 2012 through September 2017, and the review must be completed by the end of calendar year 2017.

1.4 DOCUMENT ORGANIZATION

This Five-Year Review Report is organized as follows:

- **Section 1.0 Introduction.** Provides the purpose and authorization for conducting the Five-Year Review, states who conducted the review, the number of the review, when the review was initiated and completed, the review period, trigger and due dates;
- **Section 2.0 Site Organization and Chronology.** Provides the MCLB Barstow IRP organization by Operable Unit (OU) and CERCLA Area of Concern (CAOC), and summarizes the site chronology;
- **Section 3.0 Background.** For Yermo Annex and Nebo Main Base, describes the physical characteristics including regional setting, climate, geology, and hydrogeology. Due to the

number of OUs and CAOCs reviewed, this section directs the reader to where to find additional background information in subsequent sections of the report;

- **Section 4.0 Five-Year Review Process.** Describes the Five-Year Review process, including administrative components, the review team, schedule, community involvement, and the technical assessment process for each of the OUs;
- **Section 5.0 Technical Assessments and Findings – Yermo Annex.** For each CAOC subject to Five-Year Review at the Yermo Annex, describes the RAOs, selected remedies including land use controls (LUCs), remedy implementation, and current status. Reviews issues identified during the prior and current Five Year Reviews. Presents the technical assessment of remedial progress and LUCs compliance, as applicable. Presents recommendations including follow-up actions to ensure protectiveness, including responsible parties and schedule. For CAOCs with LUCs only, provides a review of any actions at those sites during the review period;
- **Section 6.0 Technical Assessments and Findings – Nebo Main Base.** Same as Section 5.0, but for Nebo Main Base sites;
- **Section 7.0 Protectiveness Statements, Issues, and Recommendations.** Provides statement of the short-term and long-term protectiveness of the remedies and summarizes issues and recommendations from Sections 5 and 6;
- **Section 8.0 Next Review.** Proposes the date for the next review; and
- **Section 9.0 References.** Provides a list of documents cited in this report.

2.0 SITE ORGANIZATION AND CHRONOLOGY

2.1 ORGANIZATION OF THE OPERABLE UNITS

To organize the CERCLA site characterization and cleanup process, the MCLB Barstow has been divided into seven OUs. Each OU comprises several CERCLA Areas of Concern (CAOCs), as summarized on Figure 2-1. For the locations of the OUs and CAOCs, please refer to Figures 1-2 through 1-3. A short description of the OUs follows.

- **OU 1** – Addresses groundwater contamination at Yermo Annex:
  - Comprises CAOC 37; historically, three comingled groundwater VOC plumes were present at the Yermo Annex with sources (or potential sources) identified as CAOCs 16, 15/17, 35, and 26.
- **OU 2** – Addresses groundwater contamination at Nebo Main Base:
  - Comprises CAOC 38, consisting of the Nebo North and Nebo South (CAOC 6) plumes.
- **OU 3** – Addresses shallow soil contamination at Yermo Annex:
  - Comprises CAOCs 18, 20, 21, 23, and 34.
- **OU 4** – Addresses shallow soil contamination at Main Base:
  - Comprises CAOCs 2, 5, 9 and 11.
- **OU 5** – Addresses shallow soil contamination at Yermo Annex:
  - Comprises CAOCs 15/17, 16, 19, 22, 24 through 32, 35, and 36.

- **OU 6** – Addresses shallow soil contamination at Nebo Main Base:
  - Comprises CAOCs 1, 3, 4, 6, 7, 8, 10, 12, 13, 14, and 33.
- **OU 7** – Addresses the remaining sites not covered by OUs 1-6:
  - At Yermo Annex, OU 7 comprises CAOCs 9.60, 9.68 and Y-7 TA-12; and
  - At Nebo Main Base, OU 7 comprises CAOCs 10, N-2 Area 1, 10.38/10.39 Units 1-7, CAOC 7 Stratum 1 (soil vapor and groundwater), 10.12, 10.27, 10.35, 10.37, 10.3, 10.4, 10.5, 10.49, and 10.80, and the NPZ-14 groundwater area.

2.2 RECORDS OF DECISION

Records of Decision (RODs) have been signed for OUs 1-6, as follows:

- *Operable Units 1 and 2, Final Record of Decision, Marine Corps Logistics Base, Barstow, California* (OUs 1 and 2 ROD) (DON 1998a);
- *OU 2 Nebo South: Final Record of Decision, Nebo South Groundwater – Operable Unit 2, Marine Corps Logistics Base, Barstow, California* (OU 2 Nebo South ROD) (DON 2006);
- *OUs 3 and 4: Operable Units 3 and 4, Final Record of Decision, Marine Corps Logistics Base, Barstow, California* (OUs 3 and 4 ROD) (DON 1997);
- *OUs 5 and 6: Operable Units 5 and 6, Final Record of Decision, Marine Corps Logistics Base, Barstow, California* (OUs 5 and 6 ROD) (DON 1998b); and
- *OU 7 Final Record of Decision, Operable Unit 7, Marine Corps Logistic Base, Barstow, California* (DON 2014).

Selected remedies can be broadly classified into the following three categories:

1. No further action (NFA);
2. Requiring institutional controls and/or land-use controls (ICs/LUCs) to protect human health and the environment; and
3. Requiring remedial action (RA).

Those CAOCs closed with NFA in their respective RODs do not require Five-Year Reviews. There are no IRP-related restrictions for land use at NFA sites.

CAOC with ICs or LUCs generally require a Five-Year Review to ensure actions at these sites have not violated the intentions of those LUCs, causing the remedy to fail to meet effectiveness or protective standards. A number of CAOCs in the RODs signed in 1997 – 1998 were identified as requiring no action accept Base Master Plan modifications consisting of a site history, location data, description residual contaminants present, and the requirement that the MCLB Barstow Environmental Division be contacted prior to land use changes or invasive activities at these CAOCs. The so-defined BMP modifications serve the same purpose as ICs or LUCs. Therefore, for the purposes of this Five Year Review, CAOCs with selected remedies of “no action with BMP modifications” are identified as CAOCs with “LUCs only” remedies in this report.

Groundwater contamination related to soil CAOCs in OUs 3, 4, 5, and 6 is addressed under OU 1 (Yermo Annex), OU 2 (Nebo Main Base), or OU 7 (Nebo Main Base).

Some of the CAOCs are further divided into strata (discrete lateral areas of contamination) and zones (vertical depths of contamination in soil); where relevant those strata or zones are described in this report.

The CAOCs, OUs to which they belong, and Five-Year Review requirements are summarized in Table 2-1; the organization of OUs and CAOCs is charted on Figure 2-1.

2.3 DESCRIPTION OF OPERABLE UNITS 1 - 7

2.3.1 OU 1 Yermo Annex Groundwater

OU 1 consists of CAOC 37, which is the groundwater at Yermo Annex. The remedy for OU 1 was established in the OUs 1 and 2 ROD signed in 1998. The ROD addresses three comingled groundwater VOC plumes identified as the CAOC 26, Yermo North, and Yermo South plumes. The primary VOCs affecting groundwater are perchloroethylene (also called tetrachloroethene or PCE) and trichloroethene (TCE). Site location and the current extent of the Yermo Annex groundwater contaminant plume are shown on Figure 2-2.

The OU 1 groundwater selected remedy includes removing contaminants by air sparging/soil vapor extraction (AS/SVE) and a Groundwater Extraction and Treatment System (GETS). The GETS includes extraction wells, treatment of extracted groundwater through granular-activated carbon (GAC), and infiltration of treated water back into the aquifer. The remedial systems were installed during 1996 to 1998. The CAOC 26 AS/SVE system was shut down in 1998 after meeting remedial objectives and was decommissioned in March 2015. The CAOC 16 AS/SVE system remains in operation. During the review period, due to significant reductions in the CAOC 26 and Yermo South plumes, only three extraction wells were operated to meet the containment objectives.

The OU 1 remedy also includes:

- GAC treatment systems on two on-Base drinking water production wells and two off-Base residential wells. The GAC treatment systems are maintained and monitored on a regular basis;
- A provision for four off-site extraction wells if hydraulic containment is not achieved at the Base boundary;
- Groundwater monitoring for CAOCs under other OUs, specifically CAOCs 15/17, 16, 23, 26, and 35;
- Monitoring to determine if dissolved metals are site-related contaminants in the CAOC 16 area;
- An institutional control (IC) to prevent use of Base groundwater within contaminated zones unless treated; and
- Notification of San Bernardino County regarding off-Base migration of contaminated groundwater.

