



Headquarters Marine Corps

FINAL

Range Environmental Vulnerability Assessment Marine Corps Logistics Base Barstow





Headquarters Marine Corps

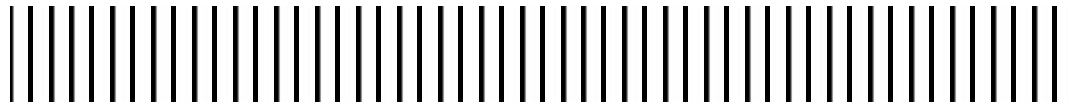
Code LFL • 2 Navy Annex • Washington, D.C. 20380-1775

FINAL

Range Environmental Vulnerability Assessment

Marine Corps Logistics Base Barstow

January 2009



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 - 1 – Rifle Range
 - 2 – Close Combat Pistol Range
 - 3 – Pistol Range

Acronym List

°F	Degrees Fahrenheit
amsl	Above Mean Sea Level
ASR	Archive Search Report
bgs	Below Ground Surface
BLM	Bureau of Land Management
CSM	Conceptual Site Model
DoD	Department of Defense
DoDD	Department of Defense Directive
DoDIC	Department of Defense Identification Code
DWMA	Desert Wildlife Management Area
EA	Environmental Assessment
FMD	Facilities Management Division
ft	Feet
GIS	Geographic Information System
HMX	Cyclotetramethylene Tetranitramine
HQMC	Headquarters Marine Corps
INRMP	Integrated Natural Resources Management Plan
IRP	Installation Restoration Program
lb/yr	Pounds per Year
Marine Corps	United States Marine Corps
MC	Munitions Constituents
MCAGCC	Marine Corps Air Ground Combat Center
MCLB	Marine Corps Logistics Base
mg/kg	Milligrams per Kilogram
mm	Millimeters
mph	Miles per Hour
MTU	Marksmanship Training Unit
NRCS	Natural Resources Conservation Service
PRA	Preliminary Range Assessment
RDX	Cyclotrimethylene Trinitramine
REVA	Range Environmental Vulnerability Assessment
SAR	Small Arms Range
SARAP	Small Arms Range Assessment Protocol
SDZ	Surface Danger Zone
SSURGO	Soil Survey Geographic
TNT	Trinitrotoluene
U.S.	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey

Executive Summary

The Range Environmental Vulnerability Assessment (REVA) program is a proactive and comprehensive program designed to support the United States Marine Corps (Marine Corps) environmental range sustainment initiative. The Department of Defense (DoD) has issued several policy, guidance, and planning documents that drive and guide the need to assess operational ranges with respect to potential munitions constituents (MC) migration from operational ranges, including DoD Directive (DoDD) 3200.15 *Sustainment of Ranges and Operating Areas*, DoDD 4715.11 *Environmental and Explosives Safety Management on Operational Ranges Within the United States*, and specifically, DoD Instruction 4715.14 *Operational Range Assessments*.

Operational ranges across the Marine Corps are being assessed to identify areas and activities that are subject to possible impacts from external influences and to determine whether a release or substantial threat of a release of MC from an operational range to an off-range area creates an unacceptable risk to human health or the environment. This is accomplished through a baseline assessment of operational range areas, development of conceptual site models, and, where applicable, the use of fate and transport modeling / analysis of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges. Indicator MC selected for the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and perchlorate.

For small arms ranges (SARs), REVA focuses on lead as the indicator MC because lead is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. Lead is geochemically specific regarding its mobility in the environment; modeling of lead requires site-specific geochemical data that are generally unavailable during a baseline assessment. Therefore, instead of modeling lead transport, operational SARs at the installations are qualitatively reviewed and assessed through the Small Arms Range Assessment Protocol (SARAP) to identify factors that influence the potential for lead migration. The SARAP was developed as a qualitative approach to identify and assess factors that influence the potential for lead to migrate from an operational range. These factors include the following:

- Range design and layout
- Physical and chemical characteristics of the area
- Past and present operation and maintenance practices

In addition, potential receptors and pathways are identified relative to the SAR being assessed. The potential for an identified receptor to be impacted by MC migration through an identified pathway is evaluated.

This report presents the assessment results for the operational ranges and training areas at Marine Corps Logistics Base (MCLB) Barstow, California. This report is the first comprehensive report on MC associated with the operational ranges at MCLB Barstow and serves as the baseline of environmental conditions of the operational ranges.

MCLB Barstow is located in the Mojave High Desert region of Southern California, approximately 3.5 miles east of the city of Barstow. The installation, subdivided into three units (Nebo Area, Yermo Annex, and the Rifle Range Complex), consists of approximately 6,166 acres. The mission of MCLB Barstow is to procure, maintain, store, and issue all classes of supplies and equipment and to repair and rebuild Marine Corps and other DoD-owned equipment. MCLB Barstow furnishes supplies for Marine Corps facilities worldwide and is a direct support provider for all installations.

Military training on operational ranges at MCLB Barstow consists solely of small arms training for weapon proficiency and requalification. MCLB Barstow uses three SARs for this training: the Rifle Range, Close Combat Pistol Range, and Pistol Range. A summary of the SAR assessment results are provided in Table ES-1. Because the SARs are located immediately adjacent to one another, the physical and environmental characteristics that factor into the SAR assessments are similar for all three ranges. The only differences in the ranges consist of operational aspects, such as the types of ammunition used, expenditure rates, direction of fire, and engineered controls established on the ranges. The SARs were characterized as minimal environmental concern based on the surface water and groundwater scores.

Table ES-1: Summary of SAR Prioritizations

Range Name	Surface Water Priority	Groundwater Priority
Rifle Range	Minimal	Minimal ^a
Close Combat Pistol Range	Minimal	Minimal ^a
Pistol Range	Minimal	Minimal ^a

^aOriginal environmental concern evaluation priority was moderate; the priority was adjusted based on professional judgment.

Based on the following site conditions and existing range management practices, the moderate groundwater concern for each SAR was adjusted to minimal:

- Current and continued low use of small arms ammunition
- Regional and site-specific values of soil pH, indicating that lead is unlikely to be mobile at the site

- Lack of surface water and groundwater pathway/receptor interactions for human receptors
- Limited potential for surface water pathway/receptor interaction for ecological receptors (the desert tortoise).

1. Introduction

1.1. Purpose

The Range Environmental Vulnerability Assessment (REVA) program is a proactive and comprehensive program designed to support the United States (U.S.) Marine Corps (Marine Corps) environmental range sustainment initiative. The Department of Defense (DoD) has issued several policy, guidance, and planning documents that drive and guide the need to assess operational ranges with respect to potential munitions constituents (MC) migration from operational ranges, including DoD Directive (DoDD) 3200.15 *Sustainment of Ranges and Operating Areas*, DoDD 4715.11 *Environmental and Explosives Safety Management on Operational Ranges Within the United States*, and specifically, DoD Instruction 4715.14 *Operational Range Assessments*.

Operational ranges across the Marine Corps are being assessed to identify areas and activities that are subject to possible impacts from external influences and to determine whether a release or substantial threat of a release of MC from an operational range to an off-range area creates an unacceptable risk to human health or the environment. This is accomplished through a baseline assessment of operational range areas, development of conceptual site models (CSMs), and, where applicable, the use of fate and transport modeling / analysis of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges.

In recent years, the DoD and the Marine Corps have experienced a dramatic increase in encroachment pressures associated with operational range activities. In some instances, encroachment issues have impacted training. The early identification of encroachment issues will allow the Marine Corps installation to minimize external pressures, thereby minimizing potential impacts to training. Operational ranges and maneuver areas are essential to Marine Corps training; therefore, sustaining these areas for use is critical to mission readiness.

This report presents the assessment results for the operational ranges at Marine Corps Logistics Base (MCLB) Barstow, California. It is the first comprehensive report on MC associated with the operational ranges at MCLB Barstow and, as such, serves as the baseline of environmental conditions and potential vulnerabilities of the ranges. Subsequent vulnerability assessments will be conducted on operational ranges at MCLB Barstow on a five-year cycle or when significant changes are made to existing ranges that potentially affect the determinations made during this baseline assessment, as described in the *REVA Reference Manual* (HQMC, 2006).

1.2. Scope and Applicability

The scope of the REVA program includes Marine Corps operational ranges located within the United States and overseas. Operational ranges (as defined in 10 United States Code 101(e)(3)) include, but are not limited to, fixed ranges, live-fire maneuver areas, small arms ranges (SARs), buffer areas, and training areas where military munitions are known or suspected to be currently or have been historically used. The presence of other than operational ranges is noted where applicable, but they are not assessed under the REVA program. Other than operational ranges are being addressed under the Marine Corps' Munitions Response Program.

Site-specific environmental conditions and MC loading rates are used in CSMs and, if warranted, screening-level quantitative models are used to assess whether the potential exists for a release or substantial threat of a release of MC from an operational range to an off-range area. Exposure pathways considered in the REVA process include consumption of surface water and groundwater for off-range human and ecological receptors, as described in the *REVA Reference Manual* (HQMC, 2006). Other off-range exposures scenarios (soil ingestion, incidental dermal contact, bioaccumulation and food chain exposure, etc.) currently are not considered in the REVA process.

The MC typically evaluated in the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and perchlorate. TNT, HMX, and RDX are common high explosives used in a wide variety of military munitions and are considered to be indicator MC. Studies have shown that they are detected in a high percentage of samples containing MC due to their chemical stability within the environment. Perchlorate is a component of the solid propellants used in some military munitions. It is also considered an indicator MC because its high solubility, low sorption potential, and low natural degradation rate make the compound highly persistent and mobile in the environment. Additional information pertaining to the physical and chemical characteristics of the REVA indicator compounds is provided in the *REVA Reference Manual* (HQMC, 2006).

Military training on operational ranges at MCLB Barstow consists solely of small arms training for weapon proficiency and requalification. MC associated with small arms ammunition commonly used at operational ranges include lead, antimony, copper, and zinc. REVA focuses on lead as the indicator MC for SARs because lead is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition.

Quantitative modeling of lead fate and transport requires site-specific geochemical data that are generally unavailable during a baseline assessment. Therefore, instead of modeling lead, operational SARs at the installations are qualitatively reviewed and assessed through the Small Arms Range Assessment Protocol (SARAP) to identify

factors that influence the potential for lead migration. These factors include a range's design and layout, the physical and environmental conditions of the area, and current and past operation and maintenance practices. The amount of lead that has been loaded to the operational ranges is determined to identify high-use ranges.

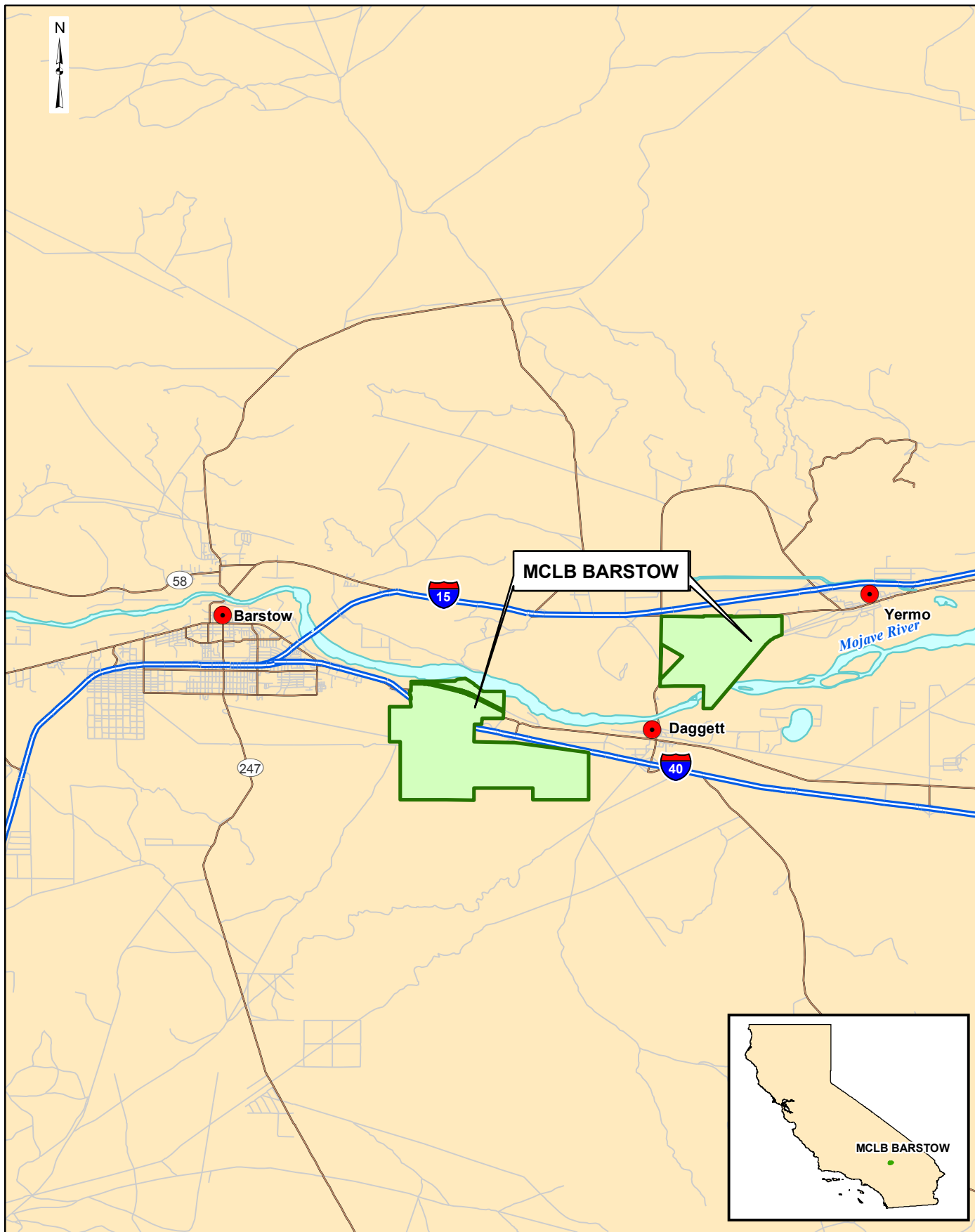
MCLB Barstow, located approximately 3.5 miles east of the city of Barstow, contains three units: the Nebo Area, Yermo Annex, and Rifle Range Complex. This document focuses on three currently operational ranges located at the Rifle Range Complex at MCLB Barstow, San Bernardino County, California (Figure 1-1, Figure 1-2, and Figure 1-3). It includes a summary of the major physical, environmental, and operational conditions at the installation that can impact MC deposition, migration, and exposure to potential receptors. Because the operational ranges at MCLB Barstow are SARs (no high explosive live-fire ranges are present), the MC of concern for this report is limited to lead. As such, quantitative modeling and transport analyses were not conducted for the ranges at MCLB Barstow.

This document is based on information collected during a site visit conducted in May 2007 and provided by the Environmental Division, Range Control, and other installation offices at MCLB Barstow. This baseline environmental range assessment report presents the conditions of the operational ranges at the time the assessment was conducted. The baseline environmental range assessment was performed using available data and personnel interviews and is supplemented with information from external sources, including reports and documentation.

1.3. Report Organization

This REVA baseline environmental range assessment report for MCLB Barstow is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Summary of Data Collection Effort
- Section 3 – Conceptual Site Model
- Section 4 – Munitions Constituents Loading Rate and Assumptions
- Section 5 – Small Arms Range Assessments
- Section 6 – References








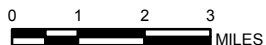
REVA
FIGURE 1-1
SITE LOCATION MAP

MCLB BARSTOW
BARSTOW, CA

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LEGEND

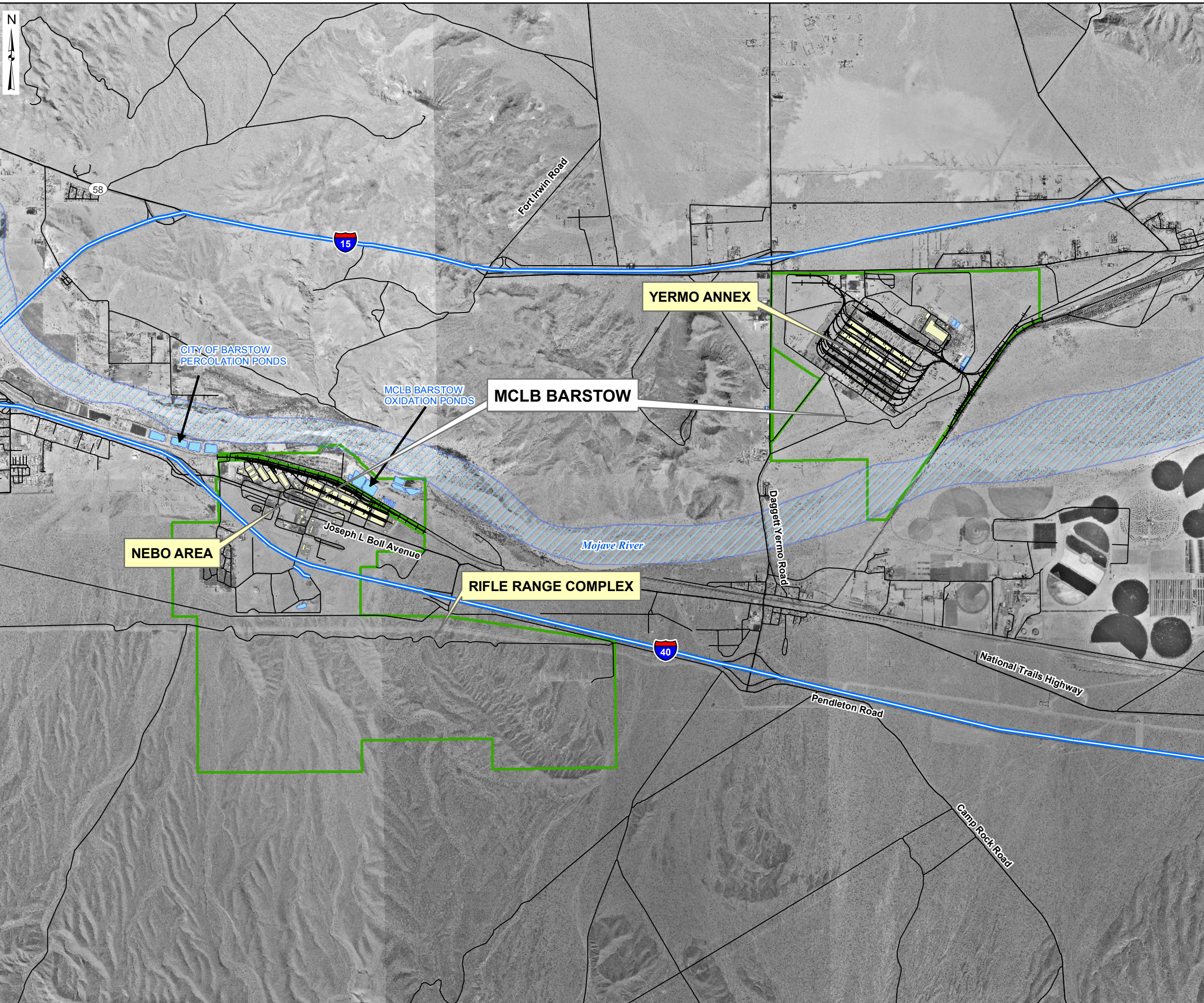
-  INSTALLATION BOUNDARY
-  INTERSTATE
-  MAJOR ROAD
-  MINOR ROAD
-  CITY



DATE: JANUARY 2009
 SOURCE: MCLB FMD/GIS, 2007
 TECOM, 2008



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




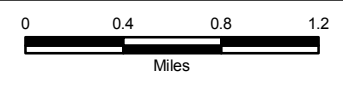
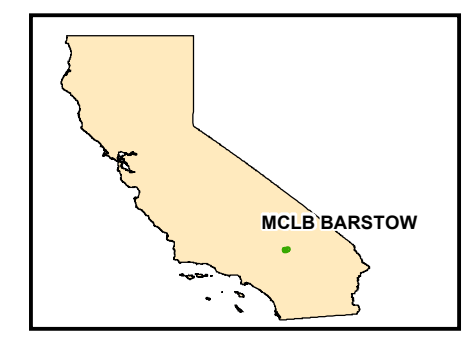
**REVA
FIGURE 1-2
INSTALLATION LOCATION**