2.3.2 OU 2 Nebo Main Base Groundwater

OU 2 consists of CAOC 38, which is the groundwater at Nebo Main Base. CAOC 38 includes two dissolved VOC plumes identified as Nebo North and Nebo South. The selected remedy for the Nebo North Plume is AS/SVE treatment of VOCs in the source area, with natural attenuation to reduce contamination in groundwater downgradient of the source area. The Nebo North remedy also included a "*fail-safe*" pump and treat system (Nebo GETS) to prevent off-Base migration; the Nebo GETS was decommissioned in March 2015 after FFA approval of the recommendation made in the previous five year review. The Nebo North plume source area (former Building 50) was treated with AS/SVE until RAOs were met and the

system shutdown with regulatory approval in April 2011; the system is maintained in standby-mode and periodically operated to address rebound in soil vapor concentrations as a protective measure for groundwater. The Nebo North plume area has decreased significantly with only one well exhibiting VOC levels above the MCLs in November 2016. Site locations and current plume extents are shown on Figure 2-3.

The remedy selected for the Nebo South plume in the OU 2 ROD, signed in 2006, is AS/SVE to reduce soil vapor and groundwater VOC concentrations. A portion of the plume extended off-base; however, off base groundwater concentrations have been below MCLs since at least 2003. Focused operation and major repairs of the AS/SVE system during the review period have resulted in significant reduction of the Nebo South Plume.

The OU 2 remedy also includes:

- LUCs incorporated into the BMP that prevent installation of drinking water wells within the contaminant plume areas, and
- Restriction of land use in the Nebo South area.

2.3.3 OU 3 Yermo Annex Soils

OU 3 consists of the shallow soils at Yermo Annex for which environmental data existed prior to the RI and includes CAOCs 18, 20, 23, and 34. The selected remedies under the OUs 3 and 4 ROD (signed 1997) include LUCs for CAOCs 18, 20, 23, and 34 and concrete caps constructed at CAOCs 20 and 23. The LUCs are implemented through the BMP; the CAOCs 20 and 23 caps are regularly maintained. Groundwater monitoring for CAOCs 20 and 23 is performed annually under OU 1. Locations are shown on Figure 1-2.

2.3.4 OU 4 Nebo Main Base Soils

OU 4 is the shallow soils at Nebo Main Base for which data existed prior to the RI and includes CAOCs 2, 5, 9, and 11. NFA was selected for CAOC 9; LUCs only were selected for CAOCs 2, 5, and 11. Locations are shown on Figure 1-3.

2.3.5 OU 5 Yermo Annex Soils

OU 5 consists of the shallow soils at Yermo Annex for which data did not exist prior to the RI and includes CAOCs 15/17, 16, 19, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 35, and 36. CAOC 25 was eliminated from the RI as not requiring further investigation. The remedies selected in the OUs 5 and 6 ROD for this OU includes:

- NFA for CAOCs 19, 22, 24, 27, 28, 29, 30, 31, 32, 35 Stratum 1 (east portion) and Stratum 2, and 36;
- LUCs only for CAOCs 15/17, 21, and 26;
- LUCs for CAOC 16, consisting of preservation of the existing hardstand (vadose zone and groundwater under OU 1);
- A cap and engineering controls (ECs) were selected for CAOC 35 Stratum 1 Zone 1 which is an inactive Class III Landfill located in the northeastern portion of the Yermo Annex; and
- LUCs to prevent land use change without prior review were recently implemented at CAOC 32 Stratum 2 as recommended in the Third Five Year Review (DON 2012).

Site locations for CAOCs with remedies in place including LUCs-only are shown on Figure 1-2.

2.3.6 OU 6 Nebo Main Base Soils

OU 6 is the shallow soils at Nebo Main Base for which data did not exist prior to the RI and consists of CAOCs 1, 3, 4, 6, 7, 8, 12, 13, 14, and 33. Of these, CAOC 33 was eliminated from the RI as not requiring further investigation. The selected remedies under the OUs 5 and 6 ROD for this OU include:

- NFA for CAOCs 1, 3, 4, 6, 8, 12, and 13
- LUCs only for CAOCs 1, 3, and 14;
- LUCs and ECs were selected and implemented for the native soil caps at CAOC 7 Strata 1 and 2. The cap and ECs are regularly maintained; groundwater monitoring is performed under OU 2; and
- Groundwater cleanup at CAOC 6 ("Nebo South" plume) is covered under OU 2.

Site locations for CAOCs with remedies in place including LUCs-only are shown on Figure 1-3.

2.3.7 OU 7 Yermo Annex and Nebo Main Base Soils and Groundwater

OU 7 addresses the remaining sites not covered by the OUs 1-6 RODs and is comprised of 18 sites:

- Soil sites with LUCs only at Yermo Annex including CAOCs 9.60 and 9.68 (Figure 1-2).
- NFA at Y 7 TA-12 (Yermo Annex) (not shown on a figure as no five-year review is required);
- Soil sites with LUCs only at Nebo Main Base including CAOCs 10.38/10.39 Units 1-6, 10.12, 10.27, 10.35, 10.37, 10.3, 10.4, 10.5, 10.49, and 10.80 (Figure 1-4);
- Soil remediation with LUCs was selected for CAOCs 10 and N-2 Area 1 (Figure 1-4); and
- Three groundwater sites at Nebo Main Base including CAOC 7 Stratum 1 (soil vapor and groundwater), CAOC 10.38/10.39 Unit 7, and the NPZ-14 groundwater area (Figure 1-4). Monitored natural attenuation (MNA) with LUCs to prevent groundwater use was selected as the remedy for the three groundwater sites. Additionally, SVE to address soil vapor contamination was selected for CAOC 7 Stratum 1.

2.4 Governing Plans for Remedies In Place

The current governing plans for the remedies in place at OUs 1 – 7 are referenced in the technical assessment sections for Yermo Annex (Section 5) and Nebo Main Base (Section 6).

2.5 Operable Unit Chronologies

The chronology presented in Table 2-2 identifies significant events pertaining to OUs 1-7. The history of the IRP prior to the designation of OUs is also included. Additional Base history is available in the RODs or other documents available from the DON's Administrative Record for the MCLB Barstow.

3.0 BACKGROUND

3.1 History of The MCLB Barstow

The MCLB Barstow was originally established at the Nebo Main Base location as the United States Marine Corps Depot of Supplies, in December 1942, the Depot served as a storage site for supplies and equipment needed for Fleet Marine Forces in the Pacific theater during World War II. In October 1946,

the base had outgrown its facilities and 2,000 acres of land approximately seven miles east of the Nebo Main Base were annexed from the United States Army (Yermo Annex).

In March 1961, the Depot Maintenance Activity was established at the Base. In November 1978, the Base was re-designated to its present title of the MCLB Barstow to emphasize its broad logistics support mission. The MCLB Barstow consists of the Nebo Main Base and the Yermo Annex, both of which are used for the staging, storage, and maintenance of supplies and equipment used by the United States Marine Corps and other branches of the Department of Defense.

3.2 PRIOR INVESTIGATIONS AND REGULATORY ACTION

Beginning in the mid-1980s, the DON conducted a series of studies at the MCLB Barstow as part of the DON Assessment and Control of Installation Pollutants Program to determine the presence of contamination in soil and groundwater. An initial assessment study was conducted to evaluate past practices of hazardous waste handling, storage, and disposal and to identify areas representing a potential threat to human health and the environment. The initial assessment study identified 33 potential sites of contamination through record searches, employee interviews, and site surveys. These sites are referred to as CAOCs and are currently being addressed under the base CERCLA program.

On 15 November 1989, the EPA placed the MCLB Barstow on the National Priorities List due to the presence of soil and groundwater contamination on the Base. Environmental contamination at the MCLB Barstow is being addressed through the DOD IRP under the CERCLA with the exception of contamination associated with underground fuel tanks, which is being addressed outside the IRP under regulatory oversight of the RWQCB - Lahontan Region.

A FFA under CERCLA §120 was signed on 24 October 1990 by the DON, the U.S. EPA, the DTSC, and the RWQCB - Lahontan Region. The FFA provides a procedural framework for the signatories to ensure implementation of response actions to achieve appropriate cleanup levels.

A Resource Conservation and Recovery Act (RCRA) facility assessment (RFA) was begun in 1991 to comply with the schedule set forth in the 1990 FFA. The RFA process at the MCLB Barstow included a preliminary review, visual site inspection, and sampling visits to identify releases or potential releases that may require further action or investigation. The RFA was completed in 1997; based on the findings of the RFA, an Extended RFA (ERFA) was performed from 2000 to 2001. Subsequent to the RFA/ERFA reports, seven OUs were established and the environmental investigation and cleanup activities were shifted to the CERCLA program. Remedial investigations and feasibility studies (RI/FS) were conducted by the DON for OUs 1 – 7, leading to the RODs listed in Section 2.2.

3.3 SITE PHYSICAL SETTING

This section describes the physical setting and conceptual site model of the Yermo Annex and Nebo Main Base. The MCLB Barstow location is shown on Figure 1-1, and the individual bases are shown on Figures 1-2 and 1-3.

3.3.1 Climate

The Barstow area is characterized by intense summer heat; minimal rainfall and low humidity; strong winds; periodic thunderstorms; and flash floods. Factors that tend to moderate the weather in other areas of California are absent in the Mojave Desert, resulting in an extreme climate. Temperatures range from 12 to 114 degrees Fahrenheit annually. Winds near Barstow are primarily from the west at an average annual speed of approximately 11 miles per hour.

Annual average precipitation in the Barstow area is about 4 inches per year; however, considerable year-to-year variability results in the variable discharge conditions of the Mojave River and fluctuations in the groundwater table. Precipitation in the Mojave Desert occurs primarily with the passing of weakened winter fronts from the north and the periodic development of brief, localized thunderstorms during the summer. Periodic episodes of intense rainfall create flash flood conditions (referred to as flood flows) in the Mojave River and in the intermittent washes near the Nebo Main Base and Barstow (DON, 1998b).

3.3.2 Topography

Regional topography near Barstow is dominated by broad, gently sloping surfaces formed by coalescing alluvial fans and the isolated fronts and peaks of the region's fault block mountains (DON, 1998b). Nebo Main Base was constructed near the Mojave River, where topography is relatively flat. The topographic surface at Nebo Main Base slopes north-northeast to the Mojave River. The topography overlying the Nebo Main Base North VOC groundwater plume is generally flat, with elevations between 2,025 and 2,050 feet above mean sea level (amsl) (Bechtel Environmental, Inc., [BEI] 2003).

The topography at Yermo Annex gently slopes to the south from the Calico Mountains and east from Elephant Mountain, towards the Mojave River. Topographic elevations at Yermo Annex are relatively flat and generally range between 1,950 and 1,960 feet amsl (U.S. Geological Survey [USGS] 2012b and 2012c).

3.3.3 Geology and Hydrogeology

The MCLB Barstow is within the Mojave Desert Geomorphic Province (DON, 1998b). This province is a wedge-shaped unit bounded by the Garlock Fault on the north and the San Andreas Fault on the southwest. The approximate eastern boundary is the Bristol-Granite Mountains fault zone in the eastern Mojave Desert. At this diffuse boundary, the Mojave Desert merges with the Basin and Range Geomorphic Province.

Regional geology is characterized by the following stratigraphic units: a basement complex of pre Tertiary granitic and metamorphic rocks; undifferentiated Tertiary continental volcanic and sedimentary rocks; Tertiary-Quaternary older and younger alluvial-fan deposits; Quaternary older alluvium; Quaternary younger and recent Mojave River alluvium.

The MCLB Barstow is located within the Mojave River Valley Basin hydrogeologic system, which consists of two primary aquifers: the regional aquifer composed of Pliocene and younger alluvial fan deposits and; the Mojave River aquifer composed of Pleistocene and younger river channel and floodplain deposits (California Department of Water Resources [CDWR], Planning and Local Assistance, 2004). The regional aquifer underlies and surrounds the floodplain aquifer. Most of the water from production wells in the area is from the Mojave River aquifer. Further detail on the geology of the MCLB Barstow is provided in the remedial investigation reports and ROD.

The MCLB Barstow is within the Mojave Basin Area, an adjudicated groundwater basin. The annual Watermaster report for 2015 - 2016 illustrates the region-wide groundwater elevation declines in the Baja subarea of the Basin in which the Base is located (Mojave Water Agency, 2017). The report indicates water levels in the Baja subarea show continued declines, without significant recovery after storms, due to over pumping and limited recharge. Further detail on the hydrogeology at the MCLB Barstow Yermo Annex and Nebo Main Base is provided in the annual groundwater monitoring reports for OUs 1 – 7 (AGMRs).

Groundwater contaminant plumes are shown on Figure 2-2 for Yermo Annex and Figure 2-3 for Nebo Main Base. Groundwater elevation contour maps for Yermo Annex and Nebo Main Base are provided on Figures 3-1 and 3-3, respectively. Groundwater hydrographs (groundwater levels over time) for Yermo Annex and Nebo Main Base are provided on Figures 3-2 and 3-4, respectively.

4.0 FIVE-YEAR REVIEW PROCESS

The U.S. EPA's Comprehensive Five-Year Review Guidance (U.S. EPA, 2001) and DON Policy for Conducting CERCLA Statutory Five-Year Reviews (DON, 2011) outline the Five-Year Review process and the elements required. This section of the document describes the process and presents the data reviewed.

4.1 ADMINISTRATIVE COMPONENTS

The required administration components include the notification of potentially interested parties of the initiation of process, identification of the Five-Year Review team, and schedule for the Five-Year Review.

4.1.1 Notification of Potentially Interested Parties of Initiation of Review Process

Public notices were placed in local newspapers to inform the public about the ongoing Fourth Five-Year Review process. The FFA signatories were notified prior to placing the public notices. Proofs of publication are included in Appendix A *(to be completed in final)*.

4.1.2 Five-Year Review Team

This Five-Year Review was conducted by OTIE under Contract N39430-16-D-1818, Contract Task Order 0006, for the NAVFAC SW. The NAVFAC SW RPM, Ms. Lindsey White, was responsible for the initiation and completion of this Five Year Review. Base access and interviews for the Five-Year Review were coordinated through Mr. James Debenedetti, IRP Manager, at the MCLB Barstow Environmental Division. Contact information for the aforementioned individuals is provided below:

Ms. Lindsey White, PE, RPM
NAVFAC Southwest Central IPT
937 North Harbor Drive
Building 1, Floor 3, Room 323
San Diego, CA 92132
Office: (619) 532-4451

Mr. James De Benedetti, ER/IR Program Manager
Marine Corps Logistics Base Barstow
Environmental Division – I & L Division
Building 196
Barstow, CA 92311-5050
Office: (760) 577-6982

The Five-Year Review report was submitted to the FFA regulatory team for review and comment; comments were received and addressed by the DON under the FFA agreement process. Comments and responses to comments are incorporated into Appendix H.

The FFA regulatory team includes the following:

Ms. Mary T. Aycock, RPM
U.S. EPA, Region 9
SFD-8-1, Attn: Mary Aycock
US Environmental Protection Agency
75 Hawthorne Street
San Francisco, CA, 94105
Office: (415) 972-3289

Ms. Soad Hakim, RPM
California Environmental Protection Agency
Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630
Office: (714) 484-5381

Mr. Alonzo Poach, RPM
California Regional Water Quality Control Board – Lahontan Region
Victorville Branch Office
15095 Armargosa Road
Building 2, Suite 210
Victorville, CA 92392
Office: (760) 241-7365

4.2 OUTLINE OF COMPONENTS AND SCHEDULE OF FIVE-YEAR REVIEW

The Five-Year Review consists of the following tasks:

- Community involvement via the public notifications in the local newspapers;
- Document review;
- Data review;
- Site inspections;
- Technical assessments; and
- Five-year Review Report development and review.

These tasks were accomplished during the January - November 2017 time period.

4.2.1 Community Involvement

Public notifications were placed in two local newspapers to inform the public about the Fourth Five-Year Review, including schedule for completion and how to access the Five-Year Report (Appendix A). Copies of the Fourth Five-Year Review Report will be placed into the Information Repository at the MCLB Barstow, which can be accessed by contacting Mr. James De Benedetti at the Base Environmental Division at (760) 577-6982.

4.2.2 Document Review

This Five-Year Review consists of a review of relevant documents including annual O&M and monitoring reports, landfill cap repair reports, and well installation reports. A list of references cited in the subject Five-Year Review is included in Section 9.0.

4.2.3 Data Review and Evaluation

Monitoring, remedial systems O&M information, performance data and other information were reviewed for this Five-Year Review including the following:

- Groundwater monitoring data for OUs 1, 2, and 7;
- Soil vapor monitoring data for OUs 1, 2, and 7;
- O&M costs and performance data for four active remediation systems; and
- O&M costs and performance data for four landfill cap systems.

4.2.4 Findings from Site Interviews, Inspections, and Information Requests

Site inspections were conducted and 13-14 March 2017 and 13 June 2017. Information was gathered from the MCLB Barstow Environmental Division, Public Works, Marine Depot Maintenance Command (MDMC), and the O&M contractors regarding the landfill sites and remedial systems.

Findings from the site inspection for those sites with site developments, defined as any construction altering the site since the last Five-Year Review, are summarized on Table 4-1. Site inspection logs and photographs for CAOCs 16, 20, 23, 32, and 35 at Yermo Annex, and CAOC 7 and Nebo South at Nebo Main Base, are provided in Appendix B. As documented on Table 4-1, site development activities for these CAOCs were coordinated through the MCLB Barstow Environmental Division as required by the BMP.