**MCLB BARSTOW
BARSTOW, CA**

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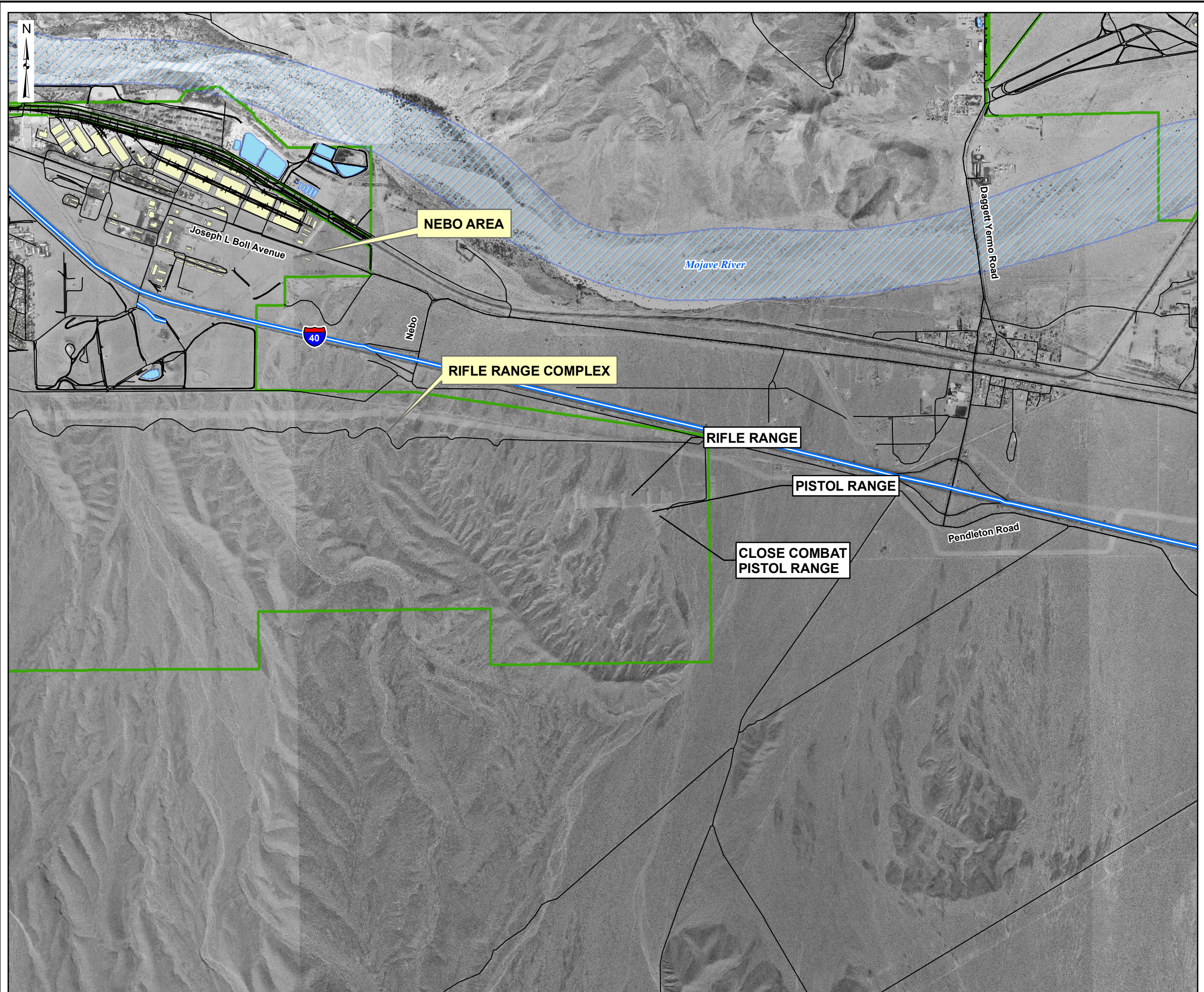
-  INSTALLATION BOUNDARY
-  MOJAVE RIVER (DRY)
-  SURFACE IMPOUNDMENTS
-  BUILDINGS
-  INTERSTATE
-  ROAD
-  RAILROAD



DATE: JANUARY 2009
SOURCE: MCLB FMD/GIS, 2007
TECOM, 2008










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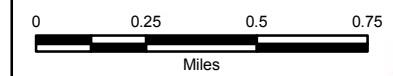


**REVA
FIGURE 1-3
OPERATIONAL RANGES**

**MCLB BARSTOW
BARSTOW, CA
FINAL**

LEGEND

-  INSTALLATION BOUNDARY
-  MOJAVE RIVER (DRY)
-  SURFACE IMPOUNDMENTS
-  BUILDINGS
-  INTERSTATE
-  ROAD
-  RAILROAD



DATE: JANUARY 2009
SOURCE: MCLB FMD/GIS, 2007
TECOM, 2008



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2. Summary of Data Collection Effort

Data required for the operational range assessments were obtained from Headquarters, Marine Corps (HQMC), from the installation during a site visit by the REVA assessment team, and from external data sources. Data obtained from HQMC and the installation includes various documents and reports prepared for the installation (e.g., Master Plans, Archive Search Report [ASR], and Preliminary Range Assessment [PRA], Installation Restoration Program [IRP], and Environmental Assessment [EA] reports). External data sources included reports and online information from organizations such as the U.S. Geological Survey (USGS) and the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS).

The REVA assessment team conducted a site visit on May 1–3, 2007. HQMC personnel participated in the site visit, which involved a review of various data repositories and interviews with installation personnel from the following offices:

- Environmental Division
- Range Operations and Control
- Facilities Management Division (FMD)
- FMD Geographic Information System (GIS) Department

Subject matter experts within each of these offices were interviewed by the REVA assessment team to identify areas of interest and specific concerns pertaining to each office. Specific issues relating to operational range use and potential impacts to training were the focus of these discussions.

3. Conceptual Site Model

Assessing off-range migration of MC requires the evaluation of potential transport pathways, such as surface water and groundwater systems, and potential receptors (human and ecological) that could be affected. To this end, the REVA assessment team developed a CSM to characterize the operational and environmental factors at MCLB Barstow that can affect MC migration from operational ranges. The CSM was developed using information obtained during the REVA site visit, environmental documents obtained from the installation, and local geologic studies. If details of site-specific characteristics and information were not available, regional information was used to characterize site-specific conditions. The CSM was used in conjunction with additional range-specific environmental data to apply the SARAP to produce the SAR assessments, presented in **Section 5** and **Appendix A**.

The CSM presented in this section includes:

- installation background, geography, and topography;
- the geologic, hydrologic, and environmental setting of the site;
- discussion of primary receptors, if present; and
- discussion of potential MC migration pathways.

Key information sources used in the development of the operational range CSM include the following:

- IRP site data
- Integrated Natural Resource Management Plan (INRMP)
- EA reports
- USGS topographic maps and regional groundwater resources reports
- USDA Soil Survey Geographic (SSURGO) data
- Marine Corps ASR
- Marine Corps PRA

Primary receptors are defined as humans and threatened and endangered species that are exposed, or that might be exposed, to MC potentially released from an operational range. Potential MC migration pathways evaluated under REVA are defined as the transport mechanisms by which MC could move off-range and reach a receptor through surface water or groundwater. Important components of the CSM are the identification of potential receptors and pathways and the determination of whether potential pathway/receptor interactions exist. Figure 3-1 depicts a schematic diagram of the site

conditions addressed in this CSM. The general surface and subsurface geologic conditions of the installation are shown relative to MC loading areas, the range boundaries, groundwater and surface water flow pathways, and potential receptors.

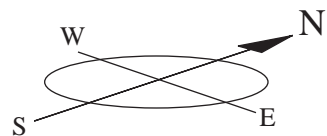
Three operational ranges were identified at MCLB Barstow during the REVA site visit; all three ranges are located within the Rifle Range Complex. No operational ranges were identified in the Nebo Area or the Yermo Annex. Other than operational ranges were identified previously in the Nebo Area (four ranges) and the Rifle Range Complex (two ranges) (USACE, 2001a and 2001b). Other than operational ranges fall under the jurisdiction of the Munitions Response Program. Two former ranges, currently located outside the installation boundary, were also identified. These ranges fall under the jurisdiction of the Formerly Used Defense Site Program (USACE, 2001b). The three operational ranges identified during the REVA site visit are summarized in Table 3-1.

Table 3-1: Range Summary Table

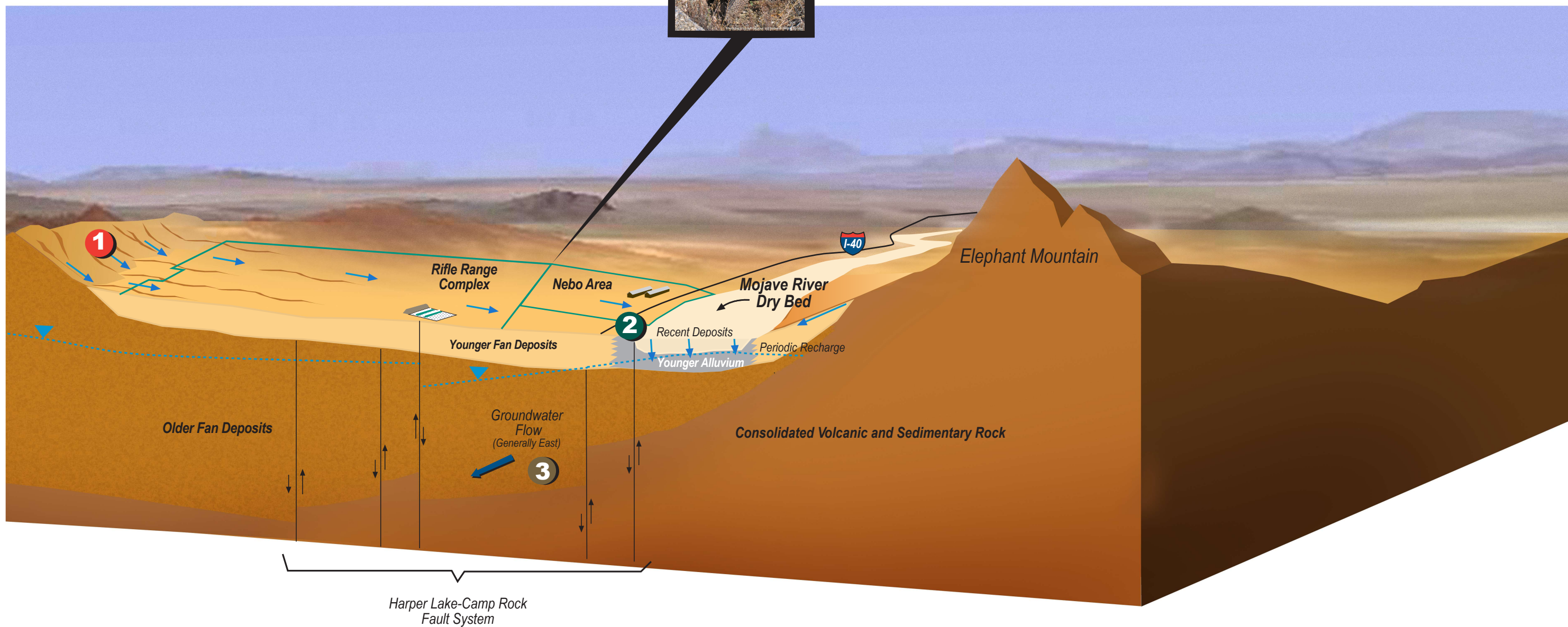
Range Name	Period of Use	Area (acres) ^a
Rifle Range	1955–present	757 ^a
Close Combat Pistol Range	1955–present	275 ^b
Pistol Range	1955–present	

^a Range size includes range footprint and surface danger zone (SDZ) from installation source data.

^b The Close Combat Pistol Range and the Pistol Range share an SDZ; therefore, a single area was estimated for both ranges.



Desert Tortoise



Not to Scale

Legend

- Consolidated Volcanic and Sedimentary Rock
- REGIONAL AQUIFER**
- Older Fan Deposits
- Younger Fan Deposits
- MOJAVE RIVER AQUIFER**
- Younger Alluvium
- Recent Alluvium Deposits
- MC Loading Area
- Water Table
- Faults
- Groundwater Flow Direction
- Surface Water

This cross-section is based on a basic distribution of geologic units and features and represents the general conceptual model for the surface and groundwater flow at the installation. Although it is based on information from reports by Densmore et al (1997) and Mojave Water Agency (2004), this figure is not intended as a geologic cross-section with accurate subsurface contacts and bedrock outcrops.

Possible MC Transport Mechanisms:

- 1.** Surface runoff towards Mojave River Bed through the Rifle Range Complex.
- 2.** Recharge of runoff water into the Mojave River Bed sediments.
- 3.** Subsurface groundwater flow generally parallel to the Mojave River Bed.

Figure 3-1
Graphical Conceptual Site Model
MCLB Barstow
Barstow, CA



3.1. Installation Profile

CSM Information Profiles – Installation Profile	
Information Needs	Preliminary Information
Installation location	<p>San Bernardino County, Barstow, California</p> <p>MCLB Barstow (Nebo Area and Rifle Range Complex) is located approximately 3.5 miles east of the city of Barstow (MCLB Barstow, 2007). The Rifle Range Complex is located directly south of the Nebo Area. The Yermo Annex of MCLB Barstow is located 3 miles east of the Nebo Area.</p>
Date of establishment	<p>The Nebo Area was established in December 1942 by the Marine Corps as the Marine Corps Depot of Supplies. After World War II, the installation was expanded to include the Yermo Annex, which was a surplus Army installation. The Rifle Range Complex was added in 1955 (USACE, 2001a).</p>
Installation area and layout	<p>Based on information presented in the INRMP, MCLB Barstow is 6,166 acres (Tierra Data, 2005). The GIS data collected during the site visit to MCLB Barstow indicate the installation has an area of 5,343 acres. The reason for the difference between the two cited areas is unknown.</p> <p>The installation consists of three separate units (MCLB Barstow, 2007):</p> <ul style="list-style-type: none"> ■ Nebo Area: 1,868 acres (base headquarters and administration, storage, recreational activities, shopping, and housing functions) ■ Yermo Annex: 1,859 acres (storage and industrial complex) ■ Rifle Range Complex: 2,438 acres (marksmanship and requalification) <p>The dry bed of the Mojave River forms the northern boundary of the Nebo Area. The Rifle Range Complex, consisting of three SARs, is located directly south of the Nebo Area, south of Interstate 40. The Yermo Annex is located 3 miles east of the Nebo Area, north of the Mojave River bed, and south of Interstate 15.</p>

CSM Information Profiles – Installation Profile	
Information Needs	Preliminary Information
Installation mission	<p>The MCLB Barstow mission is twofold: to procure, maintain, store, and issue all classes of supplies and equipment; and to repair and rebuild Marine Corps and other DoD-owned equipment. MCLB Barstow furnishes supplies for Marine Corps facilities worldwide and is a direct support provider for all installations. Secondly, MCLB Barstow is responsible for the technical training of Marines (Tierra Data, 2005; MCLB Barstow, 2007; GlobalSecurity.org, 2007).</p>
Installation history	<p>The installation (Nebo Area) originally was planned as a Navy supply depot; however, on December 28, 1942, the Navy turned the property over to the Marine Corps (GlobalSecurity.org, 2007). The installation, then called the Marine Corps Depot of Supplies, served as a storage facility annex to the San Francisco Marine Corps Supply Depot. The Yermo Annex was acquired from the Army in October 1946 (EDAW, 2006). The Commanding General, Marine Corps Depot of Supplies transferred operations from San Francisco to Barstow in 1954. The Rifle Range Complex was acquired in 1955 to establish several SARs for Marines marksmanship training (Tierra Data, 2005). Prior to 1955, the Rifle Range Complex was unclaimed and undeveloped public land (USACE, 2001a). In November 1978, the base was redesignated as MCLB Barstow (USACE, 2001a).</p> <p>Since the end of the Vietnam War, the base has continued to maintain and distribute equipment and supplies. Since the early 1970s, there has been a significant decline in military personnel stationed at MCLB Barstow. Up to 1,200 Marines were stationed at MCLB Barstow in the past; only 350 Marines were present in 1998, and approximately only 100 are present today (USACE, 2001a and 2001b; . Civilian personnel now represent the majority of employees at MCLB Barstow; the latest Integrated Cultural Resources Management Plan (2006) reports just under 1,500 civilian employees. Many of the military housing units on the west side of the Nebo Area have been demolished (EDAW, 2006).</p>

3.2. Operational Range Profile

CSM Information Profiles – Operational Range Profile	
Information Needs	Preliminary Information
Range complex location	The Rifle Range Complex is located immediately south of the Nebo Area. The SARs are located in the eastern portion of the Rifle Range Complex, south of Interstate 40 (MCLB Barstow GIS, 2007).
Range names	The Rifle Range, Close Combat Pistol Range, and Pistol Range are located within the Rifle Range Complex.
Date of establishment	The ranges were established in 1955, when the Rifle Range Complex was acquired. The Close Combat Pistol Range and Pistol Range were separated from each other by construction of a central berm in the 1960s (USACE, 2001b).
Range area	<p>Based on information presented in the INRMP, the Rifle Range Complex is 2,438 acres. The Rifle Range, including the range footprint and its associated SDZ, occupies approximately 757 acres. The range footprint is 3,000 feet (ft) by 600 ft, oriented for firing to the west.</p> <p>The Close Combat Pistol Range and Pistol Range are located adjacent to the Rifle Range to the south and are oriented for firing to the southwest. The ranges share an SDZ and have a combined area of approximately 275 acres. The combined footprint of the ranges is 300 ft by 350 ft; each is slightly greater than one acre in size (MCLB Barstow GIS, 2007). The combined SDZ extends south over the Rifle Range Complex and the installation boundary onto Bureau of Land Management (BLM) property.</p>

CSM Information Profiles – Operational Range Profile	
Information Needs	Preliminary Information
Range design	<p>The Rifle Range has 30 firing points with firing lines at 25, 200, 300, 500, 600, and 1,000 yards (USACE, 2001b; MCLB Barstow PAO, 2007). The 600- and 1,000-yard firing lines are no longer used. Targets are raised into place by personnel behind a protected stand set in front of the rear impact berm. During visual inspection by the REVA assessment team, the rear earthen impact berm was judged to be in good condition in most locations; there is some evidence of erosion and drainage over the face of the berm on the south side of the berm.</p> <p>The Close Combat Pistol Range has 10 firing points with unmarked firing lines; the groundcover is bare soil, primarily sand and gravel. Sandbags at the base of the rear impact berm hold metal targets in place. The Pistol Range has 15 firing points with firing lines at 15, 25, and 50 yards (USACE, 2001b). A sandbag wall is in front of the rear impact berm for protection of target stands. The range floor between the firing lines and the sandbag wall is covered with gravel.</p> <p>Both of the pistol ranges have side berms extending from the rear impact berm to the firing positions. The rear berm of the Close Combat Pistol Range is slightly set back from the adjacent Pistol Range. The earthen impact berms are in fairly good condition, with some evidence of erosion and small bullet pockets across their faces. The tops of these berms are slightly sloped away from the faces to minimize drainage flowing across the impact areas.</p>
Other features	Two utility easements extend across the entire length of the Rifle Range Complex, north of the Rifle Range. Four small portable buildings used for administrative purposes are located at the entrance to the Rifle Range Complex (USMC, 2006).
Range security	Two portions of the Rifle Range Complex, including the southern boundary of the Nebo Area and along Interstate 40, are bordered by chain-link fence (Department of the Navy, 2004). The remaining 36,000 ft of fence enclosing the complex is four-strand barbed wire fence not lower than 12 inches to allow the desert tortoise to move through the fenced area (Tierra Data, 2005). The Rifle Range Complex is not actively patrolled by installation security.

CSM Information Profiles – Operational Range Profile	
Information Needs	Preliminary Information
Military munitions usage	<p>Munitions are restricted to small arms only (USACE, 2001b).</p> <p>Current usage of the ranges is low. Approximately 100 Marines currently are stationed at MCLB Barstow, all of who may use the ranges for requalification (Tierra Data, 2005; MCLB Barstow, 2007). Munitions quantity estimates reported in the September 2001 PRA suggest that historical use was likely greater in the past (USACE, 2001b). The July 2005 INRMP states that the Rifle Range Complex was used approximately 18-20 weeks per year by Marines for training (Tierra Data, 2005). In addition, the INRMP indicates that the range was used intermittently by the California Highway Patrol and by a civilian gun club. However, this nonmilitary training has not been conducted in the past two years (Woods, pers. comm.). In addition, training courses for Federal Officer police training have been recently introduced. Records of ammunition types and quantities by nonmilitary personnel are not available.</p> <p>The total training allocation of ammunition for MCLB Barstow is 47,000 rounds of ammunition. This total training allocation includes rounds used by both the Marines and non-Marine police force at the installation.</p>
MC	<p>MC evaluated under the REVA program for SARs are limited to lead (HQMC, 2006). A study involving soil sampling and lead analysis at the Pistol Range was conducted in late 2005. Peak concentrations were found at the surface of the main target berm and in front of the target line, with a maximum concentration of 1,220 milligrams per kilogram (mg/kg) at a depth of 6 inches below ground surface (bgs) in the center of the impact berm. Of the three borings taken in front of the target line, only one showed total lead above local background concentrations at 4 feet bgs, which was the maximum depth of the sampling effort (Panacea, 2005). A more detailed description of the sampling effort is provided in Section 5.4.</p>
MC loading areas	<p>The majority of the lead from small arms projectiles fired at the three MCLB Barstow ranges is expected to be concentrated in the rear impact berm at each of the three ranges. There is some potential for projectiles and fragments to be distributed in front of and behind the impact berms and elsewhere within the range SDZs due to ricochet; however, lead deposition from ricochet is likely to be minimal compared to the deposition within the impact berms.</p>

CSM Information Profiles – Operational Range Profile	
Information Needs	Preliminary Information
Maintenance	Berm material is replenished occasionally. This involves the placement of soil across the face of the berms to reduce pockets that can increase erosion. Lead mining to remove spent rounds occurs infrequently; installation personnel reported two mining events for the Rifle Range in the last 15 years and one mining event each for the Close Combat Pistol Range and Pistol Range in the past few years. The exact dates of berm mining are not known, and no information was available at the installation. Routine maintenance of the complex includes grading access roads and parking lots and trimming vegetation in the live-fire lanes. Grading work is carried out on a semiannual basis unless severe storms create the need for additional maintenance (Tierra Data, 2005).
Engineered controls	At the Rifle Range, large rocks have been placed across the southwest corner of the impact berm to reduce high-energy runoff from eroding the rear impact berm. Installation personnel noted the presence of an earthen berm south of the Close Combat Pistol Range and Pistol Range designed to deflect drainage from the up gradient hillside around the ranges. The top of each range's rear impact berm is sloped downward to the back and to the side of the berm to reduce the potential for surface run-on across the berm faces.
Potential release mechanisms	Lead from small arms projectiles fired at the ranges is expected to be concentrated in the rear impact berms. The primary mechanism for potential release would involve erosion of soil from the berm faces via precipitation or wind, followed by dissolution of lead into surface water. The potential for dissolution of lead into surface water is likely limited given near-neutral soil and surface water pH recorded at MCLB Barstow, as discussed in the following sections. Transport of lead off range would be driven primarily by surface water runoff or percolation of surface water through the vadose zone to groundwater.