4.3 TECHNICAL ASSESSMENT PROCESS

The technical assessment of the protectiveness of remedies implemented at the CAOCs is based on answering the following three questions:

Question A: Is the remedy functioning as intended by the RODs?

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Question C: Has any other information been found that could impact the protectiveness of the remedy?

The technical assessment requires evaluation a number of considerations, as discussed below. A technical assessment was performed for CAOCs with remedies in place that require RA performance monitoring.

4.3.1 Question A: Is The Remedy Functioning As Intended By The ROD(s)?

The U.S. EPA's Comprehensive Five-Year Review Guidance (2001) identifies several areas that need to be considered when evaluating whether the remedy selected in the decision documents is functioning as designed. Areas of consideration include:

- **Remedial Action Performance** – Is the remedy operating as designed?
- **System O&M** – Will the system and current O&M activities maintain the effectiveness of the response actions?
- **Cost of System O&M** – How do planned costs compare to actual costs?
- **Institutional Controls and Other Measures Implementation** – Are these functioning as planned?
- **Monitoring Activities** – Do the current monitoring activities provide adequate information to determine the protectiveness and effectiveness of the remedy implemented?

- **Optimization Opportunities** – Are there areas for improvement? and
- **Early Indications of Potential Issues** – Are there problems that could lead to the remedy being not protective or that suggest protectiveness is at risk unless changes are made?

4.3.2 Question B: Are The Exposure Assumptions, Toxicity Data, Cleanup Levels, And RAOS Used At The Time Of The Remedy Selection Still Valid?

When evaluating the validity of the selected remedy, it is important to consider changes in standards, newly promulgated standards or "to be considered" (TBC) standards, changes in exposure pathways, changes in land use, or if any new contaminants and/or contaminant sources and/or remedy by-products have been identified.

4.3.3 Question C: Has Any Other Information Been Found that Could Affect the Protectiveness of the Remedy?

The final question in conducting a technical assessment of the selected remedy includes the evaluation of any new information that may have become available that could call into question the protectiveness of the remedy selected. Situations include ecological risks, unidentified risks from natural disasters (for example, flooding), or land use changes.

In accordance with DON policy, if the Five-Year Review determines that the remedy or the RAOs are no longer protective, then the Five-Year Review Report will make recommendations concerning the steps necessary to achieve protectiveness (DON, 2011).

4.3.4 Additional Considerations/Reviews

For OU 1, the OUs 1 and 2 ROD required the additional evaluations be performed during the Five-Year Review:

- Evaluation of metals contamination in groundwater downgradient of CAOCs 16;
- Evaluation of the effectiveness of the AS/SVE and GETS in reducing groundwater and vadose zone contamination at CAOC 16 (although reduction of vadose zone contamination is not an RAO for CAOC 16) and the need for additional investigation; and
- Evaluation of the effectiveness of the CAOC 26 AS/SVE system in reducing VOC levels in the shallow subsurface (this was not specifically required in the five-year review, but was required as part of the ROD). Because the CAOC 26 AS/SVE system was shut down in 1998 after achieving RAOs, the ongoing groundwater and soil vapor monitoring data were reviewed.

For OU 2, the Technical and Economic Feasibility Report for the Nebo North AS/SVE system (OTIE, 2011) required the evaluation of the ongoing soil vapor and monitoring program for the Nebo North plume as part of this Five-Year Review.

The required additional evaluations for OU 1 and OU 2 were performed as part of this Five Year Review and are discussed in the technical assessment report Sections 7.0 and 8.0, respectively.

The OUs 3 and 4 ROD (DON, 1997) and OUs 5 and 6 ROD (DON, 1998b) selected the No Action Alternative for several CAOCs. When selecting this alternative, the RODs specifically stated that the No Action Alternative does not involve institutional or engineering controls, containment, excavation, or treatment. However, at the conclusion of the selection reasoning, the RODs indicated that for certain CAOCs, the BMP should describe the history of the CAOC and specify that any actions planned in these areas or changes in the site use should be coordinated and reviewed by the MCLB Barstow

Environmental Division. In this Five-Year Review, the phrase ”NFA with BMP amendments” is used to refer to the No Action CAOCs where Environmental Division oversight is required to maintain the conditions of the NFA decision. This remedy is essentially a land-use control remedy and is reported as such in this Five-Year Review report.

The BMP was updated by amendment in 2010 to include LUCs for OUs 1 – 6, including the procedures for the MCLB Barstow Environmental Division to follow in evaluating proposed changes to land use that may pose a risk to site workers (e.g., during construction activities) or substantially change the conditions supporting the no action decision.

Similarly, the BMP amended in 2015 to incorporate the CAOCs with LUCs-only remedies under the OU 7 ROD (DON, 2014). The intent of the LUCs-only remedies are to ensure that future Base activities do not pose unacceptable risks to human health or the environment because of low-levels of contaminants left in place at these sites. CAOC 32 Stratum 2 (OU 5) was also included in the 2015 BMP update to address contamination remaining in place, as recommended in the Third Five-Year Review (DON, 2012).

The CAOCs with LUCs only remedies (including “NFA with BMP Amendments” sites) were reviewed for any substantial changes in land use or site conditions in this Five-Year Review (*see* Sections 7.8 and 8.8 for Yermo Annex and Nebo Main Base CAOCs, respectively).

4.4 Review of Operations and Maintenance Costs

The operations, maintenance, monitoring and repair costs were obtained for the CAOCs with construction-completed remedies; these included CAOCs 7, 20, 23, 26, 35, 37 and 38. The cost summaries including comparison with the original estimated costs under the ROD, last five-year review, and this review are summarized in Tables 4-2 (Yermo Annex) and 4-3 (Nebo Main Base). Costs for remedial system equipment repairs and upgrades performed during the review period are generally shown separately. In prior reviews, the electrical costs for active remedial systems were paid by the MCLB Barstow and were not reported. This changed in 2008 when the IRP began to support those costs. The electrical costs are incorporated into the O&M average costs for this review. Further information on the O&M costs for the remedial systems in place for OUs 1 and 2 is presented in Appendix D (see Technical Assessment Report D-2).

4.5 Review of Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs

Part of the technical assessment is to evaluate whether the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy are still valid (“Question B”). This review was conducted in accordance with the DON *Policy for Conducting CERCLA Statutory Five-Year Reviews* (DON, 2011) and *U.S. EPA’s Comprehensive Five-Year Review Guidance* (EPA, 2001). When evaluating this question, it is important to consider changes in standards, newly promulgated standards or TBC standards, changes in exposure pathways, changes in land use, or if any new contaminants and/or contaminant sources and/or remedy by/products have been identified.

Question B was addressed by OUs as grouped within the RODs. Applicable or relevant and appropriate requirements (ARARs) provided in the OUs 1 - 6 RODs were reviewed and evaluated to determine if any modifications of these ARARs had occurred that might affect the RAOs in the ROD or operation of the various groundwater treatment systems had occurred since the ROD was finalized. Chemical-specific ARARs including federal or state drinking water MCLs, published federal or state soil screening levels, and discharge limits in the RWQCB-Lahontan District Basin Plan and other RWQCB resolutions originally cited in the RODs were evaluated for revisions. Additionally, the Mojave Desert Air Quality Management

District (MDAQMD) mass discharge limits were reviewed because these limits are used to evaluate compliance of the AS/SVE systems with MCLB Barstow's general permit from the MDAQMD. Supporting documentation for the review of toxicity data, cleanup levels, and RAOs is provided in Appendix C.

4.5.1 Review of Exposure Assumptions

The MCLB Barstow remains an active military facility. The ICs/LUCs are enforced and the MCLB Barstow Environmental Division reviews proposed construction or other changes on CAOCs where such activities could affect the selected remedy.

Since the prior Five-Year Review, based on the technical assessments performed, there have been no significant changes in exposure pathways or land use that would negate or degrade the assumptions of the risk assessments performed to support selection of the RAOs. A detailed review of exposure assumptions for groundwater, vapor, soil, and wastes left in place is provided in Appendix C.

4.5.2 Review of Toxicity Data, Cleanup Levels, and RAOS

The cleanup levels and RAOs established in the RODs for OUs 1-7 were compared to May 2016 U.S. EPA and State of California regional screening levels (RSLs) and promulgated standards; details are provided in Appendix C.

Additionally, the RAOs for OUs 1 and 2 include substantive compliance with discharge limits for discharge of treated water to the ground per the most recent general waste discharge requirements of the RWQCB-Lahontan Region. The O&M plan for the OUs 1 and 2 remedies requires that VOC emissions from remedial system be in substantive compliance with the MCLB Barstow's general air quality permit requirements. Substantive compliance with these standards is reviewed in Appendix C (*see* Section 3.4).

4.5.3 New Contaminants or Contaminant Sources

During this five-year review period, the DON conducted groundwater sampling to determine if Polyfluorinated Alkyl Substances (PFAS) were present in groundwater at the MCLB Barstow. The sampling was conducted at the request of the DTSC.

During 2015 – 2016, the DON conducted a review of the Navy's Administrative Record for the MCLB Barstow and interviewed Base personnel, including the IRP Program Manager and the Training Chief at MCLB Barstow Fire and Emergency Services to identify potential sources of Polyfluorinated Alkyl Substances (PFAS) from site-related activities. Locations where aqueous film forming foam (AFFF) or PFAS-containing mist suppressants for chromium plating may have been used, released, or stored were identified and groundwater monitoring wells were selected at or near these locations (OTIE 2016a).

Eighteen wells were selected for PFASs sampling due their proximity to the potential sources of PFASs contamination. The groundwater sampling was completed during May 2016; six of the 18 wells were resampled in August 2016 along with two additional wells were added to assess and further delineate the potential presence of PFASs in the northern part of the Nebo Main Base. The resulting groundwater data were compared to the EPA lifetime health advisory level ("screening levels") for PFAs.

PFASs were not detected above the screening levels in groundwater samples from the Yermo Annex nor in samples from the southern portion of Nebo Main Base. However, PFASs were detected above the screening levels in groundwater samples from wells in the northern part of the Nebo Main Base including on-Base, in the northwest corner of the Base. The source of the detected PFAs may include former industrial operations and wastewater treatment plant. At Nebo Main Base, LUCs are in place to

prevent potable use of groundwater (DON 1998; DON 2014b); therefore, exposure to PFAs in drinking water is not a completed exposure route for on-Base personnel. The DON is conducting follow-on review to further evaluate PFAs and the potential off-Base exposure pathway.

4.5.4 Remedy By-Products

The implemented remedies are not expected to produce by-products. In 2002, the California Department of Health Services (now California Department of Public Health [CDPH]) expressed a concern regarding excess nitrate or nitrite from GAC treatment on the Yermo Annex drinking water production wells. This issue, now resolved, is discussed briefly below.

4.5.4.1 Excess Nitrate or Nitrite from GAC Treatment

The MCLB Barstow operates the YDW drinking water production wells and GAC treatment system under a permit from the California Water Resources Board Division of Drinking Water (DDW); the permit requires monthly monitoring of VOCs. The MCLB Barstow added nitrate and nitrite analyses to the monthly monitoring program in 2002 in response to the California Department of Health Services (CDHS) stated concern that GAC treatment systems can generate excess nitrate or nitrite (CDHS 2002).

The long-term monitoring data for the YDW treatment system indicated nitrate and nitrite concentrations were consistently below the state action levels of 45 milligrams per liter (mg/L) (for nitrate as nitrate) and 1 mg/L (for nitrite as nitrogen). Based on the data, nitrate/nitrite monitoring frequency was reduced by the MCLB Barstow to once per year beginning in 2012. During the review period, nitrate and nitrite results were below the state action limits.

5.0 TECHNICAL ASSESSMENTS AND FINDINGS – YERMO ANNEX

The technical assessment and findings for each site undergoing five year review are summarized in Tables with five parts corresponding to the review activities. The assessments are based on October 2012 – March 2017 data, site inspections, review of relevant documents, and interviews. Each table is organized as follows:

- **Part 1:** Review of Remedial Action Objectives, Selected Remedies, Implementation, Status, and Changed Conditions Since ROD signing and Prior Review;
- **Part 2:** Progress Since Last Review (2012);
- **Part 3:** Technical Assessment. The three review questions are addressed in this part of the table;
- **Part 4:** Current Issues, including the potential for the identified issues to affect short-term and long-term protectiveness; and
- **Part 5:** Recommendations and Follow-up Actions (implementation by the DON with oversight by the FFA regulators); also included is a schedule and any relevant comments.

CAOCs at Yermo Annex requiring Five-Year Review include those with remedial actions and IC/LUCs as summarized in Table 5-1. Site locations and information are provided on Figures 5-1 through 5-6. The following sites were reviewed:

- CAOC 37 (OU 1) groundwater, including the Yermo North plume groundwater extraction and treatment system (GETS), and AS/SVE remedy, plus evaluation of vadose zone and groundwater contamination related to CAOCs 16, 15/17, 35, and 23. The OU 1 five year review summary is presented on Table 5-2, with supporting technical assessments (data reviews, trends analysis, etc.) provided in Appendix D.

- Cap remedies at CAOCs 16 (OU 5), 20 (OU 3), 23 (OU 3), and 35 (OU 5) are reviewed in Tables 5-3 through 5-6. Supporting data analyses for CAOC 20 are provided in Appendix F.
- CAOCs with LUCs only are reviewed for current status and any changes during the review period in Table 5-7.

6.0 TECHNICAL ASSESSMENTS AND FINDINGS - NEBO MAIN BASE

CAOCs at Nebo Main Base requiring a Five-Year Review include those with remedial actions, LUCs, and NFAs with BMP modifications, and are listed in Table 6-1. Site locations and information are provided on Figures 6-1 through 6-10. The Fourth Five-Year Review technical assessments are summarized in tables as described in Section 5.0. The following sites were reviewed:

- CAOC 38 (OU 2) groundwater, including Nebo North, Nebo South remedies (Table 6-2), with detailed assessments in Appendix E for both sites;
- CAOC 7 (OU 6) cap remedies (Table 6-3);
- Groundwater remedies at CAOC 7 Stratum 1, CAOC 10.38/10.39 Unit 7, and NPZ-14 (OU 7) are reviewed in Tables 6-4, 6-5, and 6-6, respectively. Statistical assessments of the three MNA sites groundwater data are provided in Appendix G;
- Soil remedies at CAOC 10 and CAOC N-2 Area 1 (OU 7) are reviewed in Table 6-7 (these remedies are in the remedial design phase); and
- Nebo Main Base CAOCs with LUCs only are reviewed for current status and any changes during the review period in Table 6-8. Figures 6-9 and 6-10 provide locations and LUC boundaries.

7.0 PROTECTIVENESS STATEMENTS, ISSUES AND RECOMMENDATIONS

The issues identified, current and long-term protectiveness statements, and recommendations for each of the CAOCs reviewed during the technical assessment of the Yermo Annex remedies-in-place are summarized in Table 7-1, and for Nebo Main Base in Table 7-2.

8.0 NEXT REVIEW

The next Five-Year Review for OUs 1-7 is required to be completed by December 31, 2022. The trigger to initiate the Fifth Five-Year Review is five years from the signature date of this review. The review period will be October 2017 through September 2022.

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FIGURES

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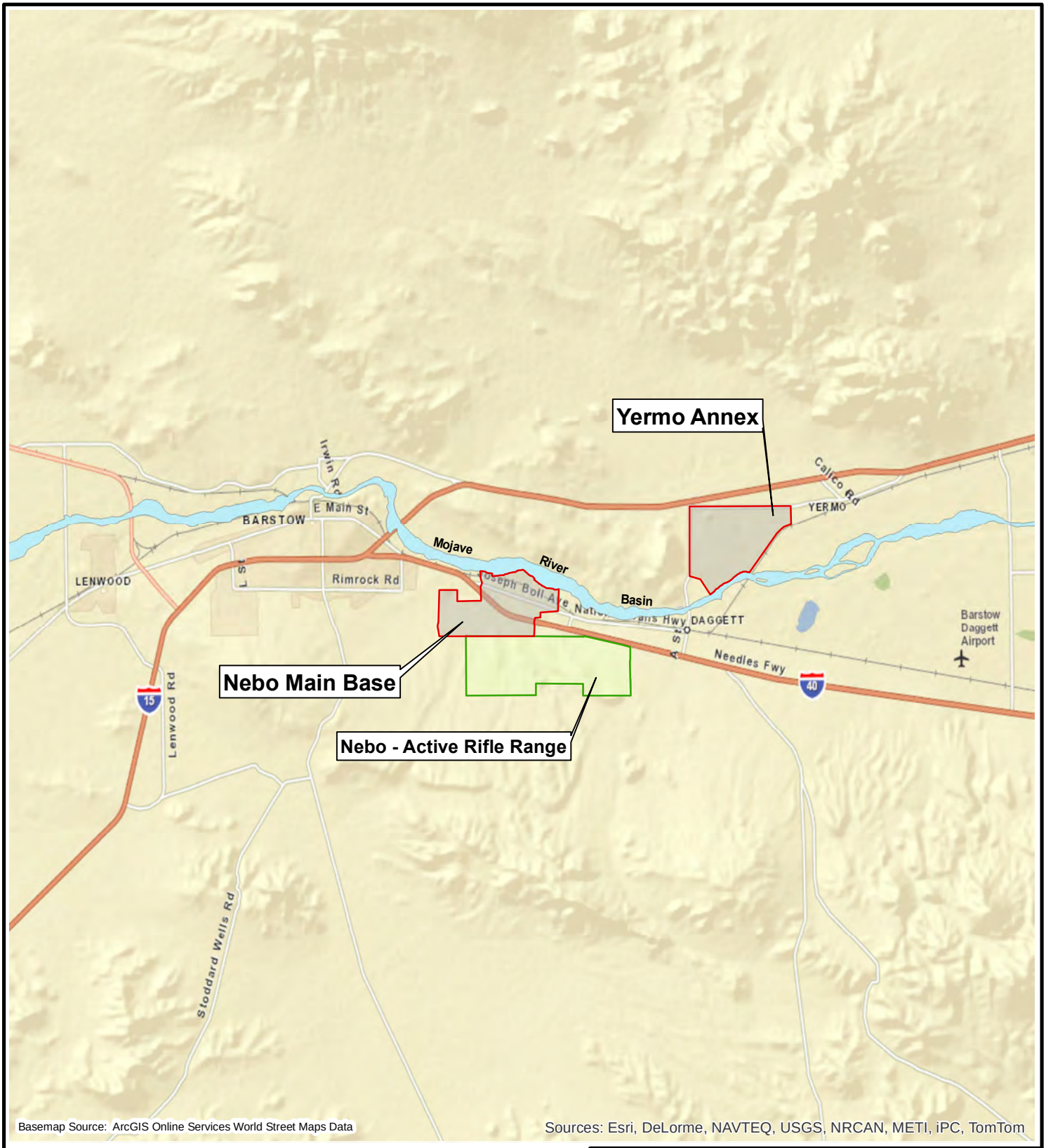