3.3. Physical Profile

CSM Information Profiles – Physical Profile	
Information Needs	Preliminary Information
Climate	<p>The climate at MCLB Barstow can be characterized as very arid, as it is located in the north-central part of the Mojave Desert. The area receives an average of 4.4 inches of precipitation annually, with an annual minimum of 1.08 inches and an annual maximum of 10.62 inches recorded between 1913 and 2003. The majority of precipitation occurs between November and March. During summer months, scattered, torrential thunderstorms can occur, producing localized flash flooding. Snow is rare, but known to occur, with an average of 58 days a year falling below freezing. High temperatures range from 60 degrees Fahrenheit (°F) during the winter to 100°F during the summer. Winds primarily originate from the west at monthly average speeds approaching 8 to 9 miles per hour (mph); gusts exceeding 40 to 50 mph are not uncommon (Tierra Data, 2005). Pan evaporation rates for the Mojave weather station, recorded between 1948 and 2005, is 111 inches per year (Western Region Climate Center, 2007).</p>
Elevation	<p>The entire installation lies between approximately 1,940 and 2,650 ft above mean sea level (amsl) (Tierra Data, 2005). Based on USGS topographic maps, the Rifle Range Complex ranges in elevation from 2,500 ft amsl in the southwestern corner to 2,100 ft amsl in the northeastern corner.</p>
Topography and geologic features	<p>MCLB Barstow is located in the lower Mojave River Valley Basin. It is characterized by low ridges and terraces that surround and slope downward to an alluvial valley that generally trends west to east. The Mojave River channel is usually dry in the vicinity of Barstow, with no surface water present outside of a few weeks during the winter months. Typically, groundwater is found at shallow depths within the riverbed in areas where the river is dry. Additionally, a number of northwest-trending, right-lateral, strike-slip faults are present throughout the area (Jacobs Engineering, 1997). Notably, the Harper Lake–Camp Rock fault zone traverses the eastern portion of the Nebo Area and Rifle Range Complex. This fault zone displaces sediments as recent as the Holocene and Pleistocene eras, while many of the other fault zones in the area displace only older units. The Rifle Range Complex contains plateaus and ephemeral washes that drain toward the Mojave River. The Nebo Area and Yermo Annex are flatter, with fewer topographic features. Elephant Mountain, located between the Nebo</p>

CSM Information Profiles – Physical Profile	
Information Needs	Preliminary Information
Topography and geologic features, cont.	Area and the Yermo Annex, is the dominant topographic feature in the area (Densmore et al., 1997).
Stratigraphy	MCLB Barstow is situated in the Mojave River valley, where holocene alluvial fan and stream channel deposits constitute the upper 600 ft of unconsolidated sediments, which are underlain in places by Pleistocene and late Miocene alluvium, fanglomerate, and playa deposits. The Rifle Range Complex is set south of the dry riverbed where Pleistocene and Holocene aged alluvium is exposed at the surface. Tertiary volcanics and sedimentary rocks up to 6,000 ft thick underlie the entire basin. The greatest depth to bedrock in the Barstow area is approximately 8,300 ft; consolidated volcanic and metavolcanic bedrock beneath the base is between 100 and 1,000 ft bgs (Jacobs Engineering, 1997; Densmore et al., 1997). Figure 3-1 provides a graphical representation of the stratigraphy at MCLB Barstow.
Aquifers	Water-bearing deposits in this basin are predominantly unconfined. The two primary water-bearing units are the Mojave River aquifer and the underlying Regional aquifer. The Mojave River aquifer consists of alluvial deposits of Pleistocene and younger age and is restricted to within approximately 1 mile of the Mojave River channel. The Regional aquifer consists of alluvial fan deposits of Pliocene and younger age and is more areally extensive than the Mojave River aquifer. Additional data regarding these units are provided in the groundwater profile (DWR, 2004; Densmore et al., 1997; Tierra Data, 2005).
Soil and vadose zone characteristics	Soils across the installation typically consist of alluvial deposits, characterized as generally unconsolidated to partially consolidated sediments consisting of sand and gravel with some fine-grained material. The three operational ranges are located primarily in Cajon Gravelly Sand, 2-15% slopes. The Cajon series is described as very deep, somewhat excessively drained soils with moderate alkalinity (pH of 8.0), formed in sandy alluvium from granitic rocks (NRCS, 2002). Bedrock formations crop out in the higher elevations of MCLB Barstow and at the southern end of the installation, near the Rifle Range Complex. In 1993, a background metals in soil study was conducted on the southern portion of the Nebo Area and northern portion of the Rifle Range Complex. The arithmetic mean lead concentrations from 15 soil sample locations resulted in

CSM Information Profiles – Physical Profile	
Information Needs	Preliminary Information
Soil and vadose zone characteristics, cont.	<p>the following background levels:</p> <ul style="list-style-type: none"> ■ Surface (0–3 feet bgs): 6.5 mg/kg ■ Mid-depth (3.1–10 feet bgs): 4.4 mg/kg ■ Deep (10.1 feet bgs and deeper): 3.6 mg/kg <p>The maximum detected lead concentration in soil for the southern Nebo Area was 14.3 mg/kg. Background lead concentrations at the Yermo Annex were 7.5 mg/kg at the surface, 4.4 mg/kg at mid-depth, and 3.6 mg/kg at the deep interval (Department of the Navy, 1995).</p> <p>Installation personnel also indicated that studies associated with the landfill cap at the Nebo Area found surface soil pH to range from 7.4 to 7.5.</p>
Erosion potential	<p>The local topography of the Nebo Area and the Rifle Range Complex is subject to flash floods capable of moving large loads of sediment during high-intensity rainfall. A small portion of the northern Nebo Area is located within the 100-year floodplain of the Mojave River (Tierra Data, 2005). The arid, hot climate and sparse vegetation of the Mojave Desert, combined with the availability of loose surface material, allow wind to act as an erosion agent (EDAW, 2006). Wind represents a persistent erosional force for smaller particles in the Mojave Desert (Tierra Data, 2005).</p>

3.4. Surface Water Profile

CSM Information Profiles – Surface Water Profile	
Information Needs	Preliminary Information
Hydrological unit and area	The installation is located completely within the South Lahontan Hydrological Region, Mojave Unit, Lower Mojave Area (California Regional Water Quality Control Board, Lahontan Region, 1994).
Designated beneficial uses	<p>The beneficial uses of surface water in the Lower Mojave Hydrologic Area, as designated in the California Regional Water Quality Control Board's Lahontan Regional Basin Plan (1994), include:</p> <ul style="list-style-type: none"> ■ municipal and domestic supply, ■ agricultural supply, ■ groundwater recharge, ■ contact and noncontact water recreation, ■ cold and warm freshwater habitat, and ■ wildlife habitat. <p>Because the Mojave River is typically dry most of the year at MCLB Barstow, the principal beneficial uses of surface water at the installation and in downstream areas is groundwater recharge to the Mojave River aquifer and wildlife habitat. Because surface water is intermittent, it is insufficient for agricultural supply and recreation.</p> <p>Wetlands in the area are designated for the same uses as above, as well as for freshwater replenishment; rare, threatened, or endangered species habitat; water quality enhancement; and flood peak attenuation and storage. There are approximately 0.9 acres of jurisdictional wetlands on base, including areas north of the golf course, areas along an old water diversion canal, and portions of old percolation ponds located in the Nebo Area (Tierra Data, 2005).</p>
Surface water collection points	There are no surface water intakes present in the vicinity of the installation. The water utility that supplies the city of Barstow with water (Golden State Water Company) obtains its drinking water from regional groundwater sources located outside of MCLB Barstow (Golden State Water Company, 2007).

CSM Information Profiles – Surface Water Profile	
Information Needs	Preliminary Information
Features (e.g., reservoirs, streams, drainages, playas)	<p>The Mojave River is the dominant surface water feature in the area, although for the majority of the year it is a dry riverbed. The Mojave River begins in the San Bernardino Mountains, located to the west, and terminates at the Soda and Cronese Lakes, located to the east (Tierra Data, 2005). Wastewater treatment ponds operated by MCLB Barstow and the city of Barstow for treatment of industrial and domestic waste (oxidation and effluent ponds) are located along the banks of the Mojave River (Tetra Tech, 2003). Water in these ponds evaporates or seeps into the Mojave River aquifer by discharge to river channel deposits. Effluent from MCLB Barstow is also used for irrigation at the golf course (Jacobs Engineering, 1995). Natural drainages carry runoff from plateaus and mountainous areas toward the river in ephemeral streams and dry washes (Tierra Data, 2005). The general flow of surface water in the Rifle Range Complex is from the southwest to northeast, toward the Mojave River (Figure 3-2). Drainage channels around the improved areas at the Nebo Area and the Yermo Annex are concrete-lined. There are no playas, springs, or seeps located at MCLB Barstow.</p>
Feature description (e.g., size, flow amount and direction)	<p>When water is present in the Mojave River channel, it flows from west to east. More than 80% of the flow in the Mojave River system originates in the San Bernardino Mountains. Only minor amounts of rain contribute to the streamflow once the river leaves the mountains and flows toward the desert (Tierra Data, 2005). The river generally flows underground through a coarse grained, porous channel. It resurfaces periodically as it is forced over impermeable clays or bedrock. The river is dry for an approximately 40-mile stretch upstream of MCLB Barstow near Victorville. The riverbed remains dry approximately 35 miles downstream of MCLB Barstow until it resurfaces at the Afton Canyon.</p> <p>At the Nebo Area, the riverbed bends to the southeast for a short distance before turning east again. Surface water in the Mojave River channel in the Barstow area only occurs during periods of intense rainfall. The average surface water flow recorded at the USGS surface water gage at Barstow (gage number 10262500) is 16,434 acre-ft per year, with a minimum rate of 0 acre-ft per year and a maximum of 146,341 acre-ft per year, as measured between 1930 and 2001 (Tierra Data, 2005; USGS, 2007).</p>

CSM Information Profiles – Surface Water Profile	
Information Needs	Preliminary Information
Source of surface water feature	Precipitation as rain or snow in the San Bernardino Mountains to the west represents the main source of surface water in the Mojave River. Surface water is only present in its channel around the installation during infrequent periods of notable precipitation or snowmelt. Flash floods can occur, mainly in the summertime, due to intense, localized thunderstorms. The ephemeral streams and dry washes will flow with water for a short period of time, a few hours to a few days (Tierra Data, 2005).
Perennial or intermittent	There are no perennial streams or rivers present at MCLB Barstow; ephemeral washes carry runoff toward the Mojave River from the mountainous areas of MCLB Barstow. Natural drainages are deeply incised due to high-energy runoff, particularly in the Rifle Range Complex area. The wastewater ponds located next to the Mojave River hold treated wastewater year-round.
Supported habitats/ ecosystems	No notable aquatic surface water habitats are present on the installation because the Mojave River and surrounding intermittent dry washes are typically dry year-round. Based on a 1996 ecological survey, jurisdictional wetlands are present along the Mojave River, north of the golf course, along the old canal in the Nebo Area, and in portions of the percolation ponds along the Mojave River (Tierra Data, 1998 and 2005).
Gaining or losing surface waters	When present, water in the Mojave River and surrounding washes generally recharges groundwater aquifers by infiltration into the subsurface. The Mojave River aquifer recharges the Regional aquifer (Densmore et al., 1997). There is also recharge to the local aquifers from underflow in the Mojave River alluvium (DWR, 2004).
Relation to MC loading area(s)	The operational ranges are on an elevated area approximately 0.8 miles south of the Mojave River channel. The hillside area is dissected by shallow dry washes that carry runoff during the infrequent, brief, and intense rainfall events that occur in the region. Interstate 40 runs between the operational ranges and the Mojave River.

3.5. Groundwater Profile

CSM Information Profiles – Groundwater Profile	
Information Needs	Preliminary Information
Groundwater basin(s)	MCLB Barstow is located in the Baja subarea of the Mojave River Basin (Densmore et al., 1997; Mojave Water Agency, 2004).
Designated beneficial uses	Designated beneficial uses for all groundwater basins within the Mojave Basin include municipal supply, agricultural supply, industrial service supply, freshwater replenishment, and aquaculture (California Regional Water Quality Control Board Lahontan Region, 1994). Groundwater is used for municipal supply at MCLB Barstow, for limited irrigation at the Nebo Area, and for drinking water supply at the Yermo Annex (Tierra Data, 2005). The groundwater supply wells at the Yermo Annex are located within the Mojave River aquifer. Groundwater from the Mojave River aquifer is also accessed by three private wells 2 miles down gradient from the Yermo Annex (ATSDR, 2007).
Groundwater supply wells	Yermo Annex, located on the north side of the Mojave River channel, draws its potable water supply from on-site groundwater supply wells. Three private water supply wells are located 2 miles down gradient of the Yermo Annex. Two water wells on private property are present east of the Nebo Area. Due to migration of industrial contaminants from the Nebo Area, the private residences are now supplied with water from the city of Barstow and the wells have been inactivated. Prior to 1977, the Nebo Area main base obtained potable water from six on-base production wells for drinking and operations. In 1997, MCLB Barstow stopped using the wells for drinking water and production water because of high levels of total dissolved solids. The Nebo Area now obtains potable water from the city of Barstow. The only supply wells operated by the installation at the Nebo Area are irrigation wells for the on-site golf course (ATSDR, 2007).

CSM Information Profiles – Groundwater Profile	
Information Needs	Preliminary Information
Recharge source(s)	<p>Primary recharge sources include direct precipitation and stream runoff, ephemeral stream flow, infrequent surface flow of the Mojave River, and underflow of the Mojave River from the west subbasin of the aquifers (Stamos et al., 2001). Other sources of groundwater recharge include seepage of sewage effluent and irrigation return flow (Densmore et al., 1997). The historical recharge rate at the city of Barstow is estimated at approximately 9,000 acre-ft per year (Tierra Data, 2005; Jacobs Engineering, 1997). Recharge near MCLB Barstow includes anthropogenic or artificial recharge sources, such as irrigation return flow, fish hatchery return flow, sewage return flow, septic system effluent, and golf course irrigation (Stamos et al., 2001). Because precipitation is low and the potential for evaporation is high, little, if any, recharge occurs from direct infiltration of precipitation (Densmore et al., 1997).</p>
Porous or fracture flow	<p>MCLB Barstow is covered with several hundred feet of unconfined fan deposits, which allow significant porous flow.</p> <p>The Mojave River aquifer has a hydraulic conductivity of 150 feet per day (ft/d), and the Regional aquifer has a hydraulic conductivity of 1.5 ft/d. The Mojave River aquifer is typically made up of recent and younger alluvial and fan deposits. The Regional aquifer underlies and surrounds the Mojave River aquifer. It generally consists of younger and older fan deposits and older alluvium (Densmore et al., 1997).</p> <p>Groundwater studies indicate that the Harper Lake–Camp Rock fault zone, which extends within approximately 40 ft of the surface at the Nebo Area, acts as a partial barrier to groundwater flow. Groundwater west of the fault zone tends to be relatively shallow, whereas groundwater east of the fault zone resides at greater depths; however, groundwater chemistry is fairly similar on both sides of the fault zone (Tetra Tech, 2003).</p>

CSM Information Profiles – Groundwater Profile	
Information Needs	Preliminary Information
Depth to groundwater	<p>A large range of groundwater depths has been recorded at MCLB Barstow. Observations at the Nebo Area indicate that the depth to the water table has ranged from 10 to 138 ft bgs. Installation personnel indicated that studies conducted at an IRP site located approximately 1.5 miles northwest of the Rifle Range documented depth to water between 160 and 210 ft bgs; depths up to 175 ft bgs have been noted on the alluvial fan south of Interstate 40 near the Rifle Range Complex (Jacobs Engineering, 1997; Tetra Tech, 2003). Typical depths at the Nebo Area are on the low side of this range; the relatively deeper observations have been made largely on the east side of the Harper Lake–Camp Rock fault zone where groundwater elevations drop sharply, presumably due to restricted flow across the fault zone. Groundwater depths are relatively shallow within the Mojave River bed, typically 4 to 5 ft bgs. The depth to groundwater in the drinking water supply wells at the Yermo Annex range from 174 to 400 ft bgs (ATSDR, 2007). The fault zone likely accounts for the large range of groundwater depths recorded at the installation.</p>
Gradient and flow velocity	<p>Historical monitoring has revealed groundwater gradients at the Nebo Area ranging from 0.002 to 0.03. Reported gradients east of the fault zone range from 0.005 to 0.008 (Jacobs Engineering, 1995; Tetra Tech, 2003). Combining these gradient values with the hydraulic conductivity values presented above yields a flow velocity of 0.3 to 4.5 ft/d in the Mojave River aquifer and a flow velocity of 0.002 to 0.045 ft/d in the Regional aquifer.</p> <p>West of the Harper Lake–Camp Rock fault zone, groundwater generally flows northeast and east; east of the fault zone, it flows southeast to northeast (Figure 3-3). There is significant communication between the river aquifer and the Regional aquifer. Currently, groundwater flow from the Mojave River floodplain is a primary recharge component for the Regional aquifer. However, before development of the area, groundwater flow was in the opposite direction, from the Regional aquifer to the river aquifer (Mojave Water Agency, 2004). The reversal was likely due to increased pumping from the Regional aquifer in the surrounding communities.</p> <p>The Mojave Water Agency (2004) cites a chemical tracer study near Victorville, which indicated that it could take up to 200 years for the natural recharge from an intermittent streambed to infiltrate to the water table, about 430 feet bgs.</p>

CSM Information Profiles – Groundwater Profile	
Information Needs	Preliminary Information
Gradient and flow velocity, cont.	Water depths are much shallower in the vicinity of MCLB Barstow, but based on the recharge data infiltration occurs very slowly.
Known water quality characteristics	Groundwater quality in the area is characterized as a sodium bicarbonate type (DWR, 2004). High concentrations of dissolved solids have been noted in the Barstow area (Mojave Water Agency, 2004), likely the result of release of industrial and domestic effluent, irrigation return flow, and naturally-occurring high dissolved solids water from underlying and surrounding older fan deposits (Densmore et al., 1997). A 2002 groundwater study and Yermo Annex drinking water reports referenced by installation personnel indicate that the pH typically ranges between 7 and 8 (Tetra Tech, 2003). Early 1993 sampling at the Nebo Area revealed low background concentrations of lead in groundwater across the base, ranging to a maximum of 5 micrograms per liter (Jacobs Engineering, 1995). There is known contamination of the unconfined groundwater in the area, including solvent plumes associated with the Nebo Area and the Yermo Annex. Lead is not a contaminant associated with these plumes.
Discharge location(s)	Discharge of treated effluent from percolation ponds at the city of Barstow and MCLB Barstow treatment facilities occurs on the southern bank of the Mojave River. There are no playas, springs, or seeps in the MCLB Barstow area.
Relation to MC loading areas	Much of the available site-specific data for soil and groundwater pertains to the Nebo Area, where groundwater from the Mojave River aquifer is very shallow. The actual MC loading areas (e.g., impact berms at each SAR) sit at higher elevations in the hills and are just over 1.5 miles cross gradient from the Nebo Area. Groundwater depths at these elevations are much greater than in the Nebo Area, potentially limiting the potential for lead to migrate to groundwater.

3.6. Land Use and Exposure Profile

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	Preliminary Information
Land use	<p>The Nebo Area is used for base headquarters, administration, storage, recreational activities, shopping, and housing. The Yermo Annex is primarily for storage, equipment repair, and loading/unloading. The Rifle Range Complex contains three operational ranges. There are no active uses of the Rifle Range Complex beyond training and qualification; the majority of the complex serves as a buffer zone. A utility corridor runs along the northern portion of the Rifle Range Complex (USMC, 2006).</p> <p>Much of the land immediately surrounding MCLB Barstow is undeveloped BLM lands; the Ord-Rodman Desert Wildlife Management Area (DWMA) is located south of the range complex and is used for sheep grazing and recreation (off-road vehicles) (BLM, 2007). A few commercial buildings and private residences are located east of the Rifle Range Complex, on the north side of Interstate 40. Quarry operations are located to the west of the installation and are operated by Service Rock Products for concrete and aggregate production (Service Rock Products, 2007). The city of Barstow is located west of the installation boundaries. Installation personnel reported initial discussions between the Marine Corps and BLM to obtain additional acreage south of the Rifle Range Complex to serve as a buffer to the installation.</p>
Current human receptors	<p>Potential human receptors are limited due to the lack of significant development and use of the area. The closest existing water wells are located at the Yermo Annex, several miles from the Rifle Range Complex. Potential receptors include installation personnel and users of privately owned groundwater wells farther down gradient of the installation; there are no surface water users in the vicinity of MCLB Barstow, as the Mojave River is dry throughout most of the year. Potable water for use at the Rifle Range Complex is trucked in and stored (Tierra Data, 2005); thus, there is no direct exposure from consumption of water at the Rifle Range Complex.</p>

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	Preliminary Information
Land use restrictions	<p>In general, the public is not allowed on MCLB Barstow; however, in the past, California Highway Patrol and other public groups have been granted access to the Rifle Range Complex (Tierra Data, 2005). Warning signs are posted around the range complex to warn the public of the training exercises conducted at the Rifle Range Complex (Department of the Navy, 2004). Operation and maintenance activities at the range complex have required Section 7 consultation with the U.S. Fish and Wildlife Service due to the presence of the federally listed threatened desert tortoise and its designated critical habitat (see Section 3.7). The presence of cultural resources at the range complex has also necessitated occasional consultation with the State Historic Preservation Officer.</p>

3.7. Natural Resources Profile

CSM Information Profiles – Natural Resources Profile	
Information Needs	Preliminary Information
Ecosystems	MCLB Barstow is located within the north-central Mojave Desert (Tierra Data, 2005). Ecosystems are consistent with high desert ecosystems in the region.
Vegetation	Five plant communities have been identified at MCLB Barstow, with creosote bush scrub covering an overwhelming majority of the base. Sensitive plant communities include the desert wash scrub and cottonwood-willow desert riparian communities (Tierra Data, 2005).
Fauna	Fauna at MCLB Barstow primarily consists of small mammals (such as mice, squirrels, and rabbits), as well as small reptiles. Snakes, bobcats, and coyotes are also known to be present in the area. A number of bird species utilize available vegetated areas; migratory birds that pass through the region commonly are associated with the limited wetlands present in the Nebo Area. Although not surveyed at the base, bats are known to be present in urban areas of the region (Tierra Data, 2005).
Special status species	<p>The desert tortoise is a federally and state-listed threatened species whose presence on MCLB Barstow has been documented in the Nebo Area and the Rifle Range Complex (Tierra Data, 2005). There are a number of other special concern, threatened, or endangered plant and animal species that have the potential to occur on the base; however, very few have been observed at the base:</p> <ul style="list-style-type: none"> ■ A recent bird survey indicates sightings of the southwestern willow flycatcher (federally and state-listed endangered), but no nests were observed (Lovio, 2006). ■ The golden eagle (California Species of Concern, Federal Bald and Golden Eagle Protection Act) and vermilion flycatcher (California Species of Concern) were observed at the installation during an older survey (Tierra Data, 1996). ■ The 2005 INRMP indicates the burrowing owl has been observed at the installation, though installation personnel could not confirm that sightings of these species have ever been made. <p>The desert tortoise represents the primary species of concern due to its consistently observed presence and</p>

CSM Information Profiles – Natural Resources Profile	
Information Needs	Preliminary Information
Special status species, cont.	habitat at the Rifle Range Complex.
Management zones	To protect the Mojave population of the desert tortoise, several DWMA's were established. One of these, the Ord-Rodman DWMA, includes approximately 540 acres of the southern portion of the Rifle Range Complex (Tierra Data, 2005). This area is considered critical habitat for the recovery of the desert tortoise (Figure 3-4).
Relationship of MC sources to habitat and potential receptors	The three operational ranges are estimated to be 800 ft north of the Ord-Rodman DWMA boundary. Surface water runoff from the ranges flows north toward the Mojave River, away from the Ord-Rodman DWMA. The combined SDZ for the Close Combat Pistol Range and Pistol Range extends over the DWMA, while the SDZ for the Rifle Range slightly overlaps the DWMA boundary. Desert tortoises are recorded regularly within the range complex; the complex has been characterized as having moderate to high population densities, where a previously cited 2000 survey found a density of 68 tortoises per square mile (USMC, 2006). The REVA assessment team observed burrows adjacent to the Rifle Range along an access road during its May 2007 visit at the installation.
Degree of disturbance	The range complex has been in its present location since 1955 and is anticipated to continue in its general form and function. Range maintenance activities and minor structural modifications have resulted in relatively minimal disturbance of habitat and population of desert tortoises. For example, the 2005 installation of a perimeter fence around the range complex only resulted in the disturbance of 25.88 acres of desert tortoise habitat—of which 8.31 acres were critical habitat—and one accidental mortality, with no individual relocations (Palmer, 2006). The existing Incidental Take Statement allows two mortalities and 15 harassments annually. Active training activities at the ranges are limited and are unlikely to directly affect tortoise populations.