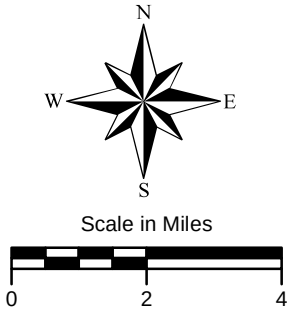


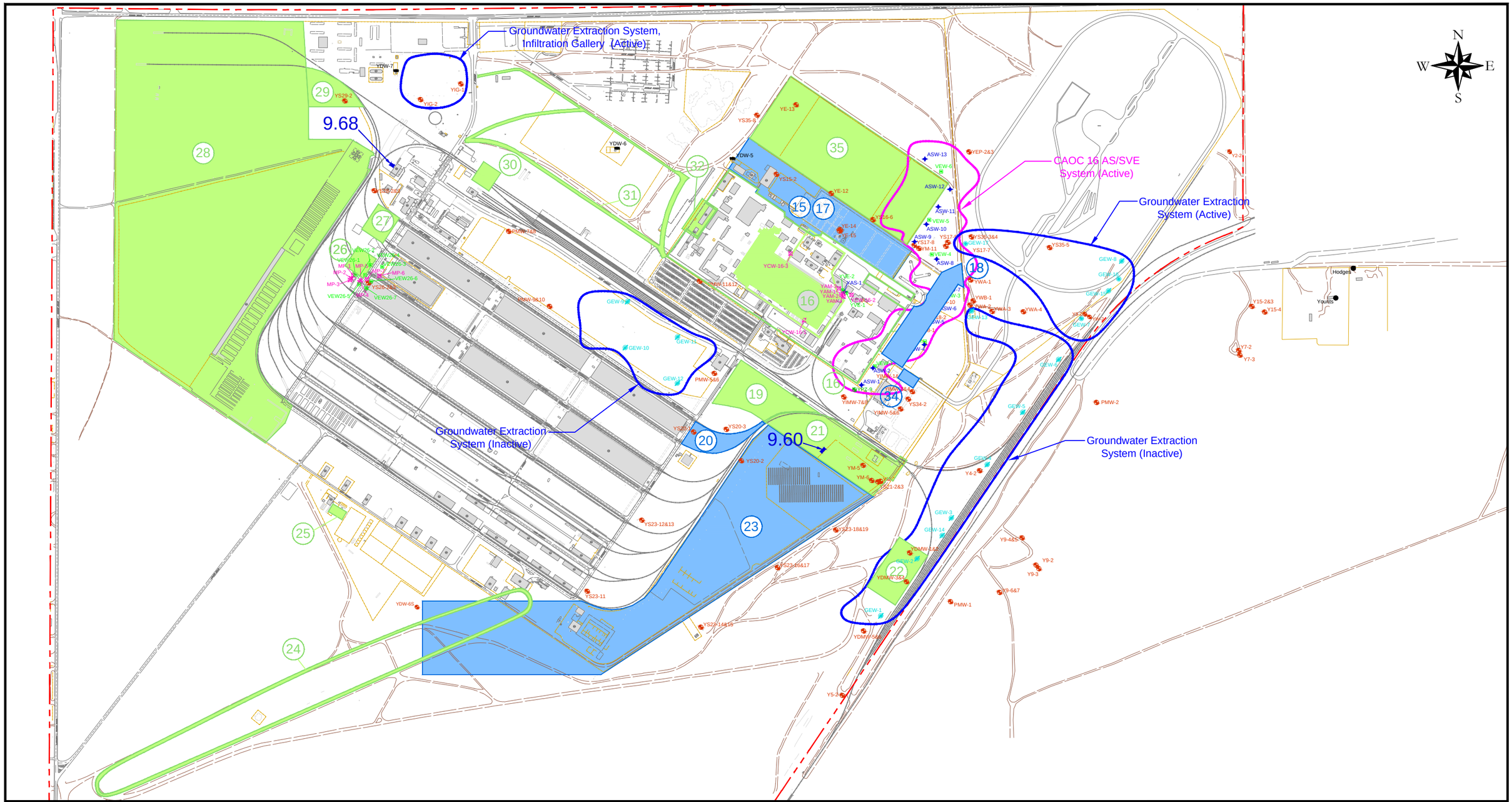
Figure 1-1
MCLB Barstow Vicinity Map

Marine Corps Logistics Base
Barstow, California

OTIE
An Oneida Nation Company

Date:
May 31, 2017

File:
Figure 1-1 - MCLB Barstow Vicinity Map.mxd



Legend

- Paved Road
- Dirt Road
- Railroad Tracks
- Fence Line
- Base Boundary
- Remediation Line
- Operable Unit 3 (CAOC ##)
- Operable Unit 5 (CAOC ##)
- 9.60 — Operable Unit 7 (CAOC ##)
- YMP-2 — Groundwater Monitoring Well
- YPZ-2 — Piezometer
- YDW-5 — Base Groundwater Supply Well
- GEW-7 — Groundwater Extraction Well (Active)
- GEW-2 — Groundwater Extraction Well (Inactive)
- VEW-1 — Vapor Extraction Well
- ASW-1 — Air Sparge Well
- YCW16-1 — Combination Well
- Younts — Residential Well

Notes

1) AS/SVE = air sparge / soil vapor extraction
   CAOC = CERCLA Area of Concern
   CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act