3.8. Potential Pathways and Receptors

3.8.1. Surface Water Pathway

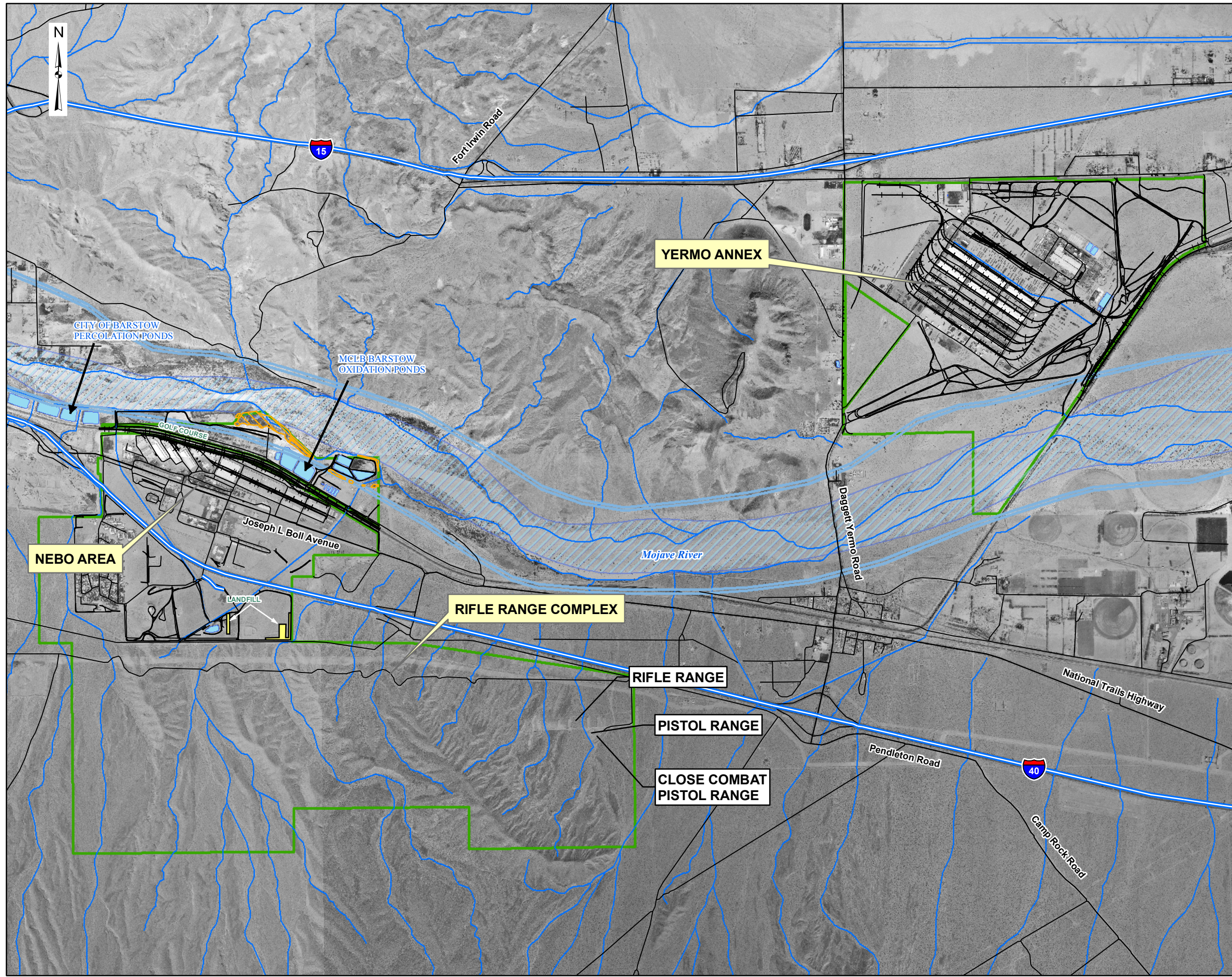
Transport of MC via surface water runoff is the primary transport mechanism at the MCLB Barstow operational ranges. Annual precipitation is low and generally limited to the winter months, though brief and intense thunderstorms during the summer can create flash floods that may move relatively significant amounts of material. Surface runoff

follows natural topographic gradients from the ranges through incised washes northward toward the Mojave River, approximately 0.8 miles from the ranges. Such drainage patterns can transport MC (lead) downstream through dissolution in runoff water or erosion of soil. However, because site soils and storm water measurements indicate neutral or slightly alkaline conditions (soil pH between 7.4 and 8.4; storm water pH between 6.5 and 7.8), lead migration via dissolution in surface water is likely to be limited. In addition, engineered controls at the Close Combat Pistol Range and Pistol Range, which limit run-on from entering the range, combined with regular maintenance at all three ranges (addition of soil to bullet pockets), minimize the potential for erosion and surface water transport of lead.

Because surface water is present within the Mojave River and its associated drainages only during infrequent storm events, there are no active uses of surface water (e.g., potable water source, irrigation) for human receptors. The desert tortoise, which is present on the Rifle Range Complex, potentially may interact with surface water in drainages running north toward the Mojave River. However, given the velocity of runoff moving through the drainages during the torrential storms in the region, it is unlikely that the desert tortoise would be exposed to lead dissolved in surface water leaving the operational ranges. While desert tortoises have been noted to create depressions in their territories to collect rainwater and occasionally sit in the depressions in anticipation of storms (Malcolm Pirnie, 2007), it is unlikely that these depressions would be located within ephemeral washes.

3.8.2. Groundwater Pathway

The gravelly sandy soil present at the Rifle Range Complex is highly permeable, potentially facilitating infiltration of lead into the subsurface. However, precipitation at the installation usually occurs during high intensity storm events; as such, surface runoff is expected to dominate. In addition, high temperatures and low humidity in the region contribute to high rates of evaporation. Therefore, only limited infiltration is likely to occur. In addition, the anticipated depth to groundwater in the vicinity of the ranges makes it unlikely that the MC that do infiltrate into the subsurface will reach groundwater. Observations at the Nebo Area indicate that the depth to the groundwater table has ranged from 10 to 138 ft bgs, though the deeper depths generally have been found east of the Harper Lake–Camp Rock fault zone. Groundwater depths of up to 175 ft bgs have been noted on the alluvial fan south of Interstate 40, and the range complex sits at a notably higher elevation. Additionally, limited soil data recently collected at the Pistol Range suggest infiltration of lead into the subsurface at the range complex itself is very limited. If lead should reach the deep groundwater, pH measurements of groundwater (pH between 7.79 and 7.81) indicate that it is unlikely to migrate with subsurface flow. There are no human receptors for groundwater consumption; the closest groundwater extraction wells for potable use are located approximately 2.5 miles to the northeast of the ranges.

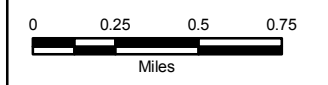
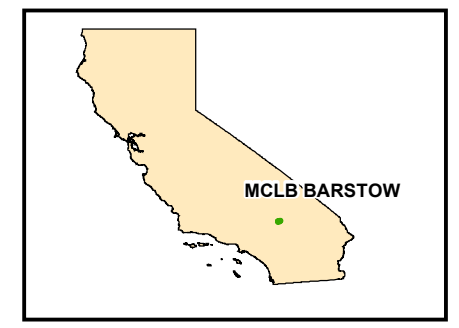


**REVA
FIGURE 3-2
RANGE LOCATIONS
AND DRAINAGE PATHS**

**MCLB BARSTOW
BARSTOW, CA
FINAL**

LEGEND

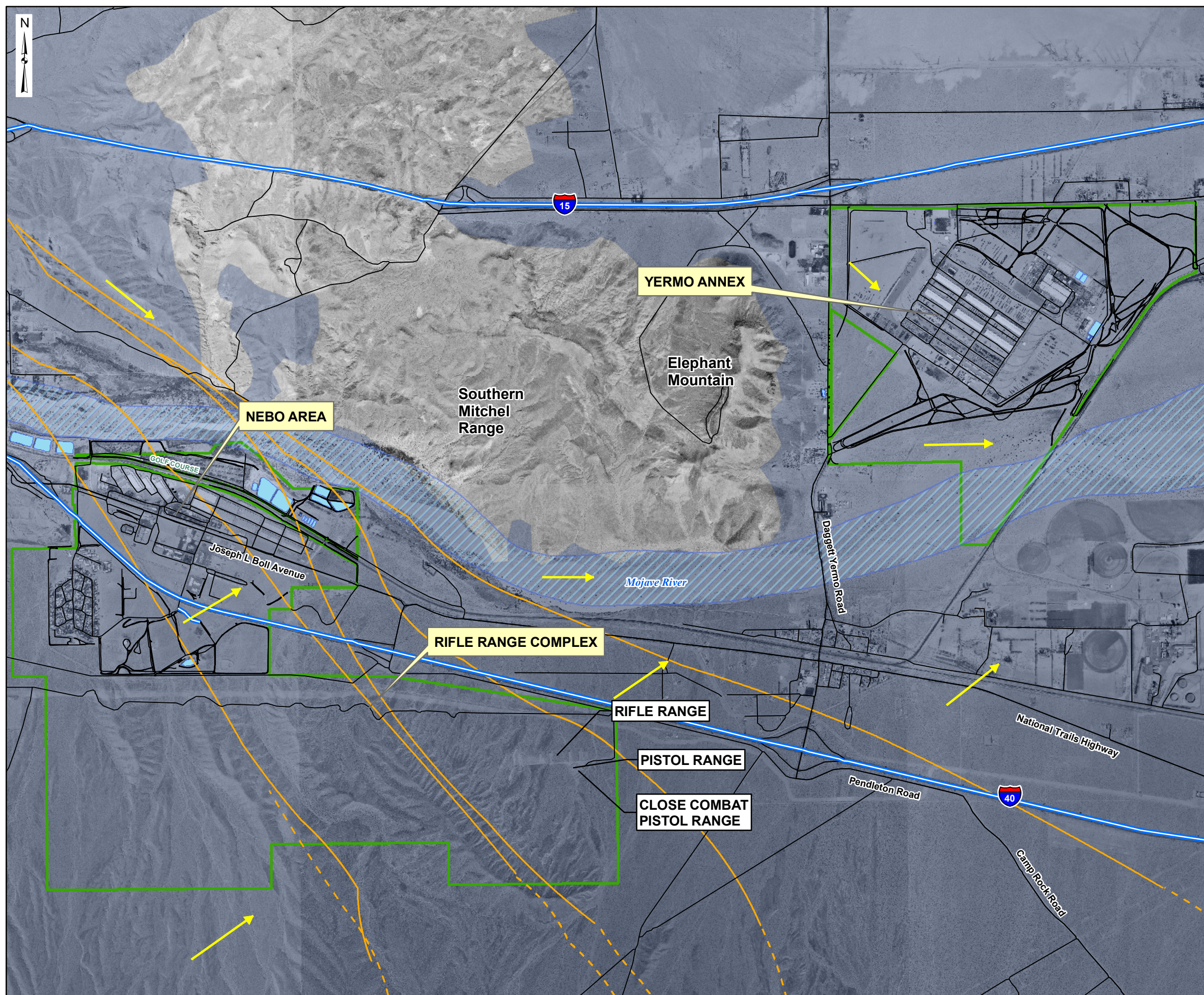
- INSTALLATION BOUNDARY
- MOJAVE RIVER (DRY)
- SURFACE IMPOUNDMENTS
- ESTIMATED 100-YEAR FLOODPLAIN
- SURFACE DRAINAGE (INTERMITTENT)
- INTERSTATE
- ROAD
- RAILROAD
- LANDFILL
- JURISDICTIONAL WETLANDS



DATE: JANUARY 2009
SOURCE: MCLB FMD/GIS, 2007
TECOM, 2008



**MALCOLM
PIRNIE**

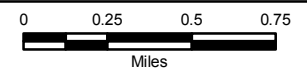
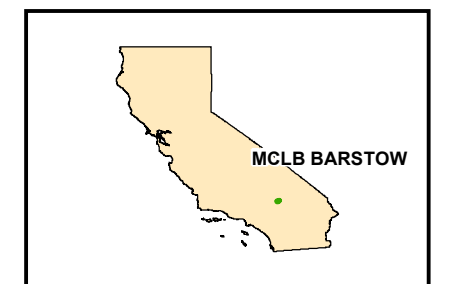


**REVA
FIGURE 3-3
RANGE LOCATIONS
AND GROUNDWATER BASINS**

**MCLB BARSTOW
BARSTOW, CA
FINAL**

LEGEND

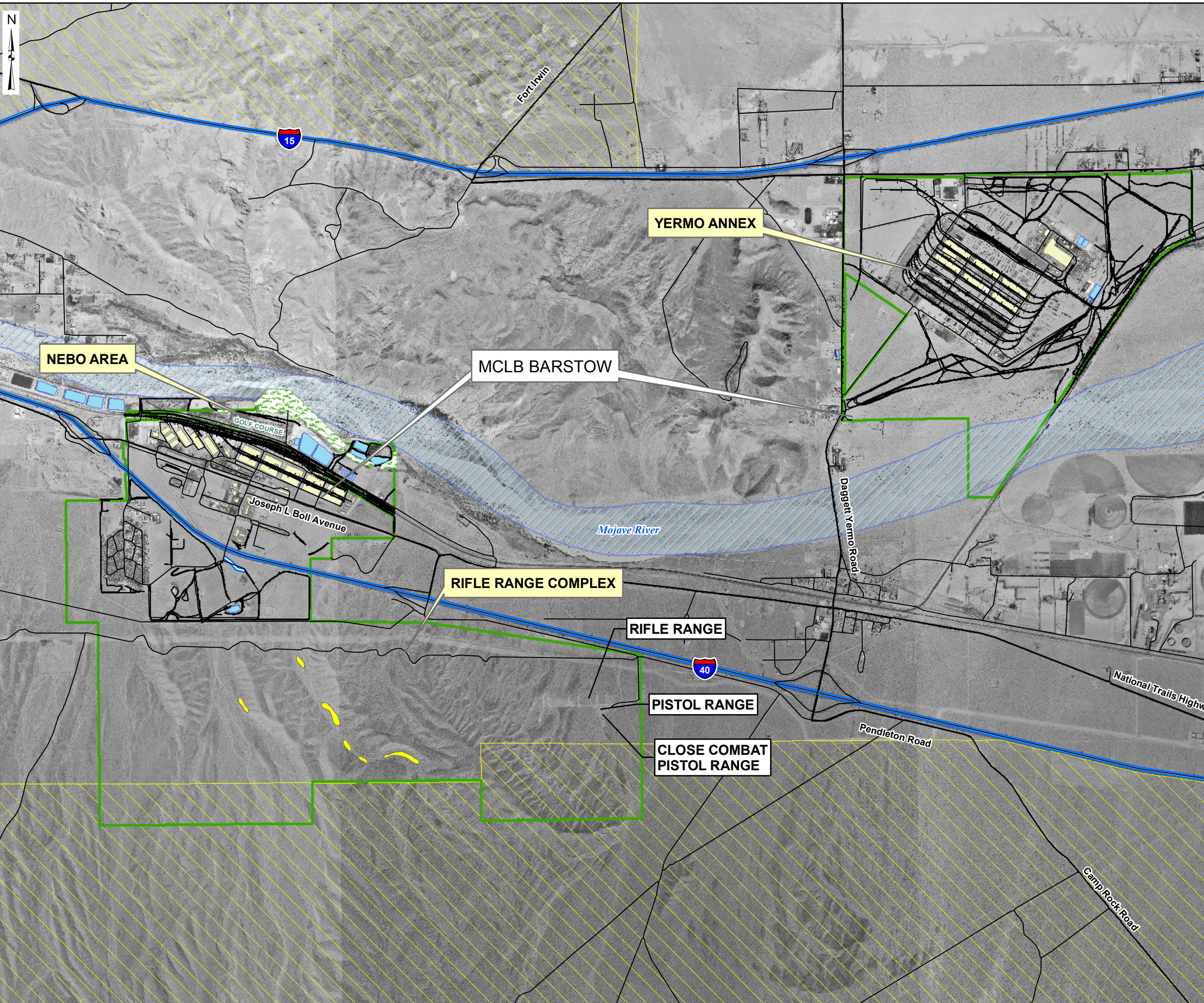
- INSTALLATION BOUNDARY
- LOWER MOJAVE RIVER VALLEY GROUNDWATER BASINS
- MOJAVE RIVER (DRY)
- SURFACE IMPOUNDMENTS
- FAULT LINE
- FAULT LINE (APPROXIMATE LOCATION)
- INTERSTATE
- ROAD
- GROUNDWATER FLOW



DATE: JANUARY 2009
SOURCE: DENSMORE, ET AL., 1997
MCLB FMD/GIS, 2007
TECOM, 2008
USGS REPORT 83-4053



**MALCOLM
PIRNIE**



**REVA
FIGURE 3-4
DESERT TORTOISE CRITICAL HABITAT**

**MCLB BARSTOW
BARSTOW, CA**

FINAL

LEGEND

- INSTALLATION BOUNDARY
- MOJAVE RIVER (DRY)
- SURFACE IMPOUNDMENTS
- BUILDINGS
- INTERSTATE
- ROAD
- RAILROAD
- ORD - RODMAN DESERT WILDLIFE MANAGEMENT AREA



SENSITIVE PLANT COMMUNITIES

- COTTONWOOD - WILLOW
- DESERT SCRUB WASH



0 0.3 0.6 0.9
Miles

DATE: JANUARY 2009
SOURCE: MCLB FMD/GIS OFFICE, 2007
TECOM 2008

4. Munitions Constituents Loading Rates and Assumptions

The amount of indicator MC deposited on operational ranges, referred to as MC loading, must be estimated to evaluate the potential for an off-range release from defined MC loading areas. The general locations of the operational ranges at MCLB Barstow are shown in Figure 3-2. The following operational range-specific information regarding military munitions is typically required to calculate the potential MC loading for each operational SAR:

- Expenditure data (type and quantity of munitions fired or used)
- Quantity of REVA indicator MC in each military munition expended
- Estimation of the physical area across which the REVA indicator MC are distributed on the operational range (MC loading area)
- Activities potentially decreasing the MC loading rate (e.g., range maintenance)

The methodology for estimating MC loading at MCLB Barstow was modified from the methodology defined in the *REVA Reference Manual*. Because of the significant reduction in the number of Marines stationed at MCLB Barstow, MC loading at the three SARs differs greatly between historical use and current use. Therefore, separate loading rates have been estimated based on historical and current uses. Due to the data limitations for range utilization at MCLB Barstow (e.g., lack of historical use expenditures), the estimates of historical small arms ammunition use were based on the ammunition loading rates provided in the PRA (USACE, 2001b). Small arms expenditures have only recently begun to be tracked by Range Control personnel; only two months of data were available to the REVA assessment team during the site visit (January and February 2007). During this time, the Rifle Range was not active. Construction of upgrades at the Rifle Range closed the range for three years (MCLB Barstow PAO, 2007). Therefore, the current MC loading for the three SARs is primarily based on the known training allocation for the installation, as well as estimates of range use, taking into account the current number of Marines stationed at MCLB Barstow (approximately 100), the number of firing lines at each range, and the number of rounds generally used during requalification. Additional details regarding the MC loading assumptions are provided in **Section 4.4**.

4.1. Indicator MC

Based on information compiled during the REVA site visit, the ammunition types used at the three operational ranges at MCLB Barstow are limited to small arms. MC associated

with small arms ammunition used by the Marine Corps include lead, antimony, copper, and zinc. REVA focuses on lead as the MC indicator for SARs because lead is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition.

4.2. Small Arms Expenditure Records

Operational range-specific expenditure records (detailed small arms ammunition types and quantities) represent an ideal data source upon which to calculate potential MC loading for each operational SAR. During the site visit by the REVA assessment team, interviews with previous and current installation personnel provided information that characterized general training and small arms use at the installation. Because of the limitations associated with the expenditure records (e.g., lack of tracking of historical expenditures), information from these interviews served as the basis for conservatively estimating lead loading at MCLB Barstow. Based on current installation personnel interviews, Range Control only began tracking ammunition expenditures at MCLB Barstow within the past year. The current estimated lead loading rates are 2.5 to 20 times lower than the estimated historical loading due to a decrease in the number of active duty Marines stationed at MCLB Barstow. Up to 1,200 Marines were stationed at MCLB Barstow in the past; only 350 Marines were present in 1998, and approximately only 100 are present today (USACE, 2001a and 2001b). In addition to military expenditures, nonmilitary personnel (such as the California Highway Patrol) used the ranges for practice for a period of four to five years (Tierra Data, 2005). The exact number of nonmilitary personnel and the number of rounds that were used at each range are not documented by MCLB Barstow. However, discussions with Range Control personnel indicated that the nonmilitary personnel used the range approximately once per quarter, with five or six people for a half day. As of 2006, nonmilitary uses have ceased. The majority of the lead loading is currently associated with Marines stationed at the installation and the installation police/Federal Officer training that has been recently initiated.

4.3. Loading Areas

Based on the known use of the SARs at MCLB Barstow, lead deposition is expected to be concentrated in the impact berms at each range. Smaller amounts of lead may be deposited on the range floor, just below the impact berm and just beyond the berm, due to ricochet.

Based on tests conducted at Marine Corps Air Ground Combat Center (MCAGCC) Twentynine Palms (located approximately 60 miles southeast of MCLB Barstow), lead concentrations significantly decrease as distance from the impact berm increases. Soil sampling was conducted at MCAGCC Twentynine Palms in 1998 as part of a Small Arms Range Maintenance and Repair Project for the Marksmanship Training Unit

(MTU) (Battelle, 1998). Results of the sampling effort indicate that, although lead was present in soil up to 1,000 feet from the impact berms, the majority of the lead was concentrated within the impact berms. Soil sampling in areas outside of the range footprint and berm areas indicated very limited migration of lead in the subsurface. Soil samples collected from a depth of 4 to 8 inches bgs were within the acceptable limits for lead in soil. Similar conditions are expected at the MCLB Barstow SARs because the physical and environmental characteristics (climate, precipitation, intermittent surface runoff, and soil types) are similar to those observed at the MCAGCC Twentynine Palms MTU SARs.

4.4. SAR Assumptions and Lead Loading Rate Estimates

A number of assumptions were made throughout the MC loading estimation process. The method used to estimate lead loading at the SARs was based on the principles described in the *REVA Reference Manual* (HQMC, 2006); however, the MC Loading Calculator method described in the manual could not be applied due to the data limitations. The existing expenditure data are very limited and do not match the level of training described for the operational ranges, nor do they cover the entire range of small arms ammunition historically used at the ranges. The most useful information available to the REVA assessment team was the loading information in the PRA, the annual training allocation total for MCLB Barstow, and other estimates provided by Range Control for the range training activities for Marines and non-Marine police forces (USACE, 2001b).

4.4.1. Historical Lead Loading

Utilizing historical data sources summarized in the ASR, the PRA for MCLB Barstow estimated ammunition loading rates for the three operational ranges for the time period 1955 to 1998. Loading estimates of small arms ammunition are based upon live rounds. The following sections describe the types of ammunition historically utilized at each of the SARs.

4.4.1.1. Rifle Range

Based on the PRA, small arms ammunition was used at the Rifle Range at MCLB Barstow between 1955 and 1998. The representative DoD Identification Codes (DoDICs) were selected for each caliber of small arms ammunition based upon the highest lead content per projectile, allowing for a conservative assumption during calculations. Based on the number of projectiles reported in the PRA as used at the Rifle Range, the average historical loading rate of lead is approximately 1,425 pounds per year (lb/yr) of lead (averaged over 43 years of range usage).

4.4.1.2. Close Combat Pistol Range

Based on the PRA, small arms ammunition was used at the Close Combat Pistol Range at MCLB Barstow between 1955 and 1998. The representative DoDICs were selected for each caliber of small arms ammunition based upon the highest lead content per projectile, allowing for a conservative assumption during calculations. Based on the number of projectiles reported in the PRA as used at the Close Combat Pistol Range, the average historical loading rate of lead is approximately 250 lb/yr of lead (averaged over 43 years of range usage).

4.4.1.3. Pistol Range

Based on the PRA, small arms ammunition was used at the Pistol Range at MCLB Barstow between 1955 and 1998. The representative DoDICs were selected for each caliber of small arms ammunition based upon the highest lead content per projectile, allowing for a conservative assumption during calculations. Based on the number of projectiles reported in the PRA as used at the Pistol Range, the average historical loading rate of lead is approximately 1,544 lb/yr of lead (averaged over 43 years of range usage).

4.4.2. Current Lead Loading

MCLB Barstow only recently began tracking expenditures at its ranges; at the time of the site visit, only two months of expenditure data were available. However, current lead loading estimates can be made based on the annual training allocation for the installation as well as the known training activities conducted at each range. The annual small arms ammunition training allocation is spread amongst the three ranges and includes rounds allocated to the non-Marine police force.

The number of rounds annually issued to an installation represents the total allotment of ammunition available for training for that year; based on training tempo fluctuations and other variables, the total training allocation of ammunition may or may not be used from year to year. However, Range Control personnel indicated that over the last two years, nearly all of the training allocation has been used at the Rifle Range Complex, though the exact figure was not available. Therefore, to complete the lead loading estimates for current training patterns, the REVA team assumed that the entire training allocation is used each year, which is a conservative assumption for this assessment. Based on information provided by Range Control, the distribution of rounds is assumed to be 61 % at the Rifle Range, 24 % at the Close Combat Pistol Range, and 15 % at the Pistol Range.

4.4.2.1. Rifle Range

For lead loading at the Rifle Range, it is assumed that approximately 61% of the small arms training ammunition allocated to MCLB Barstow is expended as part of the periodic requalification requirements for active duty Marines and the non-Marine police force.

The current annual lead loading rate, conservatively based on the small arms ammunition type that contained the greatest amount of lead used at the Rifle Range, is approximately 130 lb/yr of lead.

4.4.2.2. Close Combat Pistol Range

Lead loading at the Close Combat Pistol Range was based on the expenditure of 24% of the small arms training ammunition allocated to MCLB Barstow. The rounds are used for periodic requalification requirements for active duty Marines, as well as training for the non-Marine police force. Based on communications with Range Control personnel, it was assumed that various types of small arms ammunition from pistols and shotguns were used at the Close Combat Pistol Range. Based on this assumption, the current annual lead loading rate of lead is approximately 101 lb/yr of lead.

4.4.2.3. Pistol Range

For the Pistol Range, it is assumed that 15% of the small arms training allocation were used at the Pistol Range per year. The rounds are used for periodic requalification requirements for active duty Marines, as well as training for the non-Marine police force. It was conservatively assumed that all of the rounds expended at the Pistol Range were of the variety that contained the greatest lead content of all small arms ammunition. Based on the training allocation estimates for expenditures, the current lead loading rate is 101 lb/yr of lead.

4.4.2.4. Nonmilitary Lead Loading

Nonmilitary personnel have previously used the ranges. It is documented in the MCLB Barstow INRMP that the California Highway Patrol uses the ranges approximately 60 days per year, and a civilian gun club uses the ranges approximately 12 times per year (Tierra Data, 2005). However, based on interviews with Range Control, these nonmilitary users no longer use the ranges. In addition, the number of nonmilitary users was most likely lower than that documented in the INRMP. The nonmilitary use lasted approximately four to five years and ended around 2005. None of the documents reviewed or personnel interviewed detailed the number of nonmilitary personnel using the range or the types and numbers of ammunition used.

As described in Section 4.4.2, non-Marine members of the installation police force are currently trained at the Rifle Range Complex as part of the Federal officer training program. Ammunition used for the police training is allocated from the small arms training ammunition issued to MCLB Barstow annually. Therefore, the nonmilitary lead loading associated with the non-Marine police force is accounted for in the military expenditure data.

5. Small Arms Range Assessments

The purpose of the REVA baseline study was to identify whether there has been a release or there is a substantial threat of a release of MC of concern from the operational range or range complex areas to off-range areas. The SARAP was developed as a qualitative approach to identify and assess factors that influence the potential for lead to migrate from an operational range. These factors include the following:

- Range design and layout
- Physical and chemical characteristics of the area
- Past and present operation and maintenance practices

In addition, potential receptors and pathways are identified relative to the SAR being assessed. The potential for an identified receptor to be impacted by MC migration through an identified pathway is evaluated.

5.1. Summary of the SARAP

The SARAP is to be used for:

1. identification of the SARs within the Marine Corps that have the greatest potential for environmental concern (i.e., potential for lead to impact receptors) and
2. assessing the need for implementing further actions. Recommended further actions can include, but are not limited to, the following:
 - Sampling surface water, groundwater, and/or soil
 - Conducting additional studies
 - Identifying/implementing best management practices

The qualitative assessment process for a SAR involves describing and documenting its physical and environmental conditions, as well as how the range is utilized and maintained (including the dates of use and types and amounts of small arms ammunition expended). The SAR data collection form in **Section 3** of the *REVA Reference Manual* is a guide to collecting and documenting the necessary information used to complete the evaluation forms in this protocol (Tables 1 through 6 for each SAR in Appendix A). The data collection form includes a comprehensive list of data elements that are useful in establishing the historical and current physical conditions, as well as capturing the types of information on conditions that influence the potential for lead to migrate from the range. The data collection form is organized by the following major topics or information areas associated with the operational ranges:

- Basic range information

- Current range information
- Current range layout
- Historical range operations
- Amount of lead potentially deposited
- Environmental characteristics
- Potential receptors
- Surrounding land use
- Environmental activities conducted at the range.

The data collection form in the *REVA Reference Manual* was used in the field to collect pertinent data on the major factors that can potentially influence the ability of lead to migrate from each SAR. The assessment process involves identifying and evaluating possible factors that can influence the potential for lead to migrate off range. The protocol produces two scores: the sum of surface water elements and the sum of groundwater elements. Existing data characterizing range operations, the physical environment, transport mechanisms, and potential receptors were gathered to complete the SAR assessments. The data were used to populate the SAR assessment tables, which produce scores for specific factors that may influence potential MC transport and exposure to receptors. The scores are aggregated to determine the overall environmental concern evaluation rankings for surface water and groundwater conditions. The scoring system assigns minimal, moderate, and high values for both environmental concern categories:

- Minimal (0 to 29 points) – SAR has minimal or no potential for lead migration and environmental concern, indicating minimal threat of environmental concern. No further action is currently required, but actions may be considered to maintain a minimal ranking.
- Moderate (30 to 49 points) – SAR may have the potential for lead migration and environmental concern, most likely indicating that there is not immediate environmental concern but actions may be necessary to prevent a greater or future concern.
- High (50 to 65 points) – SAR most likely has the potential for lead migration and environmental concern, creating the greatest level of environmental concern and requiring the recommendation of additional action(s).

Additional documentation describing the purpose, requirements, and supporting drivers for the performance of the SAR assessment is provided with the range-specific assessments in Appendix A, which contains the SAR assessments of the three operational ranges.

A summary of the SAR assessment results is provided in Table 5-1. Because the SARs are located immediately adjacent to one another, the physical and environmental characteristics that factor into the SAR assessments are similar for all three ranges. The only differences in the ranges consist of operational aspects, such as types of ammunition used, expenditure rates, direction of fire, and engineered controls established on the ranges. The results show that the SARs were characterized as minimal environmental concern based on the surface water and groundwater scores and professional judgment.

Table 5-1: Summary of SAR Prioritizations

Range Name	Surface Water Priority	Groundwater Priority
Rifle Range	Minimal	Minimal ^a
Close Combat Pistol Range	Minimal	Minimal ^a
Pistol Range	Minimal	Minimal ^a

^aOriginal environmental concern evaluation priority was moderate; the priority was adjusted based on professional judgment.

The evaluation results indicate that these SARs do not require further actions. This judgment follows from certain site conditions and existing range management practices, including:

- current and continued low use of small arms ammunition,
- regional and site-specific values of soil pH, indicating that lead is unlikely to be mobile at the site,
- lack of surface water and groundwater pathway/receptor interactions for human receptors, and
- limited potential for surface water pathway/receptor interaction for ecological receptor (desert tortoise).

The SAR assessments for the three operational ranges are provided in the following sections and include a summary of the data factors used in the assessment and justification for the application of professional judgment to lower groundwater priorities from moderate to minimal.

5.2. Rifle Range

5.2.1. Site Background

The Rifle Range is generally located on the eastern portion of the Rifle Range Complex at MCLB Barstow (Figure 3-2). The Rifle Range is used for marksmanship and requalification by the Marines stationed at MCLB Barstow. In addition, a new police

force for the installation has recently begun using the ranges for training. The Rifle Range was established in 1955 and has 30 firing positions with firing lines at 25, 200, 300, and 500 yards (USACE, 2001b; MCLB Barstow PAO, 2007). Firing lines also are present at 600- and 1,000-yard distances; however, these firing lines are no longer used for rifle training. Small arms ammunition is currently used at the range. The range is oriented for firing to the west, where the rear impact berm is located. Targets are raised into place behind a protective wall approximately 175 feet in front of the rear impact berm. The current annual lead loading rate by Marine and police force units is assumed to be approximately 130 lb/yr. The estimate of the historical annual loading rate was based on quantities of munitions reported in the PRA and was assumed to be approximately 1,425 lb/yr. No bullet-capturing technologies currently are used at the Rifle Range.

Many of the site-specific parameters for this range, presented in the assessment in Appendix A, were extracted from the NRCS SSURGO database and the Final EA for the installation of the 25-yard firing line. Data types include precipitation, surface slope, vegetation, runoff conditions, soil pH, soil type, infiltration conditions, depth to groundwater, and clay content (NRCS, 2002; USMC, 2006). Other data sources used in the range include field observations, historical documents, USGS monitoring data, and the Marine Corps GIS databases.

Minimal vegetation was observed during the site visit in the area between the firing lines and the backstop berm and immediately surrounding the firing lines and the berms. The Final EA for the 25-yard firing line describes the berm area as relatively open with 10% to 20% vegetative cover provided by creosote bush scrub (USMC, 2006). This is the predominant vegetative community in the Rifle Range Complex (Tierra Data, 2005). Some erosion was observed along the front of the backstop berm and on the southern boundary of the berm, as water from higher elevations runs northward toward the Mojave River.

The soils in the Rifle Range and its SDZ consist of four different soil types, according to the SSURGO database (Figure 5-1). The Rifle Range itself, including the rear impact berm in which most lead accumulates, is primarily composed of Cajon Gravelly Sands with 2% to 15% slope. The slope of the Rifle Range is flat, with dry washes bisecting the range between firing lines, running south to north toward the Mojave River. Other soil types located downrange within the Rifle Range SDZ are Typic Haplargids Yermo Complex, within the center of the range SDZ, and Nebona-Cuddeback Complex, with 2% to 9% slope, present on the range footprint as well as the far downrange extent of the SDZ (NRCS, 2002). A small section of Arizo gravelly loamy sand with 2-9% slope is present at the westernmost end of the SDZ. Generally, the soils at MCLB Barstow are recent soils that are typically immature and have low organic content. The immature

soils include a mixture of sands, gravelly sands, and loamy sands that form in Holocene alluvium and are derived primarily from granitic parent material (Tierra Data, 2005).

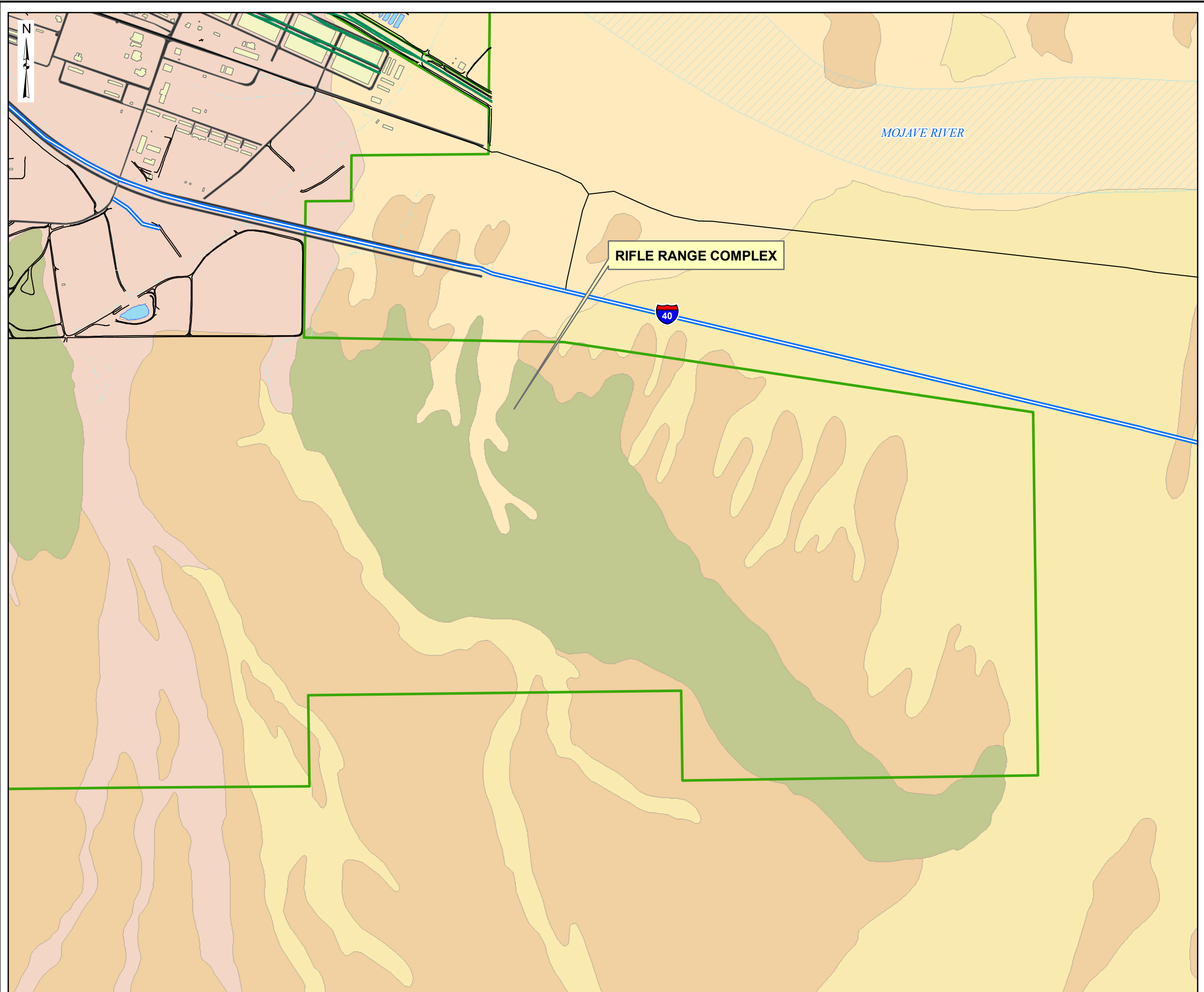
The soils at MCLB Barstow are permeable, and the slopes within the Rifle Range footprint are relatively flat, suggesting infiltration is the predominant water transport mechanism. However, the intense rainfall events that occur at MCLB Barstow generate flash flood conditions, which increase the potential for surface runoff rather than infiltration. High evaporation rates in the region likely also limit infiltration (Western Region Climate Center, 2007).

Surface water and groundwater receptors for the installation are identified in Section 3. No drinking water wells are present at the Rifle Range Complex; potable water is trucked in from an off-site source. The closest wells used for potable water sources are located 2.5 miles to the northeast. The Ord-Rodman DWMA for the desert tortoise is located south of the Rifle Range SDZ. The Ord-Rodman DWMA is considered critical habitat for the desert tortoise; they have been observed within and around the Rifle Range. As REVA only assesses threatened and endangered ecological receptors in off-range locations and surface water runoff travels from the source area (e.g., the impact berm) to the north, only desert tortoises located north of the Rifle Range have the potential to come into contact with lead in surface water. Even this potential interaction is likely to be limited, as desert tortoises are unlikely to directly consume surface water moving through the ephemeral washes. Additional site-specific information is presented in Appendix A.

5.2.2. Assessment Results

Surface Water

The surface water environmental concern evaluation ranking score was 29, placing it in the minimal score range (0 to 29). On the basis of the SAR assessment for the Rifle Range, the range has a minimal potential for off-range lead migration, and the assessment most likely indicates no immediate environmental concern. The chemical conditions at the site (i.e., soil and storm water pH between 6.5 and 8.5), moderate range use, and limited precipitation do not suggest a high possibility of off-range migration of lead at the Rifle Range. In addition, there are no human receptors utilizing surface water in the area, and only limited ecological receptor (desert tortoise) interactions with surface water may occur.