Approximate Scale in Feet

0 900 1800

Figure 1-2
OUs 3, 5, 7 CAOCs and OU 1
Groundwater Remedial System
Locations

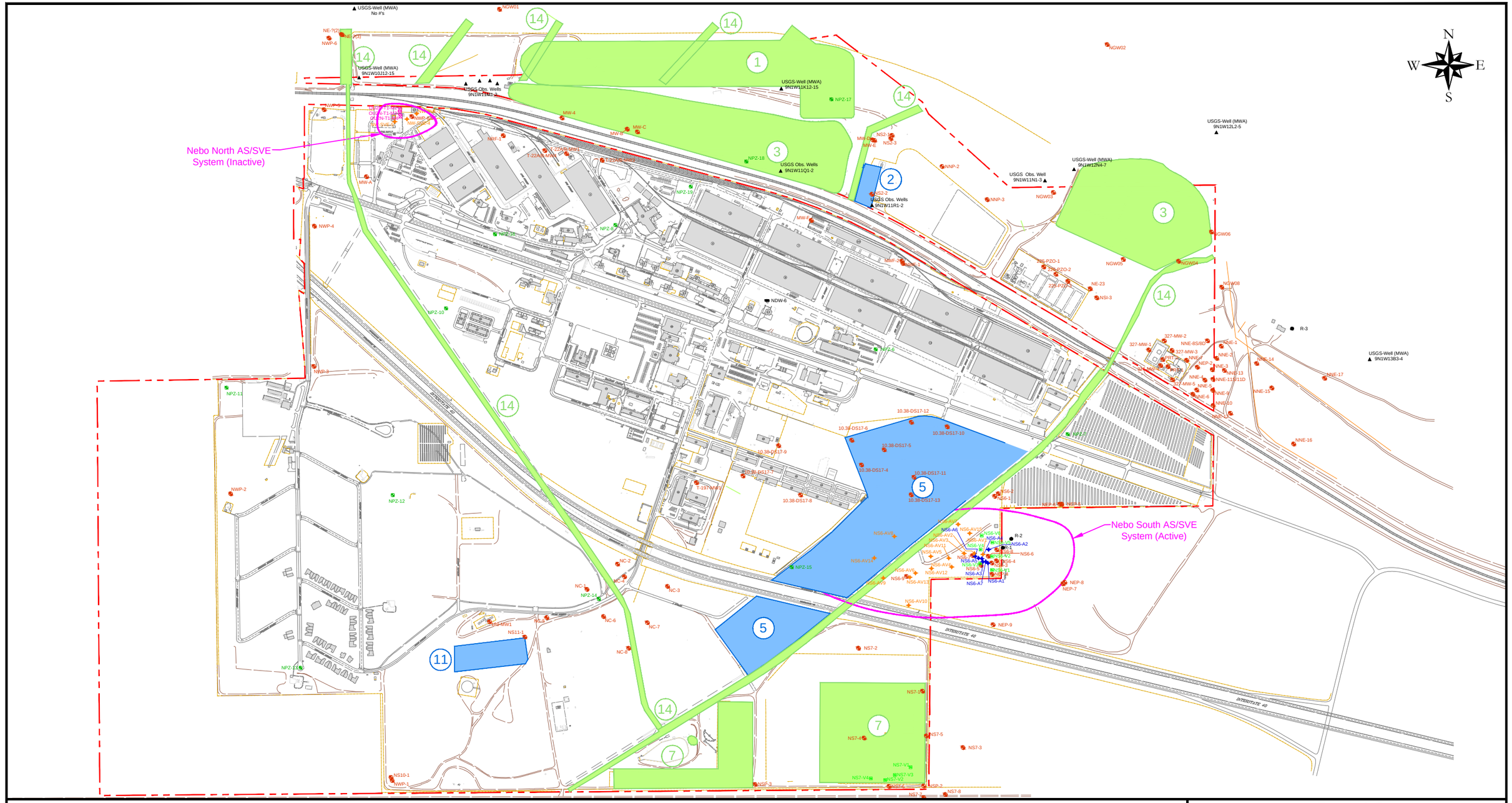
Yermo Annex
Marine Corps Logistics Base
Barstow, California

OTIE
An Oneida Nation Company

Date: June 19, 2017

File: Barstow_5yrRev - 2017.dwg

Plotted By: Adam Goldenberg



Legend

Paved Road	NEP-2	Groundwater Monitoring Well
Dirt Road	NPZ-8	Piezometer
Railroad Tracks	NDW-6	Base Groundwater Supply Well
Fence Line	NS6-V4	Vapor Extraction Well
Base Boundary	NS6-A7	Air Sparge Well
Operable Unit 4 (CAOC ##)	NS6-AV7	Vapor Extraction/Air Sparge Well
Operable Unit 6 (CAOC ##)	9N1W-11K6	United States Geological Survey (USGS) Well
	R-1	Residential Well

Notes

1) CAOC = CERCLA Area of Concern
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
OU = Operable Unit

Approximate Scale in Feet

0 900 1800

Figure 1-3
OUs 4, 6, 7 CAOCs and OU 2 Groundwater Remedial System Locations

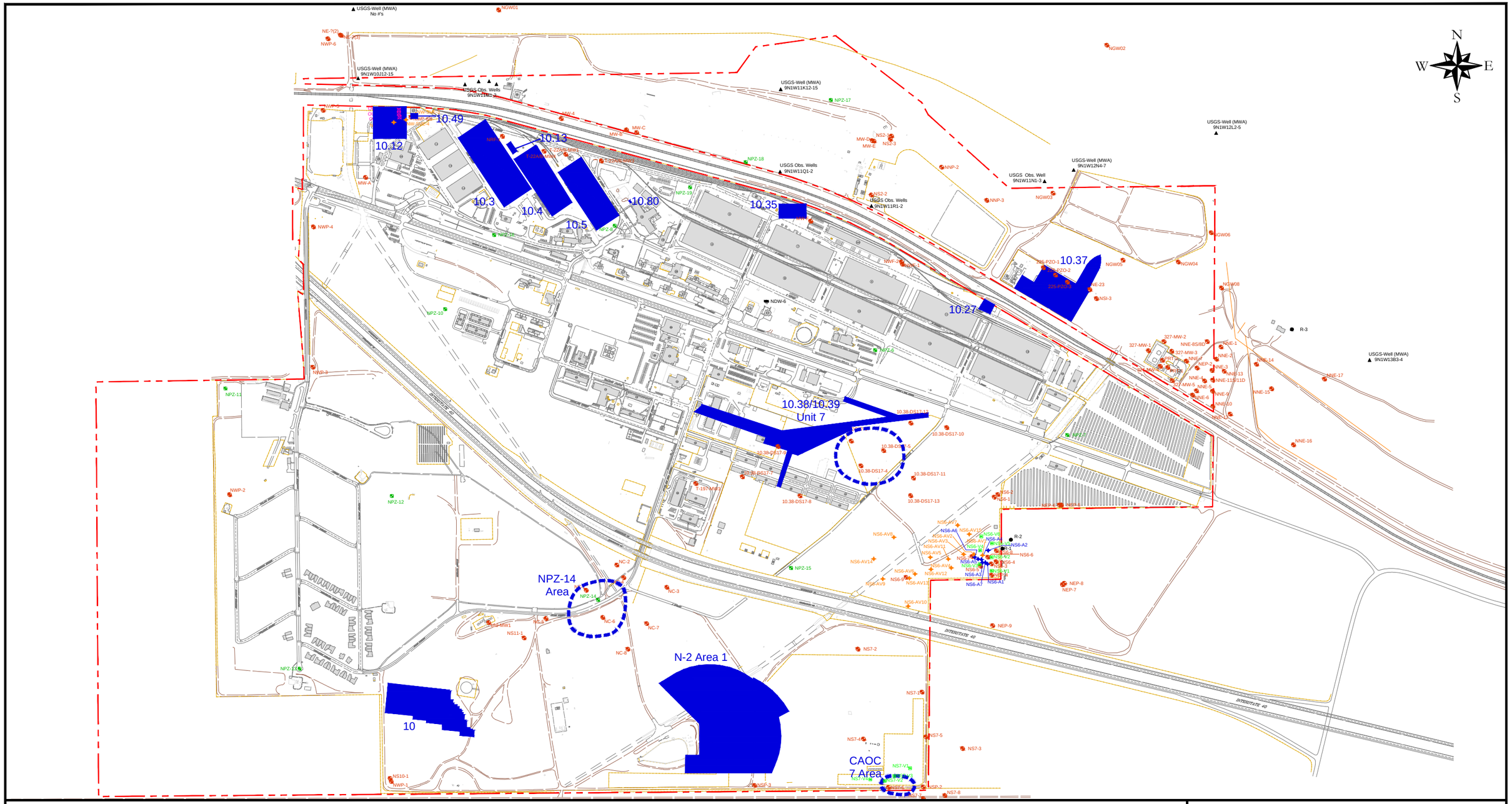
Nebo Main Base
Marine Corps Logistics Base
Barstow, California

OTIE An Oneida Nation Company

Date: June 19, 2017

File: Barstow_5yrRev - 2017.dwg

Plotted By: Adam Goldenberg



Legend

- Paved Road
- Dirt Road
- Railroad Tracks
- Fence Line
- Base Boundary
- Operable Unit 7 (CAOC ##)
- Operable Unit 7 MNA Groundwater Site

- NEP-2 — Groundwater Monitoring Well
- NPZ-8 — Piezometer
- NDW-6 — Base Groundwater Supply Well
- NS6-V4 — Vapor Extraction Well
- NS6-A7 — Air Sparge Well
- NS6-AV7 — Vapor Extraction/Air Sparge Well
- 9N1W-11K6 — United States Geological Survey (USGS) Well
- R-1 — Residential Well

Notes

1) CAOC = CERCLA Area of Concern
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
MNA = monitored natural attentuation
OU = Operable Unit