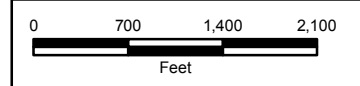
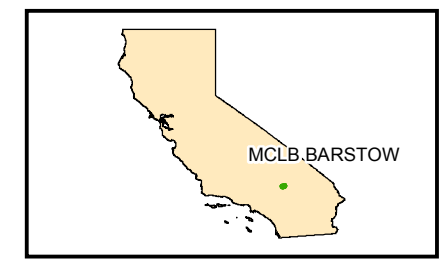
**REVA
FIGURE 5-1
SOIL TYPES AT RIFLE
RANGE COMPLEX**

**MCLB BARSTOW
BARSTOW, CA**

FINAL

LEGEND

- INSTALLATION BOUNDARY
- MOJAVE RIVER (DRY)
- SURFACE IMPOUNDMENTS
- INTERSTATE
- ROAD
- BUILDINGS
- SOILS**
- ARIZO GRAVELLY LOAMY SAND, 2-9% SLOPE
- CAJON GRAVELLY SAND, 2-15% SLOPE
- NEBONA-CUDEBACK COMPLEX, 2-9% SLOPE
- TYPIC HAPLARGIDS-YERMO COMPLEX, 8-30% SLOPE



DATE: JANUARY 2009
SOURCE: MCLB FMD/GIS OFFICE 2007
TECOM 2008
USGS REPORT 83-4053



**MALCOLM
PIRNIE**

Groundwater

The groundwater environmental concern evaluation ranking score was 31, placing it in the moderate score range (30 to 49). On the basis of the SAR assessment for the Rifle Range, the range might have the potential for lead migration off range, but the assessment most likely indicates no immediate environmental concern. Based on the chemical conditions at the site (i.e., soil and groundwater pH between 6.5 and 8.5) and the depth to groundwater (greater than 100 feet bgs), off-range migration of lead through groundwater is unlikely to occur. In addition, groundwater wells used for potable water sources at the Yermo Annex are far from the Rifle Range; the Harper Lake–Camp Rock fault also restricts groundwater flow from the range to the Yermo Annex. Therefore, there are no human pathway/receptor interactions for lead in groundwater for the Rifle Range. As such, the groundwater environmental concern evaluation ranking was reduced to minimal based on professional judgment.

5.3. Close Combat Pistol Range

5.3.1. Site Background

The Close Combat Pistol Range is generally located south of the Rifle Range and adjacent to the Pistol Range (Figure 1-3). The Close Combat Pistol Range was established in 1955 and has 10 firing points. The range is used to practice close combat firing using various types of small arms ammunition. Targets are placed in front of an earthen impact berm during training. The Close Combat Pistol Range was separated physically from the Pistol Range by an earthen side berm constructed in the 1960s (USACE, 2001b). The direction of fire is from northeast to southwest. The combined SDZ for the Close Combat Pistol Range and the Pistol Range extends beyond the installation boundary into BLM lands and the Ord-Rodman DWMA.

Based on expenditure estimates reported in the PRA, the historical lead loading rate at the Close Combat Pistol Range was approximately 250 lb/yr between 1955 and 1998. Current lead loading rates are lower than historical values; based on the assumptions presented in **Section 4**, it is assumed that the recent lead loading rate is approximately 101 lb/yr. No bullet-capturing technologies currently are used at the Close Combat Pistol Range.

Many of the site-specific parameters for this range, presented in the assessment in Appendix A, were extracted from the SSURGO database and the INRMP. Data types include precipitation, surface slope, vegetation, runoff conditions, soil pH, soil type, infiltration conditions, depth to groundwater, and clay content (NRCS, 2002; Tierra Data, 2005). Other data sources used to evaluate the characteristics of the range include field observations, historical documents, USGS monitoring data, and the Marine Corps GIS databases.

The firing lanes and rear impact berm at the Close Combat Pistol Range do not contain vegetation. Creosote bush scrub plant communities with a plant density between 10% and 20% surround the range (USMC, 2006). Engineered controls to reduce runoff are not present; however, surface water is prevented from running onto the range by a separate earthen berm constructed on the south side of the range, as well as the backstop berm at the back of the range. Areas southwest of the Close Combat Pistol Range drain toward the range and then are diverted either north or northeast, around the range. Runoff then generally runs north, toward the Mojave River. Due to the limited surface water run-on and runoff at the Close Combat Pistol Range, the majority of rainfall that falls directly on the Close Combat Pistol Range evaporates or infiltrates.

According to the SSURGO database, the soils within the footprint of the Close Combat Pistol Range are the same as those described for the Rifle Range (Cajon Gravelly Sands, with 2% to 15% slope; Figure 5-1). The soils are described as gravelly sands with a pH between 7.4 and 8.4. Soils within the combined SDZ of the Close Combat Pistol Range and the Pistol Range also include the Nebona-Cuddeback Complex, with 2% to 9% slope, and Typic Haplargids Yermo Complex (NRCS, 2002).

Surface water and groundwater receptors for the installation are identified in **Section 3**. No drinking water wells are present at the Rifle Range Complex; potable water is trucked in from an off-site source. The closest wells used for potable water sources are located 2.5 miles. The Ord-Rodman DWMA for the desert tortoise overlaps a large portion of the Close Combat Range / Pistol Range SDZ (Figure 3-4). The Ord-Rodman DWMA is considered critical habitat for the desert tortoise. As REVA only assesses threatened and endangered ecological receptors in off-range locations, and surface water runoff travels from the source area (e.g., the impact berm) to the north, only desert tortoises located north of the Close Combat Pistol Range have the potential to come into contact with lead in surface water. Even this potential interaction is likely to be limited, as desert tortoises are unlikely to directly consume surface water moving through the ephemeral washes. Additional site-specific information for the Close Combat Pistol Range is presented in Appendix A.

5.3.2. Assessment Results

Surface Water

The surface water environmental concern evaluation ranking score was 29, placing it in the minimal score range (0 to 29). On the basis of the SAR assessment for the Close Combat Pistol Range, the range has a minimal potential for lead migration off-range, and the assessment most likely indicates no immediate environmental concern. The chemical conditions at the site (i.e., soil and storm water pH between 6.5 and 8.5), moderate range use, and limited precipitation do not suggest a high possibility of off-range migration of lead at the range. In addition, there are no human receptors utilizing surface water in the

area, and only limited ecological receptor (desert tortoise) interactions with surface water may occur.

Groundwater

The groundwater environmental concern evaluation ranking score was 31, placing it in the moderate score range (30 to 49); this score indicates the potential exists for lead migration off range. However, based on the chemical conditions at the site (i.e., soil and groundwater pH between 6.5 and 8.5) and the depth to groundwater (greater than 100 feet bgs), off-range migration of lead through groundwater is unlikely to occur. As stated for the Rifle Range, there are no human pathway/receptor interactions for lead in groundwater. As such, the groundwater environmental concern evaluation ranking for the Close Combat Pistol Range was reduced to minimal based on professional judgment.

5.4. Pistol Range

5.4.1. Site Background

The Pistol Range is generally located on the eastern portion of the Rifle Range Complex, just south of the Rifle Range (Figure 1-3). The range is used by Marines and the installation police force for periodic marksmanship training and pistol requalification. The Pistol Range has 15 firing points with firing lines at 15, 25 and 50 yards. Various types of small arms ammunition are used at the Pistol Range. The Pistol Range was separated physically from the Close Combat Pistol Range by a protective side berm in the 1960s (USACE, 2001b). The direction of fire is from northeast to southwest. The combined SDZ for the Close Combat Pistol Range and the Pistol Range extends beyond the installation boundary into BLM lands and the Ord-Rodman DWMA.

Based on expenditure estimates from the PRA, the historical lead loading rate at the Pistol Range was 1,544 lb/yr between 1955 and 1998. Current lead loading rates are lower than historical values; based on the assumptions presented in **Section 4**, it is assumed that the recent lead loading rate is approximately 101 lb/yr. No formal bullet capturing technologies currently are used at the Pistol Range, although a bullet trap is proposed for installation at this range (Tierra Data, 2005). An EA has been completed in anticipation of the project; however, construction of the system has yet been initiated.

The range floor at the Pistol Range does not contain vegetation; it is covered with gravel and small cobbles. Individual plants were observed around the perimeter of the range. Surrounding the range are creosote bush scrub plant communities with a plant density between 10% and 20% (USMC, 2006). Engineered controls to reduce runoff are not present; however, surface water is prevented from running onto the range by a separate earthen berm constructed on the south side of the Close Combat Pistol Range, as well as the backstop berm at the back of the Pistol Range. Areas southwest of the Close Combat

Pistol Range drain toward the range and then are diverted either north or northeast, around the range. Runoff then generally runs north, toward the Mojave River.

According to the SSURGO database, the soils within the Pistol Range footprint are Cajon Gravelly Sands, with 2% to 15% slope (Figure 5-1). The soils are described as gravelly sands with a pH between 7.4 and 8.4. Soils within the combined SDZ of the Close Combat Pistol Range and the Pistol Range also include the Nebona-Cuddeback Complex, with 2% to 9% slope and Typic Haplargids Yermo Complex (NRCS, 2002). Due to the limited surface water run-on and runoff at the Pistol Range, the majority of rainfall that falls directly on the Pistol Range evaporates or infiltrates.

Shallow soil samples were collected from the Pistol Range in 2005. Soil samples were collected from 34 locations on the range, and two background samples were collected. The depths of the samples ranged from 0 to 2 ft bgs. The lead concentrations detected in the soil ranged from 1,220 mg/kg in the center of the target berm to 4 mg/kg along the side berms. Lead concentrations generally decrease as the distance from the impact berm increases (Panacea, 2005b). The range is generally flat, although the regional topology slopes from southwest to northeast, toward the firing line. The lead concentrations detected in soil at the 50-yard firing line (5.40 and 7.0 mg/kg) are below the average lead concentrations established at MCLB Barstow (7.5 mg/kg). These data suggest that lead is not migrating off range in surface water runoff (Panacea, 2005; Department of the Navy, 1995).

Surface water and groundwater receptors for the installation are identified in **Section 3**. Potential pathway/receptor interactions for surface water and groundwater at the Pistol Range are the same as those described for the Close Combat Pistol Range. Additional site-specific information for the Pistol Range is presented in Appendix A.

5.4.2. Assessment Results

Surface Water

The surface water environmental concern evaluation ranking score was 29, placing it in the minimal score range (0 to 29). On the basis of the SAR assessment for the Pistol Range, the range has a minimal potential for lead migration off range, and the assessment most likely indicates no immediate environmental concern. The chemical conditions at the site (i.e., soil and storm water pH between 6.5 and 8.5), moderate range use, and limited precipitation do not suggest a high possibility of off-range migration of lead at the range. In addition, soil sampling conducted at the range suggests that lead migration is not occurring. There are no human receptors utilizing surface water in the area, and only limited ecological receptor (desert tortoise) interactions with surface water may occur.

Groundwater

The groundwater environmental concern evaluation ranking score was 31, placing it in the moderate score range (30 to 49); this score indicates the potential exists for lead migration off range. However, based on the chemical conditions at the site (i.e., soil and groundwater pH between 6.5 and 8.5) and the depth to groundwater (greater than 100 feet bgs), off-range migration of lead through groundwater is unlikely to occur. As stated for the Rifle Range, there are no human pathway/receptor interactions for lead in groundwater. As such, the groundwater environmental concern evaluation ranking for the Pistol Range was reduced to minimal based on professional judgment.

6. References

- Agency of Toxic Substances and Disease Registry (ATSDR). 2007. *Public Health Assessment Barstow Marine Corps Logistics Base* (a/k/a Marine Corps Logistics Base Barstow) Barstow, San Bernardino County, California.
www.atsdr.cdc.gov/hac/PHA/barstow/bmc_toc.html. (Accessed September 14, 2007).
- Battelle. 1998. *FINAL – Volume I: Environmental Assessment Small-Arms Range Maintenance and Repair Project at MCAGCC, Twentynine Palms, CA*.
- Bureau of Land Management. 2007. Environmental Assessment Livestock Grazing Authorization EA Number - CA-680-07-17 Allotment Name: Stoddard Mountain. Barstow Field Office.
- California Department of Water Resources (DWR). 2004. California's Groundwater Bulletin 118: South Lahontan Hydrologic Region, Lower Mojave River Valley Groundwater Basin.
- California Regional Water Quality Control Board Lahontan Region. 1994. *Water Quality Control Plan for the Lahontan Region, North and South Basins*.
- Densmore, Jill N., Brett F. Cox, and Steven M. Crawford 1997. *Geohydrology and Water Quality of Marine Corps Logistics Base, Nebo and Yermo Annexes, near Barstow, California*. U.S. Geological Survey. Water-Resources Investigations Report 96-4301.
- Department of Defense. 2005. Instruction 4715.14, *Operational Range Assessments*.
- Department of Defense. 2005. Department of Defense Instruction 4715.14 *Operational Range Assessments*.
- Department of the Navy. 1995. Marine Corps Logistics Base, Barstow California Background Soils Investigation, Technical Memorandum 023, Draft Final. Revision 0. Naval Facilities Engineering Command, Southwest Division.
- 2004. *Final Rifle Range Perimeter Fence at the Marine Corps Logistics Base Barstow, California*. Naval Facilities Engineering Command Southwest Division.
- DWR. See California Department of Water Resources.
- EDAW, Incorporated. 2006. *Integrated Cultural Resources Management Plan for the Marine Corps Logistics Base, Barstow, California*.
- GlobalSecurity.org. 2007. *Marine Corps Logistics Base (MCLB) Barstow*.
www.globalsecurity.org/military/facility/mclb-barstow.htm. (Accessed September 11, 2007).
- Golden State Water Company. 2007. *Water Quality Report 2007: Barstow Water System*.

- Headquarters Marine Corps (HQMC). 2006. *Final REVA User's Manual*.
- Jacobs Engineering Group, Incorporated. 1995. *Marine Corps Logistics Base Barstow, California, Remedial Investigation/Feasibility Study, Remedial Investigation Operable Units 1 and 2, Draft Final, Revision 0*. Prepared for Naval Facilities Engineering Command Southwest Division.
- , 1997. *Marine Corps Logistics Base Barstow, California – CTO 0260, Remedial Investigation / Feasibility Study, Remedial Investigation Operable Units 5 and 6, Draft Final, Revision 1*. Prepared for Naval Facilities Engineering Command Southwest Division.
- Lovio, John C. 2006. *Report of 2005 Riparian Bird Survey on the Mojave River at Marine Corps Logistics Base Barstow (Nebo Section), San Bernardino County, California*.
- Malcolm Pirnie. 2007. *Evaluation of Potential Ecological Effects of Munitions Constituents in Surface Water of Playas Adjacent to the Marine Corps Air Ground Combat Center Twentynine Palms, California to Receptors of Concern*.
- Marine Corps Logistics Base (MCLB) Barstow. 2007. Installation home page. <https://www.bam.usmc.mil/index.htm>. (Accessed September 12, 2007).
- Marine Corps Logistics Base (MCLB) Barstow, Geographic Information System (GIS), 2007. Electronic GIS data.
- Marine Corps Logistics Base Barstow Public Affairs Office (MCLB Barstow PAO). 2007. *Barstow Log* June 28, 2007.
- Mojave Water Agency. 2004. *Mojave Water Agency, 2004 Regional Water Management Plan, Volume 1: Report*. September 2004, Adopted February 24, 2005.
- Natural Resources Conservation Service (NRCS). 2002. Official Soil Description for Cajon Series Soils.
- Palmer, Robert L. 2006. Letter report of annual monitoring required under Biological Opinions 1-8-93-F-16 and 1-8-97-F-20R.
- Panacea, Incorporated. 2005. Draft field sheets and results (unbound) of Panacea, Inc. Project No. C05-531, provided by MCLB Barstow personnel in May 2007.
- Service Rock Products. 2007. Service Rock Products Homepage. www.servicerock.com (Accessed September 13, 2007).
- Stamos, Christina L., Peter Martin, Tracy Nishikawa, and Brett F. Cox. 2001. *Simulation of Ground-water Flow in the Mojave River Basin, California*. U.S. Geological Survey Water Resources Investigation Report 01-4002 Version 3.

- Tetra Tech EM, Incorporated. 2003. *Final TDS and Nitrate Phase I Investigation and Well Installation Report, Marine Corps Logistics Base Barstow.*
- Tierra Data, Incorporated. 2005. *Integrated Natural Resources Management Plan, MCLB Barstow, California.*
- Tierra Data Systems. 1996. *Vegetation Survey Marine Corps Logistics Base Barstow.*
- United States Army Corps of Engineers (USACE), St. Louis District. 2001a. *Archives Search Report, United States Marine Logistics Base Barstow, Barstow, California.*
- . 2001b. *Range Identification and Preliminary Range Assessment, United States Marine Logistics Base Barstow, Barstow, California.*
- United States Geologic Survey. 2007. Surface Water Gage Data. Accessed September 28, 2007.
- United States Marine Corps (USMC) Material Command, Marine Corps Logistics Base Barstow. 2006. *Final Environmental Assessment, Rifle Range Operations and Training Facility, Marine Corps Logistics Base, Barstow, California.*
- Western Region Climate Center, 2007. Evaporation Station Data: California. Accessed November 12, 2007.

Appendix A

Small Arms Range Assessment Protocol and Assessments

SMALL ARMS RANGE ASSESSMENT

Introduction

The purpose of the Range Environmental Vulnerability Assessment (REVA) is to identify whether there has been a release or there is a substantial threat of a release of munitions constituents (MC) of concern from the operational range or range complex areas to off-range areas. This is accomplished through the use of fate and transport modeling and analysis of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas at an installation.

For small arms ranges, the fate and transport parameters are based entirely on site-specific geochemical properties, which cannot be determined solely by physical observation. Therefore, small arms ranges associated with the installation are qualitatively reviewed and assessed to identify factors that influence the potential for lead migration at the operational range, including:

- design and layout,
- the physical and chemical characteristics of the area, and
- current and past operation and maintenance practices.

In addition, potential receptors and pathways must be identified relative to the small arms range being assessed. The potential for an identified receptor to be impacted by MC migration through an identified pathway will be evaluated.

MC associated with small arms ammunition commonly used at operational ranges include lead, antimony, copper, and zinc. REVA focuses on lead as the MC indicator for small arms ranges because lead is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. No specific quantitative conclusions can be made regarding the fate and transport of lead since it is unlike any other MC. Lead is geochemically specific regarding its mobility in the environment. Site-specific conditions must be known (i.e., geochemical properties) in order to quantitatively assess lead migration. Site-specific geochemical properties are only identified via sampling and cannot be observed physically. Without site-specific physical and chemical

characterization, lead cannot effectively be modeled using fate and transport modeling like the other indicator MC in REVA. The scientific community has established that metallic lead (such as recently fired, unweathered bullets and shot) generally has low chemical reactivity and low solubility in water and is relatively inactive in the environment under most ambient or everyday conditions. However, a portion of lead deposited on a range may become environmentally active if the right combination of conditions exists.

This Small Arms Range Assessment Protocol was developed in lieu of collecting site-specific information for every small arms range. The protocol will help to determine which ranges necessitate data collection of site-specific geochemical properties or further assessment based the range's overall prioritization regarding the potential for an identified receptor to be impacted by potential lead migration through an identified pathway.

Purpose

This Small Arms Range Assessment Protocol outlines a qualitative approach to assess the small arms ranges in the REVA process in lieu of collecting site-specific geochemical properties at every range. This qualitative approach helps to identify and assess factors that influence the potential for lead to migrate at an operational range.

This protocol is to be used for:

- 1) Identifying the small arms ranges within the Marine Corps that have the greatest potential for environmental concern (i.e., potential for lead migration to impact identified receptors) and
- 2) Assessing the need for implementing further actions. Recommended further actions may include, but are not limited to, the following:
 - Sampling surface water, groundwater, and/or soil
 - Conducting additional studies
 - Implementing best management practices (BMPs)

Data Collection and Documentation

The qualitative assessment process for a small arms range involves first capturing and documenting its physical and environmental conditions, as well as how the range is utilized and maintained (including dates of use and types and amounts of small arms ammunition expended). The small arms range data collection form within Section 3 of the REVA Reference Manual is a guide to collecting and documenting the necessary information in order to complete the evaluation forms presented later in this protocol (Tables 1 through 6). It includes a comprehensive list of data elements that are useful in establishing the historical and current physical and environmental conditions, as well as capturing the types of information on conditions that influence lead's potential to migrate from the range. The data collection form is organized by major topics or information areas associated with the operational range, including the following:

- Basic range information
- Current range layout
- Current range operations
- Historical range operations
- Amount of lead potentially deposited
- Environmental Characteristics
- Potential receptors
- Surrounding land use
- Environmental activities conducted on the range
- Summary

The data collection form in the REVA Reference Manual can be modified, where needed, to fully capture the major factors that can potentially influence lead's ability to migrate from each specific small arms range.

Qualitative Assessment

The small arms range can be qualitatively assessed once the conditions of the range have been fully understood and documented. The assessment process involves a discussion of

possible factors that can influence the potential for lead to migrate off range. Several of these factors are listed below, followed by a detailed discussion:

- Range use and range management (source)
- Surface water
- Groundwater and soil
- Pathways
- Receptors

Range Use and Range Management (Source)

The amount of lead and other MC deposited on a range is a combination of the following factors:

- Duration of use
- Current and historical frequency of range usage
- Amount and types of small arms ammunition expended on the range
- Scope and frequency of any range maintenance activities involving the removal of lead from the range
- Presence and duration of bullet-capturing technologies

Surface Water

Under specific pH conditions, lead from shot or bullets can slowly dissolve in water. Runoff and groundwater recharge could transport this dissolved lead off range. The primary factors influencing the potential for dissolved lead to migrate via surface water include, but are not limited to, the following:

- pH of the water
- Duration of water contact with the lead
- Intensity and frequency of rainfall
- Steepness of the slope containing lead
- Amount and type of vegetation on the slope
- Infiltration rate of surface soils
- Presence of engineering controls or BMPs to modify or control surface water runoff

Groundwater and Soil

The amount of lead that dissolves in water is primarily influenced by the pH of the water and the duration of water contact with the lead. Once lead is dissolved in water, the amount of lead that attaches to the soil and/or enters the groundwater is determined by several factors, including the following:

- Organic carbon content of the soil
- pH of the soil
- Properties of the soil, including porosity, irreducible water content, and hydraulic conductivity
- Amount of recharge percolating through the vadose zone
- Clay content of the soil (lead attaches to clay minerals more than other soil fractions)
- Depth to groundwater

Pathways

The REVA Small Arms Range Assessment involves developing a conceptual site model (CSM) for the range to identify the range's physical and environmental conditions. The CSM's purpose is to identify if a potential for source-receptor-pathway interaction may exist. Factors that influence the potential for a source-receptor-pathway interaction (e.g., heavy range use, potable water supply wells in proximity to the range), as well as factors that decrease the potential for such interactions, should be discussed in the assessment.

Potential pathways include:

- groundwater used as a source of potable or agricultural water,
- the use of surface water downstream of a range as a source of potable or agricultural water, and
- the use of the soil, surface water, or groundwater by sensitive species.

Receptors

Receptors in REVA can include on-range and off-range personnel and sensitive species and ecosystem areas. Factors considered when assessing the potentially complete exposure pathways for receptors include, but are not limited to, the following:

- The number and proximity of water supply wells relative to the range
- The characteristics of nearby water supply wells (e.g., depth to groundwater, well construction details)
- The uses of the surface water or groundwater (e.g., agriculture, drinking water)
- The locations of nearby sensitive species areas, such as endangered species habitats (i.e., within proximity to the range)

Small Arms Range Assessment Protocol

This Small Arms Range Assessment Protocol is based on evaluating the potential environmental concerns posed by MC. Environmental concern evaluation rankings for surface water and groundwater conditions are established for each small arms range. The rankings range between High (indicating the highest potential environmental concern) and MINIMAL (indicating the lowest potential environmental concern). Sites for which there is insufficient information to complete the evaluation are placed into an Evaluation Pending ranking. Possible recommended actions are based on the relative environmental concern evaluation rankings assigned by the protocol. High rankings necessitate further actions. Further actions may included sampling, additional site-specific studies, and/or BMPs. These actions will be evaluated based on site conditions for each range.

Protocol Instructions

1. For Tables 1 through 5:
 - a. Enter the appropriate score for each criteria in the site score column. Use the highest (i.e., most conservative) value if no information is known to complete the score. Professional judgment may be used at any time to override a designated score. If professional judgment is used, mark the score column appropriately (*) and fill in the notes section at the bottom of the table with text detailing why professional judgment was used and how it impacted the scores.
 - b. Sum the site scores in the last row.
2. Transfer the scores from Tables 1 through 5 onto Table 6 in the appropriate rows.
3. Use the scores in Table 6 to determine the surface water and groundwater environmental concern evaluation rankings.

Evaluation Ranking Designation

Once Table 6 is complete, the protocol finishes with two scores: the sum of surface water elements and the sum of groundwater elements. These scores are used to identify the appropriate evaluation ranking (High, Moderate, Minimal) for surface water and groundwater (as mentioned in step 3 of the protocol instructions).

The surface water concern evaluation ranking and the groundwater concern evaluation ranking identify the potential impact for lead migration for each of those pathways at the small arms range. The ranking designations and their descriptions follow:

- High = Small arms range most likely has the potential for lead migration and environmental concern, creating the greatest level of environmental concern and requiring additional action(s).
- Moderate = Small arms range may have the potential for lead migration and environmental concern, most likely indicating that there is no immediate environmental concern, but actions may be necessary to prevent a greater concern.
- Minimal = Small arms range has minimal or no potential for lead migration and environmental concern, indicating minimal threat of environmental concern, but actions may be necessary to ensure that the no concerns elevate.

These rankings are used to determine whether additional actions are appropriate. The higher environmental concern evaluation ranking (surface water or groundwater), as determined in Table 6, is used to evaluate if further actions are suggested, based on the guidelines for recommended actions (Table 7, provided on Page C-9).

The overall range evaluation rankings should be compared to each range within the installation and to the overall rankings of all ranges across the Marine Corps. These rankings will assist in determining how funding should best be allocated across the Marine Corps to prevent environmental concerns due to small arms ranges.

Assessment Report

Once the Small Arms Range Assessment Protocol has been completed and appropriate actions have been designated and implemented, the assessment should be written into a report that describes the process taken, details the information used to score Tables 1

through 5, outlines the scores and evaluation rankings, and identifies the additional actions taken. The report should detail whether an identified receptor is or is not impacted by lead migration through the identified pathway(s). The completed protocol tables should be included as an appendix to the report.

Best Management Practices for Small Arms Ranges

BMPs are important for all ranges and should be used appropriately to maintain the sustainability of operational ranges. However, this protocol prioritizes which small arms ranges may need BMPs to address specific possibilities of lead migration.

Following the Small Arms Range Assessment, BMPs may be recommended based on the environmental concern evaluation ranking. Prior to selecting and implementing BMPs, the management objectives must be established. Depending on the range-specific site conditions and the management objectives, the following BMPs should be considered:

- Bullet and shot containment techniques (e.g., berms, backstops, traps)
- Prevention of soil erosion from berms, aprons, and other range areas
- Soil amendments
- Recovery and/or recycling of lead

Negative impacts of implementation should also be considered when selecting a BMP. For example, using soil amendments may affect water quality of nearby water bodies or modifying surface water runoff may impact nearby habitats.

The prevention of soil erosion can be achieved by implementing one or several of the following practices:

- Maintaining vegetation on berms and drainageways
- Reducing runoff rates by adjusting site drainage patterns
- Providing sediment traps such as a vegetated detention basin or infiltration area
- Preventing the creation of a “point source”

Soil amendments may be an effective BMP by implementing one or both of the following practices:

- Increasing the retentive capacity of soil by adding organic matter, fertilizer, and/or lime
- Maintaining a pH range between 6 and 8 by adding triple superphosphate, bone meal, or other applicable additives

The recovery and recycling of lead from operational ranges should be considered as a way to control the migration of lead. The following should be considered when implementing recovery and recycling practices:

- Focus on safety as the primary concern of the proposed activities
- Avoid practices that appear as treatment activities (e.g. acid leaching, fixation, etc.)
- Dispose lead by using a lead recycler or smelter
- Use residual soil for the original purpose (e.g. berm/target area soil) following lead recovery practices.

Table 7: Guidelines for Recommended Actions	
Environmental Concern Evaluation Ranking	Recommended Action
High	Action required. 1) Consider sampling appropriate media (groundwater, surface water, and/or soil). 2) Identify and implement BMPs, if necessary.
Moderate	1) Consider identifying and implementing BMPs, if necessary. 2) Consider sampling appropriate media (groundwater, surface water, and/or soil).
Minimal	1) No further action is needed at this time. 2) Consider identifying and implementing BMPs, if necessary.

INSTALLATION: Marine Corps Logistics Base (MCLB) Barstow
LOCATION: Barstow, California
RANGE: Rifle Range
DATE: May 12, 2008

ASSESSMENT RESULTS:

The surface water environmental concern evaluation ranking resulted in a minimal score. Limited precipitation and favorable soil and surface water pH likely limit lead off-range migration. In addition, there are no human receptors and limited potential exists for ecological receptor exposure to lead. On the basis of the Small Arms Range Assessment Protocol (SARAP), there is minimal potential for lead migration and impact to surface water.

The groundwater environmental concern evaluation ranking resulted in a moderate score. However, it is the professional judgment of the REVA assessment team that the overall concern for lead migration and exposure to groundwater receptors is more accurately categorized as a Minimal level. The groundwater pathway score is biased high by the sandy nature of the soils and the lack of clay in the soil unit. The chemical conditions at the Rifle Range (soil and groundwater pH between 6.5 and 8.5), combined with previous sampling data at the adjacent Pistol Range, indicate that lead migration on this range is limited. In addition, the depth to groundwater and the lack of groundwater receptors in the area likely preclude any significant groundwater impacts. Therefore, the groundwater evaluation ranking has been adjusted to minimal based on professional judgment.

Table 1: Range Use and Range Management (Source) Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Duration of Range Use	Used from 1955 to present.	5 if usage greater than 30 years 3 if usage is 10 to 30 years 1 if usage less than 10 years	5
Bullet-Capturing Technology	No bullet-capturing technology noted by installation personnel or observed by the REVA assessment team.	If [range usage duration = bullet capture duration], then apply a negative score so that the [range usage duration + bullet capture duration] = 1 If [range usage duration – bullet capture duration] = 10 to 30 years, then apply a negative score so that the [range use duration + bullet capture duration] = 3 0 if [range usage duration – bullet capture duration] greater than 30 years	0
MC Loading Rates	Historically, approximately 1,425 pounds per year (lb/yr); recently, approximately 130 lb/yr.	5 if MC loading greater than 1,000 pounds/year 3 if MC loading equals 100 to 1,000 pounds/year 1 if MC loading less than 100 pounds/year	3
Range Maintenance	Two instances of lead mining have occurred in the past 15 years.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	5
Source Element Score			13
<p><u>Notes:</u></p> <p>Based on the Range Identification and Preliminary Range Assessment (PRA) report, the Rifle Range was established in 1955 (USACE, 2001b).</p> <p>The PRA provides a partial estimate of small arms ammunition expenditures from initial use to 1998 (43 years of use; approximately 1,425 lb/yr). Interviews with Range Control personnel indicate that approximately 61 percent of the ammunition allocated annually to MCLB Barstow are expended at the Rifle Range. Based on the types of small arms ammunition used at the Rifle Range, the current annual lead loading rate at the range was calculated at 130 lb of lead per year.</p> <p>From interviews with installation personnel, mining of the rifle berm has occurred in the past, though less frequently than once every three years.</p>			

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
pH of Water	Historically, the pH has been above 6.5. Most recent storm water sampling near Barstow had pH measurement of 7.8.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Precipitation	Average annual precipitation is approximately 4 inches/year.	5 if precipitation greater than 40 inches/year 3 if precipitation equal to 20-40 inches/year 1 if precipitation less than 20 inches/year	1
Slope of Range	Berm slope is greater than 10%, generally located on a larger hillside. A relatively wide, flat graded sandy area is in front of the target berm.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	The backstop berm does not contain vegetation. Vegetation density surrounding the range is between 10% and 20% and is primarily creosote bush scrub.	5 if vegetation cover less than 20% 3 if vegetation cover is between 20% to 50% 1 if vegetation cover greater than 50%	5
Soil Type / Runoff Conditions	Natural Resource Conservation Service (NRCS) data describe the soil beneath the range floor and impact berm as primarily Cajon gravelly sand, though portions of the firing lanes are located over Nebona soil series, which includes sandy loam and gravelly sand.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	1
Runoff/ Erosion Engineering Controls	Large rocks (up to 1 foot in diameter) are located along the up gradient side of the impact berm. Fresh sand is also present across the face of the berm. These erosion controls were noted to be present during the site visit.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Storm water sampling has not been conducted in recent years, though installation personnel stated that the pH of storm water is generally above 6.5. Water quality data collected from United States Geological Survey (USGS) stream gages at Barstow (USGS stream gage 10262500) have field measured pH concentrations above 6.5. One water quality sample at Barstow had a pH of 7.8 (USGS, 2007).

Previous research in various reports and documented in the Integrated Natural Resources Management Plan (INRMP) report supports rainfall being less than 20 inches per year, typically around 4.4 inches per year near MCLB Barstow (Tierra Data, 2005; USMC, 2006).

The observed slope of the berm is greater than 10%; the target berm is set within a larger hillside. A relatively wide, flat graded sandy area is in front of the target berm and appears to consist of the same material as the berm. This graded area sits at a slightly higher elevation than the dirt access road separating the berm from the target line.

The dominant plant community at the Rifle Range is creosote bush scrub, which covers 10% to 20% of the land surface (Tierra Data, 2005; USMC, 2006).

Boring logs and geologic cross sections from reports typically suggest the presence of gravelly sands or silty sands at depth (Panacea, 2005). The NRCS soil descriptions document the soil at the Rifle Range as being Cajon Gravelly Sand, 2 to 15 percent slopes. The soils are described as gravelly sands (NRCS, 2002).

From observations made during the site visit, gullies appear to divert the bulk of storm water runoff behind the backstop berm and prevent storm water from running onto the range. Large rocks up to 1 foot in diameter are noted along the up gradient side of the impact berm; fresh sand is located across the face of the berm, as warranted. Together, these were considered partial engineering controls with respect to controlling surface water run-on, runoff, and erosion of the backstop berm.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Depth to Groundwater	Previous studies across the installation suggest groundwater is located between 160 and 210 feet below ground surface (bgs).	5 if depth to groundwater less than 20 feet 3 if depth to groundwater is between 20-99 feet 1 if depth to groundwater is between 100-300 feet 0 if depth to groundwater greater than 300 feet	1
Precipitation	Typical precipitation is approximately 4 inches/year.	5 if precipitation is greater than 40 inches/year 3 if precipitation is between 20 - 40 inches/year 1 if precipitation is less than 20 inches/year	1
pH of Water	Groundwater sampling suggests pH above 6.5 but below 8.5.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
pH of Soil	NRCS soil data suggest a pH between 7.4 and 8.4.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Soil Type / Infiltration Conditions	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Clay Content in Soil	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Groundwater Pathway Score			14
<p><u>Notes:</u></p> <p>Installation personnel stated that groundwater-related studies associated with the Nebo main base have found depth to groundwater influenced by the Harper Lake–Camp Rock Fault, as well as storm events. Generally, areas east of the fault (where the ranges are located) have depths to groundwater that fall between 100 and 300 feet bgs. A summary prepared for the landfill cap (1998), located approximately 1.5 miles northwest of the range, indicates groundwater to be 160 to 210 feet bgs; other reports have noted depths up to 175 feet bgs on the alluvial fan south of Interstate 40 near the Rifle Range Complex (Jacobs Engineering, 1997; Tetra Tech, 2003). A well once was present adjacent to the ranges, but no information or data regarding this well were located.</p> <p>Sampling logs for groundwater wells collected in 2003 in the Nebo main base of MCLB Barstow had pH above 6.5. Two laboratory samples had pHs of 7.79 and 7.81 (Tierra Tech, 2003). NRCS soils data suggest a pH between 7.4 and 8.4 for Cajon series soils (NRCS, 2002).</p> <p>NRCS soil series data described the predominant soil type at the Rifle Range as Cajon Gravelly Sand, 2 to 15 percent slopes (NRCS, 2002). Boring logs from surface soil samples collected at the Pistol Range, which overlays the same soil type, describe the surface soils as fine to coarse grain sand, with some gravel and cobbles (Panacea, 2005).</p>			

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Drinking Water Usage	The Mojave River is the primary surface water body in the area. It is not used as a drinking water in the area surrounding MCLB Barstow; however, the Mojave River is in connection with the Mojave River aquifer and the Regional aquifer.	<p>10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet), or could move, but is not moving appreciably, toward surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	2
Agricultural or Other Beneficial Usage	Agriculture is not anticipated given the climate, though some grazing may occur on nearby Bureau of Land Management land to the south, which is up gradient of the range. Agricultural farms are located approximately 10 miles east of the installation.	<p>5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural; or other beneficial usage is unknown.</p> <p>3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably.</p> <p>1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	1
Sensitive Species Habitat and Threatened or Endangered Species	The desert tortoise is known to be present at the Rifle Range. Designated critical habitat is present south of the range complex. Impact berms and infrequent rainfall are anticipated to reduce access to any media potentially contaminated through active range use.	<p>10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary.</p> <p>5 if potential for receptors to have access to possibly contaminated media.</p> <p>1 if little or no potential for receptors to have access to possible contaminated media.</p>	5
Surface Water Receptor Score			8

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

The Mojave River is typically dry in the vicinity of MCLB Barstow, and surface water is present only during notable storm events. Surface water is not used as a potable water source in the Barstow area.

The desert tortoise is present at the Rifle Range Complex (Tierra Data, 2005). The presence of the desert tortoise is considered in the environmental assessments for construction works at the Rifle Range Complex (USMS, 2006; Department of the Navy, 2004). To protect the Mojave population of the desert tortoise, several desert wildlife management areas (DWMAs) were established. One of these, the Ord-Rodman DWMA, includes approximately 540 acres of the southern portion of the Rifle Range Complex (Tierra Data, 2005). This area is considered critical habitat for the recovery of the desert tortoise. Only a small section of the Rifle Range surface danger zone overlaps this DWMA; however, desert tortoises have been observed throughout the Rifle Range Complex. The Ord-Rodman DWMA is up gradient of the Rifle Range; surface runoff flows northward, which restricts exposure of lead in surface water to desert tortoises living within the DWMAs. The off-range exposure pathways considered in the REVA program are exposures to lead via surface water or groundwater. Based on an evaluation of the potential ecological effects of MC conducted for Marine Corps Air Ground Combat Center Twentynine Palms, the desert tortoise is unlikely to be exposed to surface water runoff from the Rifle Range (Malcolm Pirnie, 2007). Therefore, some potential exists for ecological receptors to have access to possibly contaminated media, but it is likely quite limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Wells Identified as Potable Water Sources	All known groundwater wells used to access potable water are more than 1 mile from the Rifle Range.	<p>10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure; or if a designation as a potable water source is unknown.</p> <p>5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably.</p> <p>2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.</p>	2
Wells Identified for Agricultural or Other Beneficial Usage	Groundwater supply wells for the MCLB Barstow golf course are located cross gradient from the Rifle Range. The closest nonpotable water well is over 1 mile from the Rifle Range.	<p>5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure, or if a designation as agricultural or other beneficial usage is unknown.</p> <p>3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but is not moving appreciably.</p> <p>1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure.</p>	1
Sensitive Species Habitat and Threatened and Endangered Species	The desert tortoise is known to be present; designated critical habitat is south of the Rifle Range. There are no known springs or other pathways to expose the desert tortoise to groundwater in the area.	<p>5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p>	1
Groundwater Receptor Score			4

Notes:

MCLB Barstow groundwater supply wells are also located in the Yermo Annex, on the northern side of the Mojave River. The Nebo Area receives its drinking water from the Golden State Water Authority. Potable water for the Rifle Range Complex is trucked in from off site (USMC, 2006). Private wells were previously active north of the range, immediately adjacent to the Nebo Area. The private residences at these locations have been linked to water provided by the city of Barstow, and the wells are no longer used. All off-site wells are located well over 1 mile from the range.

There are no groundwater discharge locations within proximity of the range.

Table 6: Relative Environmental Concern Evaluation (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)										
Surface Water										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Surface Water Pathways	2	8								
Surface Water Receptors	4	8								
Sum of Surface Water Element Scores		29								
Groundwater										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Groundwater Pathways	3	14								
Groundwater Receptors	5	4								
Sum of Groundwater Element Scores		31								
<p>The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:</p> <table border="0" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: left;"><u>Environmental Concern Evaluation Ranking*</u></th> <th style="text-align: left;"><u>Score Range</u></th> </tr> </thead> <tbody> <tr> <td>High</td> <td>50-65</td> </tr> <tr> <td>Moderate</td> <td>30-49</td> </tr> <tr> <td>Minimal</td> <td>0-29</td> </tr> </tbody> </table> <p>*Use the Environmental Concern Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.</p>		<u>Environmental Concern Evaluation Ranking*</u>	<u>Score Range</u>	High	50-65	Moderate	30-49	Minimal	0-29	
<u>Environmental Concern Evaluation Ranking*</u>	<u>Score Range</u>									
High	50-65									
Moderate	30-49									
Minimal	0-29									
Surface Water Environmental Concern Evaluation Ranking		MINIMAL								
Groundwater Environmental Concern Evaluation Ranking		MODERATE*								
<p><u>Notes:</u></p> <p>* Based on the chemical conditions (soil and groundwater pH between 6.5 and 8.5), depth to groundwater (greater than 100 feet bgs), frequency of precipitation (4 inches/year during short duration, intense storms, which generate rapid runoff), and high evaporation at the Rifle Range, the groundwater evaluation ranking is downgraded from Moderate to Minimal based on professional judgment.</p>										

INSTALLATION: MCLB Barstow
LOCATION: Barstow, California
RANGE: Close Combat Pistol Range
DATE: May 12, 2008

ASSESSMENT RESULTS:

The surface water environmental concern evaluation ranking resulted in a minimal score. Limited precipitation and favorable soil and surface water pH likely limit lead off-range migration. In addition, there are no human receptors and limited potential exists for ecological receptor exposure to lead. On the basis of the SARAP, there is minimal potential for lead migration and impact to surface water.

The groundwater environmental concern evaluation ranking resulted in a moderate score. However, it is the professional judgment of the REVA assessment team that the overall concern for lead migration and exposure to groundwater receptors is more accurately categorized as a Minimal level. The groundwater pathway score is biased high by the sandy nature of the soils and the lack of clay in the soil unit. The chemical conditions at the Close Combat Pistol Range (soil and groundwater pH between 6.5 and 8.5), combined with previous sampling data at the adjacent Pistol Range, indicate that lead migration on this range is limited. In addition, the depth to groundwater and the lack of groundwater receptors in the area likely preclude any significant groundwater impacts. Therefore, the groundwater evaluation ranking has been adjusted to minimal based on professional judgment.

Table 1: Range Use and Range Management (Source) Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Duration of Range Use	Used from 1955 to present.	5 if usage greater than 30 years 3 if usage is 10 to 30 years 1 if usage less than 10 years	5
Bullet-Capturing Technology	No bullet-capturing technology noted by installation personnel or observed by the REVA assessment team	If [range usage duration = bullet capture duration], then apply a negative score so that the [range usage duration + bullet capture duration] = 1 If [range usage duration – bullet capture duration] = 10 to 30 years, then apply a negative score so that the [range use duration + bullet capture duration] = 3 0 if [range usage duration – bullet capture duration] greater than 30 years	0
MC Loading Rates	Historically, approximately 250 lb/yr; recently, approximately 101 lb/yr	5 if MC loading greater than 1,000 pounds/year 3 if MC loading equals 100 to 1,000 pounds/year 1 if MC loading less than 100 pounds/year	3
Range Maintenance	Only one known occurrence of lead mining in past years	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	5
Source Element Score			13
<p><u>Notes:</u></p> <p>The PRA for MCLB Barstow states that the Close Combat Pistol Range was established in 1955 (USACE, 2001b).</p> <p>The PRA provides a partial estimate of small arms ammunition expenditures from initial use to 1998 (43 years; approximately 250 lb/yr). Interviews with Range Control personnel indicate that approximately 24 percent of the ammunition allocated annually to MCLB Barstow were expended at the Close Combat Pistol Range. Based on the estimated use of small arms ammunition, the annual lead loading rate is calculated to be 101 lb of lead per year.</p> <p>Based on installation personnel interviews, mining of the berm has occurred in the past, though less frequently than once every three years.</p>			

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
pH of Water	Historically, the pH has been above 6.5. Most recent storm water sampling near Barstow had a pH measurement of 7.8.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Precipitation	Typical precipitation is approximately 4 inches/year.	5 if precipitation greater than 40 inches/year 3 if precipitation equal to 20-40 inches/year 1 if precipitation less than 20 inches/year	1
Slope of Range	Berm slope is greater than 10%, though the range itself is located on a generally flat portion of a larger hillside.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	The firing lanes and backstop berm do not contain vegetation. The areas surrounding the range have a plant density of 10% to 20%.	5 if vegetation cover less than 20% 3 if vegetation cover is between 20% to 50% 1 if vegetation cover greater than 50%	5
Soil Type / Runoff Conditions	Based on the NRCS database, the soils at the firing lines and backstop berms are Cajon Gravelly Sand.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	1
Runoff/ Erosion Engineering Controls	Based on installation interviews and aerial photographs, surface water is prevented from running onto the range by a protective berm south of the range, as well as the rear backstop berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	- 5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Storm water sampling has not been conducted in recent years, though installation personnel stated that the pH of storm water is generally above 6.5. Water quality data collected from USGS stream gages at Barstow (USGS stream gage 10262500) have field measured pH concentrations above 6.5. One water quality sample at Barstow had a pH of 7.8 (USGS, 2007).