Figure 1-4
OU 7 CAOCs Site Locations

Nebo Main Base
Marine Corps Logistics Base
Barstow, California

OTIE
An Oneida Nation Company

Date: June 19, 2017

File: Barstow_5yrRev - 2017.dwg

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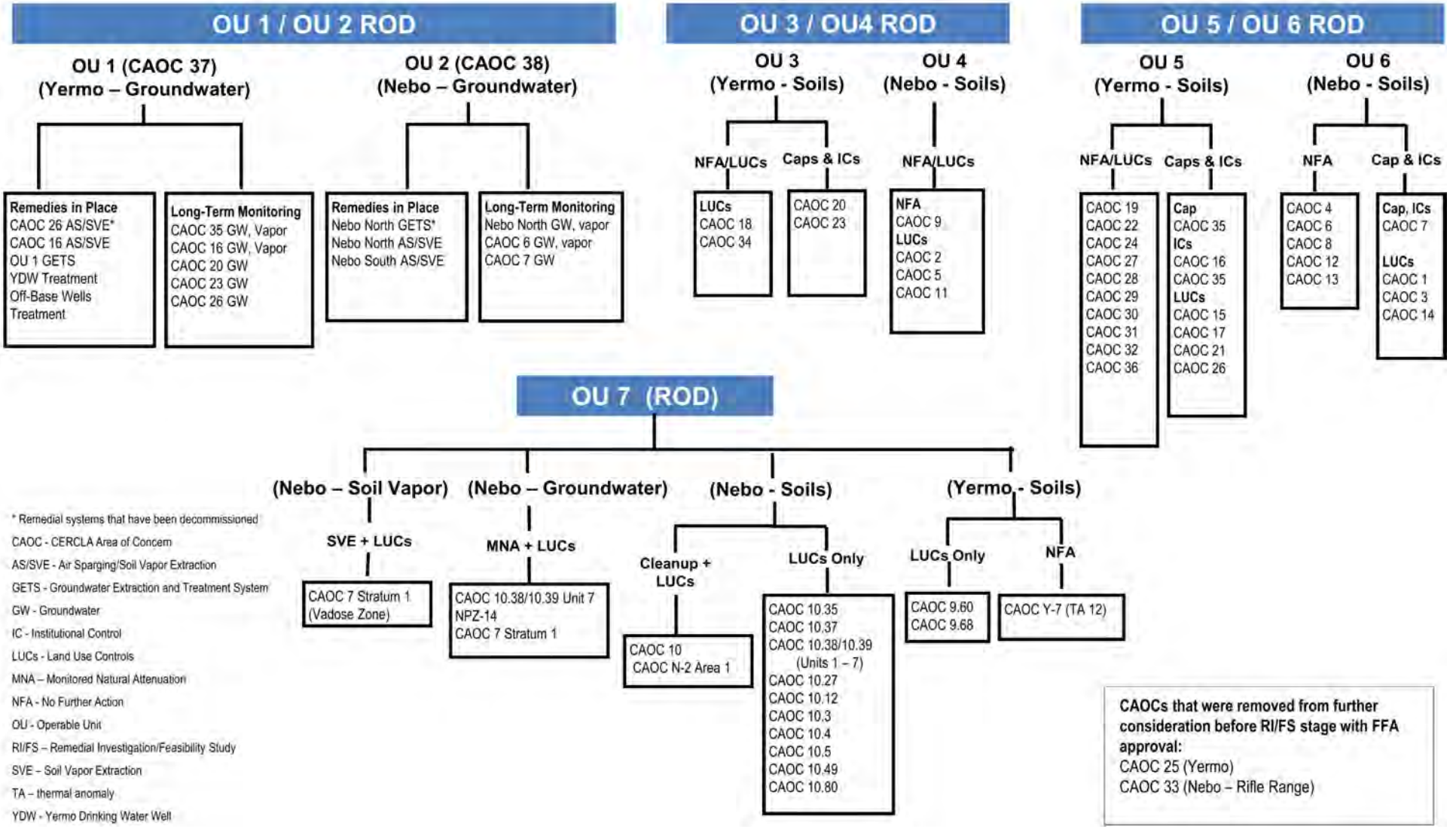


Figure References:
OUs 1, 3, 5, 7 Yermo Annex – Figure 1-2
OUs 2, 4, 6, 7 Nebo Main Base – Figure 1-3
OU 7 Nebo Main Base – Figure 1-4

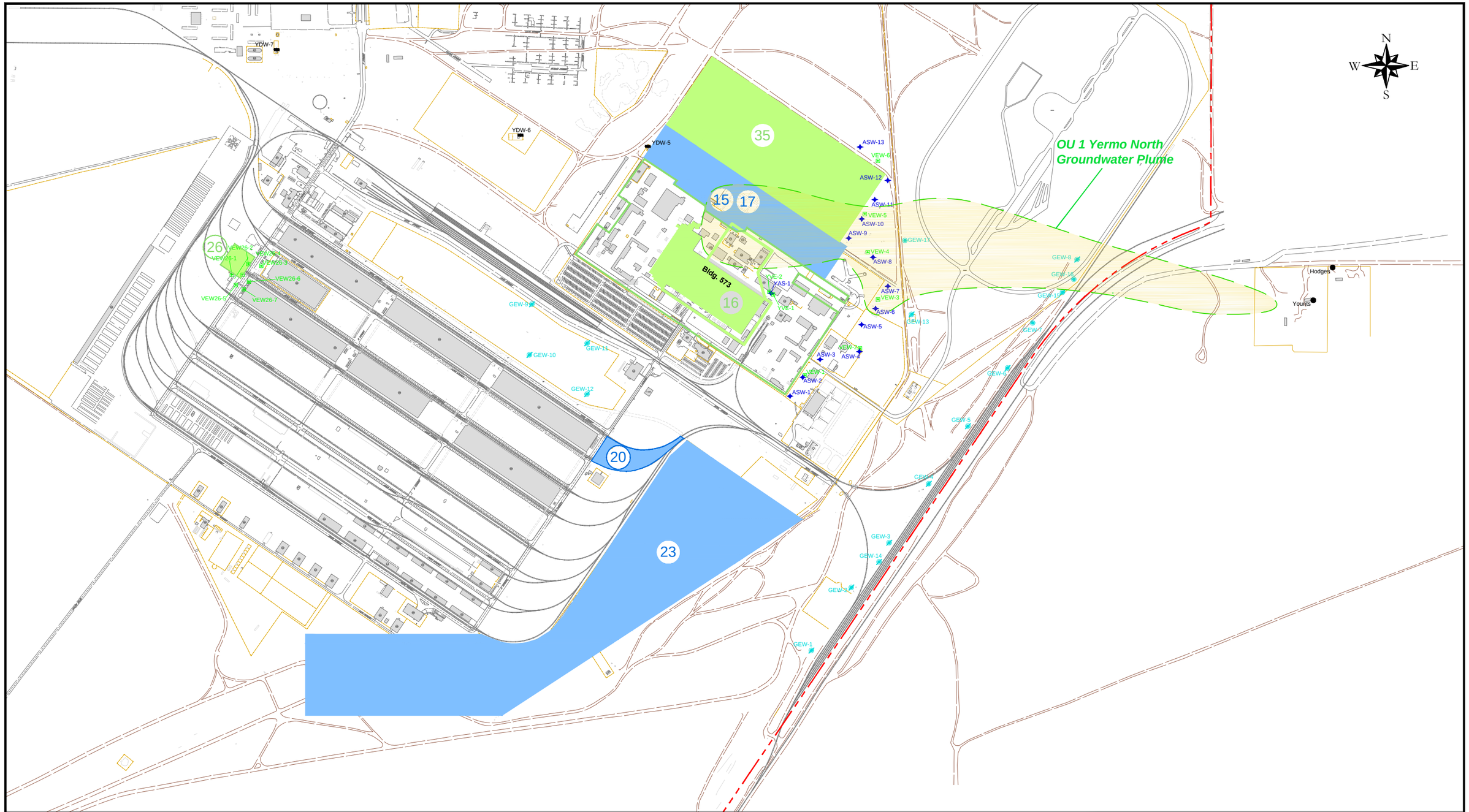
Figure 2-1
Organizations of OUs and CAOCs

Marine Corps Logistics Base
Barstow, California

OTIE
An Oneida Nation Company

Date: July 16, 2017

File: Barstow_5yrRev - 2017.dwg



Legend

- Paved Road
- Dirt Road
- Railroad Tracks
- Base Boundary
- YDW-5 — Base Groundwater Supply Well
- GEW-7 — Groundwater Extraction Well (Active)
- GEW-2 — Groundwater Extraction Well (Inactive)
- VEW-1 — Vapor Extraction Well
- ASW-1 — Air Sparge Well
- Younts — Residential Well
- Approximate OU1 Groundwater VOC Plume

Notes

1) Analytical results used to delineate the OU 1 (Operable Unit 1) groundwater plume are a combination of wells sampled during the November 2016 event.

Approximate Scale in Feet

0 800 1600

Figure 2-2
Groundwater VOC Plume Extent
(November 2016)

Yermo Annex
Marine Corps Logistics Base
Barstow, California

OTIE
An Oneida Nation Company

Date: June 19, 2017

File: Barstow_5yrRev - 2017.dwg