Previous research in various reports and documented in the (INRMP) report supports rainfall being less than 20 inches per year, typically around 4.4 inches per year near MCLB Barstow (Tierra Data, 2005; USMC, 2006).

Observed slope of the berm is greater than 10%. However, the presence of side berms suggests runoff drains across the middle of this range, which is a relatively flat, dirt surface. Observed vegetation consisted of limited patches of grasses, weeds, and scrub. The area surrounding the range consists of creosote bush scrub with a plant density between 10% and 20% (USMC, 2006)

Boring logs and geologic cross sections from reports typically suggest the presence of gravelly sands or silty sands at depth (Panacea, 2005). The NRCS soil descriptions document the soil at the Close Combat Range as being Cajon Gravelly Sand, 2 to 15 percent slopes. The soils are described as gravelly sands (NRCS, 2002).

Based on observations made during the site visit and interviews with installation personnel, it was noted that the top of the rear impact berm is subtly sloped in a manner that diverts runoff away from the face of the berm. Additionally, a berm is present to the south of the pistol ranges that is designed and maintained to divert much of the surface water runoff originating south of the ranges to the north and northeast around the ranges. Together, these were considered partial engineering controls with respect to controlling runoff and erosion.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Depth to Groundwater	Previous studies across the installation suggest groundwater is located between 160 and 210 feet bgs.	5 if depth to groundwater less than 20 feet 3 if depth to groundwater is between 20-99 feet 1 if depth to groundwater is between 100-300 feet 0 if depth to groundwater greater than 300 feet	1
Precipitation	Typical precipitation is approximately 4 inches/year.	5 if precipitation is greater than 40 inches/year 3 if precipitation is between 20-40 inches/year 1 if precipitation is less than 20 inches/year	1
pH of Water	Groundwater sampling suggests pH above 6.5 but below 8.5.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
pH of Soil	NRCS soil data suggest a pH between 7.4 and 8.4.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Soil Type / Infiltration Conditions	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Clay Content in Soil	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Groundwater Pathway Score			14
<p><u>Notes:</u></p> <p>Installation personnel stated that groundwater-related studies associated with the Nebo main base have found depth to groundwater influenced by the Harper Lake–Camp Rock Fault, as well as storm events. Generally, areas east of the fault (where the ranges are located) have depths to groundwater that fall between 100 and 300 feet bgs. A summary prepared for the landfill cap (1998), located approximately 1.8 miles northwest of the range, indicates groundwater to be 160 to 210 feet bgs; other reports have noted depths up to 175 feet bgs on the alluvial fan south of Interstate 40 near the Rifle Range Complex (Jacobs Engineering, 1997; Tetra Tech, 2003). A well once was present adjacent to the ranges, but no information or data regarding this well were located.</p> <p>Sampling logs for groundwater wells collected in 2003 in the Nebo main base of MCLB Barstow recorded pH above 6.5. Two laboratory samples had pHs of 7.79 and 7.81 (Tierra Tech, 2003). NRCS soils data suggest a pH between 7.4 and 8.4 for Cajon series soils (NRCS, 2002).</p> <p>NRCS soil series data described the predominant soil type at the Close Combat Pistol Range as Cajon Gravelly Sand, 2 to 15 percent slopes (NRCS, 2002). Boring logs from surface soil samples collected at the Pistol Range describe the soils as fine to coarse grain sand, with some gravel and cobbles (Panacea, 2005).</p>			

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Drinking Water Usage	The Mojave River is the primary surface water body in the area. It is not used as a drinking water in the area surrounding MCLB Barstow; however, the Mojave River is in connection with the Mojave River aquifer and the Regional aquifer.	<p>10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet), or could move, but is not moving appreciably, toward surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	2
Agricultural or Other Beneficial Usage	Agriculture is not anticipated given the climate, though some grazing may occur on nearby Bureau of Land Management land to the south, which is up gradient of the range. Agricultural farms are located approximately 10 miles east of the installation.	<p>5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural; or other beneficial usage is unknown.</p> <p>3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably.</p> <p>1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	1
Sensitive Species Habitat and Threatened or Endangered Species	The desert tortoise is known to be present at the Close Combat Pistol Range. Designated critical habitat is present south of the range complex. Impact berms and infrequent rainfall are anticipated to reduce access to any media potentially contaminated through active range use.	<p>10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary.</p> <p>5 if potential for receptors to have access to possibly contaminated media.</p> <p>1 if little or no potential for receptors to have access to possible contaminated media.</p>	5
Surface Water Receptor Score			8

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

The Mojave River is typically dry in the vicinity of MCLB Barstow, and surface water is present only during notable storm events. Surface water is not used as a potable water source in the Barstow area.

The desert tortoise is present at the Rifle Range Complex (Tierra Data, 2005). The presence of the desert tortoise is considered in the environmental assessments for construction works at the Rifle Range Complex (USMS, 2006; Department of the Navy, 2004). To protect the Mojave population of the desert tortoise, several desert wildlife management areas (DWMAs) were established. One of these, the Ord-Rodman DWMA, includes approximately 540 acres of the southern portion of the Rifle Range Complex (Tierra Data, 2005). This area is considered critical habitat for the recovery of the desert tortoise. Desert tortoise and their burrows have been identified near the Close Combat Pistol Range (USMC, 2006). The Ord-Rodman DWMA is up gradient of the Close Combat Pistol Range; surface runoff flows northward, which restricts exposure of lead in surface water to desert tortoises living within the DWMAs. The off-range exposure pathways considered in the REVA program are exposures to lead via surface water or groundwater. Based on an evaluation of the potential ecological effects of MC conducted for Marine Corps Air Ground Combat Center Twentynine Palms, the desert tortoise is unlikely to be exposed to surface water runoff from the Close Combat Pistol Range (Malcolm Pirnie, 2007). Therefore, some potential exists for ecological receptors to have access to possibly contaminated media, but it is likely quite limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Evaluation Characteristics	Score Criteria	Site Score
Wells Identified as Potable Water Sources	All known groundwater wells used to access potable water are located more than 1 mile from the range.	<p>10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure; or if a designation as a potable water source is unknown.</p> <p>5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably.</p> <p>2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.</p>	2
Wells Identified for Agricultural or Other Beneficial Usage	Groundwater supply wells for the MCLB Barstow golf course are located cross gradient from the range. The closest nonpotable water well is over 1 mile from the Close Combat Pistol Range.	<p>5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure, or if a designation as agricultural or other beneficial usage is unknown.</p> <p>3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but is not moving appreciably.</p> <p>1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure.</p>	1
Sensitive Species Habitat and Threatened and Endangered Species	The desert tortoise is known to be present; designated critical habitat may be found south of the ranges. There are no known springs in the area.	<p>5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p>	1
Groundwater Receptor Score			4

Notes:

MCLB Barstow groundwater supply wells are also located in the Yermo Annex, on the northern side of the Mojave River. The Nebo Area receives its drinking water from the Golden State Water Authority. Potable water for the Rifle Range Complex is trucked in from off site (USMC, 2006). Private wells were previously active north of the range, immediately adjacent to the Nebo Area. The private residences at these locations have been linked to water provided by the city of Barstow, and the wells are no longer used. All off-site wells are located well over 1 mile from the range.

There are no groundwater discharge locations within proximity of the range.

Table 6: Relative Environmental Concern Evaluation (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)										
Surface Water										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Surface Water Pathways	2	8								
Surface Water Receptors	4	8								
Sum of Surface Water Element Scores		29								
Groundwater										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Groundwater Pathways	3	14								
Groundwater Receptors	5	4								
Sum of Groundwater Element Scores		31								
<p>The relative environmental concern evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:</p> <table border="0" style="margin-left: 40px;"> <thead> <tr> <th style="text-align: left;"><u>Environmental Concern Evaluation Ranking*</u></th> <th style="text-align: left;"><u>Score Range</u></th> </tr> </thead> <tbody> <tr> <td>High</td> <td>50-65</td> </tr> <tr> <td>Moderate</td> <td>30-49</td> </tr> <tr> <td>Minimal</td> <td>0-29</td> </tr> </tbody> </table> <p>*Use the Environmental Concern Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.</p>		<u>Environmental Concern Evaluation Ranking*</u>	<u>Score Range</u>	High	50-65	Moderate	30-49	Minimal	0-29	
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Surface Water Environmental Concern Evaluation Ranking		MINIMAL								
Groundwater Environmental Concern Evaluation Ranking		MINIMAL*								
<p><u>Notes:</u></p> <p>* Based on the chemical conditions (soil and groundwater pH between 6.5 and 8.5), depth to groundwater (greater than 100 feet bgs), frequency of precipitation (4 inches/year during short duration, intense storms, which generate rapid runoff), and high evaporation at the Close Combat Pistol Range, the groundwater evaluation ranking is downgraded from Moderate to Minimal based on professional judgment.</p>										

INSTALLATION: MCLB Barstow
LOCATION: Barstow, California
RANGE: Pistol Range
DATE: May 12, 2008

ASSESSMENT RESULTS:

The surface water environmental concern evaluation ranking resulted in a minimal score. Limited precipitation and favorable soil and surface water pH likely limit lead off-range migration. In addition, there are no human receptors and limited potential exists for ecological receptor exposure to lead. On the basis of the SARAP, there is minimal potential for lead migration and impact to surface water.

The groundwater environmental concern evaluation ranking resulted in a moderate score. However, it is the professional judgment of the REVA assessment team that the overall concern for lead migration and exposure to groundwater receptors is more accurately categorized as a minimal level. The groundwater pathway score is biased high by the sandy nature of the soils and the lack of clay in the soil unit. The chemical conditions (soil and groundwater pH between 6.5 and 8.5) and previously sampling data at the Pistol Range indicate that lead migration on this range is limited. In addition, the depth to groundwater and the lack of groundwater receptors in the area likely preclude any significant groundwater impacts. Therefore, the groundwater evaluation ranking has been adjusted to minimal based on professional judgment.

Table 1: Range Use and Range Management (Source) Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Duration of Range Use	Used from 1955 to present.	5 if usage greater than 30 years 3 if usage is 10 to 30 years 1 if usage less than 10 years	5
Bullet-Capturing Technology	No bullet-capturing technology noted by installation personnel or observed by the REVA assessment team.	If [range usage duration = bullet capture duration], then apply a negative score so that the [range usage duration + bullet capture duration] = 1 If [range usage duration – bullet capture duration] = 10 to 30 years, then apply a negative score so that the [range use duration + bullet capture duration] = 3 0 if [range usage duration – bullet capture duration] greater than 30 years	0
MC Loading Rates	Historically, approximately 1,544 lb/yr; recently, approximately 101 lb/yr.	5 if MC loading greater than 1,000 pounds/year 3 if MC loading equals 100 to 1,000 pounds/year 1 if MC loading less than 100 pounds/year	3
Range Maintenance	Only one known occurrence of lead mining in past years.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	5
Source Element Score			13
<p><u>Notes:</u></p> <p>The PRA for MCLB Barstow states that the Pistol Range was established in 1955 (USACE, 2001b).</p> <p>The PRA provides a partial estimate of small arms ammunition expenditures from initial use to 1998 (43 years; approximately 1,544 lb/yr). Interviews with Range Control personnel indicate that approximately 15 percent of the ammunition allocated annually to MCLB Barstow was expended at the Pistol Range. Based on the type of small arms ammunition used at the Pistol Range the current annual lead loading rate was estimated at approximately 101 lb of lead per year.</p> <p>Based on installation personnel interviews, mining of the berm has occurred in the past, though less frequently than once every three years. An environmental assessment has been completed for the future installation of a bullet trap at the Pistol Range. The project has not yet been initiated.</p>			

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
pH of Water	Historically, the pH has been above 6.5. Most recent storm water sampling near Barstow had a pH measurement of 7.8.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Precipitation	Typical precipitation is approximately 4 inches/year.	5 if precipitation greater than 40 inches/year 3 if precipitation equal to 20-40 inches/year 1 if precipitation less than 20 inches/year	1
Slope of Range	Berm slope is greater than 10%, though the range itself is located on a generally flat portion of a larger hillside.	5 if slope greater than 10% 3 if slope equal to 5% to 10% 1 if slope less than 5%	5
Vegetation	The firing lanes and backstop berm generally do not contain vegetation. The areas surrounding the range have a plant density of 10% to 20%.	5 if vegetation cover less than 20% 3 if vegetation cover is between 20% to 50% 1 if vegetation cover greater than 50%	5
Soil Type / Runoff Conditions	Based on the NRCS database, the soils at the firing lines and backstop berms are Cajon Gravelly Sand.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	1
Runoff/ Erosion Engineering Controls	Based on installation interviews and aerial photographs, surface water is prevented from running onto the range by a protective berm south of the range, as well as the rear backstop berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	- 5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

Storm water sampling has not been conducted in recent years, though installation personnel stated that the pH of storm water is generally above 6.5. Water quality data collected from USGS stream gages at Barstow (USGS stream gage 10262500) have field measured pH concentrations above 6.5. One water quality sample at Barstow had a pH of 7.8 (USGS, 2007).

Previous research in various reports and documented in the INRMP MCLB Barstow (Tierra Data, 2005; USMC, 2006).

Observed slope of the berm is greater than 10%. However, the presence of side berms suggests runoff drains across the middle of this range, which is a relatively flat, dirt surface. Observed vegetation consisted of limited patches of grasses, weeds, and scrub. The area surrounding the ranges consists of creosote bush scrub with a plant density between 10% and 20% (USMC, 2006).

Boring logs and geologic cross sections from reports typically suggest the presence of gravelly sands or silty sands at depth (Panacea, 2005). The NRCS soil descriptions document the soil at the Pistol Range as being Cajon gravelly sand, with 2% to 15% slopes. The soils are described as gravelly sands (NRCS, 2002).

Based on observations made during the site visit and interviews with installation personnel, it was noted that the top of the rear impact berm is subtly sloped in a manner that diverts runoff away from the face of the berm. The backstop berm also diverts surface water from running onto the range. Another protective berm is present south of the pistol ranges, which is designed and maintained to divert much of the surface water runoff originating south of the ranges to the north and northeast around the ranges. Together, these were considered partial engineering controls with respect to controlling runoff and erosion.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Depth to Groundwater	Previous studies across the installation suggest groundwater is located between 160 and 210 feet bgs.	5 if depth to groundwater less than 20 feet 3 if depth to groundwater is between 20-99 feet 1 if depth to groundwater is between 100-300 feet 0 if depth to groundwater greater than 300 feet	1
Precipitation	Typical precipitation is approximately 4 inches/year.	5 if precipitation is greater than 40 inches/year 3 if precipitation is between 20-40 inches/year 1 if precipitation is less than 20 inches/year	1
pH of Water	Groundwater sampling suggests pH above 6.5 but below 8.5.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
pH of Soil	NRCS soil data suggest a pH between 7.4 and 8.4.	5 if pH less than 6.5 3 if pH greater than 8.5 1 if pH is between 6.5 and 8.5	1
Soil Type / Infiltration Conditions	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Clay Content in Soil	NRCS soil data describe gravelly sand or silty sand at depth.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Groundwater Pathway Score			14
Notes:			
<p>Installation personnel stated that groundwater-related studies associated with the Nebo main base have found depth to groundwater influenced by the Harper Lake–Camp Rock Fault, as well as storm events. Generally, areas east of the fault (where the ranges are located) have depths to groundwater that fall between 100 and 300 feet bgs. A summary prepared for the landfill cap (1998), located approximately 1.8 miles northwest of the range, indicates groundwater to be 160 to 210 feet bgs; other reports have noted depths up to 175 feet bgs on the alluvial fan south of Interstate 40 near the Rifle Range Complex (Jacobs Engineering, 1997; Tetra Tech, 2003). A well once was present adjacent to the ranges, but no information or data regarding this well were located.</p> <p>Sampling logs for groundwater wells collected in 2003 in the Nebo main base of MCLB Barstow had pH above 6.5. Two laboratory samples had pHs of 7.79 and 7.81 (Tierra Tech, 2003). NRCS soils data suggest a pH between 7.4 and 8.4 for Cajon series soils (NRCS, 2002).</p> <p>NRCS soil series data described the predominant soil type at the Pistol Range as Cajon Gravelly Sand, 2 to 15 percent slopes (NRCS, 2002). Boring logs from surface soil samples collected at the Pistol Range describe the soils as fine to coarse grain sand, with some gravel and cobbles (Panacea, 2005).</p>			

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Drinking Water Usage	The Mojave River is the primary surface water body in the area. It is not used as a drinking water in the area surrounding MCLB Barstow; however, the Mojave River is in connection with the Mojave River aquifer and the Regional aquifer.	<p>10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet), or could move, but is not moving appreciably, toward surface water body used as a potable water supply; or if a designation as a potable water source is unknown.</p> <p>2 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	2
Agricultural or Other Beneficial Usage	Agriculture is not anticipated given the climate, though some grazing may occur on nearby Bureau of Land Management land to the south, which is up gradient of the range. Agricultural farms are located approximately 10 miles east of the installation.	<p>5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural; or other beneficial usage is unknown.</p> <p>3 if contamination in the media has moved only slightly beyond the source (tens of feet), or could move but is not moving appreciably.</p> <p>1 if low possibility for contamination in the media to be present at or migrate to a point of exposure.</p>	1
Sensitive Species Habitat and Threatened or Endangered Species	The desert tortoise is known to be present at the Pistol Range. Designated critical habitat is present south of the range complex. Impact berms and infrequent rainfall are anticipated to reduce access to any media potentially contaminated through active range use.	<p>10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary.</p> <p>5 if potential for receptors to have access to possibly contaminated media.</p> <p>1 if little or no potential for receptors to have access to possible contaminated media.</p>	5
Surface Water Receptor Score			8

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)

Notes:

The Mojave River is typically dry in the vicinity of MCLB Barstow, and surface water is present only during notable storm events. Surface water is not used as a potable water source in the Barstow area.

The desert tortoise is present at the Rifle Range Complex (Tierra Data, 2005). The presence of the desert tortoise is considered in the environmental assessments for construction works at the Rifle Range Complex (USMS, 2006; Department of the Navy, 2004). To protect the Mojave population of the desert tortoise, several desert wildlife management areas (DWMAs) were established. One of these, the Ord-Rodman DWMA, includes approximately 540 acres of the southern portion of the Rifle Range Complex (Tierra Data, 2005). This area is considered critical habitat for the recovery of the desert tortoise. Desert tortoise and their burrows have been identified near the Pistol Range (USMC, 2006). The Ord-Rodman DWMA is up gradient of the Pistol Range; surface runoff flows northward, which restricts exposure of lead in surface water to desert tortoises living within the DWMAs. The off-range exposure pathways considered in the REVA program are exposures to lead via surface water or groundwater. Based on an evaluation of the potential ecological effects of MC conducted for Marine Corps Air Ground Combat Center Twentynine Palms, the desert tortoise is unlikely to be exposed to surface water runoff from the Pistol Range (Malcolm Pirnie, 2007). Therefore, some potential exists for ecological receptors to have access to possibly contaminated media, but it is likely quite limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol)			
Criteria	Justification/Source	Score Criteria	Site Score
Wells Identified as Potable Water Sources	All known groundwater wells used to access potable water are located more than 1 mile from the range.	<p>10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure; or if a designation as a potable water source is unknown.</p> <p>5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably.</p> <p>2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure.</p>	2
Wells Identified for Agricultural or Other Beneficial Usage	No other water supply wells have been identified.	<p>5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure, or if a designation as agricultural or other beneficial usage is unknown.</p> <p>3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but is not moving appreciably.</p> <p>1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure.</p>	1
Sensitive Species Habitat and Threatened and Endangered Species	The desert tortoise is known to be present; designated critical habitat may be found south of the ranges. There are no known springs in the area.	<p>5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p> <p>1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources.</p>	1
Groundwater Receptor Score			4

Notes:

MCLB Barstow groundwater supply wells are also located in the Yermo Annex, on the northern side of the Mojave River. The Nebo Area receives its drinking water from the Golden State Water Authority. Potable water for the Rifle Range Complex is trucked in from off site (USMC, 2006). Private wells were previously active north of the range, immediately adjacent to the Nebo Area. The private residences at these locations have been linked to water provided by the city of Barstow, and the wells are no longer used. All off-site wells are located well over 1 mile from the range.

There are no groundwater discharge locations within proximity of the range.

Table 6: Relative Environmental Concern Evaluation (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)										
Surface Water										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Surface Water Pathways	2	8								
Surface Water Receptors	4	8								
Sum of Surface Water Element Scores		29								
Groundwater										
Element	Table	Score								
Range Use and Range Management (Source)	1	13								
Groundwater Pathways	3	14								
Groundwater Receptors	5	4								
Sum of Groundwater Element Scores		31								
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